DEVELOPING COMPLEMENTARY FOOD PRODUCTS BASED ON CASSAVA AND SWEET POTATO

BY

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1995

DECLARATION

I here by declare that this thesis entitled "DEVELOPING COMPLEMENTARY FOOD PRODUCTS BASED ON CASSAVA AND SWEET POTATO" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship fellowship or other similar title of any other University or society

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Certified that the thesis entitled DEVELOPING COMPLEMENTARY FOOD PRODUCTS BASED ON CASSAVA AND SWEET POTATO is a record of research work done independently by S CHELLAMMAL under my guidance and supervision and that it has not previously formed the basis for the award of any degree fellowship or associateship to her

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INTRODUCTION

INTRODUCTION

Food has to be viewed as national wealth The availability of food has to be ensured to meet the challenge of growing poverty in the country Over the last four decades India has made great strides in the production of food, still there exists a discrepancy in the per capita availability of food One of the main reasons for this is the huge post harvest losses

With the difficulties faced by many countries in obtaining traditional food grains, dependence on tuber crops is gaining importance day by day as a source of food Tuber crops are the third most important food crop and about one fifth of the world s population depends upon these crops as staple or main supplementary food Among the tuber crops, cassava and sweet potato occupy the second and third position after potato in South Asia

Production of cassava is confined to a few states in our country like Kerala, Tamilnadu and Andhra Pradesh Production wise Kerala contributes to about 80 percent of cassava produced in the country (Ghosh 1985) Sweet potato is grown in Orissa, Bihar Uttar Pradesh and Kerala The annual production of cassava and sweet potato is 2 80 and 1 90 lakh tonnes in Kerala (Anon 1994)

In Kerala cassava is a poor man s food, used as a partial substitute for cereals The tuber is mainly a carbohydrate food and can be used in place of cereals partly supplemented it with protein In addition to the starch content sweet potato contains various sugars, minerals and proteins, with all essential amino-acids (Tsou and Hong 1992) It also contains a sufficient amount of carotene The labour input for the production of calories is also less for cassava and sweet potato than for rice, with the result that they are the cheapest source of calories (Ramanathan *et al* 1990)

Both cassava and sweet potato roots deteriorate rapidly after harvest accounting for huge post harvest losses Improved food processing is a way of using valuable supplies of such foods in the most economic and efficient way Processed foods provide the consumers with stuffs that are safe, nutritious and attractive (Thirumaran 1993)

The rapid process of urbanization that is occurring in our country especially in our state, is leading to marked changes in the food consumption pattern A great variety of foods are being incorporated into the diet Besides the increase in the number of working women the number of small and nuclear families is increasing, creating intensifying demands for processed foods

In our state, the situation is disappointing in that the knowledge about processing technologies has not yet developed Processing of novel food items, utilizing the locally available foods will provide the consumers of all strata with a variety of wholesome foods and at the same time increase the profit rate for the farmers and create employment opportunities for the local people

Information of the suitability of cassava and sweet potato for the production of convenience foods is extremely lacking One of the possibilities for cassava and sweet potato flour in meeting the food needs is, partial substitution for wheat flour in baking industries and partial incorporation in developing extruded products They can also be used for the production of various convenience products such as snack items, weaning mixes and ready to eat foods Products developed through partial substitution with these root flours will cost less, which is profitable for the farmer and entrepreneur and at the same time beneficial to the consumers Developing appropriate processing technologies for cassava and sweet potato based products will be a boon to the rural poor in our state because of their immense income generation potential

So far, no attempt has been made to develop technologies for the processing of cassava and sweet potato based products Hence in this study, complementary food products based on cassava and sweet potato were developed and their nutritive value, physiological tolerance, acceptability among different strata of consumers and shelf-life qualities assessed

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Literature available on different aspects related to the present study, Developing complementary food products based on cassava and sweet potato , is furnished under the following headings

2 1 Significance of food processing

2 2 Utilization of cassava, sweet potato and soy bean in processed foods

2 3 Processing extruded and weaning foods

2 4 Acceptability studies on new food products, and

2 5 Storage and shelf life studies of processed foods

2 1 Significance of food processing

All developing nations are struggling eternally to attain self- sufficiency in food Although India has registered impressive strides in the production of food grains, there exists a discrepancy in the per capita availability of food One of the reasons attributed to this situation is the huge post harvest losses which could be prevented by proper processing technologies

Post harvest losses of food can be defined as a reduction in food supply after harvest Once food is harvested, micro organisms, insects and rodents attack it damaging both its quality and quantity (Sree Narayanan 1992) According to Girish (1992), post harvest loss of food is the reduction in food supply brought out either by reduction in weight or by deterioration between handlings Devadas (1992) opines that the major enemy against global development is the post-harvest losses of food She also states that food losses, whether quantitative or qualitative or both, occur throughout the post harvest chain from harvest time to final consumption

According to Chaudhary (1992), post-harvest losses of food occur during different operations like harvesting, transportation, handling, storage and processing

Salunke and Desai (1984) report that seventy-five million tonnes of perishables are produced in our country, but only 0 5 to 1 0 percent of the products are processed, while 25 to 30 percent go as waste due to poor post-harvest technological practices

According to Easwaran (1992), India has been losing food worth Rs 350 crores every year because of the lack of storage facilities and transport bottlenecks The loss of foodgrain is not merely in terms of quantity alone but also in terms of quality She also stresses that over 30 percent of the foodgrains harvested is lost before consumption

Viswanathan (1992) reports that at present the harvest and post-harvest losses are estimated to be ranging between 10 and 15 percent in the case of grains, and 30 to 50 percent in the case of perishables such as vegetables, fruits and tubers

Gogoi (1992) feels that keeping in view the production of food grains, the retention at farm level and the magnitude of losses per annum involve a significant amount of money for a developing country like India

Chandrasekhar (1992) opines that the food losses during post harvest period is a universal phenomenon and combined effort of the farmers Governmental and non Governmental agencies involved in the promotion of post harvest conservation is required to overcome this situation

According to Thirumaran (1992) many regions of the world lack a food processing industry capable of providing an adequate supply of food for inhabitants As far as India is concerned, there is vast scope to improve the food processing industry Food preservation industry has now assumed perennial importance as it assures a stable market to farmers and horticulturists and enable them to expand their production without fear of a fall in demand (Premakumari 1992)

In order to further improve food supplies it is not only sufficient to increase food production, but also to harvest, handle process and store foodstuffs with least possible losses, according to Kumar and Chellappa (1992)

Demand for processed foods is rising exponentially, since consumer food preferences especially in the urban areas are changing rapidly with people becoming more adventurous and unrestrained by cultural or social eating habits In a way the spirit of activity in the processed food industry has been brought about primarily due to the need for convenience demanded by changing life styles (Gitamanian 1987)

Sethi and Maini (1989) opine that because of their immense income generation potential in the rural areas, the World Bank has shown a keen interest in assisting food processing technology in the country

According to Thirumaran (1993) the introduction of locally processed and preserved nutritious ready to-use foods will reduce the time spent in drudgery by the farm women along with income generation and improved nutritional standards She has further reported that Agro horticulture based food processing technologies appear to be appropriate for the rural women to improve their living standards

Food processing technology is a means of extending the food availability during all periods as demanded by the consumers Over the years it has evolved into a modern discipline with high scientific and engineering workout, reports Potty (1993) Walker (1993) feels that food processing will have to play an increasing market role, as demand created both by population growth and by requirement for improved nutrition generates a need for an estimated 60 percent increase in available foodstuffs by 2000 A D

According to Mukherjee (1990), the need for food processing is no more questionable in an agricultural country as foods are highly perishable and most foods are seasonal and the demand is inflexible in nature Food processing by itself can augment food availability not only by preventing wastage but also by indirectly promoting more food production Rao (1990) suggests that with the changed scenario of Indian agriculture with surplus production, a need has arisen for immediate development of needed technologies and to establish agro-processing units in different regions of the country

Purushotham (1990) feels that in a developing economy like India the growth of the agro based food processing industries is significant for several reasons since it helps in generating more employment opportunities and improving the purchasing capacity of the rural poor According to Geervani (1990), food processing industry is not a new field but it has largely remained a big or medium industry located in urban and semi urban sectors She further suggests that more smallscale food enterprises in the rural sector, which can be managed at the village level to promote utilisation of local foods and support employment of women are needed

2 2 Utilization of cassava sweet potato and soy bean in processed foods

In today s food scenarios, root crops are of economic and nutritional importance Today, potatoes are grown in more than 125 countries Cassava and sweet potatoes are grown in around 100 countries and yams and cocoyams are grown in about 50 countries Cassava, sweet potatoes and potatoes are reported to be the three most valuable food crops grown in developing countries (Ghosh 1985) He also points out that starchy tubers such as cassava, sweet potato and potato constitute a substantial part of the agricultural production of developing countries

Starchy root crops which are the least expensive sources of calories could play an even more important nutritional role, if they were not so perishable The biggest constraint in limiting the utilisation of cassava and sweet potato itself is their short life

Carlos and James (1977) have reported that cassava roots deteriorate rapidly after harvest and the post harvest loss may be due to physiological or micro biological attack

Onwume (1978) has studied the deterioration of cassava tubers within a day, soon after it is harvested the tuber begins to deteriorate and tuber loss occurs

According to Raja *et al* (1978) and Padmaja and Balagopal (1984), cassava tuber has an extremely short storage life The spoilage of cassava tuber has been found to occur at two distinct stages The first is the formation of bluish black streaks followed by microbial spoilage leading to tuber loss

Tanaka *et al* (1983) reviewed the deterioration of cassava roots and found that deterioration of roots occurs both in quantity and in quality

According to Data and Eronico (1987), sweet potato tubers after harvest are perishable and metabolically active and hence their shelf-life is comparatively low

Sweet potato roots being perishable staples, remain metabolically active after harvest resulting in weight loss shrivelling decay and sprouting, report Siddique and Rashid (1988)

Datta and Opario (1992) opine that keeping sweet potato in good quality and as acceptable for human consumption after harvest is a major problem and the high perishability of fresh roots greatly limits their market flexibility

Padmaja (1990) has reported that sweet potato tubers cannot be normally stored for more than one month without deterioration in its nutritional quality

Prasad *et al* (1981) recorded tuber loss in sweet potato due to rot after the first week of harvesting The rot was initially confined to damage tubers alone whereas in undamaged tubers signs of rot were observed in the second week causing huge post harvest losses

Perishability of such staple foods stresses the need for the utilization of tuber crops in processing industries

Cassava

Cassava otherwise known as tapioca is the fifth important staple food in the world (Phillips 1974)

According to Coursey (1973) it is more closely identified as a subsistence crop Cassava s centre of origin is Tropical America

In India the cultivation of cassava is centred around the State of Kerala since this state constitutes 80 percent of the total acreage and production of the crop in the country It is a poor man s food crop and is used as a partial substitute for cereals (Ghosh 1984)

Cock (1985) feels that cassava produces four times more carbohydrates than rice from the the same area Since it is mainly a carbohydrate food, it can be used in place of cereals partly supplemented with protein According to Padmaja (1980), cassava is used as a primary and secondary staple by about one fifth of the world population of the low income group of the tropical countries

Poulose *et al* (1984) state that the increase in population and decrease in production of rice have made cassava an important food item in Kerala From the point of view of food energy output versus labour input, cassava is reported to be very efficient (Chandra *et al* , 1974)

According to OnWume (1978) cassava as food industrial raw material or animal food is important in many tropical countries Cassava is responsible for the supply of 38 percent calories in African diets, 12 percent in Latin American diets and 7 percent in the diets of the Far East countries (Maharana 1980) Cassava or tapioca is an important tuber crop cultivated in the tropical and sub tropical regions of the world and it forms the staple food of more than 30 million people all over the world (Karuna *et al* 1987)

Cassava is extensively used as food and the starch manufactured from it is being used in the food and textile industries and also in the manufacture of sago The importance of cassava as food was best realised during the Second World War when it helped to reduce the food shortage (Swaminathan 1984)

Maini *et al* (1987) has pointed out that dried cassava was found to contain 82 09 percent carbohydrate, 2 01 percent salts and 1 05 percent protein Jacob (1985) in her study on the nutritive value of tuber crops has observed that cassava starch was found to contain 20 per cent amylase and

80 per cent amylopectin and had a digestibility of 48 per cent in the raw state and 78 per cent when cooked

The protein content of cassava is low even though the protein contains all the essential amino acids The starch content ranged from 78 1 to 90 1 per cent on dry basis The protein content of cassava was reported to be as low as 1 6 to 2 6 per cent (Anon 1975) Meera (1985) also feels that cassava is nutritionally very much inferior to other cereals due to its low protein content

Bradbury (1990) in his study on the chemical composition of tropical root crops and its implication for nutrition has found out that cassava is a good source of phosphorus and a fair source of calcium and iron

According to Kays (1990) cassava contains a large number of volatile compounds but their concentration is normally very low

Emilia Abraham *et al* (1979) have studied the physico chemical and processing characteristics of five selected hybrid varieties of cassava and found considerable difference among them

In India, cassava is traditionally processed into several products Nair (1976) has stated that, in India, cassava is used as fresh root, as chips and flour

Gari made from fermented cassava is a staple food in many parts of West Africa Watts (1980) states that many gari producing plants were installed in Nigeria because of its world wide importance

Larty (1984) reviewed the importance of gari and of the different improved small processing equipment and machines which are in use or can be used for making gari

The method of processing and the protein quality of gari-based weaning foods were explained by Prema and Chellammal (1986) in their study on developing weaning foods based on fermented cassava

Yosh and Garcia (1979) have studied the suitability of cassava flour substitution in the preparation of puttu

Palomer *et al* (1980) report that based on cost analysis, root crop flour is a good substitute for wheat flour and substitution of wheat flour (20 percent) with cassava flour in bread making is explained by them

The acceptability as well as nutritional significance of cassava chappathis was studied by Chellammal and Prema (1994) in their study on nutritional enrichment of cassava flour

Thampan (1979) has reviewed the different types of cassava chips available in Kerala and their usage in the diets of Keralites Prema *et al* (1982) have developed different recipes based on fresh cassava and cassava chips

Pillai (1990) explains the utilization of cassava in food items like rava, which could be used as a breakfast item, and vattal which can be used as a snack item

Different types of pickles were processed and their acceptability and shelf-life were studied by Prema and Chellammal (1986) The feasibility of developing macaroni based on cassava was also studied by Chellammal and Prema (1993)

The possibility of incorporating cassava flour into some traditional Kenyan foods was studied by Imungi (1990) and he found out that, cassava flour upto 50 per cent could be incorporated in the recipes

Ajibola (1990) has explained the methods of processing of fermented cassava and its utilization as food, in his study on the development of a new process line for gari production

Eldash and Chang (1990) view that improving cassava-based products and relevant technology as well as developing new products will be the cornerstone of a decisive programme to meet today s food demand

Sweet Potato

Sweet potato is one of the five most important crops in terms of production, economic value and contribution to calories and protein Although it originated in America sweet potato is now an Asian crop (Mackay 1989)

Sweet potato occupies an area of about 9 3 million hectares spread over more than one hundred countries and produces about 135 million tonnes of tubers (Anon - 1987)

In India sweet potato is grown throughout the country occupying an of area about 158 thousand hectares with a production of about 1279 thousand tonnes (Anon 1989) and the annual production of sweet potato in Kerala is 19951 tonnes from an area of 2457 hectares (Anon 1994)

According to Onwueme (1978), sweet potato is an important staple for many tropical countries Sweet potato is much more important than cassava in Asia because more than 90 percent of the world s sweet potato is produced in these countries as reported by Bradbury (1990)

Tsou *et al* (1989) feel that this crop has many desirable characteristics for consumption, such as high yielding potential, wide adaptability, multi-functional usage and a wide range of nutritional composition

Truong (1989) feels that the consumption of sweet potato for food, however, is inversely related to the income levels of the population He also states that though sweet potato has been consumed in many parts of the world for centuries yet it remains a survival food or food of the poor

Tsou and Villareal (1982) suggest that the increase in the availability of food and probably a better standard of living must have caused a discrimination against eating sweet potato According to Kabeerathumma (1990), among the roots and tubers, sweet potato is one of the highest yielding crops and has been cultivated and consumed as an important source of food in many countries

Tsou (1989) explains that in most developing countries, the primary use of sweet potato is for food

According to Pillai (1990), sweet potato occupies the second and most important place in the tropics next to cassava

Jairth *et al* (1990) have observed that the cultivation of sweet potato is spread widely in all States in India mainly in Orissa, Bihar and Uttar Pradesh Kanua and Rangat (1989) have reviewed the importance of sweet potato as a major food crop, particularly in densely populated high lands in tropical countries

Bradbury and Halloway (1988) have reviewed the chemical and nutrient composition of sweet potato with reference to energy protein fibre, carotene and other vitamins present in different varieties Dayal (1990) feels that sweet potato plays a very important role as staple food because of its high nutritive value and greater energy production Tsou and Hang (1992) fully agree with this and according to them sweet potato has got a significant amount of energy, dietary fibre, minerals and vitamins

According to Rhodes and Horton (1990), sweet potato contributes significant amounts of essential dietary vitamins and minerals It is a good source of ascorbic acid in which the cereals are deficient

The most important constituent of sweet potato is its sugar content, observes Maini (1976) Lila and Nambisan (1990) found that the percentage of reducing sugar constitutes 0 85 to 6 00 percent of tuber by dry weight According to Nair (1976) sweet potato is a good source for starch Moorthy and Balagopal (1985) also express that the root is a good source of starch

The vitamin content with special reference to carotene of the tuber was discussed by Broadbury (1990)

Jose *et al* (1990) have clarified that the dark orange flesh colour of tuber is associated with its carotene content Goswami (1990) has reported that the carotene content in sweet potato ranged from 0 30 to 7 20 percent in different varieties According to Tsou and Hang (1992) the fleshed variety of sweet potato is the rich source of β Carotene Lu *et al* (1986) and Woolfe (1988) have stressed that sweet potato is a good source of ascorbic acid According to Grant *et al* (1992), phosphorus and potassium are the major minerals present in sweet potato with a modest amount of iron magnesium and calcium

Hill *et al* (1992) feel that the auto-oxidant nutrients, beta carotene ascorbic acid and tocopherol in sweet potato have a protective effect According to Kays (1992), the fibre content in sweet potato could play an important role in decreasing blood cholesterol level

Kays (1990) feels that in sweet potato amino acids, related nitrogen containing substances and sugars are known to be the major components in the taste perceived

According to Truong (1989) a reduction in sweet potato consumption in a number of Asian countries has been noticed in the past two decades, and strtagies to increase consumption should be identified through extension of its present utilization and development of new food products

In various parts of the world sweet potato is boiled or cooked with rice and served as staple food The crop is also prepared into fried chunks, chips (Al Kuno and Truong 1987) and French fry type product (Walter and Hoover 1986)

Edmond and Ammerman (1971) have reported the processing of commercial food products such as flakes and canned and frozen items from sweet potato Technology for the processing of sweet potato chips has been reported by Tam (1985) In Peru, sweet potato flour is a common item in grocery stores and used for many preparations, as reported by Martin (1984) While Data *et al* (1986) reveal that sweet potato flour can totally replace wheat flour in Soy Sauce production

To extend the utilisation of sweet potato in urban areas, ready to cook products such as dehydrated shredded sweet potato was developed by Siki (1979) Processing of dried sweet potato cubes has been reported by Truong *et al* (1990)

The method of processing dried, sweet and sour sweet potato has been discussed by Truong (1984) Likewise, the method for the preparation of sweet potato catsup has been explained by Truong *et al* (1986)

The preparation of sweet potato jam has been discussed by Truong (1989) A process of producing non-alcholic beverage from sweet potato with taste and appearance similar to those of commercial fruit drinks has been pioneered by Troung and Rosario (1986)

The technology for the processing of dehydrated sweet potato cubes and its utilization in various preparations have been discussed by Troung *et al* (1990) Seralathan and Thirumaran (1990) were successful in the incorporation of sweet potato flour into various traditional South Indian dishes and baked products

Bouwkamp (1985) reviewed the use of sweet potato starch as the raw material for the preparation of candy drops, icecream, sausage, jams, bread, biscuit, cake, and juice

Walter *et al* (1990) state that sweet potato is one of the eight crops being studied by the U S National Aeronautics and Space Administration for production as a food source for controlled ecological life support system

Moorthy (1990) and Padmaja *et al* (1991) have developed new recipes from sweet potato Nayar and Rajendran (1988) have pointed out the utility of sweet potato flour as a supplement to cereal flour in bakery products

Woolfe (1992) and Zozima (1992) have opined that since the price of sweet potato is several times lower than wheat flour, it could be used in bread making

The utilization of sweet potato flour for the preparation of noodles, baby foods, pies and a range of other products in China has been reported by Ono and Hirano (1992)

2 2 3 Soybean

According to Nelson and Wei (1987), the need for high protein and calorie foods for home preparation by low income people all over the world is great Goranov (1989) and Manickam (1992) feel that in solving the protein supply problems, the criteria applied should not only be protein quality but protein of animal origin should be replaced partially or fully with pulses Soybean occupies a key position in this aspect and also in the economic effectiveness in cereal and forage grain utilization Although the use of soyprotein is still relatively small, many of the major food companies are now incorporating them into some of their products (Walter 1990) He also feels that one of the major constraints in the availability of soy based foods is lack of simple low cost technologies at small industry level to prepare products similar to traditional foods

According to Jayalakshmi and Neelakantan (1988), soybean and its products have become increasingly popular but a large section of the population in India is still not aware of the food value of soybean

Varma *et al* (1987) feel that the lower cost of soyprotein when compared with milk, meat and fish, is the most favourable point, in utilizing soybean in human food preparation As a protein source, soybean contributes two-thirds of world s consumption of protein grains It is also the major source of oil providing for one third of the world s consumption by man (Goronov 1989)

The demand for soybean products is consistently increasing in India as they have a great potential in solving the food shortage created by ever-expanding population (Gandhi *et al* 1985)

According to Natarajan (1989) soybean is currently the largest commercially available vegetable protein source in most parts of the world

Brand and Label (1988) feel that defatted soy flour contains 50 percent protein, unmatched by any other known vegetarian sources Easter (1981) also feels that defatted soy flour contains two times as much protein as in dal, three times as much as in eggs, and 15 times as much as in milk

The increased protein, ash, fat and calorie contents in soybean-incorporated blends were recorded by Jayalakshmi and Neelakantan (1988) Seralathan *et al* (1989) have observed that soy flour had 85 00 percent acceptability Rao and Prasannapa (1989) found that the hardness of expanded soy dhal is comparable to the hardness of the roasted groundnut kernel Improvement in the protein quality and lysine content by the incorporation of soy flour in a weaning food is reported by Cheryan and Tarur (1992)

According to Jimbu (1990), the quality of Vitamin A is low in soybean, but the Vitamin is present to a level of 1 4 meq/g and prevents the oxidation of fatty acids A fibre content of 9 90 g, ash 7 52 g, and protein 53 54 g in soy flour was reported by Raunet *et al* (1992) It was also found that soy fibre contains 20 to 23 percent soluble fibre which could help in controlling cholesterol

Kauffman (1987) feels that soybean products suffer from objectionable beany flavour and this has to be overcome by extensive studies

Tandon and Sing (1987) feel that soy flour can be incorporated in various food preparations Its use in bread, biscuits, chappathis, snacks and textured products has been successfully demonstrated by them Incorporation of defatted soy flour in such products has also been demonstrated by Sushma *et al* (1979) and Chauhan and Bains (1988) Soy flour-incorporated cassava chappathi as well as its acceptability was successfully demonstrated by Prema and Chellammal (1986)

Singh and Chauhan (1989) found that equally acceptable noodles of better nutritional value can be manufactured by supplementing of semolina flour with 10 percent defatted soy flour

Thirumaran and Seralathan (1989) conducted a study to incorporate whole and defatted soy flour at 10,20 and 30 percent levels for the manufacture of vermicelli It was found that incorporation of defatted soy flour for the extrusion of vermicelli was feasible at 30 percent level with increased nutritive value The successful incorporation of soy flour in extruded products was also reported by Lunine *et al* (1992)

The feasibility of incorporating soy flour in extruded food macaroni as well as its acceptability was studied by Chellamal and Prema (1993) Chopra *et al* (1984) have prepared an acceptable yoghurt-like fermented product from soy milk Seralathan *et al* (1987) prepared South Indian recipes with soy bean, like soy milk and vadai and both were found to be acceptable

Jayalakshmi and Neelakantan (1987) found that soy flour could be incorporated with sorghum flour upto 50 percent level for making deep fat fried products like methupakkoda and murukku For the preparation of puttu, laddu, sevai, uppumav and roti soy flour could be blended with sorghum flour upto 30 percent level Gandhi and Ali (1987) developed a simple technology for making soy paneer at home level which involved cleaning, splitting and soaking of soybeans, wet grinding extraction of soy milk, and precipitation of protein with coagulants

The feasibility of incorporating soy flour in weaning foods based on fermented cassava flour was studied by Prema and Chellammal (1986) It was found that the nutritive value could be considerably increased

The successful incorporation of soy flour in the development of weaning foods was also reported by

Easthan *et al* (1978), Ralda and Wei (1980), Kapoor and Gupta (1981), Gupta and Kaur (1982), Prasad (1988), Philip (1988), Subbulakshi (1990), Ashturkar (1992) and Mugula (1992)

2 3 Processing of extruded foods and weaning foods

Extruded foods

There have been unceasing efforts to develop more and more effective methods of cooking, since man first found that heat could be used to his advantage Extrusion may be defined as the process by which moistered expansible starchy or proteinaceous materials are plasticized in a tube by a combination of pressure heat and mechanical shear (Vaidehi 1922) A wide range of products with different textures, forms and densities can be prepared through extrusion cooking The utilization of extrusion technique has grown at a rapid pace throughout the food industry Extrusion appears to have great promise in less developed nations whereas ready supply of nutritious, low cost preserved foods is an urgent necessity to solve the existing food problem

In today s food processing scenario, extrusion is gaining much popularity According to Williams *et al* (1977) extrusion is a very versatile process They feel that it possesses large production capacities requiring less labour than any other system and limited floor space

Extrusion causes practically no harms to protein quality and results in the destruction of growth inhibitors (Janson *et al* , 1978 and Wolfe *et al* , 1978)

According to Smith (1979) snack foods pre-cooked flour, flakes and other cereal products could be processed through extrusion Payumo *et al* (1979) feel that weaning foods could be processed by extrusion Because of its versatility, efficiency, flexibility and ease of obtaining products and economy of space and labour, it is superior to conventional processing (Linko *et al* , 1981) Cheftal (1986) opines that extrusion has become a well established industrial technology with a number of food applications

Nierle *et al* (1980) feel that the starch constituents in cereal or legume flours may be more readily hydrolysed than in purified starches because of endogenous amylase activity during the initial extrusion steps

Linko *et al* (1981) report that complete starch gelatinization is achieved during extrusion provided with high shear and temperatures during extrusion

According to Zenthen *et al* (1984), extrusion depends on the number of mechanical and thermal processing steps taking place in the screws and barrel, the high shear and pressure exerted on low moisture food mixes

Harper and Jansen (1985) states that, based on the gelatinization and partial hydrolysis of starch, extrusion is used to produce flours and starches with a whole range of functional and rheological properties of pre-cooked flours of reduced viscosity, and increased solubility permit the preparation of higher concentration and caloric density

Cheftal (1986) reviewed the beneficial changes in the bioavailability and in the content of nutrient which may take place during extrusion

Tsou *et al* (1976) studied the qualities of rice sphagetti prepared by extrusion of commercial white rice and compared it with conventional sphagetti prepared from durum semolina It was found that rice sphagetti required a shorter cooking time than conventional sphagetti, but was less tolerant to excess cooking The cooked weight and cooking loss for both sphagetti increased with increased cooking time but the flavour of conventional sphagetti was better than that of rice sphagetti

Mosqueda *et al* (1986) observed a decrease in gel viscosity of the rice flour without reduction in the amylase content of rice by extrusion cooking of batters at 15 percent moisture and at 120 - 150 ^{o} C in twin screw extruder Eggum *et al* (1986) reported that extrusion cooking in a twin screw extruder of milled rice batter of two rice varieties at 15 percent moisture and at 120 - 150^{o} C reduced the total lysine content

Last (1979) studied the suitability for texturing by thermoplastic extrusion of vital wheat gluten and its blends with legume and oil seed proteins while Indrani *et al* (1987) studied 44 samples of durum wheat cultivars for the chemical milling and vermicelli quality characteristics A wide variation in the cooking quality could be observed The dough consistency, appearance and texture of cooked vermicelli, water uptake and gruel solids loss were studied

Lorenz *et al* (1975) extruded whole triticale kernels and found out that acceptable products could be produced at 20 percent initial moisture using either a small nozzle and operating at 350^{o} F or a large nozzle and operating at 400^{o} F

Beetner *et al* (1974) also studied the extrusion properties of triticale kernels Bakshi and Barains (1987) studied the noodles quality of improved durum wheat cultivars and found that certain varieties were outstanding characterised by pigment content and gruel clarity

Seiler (1974) used samples of corn to study the effect of various pre treatments at different temperatures on the milling characteristics of the grain and the extrusion characteristics of the resulting grits The particle size of the grits tended to increase with increasing steaming temperature resulting in deterioration in the appearance, colour and texture of the extrudate

Seiler (1976) studied the effect of temperature, particle size and screw speed on the extrusion characteristics of the quality of corngrits-based snacks and found that certain maize varieties were suitable for the manufacture of extruded products

Kumar *et al* (1978) studied the expansion index bulk volume and water absorption index of maize legume flour blends These changes are attributed to an increased protein content in the composite flours and to a slight reduction in starch

The effect of soy and cotton seed fortification on the nutritional characteristics, storage stability, flavour and colour of sorghum was determined by Walter *et al* (1977) Protein efficiency ratio was significantly by higher in blends of sorghum meal with 25 percent defatted toasted soy All combinations stored in different temperatures for different periods displayed adequate stability as measured by changes in available lysine, rancidity and flavour

Conversion of sucrose molecules into glucose and fructose permitting maillard condensation during biscuit processing through extrusion was reported by Noguchi *et al* (1982)

Nielson (1976) reports that extrusion cooking of full fat soy eliminates heat labile growth inhibitors and beany bitterness in soya

Cheftal (1986) reported a decrease in the nitrogen solubility index and trypsin inhabitor inactivation upto 70 to 95 percent when the defatted soy flour and corn soy blends were pre-cooked in a single screw extruder An improved PER of 2 15 was recorded in the product The growth of domestic animals on nitrogen balance was also found to be effective

The nutritional quality of rice, ragi and defatted soyflour blends as affected by extrusion was studied by Dublish *et al* (1988) Extrusion resulted in the inactivation of trypsin inhibitor activity The losses of the available lysine content varied as per temperature The PERs of the processed rice, defatted soyflour, rice and ragi, and defatted soyflour, and defatted soy flour blends, were 2 61, 2 41 and 2 23 respectively

The extruded variables on physico-chemical properties of extruded rice legume blends were studied by Chauhan and Bains (1988) It was found that the physico chemical properties altered to a great extent

The texture of the extruded soy bean products was found good by Vandor Ven (1975) and incorporation of extruded soya and cotton seed in traditional and popular foods was studied by Gutirrez (1979)

However, Sing and Chauhan (1989) found out that noodles from the blends of durum semolina and acstirum flour with defatted soy flour exhibited harder texture as compared to those prepared from acstivum semolina defatted soy flour blend Higher water soluble nitrogen and available lysine contents were observed in noodles prepared from the blends containing defattted soy flour

A low cost extruded powdered infant formula made from soy bean, oats and sucrose fortified with methionine, vitamins and minerals was developed by Valle *et al* (1981) The product was of good microbiological quality and dispersed readily in water to give a milk-like suspension The nitrogen balance studies conducted indicate its adequacy as an infant formula

The protein digestibility and nitrogen balance of commercially available texturised vegetable protein was studied by Abid *et al* (1981) and Elias *et al* (1984) In rats the PER of commercial soy TVP ranged from 1 5 to 2 4

A process was described by Atkinson (1974) for preparing expanded food products by the extrusion mixtures of solvent extracted oil seed protein concentrate

Commercial defatted peanut flour was analysed for texturization by Agullera *et al* (1980) Functional properties of the extrudates, such as water retention, hardness and product integrity, were similar to those of textured soy protein

Abid *et al* (1981) texturized defatted peanut flour and found that texurization did not have any significant effect upon the amino acid pattern and PER of the flour

Bjorck *et al* (1994) found out that severe extension cooking of wheat flours caused an apparent increase in dietary fibre due to the formation of amylase resistant starch fractions, and extrusion cooking of white wheat flour was found to cause a redistribution of insoluble dietary fibre

Extrusion cooking results in denaturation of the protein components were reported by Smith (1979) The soluble protein was broken down to form insoluble protein fractions

The effect of extrusion on protein availability was studied by Beetnur and *et al* (1974) They found that there was an overall 32 percent loss of lysine after extrusion of a cereal mixture Tsao *et al* (1976) reported that glucose molecules from disrupted starch accelerated lysine destruction

Mega and Sizer (1979) reported that there were significant losses in free amino acids during extrusion of potato flakes, especially at high temperature

Mega (1978) reported that extrusion at 155^{o} C resulted in the conversion of approximately 1 percent of unsaturated fatty acids to trans-fatty acids, while at 171^{o} C the value increased to 1 5 resulting in the formation of a relatively low level of trans fatty-acids

Cheftal (1986) feels that low liquid level facilitate steady extrusion and improve the texture Most extruded cereal foods contain less than 6-7 percent lipids immediately after extrusion

Beetner *et al* (1974) studied the destruction of thiamine and riboflavin during extrusion The average retention of B_1 was 54 percent and that of B_2 was 92 percent Maga and Sizer (1978) determined the retention of ascorbic acid and thiamine in potato flakes extruded under varying conditions

Lee *et al* (1978) studied the stability of Vitamin A and carotenoids in extrusion cooking There was only 30 percent retention Berset *et al* (1984) studied the stability of carotenoid pigments during extrusion and storage and reported that carotenoid resisted extrusion fairly well but was oxidized during storage

A reduction of 13-35 percent in the phytate content after extrusion was reported by Anderson *et al* (1981) Polon and Glasiue (1978) reported some newly developed flavourings resistant to high extrusion temperatures, since flavouring before extrusion generally result a in flavour loss change

Weaning foods

Weaning is a crucial event in the life of an infant Wharton (1980) reported that use of foods inadequate in nutrients can produce under nutrition syndrome in infants According to Devadas (1983) suitable weaning foods should be introduced to complement breast milk during the first year of life

Protein calorie malnutrition has been an important cause of infant and child mortality in many developing countries and consequently major emphasis was placed on the processing and utilization for protein rich raw material for child feeding (Subramaniyam 1980)

According to UNICEF (1985) many attempts have been made by Government, international organisations and commercial enterprises to manufacture and market foods which provide a balanced weaning food the child needs at a cost which the mother can afford From the point of view of customs, practice, feasibility and cost, it is obvious that it would be most convenient for the mother to feed the infant on early modified diet (Devadas 1983) She has also explained the easy adaptations of normal Indian meals to suit the child s need

The volume/high viscosity characteristic referred to as dietary bulk makes it difficult for small children to fulfil their energy requirement This is considered a major factor in the development of malnutrition in areas where cereals and starchy staples are the main foods (Thirumaran 1993)

Desikachar (1980) and Mosha and Sumberg (1983) have reported that adding a small amount of germinated grain to cereal gruel produces a remarkable reduction in viscosity and the energy density can be increased while an acceptable low viscosity is maintained

Helstrom *et al* (1981) reviewed the dietary bulk as a limiting factor of energy and nutrient intakes of children

Peadersen *et al* (1989) feel that all germinated cereals have potent liquefying potential due to the presence of amylase The dietary bulk is primarily related to the starch content of the diet rather than to the content of the dietary fibre He also found out that the capacity of weaning gruels to meet the protein and energy requirements of infants depended on their dietary bulk as well as their nutritional quality

A malted RTE mix with ragi, green gram and groundnut was developed by Tajuddin (1981), who found that the mixture was superior to roasted RTE mixes in meeting the calorie deficit

Pandya (1982) processed five malted mixes based on the locally available cereals and oilseeds and a high consumption of calorie was observed

A study was undertaken by Nayak (1983) for obtaining the most suitable roasted and malted proportion in weaning mix with substantially reduced viscosity as compared to the roasted one A higher intake of porridge was observed with reference to malted mix

Gandhi (1985) developed a weaning mix based on malted bajra and rice and found out that 4g of malt mix to 100g rice gruel could substantially reduce bulk density

Kapoor (1986) found malted maize based weaning mix to be highly acceptable among tribal children Chaudhary (1986) developed jowar-based weaning mix with added malted jowar flour The bulk density was reduced to a great extent and consumption was considerably increased

Sago-based weaning mix developed by Kurani (1981) with added wheat amylase-rich food He has found out that it can easily be used to achieve better young child feeding within the economic constraints of poor communities John (1989) found out that jowar-based Amylase-rich food could considerably reduce the bulk density of sago-based weaning mix

Parveen (1990) developed malted red gram-based weaning mix and claimed that the technique was simple, inexpensive and adaptable at both household and commercial levels

Copaldas *et al* (1975) has developed a weaning food called Poshak The main ingredients were cereal, pulse, oilseed and jaggery in the proportion of 4 2 1 2

Chandrasekhar *et al* (1976) had developed KIF (Kerala Indigenous Food) which included tapioca, rava, soya-fortified bulgar wheat (SFB) and ground nut flour

Inamder (1981) had developed malted and roasted, powdered multimixes of staples, viz , wheat, bengalgram and ground nut in ratios of 4 1 2, 8 1 1 and 8 1 0 respectively

Changari *et al* (1983) developed a weaning food with wheat flour and peanut flour, while Prasannappa and Jaganath (1985) formulated a highly acceptable weaning food with wheat, maize, groundnutmeal, chickpea dal and unrefined sugar

A weaning mix based on wheat, bengalgram and ground nut was developed by Gopaldas *et al* (1982) while weaning foods based on malted wheat, bengalgram, roasted ground nuts or gingelli seeds were developed by Solanki (1986)

Venkat Rao (1976) formulated a weaning food with rice flour, barley flour, roasted groundnut cake flour, roasted bengalgram flour, hydrogenated groundnut oil, common salt, calcium carbonate ($CaCo_3$), tricalcium phosphate, vitamin premix and protein

Bushra *et al* (1983) developed a protein-rich weaning mix with rice, wheat, chickpea, milk and drum-stick leaves

Roman *et al* (1987) developed a weaning food based on rice, cowpea and milk powder Their experiments revealed that the protein quality of the developed weaning food was good

Four weaning foods based on raykeera, greengram, bengalgram dhal, bajra, rice flakes jowar and soy bean were developed by Ashturkar *et al* (1992) The developed weaning foods were reported to supply 349 to 362 K Cals and 12 6 to 17 2 g of protein per 100 g

An infant weaning food, soy bean - banana food bars, was developed by Ralda and Wei (1980) A soy whey weaning food, constituted by grinding the soy-whey mixture, oil and oil soluble vitamins, was standardised by Kapoor and Gupta (1981)

Prasad (1988) developed a weaning food of high biological value based on banana flour which was supplemented with different proportions of food articles such as sesame, horsegram, and skim milk powder

Philip (1988) developed a weaning food based on ragi flour which is nutritious low cost and acceptable In a study by Chandrasekhar *et al* (1988) a formulation was prepared from malted ragi, malted horsegram and roasted groundnut in the proportion of 65 25 10

Malted ragi and greengram-based weaning food was developed by Mallashi *et al* (1989) They also studied the packaging and storage possibilities of the developed weaning food

2 4 Acceptability studies on new products

Efforts in product development and testing cover a broad spectrum The new product should be evaluated carefully

Scientific methods of sensory analysis of food are becoming increasingly important in evaluating the acceptability of the food product When the quality of food is assessed by means of human sensory organs, the evaluation is said to be sensory analysis Sensory analysis of food relies upon evaluation through the use of our senses only, by applying exact scientific testing methods (Skelton 1984) Clement *et al* (1989) feel that sensory evaluation can be used to predict the consumer acceptance of a food item

According to Mc Dernott *et al* (1992), sensory method in which palatability is evaluated by a panel of judges is essential to every standardisation procedure because they answer all important questions of the food tastes, smells, looks and feels

Osnabrugge (1988) opines that taste testing should never be overlooked since it can guide recipe developers in creating products that have a greater appeal for the intended audience According to Rose (1987), success with products is highly dependent on careful evaluation of products and their potential in the generation

Mc Laren (1984) opines that the criteria included in food quality system are general acceptance, taste, appearance, texture and aroma of food

According to Ylimaki *et al* (1989) sensory analysis is a multidisciplinary science that uses human panelists and their senses to measure the sensory characteristics and acceptability of food products It is applicable to product development and quality control A sensory panel must be treated as a scientific instrument to produce reliable valid results

Acceptability of extruded and weaning foods

Rao *et al* (1975) conducted acceptability trials with ready-to-eat extruded foods on pre-school children and found that the food was acceptable to them

The acceptance of soya based snacks and textured proteins has been successfully demonstrated by Hoover (1974)

Tandon and Singh (1987) studied the acceptability of soya-incorporated extruded products Statistical analysis of consumer acceptability data revealed that addition of defatted soy flour upto 15 percent in the product did not bring any significant difference in their overall acceptability

A nutritional evaluation of sorghum blended with soy or cotton seed by Janasan *et al* (1978), revealed that the P E R of the blend with soya was comparable to Casein while that of sorghum with cotton seed was significantly lower than with casein

A study was conducted on extruded chickpea and cereal blends containing chick pea (44 per cent), cereal (44 per cent), non fat milk (10 per cent) and vitamin mineral (2 per cent) blended with wheat sorghum, which gave P E R equal to casein while the blend with corn gave lower P E R than with casein (Anon 1978)

The quality of glandless cotton seed flour compared to soy bean prepared in the same way was assessed by Rouanet *et al* (1992) P E R B V and N P U demonstrated a good intrinsic nutritional quality for cotton seed protein when compared with casein and soy bean

Sevian was processed with colocasia mass by Manar *et al* (1991) The organoleptic studies conducted revealed that the products were highly acceptable to the panel members

Inamdar (1980) conducted acceptability studies on weaning mixes based on malted and roasted cereal and legumes The study revealed that fully malted and fully rated mixes were well accepted by the children

The study conducted by Pandya (1982) on the acceptability of five malted mixes based on locally available cereal pulse and oilseeds revealed that there was no significant difference in the acceptability of the different mixes

The acceptability of Bajra malt was evaluated by Gandhi (1985) Three days acceptability trials of 10% hot paste gruels of rice flours with and without malt were conducted on 30 toddlers The results showed that children preferred gruel with malt Gopal Das (1988) and Mosha and Svarberg (1989) found out that weaning mixes based on locally available cereals with the addition of A R F were acceptable to children, owing to reduced viscosity

Reddy (1990) found out that four weaning mixtures formulated using local foods and traditional processing techniques were highly acceptable to children and their mothers even after a storage period of one month

2 5 Storage and shelf-life studies

A stochastic relationship is existing between the quality changing and the packaging of foods The mechanism and the kinetics of food deterioration is controllable by storage and packaging techniques It can be stated that the physical, chemical and micro-biological effects can influence it (Varsanyl 1993)

According to Bhattarjee and Bhole (1984) food packing and storage is the vital step to ensure product quality because it provides protection against deterioration and damage during storage transportation and distribution The criteria for quality in packed food products include availability of wholesome clean unadulterated food items with minimal losses during transport hygienic conditions and a reasonable price for the consumer

The same authors studied the keeping quality of wheat in different packaging materials and recommended that it could be stored safely in polythene bags for a period upto 35 days in polythene impregnated jute bag upto 21 days, and in jute bags only upto 14 days from the standpoint of insect infestation and the development of free fatty acid in stored wheat flour

Venkatesh *et al* (1984) studied the effect of heat treatment and addition of antioxidants to extend the shelf life of balahar It was found that exposure of balahar to 100^{o} C for 10 minutes protected the material against free fatty acid (FFA) development during storage Addition of antioxidant and jaggery retarded peroxide value and TBA formation but had no effect on FFA development

The shelf-life studies on a low dietary bulk weaning food based on malted ragi and greengram was conducted by Mallashi (1988) The moisture-humidity relationship studies at 27^{o} C revealed moisture content of 11 percent and equilibrium relative humidity of 65 percent

Chaudhary and Kapoor (1984) found out that pearl millet flour could be stored at 20^{o} C and 70 percent relative humidity for six seven, eight and ten days in gunny sacks, earthern pots, tin cans and polythene bags

Studies on shelf life of snack products made from bajra were conducted by Seth and Rathore (1993) The products were stored in five different types of containers, viz , glass, tin, plastic and polyethylene bags of 200 and 400 gauge No significant change could be found in chemical attributes

The suitability of indigenously available glass containers has been studied for packing mango juice, banana puree, tomato puree and processed peas Reduction in beta carotene was found to be less in amber coloured bottles compared to colourless bottles (Purushotham *et al* , 1992)

Rao (1991) developed dehydrated coconut chutney which could be reconstituted well in cold water The assessment on the shelf life revealed that the product had a shelf-life of 3 months at 37^{o} C and 6 months at ambient temperature when packed in flexible pouches

The storage studies conducted by Gopaldas (1982) on malted and roasted young child mixes revealed that malted mix had a shelf life of 7 days, while roasted mix had a shelf-life of 28 days

Solanki (1986) assessed the shelf-life of weaning mixes Different parameters such as moisture, alcoholic acidity, peroxide value and bacteriological count were analysed All the malted RTE mixes could meet the ISI specifications for processed foods upto 42 days

According to Malleshi (1989), under ambient storage LDPE packed weaning samples showed fair quality upto a period of 120 days

According to Malleshi *et al* (1988), weaning food packed in flexible pouches and stored at accelerated (38 ^{o} C and 92 percent RH) and Indian standard (27^{o} and 65 percent RH) storage conditions exhibited increases in moisture content, free fatty acids, cooked paste, and viscosity, progressively on storage The shelf-life of the product in low density polyethylene pouches was about two months and five months under accelerated and ambient storage conditions whereas in laminated pouches, the shelf life was about three months and five months respectively in the corresponding storage conditions

Chaudhary and Kapoor (1984) have reported that flour could be stored at 20 ^{o} C and 70% relative humidity for 6, 7 8 and 10 days in gunny sacks, earthen pots, tin cans and polyethylene bags, respectively without affecting its acceptability

Kulkarni *et al* , (1989) reported that the quality of papads made from blends containing bengalgram or redgram was comparable to that pf papads made from blackgram Papad remained quite acceptable in 200 gauge LDPE and 120 gauge pp bags during 4 months storage without much change in quality

The effect of ingredient compostition and packaging on the storage stability of fried wheat snacks was studied by Kapoor and Kapoor (1990) Frying medium and packaging material influenced the product Microbiological examination of the flour samples revealed a considerable increase in fungal count while the bacterial count remained constant during storage

The common Chat products sold in Chandigrah were tested for total and specific microbial count, which ranged from 10^8 to 10^{10} CFU/g and 10^3 to 10^{7} CFY/g respectively An increase in microbial count by 1 to 3 log cycles was seen after storage for 16 hours and 24 hours room temperature Standard samples prepared in the laboratory showed 2-3 log cycles lower counts as compared to the test samples (Kaul and Aggarwal 1988)

Al-Kahtani (1989) processed different wheat flour supplementary sorghum flakes and conducted sensory, nutritional and microbiological evaluation tests It was reported that the total plate counts and mould and yeast counts were very low even in the lowest dilution of 1 10

The effect of ingredient composition and packaging on the storage stability of fried wheat snacks was studied Frying medium and packaging material influenced the rate of peroxidation, and sensory scores of wheat snacks during storage of sweet and salted snacks fried in vanaspathi and packed in paper aluminium foil-polyethylene laminate remained stable for one year Snacks fried in groundnut oil and palm oil remained stable for 120 to 240 days respectively in various packaging films Relatively sweet snacks were more stable to peroxidation than salted snacks Crispness, aroma and taste were the major determinants of overall acceptability of fried wheat snacks (Thakur and Arya, 1990)

Sorption studies carried out by Singh *et al* (1990) at relative humidities (RH) ranging from 11 to 86% of kheer ready-mixes, based on 30% powdered sugar and 40% whole milk powder, indicated that an equilibrium moisture content (EMC) of 5 7 - 5 8% at 44% was critical beyond which sogginess and lump formation were observed The ready mixes, when packed in polypropylene (200 gauge) and metallized polyester/poly pouches remained well for (i) 120 and 150 days respectively at 65% RH and 27° C and (ii) 46 days at 92% RH and 38° C

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation Developing Complementary food products based on cassava and sweet potato comprises

3 1 A survey on the consumption pattern of processed foods in selected families of different socio-economic status in Trivandrum District,

3 2 Standardisation of raw materials/ingredients for developing complementary food products,

3 3 Formulation and processing of different complementary foods,

3 4 Acceptability of the processed foods developed with special reference to

3 4 1 Nutritional significance of the processed foods,

3 4 2 Physiological tolerance of the processed foods,

3 4 3 Organoleptic qualities of the developed foods, and

3 4 4 Storage and shelf life of the processed foods

3 1 A survey on the consumption pattern of processed foods comprised of

3 1 1 Framing the schedule

Income of the family, type and size of the family education and employment status of the housewife, food habits of the family, food expenditure are few variables influencing the consumption of processed foods in a family

A schedule (Appendix 1) with these variables was suitably structured and pretested among 20 housewives in the field

3 1 2 Selection of the families

The selection of the families was confined to Trivandrum District purely on convenience basis The target sample size was 90 The samples were selected using judgment sampling method (Gupta and Kapoor 1992)

3 1 3 Conduct of the survey

In the families, women are mainly responsible for the purchase and preparation of foods Hence they were the respondents of the survey and were interviewed by the investigator herself

3 2 Standardisation of raw materials/ingredients for developing root based complementary food products

The term complement is used when a relative deficiency of one nutrient in a food is compensated by a relative surplus of another food (Webster 1974 and Bender 1976) Based on this principle, raw materials, ingredients listed below were selected for the development of root based complementary foods

1 Cassava flour
2 Sweet Potato flour
3 Maida
4 Defatted soy flour
5 Blackgram flour
6 Rice flour and
7 Milk Powder

3 2 1 Preparation of cassava flour

Because of the resulting increase in demand for food in the State, there is a need to introduce high yielding root crops which have a wide range of preparation adaptability in our daily menu

According to Gosh (1985) Kerala accounts for about 75 percent of the area and for about 71 per cent of the production of Cassava Although Cassava has long been consumed in various conventional forms, research is needed to develop more convenient food items based on cassava and hence expand its use for various new food application such as convenience food, snacks, breakfast cereals and baby foods

M_4 variety of Cassava tubers (150 Kg) grown in the Instructional Farm, College of Agriculture, Vellayani and Central Tuber Crops Research Institute, Thiruvananthapuram was purchased in bulk The tubers were washed thoroughly with water to remove solid particles and dirt Peeling and chipping were done manually with sharp knives During chipping the end portions of the tubers were discarded The thickness of the chips ranged from 0 5 to 0 7 cm The fresh chips were sundried for 4 days and milled The ground flour was sieved through B S Test sieve 100 mesh (Fig 1)

Type tests specified by ISI to the requirements of the standard cassava flour was carried out by analysing, moisture, total ash, starch crude fibre, pH of aqueous extract, and cold water solubles (ISI specification No IS 1318) The flour was then stored in air tight containers

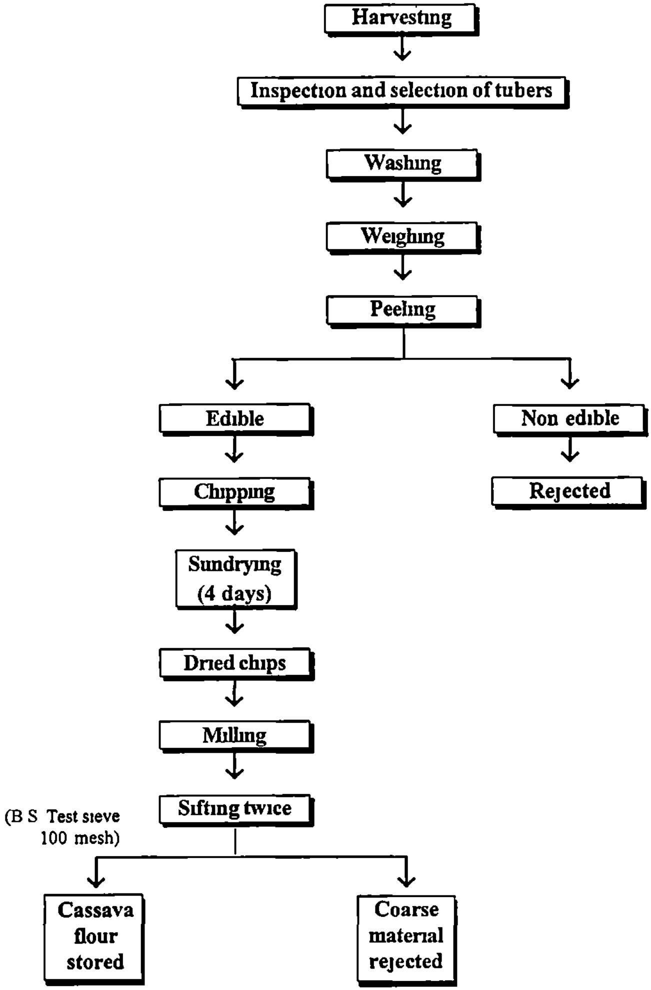


Fig. 1. Flow chart for the preparation of cassava flour

3 2 2 Preparation of sweet potato flour

As stated by Akpapuram and Abianate (1991) the production and processing of sweet potato has received only limited attention from researchers Presently sweet potato is ranked 7th among world food crops (FAO Year Book, 1993) Earlier studies by Kays (1990) on Sweet Potato based products revealed its suitability for formulating different types of processed foods

300 Kg of sweet potato tubers was procured from Central Tuber Crops Research Institute and adjacent private farms Flour was prepared as described earlier in 3 2 1

The sieved flour was analysed for moisture, total ash, acid insoluble ash, total sugar content, starch, crude fibre, pH of aqueous extract, cold water solubility, and presence of Salmonella as type tests to confirm ISI specification (ISI Specification IS 13046) The flour was then stored in air tight containers

3 2 3 Maida

25 Kg of maida was purchased in bulk from the Super market The purchased maida flour was analysed for moisture,

total ash, acid insoluble ash, gluten and alcoholic acidity as type tests to confirm ISI Specification (ISI Specification No IS 1009) The analysed flour was stored in air-tight containers

3 2 4 Soy flour

Soybean represents two thirds of the world s production of major high protein meals (Indian Express 1992) and as a protein source it contributes two third of the world s consumption (Gornov 1989) Tandon and Singh (1987) have tried to incorporate defatted soy flour at lower level in some traditional foods which gave encouraging results One of the major constraints in availability of soy based foods is lack of simple low cost technology of incorporating it in traditional foods

Twelve Kg of defatted soy flour was purchased in bulk and analysed for ISI conformity Analysis was carried out for moisture, protein, total ash, acid insoluble ash fat and, crude fibre as type tests to confirm ISI Specification (No IS 7836) The flour was stored in air tight containers

3 2 5 Blackgram Flour

According to Desikachar (1983) pulses in the right proportion in any mixture of food can ensure an adequate supply of good quality proteins Since blackgram is rich in protein, minerals and Vitamins it s inclusion in a root based food is important

Accordingly 8 Kg of good quality blackgram dhal was purchased from Super market and impurities removed It was sun dried for 4 hours Dried dhal was powdered in commercial flour mill, and sifted using B S Test sieve 100 The sifted flour was analysed for moisture, protein and total ash

3 2 6 Preparation of rice flour

Rice is the staple food in South India which is moderate in proteins Mixing rice flour with cassava/sweet potato flour will increase the protein content of the products Accordingly 8 Kg of good quality rice was purchased from the super market and flour prepared as in Fig 2

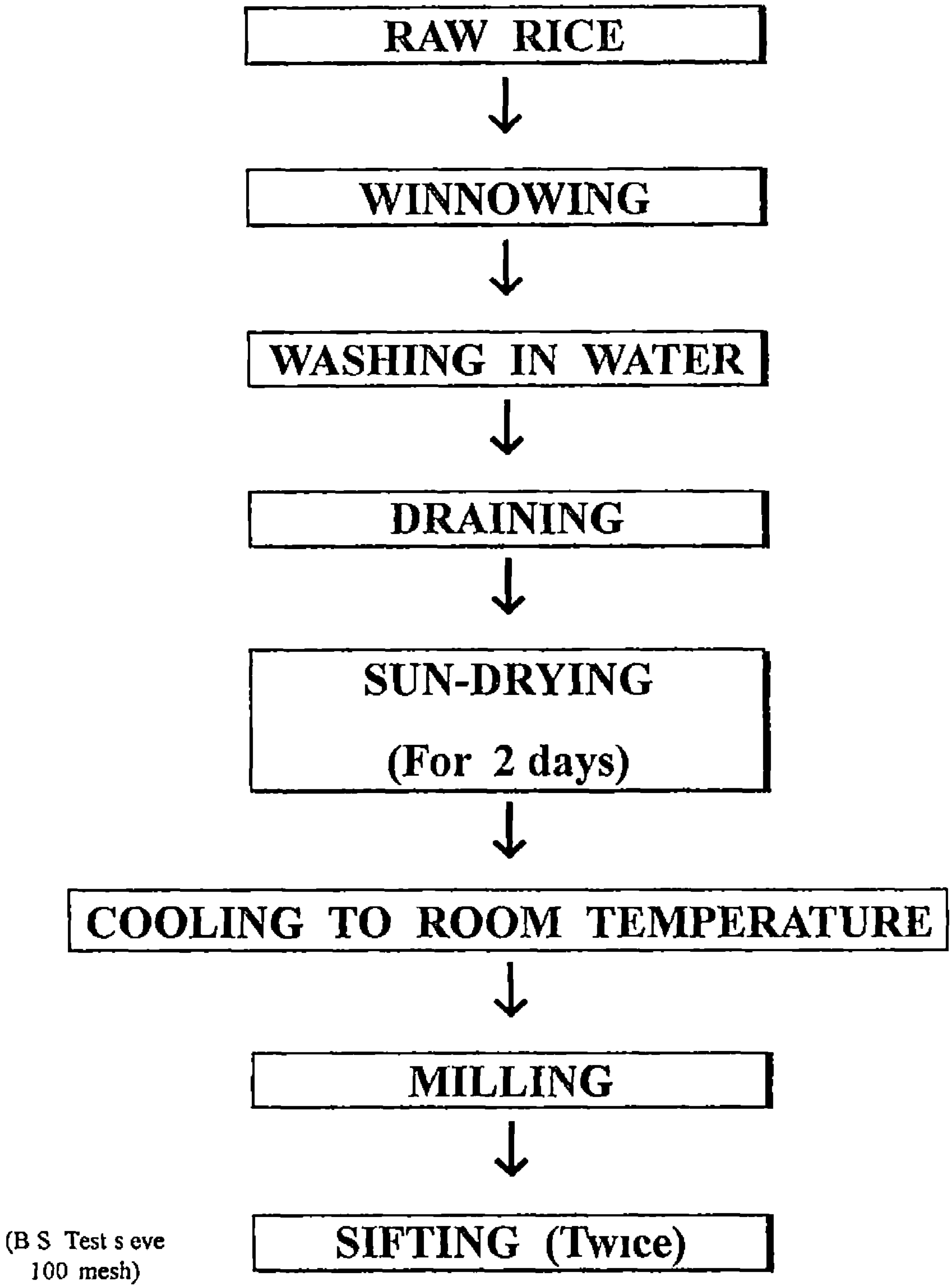


Fig. 2. Flow chart for the preparation of rice flour

The sifted flour was analysed for moisture, ash starch and crude fiber The processed rice flour was stored in air tight containers

3 2 7 Milk Powder

Supplementation with milk solids in weaning foods could increase the nutritive value and make them nutritionally complete (Desikachar 1983) Accordingly 5 Kg of whole milk powder was purchased from the super market and tests were done for moisture, total ash and fat as type tests, for ISI specification (IS 1165) The milk powder was stored in air tight containers

3 3 Formulation and processing of different complementary foods

This includes

3 3 1 Selection of food products

3 3 2 Different combination tried for the development of the products and

3 3 3 Development of the food products

3 3 1 Selection of food products

Cassava flour and starch provide an excellent raw material for the production of extruded foods and breakfast cereals (Eldash and Chang 1990) A study conducted by Seralathan and Thirumaran (1990) revealed that sweet potato flour incorporated breakfast item and recipes are highly acceptable among consumers According to El Dash and Chang (1990) extruded products are very popular with children and they can serve as an effective means for the introduction of important nutrients

Snacks are becoming the fourth meal in the modern life style About 40 to 64 percent of the population in USA consume atleast one snack food per day and this accounts for approximately 12 percent of protein, 16 percent of fat and 25 percent of their daily carbohydrate intake (Morgan 1983) Among snacks, wafers are very popular especially among teen-agers and children

According to Malleshi (1988) weaning foods are nutritious blends of cereals, legumes and milk and are excellent supplements to children Eldash and Chang (1990) states that one promising solution for the growing shortage of animal milk and protein for human food is to produce root based foods fortified with plant proteins

In the present study attempts were made to Standardise noodles, macaroni, wafers and weaning mix

3 3 2 Different combinations tried for the development of food products

The different combinations of the products were cassava flour sweet potato flour, flours made from cereals, pulses, oil seeds and milk powder in various proportions The principles governing the selection of the combinations were protein quality, extrusion behaviour, textural quality, cost and appearance

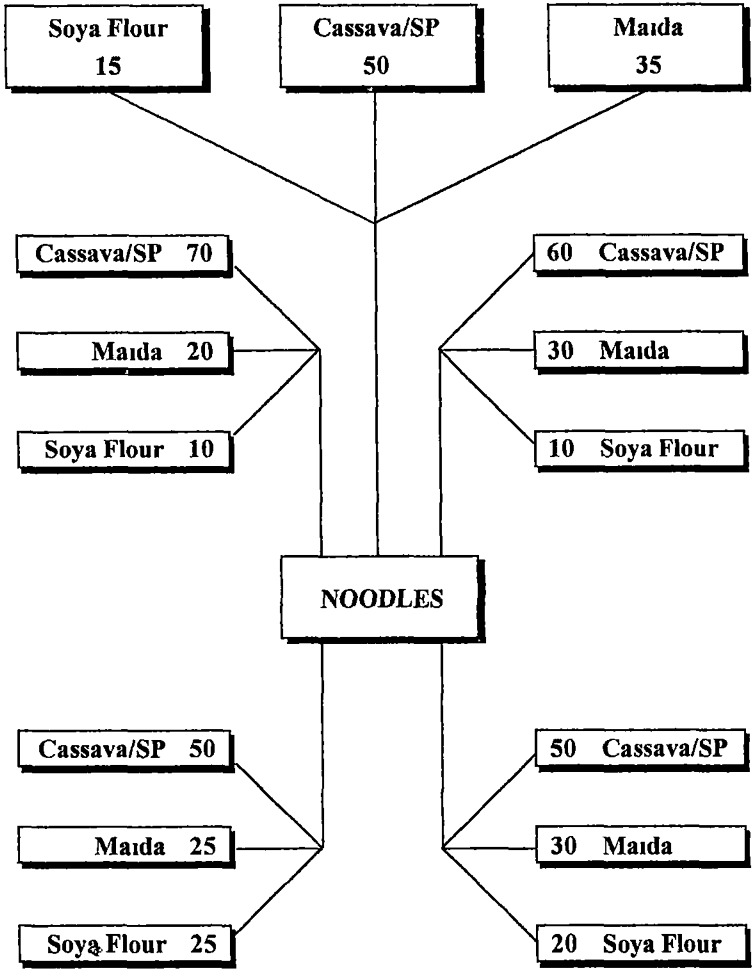
According to Jansen and Harper (1985) amino acid score provides an useful estimate of the protein quality of blended foods and is an acceptable substitute for the biological assay The amino acid scores of the different combinations tried were computed (Appendix II) Based on the amino acid scores, scores for protein quality was allotted The extrusion behaviour or textural quality was assessed through observation by technical experts Cost of the different combinations were computed as per the market price of the ingredients

Noodles

Noodles can be defined as shaped dried dough made from semolina or wheat flour with water and egg The dough is partially dried in hot air and are shaped into sheets or ribbons (Bender 1976) Usually noodles are prepared from maida In the present study an attempt was made to develop noodles from cassava or sweet potato flour The different combinations of cassava or sweet potato, maida and soy flour for the development of noodles are presented in Fig 3

Macaroni

Macaroni can be defined as dried dough made from maida or wheat flour with water It is also called as macaornalli and usually in tubular shape (Bender 1976) According to Eldash and Chang (1990) macaroni is a popular food economically accessible to the population The different combinations tried for the development of macaroni are presented in Fig 3



SP - Sweet Potato

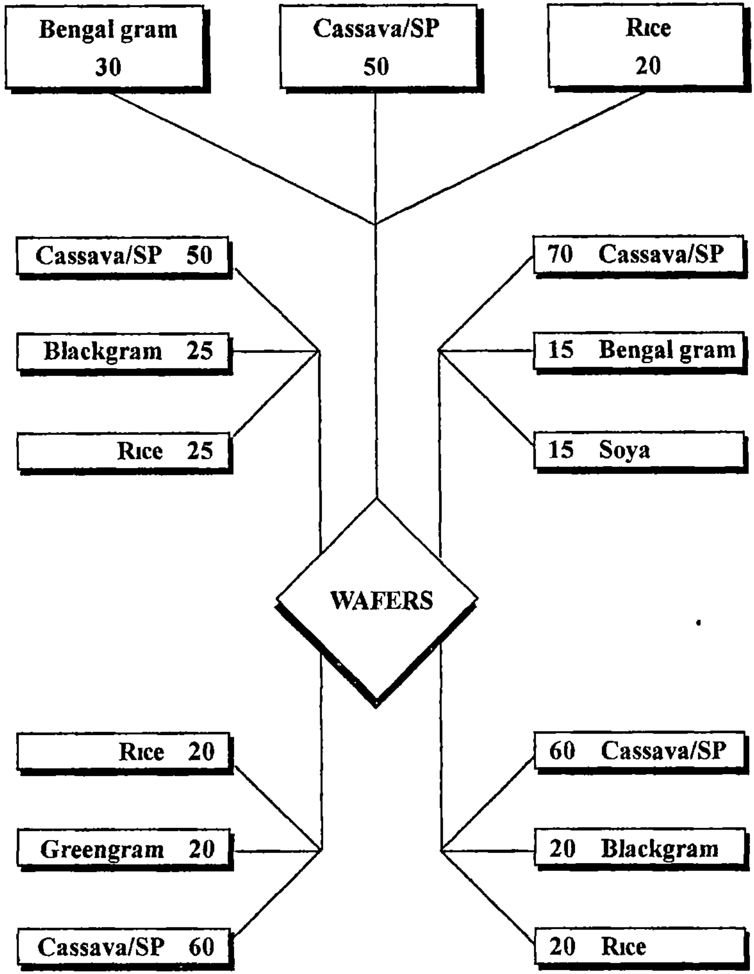
Fig. 3. Different combinations tried for the development of noodles

Wafers

Wafers are one of the popular snack foods Snack foods can be defined as Ready To Eat (RTE) foods consumed between the main meals of the day (Morgan 1983) The different combinations tried for the development of cassava/sweet potato wafers are presented in Fig 4

Weaning Mix

The semi solid foods given to the child when the child attains 4 to 6 months of age are called weaning foods (Malleshi 1988) Philip (1987) opines that though so many commercial expensive weaning mixes are available in the market there is a need to develop cheap, nutritious weaning foods from the locally available resources The ingredients selected for weaning food formulation should be based on their local availability, nutritional value, economic significance, shelf life qualities, acceptability and easiness for processing (Mitzner *et al* 1984) Accordingly cassava/sweet potato flour, soya and milk powder were chosen and the different combinations tried for the development of weaning mix are presented in Fig 5



SP - Sweet Potato

Fig. 4. Combinations tried for the development of wafers

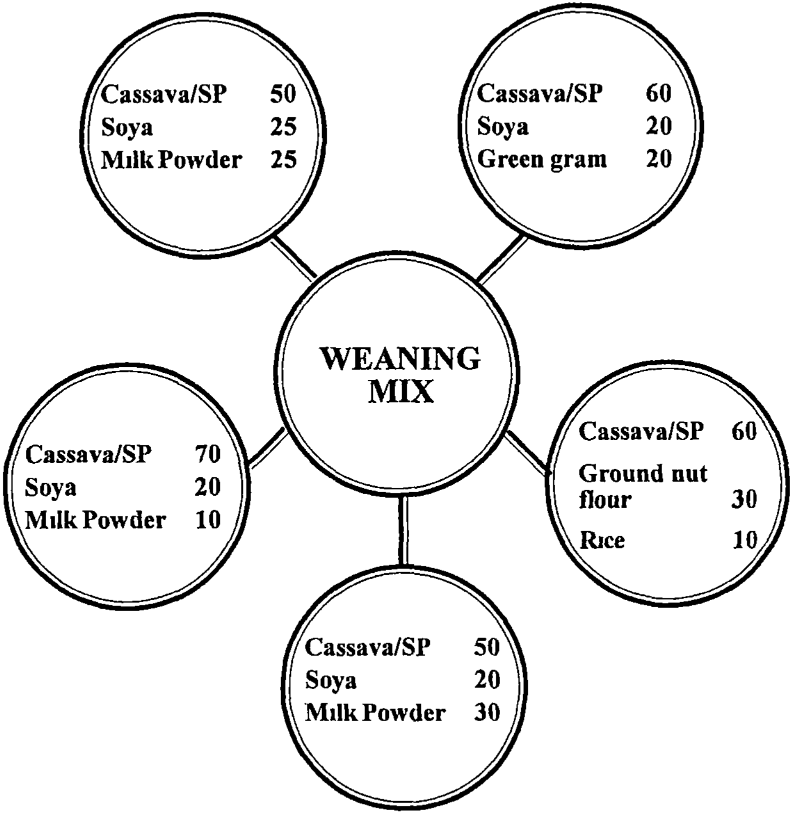


Fig. 5. Different combinations tried for the development of weaning mix

3 3 3 Development of the food products

Noodles

Fifteen Kg of cassava flour 10 5 Kg of maida and 4 5 Kg of soyflour were mixed for the processing of cassava noodles In the same way 15 Kg of sweet potato flour 10 5 Kg of maida and 4 5 Kg of soy flour were mixed for the processing of sweet potato noodles A total of 30 Kg of cassava noodles and 30 Kg of sweet potato noodles were developed The steps involved are presented in Fig 6

Macaroni

For processing cassava macaroni 15 Kg of cassava flour 10 5 Kg of maida and 4 5 Kg of soy flour were mixed For processing sweet potato macaroni 15 Kg sweet potato flour 10 5 Kg of maida and 4 5 Kg of soy flour were mixed A total of 30 Kg of cassava macaroni and 30 Kg of sweet potato macaroni were processed for the study The steps involved in the processing are presented in Fig 7

3 3 3 1 Physical characteristics and extrusion behaviour of noodles and macaroni

Physical characteristics are one of the important criteria for the acceptance of any product The important

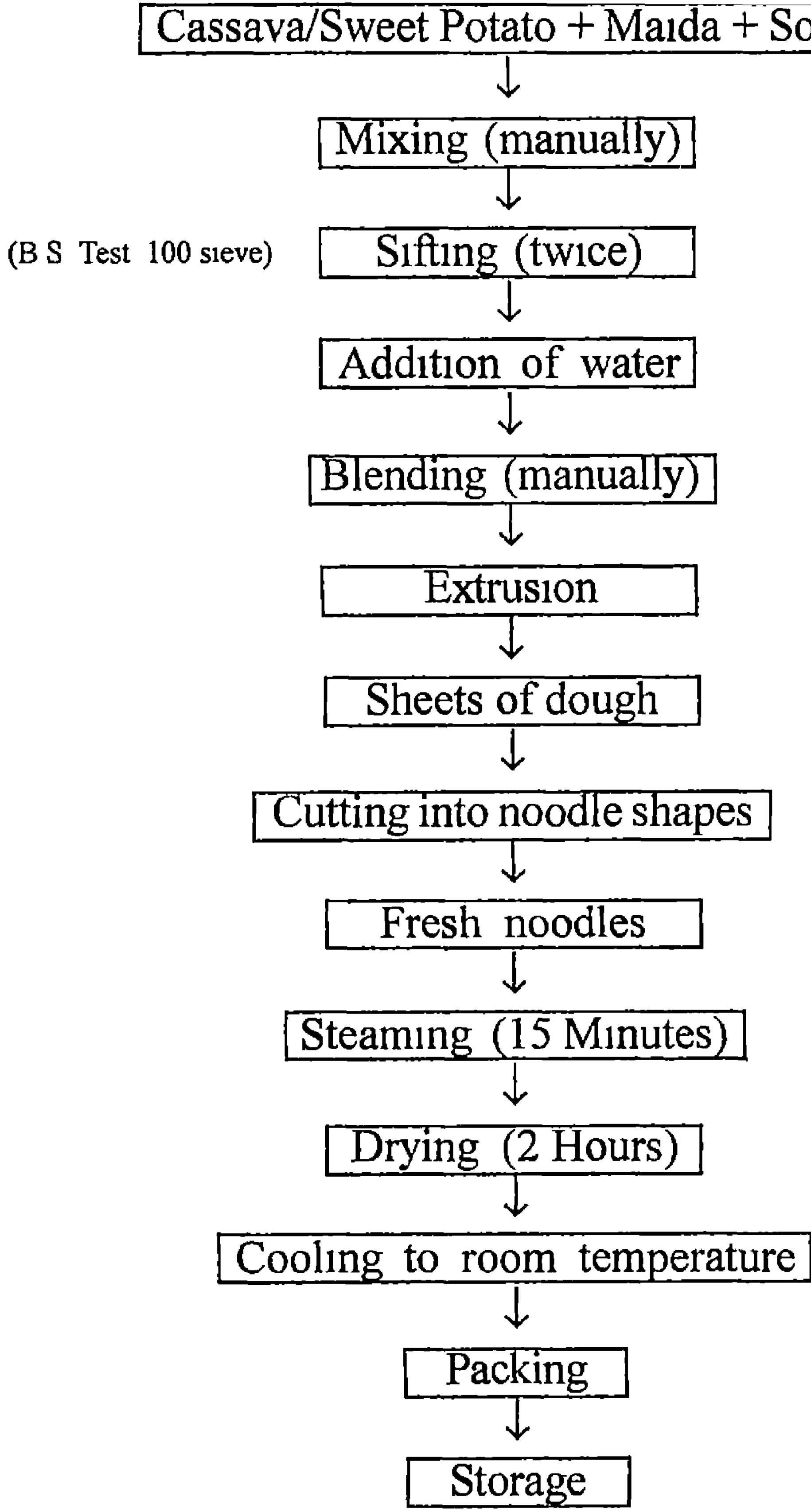


Fig. 6. Flow chart for the processing of noodles

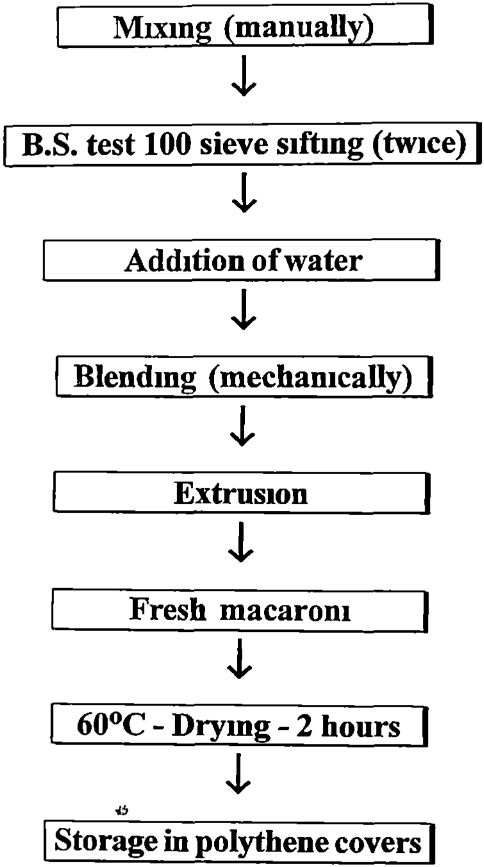


Fig. 7. Flow chart for the processing of macaroni

physical characteristics of any extruded product are fineness, shape, uniformity of strands, tensile strength and packaging quality A panel of ten technical experts were selected using triangle test (Watts 1989) to ascertain the physical characteristics of the developed noodles and macaroni using a score card The score card developed for the test is presented in Appendix III

3 3 3 2 Extrusion behaviour

The extrusion behaviour of noodles and macaroni was ascertained through observation by the technical experts for the uniformity in flow of strands and external appearance during extrusion

3 3 3 3 Cooking quality of noodles and macaroni

The cooking quality of the products was ascertained through, Cooking time, Water absorption Index and Bulk density

Cooking time

The cooking time of the products was assessed by cooking 25 g of noodles/macaroni with 100 ml of water The product was cooked till done and the time taken was recorded The end point was tested by pressing the cooked samples between two glass slides

Water absorption index

Water absorption index is the quantity of water absorbed by a known quantity of the food sample This is mainly used to assess the rehydration capacity of the extruded products 50 g of raw noodles/macaroni sample was taken in a glass beaker 100 ml of water was added to it The water was drained after 10 minutes The weight of the hydrated sample was recorded The water absorption index was calculated by Weight of hydrated sample minus Weight of raw sample

Bulk density of extruded products

Bulk density is the ratio of the weight of the sample to the weight of equal volume of water Bulk density is used as an index for comparing the volume of different foods The required quantity of noodles/macaroni sample was taken at a height of 20 cm in a 250 ml beaker until it filled up It was leveled without compressing The weight of the sample with the beaker was recorded The sample was then removed from the beaker and the water was filled at the same level (20 cm) The weight of the water with beaker was recorded

$$\text{Bulky density} = \frac{\text{Weight of sample}}{\text{Weight of equal volume of water}}$$

Wafers

For the processing of cassava wafers 10 Kg of cassava flour, 5 Kg of rice flour and 5 Kg of blackgram flour were mixed Cassava flour was replaced by sweet potato flour for sweet potato wafers 20 Kg of cassava wafers and 20 Kg of sweet potato wafers were processed The steps are shown in Fig 8

Weaning Mix

Weaning mix is a pre-cooked material rich in calories, protein, vitamin and minerals with low dietary bulk

Mixing (manual)

↓

B.S. test 100 sieve sifting (twice)

↓

Addition of water (5 volumes)

↓

Slow flame - Cooking (20 minutes)

↓

Cooling to room temperature

↓

Spreading thinly on plastic sheets

↓

Sundrying for three days

↓

Storage

Fig. 8. Flow chart for the processing of wafers

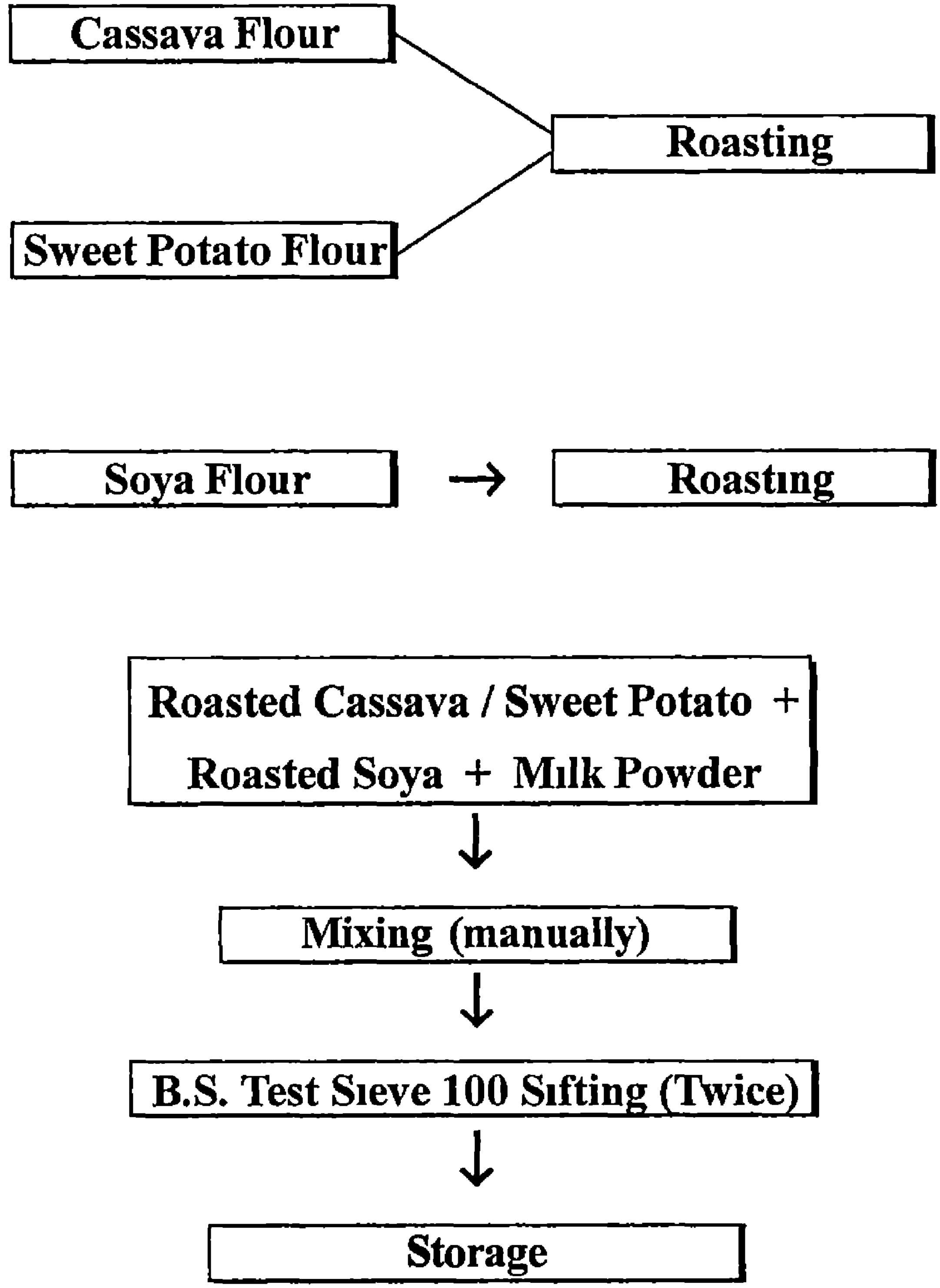


Fig. 9. Flow chart for the processing of weaning mix

and of antinutritional factors Accordingly 20 Kg of cassava weaning mix was processed with cassava, soya and milk powder and 20 Kg of sweet potato weaning mix was processed by replacing cassava flour with sweet potato flour (Fig 9)

3.4 Acceptability of the complementary foods developed

The acceptability of the developed foods was assessed with special reference to, nutritional significance, physiological tolerance, organoleptic qualities and storage and shelf life of the products

3.4.1 Nutritional significance of the processed foods

Nutritional significance of the processed foods was assessed by determining nutrients (Table 1)

Table 1 Methods used to assess the nutrients of the products

Nutrients	Method
Energy	Swaminathan 1984
Protein	Micro Kjeldhal (ICMR 1983)
Carbohydrates	Anthrone method (Sadasivam & Manickam 1992)
Carotene	AOAC (1975)
Calcium	
Iron	Jackson (1973)
Magnesium	
Zinc	
Total ash	AOAC (1975)

3 4 2 Physiological tolerance of the processed foods

Physiological tolerance and protein quality are important parameters to be considered before floating a new product, in the community The physiological tolerance of the developed food products were assessed by determining the protein efficiency ratio (PER) biological value (B V) digestability coefficient (D C) and net protein utilization (NPU)

In animal studies, weanling albino rats were used since growth phase gives the most sensitive measure of protein quality The nitrogen balance study was also intentionally conducted in rats because it is known that a protein that would support growth of young animals could maintain body weight in adult animals as well (Okeke and Obizoba 1986)

3 4 2 Determination of protein efficiency ratio

The most realistic way to assess the nutritional quality of protein is by conducting feeding trials on animals usually rats Among the several biological measurements suggested as indicators of protein quality, the simplest among them is protein efficiency ratio (Ritchey and Harper 1981) Measuring the growth rate of experimental animals fed on a test food over a period of time offers the simplest method to evaluate the nutritive value of proteins The protein efficiency ratio is derived from the weight gain of the test animals

Forty two weanling albino rats of wistar strain of 20 to 23 days old with body weight ranging from 46 to 49g were selected for testing the protein quality of the food products The rats were divided into 7 equal groups of 6 rats in a group Since the products tested viz noodles and macaroni had the same composition they were considered as one group The seventh group served as control with casein diet

Table 2 Composition of diet

[in g]

Ingredients	Group I	Group II	Group III	Group IV	Group V	Group VI	Control group
Cassava	44 0	--	45 0	-	38 1	-	-
Sweet Potato	-	43 0		45 0	--	36 0	-
Maida	28 5	29 1	--	-	-	--	-
Soya	11 5	12 9		-	12 7	12 0	-
Rice	--		20 0	20 0			
Blackgram		-	20 0	20 0	-	-	
Milk Powder	-	-	-		12 7	12 0	--
Casein			-	-		--	26 3
Starch		-			21 5	25 0	58 7
Vitamin Mixture	2 0	2 0	2 0	2 0	2 0	2 0	2 0
Mineral mixture	4 0	4 0	4 0	4 0	4 0	4 0	4 0
Groundnut oil	9 0	9 0	9 0	9 0	9 0	9 0	9 0

The experiment was conducted in CRD with 6 replications The seven treatments/products are cassava noodles/macaroni, sweet potato noodles/macaroni, cassava wafers, sweet potato wafers, cassava weaning mix, sweet potato weaning mix and casein The experiment was carried out for a period of 28 days as per the procedure of Pellet and Young (1980)

3 4 2 2 Nitrogen Balance Study

The extent of utilization of protein in the food products developed was measured through nitrogen balance study Groups of 6 male adult wistar rats each weighing approximately 70 g were used in the balance experiments The rats were housed individually in metabolic cages in a controlled environment The whole experiment was divided into 3 phases During the first phase of 4 days all the rats were fed with non protein diet to measure the endogenous nitrogen (Table 3) During the second phase of 3 days the rats were fed on stock diet (Table 3) During the third phase of four days the differnt groups were fed with 6 different experimental diet and one control diet Each animal received 15 g of diet, water was supplied adlibitum Body weight and dietary intake of the animals were recorded Urine and faeces were collected separately during the period of the investigation The faeces were dried and ground into a fine powder The nitrogen in urine and faeces were determined and NPU was calculated as per the procedure of Pellet and Young (1980)

Table 3 Percentage of composition of Non-protein diet and stock diet

Ingredient (g)	Non-Protein diet	Stock diet
Starch	85	58 7
Groundnut oil	9	9
Mineral mix	4	4
Vitamin mix	2	2
Skim milk powder	--	26 3

3 4 3 Organoleptic qualities of the developed foods

Beyond satisfying the nutritional needs The foods choosen by people and the quantity consumed depend upon its quality When we choose our food physical senses of sight, touch, smell, and taste play an important part (Potter 1986) According to Donald *et al* (1984), sensory evaluation utilises the senses to measure particular characteristics of food and organoleptic tests can be considered as one of the important means for evaluating a new product Clement *et al* (1989) opine that sensory evaluation can be used to predict the consumer acceptance of a food item Since the product development and its acceptance by the people depend on the overall acceptability, these tests are considered as one of the important criteria for evaluating the acceptability of the newly developed products (Thirumaran 1993)

The acceptability of the developed products were tried at three levels viz

1 Among technical experts at institutional level
2 Among consumers of high income strata and
3 Among consumers of low income strata

3 4 3 1 Acceptability of the developed food among technical experts

A panel of 10 members trained in different scientific methods of sensory analysis was chartered for conducting the sensory analysis This panel was selected from 30 technical experts from the College of Agriculture, Vellayani through triangle test (Watts *et al* 1989) The developed products were studied for their acceptability through organoleptic tests by these selected judges The score card used for testing had the parameters of quality characteristics of foods such as appearance, colour, texture, flavour and taste A scale from five to one was used five representing optimum for all the quality characteristics (Appendix IV)

3 4 3 2 Acceptability of the developed foods among consumers of the high income strata

According to Puri *et al* (1985) there is a linear increase in the consumption pattern of processed foods with the higher level of education of women and total family income Singh and Shurpalekar (1989) feel that in the newly emerging era of fast and convenience foods, instant foods are becoming increasingly popular among wealthy Indian households High society women were found more exposed to processed novel foods like noodles, macaroni and wafers and the acceptability of these new products among them was studied A panel of 30 judges were selected from the Lions Club and Inner wheel Clubs of Trivandrum using purposive sampling method The main criteria for selection of the judges were

1 Their willingness to participate
2 Frequency and quantity of processed foods used in their households
3 Their exposure to novel foods and
4 The number of children in the family

The developed products were judged by these judges as explained in 3 4 3 1

Ten women were selected from the selected 30 judges, using convenience sampling method The main criteria for the selection of these women were

1 Interest in participation,
2 Taste and aptitude for cooking,
3 Leisure time available at home and
4 Age and number of children they have

50 g samples of noodles and macaroni were distributed to these women and they were requested to frame their own recipes The recipes framed by these women were collected by the investigator after an interval of one month Based on these findings the new recipes were standardised in the laboratory by the investigator Details of the recipes formulated are given in Appendix V

3 4 3 3 Preference for the developed foods among rural women

According to Swaminathan (1984) for preference tests a large number of persons are required Their evaluation should come spontaneously based on their judgment In a farm family women are responsible for monitoring food, storage, purchase of food, cooking and apportioning food Any results obtained in the laboratory should reach the land for the timely utilization of the findings The tendency of using cassava as a main item in the farmer's diet is slowly disappearing owing to the change in life style Hence introducing these tubers as different novel food products, to familiarise farm women with them is a highly essential step However the developed product should be acceptable to farm women Hence the acceptability of the developed products among farm women was assessed Fifty farm women were selected at random from Kalliyoor Panchayat in Nemom Block A good rapport had already been established through several extension education programmes and the University personnel were very familiar to the women in their area The prepared products were served to the women and they were requested to rank the products according to their preference A scale from nine to one was used, nine representing the optimum (Appendix VI), steps were taken to avoid discussion among them during rating

3 4 4 Storage and shelf life of the processed foods

The storage and shelf life of the processed foods include

1 Selection of storage containers
2 Insect infestation of the products
3 Microbiological profile and
4 Shelf life of the products

1 Selection of storage containers

A primary container is one that comes in direct contact with the food It should be non toxic and compatible with the food causing no colour, flavour or other foreign chemical reactions (Potter 1986) The containers for packaging should not impart any toxicity or flavour to the food stuff and should be able to integrate at one end ~~and~~ with the food manufacturing system and at the other end with the marketing system and should be of low cost (Veeraraju 1993)

Four containers, metal (steel), plastic, glass and polythene were selected as storage containers considering their popularity, local availability and cost

2 Insect infestation on the processed foods

Observation on the percentage of infestation and the population count in all the products stored in different containers were recorded at monthly intervals for a period of 12 months

3 Microbiological evaluation of the processed products

The food samples stored in different containers were assessed for their total plate count for different group of micro organism at the end of the storage period as per standard procedure (AOAC 1976)

4 Shelf life of the processed products

There are many parameters which help determine the shelf life of any product They include moisture level, per oxide value, total sugar content and acidity Accordingly all these parameters were assessed at a time interval of 3 months during the storage period (Table 4)

Table 4 Assessment of shelf life qualities

Parameters	Methods	Relevant details
Moisture	AOAC (1976)	All the 64
Per oxide value	AOAC (1975)	Samples were analysed
Total sugar	AOAC (1976)	Once in 3 months during the storage
Acidity	AOAC (1976)	period of one year

3 4 5 Statistical analysis

The data collected during the study were compiled analysed statistically and presented under results and discussions

Statistical techniques attempted in this study were

Statistical methods	Reference
Correlation and Regression	Statistical methods Snedecor, G W , and Cochran, G W (1967)
Chi square	
Complete randomised design	Gomez and Arturo A Gomes (1984)
Split plot design	M N Das and N C Giri (1979)

Popularisation of the developed products

Universities in general have been acclaimed as mixes of information However much of these information remains out of reach of the common needy man, since they remain within the pages of of printed media, or produce echoes with the walls of classroom or seminar halls Transfer of technology from Lab to land or from the point of its origin to the hands of the actual consumer is one of the primary responsibility of all scientific/academic institutions An attempt on these lines was also undertaken as part of this research work The processed products developed through this study were exhibited before a cross section of urban population in Trivandrum city with three objectives

1 To create awareness about the new product among the public

2 To transfer the technology to new entrepreneur and fellow scientists

3 To estimate the preference and acceptability of the new products among different categories of consumers

With the above objectives the processed products, as well as the recipes prepared from them were presented before the public as detailed below

Period	Methods choosen	Sponsoring agency	Occasion
November 1991	Exhibition	Kerala Horticultural Development Board	
August 1992	Exhibition	Kerala Agricultural University	Farmers day
November 1993	Recipe display	Indian society for root crops	International symposium on tropical tuber crops
December 1993	Cooking Competition	Farm Information Bureau	All India Agmark exhibition
December 1993	Recipe display	Regional research Laboratories Thiruvananthapuram and Hindustan Lever Ltd	National Symposium on carbohydrate and allied products
January 1994	Demonstration Classes	Womens club Thiruvananthapuram	Monthly meeting
March 1994	Demonstration Classes	Innerwheel club Thiruvananthapuram	Monthly meeting
March 1994	Demonstration Classes	Lions club Thiruvananthapuram	Monthly meeting
June 1995	Exhibition	Kerala Agricultural University	Inauguration of of new K V K Station at Kottarakara

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The present investigation on developing complementary food products based on cassava and sweet potato gives a comprehensive information on

4 1 Consumption pattern of processed foods in selected families of different socio-economic status in Trivandrum District

4 2 Standardisation of raw materials/ingredients for developing cassava and sweet potato based complementary food products

4 3 Formulation and processing of different complementary foods

4 4 Acceptability of the complementary foods developed with reference to

4 4 1 Nutritional significance

4 4 2 Physiological tolerance

4 4 3 Organoleptic qualities and

4 4 4 Shelf life qualities

4 1 Consumption pattern of processed foods in selected families in Trivandrum district

There is a large variety of processed foods to which the average citizen is exposed today No data is available about the extent of the popularity and consumption of these foods with special reference to Trivandrum District So a study of these aspects was undertaken

The consumption patterns of processed foods were ascertained by conducting a survey among ninety families of different socio economic backgrounds in Trivandrum district selected by purposive sampling methods The selection of the families was confined to Trivandrum district purely on convenience basis

According to Seema and Sirshi (1985), to study the socio economic profile of a community, certain major determinants such as place of residence, type and size of family caste, religion educational and employment status and family income are to be ascertained Along with these variables, food consumption pattern, with reference to total food expenditure, expenditure on processed foods and frequency of consumption of processed foods, was also examined

Many of the respondents (84 35) were found to reside either in urban area (55 50 per cent) or in suburban area (28 80 per cent) (Table 5) Only 15 50 per cent families of the sample were found to have their residence in rural areas Though people residing in rural areas were aware of processed foods, these items had not as yet found a place in their dietary pattern due to higher cost and non-availability The situation was, however, different in the case of residents in urban and suburban areas

Religion may have an influence on dietary habits Hence, families selected in the study were chosen from major religions like Hinduism (68 90 per cent), Christianity (27 80 per cent) and Islam (3 20 per cent) Of these, 20 per cent families were from the under-privileged section of the community However, all the families surveyed, irrespective of their religion and caste, were non-vegetarians Earlier studies conducted by Jayanthakumari (1993) Paul (1993) and Gopinath (1994) in Trivandrum City have revealed that a majority of the families (92 per cent) were non-vegetarians Complementary or processed foods were also found to be more acceptable to non vegetarian dietaries, may be due to their textural and flavour qualities The dietary habits of all the families had only favoured the consumption of processed foods

Table 5 Socio Economic Profile of Families

Socio Economic Characteristics	Categories		Distribution
1 Place of Residence	Urban		50 (55 50)
	Sub-urban		26 (28 80)
	Rural		14 (15 50)
Total			90 (100 00)
2 Religion	Hindhu		62 (68 90)
	Christian		25 (27 80)
	Muslim		3 (3 20)
Total			90 (100 00)
3 Caste	Foward		72 (80 00)
	Backward		18 (20 00)
Total			90 (100 00)
4 Family Type	Joint		27 (30 00)
	Nuclear		63 (70 00)
Total			90 (100 00)
5 Family size	Upto 3		7 (7 80)
	Upto 4		54 (60 00)
	Upto 5		20 (22 00)
	Upto 6		7 (7 80)
	Upto 7		2 (2 21)
Total			90 (100 00)
6 Family Consumption	Adults		Children
	1 Member	0 (00 0)	14 (15 60)
	2 Member	64 (71 1)	72 (80 00)
	3 Member -	15 (16 7)	4 (4 40)
	4 Member -	9 (10 0)	---
	5 Member -	2 (02 2)	---
		90 (100 00)	90 (100 00)
7 Age of Children	Below 5 years		45 (30 00)
	6 to 10 years		60 (40 00)
	11 to 15 years		36 (24 50)
	16 years		7 (4 70)
8 Monthly Income	Upto Rs 3,000/		30 (33 30)
	3,000/ to 6 000/-		30 (33 30)
	6,001/- and above		30 (33 30)
Total			90 (100 00)

(Numbers in parethesis denotes percentage)

Earlier studies conducted by Augustine (1993) and Paul (1993) revealed that the type and size of the family had a significant influence on the food consumption pattern of the family Among the families surveyed, nuclear type families were more predominant (70 per cent) than joint families (30 per cent) The findings of the studies of Thomas (1989) and Jayanthakumari (1993) are also in line with these observations Processed foods may became more popular in nuclear type families since the woman will be involved in multi-faceted activities within the house Saxena (1986) has also stated that nuclear type families were better than joint families in adopting new practices Family size is an important factor which greatly influences the development of the family (Devadas *et al* 1980) Among the families surveyed, 67 80 per cent were small families with four members Among the remaining families, 30 00 per cent had 5 to 6 members and 2 20 per cent had seven members Processed foods and ready-to-eat foods are very popular among children (Eldash and Chang 1990) So the number of children in a family is an important determinant influencing the consumption of processed foods In the present study, it was found that the majority of the families (80 00 per cent) had two children, followed by one child (15 60 per cent) Only 4 40 per cent of the families had more than two children

The income of the family is an important aspect which has a direct association with the purchasing power of the family, especially food Devadas *et al* (1980) have found out that the higher the income, the larger the per centage of income spent on a variety of food items In the present study, 30 per cent of the families had a monthly income of Rs 3,000/-, and a similar per cent had their monthly income between Rs 3,001/- and Rs 6,000/ , while another group of families (30 per cent) had a monthly income above Rs 6,001/- Based on these data, the families were categorised as middle high middle, and high income families

Better educational level creates better opportunities for employment, which in turn may influence the purchasing power of the family In the present study, most of the respondents (83 30 per cent) had moderate to high educational level (Table 6) Among them, 42 20 per cent were graduates and 41 10 per cent were post graduates and the remaining 16 70 per cent had education upto the high school Among the ninety respondents, 50 per cent were employed and 50 per cent were unemployed In Kerala, a majority of the women (81 00 per cent) are literate (1991 census) Keralites, in general, are familier with the various media like newspaper, radio and Doordarshan T V (Paul 1993) There is an increasing trend among women in the state to continue domestic chores with side jobs

Table 6 Education and Employment Status of Women

Sl No	Educational Status		Employment Status		Total
			Working	Non-working	
1	High School	15 (16 7)	1 (10 00)	14 (15 00)	15
2	Degree	38 (42 2)	16 (17 00)	22 (24 00)	38
3	Post Graduate	37 (41 1)	28 (32 00)	9 (10 00)	37
	Total	90 (100)	45 (50)	45 (50)	90

Number in parenthesis denotes per centage

Puri and Sanghera (1989) have proved a linear increase in the consumption of processed foods with the higher education of women They also state that women spending more time for outside activities are also found to depend more on convinient foods If low cost nutritious processed foods are manufactured and floated in the market, it will introduce variety in the diets of many families of different income strata

A comparison of total food expenditure and expenditure on processed foods depicted that the latter had a direct association with the former In most of the families (82 00 per cent) the expenditure on food was directly proportional to the total income (Table 7) Similarly, the expenditure on processed foods was also directly proportional to the total food expenditure This finding is in line with the findings of Guitnam and Gorden (1982) who observed that as the income increased people had the tendency to buy all sorts of processed food items

In the families surveyed the food expenditure varied from Rs 800/- to Rs 3,400/- 12 20 per cent families spent upto Rs 1,000/- on food while 44 60 per cent spent Rs 1,001/- to 2,000/ and 43 20 per cent spent more than Rs 2,001/ -. For the same reason, the expenditure on processed foods was also found to increase with the total food expenditure 12 20 per cent from the first category, (for whom the food expenditure was upto Rs 1 000/-) and

11 00 per cent from the second category (for whom the food expenditure was between Rs 1,001/ and Rs 2,000/-) spent upto Rs 250/- on processed foods 25 60 per cent from the second category (food expenditure from Rs 1001 to 2000) spent between Rs 501 and 750 13 30 and 21 10 per cent of the families from the third category (food expenditure more than Rs 2001) spent between Rs 1,001/ and above respectively on processed foods This observation is in line with the findings of Bhatji and Kusha (1975) who have stated that as the total food expenditure increases, there is an increase in the expenditure on processed foods

Table 7 Monthly food expenditure pattern of families

Sl No	Amounts spent on food (Rs)	Amount spent on processed foods Rs: upto 250	251-500	501-750	751-1000	1001 and above	No of families
1	Upto Rs 1,000/	11 (12 20)	-			-	11 (12 20)
2	Rs 1001 2000	10 (11 00)	23 (25 60)	7 (8 00)			40 (44 60)
3	Rs 2001 & above	-	---	8 (9 00)	12 (13 30)	19 (21 00)	39 (43 20)
	Total						90 (100)

Number in parenthesis denotes per centage

Unlike other states, the people in Kerala, due to their high literacy level, are more exposed to the media, which in turn has created an awareness regarding the various processed foods available in the market In the present study, it was found that almost all the respondents were familiar with different processed and convenience foods irrespective of their income level Among the different processed foods (Table 8), jam and squash were very popular 75 60 per cent of the families consumed jam and squash while weaning food was consumed by 56 70 per cent, wafers by 44 40 per cent, and extruded foods by 30 00 per cent of the families, irrespective of their income Being a conventional food, wafer is found to be more popular than extruded foods Similar findings were reported by Puri and Sanghera (1989) Though the families were aware of extruded foods, only 30 per cent used to consume them The common extruded foods used by the families were vermicelli and noodles

Familiarity with such complementary foods as noodles, macaroni and wafers was low mainly because of their non-availability in the local market Respondents from the families wanted to include these novel foods in their menu because of their popularity children s preference easiness in their preparation and their better nutritive value

Table 8 Type and frequency of consumption of processed foods

Sl	Types of processed foods	No of families consuming	Frequency of usage per week: More than 3 days	Thrice	Twice	Occasion-ally	Total
1	Jam and Squash	68 (75 60)	10 (14 70)	32 (47 60)	18 (26 40)	8 (11 70)	68 (100)
2	Bakery Items	55 (61 10)	18 (32 70)	24 (35 20)	10 (18 20)	3 (5 50)	55 (100)
3	Pickles	38 (42 20)	38 (100 00)		-		38 (100)
4	Weaning Foods	51 (56 70)	51 100 00)		-		51 (100)
5	Wafers	40 (44 40)	4 (10 00)	20 (50 00)	9 (22 50)	7 (2 50)	40 (100)
6	Extruded Foods	27 (30 00)	3 (11 10)	9 (33 30)	8 (29 60)	7 (25 90)	27 (100)

Number in parenthesis denotes percentage

Fennema (1987) has stated that an increase in the employment status of women and the standard of living has created a powerful demand for processed foods In Kerala, the employment status of women is 12 77 per cent (1991 census) The association between the employment status and the consumption pattern of processed foods was statistically analysed

For the purpose, the families were categorised into three groups according to their expenditure on processed foods families which spent low on processed foods (Rs 250 and below), moderately (Rs 251/- to Rs 750/-), and high (Rs 751/- and above) on processed foods The results of X^2 analysis (Table 9) revealed that the employment status of women had a significant positive correlation with the consumption of processed foods In the high income group, the consumption of processed foods was more among families where women were unemployed Since these women have enough leisure time and money, they show inclination to buy all types of processed foods However, the employed women from this category included only a moderate quantity of processed foods in their dietary pattern and the X^2 value (X^2 - 10 16**) revealed a highly significant difference among these groups In contrast the consumption of processed foods in the high middle income families was more among the families with employed women than among those with unemployed women, and the difference between the two groups was highly significant (X^2 - 12 55**) Similar findings were reported by Guitnam and Gorden (1982), who had found that high middle income families with employed women members and residing in urban areas were more frequent users of processed foods

Table 9 Influence of employment status of women on the consumption pattern of processed foods

Employment Status	Consumption pattern of processed foods						Total
	High Income		High MIddle Income		Middle Income		
	Mode rate*	High*	Moderate*	High*	Low*	High*	
1 Working	9 (20 00)	6 (13 33)	5 (11 11)	10 (22 22)	13 (28 88)	2 (4 44)	45
2 Non working	0 (0 00)	15 (33 33)	15 (33 33)	0 (0 00)	15 (33 33)	0 (0 00)	45
Total							90
X^2	10 16**		12 15**		0 535^{ns}		

** Significant at 1% level
* Utilisation pattern
NS Not significant
Number in parenthesis denotes per centage

In middle income families, the employment status of women did not have any significant association (X^2 - 0 535^{ns}) with the consumption of processed foods Bhatji and Kusha (1975) also state that as the family income decreases the consumption of processed foods also decreases Their family income is limited and they are not in a position to give priority to processed foods which are quite expensive

The association of the consumption of processed foods with specific dependent variables, such as food expenditure, family income, educational status of housewife number of children in the family and size of the family was further tested statistically It was found that all these variables had significant positive correlation with the consumption of processed foods

There was inter-relationship between these independent variables (Table 10) The variable of family size showed a positive significant correlation with the number of children (0 8468**) and the total food expenditure (0 2612*), indicating the correlation with the total food expenditure (0 2758*) The educational status of housewives also had a highly significant positive correlation with family income (0 3979**) and total food expenditure (0 6421**) The educational status of the housewives will create better employment opportunities which in turn will increase the family income which is directly proportional to food expenditure

Simple regression analysis of consumption of processed foods on different independent variables was carried out and the results (Table 11) indicate, that the variables of total expenditure on food, family income, number of children in the family, family size and educational status of housewife, had a positive effect on the consumption of processed foods

Table 10 Inter correlation matrix contributing to the consumption of processed foods

Variable Name		X_5	X_6	X_{12}	X_{14}	X_{15}
X_5	Family Size	1				
X_6	Number of children	0 8468**	1			
X_{12}	Educational Status of mother	0 0013	0 0703	1		
X_{14}	Family Income	0 1525	0 2002	0 3979**	1	
X_{15}	Total food expenditure	0 2612*	0 2758*	0 4745**	0 6421**	1

Table 11 Simple regression analysis of comsumption of processed foods based on different selected independent variables

	Variable Name	Regression	t value	adj R^2
X_5	Family size	236 949	2 387*	0 049
X_6	No of Children	276 945	2 595	0 061
X_{12}	Educational Status of House wife	232 616	2 033*	0 033
X_{14}	Family income	0 048	3 511**	0 112
X_{15}	Total expenditure on food	0 260	4 206**	0 158

* Significnat at 5% level
** Significant at 1% level

The direct proportionality reveals that if there is an increase of one rupee in the food expenditure 0 26 rupee is actually being spent on processed foods Likewise, if there is an increase of one rupee in the family income, 0 05 rupee is spent on processed foods One unit increase in the number of children will increase the consumption of processed foods by 277 units and one unit increase in family size increases the consumption of processed foods by 237 units In the case of housewives of high educational status, it is 237 units

In the total consumption of processed foods, 16 00 per cent is explained by total food expenditure followed by family income (11 00 per cent), number of children in the family (6 00 per cent), family size (4 00 per cent), and educational status of housewife (3 00 per cent)

The remaining part of nearly 60% is explained by unknown variables which have yet to be analysed

The direct and indirect effects of the above mentioned variables on consumption of processed foods is presented in Table 12 and diagramatically represented in Fig 10 A perusal of different variables revealed that the rate of consumption of processed foods was mainly reflected in the total food expenditure (0 2585), total family income (0 1429), and number of children in the family (0 1122) The maximum positive indirect effect was exerted by the family income (0 1660) and the educational status of the housewife (0 1227) The educational status of the housewife will create an opportunity for employment and thereby, the increase in the total family income and consumption of processed foods None of those variables had a negative effect on the consumption of processed foods

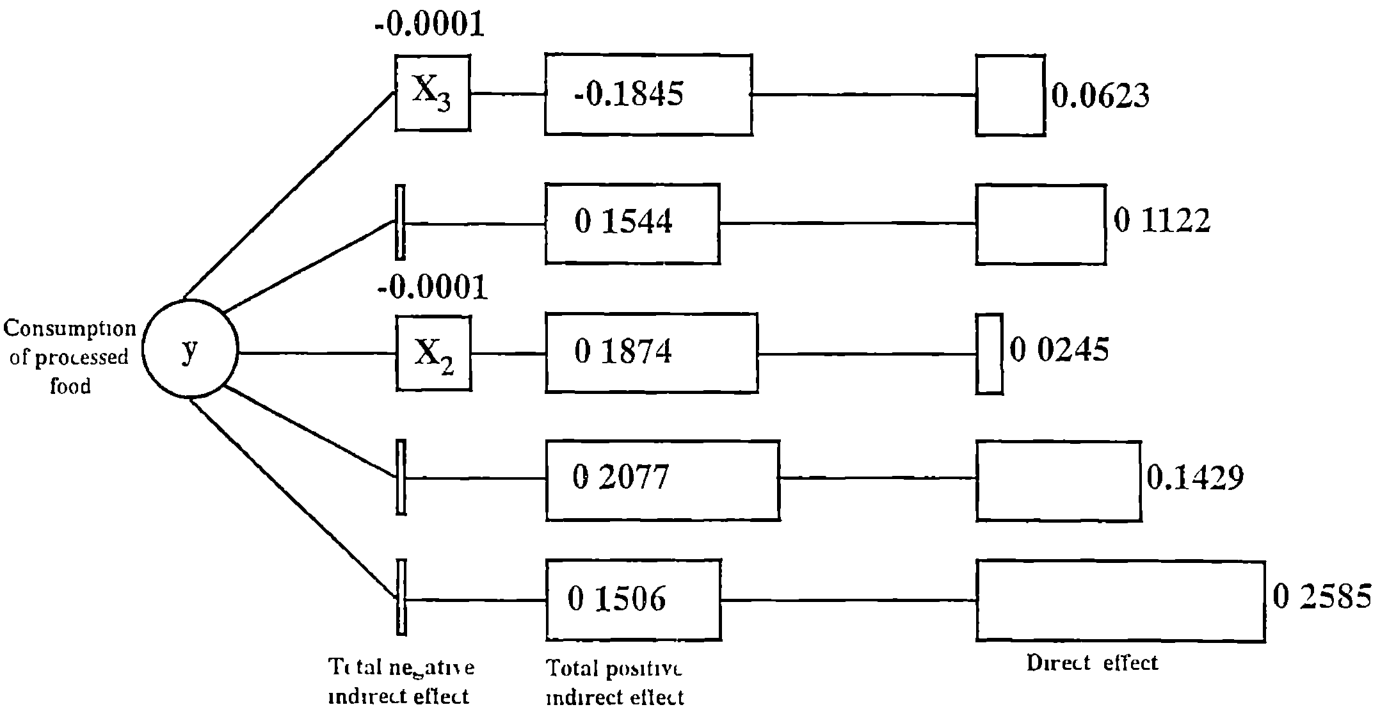
Table 12 Direct and indirect effects of certain variables (X_n) on consumption of processed food (Y)

Xn	Direct effect	Maximum indirect negative effect	Maximum indirect positive effect	Total positive indirect effect	Total negative effect
X_5	0 0623	0 0001 (X_{12})	0 0951 (X_5)	0 1845	0 0001
X_6	0 1122	0 0000	0 0713	0 1544	0 0000
X_{12}	0 0245	0 0001 (X_8)	0 1227 (X_{14})	0 1874	0 0001
X_{14}	0 1429	0 0000	0 1660 (X_{15})	0 2077	0 0000
X_{15}	0 2585	0 0000	0 0918	0 1506 (X_{15})	0 0000

Variables shown within parenthesis are the corresponding variable numbers

The salient findings of the survey throw light on the fact that people are familiar with processed foods irrespective of family income Their unpopularity among some of the middle income families is mainly because of their cost If complementary foods are processed at low cost with locally available food articles and floated in the market, it is evident that they will become popular among small-sized nuclear families with home-makers of medium education

Fig 10 Diagram sl ying direct effect total p sitive and negative indirect effects etc



Note The length of e ich box n the di ram s pr port onate to ts value

4 2 Standardisation of raw materials/ingredients for developing cassava and sweet potato-based complementary food products

Quality control in the field of food industry was started in India in 1899 and this has become more systematized since the middle of this century, with the introduction of more and more processed foods (Bhavani and Sareen 1990) The Bureau of Indian Standards has specified approved standards for raw materials as well as for different possessed products as type tests (1969-1992)

In this study, standardisation of raw materials and ingredients for developing cassava and sweet potato based complementary foods was undertaken using type tests specified by ISI, for cassava flour, sweet potato flour, maida, low fat soy flour and milk powder

These type tests included analysis of moisture, total ash, acid insoluble ash, total sugar, starch, crude fibre, pH of aqueous extract, cold water solubles, gluten, alcoholic acidity, protein and fat of the raw materials used Analysis of moisture, protein, ash and crude fibre content of rice and black gram flour was also undertaken, since ISI specifications were not available These constituents are the major determinants of shelf life quality (moisture), nutritional quality (ash, fibre protein, and fat) and rheological quality (starch and gluten) of the products developed

4 2 1 Type test analysis for cassava flour

The values obtained for the different type tests for cassava flour were on a par with the ISI specification (Table 13) The moisture content of the cassava flour used in the experiment was 9 80 per cent against the ISI specification (IS 1318 1969) of 13 00 per cent In a study on shelf-life qualities of dried tapioca chips for the manufacture of sago, the moisture content of 10 50 content or below was reported to be optimum for better shelf-life (Karuna and Neelakantan 1987)

The ISI specification for maximum ash content in good quality cassava flour is 1 80 per cent Emilia *et al* (1979) have observed an ash content of 1 50 to 2 00 per cent in different cassava varieties

Table 13 Type tests administered for cassava flour and sweet potato flour

Sl No	Tests	Cassava Flour		Sweet Potato Flour	
		Values of samples	ISI specification	Values of samples	ISI Specification
1	Moisture (per cent)	9 80	13 00	8 50	10 00
2	Total ash (precent)	1 60	1 80	1 80	2 00
3	Acid insoluble ash (per cent)	0 10	0 10	0 09	0 10
4	Total sugar (per cent)			6 60	6 00
5	Starch (per cent)	79 00	82 00	58 00	60 00
6	Crude fibre (per cent)	2 00	2 10	3 80	3 00 to 5 00
7	pH of aqueous extract	5 10	4 5 to 7 00	6 30	4 50 to 7 00
8	Cold water solubles (per cent)	10 10	11 00	11 20	12 00

In a similar experiment, a range of 1 80 to 2 00 per cent has been reported by Karuna *et al* (1990) A higher value of upto 3 00 per cent was reported by Gomez *et al* (1984) In the present experiment, the ash content of test cassava flour processed for product development was 1 60 per cent The acid insoluble ash content of the test flour was in accordance with the ISI specified value of 0 10 per cent (ISI 1318 1969)

The starch content of cassava flour was 79 00 per cent which was in line with the values reported earlier on cassava flour such as 79 1 per cent by Emila *et al* (1979) 78 9 per cent by Raja *et al* (1978) and 78 8 per cent by Karuna *et al* (1990) However, the ISI has specified a maximum starch content of 82 00 per cent The starch content may vary among varieties and the variation in this experiment may be due to this factor

The crude fibre content of cassava was found to be 2 00 per cent and the finding was in line with the findings of Karuna *et al* (1990) The ISI has specified a maximum value of 2 10 per cent for crude fibre The value of cassava flour processed in this study was less and to that extent it has been an advantage to use it as a food ingredient for product development

The pH of the aqueous extract of test cassava flour was found to be 6 10 well within the range of 4 50 to 7 00 specified by the ISI The cold water solubles in the test cassava flour formed 10 10 per cent which was less than the maximum limit (11 0 per cent) specified by the ISI The lower value for cold water solubles is an advantage in product development because the loss of nutrients will be less during cooking

Based on the above findings cassava flour processed in this experiment was found suitable and ideal for product development 75 kg of cassava flour of this quality was processed in the laboratory

4 3 2 Type tests for sweet potato flour

An analysis of sweet potato flour revealed the moisture content to be 8 50 per cent against the ISI specification of 10 00 per cent Less moisture content indicates better shelf life quality

The total ash content of sweet potato flour was 1 80 per cent against the ISI specification of 2 00 per cent A higher value for ash content upto 3 20 per cent in sweet potato flour was reported by Yeh and Bownkemp (1988) The acid insoluble ash content of the processed sweet potato flour was 0 09 as against the maximum limit of 0 10 per cent specified by ISI

The total sugar content of the tested sweet potato flour was 6 60 per cent against the ISI specification of 6 00 per cent Broadbury (1990) had reported a variation in the total sugar content of sweet potato according to the varieties and variation in maturity

The starch content of sweet potato flour processed for the experiment was 58 00 per cent and was comparable with the maximum limit specified by ISI (60 00 per cent) Higher values for starch upto 65 00 per cent were reported in sweet potato as the optimum by Broadbury (1990)

The crude fibre content of sweet potato flour obtained in this experiment was 3 80 per cent against the ISI specification of 3 00 to 5 00 per cent Lower values obtained in the present study may be due to varietal and maturity variation Similar deviations have been reported by Yeh and Bownkemp (1988)

The pH of aqueous extract of sweet potato flour was 6 30 and the ISI specified range was between 4 50 and 7 00 This variation may also be due to the varietal variation

The extent of cold water solubles (11 20 per cent) of sweet potato flour was also more or less near the maximum limit specified by ISI (12 00 per cent) The results on the above lines ensure the fitness of sweet potato flour to be an ingredient in the products to be developed 75 kilograms of sweet potato flour of this quality was processed in the laboratory

4 2 3 Type tests for maida

Analyses of moisture, total ash acid insoluble ash, gluten and alcoholic acidity were the type tests administered to ascertain the quality of maida flour

The moisture content obtained for maida was 11 80 per cent (Table 14) which did not exceed the maximum limit of 13 0 per cent specified by ISI The flour was sun dried for better keeping quality, and that might be the reason for the lower moisture content The total ash and insoluble ash content of maida selected for processing products were found to be 0 62 and 0 03 per cent, which were well within the maximum limit specified by ISI as 0 70 and 0 05 per cent for total ash and acid insoluble ash respectively

Table 14 Type tests administered for maida, low fat soy flour and milk powder

Sl No	Tests	Maida		Low fat Soy Flour		Milk Powder	
		Values of test samples	ISI specification	Values of test samples	ISI specification	Values of test samples	ISI specification
1	Moisture (per cent)	11 80	13 00	8 10	9 00	3 80	4 00
2	Total ash (per cent)	0 62	0 70	6 40	7 20	6 80	7 30
3	Acid insoluble ash (per cent)	0 03	0 05	0 38	0 40		-
4	Crude fibre (per cent)			3 70	4 20		
5	Gluten (per cent)	6 80	7 50				
6	Alcoholic acidity	0 10	0 10		-		-
7	Protein (per cent)			46 20	48 00		
8	Fat (per cent)			1 00	1 50	22 40	26 00

Reference IS 1009 1979 IS 7836 1975 IS 1165 1992

Gluten is the protein found in the endosperm of wheat The gluten proteins are largely responsible for the unique binding properties of wheat and maida dough Gluten plays an important role in determining the texture and mouth feel of macaroni, noodles, spaghetti and other cereal foods (Basant 1978) The gluten content of maida obtained in the present investigation was 6 80 per cent against the ISI specified value of 7 50 per cent, while the alcoholic acidity obtained was 0 10 per cent equal to the specification of ISI 15 kg of this quality maida was used for product development

2 4 Type tests for low fat soy flour

Defatted soy flour blends easily and completely with rice flour, and other cereal flours when used for product development Defatted soy flour assists in absorbing and retaining the flavour of other ingredients and improve the texture of the product

The ISI has specified estimation of moisture total ash acid insoluble ash, crude fibre, protein and fat as type tests for low fat soy flour The moisture content (8 10 per cent) of the soy sample in the study was comparable with the specification of ISI (9 00 per cent) The total ash and acid insoluble ash content of soy flour were found to be 6 40 and 0 38 per cent respectively However, the ISI has prescribed a maximum of 7 20 and 0 40 per cent for ash and acid insoluble ash

In soy flour, protein specification by the ISI is 48 g and the soy flour used for the product development contained 46 20 protein A lower value of 1 00 g was obtained for fat content of soy flour which was more or less comparable with the maximum limit specified by the ISI (1 50 per cent) 15 kg of this quality soy flour was used for product development

4 2 5 Type tests administered for milk powder

Estimation of moisture total ash and fat content formed the type tests administered for milk powder The moisture content obtained for milk powder used for developing processed foods was 3 80 per cent which was within the limit specified by the ISI (4 00 per cent) The ISI has prescribed a maximum ash content of 7 30 per cent for milk powder and the value obtained for the test sample was 6 80 per cent Fat content of the milk powder used for the study (22 40 per cent) was within the maximum limit specified by the ISI (26 00 per cent) 5 kg of this quality milk powder was used for product development

4 2 6 Moisture protein ash and crude fibre content of rice and blackgram flour

The ISI specifications for rice and blackgram flour were not available and hence the estimation of moisture, which is the most important characteristic which dertmines the shelf-life of the food, and the protein, total ash, and crude fibre content, the main nutritional determinants, was carried out for rice and blackgram flour, for assessing the quality (Table 15)

Rice flour

The moisture content of rice flour used for the processed food was 8 40 per cent and the protein content was found to be 5 80 per cent Since the ISI specification for rice flour could not be traced, the values were compared with the ICMR values The protein content of the rice flour used (5 80) was lower than the values specified by ICMR (6 40) This may be due to the varietal difference of rice

Table 15 Moisture protein ash and crude fibre content of rice and blackgram flour

Sl No	Tests	Rice Flour	Blackgram flour
1	Moisture (per cent)	8 40	8 60
2	Protein (per cent)	5 80	22 80
3	Total ash (per cent)	0 80	5 40
4	Crude fibre (per cent)	0 30	0 90

A total ash content of 0 80 per cent was obtained for rice flour and the crude fibre content was found to be 0 30 per cent

Blackgram flour

Moisture content of blackgram flour was found to be 8 60 per cent The protein content of the blackgram flour used was 22 80 per cent This value was lower than the values specified by ICMR (24 00 per cent) The total ash content was found to be 5 40 per cent and the crude fibre content was 0 30 per cent

The moisture content for all the raw ingredients was lower than the ISI specified values It ranged between 3 80 and 11 80 per cent This may be due to the variation in the processing procedure applied and varietal changes The lower moisture content is advantageous in product development and also in improving the shelf-life of the products In this experiment, the protein and ash contents of the raw ingredients were slightly lower than the ISI prescribed values Though the values obtained were lower, it was not significant Varietal variation may be one of the reasons for this Lower values were noted in the crude fibre content of the raw ingredients and low crude fibre content is a preferable quality for many products like weaning mixes The gluten content of maida used for the processing of noodles and macaroni was lower than the ISI specification This was disadvantageous because gluten gives elasticity, mouth feel and texture to such products

The alcoholic acidity, which is important to improve the shelf-life of any product, was exactly the same for maida as ISI has prescribed

With the confirmation of quality of raw materials, products were developed with different combinations of raw materials

4 3 Formulation and processing of different complementary foods

The food products to be developed were noodles, macaroni wafers and weaning mix After ensuring the quality of different product constituents, these food materials were used for processing the products The major steps observed in product development were trying different combinations for the formulation of complementary food products, ensuring the quality of the developed products, and studying the physical and cooking characteristics of the extruded products

4 3 1 Different combinations tried for the development of complementary foods

Significant progress has been made by food industries in our country in recent years in the area of development of food products (Rao 1993) The raw ingredients selected for any food product play an important role in determining the qualities of a product Mixing the food ingredients selected in different combinations will decide the nutritional quality, extrusion behaviour in the case of extruded products textural quality, cost and sensory properties of the product Hence, the combination of constituents in a product is equally important as the nature and properties of its constituents

The protein quality of each combination was assessed on the basis of amino acid score The amino-acid content of each constituent in a combination was computed and the amino-acid score of each combination was worked out (App II) The amino-acid scores of the the combinations varied from 62 to 80 The score for protein quality was allotted, based on the amino-acid score A score varying from 1 to 5 was allotted for protein quality

The extrusion behaviour, textural quality and appearance of the products processed with different combinations were assessed by ten technical experts using a standardised pretested score card Extrusion behaviour was observed by the rate of flow and uniformity of strands Extrusion behaviour was recorded three times with a time interval of 15 days by each panel member to have accurate assessment Extrusion behaviour was assessed for noodles and macaroni while textural quality was assessed for wafers and weaning mixes

The cost of each combination was worked out according to the market price of the ingredients The prices of the food materials were collected from the local markets and the actual price of the different ingredients used for 1 kg was computed The processing charge was uniform irrespective of the combinations According to Brich *et al* (1977), the first impression of a food product is usually visual and a major part of our willingness to accept a food depends on its appearance Hence the appearance of the products, processed by using different combinations, was also assessed by the technical experts

4 3 1 1 Noodles and macaroni

The results of the consumption pattern of processed foods in Trivandrum district have revealed that women are aware of extruded products irrespective of their income, and noodles and macaroni were the extruded products popular among them One of the main reasons for the low consumption of these products was stated to be their cost Hence, noodles and macaroni processed with locally available materials at low costs were selected For the development of these products the raw ingredients selected were cassava and sweet potato flour as base (50 to 70 per cent), maida (25 to 35 per cent) and defatted soy flour (10 to 20 per cent) The quantity of cassava and sweet potato flour was the same in all the combinations Since both noodles and macaroni are pasta products and they differ only in shape, they were processed with the same food combinations The different proportions attempted for the processing of noodles and macaroni are given below, and the scores obtained are furnished in (Table 16)

1	Cassava/sweet potato	Maida	soya	7 2 1
2	Cassava/sweet potato	Maida	soya	6 3 1
3	Cassava/sweet potato	Maida	soya	5 2 5 2 5
4	Cassava/sweet potato	Maida	soya	5 3 2
5	Cassava/sweet potato	Maida	soya	5 3 5 1 5

The constituents of a food product should be mixed in the correct proportion so as to get nutritionally and texturally good quality product In the present investigation, the aim was to utilise cassava and sweet potato flour to the maximum in product development So, preliminary trials were carried out with the maximum quantity of cassava and sweet potato flour (70 per cent) reduced upto 50 with 10 per cent variation Decrease in quantity of cassava/sweet potato flour was directly propotional to the increase of maida in the combination

Table 16 Selection of combinations for noodles/macaroni

Sl No	Combination tried			Quality Parameters				
				Protein Quality	Extrusion behaviour	Cost	Appearance	Total score
	Noodles/Macaroni							
	Cassava/Sweet Potato	Maida	Soya Flour					
1	7	2	1	2 50	2 80	4 20	2 30	11 80
2	6	3	1	3 00	3 00	4 00	2 50	12 50
3	5	2 5	2 5	4 40	3 20	3 10	3 50	14 20
4	5	3	2	4 20	4 00	3 50	3 80	15 50
5	5	3 5	1 5	4 20	5 00	4 30	5 00	18 50
	SE							0 357
	CD							1 126

In the first combination, where cassava or sweet potato flour was 70 per cent, the cost was less while other quality parameters like protein quality and extrusion behaviour were far from satisfactory since low scores of 2 50 and 2 80 were obtained for protein quality and extrusion behaviour The second combination consisted of 60 per cent cassava or sweet potato flour along with 30 per cent maida and 10 per cent soy flour When compared to the first combination a slight increase in the score for different quality parameters such as protein quality (3 0) and extrusion behaviour (3 0) was observed The total score for this combination (12 50) indicated a better acceptance

In the third combination, cassava or sweet potato flour was further reduced to 50 per cent, enhancing the proportions of maida (25 per cent) and soy flour (25 per cent) The highest score of 4 40 was obtained for the parameter protein quality The incorporation of 25 per cent soy flour may be the main reason for this But the combination secured a low score (3 20) for extrusion behaviour probably because of reduction in maida Gluten content, which was mainly responsible for elasticity was reduced in this combination and this might have been the reason for the poor extrusion behaviour The total score obtained for this combination was 14 20 The third combination was also found to obtain a high score (4 40) for protein quality and a low score (3 10) for cost

In the fourth combination tried, maida was increased to 30 per cent and soy flour was reduced to 20 per cent As a result, the quality of parameter extrusion behaviour improved for this and the total score was 15 50 In this combination, protein quality secured the highest score (4 20) while for cost the score was lower (3 50) Another attempt was also made to process the product with 35 per cent maida and 15 per cent soy flour, as to improve the extrusion behaviour and reduce the cost The maximum score was secured by this combination for parameters like extrusion behaviour and appearance and the total score was 18 50

When the total scores were analysed statistically, it was found that the total score (18 50) obtained by the fifth combination with cassava/sweet potato flour (50 per cent), maida (35 per cent) and soy flour (15 per cent), was significantly higher than in the other four combinations and hence this combination was selected for the processing of noodles and macaroni

4 3 1 2 Formulation of wafers

Compared to noodles and macaroni, wafers were found to be more popular as a snack food, among the families surveyed in the present investigation They were usually consumed as snack food or as side dish for major meals by most of the families Wafers were usually processed with rice flour Bhole (1992) in his study analysed the possibility of using rice mixes for the production of snack foods and found the products highly acceptable

In the present investigation, wafers were tried with cassava or sweet potato flour along with rice and other legume flours such as blackgram, bengalgram, greengram and soy flour The quality parameters selected to assess the combination for the development of wafers were the same as for noodles and macaroni, such as cost and appearance The textural quality was studied instead of extrusion behaviour Protein quality needs to be given priority while developing wafers since this product is a popular snack food among children

Wafers were tried in the laboratory with five different combinations such as

1 Cassava/sweet potato bengalgram Soy flour 7 1 5 1 5

2 Cassava/sweet potato blackgram rice 6 2 2

3 Cassava/sweet potato blackgram rice = 5 2 5 2 5

4 Cassava/sweet potato bengalgram rice 5 3 2

5 Cassava/sweet potato greengram rice - 6 2 2

(The scores obtained are furnished in Table 17)

In the first combination, where cassava or sweet potato flour constituted 70 per cent along with bengalgram (15 per cent) and soy flour (15 per cent), high scores were obtained for appearance (3 30) and cost (3 60) Comparatively lower scores were obtained for the other two parameters, protein quality (3 40) and textural quality (3 00) The total score for this combination was 13 80

In the second combination, bengalgram and soy flour were replaced with blackgram and rice flour Traditionally wafers are processed with rice flour and hence rice flour was incorporated The score for textural quality in this combination was better (3 80) than in the first combination

Table 17 Selection of combinations for wafers and weaning mix

Sl No	Combinations tried	Protein Quality	Textural quality	Cost	Appearance	Total score
	Wafers					
1	Cassava/Sweet Potato Blackgram Flour Soy Flour 7 1 5 1 5	3 40	3 00	3 60	3 80	13 80
2	Casssava/Sweet Potato Blackgram Flour Rice 6 2 2	3 50	3 80	3 10	3 60	14 00
3	Cassava/Sweet Potato Blackgram Flour Rice 5 2 5 2 5	3 60	5 00	3 00	4 80	17 30
4	Cassava/Sweet Potato/ Bengalgram Rice 5 3 2	3 60	2 60	3 00	2 10	11 30
5	Casssava/Sweet Potato Green gram Rice 6 2 2	3 60	2 00	3 20	2 30	11 10
	SE					0 183
	CD					0 575
	Weaning Mix					
1	Cassava/Sweet Potato Milk Powder Soy Flour 7 1 2	3 20	2 00	3 50	3 50	12 20
2	Cassava/Sweet Potato Greengram Soy Flour 6 2 2	3 40	2 10	3 40	3 50	12 40
3	Cassava/Sweet Potato Rice Flour Ground nut Flour 6 1 3	4 00	3 00	3 80	4 00	14 80
4	Cassava/Sweet Potato Milk Powder Soy 5 2 3	4 60	4 20	4 10	4 60	17 50
5	Cassava/Sweet Potato Milk Powder Soy 5 2 5 2 5	4 50	5 00	4 00	4 00	18 40
	SE					0 197
	CD					0 621

Comparatively lower scores were obtained for appearance (3 60) and cost (3 10) The score obtained for protein quality (3 50) was better than in the first combination A total score of 14 00 was obtained for this combination

In the third trial, the same combination was tried in a different proportion (5 2 5 2 5) The maximum score (5 00) was secured for textural quality in this combination Parameters like protein quality and appearance got better scores of 3 60 and 4 80 respectively when compared to the other two combinations The score for cost was low for this combination (3 00) and the total score (17 30) was significantly higher than in the other two combinations

The fourth combination was tried by replacing blackgram flour with bengalgram flour in view of reducing the cost When compared to the third combination, low scores were obtained for protein quality (3 50), textural quality (2 50) and appearance (2 10) A slightly higher score was obtained for cost (3 10), and the total score for this combination was 11 30

Since the fourth combination secured a very low score for appearance in the fifth combination bengalgram flour was replaced by greengram flour in an attempt to improve the appearance Then appearance obtained a better score (2 30) than in the fourth combination, but it was lower than in the third combination The score for cost (3 20) was slightly better than in the third combination The score obtained for protein quality (3 60) was comparable with these in the third and fourth combinations But the parameter textural quality secured a very low score (2 00) for this combination The Total score for this combination was (11 10) When the data was statistically analysed, it was revealed that the total score of the third combination, cassava or sweet potato flour, black gram flour and rice flour in the proportion of 5 2 5 2 5, was significantly higher than in the other combinations and this combination was selected for the development of wafers

4 3 1 3 Formulation of weaning mix

According to Chandrasekhar *et al* (1988), weaning foods should be nutritionally well balanced and should have a soft texture with low fibre content Malleshi (1988) also stresses the same point The raw ingredients selected for the development of weaning mix were cassava or sweet potato flour along with soy flour, milk powder, greengram groundnut and rice The different combinations tried for the formulation of weaning mix were

1 Cassava/sweet potato Milk powder soya 7 1 2

2 Cassava/sweet potato Greengram soya 6 2 2

3 Cassava/sweet potato Rice Ground nut flour 6 1 3

4 Cassava/sweet potato Soya MIlk powder 5 2 3

5 Cassava/sweet potato Soya Milk powder 5 2 5 2 5

In the first combination tried, cassava or sweet potato flour constituted the major portion (70 per cent) The maximum score of 3 50 was secured for both appearance and cost, followed by protein quality (3 20), while the parameter textural quality secured a very low score (2 00) Due to the high per centage of cassava or sweet potato flour, the mix seemed to be fibrous and that might have been the reason for the lower score for textural quality The total score obtained for this combination was 12 20

In the second combination tried, the percentage of cassava or sweet potato flour was reduced to 60 and milk powder was replaced by greengram The score obtained for appearance (3 50) was similar to that in the first combination, and a slightly lower score (3 40) was obtained for cost and a slightly higher score (2 10) for textural quality The score for protein quality (3 40) was better than in the first combination The total score obtained for this combination was 12 40

The third combination was tried with rice flour and groundnut flour along with cassava or sweet potato flour The highest score was obtained for appearance as well as for protein quality (4 0) This was followed by cost (3 80) and textural quality (3 00) In general, all the quality parameters obtained higher scores than in the first two combinations The total score obtained for this combination was 14 80

As a trial to improve the textural quality, the per centage of cassava or sweet potato flour was still reduced to 50 per cent and weaning mix was formulated along with milk powder and soy flour The maximum score of 4 60 was secured for both appearance and protein quality, which was better than in the other combinations, with a score of 4 10 and 4 80 for cost and for textural quality respectively (4 20) The total score obtained for this combination was 17 50

The fifth combination was tried with the same components but in different proportions Soy flour was reduced to 25 per cent with the aim of improving appearance The score obtained for appearance was 4 90 which was higher than in all the other combinations The same trend was noted in textural quality (5 00) also Though the score obtained for protein quality (4 50) and cost (4 00) were slightly lower than in the fourth combination, the total score for this combination (18 40) was higher than in the fourth

When the results were statistically analysed, it was found that the total score for the fifth combination (Cassava or sweet potato flour, milk powder and soy flour in the proportion 5 2 5 2 5) was significantly higher than the total score in the other combinations and this was selected for the formulation of weaning mix

4 3 2 Type tests administered to the developed products

Implementation of quality system standards for the food products would result in several benefits Through total efforts for improvement and sustenance of quality cost, benefit could be achieved which would lead to consumer satisfaction and better image for the products (Govindan 1993) The Bureau of Indian Standards has specified certain type tests for various products to maintain quality during marketing

Estimation of moisture, total ash, acid insoluble ash, protein and total solids in gruel, are the major type tests prescribed for noodles and macaroni (Table 18) Moisture content of both noodles and macaroni was found to be 9 00 per cent while the ISI has specified a maximum limit of 11 00 Moisture content of 10 00 per cent was reported for another extruded product, vermicelli, by Thirumaran (1993) The lower moisture content of the products is beneficial since it may improve the keeping quality of the products

The total ash content of the two products indicated slight variation The ash content of cassava noodles was 0 73 per cent, while, for noodles based on sweet potato, it was 0 76 per cent However, the trend was different in the case of macaroni since cassava based macaroni had a value of 0 78 per cent ash and for that of sweet potato based it was 0 76 per cent All these values are slightly higher than the ISI specified value of 0 75 for ash One of the raw ingredients present in the product was soy flour which is rich in minerals So, the increased mineral content of the products may be the reason for the higher value for ash

The acid insoluble ash, which gives information regarding the inorganic salts present in the product, was analysed and the result revealed (Table 18) that the values were the same for noodles and macaroni Both cassava noodles and macaroni exhibited a value of 0 40 per cent, while a higher value of 0 50 per cent was obtained by noodles and macaroni based on sweet potato However, all these values were within the limit of 0 50 per cent specified by ISI

Processed foods are not considered as protein rich foods and the ISI has prescribed 10 00 per cent protein for noodles and macaroni But the products processed in the present investigation were rich in protein The highest protein content was observed for sweet potato-based noodles and macaroni (11 90 and 11 80 per cent) The protein content was 11 27 and 11 17 per cent in the case of cassava macaroni and noodles The incorporation of soy flour in the products may be the reason for this higher value Similarly, 11 20 per cent of protein was observed for soya-incorporated vermicelli by Thirumaran (1993)

The total solids in gruel will give information regarding the water soluble ingredients and percentage of cooking loss on any product

Table 18 Type tests administered for the developed products

Sl No	Test	Noodles Cassava	Noodles Sweet potato	Macaroni Cassava	Macaroni Sweet potato	ISI Specification	Weaning Mix Cassava	Weaning Mix Sweet potato	ISI Specification
1	Moisture (Percent)	9 00	9 00	9 00	9 00	11 00*	5 10	5 20	5 00
2	Total Ash (Percent)	0 73	0 76	0 78	0 76	0 70*	1 06	1 23	5 00*
3	Acid Insoluble Ash (Percent)	0 04	0 05	0 04	0 05	0 05*	0 05	0 07	0 10*
4	Total Protein (Percent)	11 17	11 80	11 27	11 50	10 00**	17 60	18 10	12 00**
5	Total Solids in gruel (Percent)	7 50	7 80	8 10	8 20	8 00*			
6	Carbo hydrate (Percent)						55 30	48 30	55 00**
7	Crude fibre (Percent)						0 95	1 00	1 00**

* Maximum

** Minimum

In the present investigation, it was observed that the total solids in gruel was higher for sweet potato-based products (8 20 and 7 80 per cent for macaroni and noodles) than for cassava based products (8 10 for macaroni and 7 50 for noodles) Among the products, macaroni exhibited higher values than noodles The difference in the processing techniques may be the reason for this The ISI has prescribed a value of 8 00 per cent for total solids in gruel The values for cassava products were within the limit and sweet potato-based products showed slightly higher than the prescribed value for this parameter

4 3 2 2 Type test administered for weaning mix

Estimations of moisture ash, acid insoluble ash, protein, carbonhydrate and crude fibre were carried out as type tests for weaning mix (Table 18) The moisture content was 5 10 and 5 20 per cent for cassava and sweet potato-based weaning mixes These findings were in line with the findings of Thirumaran (1993) (5 26 per cent) and Malleshi (1989) (5 21 per cent) However, the ISI has specified a maximum limit of 5 00 per cent for weaning mix The moisture content of the constituents present in the weaning mixes may be the reason for the slightly higher value

The total ash content was found to be 1 06 and 1 23 per cent for cassava and sweet potato-based weaning mixes The ISI has permitted a maximum limit of 5 00 per cent for ash content of weaning mixes and the ash content of the developed weaning mixes were observed within the limit The same trend could be seen in the case of acid insoluble ash also Sweet potato based weaning mix exhibited a value of 0 07 per cent while the value for cassava-based weaning mix was 0 05 per cent Both the values were within the limit (0 10 per cent) prescribed by the ISI Protein content of weaning mix is one of the important characteristics deciding the quality of the mix The ISI has prescribed a minimum protein content of 12 00 per cent for weaning foods However, the maximum value has not been prescribed by the ISI In the present investigation, higher protein content of 18 80 per cent was recorded by sweet potato weaning mix, followed by cassava weaning mix (17 60 per cent) These findings are in line with the findings of (Gopaldas *et al* (1982), Ashtukar *et al* (1992), Mugula (1992) and Thirumaran (1993) Soy flour and milk powder present in the weaning mixes might have contributed to the higher value

In the case of carbohydrate content, 55 30 g was observed for cassava weaning mix, which is in line with the ISI prescribed value of 55 00 g However, sweet potato based weaning mix had a lower value of 48 30 g than the ISI specified value The lower carbohydrate content of sweet potato may be the reason for the lower value Carbohydrate content ranging from 49 00 to 55 00 g in developed weaning food was reported by Gopal Das (1982)

When the crude fibre content of the weaning mix was analysed, it was found that cassava weaning mix exhibited a value of 0 95 per cent and sweet potato weaning mix exhibited a value of 1 00 pre cent, which were within the maximum prescribed value of 1 00 per cent for crude fibre

4 3 3 Physical characteristics of extruded products

For product development in India, more emphasis is given to the chemical standards neglecting the physical and culinary standards The physical characteristics are among the important criteria for product acceptance The physical characteristics which may decide the acceptance of extruded products are fineness, shape, uniformity of strands packaging quality and tensile strength The fineness, shape and uniformity of strands are determinants responsible for the appearance of the product Tensile strength can be defined as the ability to withstand force (Prince *et al* 1994) The packaging quality of a product should also be given emphasis since it is the link between the food processor and consumer (Veeraraju 1993)

The physical characteristics of noodles based on cassava and sweet potato were found to differ significantly between the two tubers (Table 19) For all the quality parameters, sweet potato noodles secured lower scores when compared to cassava and standard noodles The score for fineness of sweet potato noodles (4 30) was significantly lower than that for cassava noodles (4 90) and standard noodles (4 90) Cassava noodles obtained a maximum score of (5 00) for shape, followed by standard (4 90) and sweet potato noodles (4 20) The score for uniformity of strands of sweet potato noodles (3 00) was also significantly lower than that for cassava noodles (4 30) and standard noodles (4 80) When these quality parameters were compared for cassava noodles and standard noodles, it was found that cassava noodles was comparable to standard in all the parameters except in uniformity of strands For shape, cassava noodles (5 00) was better than standard noodles (4 90)

Table 19 Physical characterstics of extruded products

Sl No	Products	Quality Parameters				
		Fineness	Shape	Uniformity of strands	Packaging quality	Tensile strength
1	Cassava Noodles	4 90	5 00	4 30	4 90	4 80
2	Sweet Potato Noodles	4 30	4 20	3 50	4 60	4 70
3	Standard Noodles	4 90	4 90	4 80	5 00	4 70
	SE	0 120	0 096	0 151	0 105	0 136
	CD	0 348	0 279	0 439	0 305	0 394^{ns}
1	Cassava Macaroni	4 80	5 00		5 00	4 40
2	Sweet Potato Macaroni	4 70	4 80		5 00	4 20
3	Standard Macaroni	5 00	5 00		4 80	4 40
	SE	0 117	0 94		0 769	0 145
	CD	0 339^{ns}	0 274^{ns}		0 223^{ns}	0 42^{ns}

ns not significant

Naratta (1986) has defined packaging quality as the ability of the product to withstand insect infestation absorption of moisture, heat and dynamic stress The maximum score for packaging quality (5 00) was obtained by standard noodles, followed by cassava noodles (4 90) and sweet potato noodles (4 60) The packaging quality of sweet potato noodles was significantly lower than that of standard noodles, but the difference was not significant when compared with cassava noodles The packaging quality of cassava noodles was on a par with that of standard noodles

Regarding tensile strength, cassava noodles obtained the highest score (4 80) Standard noodles and sweet potato noodles exhibited a score of 4 70 for tensile strength The developed noodles could be rated as equal to, or even better than the standard noodles in the quality parameter tensile strength Incorporation of soybean in the developed noodles has increased the protein content and that may be the reason for the higher scores for tensile strength This finding is in line with the findings of Prince *et al* (1994) In his study he had found out an increasing trend in tensile strength with the increased level of soya in the dough mix The analysis of physical characters of noodles revealed that cassava noodles could very well be compared with standard noodles or was even better in shape and tensile strength than standard, while sweet potato noodles secured lower scores for parameters like uniformity of strands and packaging quality

When the physical characteristics of macaroni were analysed, it was found that there was no significant difference in the quality parameters for the developed and standard macaroni

For shape, the highest score was obtained by standard macaroni (5 00), followed by cassava (4 80) and sweet potato macaroni (4 70) Though sweet potato macaroni secured a low score it was not significantly lower than the scores for the other two The same trend was noted for the quality parameter shape The maximum score (5 00) was shared by cassava and standard macaroni while sweet potato macaroni obtained a score of 4 80 which was not significantly lower than that of cassava and standard macaroni

The packaging quality of sweet potato, macaroni, unlike that of noodles was extremely good Regarding packaging quality, the maximum score of 5 00 was obtained by cassava and sweet potato macaroni while standard macaroni obtained a lower score (4 80) But the variation in scores was not statistically significant

Cassava macaroni and standard macaroni shared the highest score (4 40) for tensile strength while sweet potato macaroni scored only 4 20 Again, the variation was not statistically significant It was revealed that all the quality parameters for the physical characteristics of macaroni could be rated as equal to or even better than the quality parameter of packaging of quality standard macaroni

4 3 4 Cooking characteristics of extruded products

Food products are considered as convenient foods because of their three proven advantages in time labour and fuel saving, and these factors play a decisive role in conditioning their popularity among consumers Nagarajan (1993) in his study has found out that products which can be cooked using less energy will have a large potential It was decided to ascertain the cooking time of the products developed (Table 20) The cooking time was determined from the time of adding the product to boiled water till it got completely cooked, using a stop watch There was no significant variation observed in the cooking time of the three noodles

Table 20 Cooking characterstics of extruded products

Sl No	Products		Quality Parameters		
			Cooking time (minutes)	Water Absorption index	Bulk Density
1	Cassava noodles		7 13	0 61	0 46
2	Sweet potato noodles		7 20	0 51	0 46
3	Standard noodles		7 18	0 53	0 43
4	Cassava macaroni		5 59	0 41	0 61
5	Sweet potato macaroni		5 43	0 37	0 60
6	Standard macaroni		6 05	0 44	0 59
	Between Products	SE	0 015	0 005	0 004
		CD	0 054	0 017	0 015
	Between tubers	SE	0 027	0 008	0 003
		CD	0 093	0 029	0 009

Cassava noodles took less time (7 minutes, 13 seconds) to get cooked, while sweet potato noodles took 7 minutes 20 seconds and standard noodles took 7 minutes 18 seconds The cassava starch gelatinized more quickly than sweet potato starch, and that may be the reason for the lower cooking time recorded The noodles developed in the study were rated equal to or even better' than standard noodles in the quality indicator cooking time

A comparison in the cooking time of cassava and sweet potato-based macaroni with standard macaroni revealed significant variation among the three Standard macaroni required more time (6 minutes 5 seconds) to get cooked than cassava (5 minutes 59 seconds) and sweet potato macaroni (5 minutes 43 seconds) The developed macaroni required significantly lower time to get cooked when compared to standard macaroni The constituents used for developing macaroni and the processing methods administered may be the reason for this variation The developed macaroni was better than the standard one as far as cooking time was concerned When the two products were compared it was observed that noodles required more time than macaroni to get cooked

When the water absorption or rehydration capacity of the products was analysed, it was found (Table 20) that the highest water absorption index (0 61) was observed for cassava noodles followed by standard (0 53) and sweet potato noodles (0 51) The water absorption index of cassava noodles was significantly higher than that of standard and sweet potato noodles The water absorption index of sweet potato noodles was on a par with standard noodles The constituents or raw materials present in the product, the nature of starch, the moisture content of the raw materials as well as finished products, and method of processing, are some of the factors which affect the water absorption index The difference in these characteristics in the developed noodles and standard noodles may be the reason for the variation in the water absorption index Again, the developed noodles could be rated equal to or even better than the standard noodles in the quality parameter water absorption index

The water absorption index in macaroni exhibited a significant variation Unlike for noodles, the water absorption index was the highest (0 44) for standard macaroni, followed by cassava macaroni (0 41) and sweet potato macaroni (0 37) When the two products were compared, the water absorption index of noodles was significantly higher than that of macaroni The difference in the processing technology and the temperature at which these products were processed may the reason for this variation

Bulk density is one of the most common simple measurements in food analysis, which can be used for the analysis of solid foods It is the characteristic physical property and serves for identification purposes (Potter 1988) The volume of different food products can be compared through bulk density The products exhibited variation in bulk density (Table 20) The bulk density of standard noodles (0 43) was significantly lower than that of cassava and sweet potato noodles (0 46) This finding was in line with the finding of the study of Julianty *et al* (1994) in which he has recorded a bulk density of 0 44 for an egg white-based extruded product Contradictory to the other two characteristics viz cooking time and water absorption index, the bulk density of the developed as well as standard noodles was significantly lower than that of the developed and standard macaronis The shape of macaroni may be the reason for this variation The highest value (0 61) was recorded by cassava macaroni, followed by sweet potato (0 60) and standard macaroni (0 59)

4 4 Acceptability of the complementary foods developed

In general, while examining the acceptability of any product, the nutritive value, organoleptic qualities and the keeping quality of the product should be considered (Rolfe 1977)

Accordingly, in the present investigation, the acceptability of the developed complementary foods was studied with special reference to -

4 4 1 Nutritive value

4 4 2 Physiological tolerance

4 4 3 Organoleptic qualities

4 4 4 Shelf life qualities

4 4 1 Nutritive value of the developed complementary foods

Acceptability nutrition and cost are the prime elements of good food Traditional food satisfied these parameters adequately So any new food product should be developed based on these principles (Potty 1993) According to Rao (1992) the consumer expects to meet his nutritional needs as much from processed foods as from the natural food when he partially substitutes the latter for the former Amla (1993) feels that when developing new food products, the nutritive value may get lost because of the inappropriate processing methods

The nutritive value of the complementary foods developed was estimated in the laboratory To ascertain the nutrient loss during processing, the nutritive values were so determined in the processed foods by standard method These data are presented in Table 21 to bring out nutrient losses, if any, during processing

Protein

Protein is one of the most important nutrients required by the body to carry out a wide range of functions essential for the maintenance of life When the protein content of the developed foods was analysed it was found that weaning mixes with cassava (17 90 g) and sweet potato (18 55 g) contained the highest level of proteins

Table 21 Nutritive value of the developed complementary foods

Foods	Protein g		Ene gy K Cals		Carbohy drates g		Carotene Mg		Calcium Mg		Magnesium Mg		Zinc Mg		Iron Mg		Ash Mg
	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E
1 Cassava Noodles	10 75	11 10	350	356	67 50	70 40	62 10	72 70	86 30	90 00	77 90	78 20	0 70	0 70	4 23	4 30	0 73
2 Sweet Potato Noodles	10 95	11 60	301	307	55 70	57 30	62 40	78 70	86 90	89 00	71 10	71 20	116 00	116 70	2 75	2 80	0 86
3 Cassava Macaroni	10 70	11 10	347	356	67 80	70 40	62 10	72 70	86 30	90 00	77 80	78 20	0 70	0 70	4 20	4 30	0 71
4 Sweet Potato Macaroni	10 95	11 60	302	307	55 80	57 30	69 90	78 70	86 90	89 00	71 00	71 20	116 00	116 70	2 80	2 80	0 84
5 Cassava Wafers	8 35	8 40	335	342	75 00	75 30	9 10	9 50	75 90	86 70	80 10	81 00	1 00	1 10	3 00	3 00	0 70
6 Sweet Potato Wafers	8 75	8 90	289	293	61 90	62 20	15 10	15 50	85 00	85 70	74 60	75 00	116 00	117 00	1 35	1 40	0 83
7 Cassava Wean ng Mix	17 95	18 20	397	403	55 50	56 00	449 00	456 00	339 00	344 00	76 00	77 00	0 70	0 70	4 50	4 60	1 00
8 Sweet Potato Weaning Mix	18 55	18 70	351	354	42 00	42 90	459 00	462 00	341 00	343 00	69 50	70 00	115 00	116 00	3 00	3 00	1 23

E Estimated Value

C Computed Value

The addition of soy flour and milk powder in the preparation of weaning mixes may be the main reason for the higher value of protein both in quantity and quality From one serving of this weaning mix (20 g) nearly 3 80 g of protein is made available which is a significant quantity for the child The computation of protein content of the weaning food revealed a slightly higher value (cassava weaning food 18 20 and sweet potato weaning food 18 70 g respectively) This may be due to the loss during processing However the difference was not statistically significant The protein content of noodles and macaroni varied from 10 70 to 10 95 g The computed value of protein for noodles and macaroni varied from 11 10 to 11 60 g The protein loss during processing of both noodles and macaroni was higher which was also statistically significant This finding is in line with the results obtained by Beufrand *et al* (1978) In their study of extrusion of cereal mixture, they found that during extrusion there was an overall loss of protein with special reference to lysine Maga and Sizer (1979) also reported a similar significant loss of protein during the extrusion of potato flakes The protein content of wafers was comparatively lower with cassava wafers 8 35 and sweet potato wafers 8 75 g respectively The computed values were slightly higher (8 40 and 8 90 g) However, the variation was not statistically significant

Energy

Energy is essential for rest, activity, growth and maintenance of good health Energy expenditure must be balanced by energy intake All the foods developed in this study had a high energy content varying from 289 to 398 k calories Sweet potato wafers had the lowest value (289 K cals) and cassava weaning mix had the highest value (398 K cals) This was closely followed by sweet potato weaning mix (396 K cals), cassava noodles (351 K cals), cassava macaroni (301 K cals), sweet potato noodles (300 K cals), and sweet potato wafers (288 K cals) The computed values for energy for the developed products were higher ranging from 293 to 403 K cals This variation may be due to loss during processing However, the variation was not statistically significant

Carbohydrates

Carbohydrates in any processed foods account for about 50 to 60 per cent of energy The foods developed in the pǫresent study were found to have adequate quantity of carbohydrates in the range of 42 10 to 75 00 g Higher values were exhibited by cassava based products (noodles - 67 50, macaroni 67 80, wafers 75 00, and weaning mix 55 60 g) when compared to sweet potato based products (noodles 55 70, macaroni 55 80, wafers 61 90, and weaning mix 42 00 g) The variation in the carbohydrate content of the tubers of used may be the reason for the observed higher values for cassava products The computed values for all the products exhibited higher values revealing loss during processing However, the variations were not statistically significant The loss was greater for extruded foods Severe processing conditions may be the reason for this (Linko *et al* , 1978) Chang and Johnson (1977) who studied the effect of extrusion of carbohydrate state that the loss during processing may be due to the gelatinization of cereal starches

Carotene

There was a vast variation in the carotene content of the products developed, ranging from 9 10 to 460 00 mg The highest values were recorded by weaning mixes (449 00 and 459 00 mg) followed by cassava and sweet potato macaroni

(69 90 mg) sweet potato noodles (62 40 mg), cassava macaroni (62 20 mg) cassava noodles (62 10 mg) sweet potato wafers (15 10 mg), and cassava wafers (9 10 mg) The incorporation of milk powder and soy flour in weaning mixes may be the reason for the highest value The other ingredients in cassava and sweet potato wafers were blackgram flour and rice flour which were not rich sources of carotene, and that may be the reason for the low values The computed value for carotene content revealed higher values for all the products When the variations between the estimated and computed values were analysed, it was found that the differences was statistically significant in extruded products It was not significant for wafers and weaning mixes Destruction of vitamins in extruded foods was reported by Beetner *et al* (1974) Lee *et al* (1978) studied the stability of carotene in extrusion cooking According to them, retention of carotene is low during processing

Minerals

Minerals play a vital role in nutrition and slight changes in the concentration of the important minerals may rapidly endanger life Hence, the mineral content of any food product is highly essential

Calcium

The calcium content of the products developed was analysed It was higher for weaning mixes (339 and 341 mg), for cassava weaning mix and sweet potato macaroni (86 9), cassava macaroni (86 3), cassava noodles (86 2), sweet potato noodles and cassava wafers (85 9), sweet potato noodles and cassava wafers (85 0 mg) The addition of milk powder in weaning mixes is the primary reason for the observed higher value The computed values were significantly higher than the estimated values for extruded products revealing the higher processing loss Though the computed values were higher for wafers and weaning mixes, they were not statistically significant

Magnesium

Magnesium is highly required for cellular metabolism essential for intracellular enzyme, metabolism of carbohydrates and the structure of DNA and RNA The magnesium content of the developed products varied from 71 00 mg to 80 10 mg The magnesium contents of cassava based products were 80 10 77 90 77 80 and 76 00 mg respectively for wafers noodles, macaroni and weaning mix The same trend was observed for sweet potato products also Wafers scored the highest value (74 60 mg), followed by noodles (71 10) macaroni (71 00) and weaning mix (69 50 mg) Blackgram flour which is a constituent in wafers is a rich source of magnesium and this must have contributed to the higher value Though the computed value for magnesium content for these products was slightly higher, it was not statistically significant indicating that the loss during processing was only negligible

Zinc

Zinc is an important element as it acts as a cofactor for a number of enzymes in the body The estimation of the zinc content of the products revealed that sweet potato based products exhibited a very high value of 116 10 116 00 115 80 and 115 00 mg for wafers, macaroni, weaning mix and noodles respectively While cassava based products exhibited a very low value of 0 70 to 1 00 mg, a higher value of 1 00 mg was secured by cassava wafers The zinc content of noodles, macaroni and weaning mix was 0 70. sweet potato is a rich source (116 mg /100 g) of zinc and this might have contributed to the higher value for the products There was no significant loss of this nutrient during processing

Iron

The iron content of the products revealed higher values for cassava-based products, which ranged from 3 00 to 4 50 mg Sweet potato based products exhibited values varying from 1 40 to 3 00 mg Th lowest value was recorded by weaning mixes There was only a slight variation in the computed value When the data was statistically analysed, it was found that the difference was not significant, indicating that the loss of iron during processing for these products was only negligible

Ash

The ash content of the developed products varied from 0 70 to 1 23 mg The highest value was recorded by sweet potato weaning mix (1 20 mg), followed by cassava weaning mix (1 06 mg) sweet potato noodles (0 86 mg), sweet potato macaroni (0 84 mg) sweet potato wafers (0 83 mg) cassava noodles (0 73 mg), cassava macaroni (0 71 mg), and cassava wafers (0 70 mg) Sweet potato based products exhibited higher values than cassava based products the higher mineral content of sweet potato being the main reason for this observation The computed value for ash content revealed that there was no significant loss due to processing in these products

Economics of the developed products

High cost is unavoidable in food processing and hence the challenge in developing new food products is to keep the cost to a minimum (Amla 1993) According to Nagarjan (1993), the strategies for the development of food products have to be based on affordable price and cost effectiveness

The cost of one kilogram each of the products developed was worked out and the results are presented in Table 22 The cost of both cassava and sweet potato noodles was only half of the price (Rs 10/- and 11/- respectively) of standard noodles available in the market (Rs 20/- to 25/) The same trend was observed in macaroni also Rs 12/- and Rs 12 50 for cassava and sweet potato macaroni while standard (maida) macaroni cost Rs 24/- to 28/-

Table 22 Cost of the developed complementary foods (per kilogram)

Sl No	Foods	Cost Rs/Kg
1	Cassava noodles	10 00
2	Sweet Potato noodles	11 00
3	Standard noodles	20 00 to 24 00
4	Cassava macaroni	12 00
5	Sweet Potato macaroni	12 50
6	Standard macaroni	24 00 to 30 00
7	Cassava wafers	12 00
8	Sweet Potato wafers	12 50
9	Standard wafers	30 00 to 34 00
10	Cassava weaning Mix	30 00
11	Sweet Potato weaning Mix	32 00
12	Standard weaning Mix	60 00 and above

Weaning mix also exhibited the same trend Commercial weaning mixes cost Rs 60/- and above in the market while the weaning mixes developed in the present study were less expensive (Rs 30/- and Rs 32/- for cassava and sweet potato respectively) The cost of different types of wafers available in the market ranged from Rs 30/- onwards However the cost of the developed cassava and sweet potato wafers was Rs 12/- and Rs 12 50 per kilogram A slight increase in cost was recorded in sweet potato based products than in cassava based products This may be due to the slightly higher price of sweet potato tubers In general, all the products developed were of low cost when compared to their counterparts available in the market

4 4 2 Physiological tolerance of the processed foods developed

Physiological tolerance is one of the important criteria to be analysed before the production of any new food According to Ritchey and Harper (1981), the most realistic way to assess the physiological tolerance and nutritional quality of any new food is to conduct feeding trials on animals Several biological measurements have been proposed as indicators of the physiological utilization of foods Among these the most important is protein efficiency ratio which indicates the ratio of the gain in the body weight to the protein consumed at a specified period of time while nitrogen balance study is considered as a measure to find out the extent of utilization of proteins from any food in the body In the present investigation, animal experiments were conducted to assess the PER, nitrogen retention and net protein utilization

Table 23 explains the food intake of animals There was significant difference in food intake among the groups The highest food intake was recorded by the control group (149 357) Among the various experimental groups, animals fed with cassava noodles/macaroni registered the highest food intake (145 982 g) The lowest value was recorded by the group of animals fed with sweet potato wafers The different raw ingredients present in the different foods may be one of the reasons for the variation in food consumption

Table 23 Mean food intake of animals

Sl No	Group		Mean food intake (g)
	Experimental Groups		
1	Cassava noodles/macaroni		145 982
2	Sweet Potato noodles/macaroni		139 732
3	Cassava wafers		139 714
4	Sweet Potato wafers		138 089
5	Cassava weaning mix		141 392
6	Sweet Potato weaning mix		142 642
	Control Group		149 357
		SE	0 108
		CD	0 362

Table 24 details protein intake by various groups The highest protein intake was observed in the control group (14 935 g) Among the experimental groups, animals fed with cassava noodles/macaroni registered the highest protein intake (14 598) The lowest protein intake was exhibited by sweet potato noodles/macaroni and cassava wafers (13 973) When the two tubers were compared, it was found that the protein intake of animals fed with cassava based foods was higher than that of animals fed with sweet potato-based foods The difference in the food intake among the group may be the reason for the variation in protein intake also

The weight gain of animals is an important parameter exhibiting the quality of protein The weight gain of the animals was analysed (Table 25 and fig 11) It was found that the gain was significantly higher for the control group (46 43 g) than for the experimental groups The control group was fed with casein and that may be the reason for this high increase Supporting results were recorded by other authors (Malleshi *et al* 1986, Okeke and Obizoba 1986 and Thirumaran 1993) Among the experimental groups, animals fed with weaning mixes registered a higher weight gain 38 60 and 36 60 g for cassava and sweet potato weaning mixes respectively The lowest weight gain was exhibited by the group of animals fed on sweet potato wafers (28 20 g)

Table 24 Mean proteın intake of anımals

Sl No	Group	Mean proteın ıntake (g)
	Experımental Groups	
1	Cassava noodles/macaronı	14 598
2	Sweet Potato noodles/macaronı	13 973
3	Cassava wafers	13 973
4	Sweet Potato wafers	13 817
5	Cassava weanıng mıx	14 139
6	Sweet Potato weanıng mıx	14 264
	Control Group	14 935
	SE	0 009
	CD	0 032

Table 25 Mean weight gain of animals

Sl No	Group		Mean weight gain (g)
	Experimental Groups		
1	Cassava noodles/macaroni		33 867
2	Sweet Potato noodles/macaroni		29 700
3	Cassava wafers		29 600
4	Sweet Potato wafers		28 200
5	Cassava weaning mix		38 600
6	Sweet Potato weaning mix		36 800
	Control Group		46 433
		SE	0 269
		CD	0 774

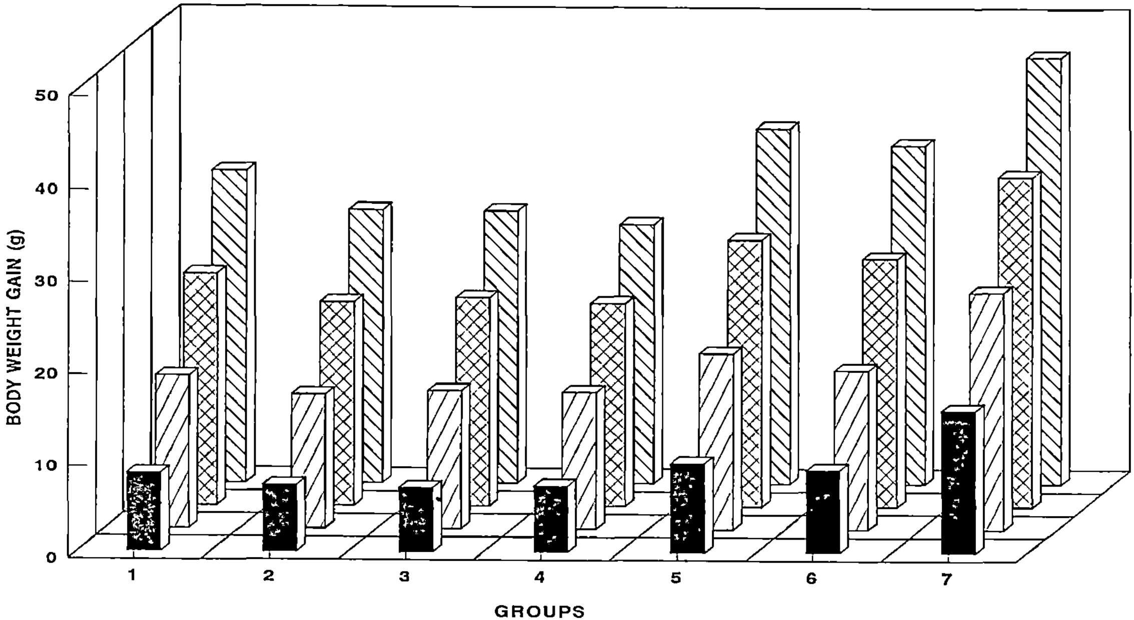


Fig 11 Mean body weight gain of animals

7 DAYS 14 DAYS 21 DAYS 28 DAYS

1 Cassava noodles/macroni 2 Sweet potato noodles/macroni 3 Cassava wafers 4 Sweet potato wafer
5 Cassava weaning mix 6 Sweet potato weaning mix 7 Casein control

In general, groups of animals fed with sweet potato-based foods showed a lower weight gain than those fed with cassava-based foods The trypsin inhibitor present in sweet potato may probably interfere with the utilization of protein and that may be a reason for the variation in weight gain

Protein efficiency ratio (PER) of the developed complementary foods

PER is the ratio between the weight gain of the animals and the quantity of protein consumed It gives a clear picture of the quality of the protein The mean PER of the different groups of animals fed with the different complementary foods developed is presented in Table 26 and fig 12 The PER of the control group (casein) was the highest (3 28) The statistical analysis revealed that there was significant difference in the PER of the different groups This finding is in line with the finding of Malleshi *et al* (1986) who reported a PER of 3 20 for casein diet A higher PER value of 3 51 was reported by Prasad (1987) for casein diet Thirumaran (1993) had reported a PER value of (3 27) for casein diet While a slightly lower PER of 3 09 was reported by Philip (1987) Yanez *et al* (1979) reported the lowest PER value of 2 54 for casein diet

Table 26 Mean PER of animals

Sl No	Food sample	PER
	Experimental group	
1	Cassava/noodles/macaroni	2 39
2	Sweet Potato noodles/macaroni	2 10
3	Cassava wafers	2 09
4	Sweet potato wafers	1 99
5	Cassava weaning mix	2 73
6	Sweet potato weaning mix	2 60
7	Control Group	3 28
	S E	0 027
	C D	0 078

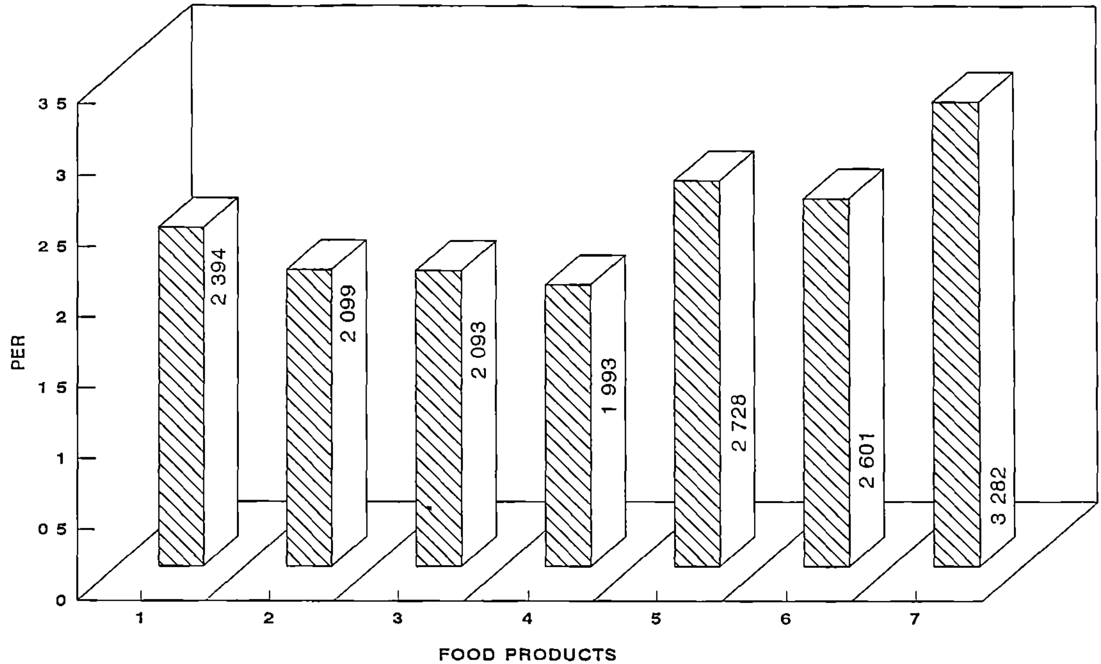


Fig 12 Mean PER of animals

1 Cassava noodles/macroni 2 Sweet potato noodles/macron 3 Cassava wafers 4 Sweet potato wafer
5 Cassava weaning mix 6 Sweet potato weaning mix 7 Casein control

Among the experimental groups, animals fed with weaning mixes recorded the highest PER values (Cassava weaning mix 2 73, and sweet potato weaning mix 2 60) The addition of milk solids in weaning mixes may be the reason for these higher values Supplementation of a weaning food mixture with 10 per cent milk solids enhanced its PER from 2 40 to 2 70 (Malleshi, 1986) The proteins in skim milk powder, which is a good source of sulphur containing amino acids, must have complemented the soya protein in the weaning mixes resulting in enhanced PER values PER values of 2 94 and 2 97 were reported by Philip (1987) and Prasad (1987) for ragi based and banana-based weaning foods Calvo *et al* (1989) have reported a PER of 2 60 for haemoglobin fortified rice-based weaning food

The PER values of noodles/macaroni ranked second among the experimental groups (cassava noodles/macaroni 2 39 and sweet potato noodles/macaroni 2 10) The amino acid profile of maida and soya flour must have complemented each other which might have been the reason for this enhanced PER This is in line with the results obtained in an experiment with extruded chickpea cereal blend (Anon 1978) However, Yanez *et al* (1979) have reported a lower PER value of 1 96 for sunflower seed soy flour extruded product Vaidehi and Varalekshmi Rao (1992) in their study on protein quality of extrusion cooked foods of blended wheat sorghum horsegram and sunflower seedcake, have reported a PER of 2 10 for the extruded foods The PER values obtained for wafers (cassava wafers 2 09 and sweet potato wafers 1 99) were comparatively lower than those for the other complementary foods developed The protein sources in wafers were only blackgram and rice flour and that may be the reason for the lower values

The general picture indicates that sweet potato-based complementary foods exhibited lower values when compared to cassava based complementary foods developed Tsou *et al* , (1988) report that the trypsin inhibitor is the factor responsible for the lower PER value in sweet potato based foods However, all the complementary foods developed exhibited a PER value of 1 99 and more, according to ISI specification, a PER of 2 00 and above shows that the quality of protein is good

Nitrogen balance studies

Since the PER of the processed foods was 1 99 and above, it was decided to find out the digestibility and biological value of the above products through nitrogen balance studies (Table 27 and fig 13)

The groups showed significant difference in nitrogen (N_2) intake The highest N_2 intake (0 65) was recorded by the control group followed by groups of rats fed with cassava and sweet potato weaning mixes (0 62) The lowest N_2 intake was registered by the group fed with sweet potato weaning mixes (0 62) The lowest N_2 intake was registered by the group fed with sweet potato wafers (0 58) The statistical analysis of the data revealed that there was significant difference in the N_2 intake among the seven groups

The same trend was observed in the biological value of the seven groups The highest biological value was registered by the control group (79 92) This finding is in line with the finding of Prasad (1987), in which she has reported a biological value of 80 00 for casein diet However, higher values were reported by Okeke and Obizoba (1987) (B V 87 7) and Philip (1987) (B V 82 2)

Among the experimental groups, animals fed with weaning mixes registered high biological value (77 86 and 75 39 for cassava and sweet potato) When the two tubers were compared, it was found that the biological value of cassava based foods was significantly higher than that of sweet potato-based foods

Table 27 Mean values of nitrogen intake, biological value, digestibility coefficient, and net protein utilization

Sl No	Group	Nitrogen Intake mg/ day/rat	Biological value	Digestibility coefficient	Net protein utilisation
1	Cassava/noodles/macaroni	0 60	73 21	93 34	68 39
2	Sweet Potato noodles/macaroni	0 60	70 34	89 98	63 31
3	Cassava wafers	0 59	71 65	89 82	64 38
4	Sweet Potato wafers	0 58	67 31	89 66	60 35
5	Cassava weaning mix	0 62	77 86	95 16	72 18
6	Sweet Potato weaning mix	0 62	75 39	92 75	71 76
7	Control Group	0 65	79 92	93 85	74 99
	S E	0 005	0 972	0 983	1 465
	C D	0 017	3 251	3 290	4 902

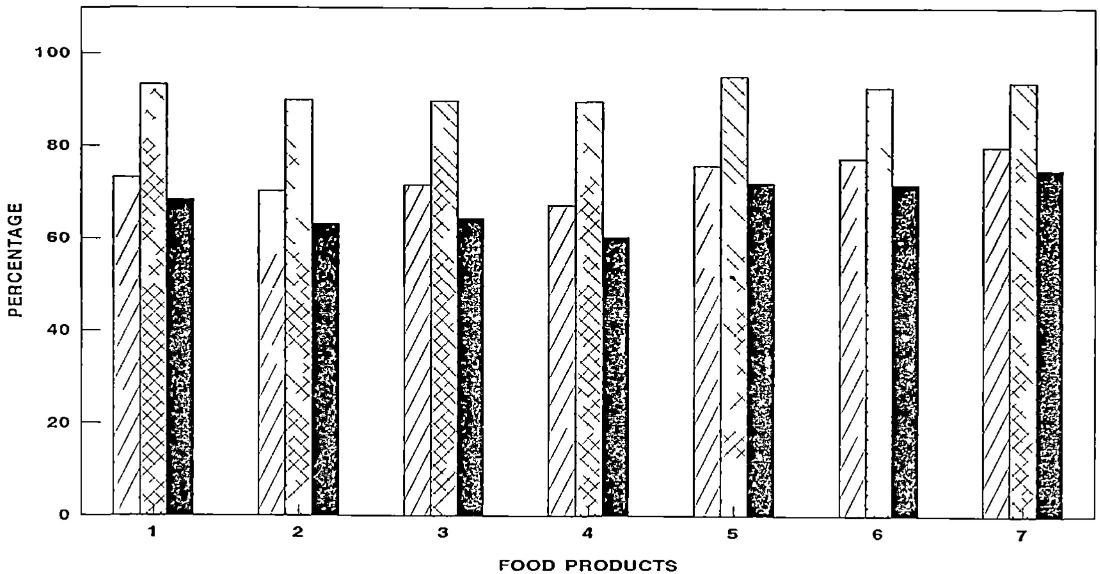


Fig 13 Mean values of biological value, digestability and net protein utilization

1 Cassava noodles/macroni 2 Sweet potato noodles/macroni 3 Cassava wafers 4 Sweet potato wafer
5 Cassava weaning mix 6 Sweet potato weaning mix 7 Casein control

With reference to digestibility coefficient, cassava weaning mix registered the highest value (95 16) The values for sweet potato weaning mix (92 75) and the control group (93 85) were on a par with it The digestibility coefficients of sweet potato noodles/macaroni (89 98), cassava wafers (89 82) and sweet potato wafers (89 66) were also on a par with one another The differences between the groups were statistically significant

When the net protein utilization of the foods was analysed, significant difference among the groups could be observed The control group registered the highest value (74 99) Among the experimental groups, cassava weaning mix (72 18) and sweet potato weaning mix (71 76) recorded values nearest to, and significantly not different from, that of the control group Sweet potato wafers exhibited the lowest value (60 35) As for biological value and digestibility coefficient, in net protein utilization also, cassava-based foods recorded higher values than sweet potato based foods

As judged by weight increase, PER, B V , D C and NPU, all the developed foods showed satisfactory results If some modification could be done to remove the trypsin inhibitor in sweet potato, all these qualities could improve in sweet potato based foods

4 4 3 Organoleptic qualities of the developed foods

The quality of a food, is a combination of the attributes that determine the degree of acceptability of the product These include nutritional value microbiological safety, cost convenience and organoleptic qualities For an average consumer the concept of food quality consists in those related to the sensory characteristics which may be classified in accordance with the human senses of perception as appearance, kinesthetics (texture), odour and taste (Setty 1989)

Traditional foods vary from place to place and have distinctive consumer appeal Any new food product should be formulated keeping in mind the requirements and acceptance of consumers and their regional bias It should aim at the targetted groups of consumers, opines Datta (1993) A consumer can be defined as a person who takes, buys or hires goods or services for himself or for his family (Kaushal 1994) According to Jayalekshmi (1991), a consumer is an individual, male or female, belonging to high, medium or low income groups or to an urban or a rural area or to the labour, administrative or business class, who buys articles and services Hence, before transferring the technology the organoleptic qualities of the developed complementary foods have to be assessed by the different categories of consumers

The developed foods were assessed for organoleptic qualities by technical experts who were persons with experience and expertise, high income women who consume more of these convenience foods, and the unprivileged group of farm women to whom these technologies could be transferred

4 4 3 1 **Organoleptic qualities of noodles**

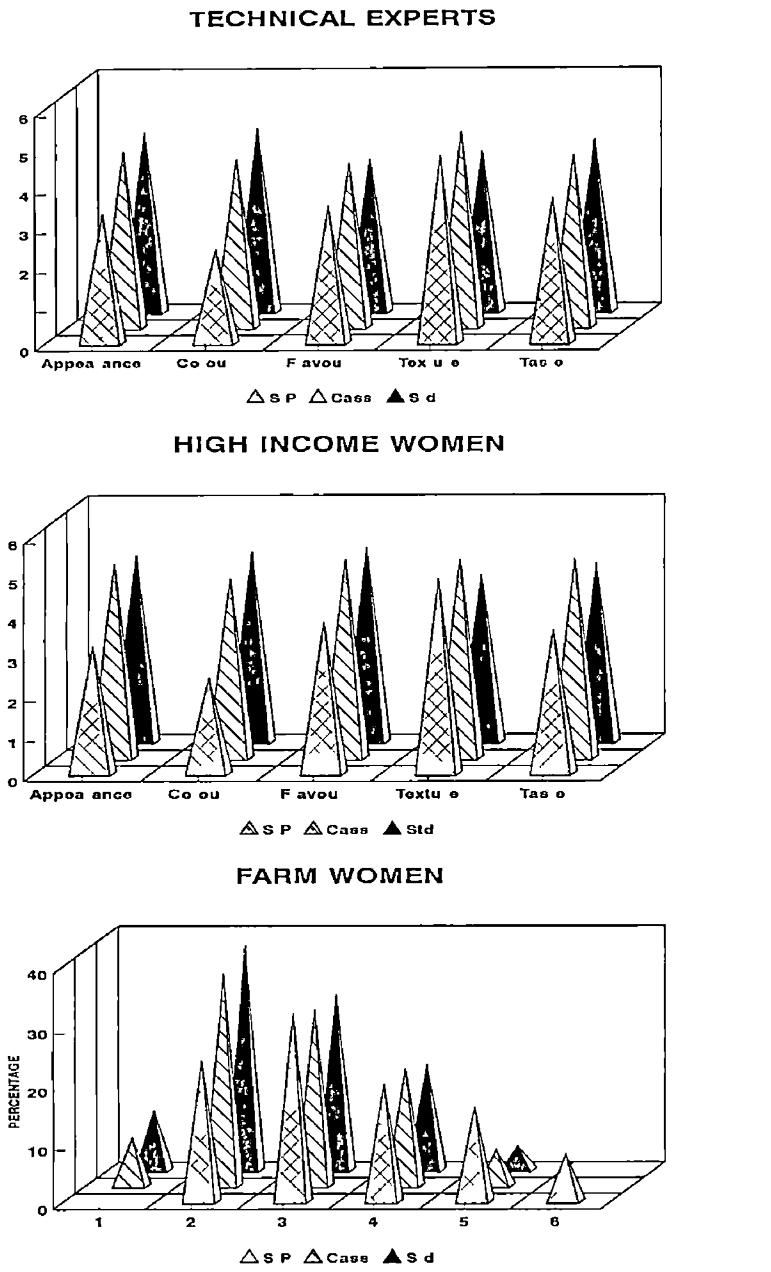
Quality is the composition of parameters which have significance in determining the acceptability of any product Quality parameters such as appearance, colour, flavour, texture and taste were assessed by technical experts (N 10) and high income women (N - 30) According to Piggot (1984) the panel of technical experts are a group of assessors In general, high discrimination sensitivity and consistency in measurement about the product depend upon these experts The information on the specific sensory characteristic of a food must be obtained by product-oriented tests and this information is obtained in the laboratory from the work of trained technical experts (Watts *et al* , 1989) Convenience, novel and instant foods are becoming increasingly popular among wealthy Indian households, since women of the high income strata are more exposed to such foods Hence these judgments on the acceptability of the complementary foods were developed Since there were two groups of judges, two values were given for all the quality parameters (Table 28 and fig 14)

Appearance

The first impression of food is usually visual and a major part of our willingness to accept a food depends on its appearance It is a composite of all information about the product and its environment which reaches the eye (Birch *et al* , 1988) The appearance of cassava, sweet potato and standard noodles was assessed by these two panels and the result revealed that the scores were 4 5 and 4 9 for cassava noodles 3 3 and 3 2 for sweet potato noodles, and 4 6 and 4 7 for standard noodles The statistical analysis of the data revealed that there was no significant difference between the scores for cassava and standard noodles

Table 28 Organoleptic qualities of noodles

Sl No	Products	Quality Parameters				
		Appearance	Colour	Flavour	Texture	Taste
1	Cassave noodles					
	Technical experts	4 5	4 3	4 2	5 0	4 4
	High income women	4 9	4 5	5 0	5 0	5 0
	Mean	4 7	4 4	4 6	5 0	4 7
2	Sweet potato noodles					
	Technical experts	3 3	2 4	3 7	4 8	3 7
	High income women	3 2	2 4	3 8	4 9	3 6
	Mean	3 3	2 4	3 8	4 9	3 7
3	Standard noodles					
	Technical experts	4 6	4 7	3 9	4 1	4 4
	High income women	4 7	4 8	4 9	4 3	4 6
	Mean	4 7	4 8	4 4	4 2	4 5
	C D (Between products)	0 253	0 213	0 281	0 175	0 231
	C D (Between experts)	-	-	0 265		0 218



1 Lke extremely well 2 Like very much 3 Lke reasonably well
4 Lke somewhat 5 Do not like or disl ke 6 Dislike somewha'

Fig 14 ORGANOLEPTIC QUALITIES - NOODLES

However the score for sweet potato noodles was significantly lower than those of the others The colour of sweet potato noodles was light brown which is not acceptable for such a product, and that might have contributed to the low score

As per the decision of the second panel of women of the high income group, cassava noodles ranked first and the score for sweet potato noodles was significantly lower than those for cassava and standard noodles The judgement by high the income women fully agreed with that of the technical experts

Colour

Colour, one of the important visual attributes, has been, used to judge the overall quality of foods for a very long time If the colour is unattractive, a potential consumer may not be impressed by the other major attributes In respect of appearance, the scores for colour of the three noodles differed significantly The scores ranged from 2 4 to 4 8 The scores for cassava noodle were 4 7 and 4 5, for sweet potato 2 4 and 2 4 and for standard noodles 4 7 and 4 8 According to the technical experts, standard noodles ranked first, followed by cassava and sweet potato noodles However, there was no significant difference between the scores for cassava and standard noodles The brown colour of sweet potato noodle was not appealing and that may be the reason for its low score

The other panel gave a slightly lower score (4 5) for cassava than for standard (4 8) noodles However, the difference was not statistically significant Though the members of the panel were not experts for assessing organoleptic qualities, their judgement was in agreement with that of the experts Colour of cassava noodle was comparable with that of the standard noodles as judged by both the groups of judges, and the score for sweet potato noodle was significantly lower than that of the other two Lower acceptability due to dark colour in sweet potato noodles has been observed by Bradbury (1990) also If the colour could be improved by some additives, sweet potato noodles would have a better score

Flavour

Odour preference is generated by stimulation of the sensory cells by specific compounds present in the food

According to Birch (1988), flavour is the mingled but unitary experience of sensation produced by a material taken in the mouth perceived principally by the senses of basic smell and by the other cutaneous sensations in the mouth The scores obtained for flavour by cassava noodle were 4 2 and 5 0, and a score of 3 7 and 3 8 were obtained by sweet potato noodles, whereas for standard noodles the scores were 3 9 and 4 9 Statistical analysis of the data revealed that the score for cassava noodles was significantly higher than those for sweet potato and standard noodles

Standard noodles which contained only refined wheat flour had a bland flavour and that might have been the reason for the low score However, there was no significant difference between sweet potato and standard noodles Sweet potato flour also had a bland flavour According to the panel of high income women, the score difference between standard and sweet potato noodles was statistically significant

Texture

Texture constitute a physical property of food stuffs apprehended by the eyes, the skin and muscle senses located in the mouth The scores for texture varied from 4 1 to 5 0 The maximum scores of 5 0 and 5 0 were secured for cassava noodles The scores for sweet potato noodles were 4 8 and 4 9, and 4 1 and 4 3 for standard noodles According to technical experts, the scores for the developed noodles were significantly higher than those for the standard ones, and between the scores for cassava and sweet potato noodles, the difference was not significant The developed noodles were very smooth

The high income group of women also judged the noodles the same was as did the technical experts The scores for developed noodles were significantly higher than for standard noodles Though the scores given for sweet potato and standard noodles were slightly higher, no significant differences could be observed in the assessment of the two groups

Taste

Taste is the major attribute which determines the acceptability of a food material It is not only a sensory response to soluble materials but also aesthetic appreciation of the mouth The scores for taste for noodles ranged from 3 6 to 4 6 The scores obtained by cassava noodles were 4 4 and 5 0 Scores of 3 7 and 3 6 were secured by sweet potato noodles, and standard noodles obtained the scores of 4 4 and 4 6 According to technical experts, the scores for cassava noodles (4 4) could be compared with that of standard noodles (4 4), while the score for sweet potato noodles (3 7) was significantly lower than those of the other two Other quality parameters such as flavour and appearance have an effect upon taste, which might have contributed to the low score

The assessment of the other group of judges revealed that the score obtained by cassava noodles (5 0) was significantly higher than those for sweet potato and standard noodles The score for standard noodle (4 6) was, however, significantly higher than that for sweet potato noodles When the judgements of the two groups were compared, it was found that the high income women differed significantly from the technical experts only in the scores for cassava noodles Though slightly higher scores were given to the other two noodles, they were not significantly different from the scores given by technical experts

The assessment on the organoleptic qualities of noodles revealed that according to technical experts cassava noodles could be rated as equal in quality parameters such as appearance and taste, and even better in texture and taste, and therefore it could be ranked first among the three The low scores obtained by sweet potato noodles in all parameters except texture were mainly due to the poor colour and appearance If these defects were rectified, the overall acceptability of the product would also increase Though the high income women are not trained judges in assessing the organoleptic qualities their judgements were in line with those of the technical experts, indicating that cassava noodles was the best, and with improvement in colour and appearance sweet potato noodles could rank equal to standard noodles

4 4 3 2 Organoleptic Qualities of Macaroni

Macaroni is usually consumed as main food or as side dish with vegetables or soup, and hence the organoleptic qualities are important

Appearance

The scores for the developed and standard macaronis ranged from 4 1 to 5 0 (Table 29 and fig 15) The scores secured by cassava macaroni were 4 4 and 4 1 Sweet potato obtained a score of 4 2 and 4 1, while a score of 4 8 and 5 0 were obtained by standard macaroni Technical experts ranked standard macaroni first (4 8), followed by cassava (4 1) and sweet potato (4 1) There was significant difference between the three macaronis

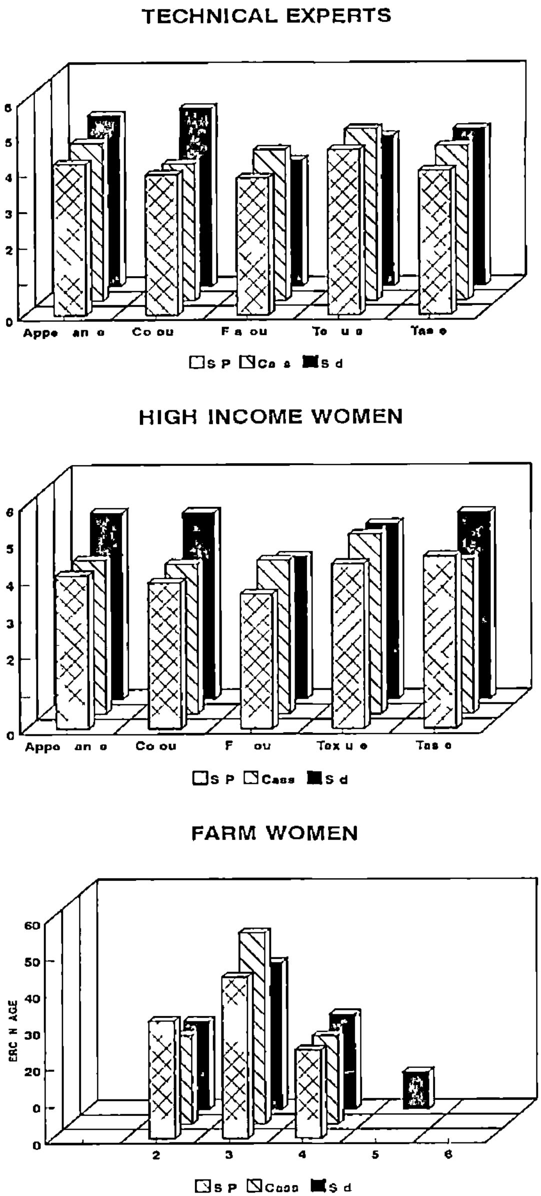
When the panel members of different income strata (high income) judged the same product, a maximum score of 5 0 was secured by standard macaroni while the score for both cassava and sweet potato macaroni was the same (4 1) The score for standard macaroni was significantly higher than the other two Higher scores for appearance might have been contributed by the bright colour of the standard macaroni

Colour

The scores for the developed macaroni ranged from 3 9 to 5 0 The scores for cassava macaroni were 4 0 and 4 0, while sweet potato macaroni obtained scores of 3 9 and 3 9

Table 29 Organoleptic qualıtıes of macaroni

Sl No	Products	Quality Parameters				
		Appearane	Colour	Flavour	Texture	Taste
1	**Cassava Macaroni**					
	Technical experts	4 4	4 0	4 2	4 8	4 3
	Hıgh Income women	4 1	4 0	4 1	4 8	4 1
	Mean	4 3	4 0	4 2	4 8	4 2
2	**Sweet Potato Macaroni**					
	Technıcal experts	4 2	3 9	3 8	4 6	4 0
	Hıgh Income women	4 1	3 9	3 6	4 5	4 6
	Mean	4 2	3 9	3 7	4 6	4 3
3	**Standard Macaronı**					
	Technical experts	4 8	5 0	3 5	4 2	4 0
	Hıgh Income women	5 0	5 0	3 8	4 7	5 0
	Mean	4 9	5 0	3 7	4 5	4 5
	CD (Between Products)	0 226	0 202	0 299	0 232	0 246
	CD (Between experts)	0 213	0 191	0 282	0 218	0 232



1 Like extremely well 2 Like very much 3 Like reasonably well
4 Like somewhat 5 Do not like or dislike 6 Dislike somewhat

Fig 15 ORGANOLEPTIC QUALITIES - MACARONI

However, the maximum score was obtained by standard macaroni According to technical experts standard macaroni ranked first (5 0), followed by cassava (4 0) and sweet potato macaroni (3 9) as far as colour was concerned

The differences between the scores of standard and developed noodles were statistically significant The bright white colour of standard macaroni might have contributed to the high score However the differences between the scores for cassava and sweet potato macaroni were statistically significant

The views of the other panel of judges of high income women were in line with the judgment of technical experts, in respect of colour In their judgments also, standard macaroni ranked first (5 0), followed by cassava (4 0) and sweet potato macaroni (3 9), and the attractive colour of the standard macaroni might have caused this difference

Flavour

The scores for the quality parameter flavour of the three macaronis differed within a range of 3 5 to 4 2

Cassava macaroni secured a score of 4 2 and 4 1 while a score of 3 8 and 3 6 was obtained by sweet potato macaroni, and standard macaroni obtained 3 5 and 3 8 According to technical experts, cassava macaroni ranked first (4 2), followed by sweet potato (3 8) and standard macaroni (3 5) The difference in the scores between the three was statistically significant The score for cassava macaroni was significantly higher than that for sweet potato macaroni, while the score for sweet potato macaroni was higher than that for standard macaroni

Women of the high income strata ranked cassava macaroni first (4 1), followed by standard (3 8) and sweet potato (3 6) macaroni The statistical analysis revealed that the score difference between cassava and sweet potato macaroni was significant, while that between sweet potato macaroni and standard macaroni was not significant These groups of judges differed only in the scores for standard macaroni There was no significant difference between the two groups in the case of cassava and sweet potato macaroni In general, the flavour of cassava macaroni was better, and that of sweet potato was incomparable with standard macaroni

Texture

A vast range of 4 2 to 4 8 could be observed in the scores obtained for this quality parameters, among the three types of macaroni Cassava macaroni secured a score of 4 8 and 4 8 while for sweet potato it was 4 6 and 4 5, and standard macaroni secured a score of 4 2 and 4 7 According to technical experts cassava macaroni secured a higher score of 4 8 followed by sweet potato (4 6) and standard macaroni (4 2) The score for standard macaroni was significantly lower than that of the developed macaronis Though there was difference between the scores for cassava and sweet potato macaronis, it was not statistically significant The textures of the macaronis developed in the present study were soft and smooth and that may be the reason for the higher score

The other panel of judges fully agreed with the views of the technical experts for cassava macaroni (4 8), while a lower score of 4 5 was obtained for sweet potato macaroni and a higher score of 4 7 for standard macaroni According to the panel members, cassava macaroni was better than the standard variety and sweet potato macaroni was comparable with the standard However, the two panel of judges differed only in the scores obtained for standard macaroni

Taste

The scores for taste of the three types of macaroni ranged from 4 0 to 5 0 Cassava macaroni obtained a score of 4 3 and 4 1, while a score of 4 0 and 4 6 was obtained by sweet potato macaroni The scores for standard macaroni were 4 0 and 5 0 According to technical experts, cassava macaroni ranked first (4 3) as far as the quality parameter taste was concerned, followed by sweet potato and standard macaroni (4 0) The score for cassava macaroni was significantly higher than the scores for sweet potato and standard macaronis, and sweet potato macaroni had an equal rank with the standard

The judgment of high income strata of women differed from that of technical experts According to them, standard macaroni ranked first (5 0), followed by sweet potato (4 6) and cassava macaroni (4 1) and the differences between the three macaronis were statistically significant

The bland taste of standard macaroni, which is preferable for recipes like soups, might have contributed to the higher score

The assessment of the organoleptic qualities of the developed macaronis revealed that cassava macaroni was superior to the standard in quality parameters like flavour, texture and taste, and sweet potato macaroni was comparable to the standard variety in the above quality parameters Comparatively lower scores than the standard were obtained for colour and appearance So, if the colour of the products were improved, the overall acceptability would be far better than that of standard macaroni

4 4 3 3 Organoleptic Qualities of Wafers

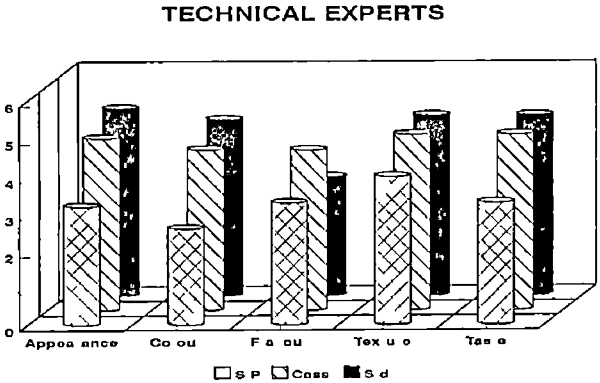
Wafers are considered as one of the popular snack foods available According to Morgan (1983), 40 - 60 per cent of the population eat at least one snack per day, and, so, assessing the organoleptic qualities of wafers is essential

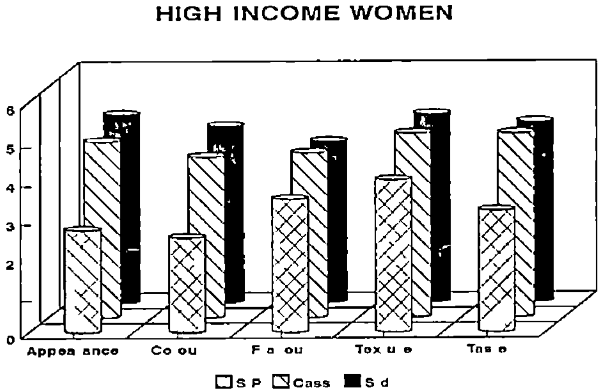
Appearance

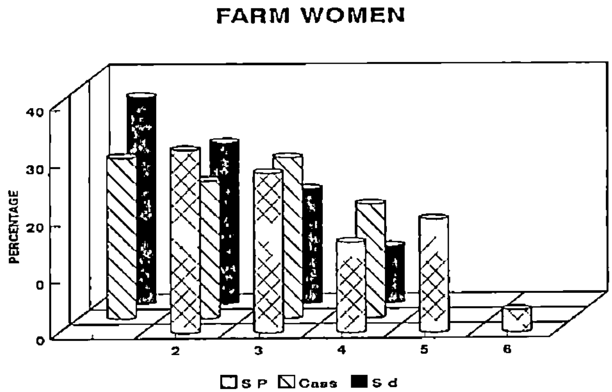
The scores for wafers varied from 2 7 to 5 0 (Table 30 and fig 16) Cassava wafers secured a score of 4 6 and 4 6, while for sweet potato, the scores were 3 2 and 2 7

Table 30 Organoleptic qualities of wafers

Sl No	Products	Quality Parameters				
		Appearane	Colour	Flavour	Texture	Taste
1	**Cassava wafers**					
	Technical experts	4 6	4 3	4 3	4 7	4 7
	High Income women	4 6	4 2	4 3	4 8	4 8
	Mean	4 6	4 3	4 3	4 8	4 8
2	**Sweet Potato wafers**					
	Technical experts	3 2	2 6	3 3	4 0	3 3
	High Income women	2 7	2 5	3 5	4 0	3 2
	Mean	3 0	2 6	3 4	4 0	3 3
3	**Standard wafers**					
	Technical experts	5 0	4 7	3 2	4 8	4 8
	High Income women	4 9	4 6	4 2	4 9	4 7
	Mean	5 0	4 6	3 7	4 9	4 8
	CD (Between products)	0 212	0 220	0 267	0 173	0 229
	CD (Between experts)	0 228	0 207	0 252	0 164	0 216







1 Lıke extremely well 2 L ke very much 3 Lıke reasonably well
4 L ke somewhat 5 Do not lıke or dıslıke 6 D sl ke somewhat

Fıg 16 ORGANOLEPTIC QUALITIES - WAFERS

Standard wafers secured the highest score of 5 0 and 4 9 According to technical experts the score for cassava wafers was 4 6 and for sweet potato it was 3 2 while the standard wafers secured the highest score of 5 0 The bright white colour of the standard wafers attracted the consumers, while the colour of cassava wafers developed in the study was dull and that of sweet potato was dark brown, which was not acceptable for such product Statistical analysis of the data revealed that the mean score for sweet potato wafers was significantly lower than cassava and standard wafers

Panel members of high income strata differed significantly in their view about the appearance of sweet potato wafers According to them standard wafer secured the highest score (4 9) followed by cassava (4 6) and sweet potato (2 7) Their judgment about cassava and standard wafers, fully agree with that of technical experts

Colour

The mean scores for the three wafers ranged from 3 9 to 5 0 Cassava wafers secured a score of 4 3 and 4 2 and a score of 2 6 and 2 5 was obtained by sweet potato while for standard wafers the scores were 4 7 and 4 6 According to the technical experts the mean score for standard was highest (4 7) followed by cassava (4 3) and sweet potato (2 6) The colour of sweet potato wafers was dark brown and that might have contributed to the low score Reducing sugars in the tubers are considered as one of the factors causing brown colour Same problem was reported by Beerh *et al* , (1990) In their study on the quality of potato wafers low scores were obtained due to the brown colour The mean score of sweet potato wafers was significantly lower than standard and cassava wafers

The other panel of judges of high income women agreed with the technical experts in their judgment though there was slight variation in scoring however it was not statistically significant

Flavour

A vast variation in the mean scores of wafers could be observed, the range being 3 3 to 4 3 According to the assessment of technical experts cassava wafers secured the highest mean score of 4 3 followed by sweet potato wafers

(3 3) and standard wafers (3 2) The score of cassava wafers (4 3) due to the pleasant aroma, was significantly higher than that of sweet potato and standard wafers Though sweet potato wafers secured a higher score (3 3) than standard wafers (3 3) it was not statistically significant

Difference of opinion could be observed between high income strata of women and technical experts in evaluating standard wafers A difference of 1 0 in the mean score was observed indicating highly significant difference In general the flavour of cassava wafer was better than standard and sweet potato wafer while the flavour of sweet potato wafer was comparable with the standard wafers

Texture

The mean scores for texture ranged from 4 0 to 4 9 The mean score for cassava wafers were 4 7 and 4 8 sweet potato secured a score of 4 0 and 4 0 while that of standard was 4 8 and 4 9 The judgment of the technical experts revealed that highest score was secured by standard (4 8) followed by cassava (4 7) and sweet potato (4 0) However, the difference in the mean score between cassava and standard wafers was not statistically significant and hence cassava can be rated as equal to standard in this quality The surface area of both cassava and standard wafers were smooth and texture was very crisp and this quality must have contributed for the higher score The mean score for sweet potato wafer was significantly lower than the other two

The other panel members also agreed with the judgment of technical experts Though there was slight variation in the mean score of cassava and standard wafers it was not statistically significant

Taste

The range of variation for the quality parameter taste was from 3 2 to 4 8 Cassava wafers secured a mean score of 4 7 and 4 8 For sweet potato wafers it was 3 3 and 3 2 and a score of 4 8 and 4 9 was secured by standard wafers Technical experts ranked standard as first (4 8) followed by cassava (4 7) and sweet potato wafer (3 3) Cassava wafers could be rated as equal to standard since the difference between the mean scores of the two was not statistically significant However the mean score for sweet potato wafer was significantly lower than the other two The quality taste is determined by other quality parameters like appearance and colour and the low scores obtained for appearance and colour by sweet potato wafers might have contributed to the lower score

The assessment of the organoleptic qualities of wafers revealed the cassava wafers can be ranked as better in quality parameters such as flavour texture and taste than standard The lower scores obtained by sweet potato wafers in mainly due to the dark colour and appearance

4 4 3 4 Organoleptic Qualities of Weaning Mix

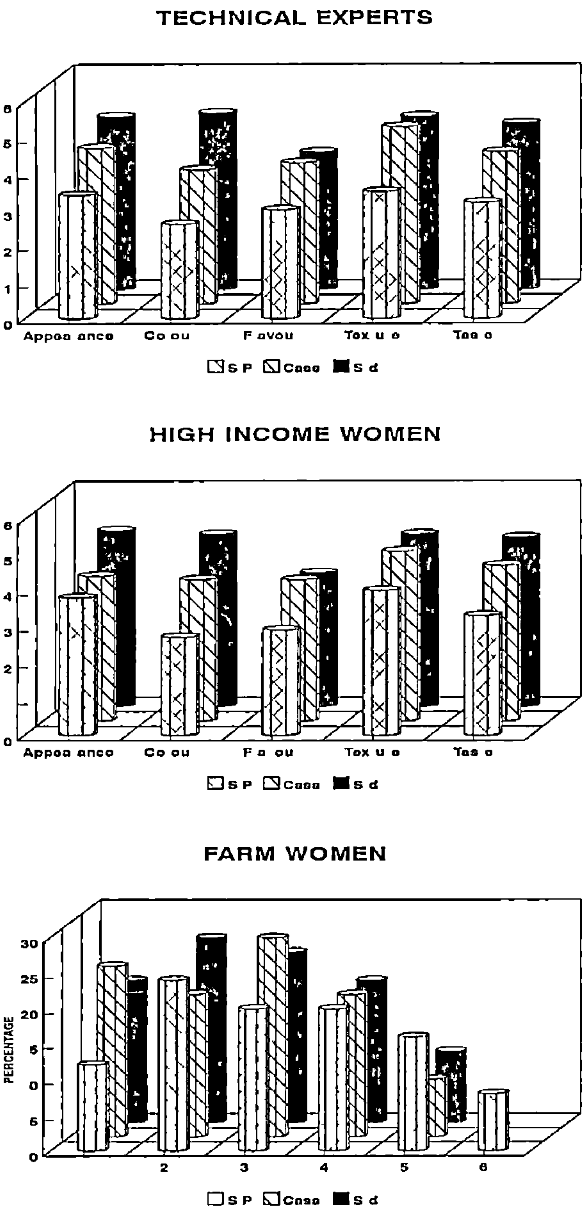
The developed weaning mixes along with standard weaning mix were assessed for the different quality parameters (Table 31 and fig 17):

Appearance

The mean score for appearance of the three weaning mixes ranged from 3 8 to 4 9 The score for cassava weaning mix was 4 3 and 4 0 A score of 3 4 and 3 8 was obtained by sweet potato while the scores for the standard weaning mix were 4 8 and 4 9

Table 31 Organoleptic qualities of weaning mix

Sl No	Products	Quality Parameters				
		Appearane	Colour	Flavour	Texture	Taste
1	**Cassava weaning mix**					
	Technical experts	4 3	4 3	3 9	4 9	4 2
	High Income women	4 0	3 9	3 9	4 7	4 3
	Mean	4 2	3 8	3 9	4 8	4 3
2	**Sweet Potato weaning mix**					
	Technical experts	3 4	2 6	3 0	3 5	3 2
	High Income women	3 8	2 7	2 9	4 0	3 3
	Mean	3 6	2 7	3 0	3 8	3 3
3	**Standard weaning mix**					
	Technical experts	4 8	4 9	3 8	4 8	4 6
	High Income women	4 9	4 8	3 7	4 8	4 7
	Mean	4 9	4 9	3 8	4 8	4 7
	CD (Between Products)	0 361	0 237	0 321	0 230	0 284
	CD (Between experts)	0 314	0 258	0 350	0 249	0 310



1 Lıke extremely well 2 Lıke very much 3 L ke reasonably well
4 Lıke somewhat 5 Do not l ke or d slıke 6 Dislıke somewhat

Fıg 17 ORGANOLEPTIC QUALITIES - WEANING MIX

According to the technical experts cassava weaning mix obtained a score of 4 3 and for sweet potato the score was 3 4 while standard weaning mix secured the highest score of 4 8 The additives in the commercial weaning food might have contributed to this high score The mean score of standard weaning mix was significantly higher than that of the two developed weaning mixes However, among the developed weaning mixes the mean score of cassava weaning mix was significantly higher than that of sweet potato

The assessment of the appearance of weaning mix by the other panel of judges revealed that they agree with technical experts only in standard Highest score of 4 9 was allotted for standard while cassava obtained a score of 4 0 and for sweet potato the score was 3 8 The difference between the mean scores of high income women and technical experts was significant for cassava and sweet potato weaning mixes If the colour of the developed weaning mixes could be improved the score for appearance will also be improved

Colour

Same trend as in appearance was registered in the score for colour also There was a vast variation in the scores of the three weaning mixes ranging from 2 7 to 4 9 Cassava weaning mix registered a mean score of 3 7 and 3 9 while that of sweet potato was 2 6 and 2 7 The highest score of 4 9 and 4 8 were registered by standard According to technical experts standard weaning mix ranked first (4 9) followed by cassava (3 7) and sweet potato The difference between the mean score of the developed weaning mixes and standard were highly significant The bright white colour of the commercial weaning mix and dark brown colour of sweet potato weaning mix might have contributed to this difference

The other panel of judges fully agreed with the technical experts regarding the colour of the weaning mixes According to them also, standard weaning mix was ranked first (4 8) followed by cassava (3 9) and sweet potato weaning mix (2 7) Though there was variation in the mean score between the two groups of judges the difference was not statistically significant

Flavour

The mean scores for flavour ranged from 2 9 to 3 9 Cassava weaning mix obtained mean score of 3 9 and 3 9 while that of sweet potato was 3 0 and 2 9 A score of 3 8 and 3 7 obtained by standard According to the first group of judges (Technical experts) the mean score for cassava weaning mix was highest (3 9) followed by standard (3 8) and sweet potato (3 0) The mean score of sweet potato weaning mix was significantly lower than cassava and standard weaning mixes Same trend could be observed in the scoring pattern of high income strata of women Cassava sweet potato and standard weaning mix obtained mean scores of 3 9, 2 9 and 3 7 respectively

Texture

The mean score for the texture of the three weaning mixes ranged from 3 5 to 4 9 Cassava weaning mix secured a score of 4 9 and 4 7 while that of sweet potato it was 3 5 and 4 0 However a score of 4 8 and 4 8 were obtained by standard weaning mix Technical experts ranked cassava weaning mix first (4 9) which was followed by standard (4 8) and sweet potato weaning mix (3 5) The mean score of sweet potato weaning mix was significantly lower than the other two The texture of sweet potato weaning mix was a bit fibrous and that might have contributed to the low score

High income strata of women ranked standard weaning mixes first (4 8) followed by cassava (4 7) and sweet potato (4 0) They differed significantly with the technical experts for the mean scores given for sweet potato weaning mix (4 0) The texture of cassava weaning mix was comparable with standard while that of sweet potato it was bit lower

Taste

The variation in the mean score for taste in the three types of weaning mixes ranged from 3 2 to 4 7 Cassava weaning mix obtained mean score of 4 2 and 4 3 while that of sweet potato was 3 2 and 3 3 and standard weaning mix secured a score of 4 6 and 4 7 According to technical experts cassava obtained a mean score of 4 2 while sweet potato and standard secured a score of 3 2 and 4 6 respectively The additives in the commercial weaning food must have enhanced the taste and which might have contributed the high score while the lower score obtained by sweet potato might be due to the rooty taste of sweet potato The mean score for standard weaning mix was significantly higher than the developed weaning mixes Among the two developed weaning mixes the difference was statistically significant

Same trend was registered with high income women also According to them standard ranked first (4 7) followed by cassava (4 3) and sweet potato (3 3) A slightly higher score was allotted by this group for the developed weaning mixes Though there was slight variation in the mean score allotted by the two groups the difference was not statistically significant

In general cassava weaning mix was equal to standard one in quality parameter such as flavour texture and taste The appearance and colour could be improved by the incorporation of some additives The scores obtained by sweet potato weaning mix was significantly lower than that of standard The unaccepted colour and fibrous texture might have contributed to this

4 4 3 5 Preference of farm women for the complementary foods developed

During the development of new food product of the reformulation of existing products the identification of changes caused by processing method, by storage or by the use of new ingredients, their acceptability could be assessed by conducting preference test on a large number of consumers (Watts *et al* , 1989) preference studies are designed to determine consumer s subjective reactions to external phenomena and their reasons for having them Preference refers to selection when presented with a choice, preferences are frequently influenced by prejudice religious principles groups conformance, and status value in addition to the quality of the food (Amerine *et al* , 1965) While conducting preference test the consumer expects to be favorably impressed with the food he tastes and expressed displeasure if the product does not measure upto his anticipation

Since in the present study, the ultimate aim was transferring the technologies developed to farm women preference test was administered among them Samples of the developed foods were tasted by farm women and their opinion on the degree of liking were obtained Data was collected using a nine point ratting scale varied from Like extremely (9) to Dislike extremely (1) Since none of the developed foods were rated as dislike very much or dislike extremely these two rating were deleted, while discussing the data

Maximum percentage of women rated the foods positively (Like extremely, like very much, like reasonably well and like somewhat) irrespective of tubers

Table 32 Preference of farm women for the complementary foods

Sl No	Foods	Rating					
		Like Extremely	Like very much	Like reasonably well	Like some what	Do not like or dislike	Dislike some what
1	Cassava noodles	4 (8)	18 (36)	15 (30)	10 (20)	3 (6)	
2	Sweet potato noodles		12 (24)	16 (32)	10 (20)	8 (16)	4 (8)
3	Standard noodles	5 (10)	19 (38)	15 (30)	9 (18)	2 (4)	
4	Cassava macaroni		12 (24)	26 (52)	12 (24)	-	--
5	Sweet potato macaroni		16 (32)	22 (44)	12 (24)		--
6	Standard macaroni	-	12 (24)	20 (40)	13 (26)	5 (10)	
7	Cassava wafers	14 (28)	12 (24)	14 (28)	10 (20)		-
8	Sweet potato wafers	-	16 (32)	14 (28)	8 (16)	10 (20)	2 (4)
9	Standard wafers	18 (36)	14 (28)	10 (20)	8 (16)	-	
10	Cassava weaning mix	12 (24)	10 (20)	14 (28)	10 (20)	4 (8)	
11	Sweet potato weaning mix	6 (12)	12 (24)	10 (20)	10 (20)	8 (16)	4 (8)
12	Standard weaning mix	10 (20)	13 (26)	12 (24)	5 (10)	10 (20)	-

N 50
(Numbers in parenthesis denotes percentage)

Negative rating such as do not like or disliked Dislike some what were recorded by a small percentage especially for sweet potato based foods Among the developed foods cassava wafers were preferred by most of the women (52 per cent) This was followed by cassava weaning mix and cassava noodles (44 per cent) and sweet potato weaning mix (36 per cent) In general cassava based foods were preferred as equal to standard ones while sweet potato based foods were less preferred However, there was a difference in the case of sweet potato macaroni which was preferred more (32 per cent) to cassava and standard macaroni

Preference for noodles

Majority of women (74 per cent) rated cassava noodles positively (Like very much, like reasonably well) While 6 per cent opined that they neither liked or disliked it In the case of sweet potato noodles many women (56 per cent) rated positively While 16 per cent of women neither liked or disliked the product However 8 per cent disliked it somewhat The reason for this was the brown colour of the product When the standard noodles was served to them 78 per cent rated it positively and 4 per cent felt that they do not like or dislike Only very few (6 per cent) could not give a positive rating for cassava noodles while 24 per cent of women were inclined to give a rating for sweet potato noodles

Preference for Macaroni

The developed macaronis were preferred more to noodles by the farm women Majority of them (76 per cent) liked sweet potato macaroni The colour of the product did not affect the overall acceptability Same trend could be observed for cassava macaroni also The preference for standard macaroni was comparatively low The preference test for macaroni revealed that both the developed macaroni were preferred more than the standard macaroni by the farm women The shape and flavour attracted them and that may be the reason for this

Preference for wafers

Wafers being a familiar food was more preferred than noodles and macaroni by the women Cassava wafers was rated positively by 80 per cent of women while the remaining

20 per cent rated as Like some what and none of them gave negative ratings Sweet potato wafers were less preferred compared to cassava and standard wafers When 76 per cent of the women rated it positively 20 per cent did not give any opinion and 4 per cent rated it negatively The dark brown colour of the product was the main reason stated by them Standard wafers was positively rated by 84 per cent of women and 16 per cent felt they liked it somewhat The bright white colour was stated as reason for this In general cassava wafers were preferred equally to standard while the preference for sweet potato wafers was a bit low due to unacceptable colour

Preference for weaning mix

Among the three weaning mixes cassava weaning mix was preferred more than standard and sweet potato weaning mix A majority of (24 per cent) women rated cassava weaning mix positively while 8 per cent neither liked nor disliked it But in the case of sweet potato weaning mix only 76 per cent women rated positively and 16 per cent felt that them neither liked or disliked it 8 per cent have negatively rated the product There was no negative rating for standard weaning mix 10 per cent of the women neither liked nor disliked and the remaining 80 per cent have rated it positively

In general both the developed weaning mixes were preferred by the farm women Cassava weaning mix was preferred more than standard and sweet potato weaning mixes which could be rated as best among the three weaning mixes

4 4 4 Shelf life qualities of the developed products

Storage of foods has become so complex that an entire industry has been developed to satisfy the need The mechanism and the kinetics of food deterioration can be controlled by the storage techniques applied (Varsanyi, 1993) According to Potter (1986) a storage container is one that comes in direct contact with the food and must be nontoxic and compatible with the food, causing no change of colour or flavour, or other foreign chemical reaction The containers should also be sanitary and moisture proof, and of low cost

According to Mahadeviah (1993) metal containers are the ideal packaging and storage materials due to their ease of fabrication, high production possibility and capacity to withstand temperature and decay

The advantages of steel or other metal containers include their strength low level of atmosphere corrosion, and ease of shaping

Glass containers are chemically inert and reusable, though they have the limitation of susceptibility to breakage These containers are an effective alternative to metal containers for storing processed food products In some of the developed countries, about 40 per cent of the food products are packed in glass containers (Mahadeviah 1981) In view of the high cost of metal containers and corrosion problem, there is a good scope for introducing glass containers for storing processed food products (Mahadeviah 1993)

Crossby (1981) states that though glass and tin have been widely used as food packaging and storage containers, besides the recently innovated plastic containers they have their own limitations according to the type of the product to be stored

Polythene bags, which are popular packaging and storage containers, are good from the aesthetic and hygienic point of view

In this study four containers, viz steel, glass, plastic and polythene were selected for the storage study of twelve months duration The eight developed food products were stored in the different storage containers in duplicate A total of 64 samples were stored to assess the shelf life qualities All the 64 samples were analysed once in three months for moisture and total sugar content peroxide value and acidity

4 4 4 1 Moisture level of the products

Moisture is one of the important parameters which determine the shelf life quality of any food product Most stored products are considered to be safe in storage at a particular moisture content, low moisture is highly important for longer storage period (Shankar 1992)

Noodles

The initial moisture level of noodles was 9 00 per cent There was an increase in the moisture content of the stored noodles irrespective of the storage containers

Table 33 Effect of storage containers on the moisture level of noodles

Sl No	Containers	Storage Period: Initial		3rd month		6th month		9th month		12th month	
		Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp
1	Steel	9 00	9 00	9 48	9 53	10 65	10 50	11 52	11 25	12 35	12 10
2	Glass	9 00	9 00	9 23	9 12	9 79	9 67	10 17	10 17	10 37	10 72
3	Plastic	9 00	9 00	9 26	9 22	9 79	9 62	10 17	10 07	10 82	10 74
4	Polythene	9 00	9 00	9 62	9 84	10 57	10 77	11 75	12 05	12 65	13 27

	3rd month	6th month	9th month	12th month
Between tubers				
SE	0 011	0 023	0 018	0 026*
CD	0 037	0 077	0 059	0 087
Between containers				
SE	0 016	0 033	0 025	0 037
CD	0 053	0 109	0 083	0 123
Interaction				
SE	0 023	0 047	0 036	0 053
CD	0 075	0 155	0 118	0 175

Cas Cassava Sp Sweet potato

It ranged from 9 00 to 13 29 per cent during the storage period of 12 months Variation in moisture level was the lowest in glass containers, followed by those in plastic, steel and polythene containers The same trend could be observed throughout the storage period Periodical analysis of moisture content of the samples revealed that the lowest variation (9 00 to 10 72 per cent) was recorded by glass, followed by plastic (9 00 to 10 82 per cent), steel (9 00 to 12 35 per cent), and polythene containers (9 00 to 13 27 per cent) at different time intervals of the third, sixth, ninnth and twelfth months of storage

Moisture increase in noodles stored in steel containers may be due to the porous nature of the metal, and the water absorption capacity of polythene may be the reason for the increased moisture level in polythene bags Because of this reason, in glass and plastic containers, the increase in moisture level was 1 72 and 1 82 per cent respectively This observation is in line with the findings of Purushottam *et al* (1992) who had observed that the quality of the products stored in glass containers was comparable with that of fresh products with special reference to moisture In a study conducted by Seth and Rathore (1993) regarding the storage of snack foods stored in different containers, glass containers exhibited a lower increase in moisture content when compared to tin and polythene bags

In the present study the highest moisture level was recorded in the products stored in polythene bags Beerh *et al* (1990) have also reported similar findings from a study on the preparation, packing and storage of potato snacks From cold stored potato, a steady increase in the moisture content was observed throughout the storage period of 6 months from the initial level of 11 00 per cent to 13 00 per cent

The statistical analysis of the data on the moisture level of the stored noodles revealed significant differences between the moisture levels of cassava and sweet potato Sweet potato noodles established a significantly higher increase in moisture level than cassava

Containers also exhibited significant differences themselves in the moisture level throughout the storage period of 12 months The interaction between tuber and container was also statistically significant at various time interval of three nine and twelve months of storage

According to ISI specification (IS 1991), moisture for noodles is 11 00 per cent Noodles stored in glass and plastic containers exhibited a maximum value of 10 72 and 10 82 per cent after the storage period of 12 months The values were higher than the ISI specified value for noodles stored in steel containers and polythene bags (12 35 and 13 27 per cent), after the storage period of 12 months

Macaroni

Increase in the moisture level of macaroni was observed irrespective of the storage containers during the storage period of twelve months However, the increase in all the samples was comparatively lower than that of noodles The different processing techniques applied may be the reason for this The increase in moisture level ranged from an initial value of 9 00 to 11 16 per cent (Table 34) The increase was 1 85 and 2 16 per cent for cassava and sweet potato macaroni stored in steel containers In polythene bags the moisture increase was within the range of 1 44 and 2 14 per cent for cassava and sweet potato respectively In the samples stored in glass and plastic containers, the moisture absorption was less than in steel and polythene

Table 34 Effect of storage containers on the moisture level of macaroni

Sl No	Containers	Storage Period: Initial		3rd month		6th month		9th month		12th month	
		Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp
1	Steel	9 00	9 00	9 21	9 25	9 83	9 85	10 05	10 24	10 85	11 16
2	Glass	9 00	9 00	9 13	9 00	9 61	9 26	9 74	9 70	9 93	9 85
3	Plastic	9 00	9 00	9 00	9 00	9 00	9 19	9 39	9 41	9 48	9 52
4	Polythene	9 00	9 00	9 20	9 30	9 79	9 89	10 05	10 32	10 44	11 14

	Initial	3rd month	6th month	9th month	12th month
Between tubers					
SE	0 001	0 008	0 013	0 018	0 032
CD	0 004	0 027	0 044	0 058	0 106
Between containers					
SE	0 002	0 011	0 019	0 025	0 046
CD	0 006	0 038	0 063	0 083	0 149
Interaction					
SE	0 002	0 016	0 027	0 036	0 065
CD	0 009	0 053	0 089	0 117	0 0211

Cas Cassava Sp Sweet potato

The increase in moisture level for the product stored in glass containers was 0 93 per cent for cassava and 0 85 per cent for sweet potato Samples in plastic containers exhibited the lowest value of 0 48 per cent for cassava and 0 52 per cent for sweet potato macaroni respectively

Sweet potato macaroni exhibited a higher increase in moisture level when compared to cassava The water absorption capacity of the tuber may be the reason for this Statistically significant difference in the increase in moisture level among tubers could be observed during the ninth and twelfth months of storage

The statistical analysis of the data further revealed that the increase in the moisture level of the products stored in different containers was statistically significant Tuber-container interaction was also statistically significant

Wafers

The increase in the moisture level of wafers was comparatively higher than that of noodles and macaroni (Table 35) This product was processed manually and that might have contributed to the higher water absorption capacity of wafers The initial moisture level of cassava wafers was 8 20 and that of sweet potato wafers was 8 10 per cent The highest increase of 7 08 per cent for cassava and 8 45 per cent for sweet potato wafers was recorded after the storage period of twelve months As in the case of noodles and macaroni the maximum increase in moisture level for wafers was recorded in polythene and steel containers Polythene bags exhibited an increase from 8 20 to 15 81 per cent for cassava and from 8 10 to 16 55 per cent for sweet potato This was followed by steel containers in which the increase in moisture level was from 8 20 to 14 81 per cent for cassava, and from 8 10 to 15 30 per cent for sweet potato wafers

Moisture retention in products stored in glass containers was comparatively less (13 80 per cent for cassava and 13 60 per cent for sweet potato), while plastic containers exhibited an increased moisture value of 12 06 and 14 10 per cent for cassava and sweet potato respectively Manan *et al* (1991) have also found out that the moisture level of wheat papads stored in polythene bag exhibited an increase from 8 00 to 8 90 per cent, while for papads stored in plastic containers, the increase was only upto 8 60 per cent after a storage period of six months

Table 35 Effect of storage containers on the moisture level of wafers

Sl No	Containers	Storage Period									
		In tial		3rd month		6th month		9th month		12th month	
		Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp
1	Steel	8 20	8 10	8 86	8 72	9 88	9 87	10 90	10 98	14 81	15 30
2	Glass	8 20	8 10	8 59	8 55	9 23	9 17	9 24	9 30	13 80	13 60
3	Plastic	8 20	8 10	8 53	8 51	9 20	9 20	8 83	9 39	12 06	14 10
4	Polythene	8 20	8 10	8 93	8 84	9 89	9 79	10 14	11 10	15 28	16 55
Between tubers											
	SE	0 030		0 018		0 012		0 021		0 134	
	CD	0 099		0 059		0 040		0 069		0 878	
Between containers											
	SE	0 043		0 025		0 017		0 030		0 190	
	CD	0 140		0 084		0 057		0 098		0 439	
Interaction											
	SE	0 061		0 036		0 025		0 042		0 269	
	CD	0 199		0 1180		0 081		0 138*		0 620	

Cas Cassava Sp Sweet potato

The increase in the moisture level of flaked rice based wafers has been reported by Kulkarni *et al* (1992) In their study the moisture level was found to be within the acceptable limit, upto a storage period of four months In the present study also the developed wafers exhibited an acceptable moisture level upto six months of the storage period

Statistical analysis of the data revealed that the increase in moisture level among tubers in three, six and nine months of the storage period was statistically significant The water retention capacity of the tubers may be the reason for this The difference in increase was highly significant among containers also However, the tuber container interaction was statistically significant only in the ninth month of storage

Weaning mix

The initial moisture level of weaning mixes (Table 36) were 5 15 and 5 20 per cent for cassava and sweet potato respectively After twelve months of storage, the highest moisture value of 14 17 per cent for cassava and 14 21 per cent for sweet potato weaning mixes were observed

Table 36 Effect of storage containers on the moisture level of weaning mix

Sl No	Containers	Storage Period: Initial		3rd month		6th month		9th month		12th month	
		Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp
1	Steel	5 15	5 20	6 10	6 30	8 26	8 59	10 90	10 98	14 17	14 22
2	Glass	5 15	5 20	5 82	5 77	7 11	7 11	9 24	9 30	10 14	10 30
3	Plastic	5 15	5 20	5 70	5 63	7 04	7 22	8 83	9 39	10 23	10 55
4	Polythene	5 15	5 20	6 05	6 29	8 17	8 54	10 14	11 08	13 66	13 60

	Initial	3rd month	6th month	9th month	12th month
Between tubers					
SE	0 001	0 018	0 026	0 021	0 030
CD	0 003	0 058	0 088	0 069	0 099
Between containers					
SE	0 001	0 025	0 038	0 030	0 043
CD	0 005	0 083	0 124	0 098	0 140
Interaction					
SE	0 002	0 036	0 059	0 042	0 061
CD	0 007	0 117	0 176	0 130	0 199

Cas Cassava Sp Sweet potato

Steel containers exhibited moisture increase upto 4 17 per cent for cassava and 4 22 per cent for sweet potato weaning mixes In samples kept in polythene bags the values were 13 66 and 13 60 per cent for cassava and sweet potato respectively Samples stored in glass and plastic containers exhibited comparatively low values than those in steel containers and polythene bags Samples in plastic containers exhibited a moisture value of 10 23 per cent for cassava and 10 55 per cent for sweet potato weaning mix, while the values exhibited by samples in glass containers were 10 14 per cent for cassava and 10 30 per cent for sweet potato weaning mix, after a storage period of twelve months

An increase from 5 26 to 6 92 per cent moisture for a storage period of two months in the thenai based weaning mix was reported by Thirumaran (1993) The mix was stored in polythene bags As storage period increased, there was increase also in the moisture content of ragi based weaning mix stored in polythene bags as reported by Malleshi *et al* (1989) Gopaldas *et al* (1982) observed a high increase in the moisture content of wheat-based weaning mixes stored in polythene bags Solanky (1986) reports an increase from 5 16g to 5 39 per cent in the developed RTE mixes after a

The statistical analysis of the data revealed that significant differences in the moisture level increase among tubers could be observed in the third, ninth and twelfth month of storage The difference in the moisture level exhibited among the containers was statistically significant The water retention capacity of the different containers might have contributed to this Since the difference among tubers and among containers were significant difference could be observed in tuber container interaction also

The assessment of the effect of storage containers revealed that there was a steady increase in the moisture level of the stored products irrespective of the products and containers

Peroxide value in stored products

Peroxides are the compounds formed when fat oxidizes This test is conducted to determine oxidative rancidity The initial stages of rancidity can be detected by this test even before the spoilage is detected through organoleptic evaluations

The data revealed that initially the peroxide value was zero for all the products upto three months of storage irrespective of tubers, products and containers Noodles macaroni and weaning mixes exhibited a per oxide value between 0 78 and 1 83 value during the sixth month of storage, while the value for wafers was still zero Probably the absence of oil seeds in wafers may be the reason for this

Noodles

The peroxide value of noodles, during six to twelve months of storage ranged from 0 87 to 4 00 meq/kg for cassava and from 0 93 to 4 10 meq/kg for sweet potato noodles As observed in moisture level the products stored in steel containers exhibited the highest peroxide values (4 00 and 4 10 meq/kg for cassava and sweet potato respectively) This was followed by the products stored in polythene bags (3 68 meq/kg for cassava and 3 88 meq/kg for sweet potato) plastic containers (2 78 and 2 58 meq/kg for cassava and sweet potato respectively), and glass containers (2 73 and 2 83 meq/kg for cassava and sweet potato respectively) The increased moisture level in the products stored in steel containers and polythene covers must have increased the peroxide value of the products stored in these containers

The analysis of the data revealed that the difference in the peroxide values of the samples stored in different containers exhibited statistically significant differences among themselves The tuber container interaction was also statistically significant The values obtained for products stored in steel containers and polythene bags were significantly higher than those of products stored in glass and plastic containers Though there were slight variations in the values for products stored in glass and plastic containers, they were not statistically significant They were on a par with one another

Macaroni

The same trend in peroxide increase, as in the case of noodles, could be observed in macaroni also

Table 37 Effect of storage containers on the peroxide value of noodles (meq/kg)

Sl No	Containers	Storage period: 6th month		9th month		12th month	
		Cas	SP	Cas	SP	Cas	SP
1	Steel	1 18	1 38	3 18	2 98	4 00	4 10
2	Glass	0 87	0 93	2 05	1 97	2 78	2 90
3	Plastic	0 90	0 98	1 98	1 77	2 85	2 60
4	Polythene	1 13	1 13	2 40	2 62	3 80	3 90
	Between tubers						
	SE	0 016		0 022		0 027	
	CD	0 047		0 069		0 091	
	Between containers						
	SE	0 021		0 029		0 039	
	CD	0 067		0 097		0 129	
	Interaction						
	SE	0 029		0 042		0 056	
	CD	0 095		0 138		0 182	

Cas Cassava Sp Sweet Potato

There was a steady increase in the peroxide value from the sixth month onwards Steel containers exhibited the highest value (3 89 and 3 95 meq/kg for cassava and sweet potato respectively) after the storage period of twelve months This was followed by polythene bags (3 68 and 3 88 meq/kg for cassava and sweet potato respectively) glass containers (2 73 and 2 83 meq/kg for cassava and sweet potato respectively) and plastic containers (2 78 and 2 58 meq/kg for cassava and sweet potato respectively) The initial values were also comparatively lower for the products stored in plastic (0 78 and 0 98 meq/kg for cassava and sweet potato respectively) and glass (0 90 and 0 83 meq/kg for cassava and sweet potato respectively) containers

The statistical analysis of the data revealed that significant difference existed among tubers in respect of peroxide value The fat content of the tubers may be the reason for the significant difference in the peroxide value of the products stored in different containers Since the difference in the peroxide value among the tubers as well as among containers were statistically significant the tuber container interactions were also statistically significant

Table 38 Effect of storage containers on the peroxide value of macaroni (meq/kg)

Sl No	Containers	Storage period: 6th month Cas	6th month SP	9th month Cas	9th month SP	12th month Cas	12th month SP
1	Steel	1 10	1 23	3 18	2 90	3 98	3 95
2	Glass	0 90	0 83	2 05	2 00	2 73	2 83
3	Plastic	0 78	0 98	1 95	1 80	2 78	2 58
4	Polythene	1 18	1 23	2 55	2 78	3 68	3 88
	Between tubers						
	SE	0 016		0 623		0 011	
	CD	0 054		2 033		0 038	
	Between containers						
	SE	0 023		0 881		0 616	
	CD	0 076		2 875		0 054	
	Interaction						
	SE	0 033		1 246		0 023	
	CD	0 042		4 066		0 076	

Cas - Cassava Sp Sweet Potato

Wafers

In wafers, peroxide value could be observed only in the ninth month The highest value of 2 13 meq/kg was exhibited by sweet potato wafers after the storage period of twelve months As in the case of noodles and macaroni, the highest peroxide value was exhibited by steel containers (2 05 and 2 13 meq/kg for cassava and sweet potato respectively) This was followed by polythene bags (2 10 and 2 08 meq/kg for cassava and sweet potato respectively) plastic containers (1 91 and 1 88 meq/kg for cassava and sweet potato respectively) and glass containers (1 90 and 1 93 meq/Kg respectively for cassava and sweet potato respectively) An increase from 0 20 to 0 79 meq/kg peroxide value in wheat papad stored in polythene bag was reported by Manan *et al* , (1991) They further reported that the increase was comparatively lower in papads stored in plastic jars Kulkarni (1992) has also reported that there was no peroxide in poha-based wafers upto a storage period of four months

The statistical analysis of the data revealed that the differences in the peroxide value of the stored products were significant among containers

Table 39 Effect of storage containers on the peroxide value of wafers (meq/kg)

Containers	Storage period 9th month Cas	SP	12th month Cass	SP
Steel	0 85	0 79	2 05	2 13
Glass	0 63	0 60	1 90	1 93
Plastic	0 69	0 67	1 91	1 88
Polythene	0 91	0 97	2 10	2 08
Between tubers				
SE	0 008		0 026	
CD	0 029		0 087	
Between Containers				
SE	0 013		0 038	
CD	0 041		0 124	
Interaction				
SE	0 017		0 053	
CD	0 058		0 000	

Cas Cassava Sp Sweet potato

The peroxide values of the products stored in steel containers and polythene bags were significantly higher than the values of products stored in glass and plastic containers However, the peroxide values of the products stored in glass and plastic containers were on a par with one another The tuber container interactions were not statistically significant

Weaning mix

Presence of peroxide could be observed in weaning mixes from the sixth month onwards The values ranged from 0 24 to 4 18 meq/kg after the storage period of twelve months The highest values (4 18 and 4 10 meq/kg for cassava and sweet potato respectively) were recorded for products stored in steel containers This was followed by polythene bags (3 86 and 3 81 for cassava and sweet potato respectively), glass containers (3 20 and 3 43 meq/kg for cassava and sweet potato respectively), and plastic containers (3 08 and 3 14 meq/kg for cassava and sweet potato respectively)

Table 40 Effect of storage containers on the peroxide value of weaning mixes (meq/kg)

Sl No	Containers	Storage period					
		6^{th} month		9^{th} month		12^{th} month	
		Cas	SP	Cas	SP	Cas	SP
1	Steel	0 57	0 63	2 83	2 83	4 18	4 10
2	Glass	0 24	0 14	2 21	2 50	3 20	3 43
3	Plastic	0 24	0 43	2 07	2 44	3 08	3 14
4	Polythene	0 61	0 83	2 68	2 68	3 86	3 81
	Between tubers						
	SE	0 012		0 012		0 052	
	CD	0 039		0 041		0 172	
	Between containers						
	SE	0 017		0 189		0 748	
	CD	0 056		0 058		0 244	
	Interaction						
	SE	0 024		0 025			
	CD	0 079		0 083			

Cas Cassava Sp Sweet Potato

Peroxide value ranging from 0 to 5 00 meq/kg in a weaning mix after a storage period of forty-two days was reported by Solanky (1986), while peroxide value of 15 92 meq/kg in stored weaning mix was reported by Inamdar (1981) Gopaldas *et al* (1982) have reported a value of 7 20 meq/kg in ragi-based weaning mix after a storage period of 28 days

The values obtained for samples stored in different containers were statistically significant indicating that storage containers have a major role to play in the shelf-life of products with special reference to peroxide value

The peroxide values of products stored in steel and plastic containers were significantly higher than the peroxide value of the products stored in glass and plastic containers However, the peroxide values of products stored in glass and plastic containers were on a par with each other

Though peroxide value could be observed in all the stored products, the values were within the limit specified by ISI (10 meq/kg)

Total sugar content of the stored products

The changes in the total sugar content of the products stored in different containers were assessed and the results are presented in Tables 41 to 43

Noodles

The total sugar content of noodles ranged from an initial value of 2 25 to a final value of 4 78 per cent after the storage period of twelve months The initial total sugar content of cassava noodles (2 25 per cent) was comparatively lower than that of sweet potato (4 00 per cent) The higher sugar content of sweet potato tuber might have contributed to this higher value

The highest values for total sugar were exhibited by noodles stored in steel containers irrespective of the tubers (3 05 and 4 78 per cent for cassava and sweet potato respectively) This was followed by polythene (2 99 and 4 77 per cent for cassava and sweet potato respectively), glass (2 96 and 4 73 per cent for cassava and sweet potato respectively) and plastic (2 97 and 4 70 per cent for cassava and sweet potato respectively) containers

Table 41 Effect of storage containers on the total sugar content of noodles (per cent)

Sl No	Containers	Storage Period: Initial		3rd month		6th month		9th month		12th month	
		Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp
1	Steel	2 25	4 00	2 34	4 21	2 54	4 34	2 71	4 56	3 05	4 78
2	Glass	2 25	4 00	2 33	4 20	2 51	4 33	2 69	4 51	2 96	4 73
3	Plastic	2 25	4 00	2 33	4 21	2 53	4 31	2 73	4 51	2 97	4 70
4	Polythene	2 25	4 00	2 34	4 21	2 54	4 30	2 74	4 56	2 99	4 77

	3rd month	6th month	9th month	12th month
Between tubers				
SE	0 009	0 011	0 011	0 021
CD	0 03	0 037	0 038	0 068
Between containers				
SE	0 013	0 016	0 016	0 029
CD	0 042	0 053	0 054	0 097
Interaction				
SE	0 018	0 023	0 023	0 042
CD	0 060	0 756	0 077	0 078

Cas Cassava Sp Sweet potato

The statistical analysis of the data revealed that the difference in the total sugar content was significant among tubers Though there were variation in the total sugar content of products stored in different containers they were not statistically significant

Macaroni

There was a steady increase in the total sugar content of macaroni as in noodles For cassava macaroni, it ranged from 2 21 to 3 40 per cent A range varying from 4 05 to 5 19 per cent was recorded by sweet potato macaroni Regarding the effect of storage containers on the total sugar content, for cassava macaroni the highest value of 3 40 was recorded by polythene bags followed by glass (3 23) steel (3 19) and plastic (3 13 per cent) containers For sweet potato macaroni steel containers ranked first (5 19), followed by polythene (4 95) plastic (4 91) and glass (4 87) Though there was difference in the values between the containers it was not statistically significant

Wafers

As in noodles and macaroni, there was a steady increase in the total sugar content of wafers

Table 42 Effect of storage containers on the total sugar content of macaroni (per cent)

Sl No	Containers	Storage Period									
		Initial		3rd month		6th month		9th month		12th month	
		Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp
1	Steel	2 21	4 05	2 42	4 23	2 64	4 435	2 91	4 69	3 19	5 17
2	Glass	2 21	4 05	2 41	4 20	2 61	4 435	2 90	4 67	3 23	4 87
3	Plastic	2 21	4 05	2 40	4 20	2 59	4 435	2 88	4 71	3 13	4 91
4	Polythene	2 21	4 50	2 43	4 24	2 65	4 440	2 90	4 40	3 40	4 95

		3rd month	6th month	9th month	12th month
Between tubers					
	SE	0 009	0 013	0 008	0 047
	CD	0 029	0 047	0 026	0 152
Between containers					
	SE	0 013	0 019	0 011	0 066
	CD	0 050	0 064	0 038	0 216
Interaction					
	SE	0 017	0 027	0 016	0 093
	CD	0 057	0 090	0 537	0 305

Cas Cassava Sp Sweet potato

Cassava wafers exhibited an increase from 2 05 to 2 87 per cent An increase from 3 65 to 4 35 was recorded by sweet potato wafers The effect of storage containers on the total sugar content of wafers revealed that for cassava wafers the highest increase was shared by steel (2 87) and glass (2 87), followed by polythene (2 85) and plastic (2 78 per cent) containers The difference between the containers was not statistically significant

The increase in the total sugar content of cassava weaning mix ranged from 3 00 to 9 04 per cent while a range from 4 60 to 5 23 was recorded by sweet potato weaning mix As in the case of other products, the increase was the highest for the products stored in steel containers irrespective of the tubers For cassava weaning mix, the ranking order based on total sugar content was steel (4 04), polythene (4 03) glass (3 97) and plastic (3 93) containers For sweet potato weaning mix, the ranking order was polythene (5 22) ranked equal to steel, followed by glass (5 21) and plastic (5 20) containers However, the difference among the containers was not statistically significantly The conversion of starches to sugars during storage may be the reason for the increase in sugar content of the stored products

Table 43 Effect of storage containers on the total sugar content of wafers (per cent)

Sl No	Containers	Storage Period: Initial		3rd month		6th month		9th month		12th month	
		Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp
1	Steel	2 05	3 65	2 31	3 83	2 47	3 90	2 69	4 17	2 87	4 33
2	Glass	2 05	3 65	2 31	3 80	2 42	3 87	2 65	4 12	2 87	4 30
3	Plastic	2 05	3 65	2 23	3 76	2 42	3 91	2 65	4 15	2 77	4 23
4	Polythene	2 05	3 65	2 31	3 83	2 46	3 90	2 69	4 13	2 85	4 35

	3rd month	6th month	9th month	12th month
Between tubers				
SE	0 008	0 009	0 015	0 008
CD	0 027	0 032	0 049	0 029
Between containers				
SE	0 012	0 013	0 021	0 012
CD	0 039	0 045	0 069	0 041
Interaction				
SE	0 060	0 019	0 030	0 017
CD	0 058	0 640	0 987	0 058

Cas Cassava Sp Sweet potato

Table 44 Effect of storage containers on the total sugar content of weaning mix (per cent)

Sl No	Containers	Storage Period									
		Initial		3rd month		6th month		9th month		12th month	
		Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp	Cas	Sp
1	Steel	3 00	4 60	3 27	4 84	3 40	5 03	3 70	5 19	4 04	5 22
2	Glass	3 00	4 60	3 45	4 75	3 38	4 98	3 63	5 03	3 97	5 21
3	Plastic	3 00	4 60	3 23	4 74	3 30	4 99	3 67	5 05	3 93	5 20
4	Polythene	3 00	4 60	3 27	4 94	3 39	5 05	3 65	5 18	4 03	5 23

	3rd month	6th month	9th month	12th month
Between tubers				
SE	0 048	0 008	0 015	0 012
CD	0 159	0 027	0 050	0 039
Between containers				
SE	0 069	0 012	0 022	0 016
CD	0 225	0 036	0 071	0 055
Interaction				
SE	0 097	0 016	0 030	0 024
CD	0 318	0 054	0 000	0 078

Cas Cassava Sp Sweet potato

In general, the assessment of the total sugar content of the stored products revealed that duration of storage had a significant interaction with the product The products stored in all the containers showed an increasing sugar content with the advancement of months However containers did not have any significant effect upon the total sugar contents of the stored products

Assessment of acidity in stored products

The stored products were analysed once in three months for any change in acidity It was observed that there was no change in the acidity irrespective of the products, containers and storage period The pH was neutral throughout the storage period, ranging from 5 6 to 6 8

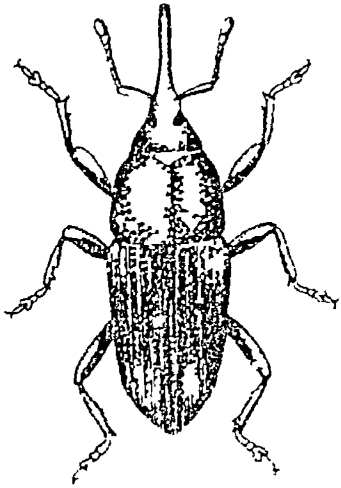
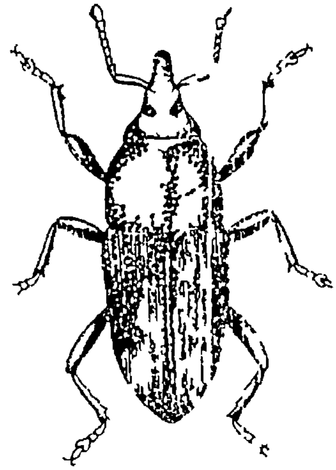
Assessment of Insect infestation in stored food products

The assessment of the incidence of insect pests in stored products was observed once in a month throughout the storage period of one year It was observed that there was no insect infestation upto ten months in noodles and macaroni, while wafers were free from insect infestation upto eleven months However, insect infestation could be observed in weaning mixes from the ninth month onwards There was no insect infestation in glass and plastic containers, irrespective of the products, and insect infestation could be observed only in steel containers and polythene bags The insects were identified as Sitophilus orysae (Linnaeus Tribolium castaneum (Herbst and Araecerus fasciculatus Deg) (fig 18)

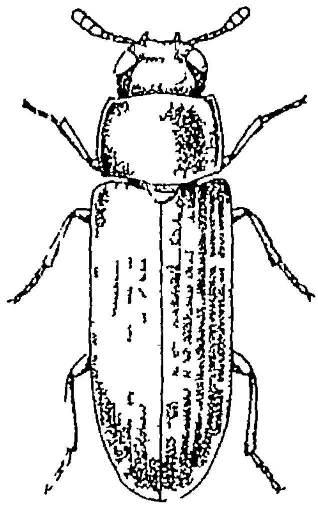
Insect count in stored noodles and macaroni (Table 45)

In cassava noodles, the count of *S orysae* ranged from 2 94 to 9 98, and for sweet potato from 4 49 to 14 98 Sweet potato noodles had more infestation than cassava Products stored in polythene bags had more insects than those in steel containers irrespective of the tubers

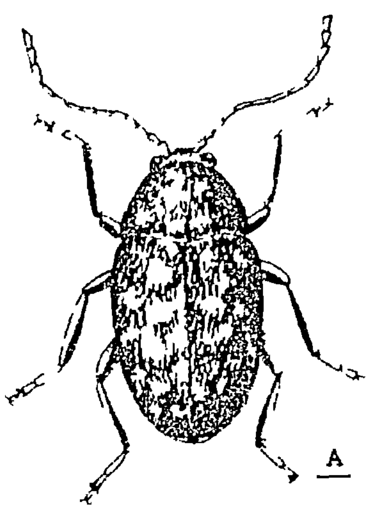
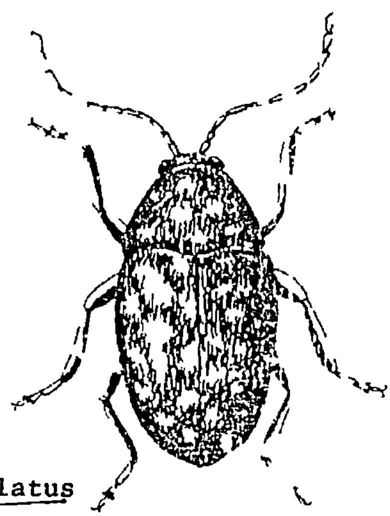
Regarding incidence of the other insect *T castaneum* the same trend could be observed The count in sweet potato noodles was comparatively higher For cassava, the range was from 0 46 to 14 46 and for sweet potato it was from 1 25 to 13 85 Polythene covers exhibited more insect infestation than steel containers

S orysae



T castaneum

A fasciculatus

Fig 18 Insects identified in stored products

Table 45 Insect count in stored noodles and macaroni

		Noodles				Macaroni			
		S Orysae		T Castaneum		S Orysae		T Castaneum	
Month	Container	Cassava	Sweet potato	Cassava	Sweet potato	Cassava	Sweet potato	Cassava	Sweet potato
11th month	Steel	2 94 (1 98)	4 49 (2 34)	0 46 (1 21)	1 25 (1 5)	2 48 (1 87)	3 49 (2 12)	0 46 (1 21)	1 47 (1 57)
	Polythene	6 49 (2 74)	8 49 (3 08)	3 95 (2 22)	7 49 (2 91)	3 49 (2 12)	9 98 (3 31)	4 49 (2 34)	8 97 (3 16)
12th month	Steel	5 49 (2 54)	8 90 (3 15)	3 49 (2 12)	8 49 (3 88)	6 49 (2 44)	17 49 (2 91)	3 95 (2 22)	5 49 (2 55)
	Polythne	9 98 (3 31)	14 98 (4 0)	14 46 (3 93)	13 85 (3 85)	18 49 (3 08)	17 99 (4 46)	6 49 (2 74)	14 98 (4 0)
C D Containers		0 410		0 425		0 301		0 304	
C D Containers X Tubers		0 579		0 600		0 425		0 429	

(Values in parenthesis are transferred values)

The insect *S orysae* count ranged from 2 48 to 18 49 for cassava macaroni and 3 49 to 17 99 for sweet potato macaroni For cassava macaroni, the highest count was recorded for samples stored in polythene bags (17 99) in the twelfth month Similar results were observed in sweet potato macaroni also

The *T castaneum* count ranged from 0 46 to 6 49 for cassava macaroni, while a minimum of 1 47 and a maximum of 14 98 were exhibited by sweet potato macaroni Samples in polythene covers exhibited a higher infestation than those in steel containers

The statistical analysis of the data revealed that the difference in insect count between tubers, products and containers was significant Insects have preference for moist food materials and increased moisture level aggravates infestation There was increase in count with the increase in storage period Among the two insects the infestation caused by *T castaneum* was comparatively lower

Insect count in stored wafers (Table 46)

Wafers were more resistant to insect infestation when compared to noodles and macaroni Infestation could be observed only in the twelfth month The insects were identified as S orysae and T castaneum The count for S orysae ranged from 7 49 to 1 98 for cassava, and for sweet potato it was from 6 49 to 9 00 The count was more in polythene bags than in steel containers Regarding T castaneum, the range was from 4 94 to 5 48 for cassava, and 7 96 to 8 88 for sweet potato The count was more in the samples stored in polythene covers

The assessment revealed that cassava wafers were more infested with S orysae than sweet potato wafers and the difference was statistically significant The tuber container interaction was also significant The same trend could be observed in the count of T castaneum also Infestation with T castaneum was comparatively lower than infestation with S orysae

Insect count in weaning mixes (Table 47)

Among the developed products weaning mixes had more insect infestation Infestations could be observed from the ninth month onwards The insects were identified as S orysae, T castaneum and A fasciculatus A fasciculatus could be identified only in the tenth month There was a steady increase in the insect count along with the storage period Products stored in polythene bags had more infestation

Table 46 Insect count ın stored wafers

	S Orysae		T Øastaneum	
Containher	Cassava	Sweet potato	Cassava	Sweet-potato
12th month				
Steel	7 49 (2 74)	6 49 (2 55)	4 94 (2 22)	7 96 (2 11)
Polythene	10 98 (3 31)	9 00 (3 00)	4 48 (2 82)	8 88 (2 98)

C D Contaıner 0 364 0 633

C D Contaıner X tuber 0 514 0 895

Values wıthın parenthesıs are the correspondıng transferred

Values x+1

Table 47 Insect count ın stored weanıng mıx

Month	Contaıner	S Orysae		T Castaneum		A fascıculatas	
		Cassa va	Sweet potato	Cassa va	Sweet potato	Cassa va	Sweet potato
9th month	Steel	3 48	3 48	0 00	0 00		
		(1 87)	(1 87)	(1 00)	(1 00)		
	Polythene	6 96	5 49	5 41	2 48		
		(2 64)	(2 34)	(2 53)	(1 87)		
10th month	Steel	4 95	6 49	1 91	2 48	3 95	
		(2 22)	(2 55)	(1 71)	(1 87)	(2 22)	(1 00)
	Polythene	9 97	7 49	7 49	4 49	3 49	1 47
		(3 16)	(2 74)	(2 91)	(2 34)	(2 12)	(1 57)
11th month	Steel	7 97	8 49	9 45	6 49	6 49	2 48
		(2 82)	(2 91)	(3 23)	(2 74)	(2 74)	(1 87)
	Polythene	9 44	7 97	7 97	6 97	4 40	3 49
		(3 07)	(2 82)	(3 00)	(2 82)	(2 32)	(2 12)
12th month	Steel	11 49	9 49	9 49	7 49	4 96	3 49
		(3 39)	(3 08)	(3 24)	(2 91)	(2 44)	(2 12)
	Polythene	10 49	11 49	7 97	9 49	5 49	4 49
		(3 24)	(3 39)	(3 00)	(3 24)	(2 55)	(2 34)
C D Contaıner		0 195		0 182		0 280	
C D Contaıner x tuber		0 276		0 257		0 396	

Values ın parenthesıs are the correspondıng transferred values x+1

The count of *S orysae* ranged from 3 48 to 11 49 for cassava, while for sweet potato the range was from 3 48 to 11 49 The difference in count in for samples stored in polythene bags and steel containers was highly significant T castaneum was absent in steel containers in the ninth month The range was from 1 91 to 9 49 for cassava, and 2 48 to 9 49 for sweet potato Infestation due to *A fasciculatus* could be observed for cassava weaning mix in the tenth month in both the samples in steel containers and polythene covers, but it was absent in sweet potato weaning mix stored in steel containers, in the tenth month The increase in count was steady during the storage period For cassava weaning mix the count varied from 3 49 to 6 49, and for sweet potato, it was from 1 47 to 4 49

In general, an assessment of insect infestation in weaning mix revealed that the infestation was comparatively higher The count increased with the storage period The insect count in cassava weaning mix was significantly lower than that of sweet potato as far as *s orysae* and *T castaneum* were concerned However, the count of *A fasciculatus* was significantly higher for cassava than for sweet potato weaning mix

The assessment of the insect infestation of the stored products revealed that sweet potato products were more infested than cassava products The moisture level increase was comparatively higher for sweet potato-based products and that might have contributed to the increased infestation The infestation in the products stored in different containers revealed that products stored in polythene covers had a comparatively higher insect count than those in steel containers The increased moisture content might have contributed to this

Assessment of microbiological quality in the developed foods after the storage period

Processed foods which are stored and consumed after a period of storage require certain microbiological criteria to be employed to ensure their quality and safety Many organisms causing food borne illness may grow in processed foods Several factors such as raw material quality storage temperature, storage containers process employed the environment in which it is processed etc will have an effect on the microbiological quality of the processed foods (Sankaran 1993)

Bryan (1974) also feels that the presence of microorganism is not the result of contamination of raw materials effect of processing and storage methods According to Leela *et al* , (1993) processed foods and ready to eat foods provide ample scope for contamination with spoilage and pathogenic microorganisms thus necessiting microbiological quality assessment as an integral part of food processing

The population of fungi and bacteria in the developed foods stored in glass, plastic, steel and polythene containers was assessed, following the serial dilution plate technique (Johnson and Curl, 1972) Peptone dextrose agar with Rose bengal and streptomycin (Martin, 1950) and nutrient agar were used for plating fungi and bacteria respectively The assessment of microbiological quality (Table 48) revealed that cassava noodles stored in glass sweet potato noodles stored in plastic, cassava macaroni stored in plastic, and sweet potato wafers stored in plastic containers had neither fungal nor bacterial attack even after the storage period of one year, probably because of the lower moisture content and peroxide value in the products stored in glass and plastic containers

Table 48 Microbiological profile of stored products

Sl No	Containers		Fungai Colonomes	Bacteria colonomes
	Cassava noodles in			
		Steel	3	0
		Glass	0	0
		Plastic	3	1
		Polythene	8	2
	Sweet potato noodles in			
		Steel	4	2
		Glass	3	0
		Plastic	0	0
		Polythene	3	3
	Cassava Macaroni in			
		Steel	1	6
		Galss	0	3
		Plastic	0	0
		Polythene	1	2
	Sweet potato macaroni in			
		Steel	10	2
		Glass	4	10
		Plastic	0	7
		Polythene	14	5
	Cassava wafers in			
		Steel	2	5
		Glass	0	14
		Plastic	4	4
		Polythene	10	3
	Sweet potato wafers in			
		Steel	13	10
		Glass	6	0
		Plastic	0	0
		Polythene	2	0
	Cassava wening mix in			
		Steel	3	6
		Glass	1	0
		Plastic	1	0
		Polythene	12	11
Sweet potato weaning mix in				
		Steel	2	2
		Glass	4	4
		Plastic	3	1
		Polythene	2	2

There was no fungal growth in cassava macaroni stored in glass and plastic, and cassava wafers stored in glass, containers But bacterial growth could be observed in these samples

In products such as cassava noodles stored in steel, sweet potato wafers stored in glass and polythene, and cassava weaning mix stored in glass and plastic containers, had no bacterial growth, but fungal growth could be observed in these samples

Fungal count in the stored products

The statistical analysis of the fungal count in stored products (Table 49) revealed that there was significant difference between cassava and sweet potato products and also among containers The products stored in polythene covers and steel containers had more fungal contamination than the products stored in glass and plastic containers

The assessment of fungal contamination in cassava noodles revealed that the highest count was recorded by polythene bags (2 996) followed by steel containers (1 805)

Table 49 Fungal count in stored products

Containers	Noodles		Macaroni		Wafers		Weaning Mix	
	Cassava	Sweet potato	Cassava	Sweet potato	Cassava	Sweet potato	Cassava	Sweet potato
Steel	1 805	2 033	1 000	2 942	1 000	3 558	2 087	1 821
Glass	1 000	1 000	1 000	1 989	1 000	1 000	1 000	1 520
Plastic	1 715	1 000	1 000	1 000	2 151	2 078	1 276	1 626
Polythene	2 996	1 910	1 520	3 208	3 265	1 520	3 208	1 900
Tuber	0 227		0 123		0 089		0 169	
C D Containers	0 321		0 174		0 126		0 239	
Tuber x Containers	0 454		0 246		0 178		0 339	

The highest count was recorded by steel containers (2 033), for sweet potato followed by polythene bags (1 910) Both glass and plastic containers exhibited significantly lower values for both noodles

For cassava macaroni, the highest count of 1 910 was recorded for the sample in polythene bag The counts of samples in steel, glass and plastic containers were the same (1 000) and were significantly lower than for the sample in polythene bag Sweet potato macaroni exhibited a different pattern of counts The highest count (3 208) was recorded for products in polythene bags, followed by those in steel (2 942) and glass (1 989) containers The lowest count of 1 000 was recorded for samples in plastic containers The differences among containers as well as the interaction between the tubers and containers were highly significant

Cassava wafers stored in polythene bags exhibited the highest count (3 265), followed by plastic (2 101), glass (1 000) and steel (1 000) containers For sweet potato wafers, the highest count was recorded for samples stored in steel (3 588) followed by plastic (2 078) polythene (1 520) and glass (1 000) containers

When weaning mixes were analysed for fungal count cassava weaning mix exhibited a higher count Samples in polythene bags exhibited the highest value (3 208), followed by those in steel (2 087) The count was the lowest in samples stored in glass containers The same trend could be observed for sweet potato weaning mix also The highest count was exhibited for samples stored in polythene (1 900), followed by those in steel (1 821), plastic (1 626), and glass (1 520) containers However the difference in count between the samples in glass and plastic containers was not significant

The assessment of the fungal contamination of the stored products revealed that there was significant difference among products among containers, and in product-container interaction The trend in count was different for the products as well as for the containers As suggested by Nanu *et al* (1992) the difference in raw materials, processing methods, post processing handling, and nature of containers, might have contributed to this

Bacterial count in the stored products

The bacterial count of the stored products showed vast variation, (Table 50) the range being 1 000 to 3 314 The analysis of the bacterial count of noodles revealed that sweet potato noodles exhibited a higher count than cassava noodles Polythene covers recorded a higher count (1 520) for cassava noodles, and a similar count was recorded by the other containers The same trend of higher count (2 078) was recorded by samples in polythene covers, followed by those in steel (1 821), in respect of sweet potato noodles also

In cassava macaroni, the highest count was recorded for samples in steel containers, followed by those in glass (2 068) polythene covers (1 821) and plastic containers (1 000) In the case of sweet potato macaroni also the highest count was recorded for samples stored in steel, followed by samples in polythene (2 443) plastic (1 821), and glass (1 520) containers

Cassava wafers exhibited a higher bacterial count than sweet potato wafers Regarding the containers, the sample in steel containers exhibited the highest count for cassava wafers, followed by samples in polythene (3 159), glass (2 228) and plastic (1 910) containers The trend was different in sweet potato wafers The highest count was recorded by samples in polythene bags (2 768), and samples stored in other containers exhibited the same value (1 000)

Table 50 Bacterial count in stored products

Containers	Products							
	Noodles		Macaroni		Wafers		Weaning Mix	
	Cassava	Sweet potato	Cassava	Sweet potato	Cassava	Sweet potato	Cassava	Sweet potato
Steel	1 000	1 821	3 054	3 051	3 314	1 000	1 000	1 626
Glass	1 000	1 000	2 068	1 520	2 228	1 000	1 000	1 910
Plastic	1 000	1 000	1 000	1 821	1 910	1 000	1 000	1 000
Polythene	1 520	2 078	1 821	2 443	3 159	2 768	1 276	1 520
Tuber	0 084		0 154		0 112		0 118	
C D Containers	0 119		0 218		0 158		0 167	
Tuber x Containers	0 168		0 308		0 223		0 055	

The count was comparatively lower for weaning mixes For cassava weaning mix the highest value was recorded for samples in polythene bag (1 276) The highest count was exhibited for samples in glass container (1 910), followed by those in steel (1 626), polythene (1 520) and plastic (1 000) containers A total count upto 2 4978 was reported by Solanki (1986) in a malted weaning food after storage

In a storage study of rice and cowpea-based weaning food a bacterial count of 20000 was reported by Roman *et al* (1987), while Gopaldas (1982) has reported a bacterial count upto 50000 during the storage of malted weaning food

The statistical analysis of the data revealed that there was significant difference among products as well as containers in the microbiological profile Presence of bacteria could be observed in all the products However, the count was within the limit specified by ISI (50000)

Popularisation of the developed products

It has been proved beyond doubt that the acceptability of a new products can generally be tested on a

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POPULARISATION STUDIES

Rotary and Innerwheel members - Judging the products

Womens club members - Judging the products

Prize winning recipes

scientific basic when exposed before a galaxy of true consumers.

Recipes developed with cassava noodles, macaroni, wafers and weaning mix logged first prize in the cooking competition held in connection with All India Agmark exhibition during December 1993.

The developed products, and recipes based on the developed products were displayed before 145 scientists, 350 women of high income strata and 1500 farmers and farm women at different occasions.

The reaction collected from the cross section of population who were exposed to the new products revealed that they have great potential as a low cost indegenous processed food suitable to the palate of the consumers and the hands of the small entrepreneurs of Kerala.

SUMMARY

SUMMARY

The study comprised of, a survey on the consumption of processed foods in selected families in Trivandrum district, standardisation of raw materials and formulation of different complementary foods and assessment of the acceptability of the developed foods with special reference to nutritional significance physiological tolerance, organoleptic and shell life qualities.

The survey on consumption pattern of processed foods of ninety families of different socio economic background in Trivandrum district revealed that majority of the families, residing in either urban or sub urban areas, are small and nuclear type families, identified under middle income (33.30 per cent) high middle income (33.30 per cent) and high income (33.30 per cent) categories.

Many of the respondents had high educational level (graduates and post graduates) and the remaining (16.70 per cent) had education upto high school. Fifty per cent of women in the families were employed.

In most of the families (82.00 percent) the expenditure on food was directly proportional to total income and the expenditure on processed foods was directly proportional to food expenditure. Almost all the respondents were aware of different processed foods irrespective of their income level and wanted to include these novel foods in their daily diets because of their popularity, children's preference, easiness in preparing and of their nutritive value. In high middle income families the consumption of processed foods was more among families where women were employed. However the employment status of the women did not have any significant association with the consumption of processed foods in middle income families.

Single regression analysis of consumption of processed foods on different independent variables indicated that the variables, such as total expenditure on food, family income, number of children in the family, family size and educational status of house wife had a positive effect on the consumption of processed foods.

Standardisation of raw ingredients include administration of type tests and it had revealed that all the quality parameters of the different ingredients were within the limits specified by ISI.

After confirming the quality of the raw ingredients complementary foods were developed using different combinations. Protein quality, extrusion behaviour, textural quality, cost and appearance of the different combinations were assessed. For noodles and macaroni the combination with cassava or sweet potato flour (50.00) maida (35.00) and soya flour (15.00 per cent) was selected since it secured a maximum score of 18.50 and was significantly higher than the other combinations. The combination with cassava or sweet potato (50.00) rice flour (25.00) and blackgram flour (25.00 per cent) which secured significantly higher total score was selected for the formulation of wafers. The combination with cassava or sweet potato flour (50.00), soya flour (25.00) and milk powder (25.00 per cent) which secured the highest total score, was selected for the development of weaning mixes. After the development of the complementary foods ISI type tests specified to such products were administered to the developed foods and the values were comparable with ISI specification.

An assessement of the physical characteristics of noodles and macaroni revealed that cassava noodles was well comparable in all the parameters, with the standard noodles. Shape of the evolved products was scored better than the standard ones. Sweet potato based noodles secured lower scores for all the parameters than cassava and standard noodles. There was no significant differences in the quality parameters for the developed and standard macaroni.

Cooking characteristics of the developed noodles and macaroni, such as cooking time and bulk density were rated as equal or even better than standard noodles.

The developed complementary food products contained all the nutrients in optimum quantity. The computed values for the nutrients were slightly higher indicating loss during processing. The loss during processing was statistically significant with reference to protein and carotene for extruded foods.

Regarding physiological tolerance, all the developed food products exhibited P.E.R of 1.99 and above indicating that the quality of protein is good. The other quality parameters such as B.V, D.C. and N.P.U of the developed weaning foods were well comparable with the standard products.

The organoleptic qualities of the developed foods were assessed by three groups of consumers viz technical experts women belonging to high income groups and farm women. The analysis revealed that all the developed foods secured higher scores for organoleptic qualities. Scores given by the women of high income and farm women, were on par with the scores given by the technical experts. Cassava based foods secured higher scores than sweet potato based foods. Cassava based foods could be rated as equal or even better to standard products in certain parameters.

Effect of storage containers such as steel, glass plastic and polythene, on the moisture level peroxide value and total sugar content revealed, steady increase, ~~only~~ in moisture level. Moisture level was highest in samples kept in polythene bags followed by these stored in steel, plastic and glass containers. The increase in moisture among the products in different containers were statistically significant.

Containers had a significant effect on peroxide values of the products. However the maximum value obtained for peroxide (4.10 meq/kg), was within the limit specified by ISI (10.00 meq/kg).

Total sugar content of sweet potato based products were significantly higher than the cassava based products. Storage containers were found to have no significant effect on the total sugar content.

Analysis of the insect infestation on the stored foods revealed that there was no insect infestation in glass and plastic containers irrespective of the products. The insects identified in the stored products were *S.orysae* *T.Castaneum* and *A.fasiculatus*. The infestation was more in products stored in polythene bags than those stored in steel containers. Wafers stored in polythene bags and steel containers were infested only after 11 months of storage. Infestation was more for cassava than for sweet potato wafers. The insects identified in weaning mixes were *S.orysae*, *T.Castaneum* and *A.fasciculatus*. The infestation was more in the products stored in polythene bags than those in steel containers and the difference was statistically significant.

Assessment of the microbial status of the developed complementary foods after the storage period of one year, revealed that sweet potato noodles and cassava wafers stored in glass containers and cassava macroni stored in plastic container had neither fungal nor bacterial growth. While products stored in other containers had such microbial changes. However the total count was within the maximum limit specified by ISI.

The salient features on the study of `*Developing complementary food products based on cassava and sweet potato*' indicated that,

> It is possible to develop energy rich complementary foods based on cassava and sweet potato. The nutritional and organoleptic qualities and physiological tolerance of the products developed were better than the commercially available products, and the developed foods had a reasonable long shelf life.

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APPENDICES

KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF HOME SCIENCE, VELLAYANI

"Developing Complementary food products based on Cassava and Sweet potato"

1. Name of the respondent :

2. Full address :

3. Religion :

4. Caste :

5. Type of family :

6. Family size :

7. Number of adults in the family :

8. Number of children in the family :

9. Age group of children :

   Below 5 years   5-10 years   10-15 years   15 and above

10. Educational qualification of mother :

    Graduate and above   Under graduate   High school   Below High school

11. Employment status of mother :

    Working   Non working

12. Total income of the family :

13. Amount spend on food/month :

14. Are you using processed food in your menu :

15. Type of processed foods used :

16. Amount spend on processed foods/month :

17. Frequency of using the following foods in your menu :

	More than 3 days	3days	Less than 3 days	Rarely
a. Noodles				
b. Macaroni				
c. Wafers				
d. Weaning mix				

18. Reason for using these foods :

    a. Easy to prepare
    b. Less time consuming
    c. Nutritious
    d. Popular
    e. Children like it
    f. Any other

12. Total income of the family :

13. Amount spend on food/month :

14. Are you using processed food in your menu :

15. Type of processed foods used :

16. Amount spend on processed foods/month :

17. Frequency of using the following foods in your menu :

	More than 3 days	3days	Less than 3 days	Rarely
a. Noodles				
b. Macaroni				
c. Wafers				
d. Weaning mix				

18. Reason for using these foods :

a. Easy to prepare

b. Less time consuming

c. Nutritious

d. Popular

e. Children like it

f. Any other

APPENDIX - II

Amino acid scores of different combinations tried cassava noodles/macaroni

	Ingredients	Arginine	Histidine	Lysine	Tryptophan	Phenylalanine	Tyrosine	Methionine	Cystine	Threonine	Leucine	Isoleucine	Valine
1	Cassava-70	406	77	203	56	126	70	35	63	140	210	175	168
	Maida-20	38	24	22	12	58	26	18	28	30	80	44	48
	Soya-10	45	15	40	8	30	21	8	10	24	48	32	32
		489	116	265	76	214	177	61	101	194	338	251	248
	Amino acid score = 66.10												
2	Cassava-60	348	66	174	48	108	60	30	54	120	180	150	144
	Maida-30	57	36	33	18	87	39	27	42	45	120	66	72
	Soya-10	45	15	40	8	30	21	8	10	24	48	32	32
		450	117	247	74	225	120	65	106	189	348	248	248
	Amino acid score = 65.16												
3	Cassava-50	290	55	145	40	90	50	25	45	100	150	125	120
	Maida-25	48	30	28	15	73	33	23	35	38	100	55	60
	Soya-25	113	38	100	20	75	53	20	25	60	120	80	80
		451	123	273	75	238	136	68	105	198	370	260	260
	Amino acid score = 67.38												
4	Cassava-50	290	55	145	40	90	50	25	45	100	150	125	120
	Maida-30	57	36	33	18	87	39	27	42	45	120	66	72
	Soya-20	90	30	80	16	60	42	16	20	48	96	64	64
		437	121	258	74	231	131	68	107	193	366	255	256
	Amino acid score = 65.90												
5	Cassava-50	290	55	145	40	90	50	25	45	100	150	125	120
	Maida-35	67	42	39	21	102	46	32	49	53	140	77	84
	Soya-15	68	23	60	12	45	32	12	15	36	72	48	48
		425	120	244	73	237	128	69	109	189	362	250	252
	Amino acid score = 66.72												

Contd...

	Ingradients	Arginine	Histidine	Lysine	Tryptophan	Phenylalanine	Tyrosine	Methionine	Cystine	Threonine	Leucine	Isoleucine	Valine
Cassava wafers													
1	Cassava-70	406	77	203	56	126	70	35	63	140	210	175	168
	Blackgram-15	78	26	60	11	47	21	14	12	33	75	51	47
	Soya-15	68	23	60	12	45	32	12	15	36	72	48	48
		552	126	323	79	218	123	61	90	209	357	274	263
	Amino acid score = 71.52												
2	Cassava-50	290	55	145	40	90	50	25	45	100	150	125	120
	Blackgram-25	130	43	100	18	78	35	23	20	55	125	85	78
	Rice-25	160	48	55	18	88	75	55	25	73	140	78	115
		580	146	300	76	256	160	103	90	228	415	288	313
	Amino acid score = 79.01												
3	Cassava-50	290	55	145	40	90	50	25	45	100	150	125	120
	Bengalgram-30	171	48	132	15	108	54	24	24	66	174	96	93
	Rice-20	128	38	44	14	70	60	44	20	58	112	62	92
		589	141	321	69	268	164	93	89	224	436	283	305
	Amino acid score = 79.13												
4	Cassava-60	348	66	174	48	108	60	30	54	120	180	150	144
	Blackgram-20	104	34	80	14	62	28	18	16	44	100	68	62
	Rice-20	128	38	44	14	70	60	44	20	58	112	62	92
		580	138	298	76	240	148	92	90	222	392	280	298
	Amino acid score = 76.3												
5	Cassava-60	348	66	174	48	108	60	30	54	120	180	150	144
	Greengram-20	100	34	92	12	70	20	16	12	40	102	70	64
	Rice-20	128	38	44	14	70	60	44	20	58	112	62	92
		576	138	310	74	248	140	90	86	218	394	282	300
	Amino acid score = 76.36												

Contd..

Ingradeints		Arginine	Histidine	Lysine	Tryptophan	Phenylalanine	Tyrosine	Methionine	Cystine	Threonine	Leucine	Isoleucine	Valine
Cassava weaning mix													
1	Cassava-70	406	77	203	56	126	70	35	63	140	210	175	168
	Soya-20	90	30	80	16	60	42	16	20	48	96	64	64
	Milk powder-10	22	18	49	9	31	30	17	5	28	63	36	42
		518	125	270	81	217	142	68	88	216	269	275	274
	Amino acid score = 67.99												
2	Cassava-60	348	66	174	48	108	60	30	54	120	180	150	144
	Greengram-20	100	34	92	12	70	20	16	12	40	102	70	64
	Soya-20	90	30	80	16	60	42	16	20	48	96	64	64
		538	130	346	76	238	122	62	86	208	374	284	272
	Amino acid score = 73.26												
3	Cassava-60	348	66	174	48	108	60	30	54	120	180	150	144
	Rice-10	64	19	22	7	35	30	22	10	29	56	31	46
	Groundnut-30	207	42	69	18	93	72	18	24	51	120	72	84
		619	127	265	73	236	162	70	88	200	356	253	274
	Amino acid score = 72.80												
4	Cassava-50	290	55	145	40	90	50	25	45	100	150	125	120
	Soya-20	90	30	80	16	60	42	16	20	48	96	64	64
	Milk powder-30	66	54	147	27	93	90	51	15	84	189	108	126
		446	139	310	57	243	182	89	80	232	435	297	310
	Amino acid score = 75.40												
5	Cassava-50	290	55	145	40	90	50	25	45	100	150	125	120
	Soya-25	113	38	100	20	75	53	20	25	60	120	80	80
	Milk powder-25	55	45	123	23	78	75	43	13	70	158	90	185
		458	138	368	83	243	178	88	83	230	428	295	385
	Amino acid score = 75.59												

Contd.

Ingradients	Arginine	Histidine	Lysine	Tryptophan	Phenylalanine	Tyrosine	Methionine	Cystine	Threonine	Leucine	Isoleucine	Valine
Sweet potato noodles/macaroni												
1 Sweet potato-70	196	63	182	77	189	105	70	21	196	252	203	266
Maida-20	38	24	22	12	58	26	18	28	30	80	44	48
Soya-10	45	15	40	8	30	21	8	10	24	48	32	32
	279	102	244	97	277	152	96	59	250	380	279	346
Amino acid score = 67.47												
2 Sweet potato-60	168	54	156	66	162	90	60	18	168	216	174	228
Maida-30	57	36	33	18	87	39	27	42	45	120	66	72
Soya-10	45	15	40	8	30	21	8	10	24	48	32	32
	270	105	229	92	279	150	95	70	237	384	272	332]
Amino acid score = 67.24												
3 Sweet potato-50	140	45	130	35	135	75	50	15	140	180	145	190
Maida-25	48	30	28	15	73	33	23	35	30	100	55	60
Soya-25	113	38	100	20	75	53	20	25	60	120	80	80
	301	113	258	70	283	161	93	75	238	400	280	330
Amino acid score = 68.57												
4 Sweet potato-50	140	45	130	35	135	75	50	15	140	180	145	190
Maida-30	57	36	33	18	87	39	27	42	45	120	66	72
Soya-20	90	30	80	16	60	42	16	20	48	96	64	64
	287	111	243	69	282	156	93	77	233	396	275	326
Amino acid score = 62.78												
5 Sweet potato-50	140	45	130	35	135	75	50	15	140	180	145	190
Maida-35	67	42	39	21	102	46	32	49	53	140	77	84
Soya-15	68	23	60	12	45	32	12	15	36	72	48	48
	275	110	229	68	282	153	94	79	229	392	270	322
Amino acid score = 66.97												

Contd.

Ingradeints	Arginine	Histidine	Lysine	Tryptophan	Phenylalanine	Tyrosine	Methionine	Cystine	Threonine	Leucine	Isoleucine	Valine
Sweet potato wafers												
1 sweet potato-70	196	63	182	77	189	105	70	21	196	252	203	266
Bengalgram-15	78	26	60	11	47	21	14	12	33	75	51	47
Soya-15	68	23	60	12	45	32	12	15	36	72	48	48
	342	42	302	100	281	158	96	48	265	399	302	361
Amino acid score = 73.95												
2 Sweet potato-50	140	48	130	35	135	75	50	15	140	180	145	190
Blackgram-25	130	43	100	18	78	35	23	20	55	125	85	78
Rice-25	160	48	55	18	88	75	55	25	73	140	78	115
	430	136	285	71	301	185	128	60	268	445	308	383
Amino acid score = 80.21												
3 Sweet potato-50	140	45	130	35	135	75	50	15	140	180	145	190
Bengal gram-30	171	48	132	15	108	54	24	24	66	174	96	93
Rice-20	128	38	44	14	70	60	44	20	58	112	62	92
	439	131	306	64	313	189	118	59	264	466	303	375
Amino acid score = 80.93												
4 Sweet potato-60	168	54	156	66	162	90	60	18	168	216	174	228
Blackgram-20	104	34	80	14	62	28	18	16	44	100	68	62
Rice-20	128	38	44	14	70	60	44	20	58	112	62	92
	400	126	280	94	294	178	122	54	270	428	304	382
Amino acid score = 78.39												
5 Sweet potato-60	168	54	156	66	162	90	60	18	168	216	174	228
Greengram-20	100	34	92	12	70	20	16	12	40	102	70	64
Rice-20	128	38	44	14	70	60	44	20	58	112	62	92
	396	126	292	92	302	170	120	50	266	430	306	384
Amino acid score = 78.44												

Contd.

Ingradients	Arginine	Histidine	Lysine	Tryptophan	Phenylalanine	Tyrosine	Methionine	Cystine	Threonine	Leucine	Isoleucine	Valine
Sweet potato weaning mix												
1 Sweet potato-70	196	63	182	77	189	105	70	21	196	252	203	266
Soya-20	90	30	80	16	60	42	16	20	48	96	64	64
Milk powder-10	22	18	49	9	31	30	17	5	28	63	36	42
	308	111	311	102	280	177	103	46	272	411	303	372
Amino acid score = 74.75												
2 Sweet potato-60	168	54	156	66	162	90	60	18	168	216	174	228
Greengram-20	100	34	92	12	70	20	16	12	40	102	70	64
Soya-20	90	30	80	16	60	42	16	20	48	96	64	64
	358	118	328	94	292	152	92	50	256	414	308	356
Amino acid score = 75.34												
3 sweet potato-50	168	54	156	60	162	90	60	18	168	216	174	228
Rice-10	64	19	22	7	35	30	22	10	29	56	31	46
Groundnut-30	207	42	69	18	93	72	18	24	51	120	72	84
	439	115	247	85	290	192	100	52	248	392	277	358
Amino acid score = 74 73												
4 Sweet potato-50	140	45	130	35	135	75	50	15	140	180	145	180
Soya-20	90	30	80	16	60	42	16	20	48	96	64	64
Milk powder-30	66	54	147	27	93	90	51	15	84	189	108	126
	296	129	357	78	288	207	117	50	272	465	317	380
Amino acid score = 79.03												
5 Sweet potato-50	140	45	130	35	135	75	50	15	140	180	145	190
Soya-25	133	38	100	20	75	53	20	25	60	120	80	80
Milk powder-25	55	45	123	23	78	75	43	13	70	158	90	185
	308	128	353	78	228	203	113	53	270	458	315	455
Amino acid score = 79.19												

APPENDIX - III

SCORE CARD FOR PHYSICAL CHARACTERISTICS

NOODLES

Product : Tasted by :

Date : Age :

1. Fineness

☐	☐	☐	☐	☐
5	4	3	2	1
Very fine				Not at all fine

2. Shape

☐	☐	☐	☐	☐
5	4	3	2	1
Uniform sticks				Ununiform sticks

3. Strands

☐	☐	☐	☐	☐
5	4	3	2	1
Round strands				Uneven strands

4. Packaging Quality

☐	☐	☐	☐	☐
5	4	3	2	1
Highly suitable				Not at all suitabale

5 Tensile strength

☐	☐	☐	☐	☐
5	4	3	2	1
Withstand weight				May not withstand weight

SCORE CARD FOR PHYSICAL CHARACTERISTICS

MACARONI

Product :

Tasted by :

Date :

Age :

1. Fineness

☐	☐	☐	☐	☐
5	4	3	2	1
Very fine				Not at all fine

2. Shape

☐	☐	☐	☐	☐
5	4	3	2	1
Very attractive				Not at all attractive

3. Packing Quality

☐	☐	☐	☐	☐
5	4	3	2	1
Highly suitable				Not at all suitable

4. Tensile strength

☐	☐	☐	☐	☐
5	4	3	2	1

Withstand Weight — Cannot withstand weight

APPENDIX - IV

SCORE CARD FOR CASSAVA

NOODLES

Product :   Tasted by

Date :   Age :

1. Appearance

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

2. Colour

White	5
Creamy White	4
Cream	3
Pale Yellow	2
Yellow	1

3. Flavour

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

4. Texture

Soft	5
Spongy	4
Hard	3
Very Hard	2
Shiny	1

5. Taste

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

SCORE CARD FOR SWEET POTATO NOODLES

Product : Tasted by

Date : Age :

1 Appearance

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

2. Colour

Light Brown	5
Brown	4
Dark Brown	3
Blackish Brown	2
Black	1

3. Flavour

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

4. Texture

Soft	5
Spongy	4
Hard	3
Very Hard	2
Shiny	1

5. Taste

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

SCORE CARD FOR CASSAVA MACARONI

Product :	Tasted by :
Date :	Age :

1. Appearance

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

2. Colour

White	5
Creamy White	4
Cream	3
Light Brown	2
Brown	1

3. Flavour

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

4. Texture

Soft	5
Spongy	4
Shiny	3
Hard	2
Very Hard	1

5. Taste

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

SCORE CARD FOR SWEET POTATO MACARONI

Product : Tasted by :

Date : Age :

1. Appearance

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

2. Colour

Pinkish Brown	5
Light Brown	4
Brown	3
Blackish Brown	2
Black	1

3. Flavour

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

4. Texture

Soft	5
Spongy	4
Hard	3
Very Hard	2
Shiny	1

5 Taste

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

SCORE CARD FOR CASSAVA WAFERS

Product : Tasted by :

Date : Age :

1. Appearance

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

2. Colour

White	5
Cream	4
Pale Yellow	3
Yellow	2
Dark Yellow	1

3. Flavour

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

4. Texture

Very Crisp	5
Crisp	4
Hard	3
Soft	2
Soggy	1

5. Taste

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

SCORE CARD FOR SWEET POTATO WAFERS

Product : Tasted by :

Date : Age :

1. Appearance

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

2. Colour

Pinkish Brown	5
Light Brown	4
Brown	3
Blackish Brown	2
Black	1

3. Flavour

Excellent	3
Good	4
Satisfactory	3
Mediocre	2
Poor	1

4. Texture

Very Crisp	5
Crisp	4
Hard	3
Soft	2
Soggy	1

5. Taste

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

SCORE CARD FOR CASSAVA WEANING MIX

Product :

Tasted by

Date :

Age :

1. Appearance

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

2. Colour

White	5
Cream	4
Pale Yellow	3
Yellow	2
Dark Yellow	1

3. Flavour

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

4. Texture

Smooth	5
Soft	4
Fibrous	3
Hard	2
Tough	1

5. Taste

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

SCORE CARD FOR SWEET POTATO WEANING MIX

Product : Tasted by

Date : Age :

1. Appearance

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

2. Colour

Pinkish Brown	5
Light Brown	4
Brown	3
Blackish Brown	2
Brown	1

3. Flavour

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

4. Texture

Smooth	5
Soft	4
Fibrous	3
Hard	2
Tough	1

5. Taste

Excellent	5
Good	4
Satisfactory	3
Mediocre	2
Poor	1

APPENDIX - V

RECIPIES

1. CHICKEN NOODLE SOUP

Ingredients :

Butter	- 1 tbsp	Cornflour	- 1 tbsp
Celery (chopped)	- 2 tbsp		
Garlic	- 3 flakes	Noodles	- 30g
Ginger	- 1/2 piece	Water	- 5 cups
Chicken stock	- 5 cups	Pepper and salt	- As required

Method

Melt butter and saute garlic ginger and celery. Add stock and cook on a slow fire for about 20 minutes Add pepper and salt. Mix cornflour with 2 tbsp water blend well and add to the soup and bring to boil. Remove from fire. Boil 5 cups water add one tsp of salt and noodles. Cook till the noodles soften. Drain add the cooked noodles to hot soup and serve.

2. MACARONI SOUP

Ingredients :

Butter	- 2 tbsp	Maida	- 2 tbsp
Onion	- 1 (finally chopped)	Milk	- 1 cup
		Egg	- 1
Macaroni	- 100g	Cream	- 1/2 cup
Chicken stock	- 1 cup	Salt and pepper to taste	

Method

Melt butter in a heavy bottommed pan. Add the onions and macaroni fry until they are soft and cooked. Add maida and stir. Now add the stock and milk, stir and let it boil gently for 25 minutes Beat the egg and add cream, add this mixture to the soup taking care to avoid curdling. Sprinkle peper and salt and serve hot.

3. PRAWNS NOODLES

Ingredients :

Cooked Noodles	- 500g	Prawns	- 50
Tomatoes	- 6	Onion (big)	- 3
Onion	- one hand full	Garlic	- 10 flakes
Green chillies	- 4	Carrot	- 3
Ginger	- small piece	Dalda	- As required
		Coconut milk	- from one coconut
Curry leaves & Coriander leaves	- few		
Chilli powder	- 2 tbsp		
Coriander powder	- 2 tbsp	grind to paste	
Turmeric powder	- 1/2 tsp		

Method

Clear the prawns well. Cut the green chillies and ginger into fine pieces. Cut onion into thin long pieces. Grate the carrots, take the first and second milk from coconut and keep separately. Fry onion, chilly and ginger and curry leaves till golden colour Add ground masala and salt and fry well. Add macaroni and tomato and fry. Add second extract of coconut milk and close the pan. Cook till the gravy is thick. Add the first milk and remove from fire. Fry onion and carrot and the remaining tomatoes. Add the cooked noodles and vegetables with the prawn mixture. Mix well sprinkle corriander leaves and keep on low fire for five minutes. Remove from fire and serve hot.

4. CHINESE FRIED NOODLES

Ingredients :

Eggs	- 2	Diced french beans	- 100g
		Diced carrots	- 2 medium
Dalda	- 2 tbsp	Sliced onion	- 1 medium
Cooked Noodles	- 500g	Diced cooked ham	- 125 g
Water	- 6 cups	Soy sauce	- 2 tbsp
Salt	- 2 tsp		
Salad oil	- 4 tbsp	Pinch of Aji-no-Moto (optional) a little salt if required	
Well cleaned shrimps	- 125 g		

Method

Beat eggs and add a pinch of salt. Heat dalda and cook an omelette with the eggs. Do not allow the omelette to brown. Cool and cut the omelette into small cubes.

Heat oil, Add shrimps and fry, cover for 2 to 3 minutes. Add beans, carrots, and onion cover and cook for another 3 to 4 minutes. Mix Noodles, bits of omelette and ham and cook for a further 2 to 3 minutes. Add soy sauce, aji-no-moto and salt (if required). Mix well. Serve hot with chilli sauce.

5. MACARONI MOTI PULAO

Ingredients :

a.	Minced meat	- 250 g
	Green chillies	- 2
	Choped coriander leaves	- few
	Beaten egg	- 3 tbsp
	Salt	- to taste

Method

Grind minced meat very fine and mix with all the ingredients except ghee. Shape into small balls of the size of marbles. Shallow-fry in hot ghee till brown.

b.	Cooked macaroni	- 250g	Chopped green chillies	- 3
	Ghee	- 2 tbsp	Turmeric powder	- 3/4tsp
	Salt	- 1/2tsp	Coriander powder	- 1tsp
	Water	- 2 cups	Chilli powder	- 1tsp
	Ghee	- 2 tbsp	Salt to taste	
	Onions	- 2 (chopped)		
	Ginger	- 1" piece		
	Sugar	- 1/2tsp		
	Coriander leaves	- a few		
	Bay leaves	- 2		

Heat ghee and brown chopped onion. Add ginger and fry for 1 to 2 minutes. Add macaroni and mix gently.

In a thick-bottomed vessel, arrange alternate layers of macaroni and the meat balls. (The last layer should be macaroni) Dot with one table spoon ghee and steam for about 10 minutes. Serve hot.

6. NOODLES AND VEGETABLE PIE

Ingredients :

Cooked noodles	- 350 g	Egg	- 1
Potato	- 500 g mashed	Butter	- 50 g
Beans	- 150 g	Cheese	- 1 cube
Cabbage	- 100 g	Pepper & salt	- to taste
Capsicum	- 1	Aji no moto	- 1/2tsp

Methods

To the mashed potato and add a little butter, pepper and salt. Cut the beans, carrot, cabbage and capsicum into long strips. Cook it in a little water. Add salt and Aji-no moto. Take a greased baking dish. Spread half the potato at the bottom. Now spread half the noodles over it followed by the vegetables. Now again spread the left over noodles and finally the mashed potato. Beat the egg lightly with a pinch of salt and evenly spread over the pie. Dot it with the remaining butter. Garnish with grated cheese and bake at 150^{o}C for about 20 to 25 minutes or until the top layer of egg is cooked and turns to golden brown. Serve hot with any spicy sauce.

7. STUFFED BREAD ROLLS

Ingredients :

Cooked macaroni	-	1/4 cup
Cooked vegetables	-	1/4 cup
Bread slices	-	4
Oil for frying		

Method

Dampen bread slices on both sides with water. Carefully squeeze out liquid by flattening eash slice between palms of our hands. Divide stuffing into 4 portions and place in the centre of each bread slice. Roll up the slice and seal edges together. Deep fry in hot oil till golden brown and crisp. Serve with chutney or tomato sauce.

8. LUSCIOUS NOODLES

Ingredients :

Noodles	- 250g		
Cheese Sauce			
Butter	- 3 tbsp	Cream	- 1/4 cup
Flour	- 1/3 cup	Grated cheese	- 1/2
Warm milk	- 2		
Meat Sauce		Celery	- 1 stalk chopped
Butter	- 2 tbsp	Tomato	- 3 tbsp (paste)
Onion	- 1 finely chopped	Salt and pepper	- to taste
Carrot	- 1 grated	Nutmeg	- a pinch
Minced meat	- 1/2 kg		

Methods

Cook noodles in a pan of boiling water. Drain and spread on a tray lined with muslin cloth.

For cheese sauce, take a pan and melt the butter. Stir in flour and add warm milk and stir till the mixture is smooth, cook the sauce till it thickens. Add cream, 1/2 cup cheese and salt and pepper to taste. Remove from fire and keep aside.

For meat sauce, melt the butter in a heavy bottomed pan. Add the chopped vegetables and cook over moderate heat. Add the cooked minced meat and fry, pressing down with a fork until the meat is crumbled. Add meat stock, tomato paste, salt and pepper to taste and let it cook slowly for half an until the sauce thicknens. Add nutmeg and remove from the fire.

Take an oven proof dish. Grease it and spread a layer of noodles. Spread half the meat sauce over it and cover with half the cheese sauce. Pour another layer of meat sauce cover with noodles and spread the remaining cheese sauce. Sprinkle with remaining half cup grated cheese and bake for 30 minutes.

9. SAVOURY POTATO NOODLE PANCAKE

Ingredients :

Cooked noodles	- 100 g
Potato	- 1/4 kg
Onion	- 1
Capsicum	- 1/2
Cooked meat	- 1/2 cup

Flour	- 1 cup
Eggs (separated)	- 2
Milk	- 1 cup
Salt & pepper	- to taste

Method

Beat flour, egg yolks and milk until smooth. Fry onion, capsicum cooked noodles and the cooked meat in little oil. Stir this into the batter. Grate the potatoes and spread in a clean cloth to extract excess moisture. Add this to the flour mixture. Fold in the beaten egg whites. Heat oil in a heavy based pan until hot. Shape the potato mixture into wide rounds and cook. Turn it once and cook till brown. Serve hot.

10. MACARONI BIRIYANI

Ingredients :

Chicken	- 1 kg	Cardamom	- 8
Macaroni	- 3 cups	Cinnamon (1" long)	- 8 pieces
Small onion	- 6	Big onion (each sliced into 4 pieces)	
Ginger (1" piece)	- 1	Tomato	- 6 (Cut into four pieces)

Green chillies	- 4		
Garlic	- 10 flakes	Garlic	- 8 flakes (sliced lengthwise)
Almond or cashew nut	- 10	Chilli powder	- 1 tsp
Butter	- 3 tbsp	Turmeric powder	- 1 tsp
Cloves	- 8	Curd	- 1/2 cup.

Method

Clean the chicken and cut into normal biriyani size pieces. Mix the pieces in curd and salt and keep aside for one hour. Grind the masalas. Melt the butter in a deep dekchi and fry cinnamon, cardamom and cloves. Then add the onion pieces and fry till golden brown. Then add thinly cut ginger and fry for some time. Now add the garlic, tomato and turmeric. When the tomato is fried and soft add the chilli powder and then the squeezed chicken pieces and continue frying till the masala is fried. Now add the ground masala and fry a little more and add half cup water. Let the chicken simmer for 5 minutes. Taste the chicken for salt and toss it in the cooked macroni. Mix and serve hot.

APPENDIX - VI

SCORE CARD FOR PREFERENCE TEST

Sl. No.	Products	Like extremely	Like very much	Like reasonably	Like some what	Do not like or dislike	Dislike some what	Relatively dislike	Dislike very much	Dislike extremely
1	Cassava noodles									
2	Sweet potato noodles									
3	Standard noodles									
4	Cassava macaroni									
5	Sweet potato macaroni									
6	Standard macaroni									
7	Cassva wafers									
8	Sweet potato wafers									
9	Standard wafers									
10	Cassava weaning mix									
11	Sweet potato weaning mix									
12	Standard weaning mix									

DEVELOPING COMPLEMENTARY FOOD PRODUCTS BASED ON CASSAVA AND SWEET POTATO

By

S. CHELLAMMAL, M.Sc.

ABSTRACT OF THE THESIS
SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENT FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
FACULTY OF AGRICULTURE
KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF HOME SCIENCE
COLLEGE OF AGRICULTURE
VELLAYANI, THIRUVANANTHAPURAM
1995

ABSTRACT

The present study on `Developing complementary foods based on cassava and sweet potato' was under taken to utilize the high energy root crops such as cassava and sweet potato for the development of complementary foods and to ascertain their nutritional adequacy, physiological tolerance, organoleptic and shelf life qualities.

The survey on the consumption of processed foods indicated that all the families surveyed were aware of the different processed foods available in the market irrespective of the family income. Variables like, food expenditure family income, educational status of the housewife, number of children in the family and family size were found to have a positive correlation with the consumption of processed foods.

The employment status of the women had a significant correlation with the consumption of the processed foods. In high income families, the consumption of processed foods was more among unemployed women. Employed women of high middle income families consumed more processed foods

than unemployed women of that category. But the employment status of women did not make any significant difference among the middle income families with regard to the consumption of processed foods.

Type tests administered for the raw ingredients revealed that the moisture content for all the raw ingredients were lower than ISI specified values. And low moisture values were advantageous in product development. Protein and ash content of certain ingredients were slightly lower than ISI prescribed values but the difference was not statistically significant. Type tests administered for the products revealed that all the characteristics were comparable with ISI specifications. Regarding physical characteristics sweet potato noodles secured lower scores than cassava and standard noodles for different quality parameters. However the developed macaronis were equal or better in physical characteristics. Cooking time for the extruded foods were on par with standard products. The bulk density of standard noodles was significantly lower than cassava and sweet potato noodles. Bulk density of macaroni was higher than that of noodles in all the three categories.

All the foods developed had essential nutrients in optimum quantity. When the nutrients were computed they were observed to be slightly higher indicating loss during processing. The loss was statistically significant for protein and carotene in the extruded foods.

Assessment on the physiological tolerance revealed that among the experimental groups weaning mixes exhibited higher values for P.E.R, B.V, D.C and N.P.U which were comparable with the control group. The PER of the developed foods were 1.99 and above, indicating that the quality of protein is good.

The study on the organoleptic qualities of the developed food revealed that cassava based foods could be rated as equal or even better on certain quality parameters than standard. Sweet potato based foods secured lower scores. Women from high income group who were the predominant consumers of processed foods, fully agreed with the judgment of technical experts. All the foods developed, were rated positively by majority of the farm women.

Regarding shelf life qualities, the storage containers had significant effect on the moisture level and peroxide value t. stored products. However the storage containers did not have any significant influence on the total sugar content. There was increase in all the three quality parameters throughout storage period, the highest being in polythene bags followed by steel containers.

There was no insect infestation upto 6 months of storage period irrespective of containers and products. Products stored in glass and plastic containers were free of insect infestation through out the storage period of one year. Among the other two containers the infestation was more in polythene bags than in products stored in steel containers. The insects identified were *S.orysae, T.castaneum* and *l.Fasciculatus.*

Microbial status after the storage period, revealed that there were five samples in which there was neither fungal nor bacterial growth. Though there was fungal or bacterial growth in other samples the count was within the maximum limit specified by ISI.

The technologies developed in the present study could be transferred to unemployed youth and women so that they can start small scale processing units which is the present lacunae in food processing industry in our country.