

**DEVELOPING BAKED AND
CONFECTIONERY PRODUCTS
BASED ON SWEET POTATO**

by

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THESIS

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1999

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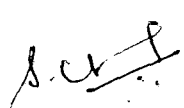
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INTRODUCTION

1. INTRODUCTION

Over the last three decades, many developing countries have achieved remarkable increase in food production. But decision makers and scientists believe that, the possibilities for further improvement in productivity, income and consumption are far from exhausted. Specialists in various discipline are convinced that to reach this goal will require efforts in expanding the utilization of agricultural commodities, through the process of 'product development'.

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. In tropical tuber crops feature as major food item in the diet of the people. Among the tuber crops, it is believed that sweet potato was domesticated in the peruvian coast of South America about 10,000 years ago, in the Neolithic period, perhaps in the late Ice Age 3000 B.C. Roughly 80 per cent of the world's sweet potato are now grown in Asia. According to Upadhya (1990) China occupies the first place in yield and production of 90 million tonnes. In India, the major area of sweet potato lies in northern states. The annual production of sweet potato in Kerala is 21000 tonnes from an area of 1990 hectares (FAO, 1993).

Sweet potato is undeniably one of the world's most important food crops due to its high yield potential and nutritive value. In addition to starch, the tuber flesh contain various sugars, minerals and protein with all essential amino acids. The tuber also contains sufficient amount of carotene and is rich in thiamine. Unlike other tuber crops, sweet potato tuber can be cultivated in certain specific season only. The perishability of the tuber limits its post harvest utilisation throughout the year. So in order to ensure a continuous utilisation of the tuber throughout the year, it is necessary to find out suitable processing techniques for the crop.

The change in day to day life of an average Indian due to urbanisation, increase in percapita income, change in life style and increase in working women population has resulted in an increased consumption of convenience foods (Anvita *et al.*, 1993). Information on the suitability of sweet potato for the production of different products and convenience foods is extremely lacking. Products developed through partial substitution with sweet potato flour will cost less, which is profitable for the farmers and entrepreneurs and at the same time beneficial to the consumers. Some attempts has already been made to develop technologies for the processing of cassava and sweet potato based extruded foods, weaning mixes and ready-to-eat foods at the department level.

In the present study, an attempt is made to develop baked and confectionary products based on sweet potato and to assess their acceptability and shelf life and to popularise them among farm women and small scale entrepreneurs.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The study entitled "Developing baked and confectionary products based on sweet potato was reviewed under the following subtitles.

- 2.1 Significance and processing of sweet potato
- 2.2 Product development
- 2.3 Acceptability studies on new foods
- 2.4 Shelf life qualities

2.1 Significance and processing of sweet potato

Sweet potato (*Ipomoea batatas*) is grown in more than 100 countries. Among the world's root crops, it is second only to white potato in importance (Horton, 1987). In the world scenario, greater than 80 per cent of area under sweet potato cultivation and production lies in Asia, and just under 5 per cent in Africa. Only about 5 per cent is grown in the rest of the world (Kenneth *et al.*, 1989).

According to the FAO statistics (1993) in the world, sweet potato is cultivated in an area of 0.91 m/ha with the production rate of 12.4 million tonnes and yield that is 13.50 t/ha.

China occupies the first place in yield and production in the world with an annual production of 90 million tonnes (Upadhyaya, 1990). In India, sweet potato is grown throughout the country occupying an area of about 0.16 m/ha with a production of about 1.22 mt. and yield 18.33 t/ha (FAO, 1993).

More than 70 per cent of the total area of production of sweet potato in India is found in 3 states namely, Orissa (28.3 per cent), Bihar (24.4 per cent) and Uttar Pradesh (19.3 per cent) (Thankappan and Nair, 1990) and (Vimala, 1990). According to FAO (1993) in Kerala sweet potato is cultivated in an area of 1990 ha and the production of 21000 tonnes, yield 10 t/ha.

Rajendran (1990) detected different varieties of sweet potatoes, including seven wild species. Cultivated species of sweet potato, botanically known as *Ipomoea batatas* L, belongs to the family Convolvulaceae. Vimala, (1990) estimated the production of sweet potato in India to be almost 50 per cent of the Asian average. This is much lower than the average world productivity (Pillai et al., 1992).

Sweet potato is one of the three most important root crops in the world. Sweet potato has been regarded as one of the most important biomass crops because both cultivation and

harvest are relatively easy (Kaoru and Katsuyoshi, 1992). According to Kenneth *et al.* (1989) in comparison with other popular tropical root crops, sweet potato is quick to mature, requiring only 4-5 months from planting to harvest.

Sweet potato plays a very important role as the survival food because of its high nutritive value and greater energy production (Dayal, 1990). Tsou and Hang (1992) observed sweet potato as a low cost food rich in food energy, dietary fibre, minerals and vitamins. According to Babu, *et al.* (1997) in addition to carbohydrates, protein, enzymes, lipid, polyphenols, phytoalexin, organic acid, vitamins, minerals, pigments and phytohormones are present in the tuber.

Sweet potato is a crop with tremendous potential. The tuber is rich in CHO and generally low in fat and protein. Polysaccharides in sweet potato are composed of starch (70%), cellulose (20%), pectic substances (2.5%), hemicellulose (3-4%) and other minor substances (Lila Babu, 1997). Starch is deposited in amyloplasts within the growing tuber and on maturity constitute 50-80% of the dry matter in the tuber starch and sugar contribute over 60 per cent of its dry matter. Raw tuber contain 4-14 per cent sugar on dry matter basis (Anon, 1997).

The starch varies from 50-75 per cent on dry weight basis in different cultivars of sweet potato (Lila *et al.*, 1990).

Ghosh *et al.* (1988) reported that protein content in sweet potato varies from 0.5-3.5 per cent. According to Woolfe (1992) sweet potato contains the important amino acid lysine, in which commodities such as rice are deficient.

Non protein nitrogen forms 15-37 per cent of the total crude protein in sweet potato and they are in the form of free amino acids and amides (Anon., 1997). According to Babu, (1997) proteinase inhibitors (trypsin inhibitors) are present in the tuber. They are stable over a pH range of 2-11 but on cooking they are generally inactivated. She has also reported that true digestibility of the protein ranged from 79-82 per cent and the biological value of the protein was 72-74 per cent. Lipid content is low 0.1 - 0.8 per cent on fresh weight basis in raw tuber. However they play a role in producing of off flavour in dehydrated sweet potato flakes.

Jos *et al.* (1990) believed that the dark orange flesh colour of tubers is associated with the high carotene content. The range of carotene in sweet potato cultivar is very wide. Goswami (1991) reported that the carotene content ranged from 0.3 - 7.2 per cent in different genotypes. The orange flesh variety of sweet potato have been widely used as a excellent source of the provitamin beta carotene (Anon, 1992 and Tsou and Hang, 1992).

NAS (1980) has reported that an intake of 8 oz of the sweet potato beverage contributes 43.7 per cent of the recommended daily vitamin allowance (10,000 I.U) for males. One hundred grams fresh roots can supply from 25-50 per cent of the recommended daily allowance of vitamin C depending on methods of processing (Anon., 1980). Sweet potato is a good source of vitamin C and iron. Grant *et al.* (1992) detected phosphorous and potassium as the major minerals present in sweet potato tuber, with modest amount of iron, magnesium, calcium and copper. The authors found that the tubers contain almost all essential amino acids; except some sulphur containing amino acid. Hill *et al.* (1992) claimed that the presence of auto oxidant nutrients such as beta carotene, ascorbic acid and tocopherol in sweet potato could be able to act against heart disease and cancer in humans.

It is well known that the tuber contained varying amount of fibre content. Kays (1992) believed that the fibre content in sweet potato is having the capacity to decrease the blood cholesterol level by daily use. Therefore, sweet potato can be considered as a natural health food also. Sweet potato tubers contain 2-5 per cent cellulose which is a constituent of the cell walls. Dietary fibre in sweet potato is superior, content and component-wise, to cereals and other staples (Babu, , 1997).

According to Rhodes and Douglas (1990) sweet potato contributes significant amount of essential dietary vitamins and minerals. It is a good source of ascorbic acid in which the cereals are deficient. The vitamin content with special reference to carotene of the tuber was discussed by Bradbury (1990).

The relatively large quantities of amylase present in the tubers break down the starch to maltose was reported by CTCRI, (1984). According to Bouwkamp (1985) sweet potato is an excellent source of nutrient providing at least 90 per cent of the recommended dietary allowance (RDA) for adult's except protein and niacin.

In tropical countries one or more of the tropical tuber crops are used as a major food item in the diet of the people. In various parts of the world, sweet potato is boiled or cooked with rice and served as staple food (Truong, 1989). The only processed product of sweet potato available in India is sweet potato flour, (Nair *et al.* 1989). Ono and Hirano (1992) noticed that in Southern China, sweet potato is usually steamed, boiled or baked, and there is little variety in preparation.

Purushotham (1990) felt that in a developing economy like India the growth of the agro-based food processing

industries is significant for several reasons since it help in generating more employment opportunities and improving the purchasing capacity of the rural poor. Rao (1993) suggested 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. In Japan, on the other hand, food demand has marginally increased, although only 4.2 kg of sweet potatoes per caput per year are currently consumed (Anon., 1992). In Asia, on the other hand, only 50 per cent is consumed as food, while nearly 40 per cent is used for feed and the remainder for other purpose (Anon. 1997).

2.2. Product development

Different type of products are developed from sweet potato.

Food product:- A number of processing techniques are used in developed countries. In central and East Java, the use of sweet potato is more popular, such as for making cakes, cookies, candy, chips and ketchup (Widodo *et al.*, 1993). According to young (1996) sweet potato is used in diverse ways, in that the roots can be boiled, steamed, baked, fried or prepared as a salad, jam, beverage, chips and other snacks, or mixed with a flour to make bread, pancakes and noodles etc.

Sweet potato flour mixed with wheat flour to make cakes for students at ST. Pauls Lutheran High School in Wapenamanda, a particular promising result was that the sweet potato wheat cake had a acceptable taste (Kanua and Rangat, 1989). In the united states, apart from its consumption as a fresh vegetable, the sweet potato is canned, frozen or dehydrated (Anon, 1997).

In many countries, sweet potato flour is used as supplement to cereal flour in bakery products, pan cakes, pudding and others (Truong and Del Rosario, 1986; Tsou and Villareal, 1982^{and} Winarno, 1982). A cheese like product made from sweet potato is a popular dessert dish in Argentinae (Boy et al., 1989). In Phillipines sweet potato is used to make ketchu.p, soft drinks, candies etc. (VanDen, 1989).

Yellow and orange types of sweet potato are canned in the U.S.A. in several style of packing - canned sweet potato in sugar syrup is an important food item (Ghosh et al., 1988). Processing noodles (China), flavoured dehydrated chips, ketchup and a hot cake mix (Phillipines) solar - dried chips, strips and flour (India) and starch extraction from different sweet potato varieties (Thailand) (CIP, 1991). Sweet potato is believed to be employed in certain food industries as a thickness or to provide 'body smoothness' and curdling effects to other food products (Haridah and Khatijah, 1994).

Technology for the processing of sweet potato chips has been reported by Tom (1985). He also reported that fried chips made out of sweet potato are used as a snack coated with spices, salt and sugar. The technology for processing sweet potato for making chips has been successfully developed by Data and Opario (1992).

In peru, sweet potato flour is a common item in grocery stores and used for many household purpose (Martin, 1984). Sweet potato can be used as a snack or dessert item and is commonly consumed in fresh form as boiled, baked or cooked with coconut milk and other ingredients (Truong, 1989). The technology for the processing of dehydrated sweet potato cubes and its utilization in various preparation have been discussed by Truong *et al.* (1990).

Ready-to-cook products such as dehydrated shredded sweet potato was developed by Siki (1979). The crop is also prepared into fried chunks, chips (Alkuno and Truong, 1987) and french-fry-type product (Walter and Hooven, 1980). Technology innovations on drying chips and flour processing on the village level has been reported by Tom (1985). Woolfe (1992) assessed that sweet potato flour replaced the use of wheat upto 50 per cent in Peru. In some part of the China large industries have been developed and sweet potato is utilized for the production of noodles, baby food, candies, pies and a range of other products.

According to Truong (1991) the sweet potato jam and sauce are superior to various commercial products in sensory quality and nutrient content. Curries could also prepared from sweet potato (Khurana *et al.*, 1991). The world's 50 per cent of sweet potato flour is used for the preparation of bread, biscuits, cakes etc. (Anon., 1997). Baked and confectionary products were prepared from sweet potato maida blend.

In India sweet potato is exclusively used for human consumption. Sweet potato flour is used as supplement to cereal flour in bakery products, pancakes, Gulabjamun etc. (Kurup and Balagopalan, 1991). According to Goswami (1991) the flour is used in producing chappathi along with wheat flour. Thirumaran and Ravendran (1992) have explained the processing techniques of sweet potato vermicelli. The authors also prepared various products like food mix, laddu, halwa, payasm from sweet potato flour.

Some 5 -10^{percent} of China's annual production is processed into noodles, starch, chips and candy (Tang *et al.*, 1990). Substitution of grated, fresh sweet potato for imported wheat flour has gained a foothold in the peruvian bread market (Cavero *et al.*, 1991). According to Christopher *et al.* (1995) from sweet potato commercial fruit products including, dried fruits, jam, candied fruits, juices and drinks, ^{were} packed in various forms. Since fresh fruits are seasonal, these products

tended to be expensive and thus accessible only to high income consumers and export markets.

Truong (1991) reported that sweet potato beverage with guava was rated higher than guava-flavored fruit nectar in cans.

Datta *et al.* (1986) revealed that sweet potato flour can totally replace wheat flour in soy sauce production. A number of speciality products like baby foods, snacks, candies, sauces, break fast food are developed by Moorthy and Padmaja (1990). Zoisima (1992) opined that, since the price of sweet potato is several times cheaper than wheat flour, it could be used as a substitute to wheat flour in bread making also. Jam, candies, sauce, jelly and juice also prepared from sweet potato (Anon., 1997).

Bouwkamp (1985) reported that speciality products like candies, sembei, crackers, paste, pies, roasted sweet potato were prepared from sweet potato. Sweet potato can be pureed to produce a product that may be used for baby foods, pie fillings, and with the addition of starch, frozen sweet potato patties. It is also utilised in the production of sweet potato flakes and other products (Anon, 1997). According to Lilababu (1997) sweet potato may be frozen in many forms; as whole roots, halves, quarters, slices, cubes, french fries,

mash/paste or as puree. Root may be canned whole, halved or otherwise cut into chunks either in a syrup or under vacuum (Anon, 1997).

Edmond and Ammerman (1971) have reported the processing of commercial food products such as flakes and canned and frozen items from sweet potato. According to Ghosh *et al.* (1988) in some parts of India, tubers are made into chips which after drying are ground into flour and used as a supplement to cereal flour in the preparation of confectionary products, chappathies, pudding etc. Anon (1992) stated that sweet potato can be consumed as a staple food, a supplementary staple food and a luxury product.

Likewise the method for the preparation of sweet potato ketchup has been explained by Truong *et al.* (1986). Padmaja *et al.* (1991) developed different recipes from sweet potatoes, including fruit salad, sherbet, cake, jellies, gulabjamun, sukhiyan, pudding etc.

Artificial orange flavour enhanced the aroma of the fruity sweet potato beverages (Truong, 1989). Wilson and Pichal (1991) developed a fruity food product from sweet potato which is considered as a new approach for improving the economic value of the crop. Addition of juice, or pulp of different fruits eg:- guava, pineapple, lemon to sweet potato beverage at concentration of 0.6 - 2.4 per cent significantly improved the aroma and scores of products.

A process of producing non-alcoholic beverage from sweet potato with taste and appearance, similar to those of commercial fruit drinks has been reported by Truong and Rosario (1986). Reichert (1989) experimented with sweet potato yogurt and found it received very favourable scores from sensory panels. A different type of beverage which is in the form of precooked powder was also developed from sweet potato by Walter *et al.* (1990).

In Maharashtra state, boiled pulp of sweet potato is dried into shreds and used during fasts and festivals (Nanda, 1984). Ray *et al.* (1991) reported that sweet potato and yam are invariably used in daily prasadam in famous temples in Orissa.

In Kerala pappad were prepared from sweet potato flour (Muralidharan, 1991). Developing different types of extruded food based on sweet potato was explained by Chellammal and Prema (1993).

CTCRI, Trivandrum in (1984) has done some work on pickling sweet potato chips. At CTCRI, some attempts have been made to produce bread and biscuit using sweet potato flour. It was found that upto 25 per cent of wheat flour can be substituted with sweet potato flour without substantially affecting the quality of the products (Nair *et al.*, 1989).

Sweet potato flour is another processed products. The powder is used as supplement to cereal flour in bakery products, pancakes and pudding. The flour has been used in producing chappathi along with wheat flour (Nair *et al.*, 1989). Seralathan and Thirumaran (1990) were successful in the incorporation of sweet potato flour in to various traditional south Indian dishes and baked products. As wheat flour substitute, sweet potato replace 10-20 per cent of the flour mix (Anon, 1991).

Industrial products:- Industrial products could also be developed from sweet potato. Bouwkamp (1985) explained the use of sweet potato starch as a raw material for the preparation of candy drops, ice cream, jam, bread, biscuit, cakes and juice. According to Nair *et al.* (1989) at CTCRI sweet potato starch is converted into alcohol on laboratory scale.

Non fermented product like sugar syrup and other derivaties, enzymes called β amylase, modified starches such as anionic, cationic and phosphate stabilized starches are developed from sweet potato (3rd international training course of sweet potato production, 1997). In China and Japan citric acid is made from saccharified sweet potato starch and the by products. From the saccharified sweet potato starch, latic acid, monosodium glutamate, gluconic acid and various amino acid could be made (Anon, 1997).

According to Winarno (1982) product like β carotene, pectin, protein enriched pulp, feed yeast and alcohol can also be developed from sweet potato. Ghosh *et al* (1988) reported that in Japan about half of the total crop is utilized in the preparation of starch for the use in textile, paper, cosmetics, glucose syrup and in food manufacturing. They also reported that alcohol, acetone, vinegar and pectin are also produced from sweet potato. Balagopalan *et al.* (1993) has extracted industrial starch from sweet potato using enzymatic treatments.

Mc Ardle and Bouwkamp (1986) reported that rapid heating of sweet potato mashes, to 80°C may be optimal for starch conversion and handling of sweet potato mashes prepared for ethanol fermentation. According to Ghosh *et al.* (1988) bactericidal and fungicidal substances have been isolated from the vines and tubers of sweet potato. They also reported that sweet potato starch is useful as an ingredient in the products of confectionary and baking industries.

Sweet potato flour can be employed as a coagulant in slurry thickness in the process of extraction alumina from bauxite. It is also used as a molding sand conditioner (Hrishi and Balagopal, 1979). Winarno (1982) reported that from sweet potato starch industrial products like chemicals, medicines are developed. According to Troung and Rosaria (1986) from the

sweet potato starch fuel alcohol is prepared. In Japan the production of "Shochu" a distilled liquor from sweet potato has long tradition.(Anon. 1997).

2.3 Acceptability studies on new foods

Organoleptic qualities play an important role in evaluating the quality of food products. For judging consumer acceptability, organoleptic evaluation of any food product is essential. According to Mc Dermott (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.

When the quality of food is assessed by means of human sensory organs, the evaluation is said to be sensory analysis. Clement and Kubena (1989) feels that sensory evaluation can be used to predict the consumer acceptance of a food item.

According to Mc Larsen (1984) the criteria included in food quality system are general acceptance, taste, appearance, texture and aroma of food. Sensory analysis of food depends up evaluation through the use of our senses only by applying exact scientific testing methods (Skelton, 1984). According to Rose (1987) success with products is highly

dependent on careful evaluation of products and their potential in the generation. Sensory analysis is a multidisciplinary science that uses human panelists and their sense to measure the sensory characteristics and acceptability of food products (Ylimaki *et al.*, 1989).

Osnabrugge (1988) opines that taste testing should never be over looked since it can guide recipe developers in creating products that have a greater appeal for the intended audience. Portability, ease of use and training flexibility, cost saving, easy and inexpensive maintenance and operational confirmity are various advantage of sensory evaluation system as expressed by Bill Meyer and Wyman (1991). According to stone and sidel (1993) sensory evaluation involves the measurement and evaluation of the sensory properties of food and other materials.

Laurin and Kay (1992) detected tremendous genetic diversity in flavour and listed more than twenty flavours in 89 advanced clones of sweet potato. An extruded product macroni with sweet potato flour, soya flour and maida was found to be highly acceptable among farm women (Chellammal and Prema, 1993).

Truong (1991) reported that a laboratory taste panel found that nonalcoholic sweet potato beverage received higher scores for aroma and general acceptability than papaya nectar

and pineapple orange drink. In Philippines some college staff found that a number of processed sweet potato products such as fried chips, candies, flour and local delicacies were developed commercially and acceptability trials were conducted (Christopher *et al.*, 1995). He also reported that consumer tests gave encouraging results, with 80 per cent of the respondents saying, they liked the products moderately to very much.

Most flavours are comprised of a combination of both taste and odour. According to Purcell *et al.* (1980) the aromatic flavour components of cooked sweet potatoes have not been identified although part of the volatile constituents of one North American cultivar. In bread making, substituting 10 per cent of wheat flour with sweet potato flour gave favourable results in the quality and form of bread (Chiappe *et al.*, 1984).

2.4 Shelf life qualities

The effectiveness of a storage method depends to some extent on the variety stored owing to varietal difference in susceptibility to a disease, length of dormancy period and transpiration rate. According to Padmaja (1990) storage of sweet potato beyond one month will adversely affect its nutritional qualities.

Sowokinos *et al.* (1987) found that sucrose is the principal sugar showing most notable increase with storage. The sugar content varies between 1-7 per cent of fresh weight basis and it increases on storage (Nair *et al.*, 1989). Padmaja (1990) indicated 50 per cent loss in starch after six months storage and reported a concomitant increase in glucose, fructose and sucrose content.

Chandhary and Kapoor (1984) have reported that flour could be stored at 20°C and 70 per cent relative humidity for 6, 7, 8 and 10 days in gunny sacks, earthen pots, tin cans and polyethylene bags, respectively without affecting its acceptability.

Snacks fried in ground nut oil and palm oil remained stable for 120-240 days, respectively in the various packaging films (Thakur and Arya, 1990). Microbiological examination of the sweet potato flour samples revealed a considerable increase in fungal count while the bacterial count remained constant during storage (Kapoor and Kapoor, 1990).

According to Chellammal (1995) analysis of the insect infestation and microbial assessment of the products developed from cassava and sweet potato blend, revealed that there was no insect infestation in glass and plastic containers after a storage period of six months.

Data and Opario (1992) evaluated the effect of polythene sacks for the storage of dried sweet potato chips. The authors concluded the efficiency of polythene covers in preventing moisture penetration. Among the storage method tried for dried sweet potato chips, Data and Oparnio (1992) noticed jute sacks with moderately good effect, whereas open crates and straw sacks were not advisable, since it gave poor results on storage.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The present investigation "Developing baked and confectionary products based on sweet potato", comprised of

- 3.1 Standardisation of raw materials
- 3.2 Product development
- 3.3 Nutritional adequacy, organoleptic qualities and preference test of the developed products
- 3.4 Demonstration of the developed products among farmers and entrepreneurs
- 3.5 Shelf life qualities of sweet potato flour and products, and
- 3.6 Standardisation of recipes with sweet potato flour

3.1 Standardisation of raw materials

The different raw materials selected for the development of the products include sweet potato flour, maida, skimmed milk powder, egg, sugar, fat and baking powder. The principles governing the selection of combination were protein quality, cost and appearance.

3.1.1 Processing of sweet potato flour

Earlier studies by Kay (1992) on sweet potato based products revealed the suitability of sweet potato flour for formulating different types of processed food.

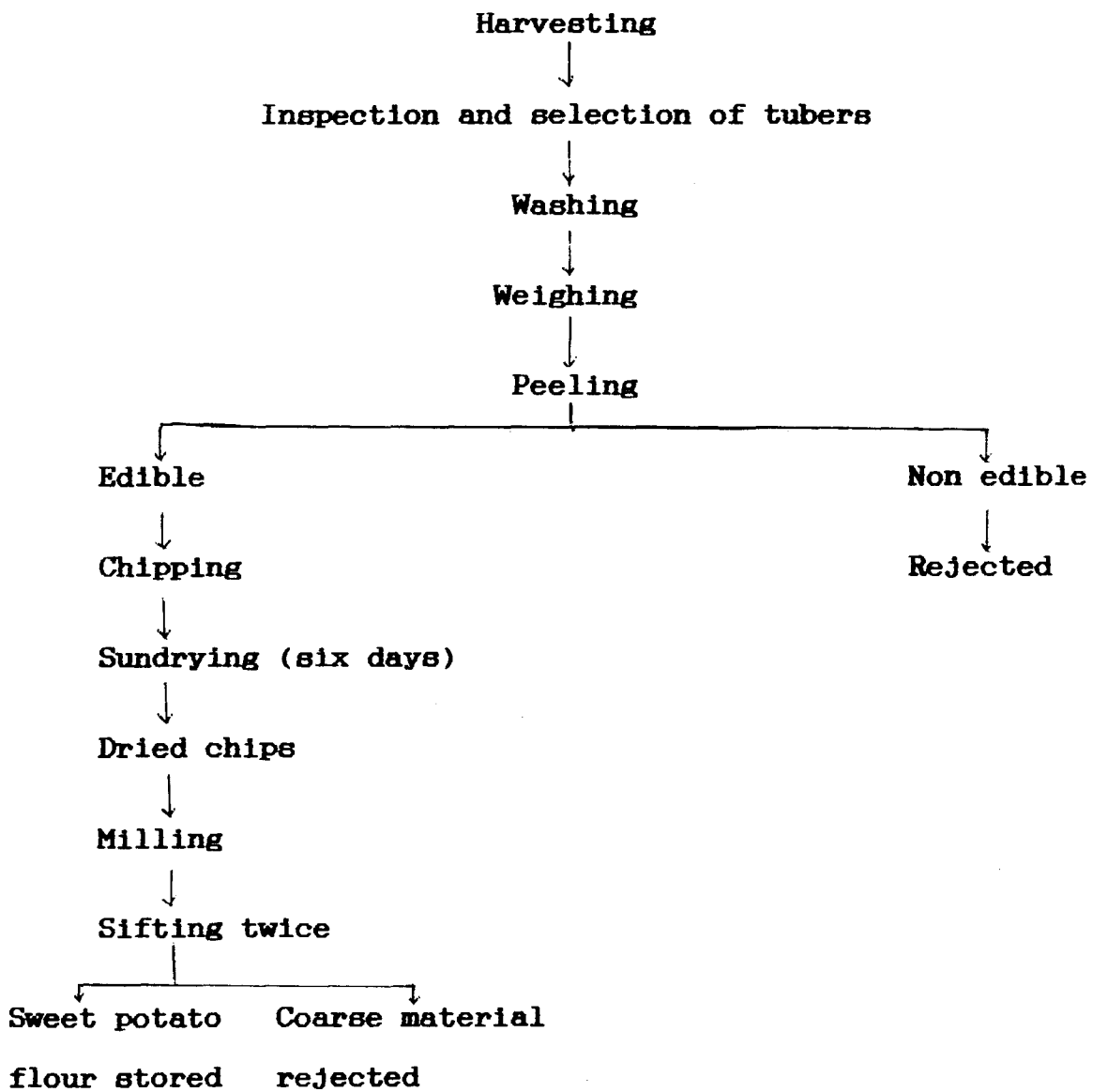
The local variety Kanjangad was selected for the study and ~~Sixty~~ 50 kg of sweet potato tubers was purchased from the Instructional farm, College of Agriculture. The tubers were washed thoroughly with water to remove solid particles and dirt. Peeling and chipping were done manually with sharp knives. During chipping the end portions of the tuber were discarded. The thickness of the chips ranged from 0.5-0.7 cm. The fresh chips were sundried for six days and milled, as explained in Fig. 1.

The flour was analysed for moisture, total ash and crude fibre, to confirm ISI specification. The flour was then stored in ^{an}air tight container .

Maida:- It is a refined wheat flour contain gluten protein, which act as binders and provide strength. Such quality is essential for an ingredient selected for formulating bakery and confectionary products. During baking the starch contained in the flour becomes gelatinized and embedded in the gluten network, and the surface particles of flour are dextrinized to contribute to the desired browning.

Maida is the most important of the cereal flour used in the preparation of baked and confectionary products. ~~Twenty five~~ 20 kg of maida was purchased in bulk from the super market. The purchased maida flour was sundried for two hours, sifted twice and stored in ^{an}air tight container .

Fig. 1 Flow chart for the preparation of sweet potato flour



Egg:- It is used as an emulsifier in the baked products. Thirty Nos. of fresh eggs were purchased from the market and stored in ^{the} refrigerator. According to Eva et al. (1971) coagulation of egg protein during baking adds strength to the cellwalls and contributes to the structure of baked products. The high moisture content of egg permits them to act as a liquid in the preparation of flour.

Baking powder:- Baking powder is a mixture that liberate carbon dioxides when moistened or heated (Arnold, 1982). Sodium bicarbonate is the source of Co₂, and an acidic substance is required, such as tartaric acid or acid salt. Effective leavenners maintain the expanded cell structure until coagulation of protein structure is completed at the end of baking. One packet (100 g) of baking powder was purchased and stored.

Sugar:- The primary function of sugar is the contribution of a sweet flavour. They also promotes tenderness, browning of the surface of baked products, fine texture in products. Eva et al. (1971) reported that the gluten strength is weakened considerably in sugar - rich products permitting a greater expansion of the cell structure and increased volume in baked products. Twenty five kg of sugar was purchased in bulk from the market. The purchased sugar was stored in air tight containers.

Fat:- They are effective tenderizing agents. Fat coat the particles of flour, inhibiting their hydration and interfering with the formation of gluten. The nature of fat influence the nature of the baked products. Fat contribute richness to a products, and also contribute desirable flavour and colour. Ten kg of fat was purchased from the super market and the purchased product was stored in ~~an~~^{an} air tight container at room temperature (28°C).

Skimmed milk powder:- In production of skimmed milk powder, the milk fat is removed or skimmed from the milk, before the milk is dehydrated to a moisture content less than 4 per cent. Skimmed milk powder is the usual form of milk used for bakery products. Its addition to dough cause the use of more water and increase the water content of the dough and helped to extend the shelf life of the products (Chaturvedi, 1977). Accordingly 5 kg of skimmed milk powder was purchased from the super market and stored in ^{an} air tight containers.

3.1.2 Selection of the best combination for the development of products

Three combinations were tried for the development of the products. The principles governing the selection of suitable combinations were protein quality, cost and acceptability.

Amino acid score provides an useful estimate of the protein quality of blended foods and this is an acceptable substitute for biological assays (ICMR, 1991). Because of this reason the amino acid content of different formulations were worked out.

Chemical score of different formulations worked out from the ratio between the content of the most limiting amino acid in the test protein to the content of the same amino acid in egg protein. The ratio is expressed as percentage.

$$\text{Chemical score} = \frac{\text{Limiting amino acid content of the test protein}}{\text{Content of the same amino acid in egg}} \times 100$$

Details of the amino acid scores and chemical scores were given in Appendix-I.

Cost of different combinations were computed as per the market price of the ingredients selected and cost involved in processing. Twenty per cent overhead charges were also added to account the cost of fuel and labour charge.

The overall acceptability of the combinations were assessed through organoleptic evaluation. Organoleptic quality assurance in food industry is an ordered set of planned and

systematic action necessary to provide adequate confidence that posses, products and services satisfy the requirements of quality (Rajalakshmi, 1993). Organoleptic qualities such as colour, flavour, taste, texture and appearance are assessed with a pannel of selected judges (Watts *et al.*, 1989). The combination which got the highest scores was selected for the formulation of the products.

3.2 Product development

According to Nair *et al.* (1989) sweet potato flour is used as supplement to cereal flours in bakery products, pan cakes and pudding. Zosima (1992) opined that, since the price of sweet potato is several times cheaper than wheat flour, it could be used as a substitute to wheat flour in bread making. Bouwkamp (1985) reviewed the use of sweet potato flour as raw material for the preparation of candy drops, ice cream, jams, sausage, bread, biscuit, cake and juice. Developing different types of extruded foods based on sweet potato was explained by Chellammal and Prema (1993).

In the present study five baked products and five confectionary products based on sweet potato flour were standardised.

3.2.1 Baked products

According to Rao (1993) the popularity of the baked products is due to their ready to eat convenience nature, unique taste and ready availability at reasonable cost in different part of the country including remote and rural areas. The baked products selected in this study were cake, biscuit, cookies, bread and nancuts.

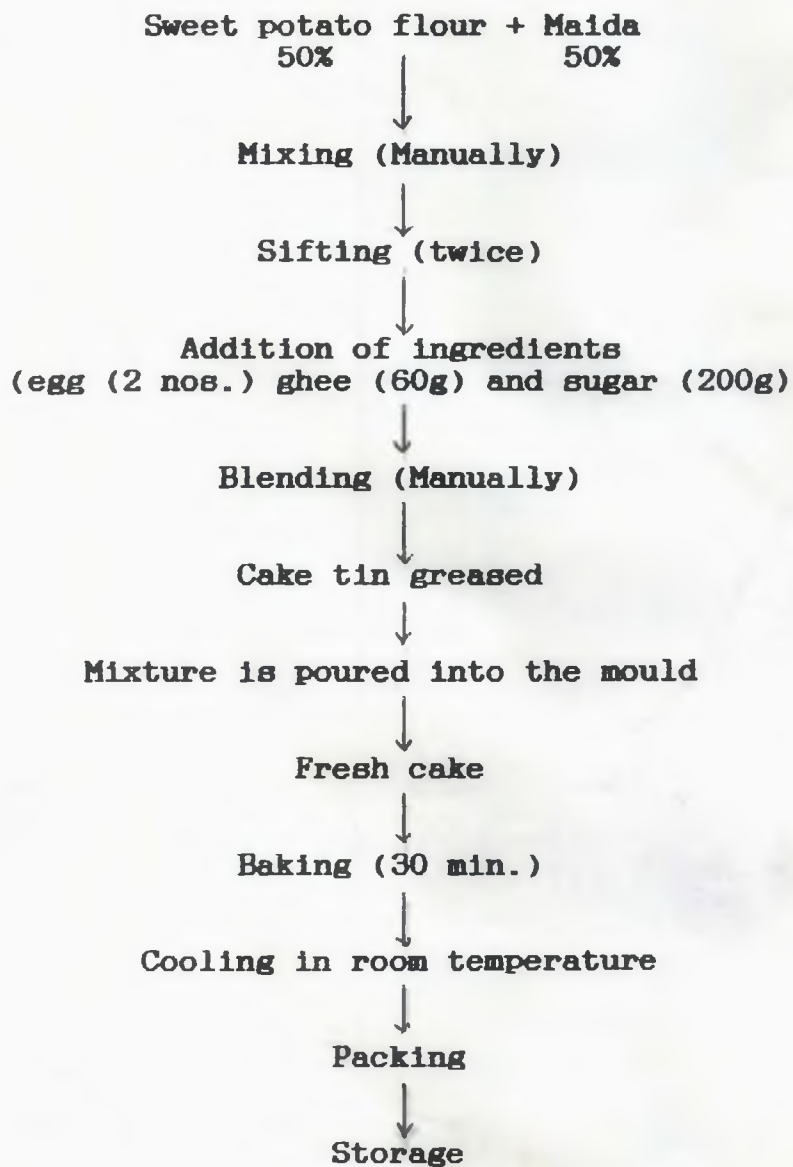
3.2.1.1 Cake

Cakes are prepared in a variety of flavours, but cake formulae usually specify the same general ingredients. In the present study 50 per cent of maida was replaced by sweet potato flour for the processing of sweet potato cake. Other ingredients added were egg, sugar and baking powder. The cake was cooked in preheated oven to 350°C for 30 minutes, as explained in Fig. 2.



PLATE NO. I - CAKE

Fig. 2. Flow chart for the processing of cake



Biscuit

Biscuit is essentially a bakery confectionary dried down to low moisture content. Its name derived from Latin for twice-cooked. Made from soft flour, mostly rich in fat and sugar and consequently of high energy content (Arnold, 1982). Biscuit is a kind of crisp dry bread, more or less hard variously flavoured and usually unleavened prepared, in small, flat, thin cakes reports Reader's Digest. In this study, 50 per cent of maida was replaced by sweet potato flour for the processing of biscuit. The dough was prepared by mixing other ingredients egg, sugar and baking powder. The biscuit cutter was pressed evenly into the dough to yield uniformly shaped biscuits. Biscuits were baked in preheated oven to 218°C for 15 minutes, as explained in Fig. 3.

Cookies

The American term for soft biscuit is cookies (Arnold, 1982). Cookies come in many shapes, forms and flavours. The consistency and nature of the cookies is determined by the kind and amount of ingredients used. For the preparation of sweet potato cookies, 50 per cent of sweet potato flour and 50 per cent of maida along with other ingredients such as coconut, egg, milk powder and sugar were mixed thoroughly. The cookies are made by dropping spoonful of a stiff dough into a cookie sheet and placed in pre heated oven at 350°F for 12 min. as explained in Fig. 4.

Fig. 3. Flow chart for the processing of biscuit

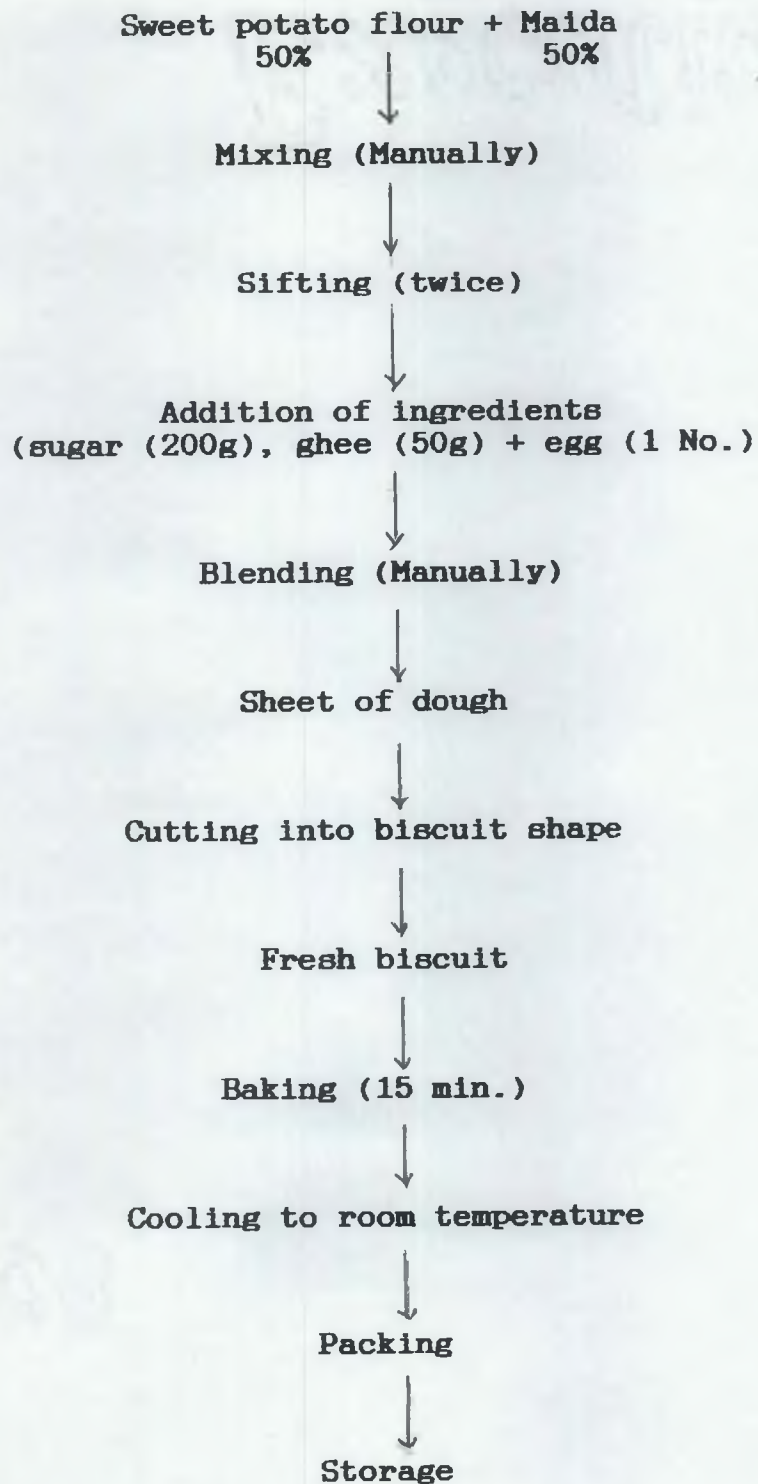
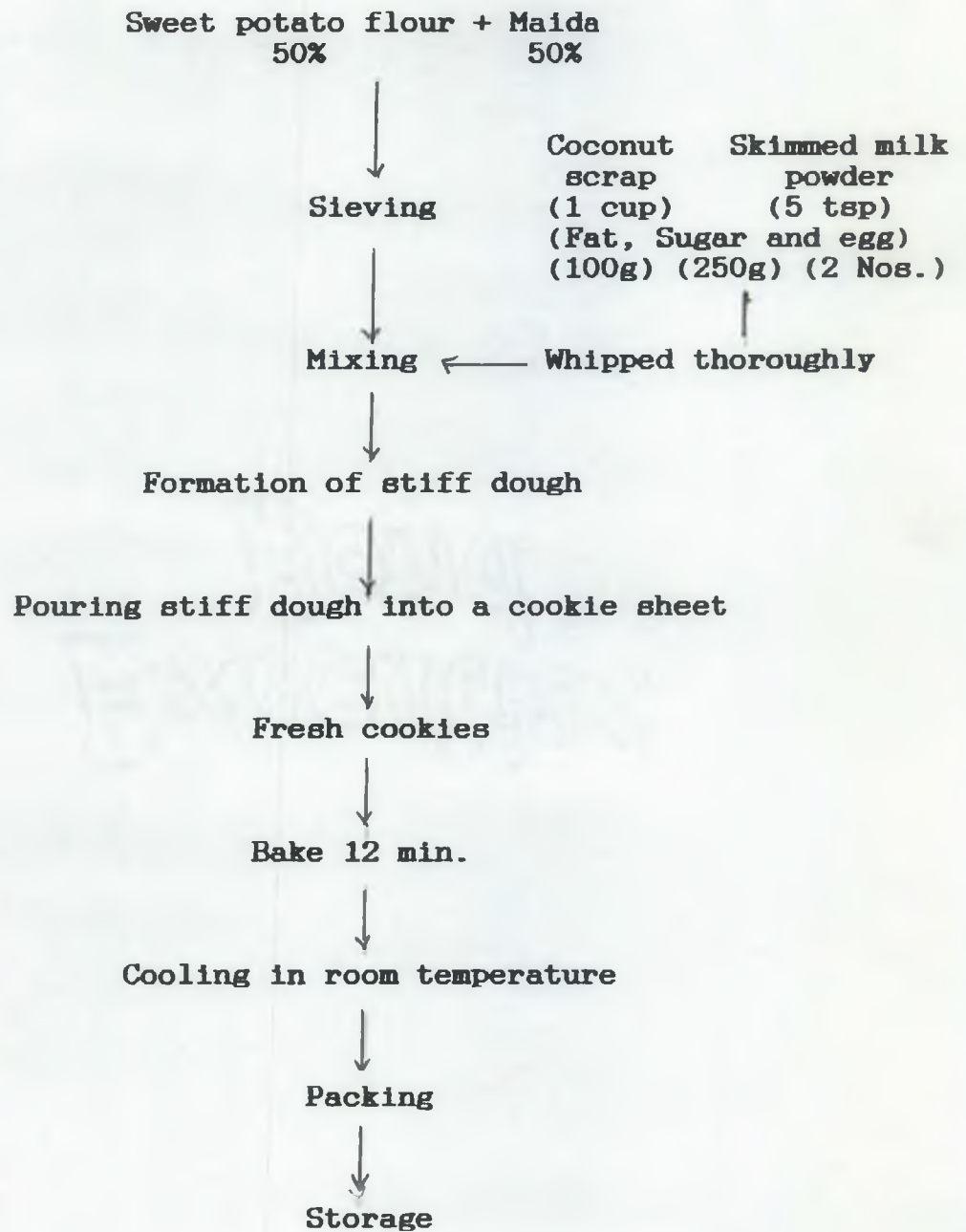




PLATE No. 2 - BISCUIT AND COOKIES

Fig. 4. Flow chart for the processing cookies



Bread

The accepted term for baked foods made of flour, sugar, shortening salt and liquid and leavened by the action of yeast is known as bread (Gopal, 1993). According to Arnold (1982) bread usually refers to a loaf made from wheat or rye flour, or mixture of many cereals. The nature of a quick bread is determined by the kind and proportion of ingredients, techniques of manipulation, utensils and baking temperature. For the preparation of bread based on sweet potato flour, maida, fat, sugar, skimmed milk and salt were mixed together and made into a dough. The dough was then baked in a preheated oven and baked at 205°C for 20 min. as explained in Fig. 5.

Nancuts

Nancuts are similar to biscuit in their ingredients but shape and taste were some what different. In the present study, for the preparation of nancuts 50 per cent of maida and 50 per cent of sweet potato flour were mixed with other ingredients, like egg, sugar and ^{ghee or} refined oil. From the mixed dough small equal sized balls were made out, flattened slightly and baked in an oven at 350°F for 20 min. as explained in Fig.6.



PLATE NO: III - BREAD

Fig. 5. Flow chart for the processing of bread

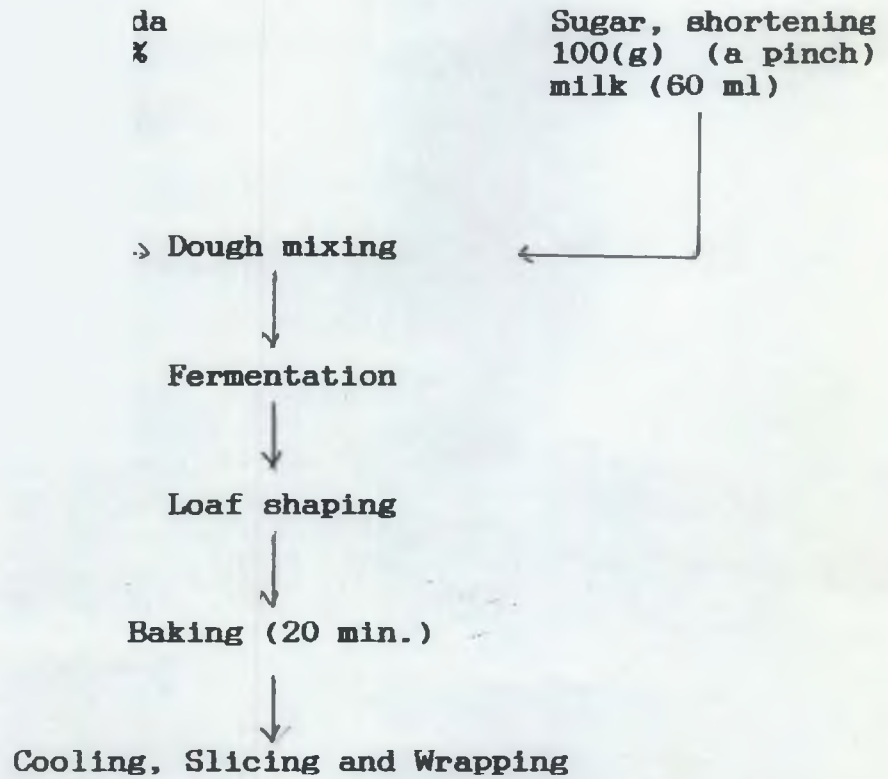




PLATE NO. 4 - NANCUTTA

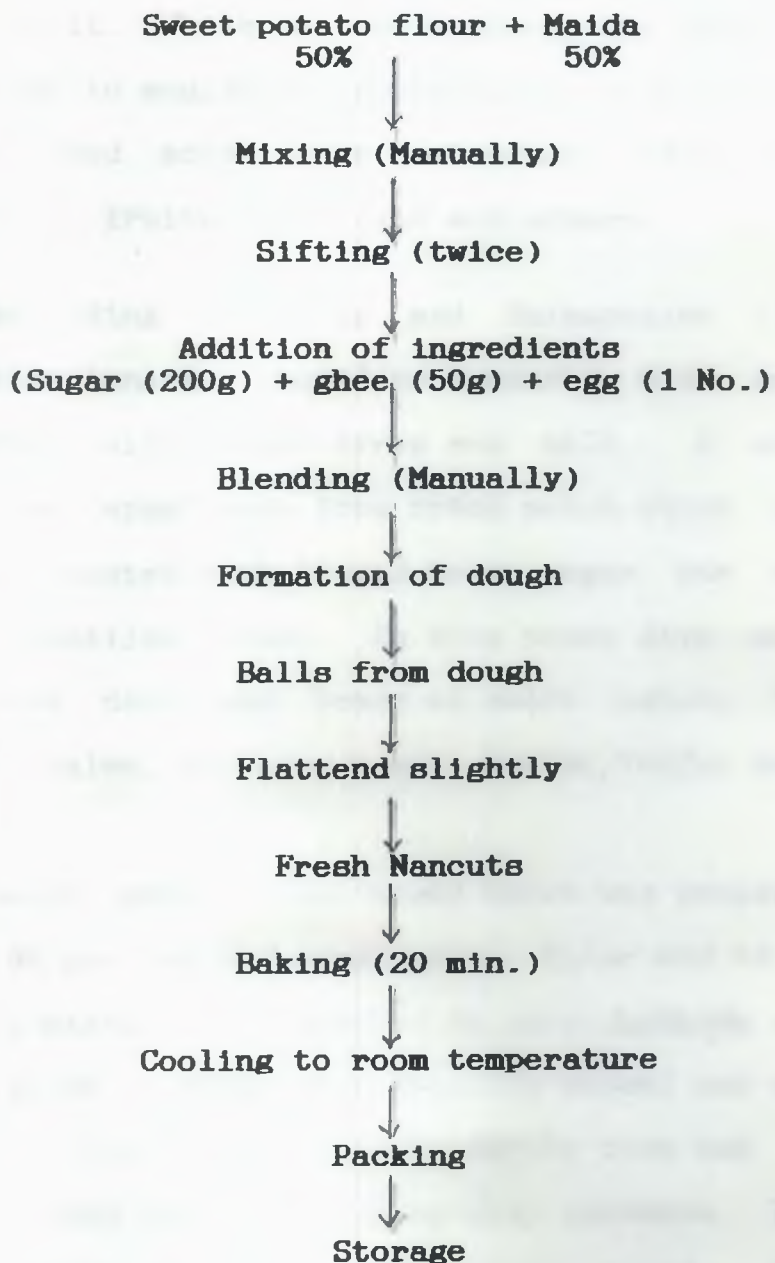
Fig. 6. Flow chart for the processing of Nancuts



PLATE NO: 5 - HALWA AND TOFFEE

3.2.2 Confectionery products

The development of confectionery products is based largely on the art of manipulating sugar, the principle ingredient in it. While the confectioner has many ingredients besides sugar to modify his confections, such as milk powder, egg white, food acid, gums, starcher, fats, emulsifiers, flavours, nuts, fruits, chocolate and others.

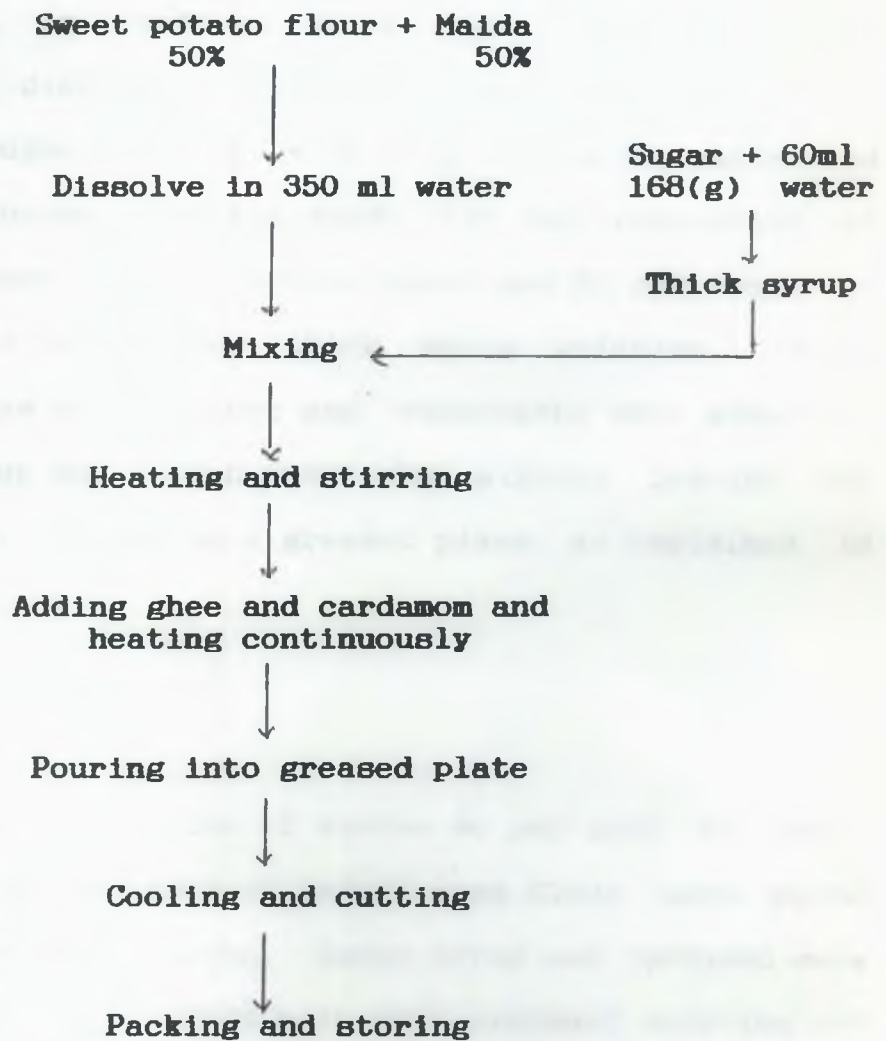
According to Kurup and Balagopalan (1991) sweet potato confectionaries could be prepared with sweet potato chips candied with sugar syrup and milk. A confectionery called "Cakar ayam" made from fried match stick sized sweet potato cuts coated with liquid brown sugar was reported by Haridah and Khatijah (1994). In this study five confectionery products were developed based on sweet potato flour. The product were Halwa, Gulabjamun mix, burfee, Toffee and cheese.

Halwa:- Sweet potato flour based halwa was prepared with a mixture of 50 per cent of sweet potato flour and 50 per cent of maida. The mixture is dissolved in water. One ~~Six~~ ^{cup} of sugar is dissolved in 60 ml water in a separate vessel and made into a thick syrup. The syrup is ~~removed from~~ the fire and mixed with flour. Ghee was then added along with cardamom. The mixture is cooked again till it turns semi solid. Then it is transferred into a greased pan, as explained in Fig. 7.



PLATE NO: 5 - HALWA AND TOFFEE

Fig. 7. Flow chart for the processing of Halwa



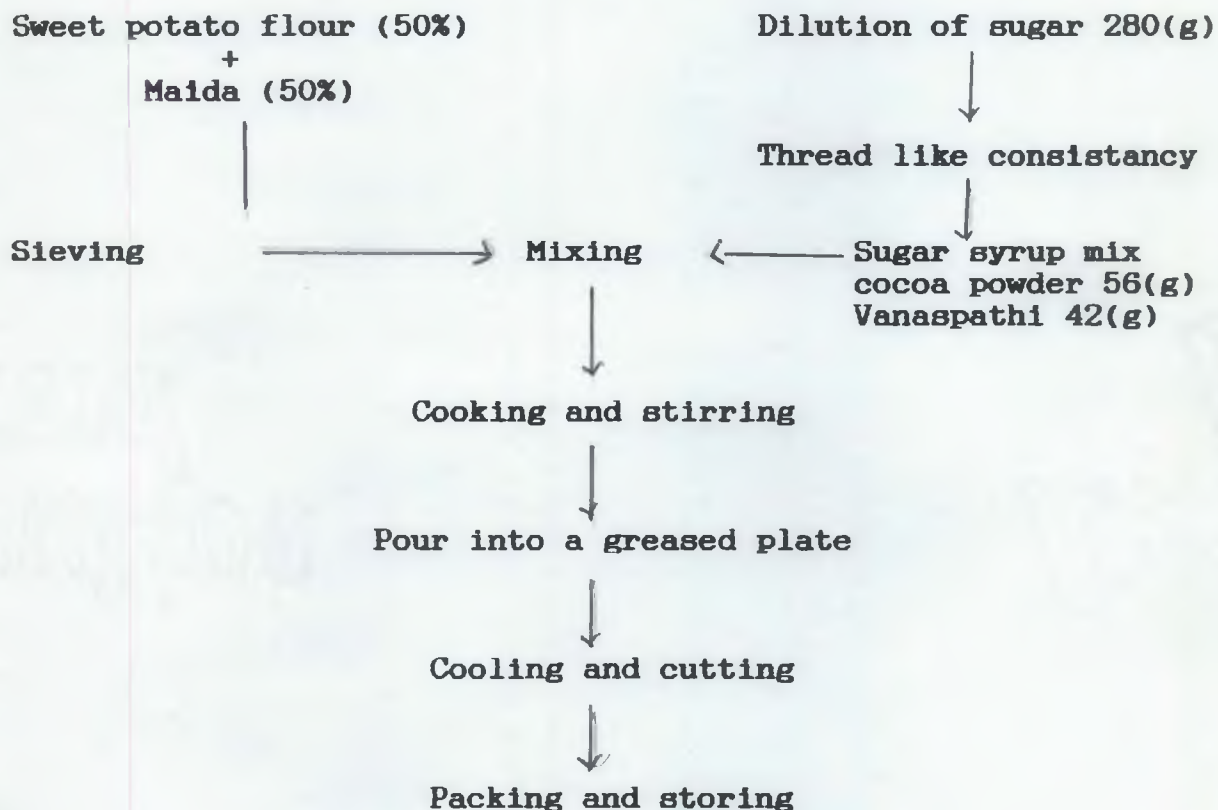
Toffee:-

Toffee is defined as a sweet meat that is essentially a dispersion of minute globules of fat in a supersaturated sugar solution, made from fat, milk, sugar and confectioner's glucose. In this study, for the preparation of toffee, 50 per cent of sweet potato flour and 50 per cent of maida were mixed with very thick syrup solution. Other ingredients such as cocoa powder and vanaspathi were added to the boiling syrup and cooked until the mixture leaving the sides of the pan. Poured on a greased plate, as explained in Fig. 8.

Burfee:-

For the production of burfee 50 per cent of sweet potato flour and 50 per cent of bengal gram flour were mixed with ghee and made into a paste. Sugar syrup and cardamom were added and the mixture is cooked well with frequent stirring and when the dough turn slightly transparent, the mass is poured on a greased plate, as explained in Fig. 9.

Fig. 8. Flow chart for the processing of toffee



Gulabjamun mix:-

In the present study for the preparation of gulabjamun mix 50 per cent of sweet potato flour and 50 per cent of maida were mixed with other ingredients like skimmed milk powder and cardamom. The ingredients taken in a bowl were sieved three times in order to get a uniform mixture. The mixture thus obtained was packed in polyethylene bags (Fig.10).



PLATE NO: 6 -BURFEE

Fig. 9. Flow chart for the processing of burfee

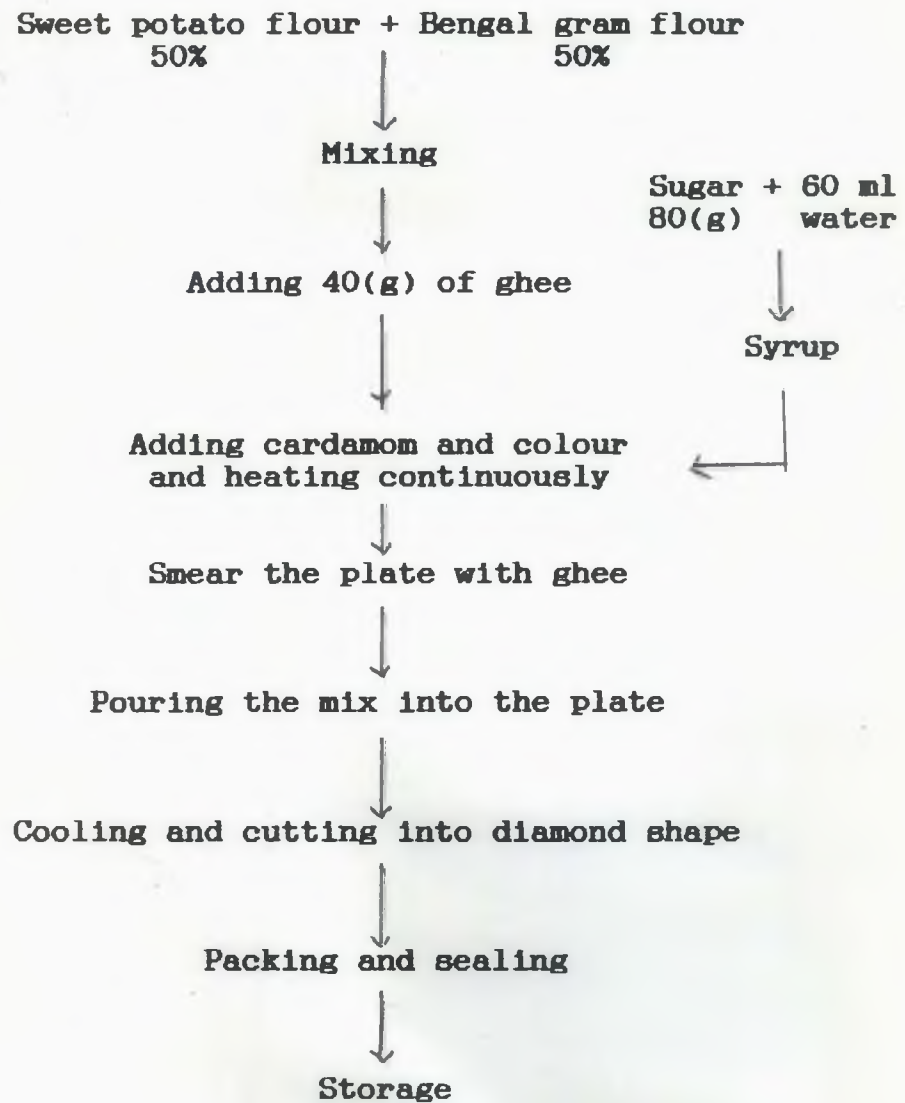




PLATE NO: 7 - GULAB JAMUN MIX

Fig. 10. Flow chart for the processing of Gulabjamun mix

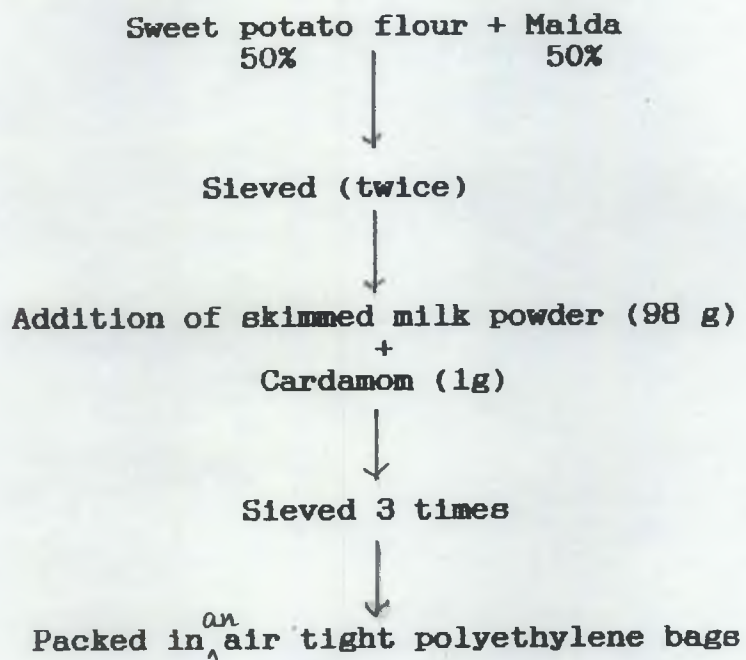


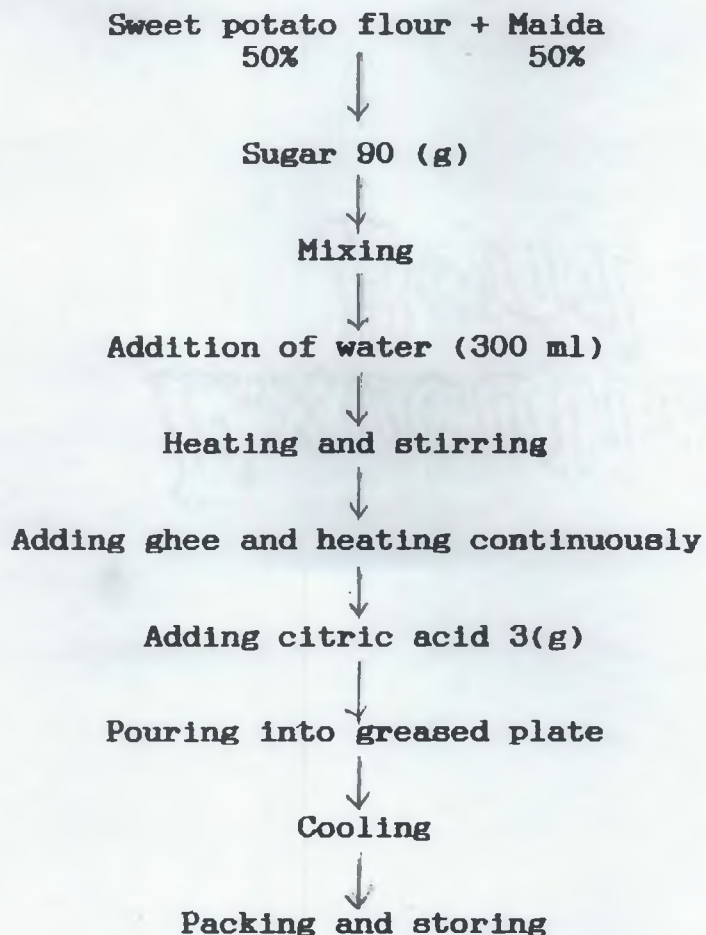


PLATE NO: 8 - CHEESE

Cheese:-

The sweet potato cheese is similar to the fruit cheese. A mixture of 50 per cent of sweet potato flour and 50 per cent of maida were mixed with sugar and water. Then it is cooked well to get sweet potato cheese. Then the product was poured into a greased plate (Fig. 11).

Fig. 11. Flow chart for the processing of cheese



3.3 Nutritional adequacy of the developed products

The nutrients present in the developed products were assessed by estimating the major nutrients using standard techniques.

Sl.No.	Estimation	Reference
1.	Calories	Swaminathan (1984)
2.	Protein	Microkjeldal (Sadasivam and Manickam (1992)
3.	β carotene	AOAC (1975)
4.	Minerals	Jackson (1973)

3.3 Organoleptic qualities of the developed products

The food chosen by people and the quantity consumed depend upon its quality. Evaluation with the help of sensory organs is defined as sensory evaluation. According to Herrington (1991) sensory evaluation technology is a method using skilled management and trained panelists to provide confirmation on the acceptability of the product profile, consumer acceptability and consistency. Sensory quality is one of the criteria of the acceptability of any food products by the consumer. The products were subjected to sensory evaluation and tested their acceptability with help of well experienced taste panel.

A five point scale scoring sheet was formulated and the taste panel was asked to score the products in terms of appearance, flavour, colour, texture and taste. Water was given in between for the removal of any after taste carried over from sample to sample. Since the product development and its acceptance by the people depend on the overall acceptability these test were considered as one of the important criteria for evaluating the acceptability of the newly developed products (Thirumaran, 1993). The testing was conducted in the afternoon between 3 PM to 4PM, since this time was considered as the ideal time for conducting the acceptability studies (Swaminathan, 1975). Appendix II revealed the detail discription of the score cards.

3.3 ISI type test for the developed products

The Bureau of Indian standards has specified certain type test for various products to maintain quality during processing and marketing. ISI type tests were administered to the products for confirmity. Estimation of moisture, ash, crude fibre, protein and fat were done for the sweet potato based products. These tests were carried out using standard techniques.

3.4 Preference test for the developed products among farm women

Creating an awareness regarding the utilization of sweet potato flour, among the farm families who are engaged in sweet potato cultivation is one of the objectives of this study. Any result obtained in the laboratory should reach the land for the timely utilization of the findings. In the present study 75 farm women were selected at random from villages. In these area the production of sweet potato were considerably larger than other areas of the city. So the new products have encouraged the farm women for increasing their production and utilization of sweet potato. The products were demonstrated and served to the women and they were requested to rank the products according to their preference. They were permitted to take enough time to score the samples leisurely. Score card for preference test was given in Appendix III.

3.4 Demonstration of the developed products among entrepreneurs

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 or academic institutions. In this study, an attempt on these lines was also undertaken. The main objectives of this demonstration was



PREFERENCE TEST AMONG ENTREPRENEURS.- PLATE NO: 9

to create awareness about the new products among the entrepreneurs for popularisation and to assess their acceptance. The processing of the products were demonstrated for the benefit of small scale entrepreneurs involved in bakery units in Thiruvananthapuram city.

3.5 Shelf life qualities of sweet potato flour and products

According to Thakur *et al.* (1995) chemical and sensory changes are also influenced by storage period. The modern days concept of total quality control involves application of sensory evaluation at all stages of processing right from processing to raw materials up to the packaging of the finished products (Sushama *et al.*, 1979).

3.5.1 Shelf life qualities of sweet potato flour

For the analysis of shelf life qualities of sweet potato flour, containers such as metal (steel), plastic, glass and polythene were selected as storage containers considering their popularity, local availability and cost. The moisture content of sweet potato flour stored in different containers were periodically recorded to assess the shelf life qualities.

3.5.2 Shelf life qualities of products

The developed products were stored in plastic container and the moisture content and overall acceptability were recorded periodically.

3.5.3 Insect and microbial infestation in sweet potato flour and products

Insects are responsible for causing enormous losses to stored sweet potato flour and their products. They destroy a substantial quantity by spillage and contamination with their droppings, urine, body hair etc. Observation on the insect infestation in sweet potato flour and products were recorded for a period of six months.

The stored sweet potato flour and food samples were assessed for their microbial growth at the end of the storage period.

3.6 Standardisation of recipes with sweet potato flour

Standardisation of recipes is an essential strive for high quality products (Crusius, 1984). As a first step for the standardisation of new recipes, sources of recipes such as standard cookery books, journals and magazine were referred.

The new recipes were formulated by replacing a part of major ingredient with sweet potato flour. The ingredients were accurately weighed and cooked at specific heat in accordance with standardised recipes, the finished product was tested by the same panel, each and every time it was prepared. The recipe standardised was first tested in small quantities and evaluated. After making the adjustments the quantity was increased 4-6 times, evaluate and adjusted. Each formulation

was tested three times before it was subjected to other tests. Ten new recipes were standardised in the laboratory by the investigator and details of the recipes formulated are given in Appendix IV.

Statistical analysis

The data generated during the study were compiled, analysed statistically and presented under results and discussion.

RESULTS

4. RESULTS

Salient finding of the study entitled "Developing baked and confectionary products based on sweet potato" are presented under the following sections:-

- 4.1 Standardisation of raw materials and selection of best combination for the development of products
- 4.2 Acceptability of the developed products
- 4.3 Demonstration of the developed products among farmers and entrepreneurs, and
- 4.4 The shelf-life qualities

4.1 Standardisation of raw materials and selection of best combination for the development of products

4.1.1 Standardisation of raw materials

The raw materials selected for the development of products were sweet potato and maida. Different percentage of sweet potato flour and maida were combined with other ingredients like egg, sugar, ghee or milk powder to improve the quality of the composite flour used for processing baked and confectionary products. Here 60 kg of fresh sweet potato tubers were sundried for six days and milled. Type tests specified by ISI was administered to the sweet potato flour for conformity (IS 13046:1991), and the results are presented in Table 1.

Table 1 ISI Type tests administered for sweet potato flour

Sl.No.	Tests	Value of sample	ISI specification
1.	Moisture	8.20	10.00
2.	Total ash	1.75	2.00
3.	Crude fibre	3.50	3 to 5

An analysis of sweet potato flour revealed that the moisture content to be 8.20 per cent against the ISI specification of 10.00 per cent. The total ash content of sweet potato flour was 1.75 per cent against the ISI specification of 2.00 per cent. The crude fibre content of sweet potato flour obtained in this experiment was 3.50 per cent against the ISI specification of 3 to 5 per cent.

4.1.2 Selection of the best combination for the development of products

The food products developed were five baked products such as cake, biscuit, nancuta, cookies and bread and five confectionary products, halwa, cheese, toffee, gulabjamun mix and burfee. For the development of above mentioned products with different combination of ingredients are presented in Table 2.

Table 2 Composition of different combinations in product development

Sl.No.	Combination	Ingredients	Proportions
1.	C1	Sweet potato flour : maida	40:60
2.	C2	Sweet potato flour : maida	45:55
3.	C3	Sweet potato flour : maida	50:50

The different combinations tried were, first combination was done with 40 per cent of sweet potato flour and 60 per cent of maida. Second combination was 45 per cent of sweet potato flour and 55 per cent of maida and third combination was 50 per cent of sweet potato flour and 50 per cent of maida.

While selecting different combinations for product development care was taken to incorporate locally available low cost food articles that can be easily processed along with sweet potato flour.

The food ingredients selected in different combinations will decide the nutritional quality and cost benefit ratio of the food products. Hence the nature and properties of constituents in a combination is very important in deciding the quality of a product.

Protein quality:- The protein quality of each combination was assessed on the basis of amino acid score and chemical score. The amino acid and chemical content of each constituent in a combination was computed and works out. Table 3 shows the amino acid and chemical scores of the baked and confectionary products.

Amino acid scores of the baked products such as cake varied from 142.13 to 143.36, biscuit 62.13 to 63.36, nancuta 62.16 to 63.36, cookies 183.20 to 184.67 and bread 62.13 to 63.36. In the case of confectionary products such as Halwas, the amino acid scores varied from 62.13 to 63.36, cheese 62.13 to 63.36, burfee 78.47 to 81.55, toffee 62.13 to 63.36 and Gulabjamun mix 62.13 to 63.36.

In the same way chemical scores of the baked products such as cake, biscuit, nancuta, cookies and bread varied from 168.88 to 174.44, 88.88 to 94.44, 88.88 to 94.44, 207.77 to 213.33 and 88.88 to 94.44 respectively. In confectionary products the chemical scores varied from 88.88 to 94.44 for halwa, 88.88 to 94.44 for cheese 39.28 to 42.85 for burfee, 88.88 to 94.44 for toffee and 88.88 to 94.44 for Gulabjamun mix.

Table 3 Amino acid score and chemical scores of different combinations

Amino acid scores

Sl. No. Combinations	Baked products					Confectionary products				
	Cake	Biscuit	Nancuta	Cookies	Bread	Halwa	Cheese	Burfee	Toffee	Gulabjam mix
1. 40:60 Sweet potato flour : maida	142.13	62.13	62.16	183.20	62.13	62.13	62.13	78.47	62.13	78.43
2. 45:55 Sweet potato flour : maida	142.75	62.75	62.75	184.07	62.75	62.75	62.75	80.54	62.75	62.75
3. 50:50 Sweet potato flour : maida	143.36	63.36	63.36	184.67	63.36	63.36	63.36	81.55	63.36	63.36

Chemical scores

Sl. No. Combinations	Baked products					Confectionary products				
	Cake	Biscuit	Nancuta	Cookies	Bread	Halwa	Cheese	Burfee	Toffee	Sulabjam mix
1. 40:60 Sweet potato flour : maida	168.88	88.88	88.88	207.77	88.88	88.88	88.88	39.28	88.88	88.88
2. 45:55 Sweet potato flour : maida	171.66	91.66	91.66	210.56	91.66	91.66	91.66	41.07	91.66	91.66
3. 50:50 Sweet potato flour : maida	174.44	94.44	94.44	213.33	94.44	94.44	94.44	42.85	94.44	94.44

Cost analysis:-

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 and are presented in Table 4.

The cost of cake varied from ₹50 to 48, biscuit and nancuta varied from ₹40.60 to 39.75 and in the case of cookies the variation ₹50 to 49 and bread ₹13 to 9.50. Cost analysis of confectionary products like halwa and cheese varied from ₹44 to 43. In the case of gulabjamun mix the cost variation from the first combination varied from ₹45.50 to 44.50. In the same way burfee and toffee also showed a slight decrease in cost like ₹48 to 46 and ₹66.50 to 65.00.

Product development

Fifteen kg of baked products and 15 kg of confectionary products were developed from the combination of 50 per cent sweet potato flour and 50 per cent maida. The developed products were further analysed for sensory tests, nutritional adequacy, organoleptic quality and preference scores.

Table 4 Cost analysis of the combinations

		Cost/kg									
Sl. No.	Combinations	Cake	Biscuit	Mancuta	Cookies	Bread	Halwa	Cheese	Burfee	Toffee	Gulabjam mix
		Baked products (Rs)					Confectionary products (Rs)				
1.	40:60 Sweet potato flour : maida	50.00	40.60	40.60	50.00	13.00	44.00	45.50	44.00	48.00	66.50
2.	45:55 Sweet potato flour : maida	49.00	40.00	40.00	49.50	12.00	43.50	44.75	43.60	47.00	66.00
3.	50:50 Sweet potato flour : maida	48.00	39.75	39.75	49.00	9.50	43.00	44.50	43.00	46.00	65.00

ISI Type tests administered to the developed products

Estimation of moisture, ash, crude fibre, protein and fat are the major ISI type tests prescribed for baked and confectionary products. Type tests were administered to cake, biscuit, bread, toffee and gulabjamun mix (IS : 9712 - 1981, IS : 1011 - 1992, IS : 1483 - 1988, IS : 1667 - 1981, IS : 12220 - 1987) (Table 5).

The estimated value of the moisture of both cake and biscuit was somewhat similar to the ISI specification. 20.3 and 7.1 per cent are the estimated moisture content of cake and biscuit. The ISI specification was 15-25 and 6 per cent. But in the case of bread the estimated moisture content was 34.66 and the ISI specification was 35 per cent. The acid insoluble ash of the three baked products were 1, 1 and 2 per cent. But in the ISI specification it was 0.1, 0.8 and 0.1 per cent respectively. Acidity of extracted fat were 3 and 2.1 per cent for cake and biscuit. In the ISI level it was 1.0 and 1.5 per cent. In the same way crude fibre content in the biscuit and bread were 2 and 1.4 per cent. According to the ISI specification the values were 3 and 0.5 per cent.

Table 5 Type tests administered to the developed products

Sl. No.	Tests	Estimated values					ISI specifications				
		Cake	Biscuit	Bread	Toffee	Gulabjamun mix	Cake	Biscuit	Bread	Toffee	Gulabjam mix
1.	Moisture (%)	20.3	7.1	34.66	10.6	9.0	15.25	6.00	35.00	8.0	8.0
2.	Acid insoluble ash (%)	1.0	1.0	2.00	1.0	1.0	0.10	0.08	0.10	0.2	0.1
3.	Acidity of extracted fat (%)	3.0	2.1	-	2.11	15.6	-	1.00	1.50	4.0	1.2
4.	Crude fibre (%)	-	2.0	1.40	-	-	-	3.00	0.50	-	-
5.	Total protein (%)	-	-	-	-	13.40	-	-	-	-	15.00

The ISI specification of toffee and gulabjamun mix showed that, the moisture content of these products were 10.6 and 9 per cent. Their ISI specification was 8 per cent. The acid insoluble ash was 1 per cent for toffee and gulabjamun mix. But according to ISI specification this value was slightly lower than the estimated value. For toffee it was 0.2 per cent and for gulabjamun mix it was 0.1 per cent. Fat content of toffee and Gulabjamun mix were 2.11 and 15.6 per cent. There was slight variation in the fat content of these products by ISI, 4 and 12 per cent respectively. Estimated total protein content of gulabjamun mix was 13.4 per cent but ISI specification was 15 per cent.

4.2 Acceptability of the developed products

The acceptability of the developed products was ascertained with special reference to

4.2.1 Nutritional adequacy and

4.2.2 Organoleptic qualities

4.2.1 Nutritional adequacy of the developed products

The nutritive value of the developed baked and confectionary products were estimated in the laboratory using standard methods.

Calorie:- The energy or calorific value of foods depends on the quantity of CHO, fats and proteins present in them. Table 6 shows ^{the} calorie content of baked and confectionary products.

Table 6 Caloric value (Kcal) of the developed products

Baked products					Total means
Cake	Biscuit	Nancuta	Bread	Cookies	
497.33	466.66	429.16	278.66	545.33	443.43
Confectionary products					Total means
Halwa	Cheese	Burfee	Toffee	Gulabjamun mix	
561.66	575.33	586.33	549.33	459.50	546.53
F	102950.4*				265738.3*
SE	0.141				0.316
CD	0.417				0.932

** Significant at 1% level

Caloric value of the baked products such as cake, biscuit, nancuta bread and cookies were 497.33, 466.66, 429.16, 278.66 and 545.33 (Kcal) respectively. The total mean value was 443.43. Among the baked products cookies got the highest score and bread was the lowest. All the baked products were significantly different in their caloric content. (CD = 0.417)

Among the confectionary products caloric value of products such as halwa, cheese, burfee, toffee and gulabjamun mix were 561.66, 575.33, 586.33, 549.33 and 459.50 (Kcal) respectively. Total mean value was 546.53. Here burfee scored the highest caloric value and gulabjamun mix got the lowest value. There was a significant different between each products in their caloric content. (CD = 0.932).

Table 7 Protein (g) content of the developed products

Baked products					Total means
Cake	Biscuit	Nancuta	Bread	Cookies	
9.16	6.83	7.26	7.83	9.66	8.15
Confectionary products					Total means
Halwa	Cheese	Burfee	Toffee	Gulabjamun mix	
4.46	4.46	3.53	3.33	7.33	4.62
F	27.14				567.65
SE	0.104				0.234
CD	0.308				0.690

When the protein content of the developed products were analysed, it was found that among the baked products, cookies scored the highest value of 9.66 (g) and biscuit 6.83 (g). The protein content of cake, nancuta and bread were 9.16, 7.26 and 7.83 (g) respectively. The total mean value was 8.15. All the products were statistically significant in their protein content. (CD = 0.308).

The protein content of confectionary products such as halwa, cheese, burfee, toffee and gulabjamun mix were 4.46, 4.46, 3.53, 3.33 and 7.33 (g) respectively. Here the highest value was obtained by gulabjamun mix and lowest for toffee. 4.62 was the total mean value. All the products were significantly different in their protein content, except halwa and cheese. (CD = 0.690).

Carotene:- The carotene content of cake, biscuit, nancuta, bread and cookies were 1914.66, 1815.33, 1314.66, 1015.33 and 1016.33 (μg) respectively (Table 8). Cake and bread were got the highest and lowest mean value. 1415.26 was the total mean value. All the products were significantly different in their carotene content. (CD = 0.340).

Table 8 Carotene (μg) content of the developed products

Baked products					Total means
Cake	Biscuit	Nancuta	Bread	Cookies	
1914.66	1815.33	1314.66	1015.33	1016.33	1415.26
Confectionary products					Total means
Halwa	Cheese	Burfee	Toffee	Gulabjamun mix	
1615.33	1219.33	1076.33	1030.33	1000.33	1188.33
F	277003*				1931180**
SE	0.115				0.258
CD	0.340				0.761

** Significant at 1% level

Confectionary products such as halwa, cheese, burfee, toffee and gulabjamun mix had a carotene content of 1615.33, 1219.33, 1076.33, 1030.33 and 1000.33 (μg) respectively. Halwa had the highest carotene content among confectionary and gulabjamun mix had the lowest carotene content. The total mean value for confectionary was 1188.33. There was significant difference between each products in their carotene content. (CD = 0.761).

Calcium:- The calcium content of the developed products was analysed and the data are presented in Table 9.

Table 9 Calcium (mg) content of the developed products

Baked products					Total means
Cake	Biscuit	Nancuta	Bread	Cookies	
82.83	72.66	70.33	53.16	60.33	67.86
Confectionary products					Total means
Halwa	Cheese	Burfee	Toffee	Gulabjamun mix	
55.16	65.16	82.16	59.33	48.33	62.03
F	1894.66				1225.74*
SE	0.117				0.263
CD	0.347				0.777

Calcium content was higher for cake (82.83 mg). Bread contained only 53.16 (mg) of calcium, this was the lowest. Products such as biscuit, nancuta and cookies had 72.66, 70.33 and 60.33 mg of calcium. The total mean value was 67.86. All the products were significantly different in their calcium content. (CD = 0.347).

Confectionary products such as halwa, cheese, burfee, toffee and gulabjamun mix had a calcium content of 55.16, 65.16, 82.16, 59.33 and 48.33 mg respectively. Burfee had the highest calcium content among confectionary and gulabjamun mix had the lowest calcium content. The total mean value was 62.03. There was significant difference between each products in their calcium content. (CD = 0.777).

Phosphorous:- Phosphorous requirement depend on the availability of phosphorous present in diets.

Table 10 Phosphorous (mg) content of the developed products

Baked products					
Cake	Biscuit	Nancuta	Bread	Cookies	Total means
301.66	300.33	282.16	201.66	242.33	265.63
Confectionary products					
Halwa	Cheese	Burfee	Toffee	Gulabjamun mix	
199.66	205.33	192.33	197.33	199.16	198.76
F	20680.35**				124775.8*
SE	0.133				0.299
CD	0.394				0.882

The phosphorous content of the developed baked products such as cake, biscuit, nancuta, bread and cookies were 301.66, 300.33, 282.16, 201.66 and 242.33 mg respectively (Table 10). Cake got the highest score value and bread was the lowest. 265.63 was the total mean value. All the products were significantly different in their phosphorus content. (CD = 0.394).

Among the confectionary products cheese got the highest phosphorous content (205.33 mg) and burfee score the lowest 192.33 (mg). Products such as halwa, toffee and gulabjamun mix had 199.66, 197.33 and 199.16 (mg) of phosphorous respectively. The total mean value was 198.76.

There was a significant difference between each products in their phosphorous content. (CD = 0.882).

Zinc:- Zinc content of the developed products such as cake, biscuit, nancuta, bread and cookies were 116.35, 114.83, 114.33, 115.40 and 112.00 mg respectively (Table 11). Cake had the highest zinc content among baked products and bread had the lowest zinc content. 114.57 was the total mean value. There was no significant difference among the products in their zinc content. (CD = 6.922).

Table 11 Zinc (mg) content of the developed products

Baked products					Total means
Cake	Biscuit	Nancuta	Bread	Cookies	
116.35	114.83	114.33	115.40	112.00	114.57
Confectionary products					Total means
Halwa	Cheese	Burfee	Toffee	Gulabjamun mix	
113.33	110.66	111.20	110.66	112.33	111.64
F	2.644				3.573
SE	2.346				5.246
CD	6.922				15.478

Zinc value of confectionary products such as halwa, cheese, burfee, toffee, and gulabjamun mix were 113.33, 110.66, 111.20, 110.66 and 112.33 mg. The highest zinc content was recorded for *halwa* and lowest value for *cheese* and toffee. The total mean was 111.64. There was no significant difference between the products in their zinc content. (CD = 15.478).

4.2.2 Organoleptic qualities of the developed products

The developed products were assessed for organoleptic qualities by college students and technical experts. Since there were two groups of judges, two values were given for all the quality parameters.

Appearance:- The mean score for the developed baked products ranged from 3.4 to 4.48. Biscuit and bread were scored as highest and lowest mean scores respectively. Other products such as nancuta, cookies and cake got a score of 4.02, 4.4 and 3.96 respectively. Scores for the products were significantly different (CD = 0.27). In the case of mean scores of experts ranged from 3.04 to 4.56. Here also biscuit and bread were scored as the two extreme mean scores. Scores for other products were 4.28, 3.96 and 4.2 respectively. There was a significant difference in the mean score of cake and bread. (CD = 0.40).

The mean scores of five confectionary products such as toffee, halwa, gulabjamun mix, burfe and cheese were 4.35, 3.98, 4.08, 3.76 and 3.26 respectively. Toffee and cheese were scored the highest and lowest^{respectively.} Products such as burfee and cheese showed significant difference (CD = 0.41). Mean scores of experts ranged from 2.72 to 4.44. Here, the halwa and cheese were scored the highest and lowest^{respectively.} Toffee, gulabjamun mix and burfe were scored 4.36, 4.28 and 3.12 respectively. There was significant difference in the mean scores of

gulabjamun mix and burfee. (CD = 0.51). The data pertaining to the above recipes are presented in Table 12.

Table 12 Mean scores of appearance in developed products

Sl. No.	Baked products	Mean scores	
		College students	Experts
1.	Biscuit	4.48	4.56
2.	Nancuta	4.02	4.28
3.	Cookies	4.4	3.96
4.	Cake	3.96	4.20
5.	Bread	3.4	3.04
	F	18.64	16.09
	SE	0.09	0.14
	CD	0.27	0.40
Sl. No.	Confectionary products	Mean scores	
		College students	Experts
1.	Toffee	4.36	4.36
2.	Halwa	3.98	4.44
3.	Gulabjamun mix	4.08	4.28
4.	Burfee	3.76	3.12
5.	Cheese	3.26	2.72
	F	7.67	19.23
	SE	0.14	0.18
	CD	0.41	0.51

Flavour:- The scores for the quality parameter 'flavour' of the five baked products differed within a range of 4.36 to 3.0. Cookies and bread got the highest and lowest mean score. The

score for biscuit, nancuta and cake were 4.08, 4.12 and 3.86 respectively. There was a significant difference between cookies and cake. (CD = 0.31). A vast range in score of 4.36 to 3.12 could be observed in the mean scores of technical experts. Biscuit and bread were scored the highest and lowest, ^{respectively.} Nancuta, cookies and cake were scored 4.04, 4.2 and 3.84 respectively. There was a significant difference between the mean scores of the cake and bread. (CD = 0.42). The mean scores for baked and confectionary products are presented in Table 13.

Table 13 Mean scores of flavour in developed products

Sl. No.	Baked products	Mean scores	
		College students	Experts
1.	Biscuit	4.08	4.36
2.	Nancuta	4.12	4.04
3.	Cookies	4.36	4.20
4.	Cake	3.86	3.84
5.	Bread	3.00	3.12
	F	20.78	10.17
	SE	0.11	0.15
	CD	0.31	0.42
Sl. No.	Confectionary products	Mean scores	
		College students	Experts
1.	Toffee	4.22	4.40
2.	Halwa	4.02	4.12
3.	Gulabjamun mix	3.80	3.92
4.	Burfee	3.50	3.28
5.	Cheese	3.02	2.84
	F	8.76	11.02
	SE	0.15	0.19
	CD	0.44	0.53

The scores for the developed confectionary products ranged from 3.02 to 4.22. The highest and lowest mean scores were for toffee and cheese. Halwa, gulabjamun mix and burfee were scored 4.02, 3.8 and 3.5 respectively. There was a significant difference in the mean scores of burfee and cheese. (CD = 0.44). The mean scores of experts group ranged from 2.84 to 4.4. Here also toffee and cheese were scored the highest and lowest mean scores. The mean scores of halwa, gulabjamun mix and burfee were 4.12, 3.92 and 3.28 respectively. There was a significant difference between the mean score of gulabjamun mix and burfee (CD = 0.53).

Colour:- The scores for colour of the baked products ranged from 2.86 to 4.34. The highest and lowest mean scores were recorded for biscuit and cookies. Nancuta, cake and bread were scored 4.02, 3.36 and 3.24 respectively. There was a significant difference between nancuta and cookies, cookies and cake. (CD = 0.46). Scores of technical experts ranged from 2.32 to 4.64. Biscuit and nancuta were scored the highest mean score and cake had the lowest one. Other products such as cake and bread were scored 2.64 and 3.12 respectively. There was a significant difference between cake and bread, nancuta and cookies. (CD = 0.48). The details pertaining to the colour of the developed products are given in Table 14.

Table 14 Mean scores of colour in developed products

Sl. No.	Baked products	Mean scores	
		College students	Experts
1.	Biscuit	4.34	4.64
2.	Nancuta	4.02	4.64
3.	Cookies	2.86	2.64
4.	Cake	3.36	2.32
5.	Bread	3.24	3.12
	F	12.82	39.99
	SE	0.16	0.17
	CD	0.46	0.48
Sl. No.	Confectionary products	Mean scores	
		College students	Experts
1.	Toffee	4.16	4.16
2.	Halwa	4.04	4.16
3.	Gulabjamun mix	3.82	4.00
4.	Burfee	3.76	3.40
5.	Cheese	3.40	2.76
	F	3.02	8.49
	SE	0.16	0.20
	CD	0.46	0.58

The scores for the five confectionary products ranged from 3.4 to 4.16. Toffee and cheese were scored as highest and lowest mean scores. Halwa, gulabjamun mix and burfee were scored 4.04, 3.82 and 3.76 respectively. There was significant difference among all products except cheese.

(CD = 0.46). The scores ranged from 2.76 to 4.16 in organoleptic evaluation of technical experts. Toffee and halwa were scored the highest value and cheese had the lowest one. The other products like gulabjamun mix and burfee were scored 4 and 3.4 respectively. There was a significant difference in the mean score of the gulabjamun mix and burfee (CD = 0.58).

Taste:- The range of variation for the quality parameter taste was from 3.1 to 4.54, in the organoleptic evaluation of students. Cookies and bread were scored the highest and lowest mean scores. Mean scores of other products such as biscuit, nancuta and cake were 4.36, 4.04 and 4. There was a significant difference between the mean score each products. (CD = 0.29). The mean scores of the experts ranged from 2.92 to 4.36. Here also cookies and bread were scored as highest and lowest. Biscuit, nancuta and cake got a score of 4.24, 4.2 and 3.96 respectively. There was a significant difference between the mean score of cookies and cake, (CD = 0.40) and the results are presented in Table 15.

Table 15 Mean scores of taste in the developed products

Sl. No.	Baked products	Mean scores	
		College students	Experts
1.	Biscuit	4.36	4.24
2.	Nancuta	4.04	4.20
3.	Cookies	4.54	4.36
4.	Cake	4.00	3.96
5.	Bread	3.10	2.92
	F	28.09	16.33
	SE	0.10	0.14
	CD	0.29	0.40

Sl. No.	Confectionary products	Mean scores	
		College students	Experts
1.	Toffee	4.08	4.48
2.	Halwa	3.74	4.28
3.	Gulabjamun mix	4.10	3.68
4.	Burfee	3.70	3.32
5.	Cheese	2.66	2.68
	F	13.04	15.71
	SE	0.16	0.18
	CD	0.45	0.51

The mean scores for the confectionary products ranged from 2.66 to 4.1. Gulabjamun mix and cheese were scored the highest ^{and} lowest. Toffee, halwa and burfee got ^{the} a score of 4.08, 3.74 and 3.7 respectively. There was a significant difference between the mean scores of gulabjamun mix and burfee (CD = 0.45). Experts scores for confectionary products ranged from

2.68 to 4.48. Toffee and cheese were scored the highest and lowest value. Halwa, burfee and gulabjamun mix were scored 4.28, 3.68 and 3.32 respectively. There was a significant difference between in the mean value of halwa and gulabjamun mix, burfee and cheese. (CD = 0.51).

Texture:-

The mean scores for texture ranged from 3.48 to 4.72. Biscuit and bread were scored the highest and lowest value. The scores for nancuta, cookies and cake were 3.98, 4.1 and 4.16. There was a significant difference between the mean score of biscuit and nancuta and cake and bread. (CD = 0.29). In the case of expert's scoring, the range of variation was from 3.36 to 4.68. Biscuit and bread were the two extreme scorers. Nancuta, cookies and cake were scored 3.92, 3.84 and 4 respectively. There was a significant difference in the mean score of biscuit and nancuta and cake and bread. (CD = 0.48). The data pertaining to the above results are presented in Table 16.

Table 16 Mean scores of texture in developed products

Sl. No.	Baked products	Mean scores	
		College students	Experts
1.	Biscuit	4.72	4.68
2.	Nancuta	3.98	3.92
3.	Cookies	4.10	3.84
4.	Cake	4.16	4.00
5.	Bread	3.48	3.36
	F	17.10	7.43
	SE	0.10	0.17
	CD	0.29	0.48

Sl. No.	Confectionary products	Mean scores	
		College students	Experts
1.	Toffee	4.18	4.52
2.	Halwa	3.88	3.64
3.	Gulabjamun mix	3.48	3.16
4.	Burfee	3.48	2.60
5.	Cheese	2.78	2.72
	F	9.06	13.25
	SE	0.17	0.21
	CD	0.48	0.60

Scores for texture of confectionary products were ranged from 2.78 to 4.18. Toffee and cheese were scored the highest and lowest value. Halwa, gulabjamun mix and burfee were scored 3.88, 3.48 and 3.48 respectively. There was a significant difference between nancuta and gulabjamun and burfee and cheese. (CD = 0.48). The expert's scores ranged from 2.6 to 4.52. Toffee and burfee got the highest and lowest scores. Other products such as halwa, gulabjamun mix and

cheese were scored 3.64, 3.16 and 2.72 respectively. There was a significant difference between the mean value of toffee and halwa. (CD = 0.60).

Doneness:- Among the baked products doneness was the important quality parameter. The range of variation for this parameter was from 4.34 to 4.92. Biscuit and bread were scored the highest and lowest value. The data is presented in Table 17.

Table 17 Mean scores of doneness in baked products

Sl. No.	Baked products	Mean scores	
		College students	Experts
1.	Biscuit	4.92	4.84
2.	Nancuta	4.72	4.60
3.	Cookies	4.50	4.40
4.	Cake	4.66	4.56
5.	Bread	4.34	3.72
	F	7.186	10.255
	SE	0.082	0.132
	CD	0.227	0.370

The other products like nancuta, cookies and cake were scored 4.72, 4.5 and 4.50 respectively. There was a significant difference between all products except cookies and cakes. (CD = 0.22). The scored value of experts ranged from 3.72 to 4.84. Biscuit and bread were scored the highest and lowest value. Nancuta, cookies and cake were scored 4.6, 4.4 and 4.56 respectively. There was a significant difference between the mean values of cake and bread. (CD = 0.37).

Masticability:- To see wheather the bread is sticky or not when chewed was ascertained through this parameter. Scores of college students and experts were 4.38 and 4.28 respectively (Table 18).

Table 18 Mean scores of masticability in baked product

Sl. No.	Baked product	Mean scores	
		College students	Experts
1.	Bread	4.38	4.28

Crumbling nature:- This parameter measured whether the tunnels or holes in bread is fine or coarse. College students and expert's gave a score of 3.72 and 3.36 respectively for this parameter (Table 19).

Table 19 Mean scores of crumbling nature in baked product

Sl. No.	Baked product	Mean scores	
		College students	Experts
1.	Bread	3.72	3.38

Overall acceptability:- Scores for overall acceptability of baked products ranged from 2.84 to 4.3. Cookies and bread were scored as the highest and lowest. Overall acceptability of other products like biscuit, nancuta and cakes were scored

4.12, 4.0 and 3.68 respectively. There was a significant difference between cookies, cake and bread except biscuit and nancuta (CD = 0.27). Score value of the experts ranged from 2.64 to 4.44. Biscuit and bread got the two extreme scorers. The mean scores of nancuta, cookies and cake were 4.32, 4.2 and 3.92 respectively. There was a significant difference in the mean scores between cake and bread. (CD = 0.37). The details pertaining to the overall acceptability are presented in Table 20.

Table 20 Mean scores of overall acceptability of developed products

Sl. No.	Baked products	Mean scores	
		College students	Experts
1.	Biscuit	4.12	4.44
2.	Nancuta	4.00	4.32
3.	Cookies	4.30	4.20
4.	Cake	3.68	3.92
5.	Bread	2.84	2.64
	F	32.95	30.25
	SE	0.100	0.133
	CD	0.278	0.372

Sl. No.	Confectionary products	Mean scores	
		College students	Experts
1.	Toffee	4.54	4.72
2.	Halwa	4.20	4.28
3.	Gulabjamun mix	3.58	3.52
4.	Burfee	2.92	3.40
5.	Cheese	2.42	2.60
	F	36.443	16.610
	SE	0.145	0.201
	CD	0.402	0.565

In the case of confectionary products the mean scores for overall acceptability ranged from 2.42 to 4.54. Toffee and cheese were scored the highest and lowest value. Halwa, gulabjamun mix and burfee were scored 4.2, 3.58 and 2.92 respectively. There was a significant difference between all products except toffee and halwa. (CD = 0.40). Mean scores of experts ranged from 2.6 to 4.72. Toffee and cheese were scored the two extreme value. Halwa, gulabjamun mix and burfee were scored 4.28, 3.52 and 3.4 respectively. There was a significant difference between halwa and gulabjamun mix and burfee and cheese. (CD = 0.56). Fig. 12 shows the graphical representation of the overall acceptability of the developed products.

4.3 Demonstration of the developed products among farmer and entrepreneurs

4.3.1 Demonstration of the developed products among farmers

In the present study, the ultimate aim was transferring the technologies developed to farm families who are engaged in sweet potato cultivation. Samples of the developed foods were tasted by farm women in Venganoor, Sreekariyam and Kalliyoor panchayats and their opinion on the degree of liking were recorded. Data was collected using a nine point rating 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 ratings were deleted, while discussing the data.

Per cent scores of the developed baked products with in Venganoor panchayath was found that, the maximum per cent of women like nancuta as like extremely well" ie 56 per cent. It was also ascertained that cake, cookies, biscuit and bread were 'Like extremely well' by 52, 36, 28 and 20 per cent of farm women. Negative scores such as dislike and dislike somewhat was recorded by 8^{Percent} of women in bread and cookies. In the case of confectionary products majority of women (48%) rated halwa as 'like extremely well' than others. Toffee, gulabjamun mix, burfee and cheese ascertained 40, 28, 24 and 20 per cent respectively. About 8^{Percent} of women reported negative scores such as dislike 4 per cent and dislike some what 4 per cent in the case of burfee and 8 per cent dislike and 8 per cent dislike some what in the case of cheese. None of the farm women rated the products as disliked very much or disliked extremely. The results are presented in Table 21.

Table 21 Preference of farm women for the developed products - Venganoor

Sl. No.	Foods	Rating					
		Like extremely	Like very much	Like reasonably	Like somewhat	Dislike	Dislike somewhat
1.	Cake	13(52)	8(32)	3(12)	1(4)	-	-
2.	Biscuit	7(28)	11(44)	4(16)	3(12)	-	-
3.	Nancuta	14(56)	2(8)	6(24)	3(12)	-	-
4.	Bread	5(20)	6(24)	8(32)	4(16)	1(4)	1(4)
5.	Cookies	9(36)	9(36)	4(16)	1(4)	1(4)	1(4)
6.	Halwa	12(48)	4(16)	7(28)	2(8)	-	-
7.	Toffee	10(40)	10(40)	4(16)	1(4)	-	-
8.	Burfee	6(24)	9(36)	5(20)	3(12)	1(4)	1(4)
9.	Gulabjamun mix	7(28)	8(32)	7(28)	3(12)	-	-
10.	Cheese	5(20)	5(20)	8(32)	3(12)	2(8)	2(8)

N = 25

(Numbers in parenthesis denotes percentage)

Preference scores among the farm women in Srikariyam panchayath, 52 per cent of women scored biscuit as the extremely liked products. Cookies, cake, nancuta and bread were scored 48, 40, 44 and 12 per cent respectively. Twelve per cent of women scored negatively for bread. The degree of liking was obtained and is given in Table 22.

Table 22 Preference of farm women for the developed products - Srikariyam

Sl. No.	Foods	Rating					
		Like extremely	Like very much	Like reasonably	Like somewhat	Dislike	Dislike somewhat
1.	Cake	10(40)	7(28)	6(24)	2(8)	-	-
2.	Biscuit	13(52)	7(28)	5(20)	-	-	-
3.	Nancuta	11(44)	8(32)	5(20)	1(4)	-	-
4.	Bread	3(12)	4(16)	7(28)	8(32)	3(12)	-
5.	Cookies	12(48)	10(40)	3(12)	-	-	-
6.	Halwa	8(32)	6(24)	5(20)	5(20)	1(4)	-
7.	Toffee	15(60)	4(16)	4(16)	2(8)	-	-
8.	Burfe	9(36)	6(24)	5(20)	2(8)	2(8)	1(4)
9.	Gulabjamun mix	11(44)	6(24)	3(12)	5(20)	-	-
10.	Cheese	9(36)	9(36)	2(8)	1(4)	1(4)	3(12)

N = 25

(Numbers in parenthesis denotes percentage)

Majority of (60%) women rated toffee as 'like extremely well product. Gulabjamun mix, burfe, cheese and halwa were rated 44, 36, 36 and 32 per cent respectively. The result revealed that 4, 12 and 16 per cent of women reported halwa, burfe and cheese were negatively scored products. None of the women rated the products as disliked very much or dislike extremely.

OVERALL ACCEPTABILITY OF THE DEVELOPED PRODUCTS

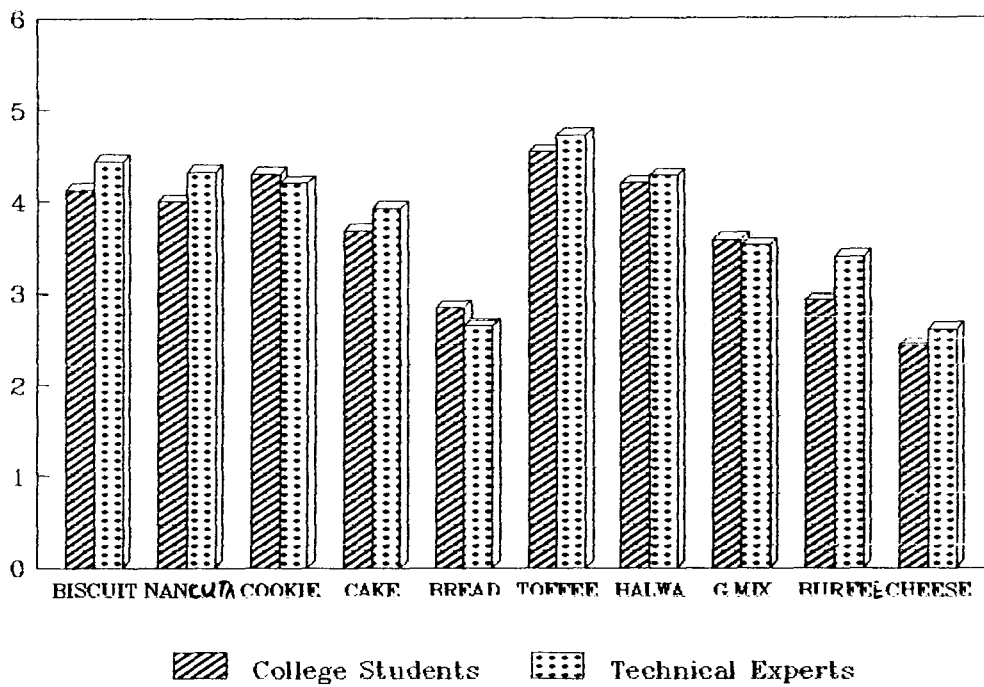


FIG.NO.12

In Kaliyoor panchayath, 40 per cent of women recorded cake and cookies were the 'like extremely well' product. Biscuit, nancuta and bread were ascertained 36, 32 and 24 per cent of scores. Negative scoring such as dislike, dislike some what were not rated by any of them. The data pertaining to the above results are showed in Table 23.

Table 23 Preference of farm women for the developed products - Kaliyoor

Sl. No.	Foods	Rating					
		Like extremely	Like very much	Like reasonably	Like somewhat	Dislike	Dislike somewhat
1.	Cake	10(40)	7(28)	7(28)	1(4)	-	-
2.	Biscuit	9(36)	8(32)	5(20)	3(12)	-	-
3.	Nancuta	8(32)	10(40)	6(24)	1(4)	-	-
4.	Bread	6(24)	6(24)	9(36)	4(16)	-	-
5.	Cookies	10(40)	7(28)	6(24)	2(8)	-	-
6.	Halwa	12(48)	5(20)	6(24)	2(8)	-	-
7.	Toffee	12(48)	8(32)	4(16)	1(4)	-	-
8.	Burfee	7(28)	6(24)	8(32)	4(16)	-	-
9.	Gulabjamun mix	8(32)	10(40)	4(16)	2(8)	1(4)	-
10.	Cheese	6(24)	5(20)	10(40)	2(8)	2(8)	-

N = 25

(Numbers in parenthesis denotes percentage)

Among confectionary products halwa and toffee ascertained 48 per cent of scores. Gulabjamun mix, burfee and cheese were rated 32, 28 and 24 per cent of scores. Only a small per cent recorded (4 and 8%) dislike the products such as gulabjamun mix and cheese. None of the farm women rated the products as dislike very much or dislike extremely.

Demonstration of the developed products among entrepreneurs

Demonstration is given before a group to show how to carry out an entirely new practice or an old practice in a better way. In the present study, the developed products were demonstrated among selected entrepreneurs of Thiruvananthapuram city. They watched the process, listen to the oral explanation, and asked questions during or at the close of the demonstration to clear up points about which there was uncertainty. Repeated the demonstration in their presence would help to fix the process in the mind of the entrepreneurs. After the demonstration the samples of the developed foods were tasted by them and their opinion on the degree of liking were obtained. Data was collected using a nine point rating 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. (Table 24).

Table 24 Preference of entrepreneurs for the developed products

Sl. No.	Foods	Rating						
		Like extremely	Like very much	Like reasonably	Like somewhat	Dislike	Dislike somewhat	Dislike reasonably
1.	Cake	-	5(20)	5(20)	9(36)	5(20)	1(4)	-
2.	Biscuit	4(16)	6(24)	7(28)	4(16)	3(12)	1(4)	-
3.	Nancuta	1(4)	8(32)	6(24)	4(16)	5(20)	1(4)	-
4.	Bread	-	-	4(16)	6(24)	8(32)	3(12)	4(16)
5.	Cookies	3(12)	6(24)	4(16)	7(28)	3(12)	2(8)	-
6.	Halwa	1(4)	3(12)	4(16)	7(28)	7(28)	3(12)	-
7.	Toffee	3(12)	5(20)	7(28)	6(24)	4(16)	-	-
8.	Burfee	-	2(8)	3(12)	8(32)	4(16)	8(32)	-
9.	Gulabjamun mix	-	1(4)	5(20)	7(28)	6(24)	4(16)	2(8)
10.	Cheese	-	-	-	7(28)	6(24)	5(20)	7(28)

N = 25

(Numbers in parenthesis denotes percentage)

Among the baked products biscuit scored (16%) the highest value and cake and bread were not preferred as like extremely. None of the entrepreneurs rated the products as dislike very much or dislike extremely.

In confectionary products toffee scored the highest (12%). Burfee, cheese and gulabjamun mix were not rated as 'like extremely'. None of the entrepreneurs rated the products as dislike very much or dislike extremely.

4.4 Shelf life qualities

The shelf life qualities was ascertained with special reference to:-

4.4.1 Shelf life qualities of sweet potato flour

4.4.2 Shelf life qualities of products

4.4.1 Shelf life qualities of sweet potato flour

4.4.1.1 Effect of storage containers on the moisture level of the sweet potato flour

Moisture is one of the important parameters which determine the shelf-life quality of any substance. Moisture content of sweet potato flour in different containers were showed in Table 25.

Table 25 Moisture content of sweet potato flour in different containers

Sl.No.	Containers	Initial	3rd month	6th month	Mean
1.	Polythene	7.33	8.85	10.11	8.76
2.	Glass	7.20	7.75	8.78	7.91
3.	Plastic	7.25	8.19	9.20	8.21
4.	Steel	7.46	8.34	9.63	8.48

CD - A = 0.503

CD - B = 0.163

CD - AB = 0.327

The initial moisture content of different containers was some what similar. The initial moisture content of different containers like steel, glass, plastic and polythene covers were 7.46, 7.2, 7.25 and 7.33 per cent respectively. After third month of storage, the moisture evaluation revealed that among the four containers, glass container showed a slight moisture variation of 7.75 per cent and all other containers such as steel, plastic and polythene cover showed 8.34, 8.19 and 8.85^{percent} moisture respectively. Moisture evaluation of flour after sixth month of storage showed an increase in the moisture content in each containers. Steel, glass, plastic and polythene bags were 9.63, 8.78, 9.20 and 10.11 per cent of moisture respectively. The moisture content in glass container showed slightly less increase

EFFECT OF STORAGE CONTAINERS ON THE MOISTURE LEVEL OF SWEET POTATO FLOUR

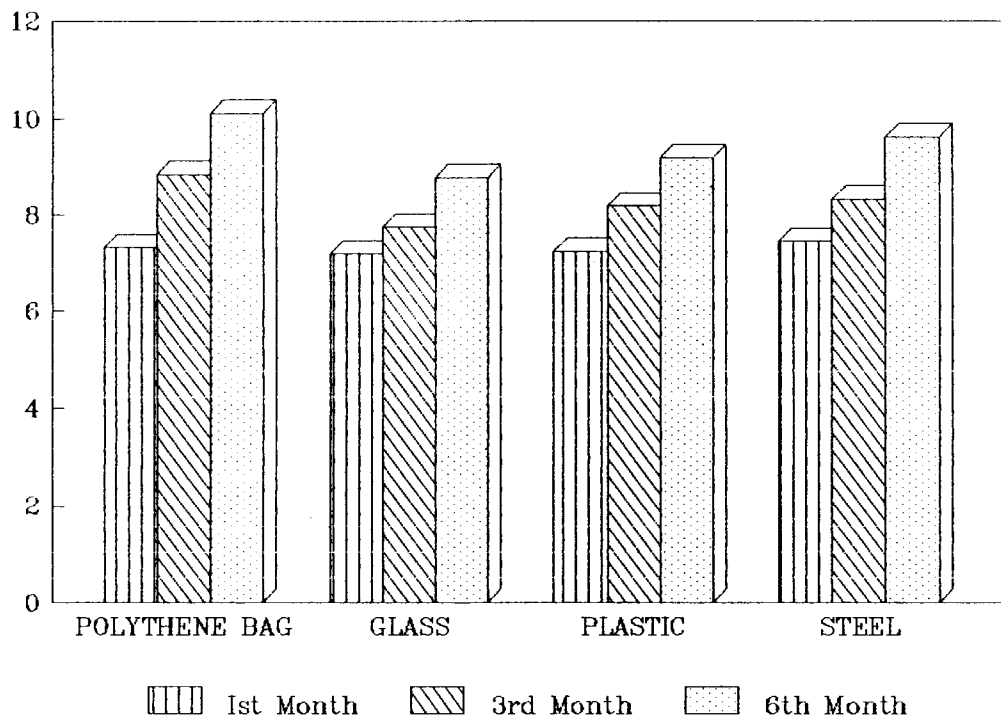


FIG. No. 13

when compared to other containers. The mean moisture content over the six month duration was 8.76, 7.91, 8.21 and 8.48 in polythene bag, glass, plastic and steel containers respectively (Fig. 13).

4.4.1.2 Assessment of insect infestation of stored sweet potato flour

Insect infestation of stored sweet potato flour was ascertained by packing sweet potato flour in four containers viz., steel, glass, plastic and polythene bag. The assessment of the incidence of insect pest in stored flour was observed once in a month through out the storage period for six months. It was observed that there was no insect infestation upto three months. There was no insect infestation in glass and plastic containers and insect infestation could be observed only in steel containers and polythene bags. The insects were identified as *Sitophilus oryzae* and *Tribolium castaneum*.

4.4.2 Shelf life qualities of the developed products

4.2.2.1 Moisture content of the stored products

For estimating the moisture content of the stored products, the products were stored in an air tight plastic container at room temperature (28°C)

The initial moisture content of the five baked products like cake, biscuit, nancuta, bread and cookies were

19.48, 6.25, 8.00, 33.81 and 9.90 respectively. After first week of storage, the moisture content of the products were slightly increased. The table revealed that after the first week of storage the shelf life quality of bread was reduced. So it was removed off from observation. In the same way after the second week of storage, the shelf life quality of cake was also reduced. Only biscuit and nancuta were stored upto one month. The cookies were stored upto three weeks. The total mean value score of the product were 21.0, 8.04, 8.92, 34.44 and 10.93. The mean moisture content over the fourth week duration for bread was 34.44 which was significantly higher than that of other products. The results are given in Table 26.

Table 26 Moisture content of the stored baked products

Sl.No.	Products	1st week	2nd week	3rd week	4th week	Mean
1.	Cake	20.22	20.96	-	-	21.00
2.	Biscuit	7.10	8.08	8.93	9.10	8.04
3.	Nancuta	8.32	8.79	9.66	9.99	8.92
4.	Bread	34.44	-	-	-	34.44
5.	Cookies	10.58	10.63	11.59	-	10.93

$$CD - A = 0.205$$

$$CD - B = 0.191$$

$$CD - AB = 0.428$$

The initial moisture content of the five confectionary products such as halwa, cheese, burfe, toffee and

MOISTURE CONTENT OF DIFFERENT DEVELOPED PRODUCTS

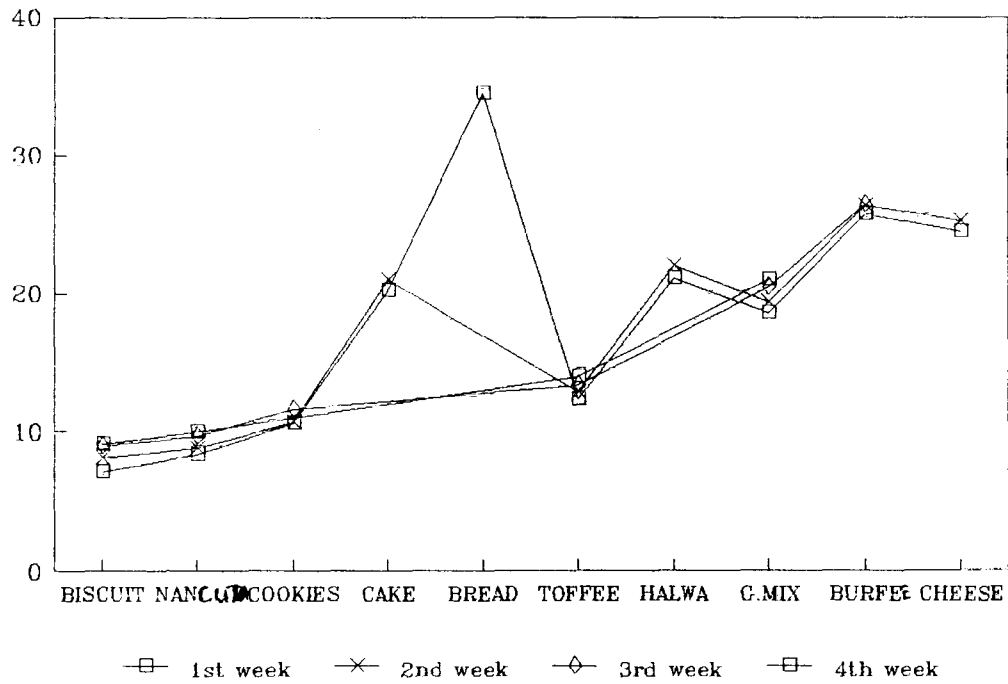


FIG.NO.14

gulabjamun mix were 20.75, 23.50, 25.00, 12.91 and 18.95 per cent respectively. Here also the moisture content of the five products were increased slightly after the second week of storage. The shelf life quality for halwa and cheese after the second week of storage was not observed due to spoilage. The shelf life quality of burfee was ^{upto} third week. The total mean score of the product were 22.00, 25.10, 26.14, 12.80 and 19.46. Burfee's mean moisture content was significantly higher than that of other products. (Fig. 14).

Table 27 Moisture content of the stored confectionary products

Sl.No.	Products	1st week	2nd week	3rd week	4th week	Mean
1.	Halwa	21.05	21.95	-	-	22.00
2.	Cheese	24.44	25.26	-	-	25.10
3.	Burfee	25.70	26.33	26.40	-	26.14
4.	Toffee	12.27	12.83	13.31	13.90	12.80
5.	Gulabjamun mix	18.58	19.36	20.44	21.00	19.46

$$CD - A = 0.689$$

$$CD - B = 0.367$$

$$CD - AB = 0.822$$

4.4.2.2 Overall acceptability of the stored products

The overall acceptability during the storage period is presented in Table 28.

Table 28 Overall acceptability of the stored products

Sl. No.	Baked products	Mean score	Sl. No.	Confectionary products	Mean score
1.	Cake	1.48	1.	Toffee	1.68
2.	Nancuta	1.64	2.	Halwa	1.44
3.	Cookies	1.52	3.	Gulabjamun mix	1.72
4.	Biscuit	1.68	4.	Burfee	1.44
5.	Bread	1.28	5.	Cheese	1.48
F		1.592	F		1.020
SE		0.124	SE		0.135
CD		0.349	CD		0.379

Among the baked products the overall acceptability was higher in biscuit (1.68) and lower in bread (1.28). Other products such as cake, nancuta and cookies were scored 1.48, 1.64 and 1.52 respectively. The F value was 1.592. There was a significant difference in the mean score of the products.

In the case of confectionary products gulabjamun mix scored the highest value, halwa and burfee were the lowest. The score value of toffee and cheese were 1.68 and 1.48 respectively. F value was 1.02. There was a significant difference among the mean scores of the products.

4.4.2.3 Assessment of insect infestation of stored products

The assessment of the incidence of insect pest in stored products were observed once in a week through out the storage period. It was observed that there was no

insect infestation upto one month. While the stored products showed only microbial growth.

4.4.2.4 Assessment of microbial growth of stored products 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. The population of fungi and bacteria in the developed foods were assessed.

The assessment of microbiological quality revealed that baked products like bread and cake were attacked by microorganism such as *Rhizopus nigricans*, *Bacillus subtilis* and *Mucor spp* after one and two weeks respectively. But in the case of biscuit and nancuta neither fungal nor bacterial attack were noticed even upto a storage period of four weeks. While after four weeks of storage some *Mucor spp* were attacked by these products. The stored cookies had some *Rhizopus nigricans* after three weeks of storage.

Confectionary products were free from microorganism up to two weeks of storage. After second weeks of storage, products like halwa and cheese were attacked by mould like *Pencillium expansum* and *Aspergillus niger*. These specious were also attacked by burfel after third weeks of storage. Toffee and gulabjamun mix had no bacterial growth upto fourth weeks, but fungal growth could be observed in these products.

DISCUSSION

5. DISCUSSION

5.1 Standardisation of raw materials and selection of best combination for the development of 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 processed products as type tests (1969-1992).

The type test of sweet potato flour revealed that, less moisture content in sweet potato flour than ISI specification. This less moisture content indicate better shelflife quality of the flour. The total ash content of sweet potato flour was less than ISI specification. According to Yeh and Bownkemp (1988) a high value for ash content upto 3.20 in sweet potato flour was reported. Lower values obtained in the crude fibre content in sweet potato flour may be due to varietal and maturity variation. Similar deviation have been reported by Yeh and Bownkemp (1988). On the above lines ensure the fitness of sweet potato flour to be a raw material in the products to be developed. Sixty kgs of sweet potato flour of this quality was processed in the laboratory.

The best combination was selected based on the amino acid scores, chemical scores and cost of the each combination. The score for protein quality was allotted, based on the amino acid score and chemical score. The amino acid scores of baked products varied from 183.20 to 62.13, 184.07 to 62.75 and 184.67 to 63.36 and chemical scores of each products varied from 207.77 to 88.88, 210.56 to 91.66 and 213.33 to 94.44. It was observed that the highest amino acid and chemical scores were obtained by combination three, that is 50 per cent of sweet potato flour and 50 per cent of maida.

In the same way, amino acid scores and chemical scores of confectionary products also showed that the amino acid scores varied from 62.13 to 78.47, 62.75 to 80.54 and 63.36 to 81.55 and chemical scores of each confectionary products varied from 39.28 to 88.88, 41.07 to 91.66 and 42.85 to 94.44.

50:50 combination got the highest score and this was selected for the development of baked and confectionary products. The combination with 50 per cent maida and 50 per cent sweet potato flour got the maximum score.

For the selection of best combination, cost analysis data is also very essential. Cost analysis table of baked products revealed that cost of each combination was vary from 50 to 13, 49 to 12 and 48 to 9.50 Rs. This variation of cost

showed that there was a reduction in the cost in each products. The cost analysis of confectionary products also showed that a reduced variation from the first combination to the third combination. The reduced variation from 44 to 66.50, 43.50 to 66 and 43 to 65 Rs/.

This reduction of cost in both baked and confectionary products revealed that by the reduction of maida in each product the cost of each products could be reduced. The result of amino acid scores, chemical scores and cost of the different combinations revealed that 50 per cent of maida and 50 per cent of sweet potato flour was the best combination for the development of products.

fifteen kgs of baked products including: cake, biscuit, nancwta, cookies and bread and fifteen kgs of confectionary products such as halwa, cheese, burfee, gulabjamun mix and toffee were developed and analysed for type tests, nutritional adequacy, organoleptic quality and preference score.

Implementation of quality system standards for the food products would result in several benefits. Though total efforts for improvement and sustenance of quality, cost benefit could be achieved which 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.

Estimated values of different type of type tests were compared with the ISI specification. The results showed that among the different estimation, the moisture content of the baked and confectionary products were slightly lower in all the products except cake and bread.

The lower moisture content of the products is beneficial since it may improve the keeping quality of the products. Moisture content of 10.00 per cent was reported for extruded product, vermicelli by Thirumaran (1993). According to Chellammal (1995) sweet potato based noodles and macroni showed a moisture content of 9 per cent. Anna and Chellammal (1997) reported that rice-soya based extruded products showed a moisture content of 8.20 per cent the ISI specification was 11 per cent.

Acid insoluble ash content in both baked and confectionary products were higher than the ISI specification. The increased mineral content of the products may be the reason for the higher value for ash. Acid insoluble ash, which gives information regarding the inorganic salt present in the products, was analysed and the result revealed. According to Chellammal (1995) the acid insoluble ash in sweet potato based extruded food was higher than the ISI specification. Acid insoluble ash in rice-soya extruded food was lower than ISI (Anna and Chellammal, 1997).

Acidity of extracted fat in baked products were higher than ISI values. In confectionary product there is a slight variationⁱⁿ the fat content of toffee and gulabjamun mix from ISI specification.

Crude fibre content of the baked products also showed a slight variation. In the case of bread^{the} estimated value was higher than the ISI specification. The higher value of crude fibre was due to the high fibre content of sweet potato flour. Compared to other cereal flour, the fibre content in the tuber flour was much higher.

Total protein was also estimated in gulabjamun mix. When compared to ISI specification the total protein content of sweet potato based gulabjamun mix was lower. The low protein content in sweet potato was the reason for this. According to Anna and Chellammal (1997) rice-soya based extruded products showed an estimated total protein which was higher than the ISI specification. 11.20 per cent of protein was observed for soya incorporated vermicelli by Thirumaran (1993). According to Chellammal (1995) sweet potato based extruded food showed higher protein value than the ISI specification. Generally processed foods were not considered as protein rich food. By the addition of various ingredients the protein content of the products may change in their protein content varied.

5.2 Acceptability of the developed products

5.2.1 Nutritional adequacy of the developed products

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.

In the present study, calorie, protein, β carotene, calcium, phosphorous and zinc content of the different baked and confectionary products were determined to assess their nutritional composition.

Calorie:- Calorie or 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. Among the baked product cookies showed the highest value and bread got the lowest caloric value. The high caloric value (545.33 Kcal) of cookies was due to the ingredients such as egg and coconut present in

dough. Tsen and Hoover (1973) reported that fortifying wheat flour with full fat soya flour in making bread can increase the bread calorific value and the protein content. According to Achaya (1986) the nutritive value of normal white and brown bread was 270 and 240 kcal respectively. He also reported that biscuit contain 443 kcal, wafers 418 kcal and cake 470 kcal of caloric value. Sindhu and Prema (1995) reported that tapioca based bread contain 337 kcal. Here the lowest caloric value of bread (278.66 kcal) may be due to the low caloric value of sweet potato flour.

When compared to the baked products, confectionary products had higher caloric value due to the fat present in it. Burfee got the highest caloric value. Instead of maida here bengalgram flour was used for the preparation of burfee. Achaya (1986) had reported a caloric value of 518 kcal in salted snacks. Chellammal (1995) reported that compared to the cassava based noodles, wafers and weaning mix, sweet potato based products had lower value for caloric. According to Shayma and Chellammal (1997) energy content of cassava vermicelli was 334 kcal.

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. Result of protein analysed showed that highest value of 9.66 g for cookies and

lowest value of 6.83 g for biscuit. The highest protein content for cookies was the presence of high protein content ingredients present in it. Tsen *et al.* (1973) found that soya flours (defatted and full fat) and protein isolates are suitable fortifiers to improve the nutritional value of cookies by raising their protein content and balancing their amino acid. Achaya (1986) reported that protein content of biscuit was 6 (g) and in the case of bread and cake, it was 8.5 (g) and 9 g respectively. Protein content of tapioca based bread was 13.19 g (Sindhu and Prema, 1995).

Protein content of confectionary products showed that the highest value was for gulabjamun mix and the lowest for toffee. The protein content of the developed foods were analysed by Chellammal (1995), it was found that sweet potato based product such as wafers, weaning food and noodles were higher than cassava based products. The protein content of ready to eat products based on cassava was 12.26 as reported by Shayma and Chellammal (1997).

β carotene:- According to Christopher *et al.* (1995) orange root flesh contain as much β carotene (Provitamin-A) as carrots and more than other vegetables and fruits. There was a vast variation in the carotene content of the products developed. Among the baked products, carotene content was highest in cake and lowest in bread. Carotene content of other product also



some what similar to each other. In the case of confectionary products halwa got the highest carotene content and gulabjamun mix had the lowest. According to Chellammal (1995) comparison between sweet potato based product with cassava based products revealed that carotene content was much higher in sweet potato based products than in cassava based products.

Calcium Calcium is the mineral play a vital role in nutrition and slight changes in the concentration of the calcium may rapidly endanger life. Among the baked product calcium content was higher (82.83 mg) in cake and lower (53.16 mg) in bread. The addition of egg in cake making is the primary reason for the observed higher value. According to Maguns (1984) the calcium content in white bread was 30 (mg). The increased calcium value in bread was due to the high content of the sweet potato flour.

Calcium content of confectionary products were higher in burfee (82.16 mg) and lower in Gulabjamun mix 48.33 (mg). Chellammal (1995) stated that calcium content was slightly higher in cassava based product than sweet potato based ones. Vermicelli made from cassava was showed 15.81 (mg) of calcium (Shayma and Chellammal, 1997).

Phosphorous:- Phosphorous content of the developed products were analysed. In the case of baked product it was higher in cake (301.66 mg) and lower in bread (201.6 mg). In confectionary products highest value for cheese and lowest value for

burfee. Similarly to the calcium content, the addition of egg was the reason for high phosphorous value for cake. According to Chellammal in (1995) there was no significant loss of this nutrient during processing.

Zinc:- Zinc is an important element performing a range of functions in the body as it is a co-factor for a number of enzymes. Zinc deficiency leads to growth failure and poor development of gonadal function. The estimation of zinc content of the products revealed that among the baked products cake score the highest value and in confectionary product burfee score the highest value. There was not much variation in the zinc content of the different products. According to Chellammal (1995) sweet potato based extruded products exhibited a very high value of 116.10, 116 and 115 (mg) for wafers, macroni and noodles respectively. She also reported that sweet potato is a rich source (1.16 mg/100 g) of zinc and this might have contributed to the higher value.

5.2.2 Organoleptic qualities of the developed products

The quality of a food, is a combination of the attributes that determine the degree of acceptability of the product. These include nutritional value and microbiological 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).

Any product that is new has to be tested in small quantities before being used in regular production. Scientific methods of sensory analysis of food are becoming increasingly important in assessing the acceptability of food products. Jellinick (1986) mentioned that sensory quality is one of the criterion for acceptability of any products by the consumer. Rajalakshmi (1993) described sensory analysis as a scientific discipline used to evoke, measure, analyse and interpret reaction to those characteristic on food and materials as perceived by the sense of sight, smell, taste, touch and hearing.

Quality parameters such as appearance, colour, flavour, texture and taste are assessed by means of human sensory organs. The evaluation is then said to be sensory evaluation. Clement and Kubena (1989) states that sensory evaluation can be used to predict consumer acceptance of a food item.

All the developed products, both baked and confectionary products were assessed for organoleptic qualities by students (N = 50) and technical experts (N = 25). The information on the specific sensory characteristic of a food must be obtained by product oriented tests and this information

was obtained in the laboratory from the selected trained technical experts (Watts *et al.*, 1989). Quality parameters such as appearance, flavour, colour, taste, texture, doneness and masticability, crumbling nature and over all acceptability were assessed by them.

Appearance:- The first impression of food is usually visual and a major part of our willingness to accept a food depends on its appearance. As the consumers preference to appearance is one of the major factor leading to the increasing demands of the product, it is very essential to keep the appearance of the product quite attractive (Christen, 1985). Appearance is a composite of all information about the product and its environment which reaches the eye (Birch *et al.*, 1988). The appearance of baked products were assessed by these two panels and the result revealed that the highest mean score for biscuit and the lowest score for bread. The shape and colour of the biscuit was very attractive than other products, and that might have contributed to the highest score. But in the case of bread the appearance was not good. The shape of the bread was not similar to the normal bread, because of it's improper puffness. Cake and nancuta showed somewhat similar result of biscuit. Score value for appearance of cookies was also not good. This is due to the lesser binding capacity of the sweet potato flour Tsen *et al.* (1976) reported that acceptable bread and buns of normal appearance can be made from wheat flour fortified with 18 per cent defatted corn germ flour.

The confectionary products were also assessed by these two panels. It was found that toffee and halwa scored the highest mean score and cheese got the lowest score. The highest mean score for toffee was due to its chocolate colour by the addition of cocopowder. The maximum score for halwa was due to its shape and colour were similar to the normal halwa. Similar to the toffee and halwa gulabjamun mix was also got a good score. The colour of cheese was light brown, which is not acceptable for such a product. This light brown colour was the colour of sweet potato flour and that might have contributed to the low score. According to Chellammal (1995) the scorers for sweet potato based noodles, macroni and wafers were lower than those of the cassava and soya based similar products.

Flavour:- Odour preference is generated by stimulation of the sensory cells by specific compound present in the food. John (1984) described that astringency is not a taste or odour sensation and it must often be include in flavour evaluation because it is a property common to many foods. Flavour is an important factor which enriches the consumers preference to a particular food (Ranganna, 1984).

Flavour is the unique character of odour and taste. It change can be attributed to alternation in chemical composition. Ranganna (1984) stated that flavour is an

important factor which enriches the consumers preference to a particular products.

According to Birch *et al.* (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 sensation in the mouth. Among the baked products cookies and biscuits scored the highest mean value. The addition of egg and coconut to the two products were the reason for this. In both group of judges gave lowest score for bread. Sweet potato flour also had a bland flavour. This bland flavour of the flour might have contributed to the low mean score for bread. Crabtree *et al.* (1978) reported that 20 per cent replacement of wheat flour by cassava in bread did not alter the odour. According to Sinha *et al.* (1993) the addition of soya flour did not effect the flavour of bread. Cake and nancuta also got good score for flavour. This was due the addition of egg to the dough.

In confectionary products, toffee got the highest score and cheese got the lowest. The good flavour of cocoapowder was the reason for highest score. In the case of cheese, the bland flavour of sweet potato flour reduced the mean value. Other products like gulabjamun mix and burfee were moderately scored. According to Chellammal (1995) sweet potato based products were showed a lower score than cassava based products.

Colour:- Colour is the most important characteristic by which quality of food is judged. If the colour is unattractive, a potential consumer may not be impressed by the major attributes. Clydesclade (1989) reported that colour affected the perception of other sensory characteristics such as taste and flavour. According to the reports from CFTRI the aesthetic, safety, sensory characteristics and acceptability of food are all affected by colour. The joint FAO and WHO expert committee on food additives recognised that colour has an effect on food choice (Anonymous, 1991).

Jellinick (1986) reported that the first impression of food is usually visual and major part of our willingness to accept a food depends upon its colour. The scores for colour of the baked products were highest in biscuit and nancuta and lowest in cookies and cake. Application of egg white over these products before baking was the reason for maximum scores. The dull brown colour of sweet potato flour was not appealing and that may be the reason for its low score. The score value for bread was in between the highest and lowest scored products.

Among the confectionery products halwa and toffee were scored the highest mean score. Results showed that the lowest mean score for cheese. The attractive colour of the toffee was due to the presence of cocoapowder. Due to the availability of different colours of halwa in the market, this

dull brown colour of halwa was also scored at maximum. The dull brown colour of the cheese was due to the colour of sweet potato flour. If the colour could be improved by some additives, cheese would have got a better score. The score value for colour of gulabjamun mix and burfe were not so bad. Bradbury (1990) had reported lower acceptability due to dark colour observation was also reported by Chellammal (1995).

Taste:- Taste is only a sensory response to soluble materials but also aesthetic appreciation of the mouth. According to Rolls *et al.* (1981) in the various quality attribute tests, the first preference goes to the taste followed appearance, texture and colour.

Cookies scored the highest mean value than other baked products and bread was the lowest. The highest score of the cookies was due to its ingredients such as coconut and little milk powder. But in the case of bread the taste of sweet potato flour was prominent. This taste was preferred only a small percentage of people in the selected groups. Almazan (1990) reported that variation in taste exist as the amount of cassava flour increased in bread. Sugar added to bread is reported to impart colour and taste (Rama, 1991).

Organoleptic evaluation for taste of confectionary products revealed that gulabjamun mix and toffee scored the highest value and cheese got the lowest value. The highest

value of the these products were due to the presence of ingredients such as cocoapowder and sugar. Addition of little lime juice on the preparation of cheese was the reason of its sour taste and low score. According to VanDen (1989) acid food products from sweet potato, whose appearance taste and nutrient are similar to those of processed fruit items. Other products like halwa and burfeg were scored moderately. The quality 'taste' is determined by other quality parameters like appearance and colour. Low scores obtained for appearance and colour by sweet potato based products might have contributed to the lower score for taste (Chellammal, 1995).

Texture:- Texture is a per cent resulting from inraction between food and its consumer (Jack et al., 1995). It constitute a physical property of food stuffs apprehended by the eye, the skin and muscle sense located in the mouth. Among the baked products biscuit and bread were scored the hight and lowest scores. The surface area of biscuit was smooth and texture was very crisp and this quality must have contributed for the highest score. The lowest score for bread was due to the fibrous nature of sweet potato flour. According to Rao and Malini (1991) addition of bran, cassava flour and full fat soya flour are reported to effect the texture of the crumb adversely. Similar findings were reported by Almazan (1990).

Organoleptic evaluation for texture of confectionery products, the result revealed that toffee obtained the highest score and cheese and burfee got the lowest scorers. The fibrous nature of flour would have contributed to the hard texture of the toffee. The lowest mean score of cheese and burfee were due to the fibre present in the flour.

Doneness:- Doneness was ascertained by pressing the crumb with fingers to see whether sticky or not. In the mean scores of the baked products revealed that the highest score for biscuit and lowest mean score in bread. Other products like nancuta, cookies and cake were scored comparatively higher scores than bread. The highest mean score in biscuit was due to the fibre which help the proper doneness of the biscuit. The lowest mean score of bread was due to the presence of sweet potato flour upto 50 per cent in the dough.

Masticability:- It was ascertained to see whether the bread is sticky or not when chewed. The result revealed that in sweet potato based bread the masticability was higher. This was due to only 50 per cent of maida in it.

Crumbing nature:- Crumb means the size of the tunnels or holes in the crumb. This parameter measures whether the tunnels or holes is fine or coarse. Result showed that the holes is not much fine. This was due to the less binding capacity of the sweet potato flour. Skorikova (1981) reported

that solid crumb is obtained when defatted soya meal was added. According to He and Hoseney (1990) moisture play an important role in crumb firming. Higher moisture of crumb resulted in slower firming rate and lower equilibrium firmness.

Overall acceptability:- Overall acceptability depends on the concentration or amount of particular components, the nutritional and other hidden attributes of a food and its palatability or sensory quality. Indian Food Industry (1995) reported that the quality is the main criteria on which the acceptability of any product depends.

The overall acceptability of the baked products revealed that cookies and biscuit scored the highest value and bread scored the lowest value. All the other parameters like appearance, colour, taste, flavour and texture were higher in cookies and biscuit. So the overall acceptability of these products were higher. Tesn *et al.* (1976) found that acceptable cookies can be prepared from wheat flour fortified with 12-15 per cent of soya products. Sensory evaluation studies done by Vaidehi and Varalakshmi (1992) have shown that the best acceptable level of soya flour was 10-15 per cent in biscuit, 5-10 per cent in cake and bread. The low score for overall acceptability of the bread was due to the lower scores of other parameters like colour, appearance, flavour, taste and texture. According to Levey (1952) cassava flour is used to replace wheat flour at rates of 20 per cent for bread, 22-35 per cent

for cakes and 15 per cent for macroni and noodles, giving good quality products. Taste panel analysis indicate that a high protein bread were organoleptically acceptable (Fleming and Sosulski, 1977). Tsen and Mustafa (1976) reported that cassava and wheat starches were found to give highly acceptable supplemented breads. In an earlier experiment conducted at CFTRI (1979-1980) it was observed that tapioca flour incorporated at a level of 20 per cent is found to yield acceptable bread.

Among the confectionary products toffee scored the highest value and cheese got a lowest overall acceptability. Here also the other parameters like colour, flavour, appearance, texture and taste were highest in toffee and lowest in cheese.

The assessment of the organoleptic qualities of the developed baked products revealed that biscuit and cookies were the highly acceptable products and bread was the lowest one. In the case of confectionary products toffee was the highly preferred one and cheese was the lowest one.

5.3 Demonstration of the developed products among farmers and entrepreneurs

Teaching or extending useful information, based on research will serve to increase the farmers and entrepreneurs production and net income. Demonstration of the developed

products could be showed the utility and feasibility of a recommended practice.

Guiteman and Gorden (1982) opined that middle income families residing in urban areas are heavy users of processed food item. Anon (1987) stated that the processed foods play on very important role in our lives today with more and more women going out of the house to work, the time and energy spent in cooking foods need to be decreased substantially and thus the dependence on processed foods has increased dramatically. Preference studies are designed to determine consumer's subjective reactions to external phenomena and their reasons for having them. Guitamanian (1987) stated that consumer food preference are changing rapidly. The preference scores of farm women in Venganoor panchayath evidently showed that most of the women considered nancuta was the most 'like extremely well' product and bread was rated much negatively (8%). The taste and appearance of the nancuta was 'most like extremely well' by the farm women. The bland taste of the bread, due to the sweet potato flour was the reason for low score of the product. Among the confectionary products halwa and cheese were scored the highest (48%) and lowest (16%) value. Flavour and appearance of the halwa and sour taste of cheese were leads to the two extreme score values.

Farm women in Srikariyam panchayath preferred biscuit and bread were the two extreme rated product. Similarity of

the biscuit towards the normal biscuit was the reason for its high score. In confectionary products toffee and cheese were rated the maximum and minimum. Colour and taste of the toffee was contributed the maximum rate.

The result from the farm women in Kaliyoor panchayath pointed out that cake and cookies scored the maximum rate. Taste and flavour of the products were the reason for this. There was no negative score among baked products. Here also among confectionary products toffee and cheese were rated to extreme level.

During the development of new food products or the reformulation of existing products, the identification of changes caused by processing method, by storages 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). While conducting preference test the consumer expects to be favourably impressed with the food he tastes and expressed displeasure if the product does not measure upto his anticipation. Evaluating food products in the lab is not enough. In the latter stages of research, they must also be tested by entrepreneurs such as food manufacturers associations. Entrepreneur's method of preparation vary greatly as do their perceptions and food preference. Preference test done among the entrepreneurs in Thiruvananthapuram city revealed that biscuit and bread were

rated as maximum and minimum level respectively. According to them the appearance and crispness of the biscuit was some what similar to the maida based biscuit. But in the case of bread it was not similar to the standard bread. Toffee and cheese were scored the maximum and minimum level respectively. Due to it's colour and flavour toffee scored the highest value. But in the case of cheese, colour and appearance were not in a pleasing level.

5.4 The shelf life qualities

Near the end of the research phase, you will need to decide on packaging and determine the appropriate shelf life.

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). There was an increase in the moisture content of the stored flour irrespective of the storage containers. Variation in the moisture content was found to be lowest in glass containers followed by those in plastics, steel and polythene containers. The same trend could be observed throughout the storage period.

Moisture content was increase in flour 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 content in polythene bags. Because of this reason, in glass and plastic containers, the

increase in moisture content was 8.78 to 10.11 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 content was recorded to the flour stored in polythene bags. Beerah *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 six months, from the initial level of 11.00 per cent to 13 per cent.

Moisture content was found to increase as the duration of storage advanced. However the moisture content of sweet potato flour which was stored in the polythene bag was higher than the other containers during the storage period. The mean moisture content over the six month of duration for flour in polythene bag was 8.76, which was significantly higher than that of all other containers.

The assessment of the incidence of insect pests in the stored flour revealed that there was no insect infestation in glass and plastic containers, and only in steel containers and polythene bags. Insects have preference for moist flour materials and increased moisture level aggravates infestation. Steel container and polythene bags had more moisture than other media. It was observed that there was no insect infestation in glass and plastic containers during the storage period. A similar result was also reported by Chellammal (1995).

Considering the moisture content of the developed baked and confectionary products, it could be observed that there was an increase in moisture content through out the storage period upto four weeks. Among the baked products bread had the highest moisture content. Due to its high moisture value, its storage life was very shorter than the other products. The high moisture content of the bread was due to its method of preparation. The moisture content of the other products were also increased during the storage period. Cake and cookies were also had^a higher moisture content with in the second and third week. So that their shelf life was also limited. In biscuit and nanc^uta, the moisture content was increased slowly. The total mean value of the moisture revealed the shelf life quality of each product. Products which possessed lowest moisture increase was scored as the highest shelf life.

In the case of confectionary product, halwa and cheese had the highest moisture content when compared to other products. Moisture content of the toffee and gulabjamun were very low. The different processing techniques applied may be the reason for the variation in moisture. According Inamdar (1980) an increase from 10 - 14.79 per cent for RTE mix after a storage period of 28 days. Solanki (1986) reports an increase from 5.16 to 5.39 per cent in the develop RTE mixes after a storage period of 28 days. The increase in the moisture content of flaked rice-based wafers has been reported by Kulkarni *et al.* (1992). In their study the moisture content was found to be within the acceptable limit, upto a storage period of four months. Shayma and Chellammal (1997) reported that savoury vermicelli has slightly higher moisture content compared to sweet vermicelli.

Moisture content was found to increase as the duration of storage advanced. Both baked and confectionary products showed the same trend. However the moisture content of the confectionary products was higher for all the storage periods.

Overall acceptability of the developed baked and confectionary products was assessed with a panel of 25 technical experts, using a standardised pretested score card. Scale from five to one was used, five representing the optimum for all the quality characteristics. The score obtained were

showed that, the highest score for biscuit and which is followed by nancuta. This showed that these products had a longer shelf life than other products. In the same way over all acceptability of the confectionary products showed that gulabjamun mix and toffee scored the highest score compared to other confectionary products. It was revealed that these products had better shelf life than that of other products. According to Chellammal (1995) the over all acceptability of the developed cassava and sweet potato based noodles and macroni were rated as equal to or even better than the standard products of noodles and macroni.

Food in excess of immediate consumption is stored for further use. One disadvantage of storing food is the deterioration it undergoes during storage. This deterioration is caused by damage due to bacterial and fungal infestation and insect infestation. Nevertheless the damage caused by the insects may be considerable, since they not only consume stored food but also contaminate them with insect fragments, faeces, webbing and illsmelling metabolic products.

According to Sankaran (1993) 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. Processed foods and ready to eat foods provide ample scope for contamination with spoilage and

pathogenic microorganisms, thus necessitating microbiological quality assessment as an integral part of food processing (Leela *et al.*, 1993).

The assessment of microbiological quality revealed that bread and cake were showed a shelf life of one and two week respectively. Herman *et al.* (1980) have reported that the commonly seen micro organism in bread are *staphylococcus*, *Lactobacillus spp* and *Saccharomyces cerevisiae*. All the bread samples developed stale or off odour may be due to the growth of microorganism like *Bacillus mesentericus*. He also reported that beside bread, the common products of bakery, such as cakes, and pies are also attacked by some moulds like *Rhizopus nigricans* and *Aspergillus niger*, especially when they are prepared with low sugar percentage.

Vaidehi and Varalakshmi (1992) reported that the shelf life of cake, bread and puffs were 4-5 days. According to Sindhu and Prema (1995) as assessment of the shelf life revealed that maida based bread with 10 per cent soyafLOUR was found to have shelflife, 5 days instead of 4 days. Sultan (1980) reported that increased moisture in the dough will also result in a greater per cent of moisture in baked bread and this will provide for a softer crumb and a longer shelflife. According to Nikolic and salihodzic (1988) and Sinha *et al.* (1993) the bread contained soya flour was observed to have the highest

shelf-life. In the case of biscuit and nancuta the shelf life was only 4 weeks. Vaidehi and Varalakshmi (1992) reported that biscuit had longer shelf life of 9 days. Here, the shelf life of biscuit was higher than the normal keeping quality due to its well doneness. Shelf life of cookies was less than the biscuit, that was three weeks.

Assessment of microbial growth of confectionary products, they had a less shelf life compare to the baked products. Halwa, cheese and burfee were possessed only two and three weeks of shelf-life respectively. It was due to the presence of high fat content in these products. Toffee and gulabjamun mix had a shelf life of four weeks. It is due to its low fat and low moisture content.

SUMMARY

6. SUMMARY

The present study on 'Developing baked and confectionary products based on sweet potato' was undertaken to utilise sweet potato as processed foods. The study comprised of standardisation of raw materials, product development and assessing the nutritional and shelf life qualities of the developed products.

Sweet potato is a crop with tremendous potential. It ranks first among cultivated crops in the developing world. Different percentage of sweet potato flour were combined with maida for processing of baked and confectionary products. Sweet potato flour was added to different combinations ranging from 40-50 per cent. From the three different combinations of sweet potato flour as basic ingredient, the one with 50 per cent sweet potato and 50 per cent maida was selected to process baked and confectionary products. The principle governing the selection of suitable combination were protein quality and cost benefit ratio. Protein quality of the combinations were assessed through amino acid scores and chemical score. Cost of the different combinations were computed as per the market price of the ingredients. The acceptability of the combination were assessed through organoleptic evaluation.

The five baked products cake, biscuit, nancuta, cookies and bread were processed by adding egg, ghee, sugar and baking powder. Confectionary products such as halwa, cheese, toffee, burfee and gulabjamun mix were processed by the addition of sugar, ghee and skimmed milk powder. After the development of the products ISI type tests were administered to the developed products and values were incomparable with ISI specification.

The nutritional adequacy of the developed products with reference to protein, calorie, fat, calcium, β carotene, phosphorous and zinc were determined through suitable laboratory techniques. Organoleptic and preference studies of the developed products were assessed by two groups of consumers viz. college students and technical experts. Appearance, flavour, colour, taste, texture and over all acceptability of the developed product were assessed by these groups.

The statistical analysis revealed that regarding organoleptic qualities of the developed baked products, biscuit and cookies were the highly acceptable and bread was the less acceptable product. In the case of confectionary products, toffee was the highly accepted and cheese was the less accepted one.

In the preference tests of the developed products conducted among farm women of Venganoor, Srikariyam and Kaliyoor panchayath and entrepreneurs in Thiruvananthapuram city it was found that biscuit and toffee were rated as maximum among baked and confectionary products and bread and cheese were rated as minimum.

Effect of storage containers such as steel, glass, plastic and polythene bag on the moisture content, a steady increase in moisture content was observed irrespective of containers. Moisture content was highest in flour kept in polythene bags followed steel, plastic and glass. The increase in the moisture content among the different containers were statistically significant. Observation on insect infestation revealed that there was no insect infestation in the glass and plastic containers upto six months of storage.

The shelf-life qualities of the developed products revealed that in baked products biscuit had the highest shelf life and bread had the lowest shelf-life. In confectionary products toffee had the highest shelf life, halwa and cheese were the lowest shelf-life among the confectionary products. There was no insect infestation in the developed products. The assessment of microbiological quality revealed that bread and cake were easily attacked by

Rhizopus nigricans, *Bacillus subtilis* and *Macor spp* of moulds. Confectionary products like halwa and cheese were more infested by *Penicillium expansum* and *Aspergillus niger*.

The salient features on the study of 'Developing baked and confectionary products based on sweet potato' indicated that, it is possible to develop baked and confectionary products based on sweet potato. The nutritional and organoleptic qualities of the developed products were in comparable with the commercially available products, and the developed food had a reasonable long shelf-life.

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* Originals not seen

APPENDICES

APPENDIX I

Amino Acid and chemical scores of different combinations tried for sweet potato based baked products

40:60 combination	Arginine	Mistidine	Lysine	Tryptophan	Phenylalanine	Tryptosine	Methionine	Cystine	Thersosine	Leucine	Isolenine	Valine
Cake												
S.P.flour	112	36	104	44	108	60	40	12	112	144	116	152
Maida	114	72	66	36	174	78	54	84	90	240	132	144
Egg	320	120	352	72	288	200	168	112	256	416	328	360
Amino acid score = 142.13						Chemical score = 168.88						
Biscuit												
S.P.flour	112	36	104	44	108	60	40	12	112	144	116	152
Maida	114	72	66	36	174	78	54	84	90	240	132	144
Amino acid score = 62.13						Chemical score = 88.88						
Mancuta												
S.P.flour	112	36	104	44	108	60	40	12	112	144	116	152
Maida	114	72	66	36	174	78	54	84	90	240	132	144
Amino acid score = 62.13						Chemical score = 88.88						
Cookies												
S.P.flour	112	36	104	44	108	60	40	12	112	144	116	152
Maida	114	72	66	36	174	78	54	84	90	240	132	144
Egg	320	120	352	72	288	200	168	112	256	416	328	360
Coconut	425	65	120	35	140	85	50	40	90	215	120	160
Amino acid score = 183.20						Chemical score = 207.77						
Bread												
S.P.flour	112	36	104	44	108	60	40	12	112	144	116	152
Maida	114	72	66	36	174	78	54	84	90	240	132	144
Amino acid score = 62.13						Chemical score = 88.88						

† S.P.Flour - Sweet Potato Flour

45:55 combination	Argi- nine	Misti- dine	Lysine	Trypto- phan	Phenyla- lanine	Tryo- sine	Methio- nine	Cys- tine	Therso- nine	Leu- cine	Isolen- cine	Valine
Cake												
S.P.flour	126.0	40.5	117	49.5	121.5	67.5	45	13.5	126	162	130.5	171
Maida	104.5	66.0	60.5	33.0	159.5	71.5	49.5	77.0	82.5	220	121.0	132
Egg	320	120	352	72	288	200	168	112	256	416	328	360
Amino acid score = 142.75						Chemical score = 171.66						

Biscuit												
S.P.flour	126.0	40.5	117	49.5	121.5	67.5	45	13.5	126	162	130.5	171
Maida	104.5	66.0	60.5	33.0	159.5	71.5	49.5	77.0	82.5	220	121.0	132
Amino acid score = 62.75						Chemical score = 91.66						

Nancuta												
S.P.flour	126.0	40.5	117	49.5	121.5	67.5	45	13.5	126	162	130.5	171
Maida	104.5	66.0	60.5	33.0	159.5	71.5	49.5	77.0	82.5	220	121.0	132
Amino acid score = 62.75						Chemical score = 91.66						

Cookies												
S.P.flour	126.0	40.5	117	49.5	121.5	67.5	45	13.5	126	162	130.5	171
Maida	104.5	66.0	60.5	33.0	159.5	71.5	49.5	77.0	82.5	220	121.0	132
Egg	320.0	120.0	352.0	72.0	288.0	200.0	168.0	112.0	256.0	416	328.0	360
Coconut	425.0	65.0	120.0	35.0	140.0	85.0	50.0	40.0	90.0	215	120.0	160
Amino acid score = 184.07						Chemical score = 210.56						

Bread												
S.P.flour	126.0	40.5	117	49.5	121.5	67.5	45	13.5	126	162	130.5	171
Maida	104.5	66.0	60.5	33.0	159.5	71.5	49.5	77.0	82.5	220	121.0	132
Amino acid score = 62.75						Chemical score = 91.66						

50:50 combination	Arginine	Histidine	Lysine	Tryptophan	Phenylalanine	Tryptosine	Methionine	Cystine	Threonine	Leucine	Isoleucine	Valine
Cake												
S.P.flour	140	45	130	55	135	75	50	15	140	180	145	190
Maida	95	60	55	30	145	65	45	70	75	200	110	120
Egg	320	120	352	72	288	200	168	112	256	416	328	360
Amino acid score = 143.36						Chemical score = 174.44						
Biscuit												
S.P.flour	140	45	130	55	135	75	50	15	140	180	145	190
Maida	95	60	55	30	145	65	45	70	75	200	110	120
Amino acid score = 63.36						Chemical score = 94.44						
Mancuta												
S.P.flour	140	45	130	55	135	75	50	15	140	180	145	190
Maida	95	60	55	30	145	65	45	70	75	200	110	120
Amino acid score = 63.36						Chemical score = 94.44						
Cookies												
S.P.flour	140	45	130	55	135	75	50	15	140	180	145	190
Maida	95	60	55	30	145	65	45	70	75	200	110	120
Egg	320	120	352	72	288	200	168	112	256	416	328	360
Coconut	425	65	120	35	140	85	50	40	90	215	120	160
Amino acid score = 63.36						Chemical score = 213.33						
Bread												
S.P.flour	140	45	130	55	135	75	50	15	140	180	145	190
Maida	95	60	55	30	145	65	45	70	75	200	110	120
Amino acid score = 63.36						Chemical score = 94.44						

Amino Acid and chemical scores of different combinations tried for sweet potato based confectionary products

40:60 combination	Argi- nine	Misti- dine	Lysine	Trypto- phan	Phenyla- lanine	Trya- sine	Methio- nine	Cys- tine	Therso- nine	Leu- cine	Isolen- cine	Valine
Halwa												
S.P.flour	112	36	104	44	108	60	40	12	112	144	116	152
Maida	114	72	66	36	174	78	54	84	90	240	132	144
Amino acid score = 62.13						Chemical score = 88.88						
Cheese												
S.P.flour	112	36	104	44	108	60	40	12	112	144	116	152
Maida	114	72	66	36	174	78	54	84	90	240	132	144
Amino acid score = 62.13						Chemical score = 88.88						
Burfee												
S.P.flour	112	36	104	44	108	60	40	12	112	144	116	152
Bengalgram flour	342	96	264	30	216	108	48	48	132	348	192	186
Amino acid score = 78.47						Chemical score = 39.28						
Toffee												
S.P.flour	112	36	104	44	108	60	40	12	112	144	116	152
Maida	114	72	66	36	174	78	54	84	90	240	132	144
Amino acid score = 62.13						Chemical score = 88.88						
Gulabjamun mix												
S.P.flour	112	36	104	44	108	60	40	12	112	144	116	152
Maida	114	72	66	36	174	78	54	84	90	240	132	144
Amino acid score = 62.13						Chemical score = 88.88						

45:55 combination	Argi- nine	Histi- dine	Lysine	Trypto- phan	Phenyla- lanine	Tryo- sine	Methio- nine	Cys- tine	Therso- nine	Leu- cine	Isolen- cine	Valine
Malwa												
S.P.flour	126.0	40.5	117	49.5	121.5	67.5	45	13.5	126	162	130.5	171
Maida	104.5	66.0	60.5	33.0	159.5	71.5	49.5	77.0	82.5	220	121.0	132
Amino acid score = 62.75						Chemical score = 91.66						
Cheese												
S.P.flour	126.0	40.5	117	49.5	121.5	67.5	45	13.5	126	162	130.5	171
Maida	104.5	66.0	60.5	33.0	159.5	71.5	49.5	77.0	82.5	220	121.0	132
Amino acid score = 62.75						Chemical score = 91.66						
Burfee												
S.P.flour	126.0	40.5	117	49.5	121.5	67.5	45	13.5	126	162	130.5	171.0
Bengalgram flour	313.5	88.0	242	27.5	198.0	99.0	44	44.0	121	319	176.0	170.5
Amino acid score = 80.54						Chemical score = 41.07						
Toffee												
S.P.flour	126.0	40.5	117	49.5	121.5	67.5	45	13.5	126	162	130.5	171
Maida	104.6	66.0	60.5	33.0	159.5	71.5	49.5	77.0	82.5	220	121.0	132
Amino acid score = 62.75						Chemical score = 91.66						
Gulabjamun mix												
S.P.flour	126.0	40.5	117	49.5	121.5	67.5	45	13.5	126	162	130.5	171
Maida	104.6	66.0	60.5	33.0	159.5	71.5	49.5	77.0	82.5	220	121.0	132
Amino acid score = 62.75						Chemical score = 91.66						

50:50 combination	Arginine	Mistidine	Lysine	Tryptophan	Phenylalanine	Tryptosine	Methionine	Cystine	Thersosine	Leucine	Isolenine	Valine
Halwa												
S.P.flour	140	45	130	55	135	75	50	15	140	180	145	190
Maida	95	60	55	30	145	65	45	70	75	200	110	120
Amino acid score = 63.36						Chemical score = 94.44						
Cheese												
S.P.flour	140	45	130	55	135	75	50	15	140	180	145	190
Maida	95	60	55	30	145	65	45	70	75	200	110	120
Amino acid score = 63.36						Chemical score = 94.44						
Burfee												
S.P.flour	140	45	130	55	135	75	50	15	140	180	145	190
Bengalgram flour	285	80	220	25	180	90	40	40	110	290	160	115
Amino acid score = 81.55						Chemical score = 42.85						
Toffee												
S.P.flour	140	45	130	55	135	75	50	15	140	180	145	190
Maida	95	60	55	30	145	65	45	70	75	200	110	120
Amino acid score = 63.36						Chemical score = 94.44						
Gulabjamun mix												
S.P.flour	140	45	130	55	135	75	50	15	140	180	145	190
Maida	95	60	55	30	145	65	45	70	75	200	110	120
Amino acid score = 63.36						Chemical score = 94.44						

6. **DONENESS**

Well cooked	5
Moderately cooked	4
Partially cooked	3
Moderately uncooked	2
Uncooked	1

7. **OVER ALL ACCEPTABILITY**

Like extremely	5
Like very much	4
Like moderately	3
Dislike slightly	2
Dislike extremely	1

6. **TEXTURE**

Crisp	5
Coarse	4
Sticky	3
Hard	2
Very hard	1

7. **OVER ALL ACCEPTABILITY**

Like extremely	5
Like very much	4
Like moderately	3
Dislike slightly	2
Dislike extremely	1

6. **DONENESS**

Well cooked	5
Moderately cooked	4
Partially cooked	3
Moderately uncooked	2
Uncooked	1

7. **OVER ALL ACCEPTABILITY**

Like extremely	5
Like very much	4
Like moderately	3
Dislike slightly	2
Dislike extremely	1

6. **Tate**

Excellent	5
Good	4
Fair	3
Poor	2
Very poor	1

7. **DONENESS**

Well cooked	5
Moderately cooked	4
Partially cooked	3
Moderately uncooked	2
Un-cooked	1

8. **TEXTURE**

Very soft	5
Soft	4
Sticky	3
Hard	2
Very hard	1

9. **OVER ALL ACCEPTABILITY**

Like extremely	5
Like very much	4
Like moderately	3
Dislike slightly	2
Dislike extremely	1

SCORE CARD FOR NANCUTS

Product: Tested by:
Date: Age:

1. APPEARANCE

Excellent	5
Good	4
Fair	3
Poor	2
Very poor	1

2. FLAVOUR

Highly acceptable	5
More acceptable	4
Acceptable to certain extent	3
Less acceptable	2
Not acceptable	1

3. COLOUR

Cream	5
Light yellow	4
Dull white	3
Brown	2
Dark brown	1

4. TASTE

Excellent	5
Good	4
Fair	3
Poor	2
Very poor	1

5. DONENESS

Well cooked	5
Moderately cooked	4
Partially cooked	3
Moderately uncooked	2
Uncooked	1

6. TEXTURE

Slightly soft	5
Moderately hard	4
Slightly hard	3
Hard	2
Very hard	1

7. OVER ALL ACCEPTABILITY

Like extremely	5
Like very much	4
Like moderately	3
Dislike slightly	2
Dislike extremely	1

SCORE CARD FOR HALWA

Product: Tested by:
Date: Age:

1. **APPEARANCE**

Excellent	5
Good	4
Fair	3
Poor	2
Very poor	1

2. **FLAVOUR**

Highly acceptable	5
More acceptable	4
Acceptable to certain extent	3
Less acceptable	2
Not acceptable	1

3. **COLOUR**

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

4. **TASTE**

Excellent	5
Good	4
Fair	3
Poor	2
Very poor	1

5. **TEXTURE**

Very soft	5
Soft	4
Rubbery	3
Gummy	2
Hard	1

SCORE CARD FOR BURFEE

Product: Tested by:
Date: Age:

1. APPEARANCE

Excellent	5
Good	4
Fair	3
Poor	2
Very poor	1

2. FLAVOUR

Highly acceptable	5
More acceptable	4
Acceptable to certain extent	3
Less acceptable	2
Not acceptable	1

3. COLOUR

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

4. TASTE

Excellent	5
Good	4
Fair	3
Poor	2
Very poor	1

5. TEXTURE

Very soft	5
Soft	4
Rubbery	3
Gummy	2
Hard	1

SCORE CARD FOR GULAB JAMUN MIX

Product:
Date:

Tested by:
Age:

1. APPEARANCE

Excellent	5
Good	4
Fair	3
Poor	2
Very poor	1

2. FLAVOUR

Highly acceptable	5
More acceptable	4
Acceptable to certain extent	3
Less acceptable	2
Not acceptable	1

3. COLOUR

Light brown	5
Brown	4
Dark brown	3
Brownish black	2
Black	1

4. TASTE

Excellent	5
Good	4
Fair	3
Poor	2
Very poor	1

5. TEXTURE

Very soft	5
Soft	4
Little hard	3
Hard	2
Very hard	1

APPENDIX - IV

Recipes

1. Sweet potato sandwiches

Ingredients

Sweet potato bread	-	2 slices
White bread	-	2 slices
Paneer crumbled	-	1/3 cup
Sweet potato chopped	-	1/3 cup
Grated onion	-	1 tsp
Butter	-	1 tsp
Salt, pepper to taste		
A few drops red and green colour		

Method

Prepare a filling by mixing sweet potato, paneer, onions, salt, pepper and butter. Divide it in 3 parts. In one part add a drop of red colour, in the second part put a drop of green colour and leave the third white. Now prepare one big sandwich in the order of brown bread, green filling, white bread, white filling, brown bread, red filling and then white bread. Press a little on top to stick properly. Cut into three long pieces and place side ways to show all the colours.

2. Sweet potato Pancakes

Ingredients

Sweet potato flour	-	2 cups
Salt	-	1/2 tsp
Oil	-	1 tsp
Spring onion	-	6-8
Egg	-	1
Refined oil for frying		

Method

Mix the first three ingredients together, add enough water and make a dough as for chapathi. Keep covered for half an hour. Finally chop the spring onions and lightly beat the egg. Divide the dough into eight parts. Roll out each part into thin round (About 16-18 cm diameter). Brush 4 rounds with beaten egg. Sprinkle with spring onions. Cover each round with one of the remaining round, press down to stick the two round together. Cook both sides on a hot tawa with 1-2 tsp of oil. Cut each pancake into 4 wedges and serve hot.

3. Sweet potato soya curry

Ingredients

Soya chunks	-	50 gm
Cooked sweet potato	-	1/4 kg
Fresh button mushroom	-	50 g
Oil	-	1/4 cup
Turmeric powder	-	1/4 tsp
Chilli powder	-	1 tsp
Coriander and cuminseed powder	-	2 tsp
Garam masala	-	1/4 cup
Gram flour	-	1 tsp
Salt to taste		
For grinding masala paste		
Coriander leaves	-	1 cup
Green chilli	-	6
Ginger	-	1/2 inch
Onion sliced	-	1/2 cup
Tomatoes, cubed	-	1/2 cup

Method

Soak soya chunks in salted hot water for 15 minutes. Drain and squeeze out water. Heat oil, add masala paste. Saute on medium heat till oil separates. Add turmeric powder, chilli powder and coriander cuminseed powder. Also mix garam masala. Saute for a minutes. Add 2 cups of water and allow it to boil. Add and mix soya chunks, sweet potato, corn, mushroom and salt to taste. Boil the curry for 5 minutes. Mix gram flour to thicken the gravy. Serve hot with steamed rice.

4. Sweet potato outlet

Ingredients

Boiled mashed sweet potato	-	1 cup
Boiled mashed potato	-	1 cup
Mint	-	2 tbs
Coriander leaves	-	2 tbs
Oil	-	1 tbs
Garlic	-	6 flakes
Ginger	-	1 cm
Onion	-	1
Green chillies	-	2
Salt	-	1 1/4 tsp
Chilli powder	-	1/2 tsp
Garam masala powder	-	1/4 tsp

Method

Fry in oil, the chopped onion till golden brown, add the mashed sweet potato and all the other ingredients. Stir well and remove from fire. Make into balls and then into flat patties. Shallow fry in a non-stick pan using minimum oil till golden brown on both sides. Serve hot with tomato sauce or any chutney.

5. Sweet potato vada

Ingredients

Gram flour	-	1/2 cup
Sweet potato flour	-	1/2 cup
Water	-	1 cup
Turmeric powder	-	1/4 tsp
Ginger chilli paste	-	1 tsp
Chopped coriander leaves	-	1 cup
Coconut grated to garnish		
Salt to taste		
Big pinch asafoetida		
Oil for shallow or deep frying		

Method:

Take gram flour, sweet potato flour, water, turmeric asafoetida, ginger - chilli paste and salt together in a thick bottom vessel. Mix well. Put on the fire and stir continuously. Cook till the mixture is thick and leaves the side of the vessel. Turn off heat and mix in coriander leaves. Allow to cool. Make round or square vade with fingers dipped in little oil. Do it when the mixture is still warm. Deep fry or shallow fry sweet potato vade to golden brown colour. Serve hot.

6. Tasty newries

Ingredients

Maida	-	1 cub
Sweet potato flour	-	1 cub
Butter	-	2 tbs
Salt	-	a pinch
Oil for deep frying		
For the filling		
Icing sugar	-	6 tabs
Cardamoms, powdered	-	1 tab
Raisins	-	4 tbs
Finally chopped cashewnuts	-	4 tsb

Method

In a mixing bowl put the maida, sweet potato flour, butter and a pinch of salt. Add enough water to make a soft pliable dough keep covered with a damp cloth for about half an hour. Make the filling. Mix together the icing sugar, powdered cardamoms, raisins and the finely chopped cashewnut. Make small balls of the dough and roll them out into discs. Put a little filling in the centre of each discs. Wet all round with a little water. Then fold the discs of form a 'D'. Heat the oil in a pan and fry newries to a golden colour.

7. Chocolate bars

Ingredients

Butter	-	125 gms
Dark chocolate	-	125 gms
Egg	-	4
Icing sugar	-	2 cups
Vanilla essence	-	1 tsp
Maida	-	1/2 cup
Sweet potato flour	-	1/2 cup
Salt	-	A pinch
Chopped walnuts	-	1 cup

Method

Put the butter and dark chocolate in a bowl and melt them over a bigger bowl of boiling water. Allow it to cool slightly. Beat the eggs well. Mix the icing sugar and the vanilla essence. Beat till creamy. Add the cooled chocolate mixture. Sift the maida, sweet potato flour and salt into the chocolate mixture. Fold in the chopped walnuts. Pour out this mixture into a slightly greased baking tin and bake in a moderately hot oven for about 30-40 minutes. When cold, cut into bars and serve.

8. Sweet Malai Kachori

Ingredients

Maida	-	1 cup
Sweet potato flour	-	1 cup
Skimmed milk powder	-	1/2 cup
Chopped almonds	-	2 tabs
Raisins	-	2 tsp
Ghee	-	4 tsp
Cardamon powder	-	1/2 tsp
Saffron	-	1/2 tsp

Method

Make stiff dough by mixing the maida, sweet potato flour, two teaspoons ghee and a little water. Heat two more teaspoons of ghee in a pan, fry khoa till brown. Add almonds, raisins and half the cardamon powder. Mix well and make small balls of the khoa mixture.

Make larger balls of the dough - roll out into puris - place half tsp of the Khoa mixture inside. Close the dough over it. Seal well. Deep fry in oil till golden brown on both sides. Keep aside. Make syrup by boiling sugar and one cup of water together. Add Saffron and remaining cardamon powder.

9. Dilkush sakkarpara

Ingredients

Maida	-	1 cup
Sweet potato flour	-	1 cup
Milk	-	1/2 cup
Sugar	-	1/2 cup
Ghee	-	4 tabs
Sesame seed	-	2 tabs
Oil for deep frying		
For coating		
Water	-	1/4 cup
Sugar	-	1 cup
Lemon juice	-	Few drops

Methods

Warm milk with sugar and ghee. Make tight dough out of flour and sesame seeds with this mixture. Knead well. Make big balls. Roll to 1 mm. thickness. Cut out shapes with tiny biscuit cutters or cut into tiny diamond shapes. Deep fry in ghee to light pink in colour. Melt sugar in water. Add lemon juice. Prepare two thread thick sugar syrup by boiling it. Pour syrup over sweet Dilkhush sakkarparas and mix evenly. Allow to cool.

10. Sweet potato kulkuls

Ingredients

Maida	-	1/4 cup
Sweet potato flour	-	1/4 cup
Butter	-	3 tabs
Rice flour	-	1 tab
Cardamon powder	-	a little
Salt	-	A pinch
Baking powder	-	A pinch
Oil for deep frying		

Method:

In a mixing bowl put the maida, sweet potato flour, baking powder, rice flour, cardamon powder, butter, salt and enough water to make a soft pliable dough. Cover with a wet cloth for sometime. Now take a fork and lightly butter the tins. Take tiny balls of the dough and press one or two on the tins. Press and quickly roll to form curly Kulkuls. Heat the oil in a pan and fry the sweet potato kulkuls in small batches till golden brown.

**DEVELOPING BAKED AND
CONFECTIONERY PRODUCTS
BASED ON SWEET POTATO**

by

ELIZABETH AUGUSTINE

ABSTRACT OF THE THESIS

**SUBMITTED IN PARTIAL FULFILMENT OF
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**DEPARTMENT OF HOME SCIENCE
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ABSTRACT

A study on 'Developing baked and confectionery products based on sweet potato' was conducted with major objective to develop value added baked and confectionery products based on sweet potato flour. The study comprised of standardisation of raw materials, product development, assessing nutritional significance, organoleptic quality studies, preference tests and shelf life studies.

The five baked and five confectionery products were formulated with sweet potato flour as the basic ingredient. Three combinations were tried with different proportions of sweet potato flour. The other ingredients added to sweet potato flour were maida, egg, sugar, ghee and skimmed milk powder. The selection of best combination was based on amino acid scores chemical scores and cost benefit ratio. A combination with 50 per cent sweet potato flour and 50 per cent maida was selected as the ideal combination, since it secured higher amino acid score and chemical score. The cost of the combination was also found to be satisfactory.

The nutritional composition of the food product revealed that the product contained all the nutrients in optimum quantity. The nutritional quality of the developed

food products after processing with reference to calories, proteins, β carotene, calcium, phosphorous and zinc were determined through suitable laboratory techniques. ISI type tests specified to such products were administered to the developed foods and the values were comparable with ISI specification.

Organoleptic studies of the developed food products was assessed by two groups of consumers viz., college students and technical experts. The parameters tested were appearance, colour, flavour, texture and taste. The analysis revealed that both the baked and confectionery products got highest scores. Baked products had a slightly higher mean score, compared to confectionary products.

In the preference tests of the developed products conducted among farm women of Venganoor, Srikariyam and Kaliyoor panchayath and entrepreneurs in Thiruvananthapuram city were also showed the same result.

Moisture and insect infestation were lower in flour stored in glass and plastic containers. Effect of storage on moisture and over all acceptability were revealed that there was an increase in moisture content during the fourth week of storage period.

There was an increase in moisture during storage and the difference was statistically significant. The overall acceptability was found to be decreased after storage. There was no insect infestation in the developed products during the storage period. The assessment of microbiological quality revealed that all the products were attacked by different types of microorganisms.

The result of the present study suggest that new methods of processing could be introduced to add value to the crop and it is possible to develop different types of processed products based on sweet potato products which may result in increased consumption of tuber in the future and also for building up a healthy rural population.

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