FORMULATING FERMENTED CASSAVA FOOD PRODUCTS

SUBTITLE: STANDARDISATION OF GARI

BY

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THESIS

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D E D I C A T E D

T O

M Y P A R E N T S

DECLARATION

I hereby declare that this thesis, entitled "Formulating fermented cassava food products, standardization of gari", is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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CERTIFICATE

Certified that this thesis entitled "Formulating fermented cassava food products, standardization of gari" is a record of research work done independently by Miss C Sathya Lakshmi under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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INTRODUCTION

INTRODUCTION

Cassava is a very important food crop, for millions of people in the world. It is a native of the eastern equatorial region of South America and was cultivated by the Indians in Brazil, Guyana and Mexico before the arrival of the Europeans. Among the miscellaneous food crops of South India, cassava occupies an important place.

In India, the cultivation of cassava is centered around the State of Kerala. Kerala constitute 80 per cent of the total acreage and production of the crop in the country. Ghosh (1984) states that cassava is a poor man's food crop and it is used as a partial substitute for cereals to an extent. Cassava produces four times as much carbohydrates from the same area as rice. The tuber is mainly a carbohydrate food and can be used in place of cereals partly supplementing it with protein. Cassava and fish are the mainstay of the poor people in Kerala State (Cock, 1985).

Cassava is used as a primary and secondary staple food by about one fifth of the world population and mainly by the low income group of the tropical countries. India is the

seventh largest producer of staple food in the world. Currently 250-300 million people in the tropics derive their major calorie intake from cassava. The labour input for the production of calories is also lesser for cassava than for maize and rice, with the result that cassava is the cheapest source of calories for both human nutrition and animal feeding.

Cassava roots deteriorate rapidly after harvest. Deterioration is either physiological or microbiological but the former generally occurs within 48 hrs of harvesting. (Uritani et al. (1982) states that bluish fluorescent phenolic compounds are formed in cassava roots in response to injury. Onwueme (1978) studied the deterioration of cassava tubers within a day or soon after they are harvested, the tubers begins to deteriorate rapidly. They develop bluish discolouration of vascular streaking. Tanaka et al. (1983), studied the post harvest deterioration of cassava roots on a biochemical level by investigating changes in the secondary metabolic and associated enzymes in roots injured by cutting and roots suffering from soft rot.

Cassava's less popularity is also due to the high hydrocyanic acid content. Nambisan et al. (1984) viewed that toxicity can be caused by the prolonged consumption of cassava. When cassava is processed into foodstuff,

this hydrocyanic acid is eliminated. In some cases detoxification is carried out by heating. Some studies indicated that during heating the hydrocyanic acid content of cassava was reduced but not completely removed. The reduction in hydrocyanic acid content was highest in oven drying than sun drying (Paula & Rangel, 1939). From the traditional processing of cassava, the glucoside is eliminated either at the soaking stage or at the heating stage or both. Casadei et al. (1984) suggested that detoxification of bitter variety by sun drying was inadequate because of general food shortage and metabolic detoxification which was reduced owing to the absence of sulphur.

In Asia and Africa, cassava has been traditionally enriched by microbial fermentation. It also completely detoxifies hydrocyanic acid. In Nigeria the effect of cyanide toxicity is counteracted by mixing palmoil and it is interesting that gari a fermented cassava product made by drying the fermented cassava pulp with palmoil which usually does not contain any cyanide.

The process of fermentation is mainly carried out by certain types of bacteria and yeast. Nartey (1981) found out the bacteria involved in the fermentation of cassava roots during gari production and their biochemical relationship with hydrocyanic acid content. They are

discussed with special reference to Pseudomonas sp. As a result of fermentation various changes take place. Fermentation improves the quality of protein and also increases the keeping quality. Fermentation brings a characteristic aroma and taste which is mostly liked by all, especially by children. Gari contains large amount of starch granules and is poorer in amylodextrins (Vignoli and Cristace, 1950). During fermentation free sugars, ash, protein and ether extract might be lost. Dietary fibre is also affected in case of gari and it is also higher than other processed products. Vitamin content of gari is increased because fermentation is carried out by microorganisms. The ascorbic acid content is reduced during the process of fermentation. According to Favier et al. (1971) ascorbic acid content was almost completely lost. Riboflavin was sometimes improved by fermentation. The storage life of cassava is increased by fermentation and gari can be stored for more than three years.

However fermentation studies with local varieties and newly evolved varieties of cassava have not been conducted.

Hence the present study on "Formulating fermented cassava food products" was planned with the following objectives:

1. To assess the hydrocyanic acid content in different varieties of cassava.
2. To standardize the method of preparation of gari with respect to time, variety and pH of the final product.
3. To assess various nutrients such as protein, starch, crude fibre, moisture and ash.
4. To assess the hygienic quality of gari.
5. To standardize different recipes from gari and to popularize the most acceptable product.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Cassava otherwise known as tapioca was the fifth important staple food in the world (Phillips, 1974). Cassava is grown mainly for its tuber used as supplementary food. Cassava's centre of origin is Tropical America but exact time and location of domestation and the direct ancestor were not known. During its evaluation cassava is probably selected for its enlarged tubers, ability to germinate from stem cutting and erect plant type (Jennings, 1976). According to Coursey (1973) in Africa, cassava was used as a food; it was more closely identified as a subsistance crop and he has also stated that an extensive trade in gari exists in Nigeria.

Ghosh (1985) stresses starchy tubers like cassava, potato and sweet potato constitute a substantial part of the agricultural production of developing countries. Cassava is used as a primary and secondary staple by about one fifth of the world population by the low income group of the tropical countries (Padmaja and Swaminathan, 1980). Cassava is grown in about 80 countries, 90 per cent of production comes from 25 countries with four countries accounting for 53.4 per cent of world production (FAO, 1980).

According to Lynam (1978) in Colombia, Brazil and Paraguay, 41 - 52.3 per cent of the land upon which cassava is grown. Phillips (1977) has stated that in Thailand 92 per cent of the land devoted to cassava is located in farms with less than 8 ha total area. In eastern Nigeria a detailed study of three villages showed that 100 per cent of the cassava is produced on farms of total area of 2.4 ha or less. (Lagemann, 1977). Cassava a native of tropical America is cultivated under various conditions of soil and climate throughout the tropics viz., Brazil, West Africa, India, Indonesia and Thailand (Anon, 1973).

Annual production of cassava in India as reported in Agricultural Situation of India (1986) is 5.8 million tonnes of fresh tuber and accounted for 4.5 per cent of the total world production. Cassava production is confined to a few states in the country. Kerala and Tamil Nadu are the major producing states accordingly for 80 per cent and 15 per cent acreage and 70 per cent and 17 per cent of the production respectively (Ghosh, 1984 and Nair, 1978). According to Menon (1980) Kerala accounts for about 75 per cent of the area production for cassava. The agro socio-economic survey conducted by CTCRI around 3000 households residing in Trivandrum rural areas in 1976 indicated that cassava is the major crop raised by them (Ramanathan, 1985).

The Directorate of Economics and Statistics (1985) has stated that production of cassava in Kerala was 39-53 lakh tonnes and the area under production is 2,32,752 hec. The area under cassava production is higher during 1984-85 in Trivandrum followed by Quilon, Kottayam, Pathanamthitta, Idukki, Trichur and Wynad Districts (Agricultural situation in India, 1986). According to Cook (1985) Kerala comes first in India where cassava is used as a dietary component. Phillips, (1974) also supports the view that in Kerala cassava was the most important food next to rice. According to Poulose et al. (1984) the increase in population and decrease in production of rice has made cassava an important food item in Kerala. From the point of view of food energy output versus labour input cassava appears to be very efficient (Chandra et al., 1974).

According to Onwueme (1978) cassava as food, industrial raw material or animal food is important in many tropical countries. Cassava is responsible for the supply of 38 per cent calories in African diets, 12 per cent in Latin American diets and 7 per cent in the diets of Fareast countries (Maharana, 1980). Bernabai (1969) in his study gives a discription of the origin of cassava, its geographical distribution, morphology, industrial application and its

uses as a food stuff in America, Asia and Africa. Toma et al. (1979) have reported that the staple food for Nigerian is Cassava.

Davidson (1980) views that cassava is the main source of food item in Zambia. International Institute of Tropical Agriculture (1981) stresses the importance of cassava in West African diets. Meuser and Smolnik (1980) have reviewed the processing of cassava to gari and other food stuffs. They also state that roots were peeled mechanically and ground to a mash which was fermented anaerobically. Emilia et al. (1979) have stated the uses of cassava, half of the total production of cassava is having used either directly or as dry chips. Yoshi and Garcia (1974) have studied the processing of cassava into fermented foods. Nair (1978) has reviewed the utilisation of cassava in India and according to him, cassava is used as food, as feed stuffs and as industrial raw material for manufacturing starch, dextrin, glucose and alcohol. Moorthy (1984) has shown the industrial uses of cassava as a raw material, for providing animal feed, starch, flour and starch derived products. Manimagalai et al. (1980) reveales that in India cassava is traditionally processed into several products both at home and at an industrial scale.

In Kerala among the roots and tubers cassava is used as a principle source of carbohydrate (Prema, 1980). Dorozynski (1978) has reported that marine production and cassava are the main two food products in Kerala. Analysis of the dietary habits of keralits by Poulose et al. (1984) revealed that 75 per cent of the people in Kerala are regular consumers of cassava and salted fish.

Cassava is mainly grown for its use as supplementary food. It is the only crop which yields more calories of 250,000 cal/ha/day as compared to 876,000 cal by paddy and 1,00,000 cal by wheat (Ketiyal and Dutta, 1976). It has been estimated that the tubers provide 200-1000 cal/day to more than 700 million people in the developing countries (Anon, 1983). Figueiredo and Vitti (1977) have studied the Nitrogen compounds present in cassava and also the carotene content in two varieties of cassava. Lila (1985) has studied the nutritive value of tuber crops and has stated that cassava starch is found to contain 20 per cent amylose and 80 per cent amylopectin and have a digestability of 48 per cent in the raw state. He has also revealed that the protein content of the tuber was meagre. Besides, cassava is found to be rich source of calcium and phosphorus. According to Okigbo (1980)

cassava is very high in carbohydrate and defecient in protein, fat, several vitamins and minerals. Cassava is a rich source of carbohydrate and calcium. However the protein content of cassava is low but the protein contains all the essential amino acids and only fair amount of lysine (Anon., 1975). Mariamm (1980) has reviewed the nutritive value of cassava and has found that among the minerals cassava is a fair source of calcium and phosphorus and little iron. It contains very few vitamins. Raja et al. (1978) views that the starch content in cassava ranged from 78.1 - 90.1 per cent on dry basis. Protein content of cassava is very low being only 1.6 - 2.2 per cent. Meera (1985) also supports this point, cassava is nutritionally very much inferior to other cereals, since cassava flour contains about only one per cent protein. Gomez et al. (1986) has stated that the low concentration of the sulphur containing amino acids and the relative high content of arginine are the common features of all cassava tubers. Bernabai (1969) reported that the incidence of Kwashiorkor in Africa is due to cassava based diets. According to Gopalan (1979) people living on a cassava diet with little of other foods are likely to suffer from protein deficiency. Mata et al. (1982) has reviewed that in Costa Rica cassava consumption contributed little to the protein content of the diet. Davidson (1980) presented

brief information on the incidence of diabetes in Zaie-Zambian border, a predominantly cassava eating zone. He has also stated that over 80 per cent of men and 60 per cent of the women had evidence of malnutrition.

Makene et al. (1972) has suggested that chronic cyanide poisoning is of great importance in areas where cassava constitutes a major portion of the diet. The hydrocyanic acid levels of a number of African cassava based food have given by Oke (1968). Clapp et al. (1966) and Coursey (1973) have stated that the toxicity of cassava was caused by the pressure of cyanogenic glucoside linamarin. Evaluation of 24 varieties of cassava for their hydrocyanic acid content by Dharmalingam et al. (1973) revealed a wide variation ranging from 10 to 55 µg/g of hydrocyanic acid in the fresh and 105 to 375 µg/g in the rind. Wood (1965) gives a value of 25 mg hydrocyanic acid/kg for cassava in Africa. Muthuswamy et al. (1973) conducted a survey in Tamil Nadu and found that hydrocyanic acid content in the tuber was 41.21 ppm, to varietal differences ranged from 5-125 ppm with an average of 41.21 ppm on a fresh weight basis while bitter varieties contained less than 160 ppm on a fresh weight basis (Anon., 1962). Aw-Yong as quoted by

Mahendranathan (1971) stated that the fresh roots of the sweet type contained about 70 ppm, while the bitter type about 200 to 300 ppm. Gopal et al. (1973) reported that the peel had higher levels of hydrocyanic acid than the pulp. Maduagwu et al. (1980) studied the distribution of free hydrocyanic acid in the various particles of gari. Nambisan et al. (1984) viewed that toxicity was caused by a prolonged consumption of cassava. Nartey (1978) has reported that the cyanide in cassava roots and tubers is mainly found in a bound form as a cyanogenic glucoside. Gomez et al. (1983) discovered that processing of cassava roots has led to a rapid conversion of bound cyanide to free cyanide which was then released.

In most traditional practices the enzyme linamarase and glucosidase contained in cassava are brought into contact in cell rupture and the liberated hydrocyanic acid was then released through volatalization or solution in water. Some methods also involves preventation as an initial means of glucoside hydrolysis (Coursey, 1973).

Studies have demonstrated that a relationship exists between iodine deficiency, human consumption of cassava and

endemic goitre and critinism (Ermans et al. (1980) and Delange et al. (1982). Iodine deficiency is a common problem in Brazil and past surveys have shown that goitre is endemic throughout the country (Neto and Dann, 1980). Colinet et al. (1982) have revealed that the consumption of cassava by the pregnant and lactating women resulted in hypothyroidism. Beamiloud et al. (1982) reported the etiological factors for goitre and critinism among them. Cassava is the most important one which cause goitre. Oyelola et al. (1983) has stated that the thiocyanide level of breast milk may be sufficiently high enough to affect the thyroid function of a breast fed infant. Poulose et al.(1984) have reported that the endemity of goitre in Kerala came from Idukki district. But Kochupillai et al. (1976) have stated that endemic goitre is not prevelant in people residing along the coastal areas.

When cassava is processed into foodstuff, not all the cyanogenic glucoside are eliminated. In the absence of β-glucosidase most glucoside is excreted unchanged in the urine and very less from the faeces (Coke and Adewasi, 1981). On the other hand if the amount of cyanide released is minimal then the body has a very efficient system of

detoxification to thiocyanate through the enzyme rhodanase as have been reviewed by Oke (1969). Maduagwu and Oben (1981) have found that inhibition of linamarase activity by 1,5 gluconolactone resulted in a significant lowering of the degradation of linamarin by about 35 per cent in 24 hrs and 65 per cent in 12 hrs. In some cases detoxification is carried out by heating. Paula and Rangel (1939) have reported that cassava containing hydrocyanic acid in the range of 39 ppm is reduced to 17 ppm by sundrying and to 6 ppm by oven drying. The effect of dry heat methods are found to be significantly superior to both steaming and boiling in detoxification of cassava as reported by vimalakumari et al. (1980) while tamarind pulp and lime juice are highly effective in reducing hydrocyanic acid, the addition of papaya also decreased it significantly. Besides this, sugar and honey when added also produced similar results. While Nambisan et al. (1985) stated that baked, fried, and steamed tubers retained maximum cyanogenic glucoside. A study conducted by Prema et al. (1980) among 250 farm families in Trivandrum and Quilon districts revealed that steaming and deep frying methods of cooking were commonly used for preparing cassava.

Casadei et al. (1984) suggested that detoxification of the bitter variety by sun drying was inadequate because of general food shortage and metabolic detoxification which was reduced owing to the absence of sulphur. El. Tinary et al. (1984) studied the extent of loss of hydrocyanic acid during fermentation of cassava tubers.

Fermentation is one of the ancient naturally occuring biotechnology exploited for human welfare as the quest for sofestication of life cycle (Balagopalan, 1985). In Asia and Africa, cassava has been traditionally enriched by microbial fermentation. Studies of Ngoddy (1978) showed that in Nigeria fermented cassava products represent 70 per cent of the cassava consumption. There are a number of fermented cassava products like gari, lafun and fufu.

A study by Levi et al. (1958) showed that gari is a staple food in many parts of West Africa where the traditional method is used for the preparation of gari. The Nigerian Department of Commerce and Industries (1957) revealed the method of making gari research on the fundamental chemical and microbiological characteristics of the fermentation stage during which hydrocyanic acid was released, flavours are developed and the nutritional fortification of gari is also

produced. According to Watts (1980) many gari producing plants were installed in Nigeria because of its worldwide importance. Ayernor (1984) has stated that the gari processing of cassava has been adapted and upgraded in West Africa. The process of gari manufacture from cassava tubers in Nigeria is explained by Naigeon (1984) and Bartsch (1984) explained the steps involved in gari processing. The processing steps are cleaning, control grating, fermentation, garification and drying. Onyekwere et al. (1984) studied the traditional cassava products is west Africa, the traditional processing of gari was also discussed. They also presented the improvement in the industrial level. Olympio (1984) obtained results with the trials for the establishment of a small scale unit for the elaboration of gari preparation . Larty (1984) was also stated that a number of improved small processing equipment and machines which are in use or can be used in Ghana for making gari.

In India much work has not been done on the preparation of gari. A study by Manimagalai et al. (1980) have reported several products of cassava which are traditionally processed at home and at industrial scale. They also revealed the utilisation of cassava as fermented products. Agaba et al.(1979) have stated that cassava fermentation is due mainly to lactic acid bacteria and to a lesser degree Streptococcus sp. are responsible for the acid production and gari flour development.

According to Okafor (1977) the organisms responsible for gari production are Leuconostoc and to a lesser extent yeast. Collard and Levi (1959) have stated that fermentation of cassava takes place in two stages. Cornybacterium manihot breakdown the starch to produce organic acids which therefore decreases the pH and results in the hydrolysis of linamarin yielding gaseous hydrocyanic acid. The production of organic acid has stimulated the growth of a fungus Geotrichum candida which produces the aldehydes and esters responsible for the characteristic flavour of fermented cassava products. Nartey (1981) has found out the bacteria involved in the fermentation of cassava roots during gari production and their biochemical relationship with hydrocyanic acid content are discussed with special reference to Pseudomonas sp.

As a result of fermentation, various changes takes place which was explained by Akinrele (1964) as, fermentation develops a characteristic flavour, lactic acid and formic acids produced from starch, pH of the media fallen up to 4.25. The HCN is liberated. According to Ohochukku et al. (1983) fermentation of cassava roots in cold water usually imports an objectionable odour to the fermented mass. The compounds responsible for this odour are isolated from the acidic fraction are butanoic acid, propionic acid and acetic acid.

Oke (1966) has made a comparision between cassava and gari for various nutrients such as protein, fat, crude fibre, carbohydrate, ash, hydrocyanic acid and energy. He has also stated that the major advantage of gari over cassava is the reduction of hydrocyanic acid content from a lethal dose to a nontoxic level. A comparision between cassava and gari is also made by Vignoli and Cristace (1950). They have concluded that gari was poorer in amylodextrins and had larger starch granules. Gari is similar to cassava flour in its rich cellulose and ash content and weak relationships between sugars resulting from hydrolysis. Harris (1970) has showed that after fermentation typical plant glycolipids are metabolised and replaced by phospholipids. Triglycerides appeared and the sterol glucoside content increased. A study by Abe and Lindsay (1979) have showed that the total free fattyacid content was similar in both mechanically processed gari and the traditional one.

Ahonkhal et al. (1979) have stated that during fermentation a crystalline compound was isolated which is L-mannitol. Longe (1980) explained that during fermentation free sugar, ash, protein and ether extract might be lost. Dietary fibre was also affected. In case of gari fiber was higher than other processed products.

Spickett et al. (1955) have explained that gari contains about a quarter of its starch in a gelatinized form. Perrisse et al. (1956) have explained that vitamin synthesis is increased in gari. They have also reported that gari is more easily hydrolysed than starch or meal and can be stored for a long time in contrast to fresh root. They also explained that gari contains less indigestable carbohydrate than the freshly harvested roots. Federal Institute of Industrial Research (1970) also studied on the total acidity and free starch concentration of gari.

Ketiku and Oyenuga (1973) have stated that during fermentation of cassava to gari a slight decrease in Gross energy from 4.5 - 4.4 k. cal/g is observed. There is also decrease in metabolizable energy from 4.25 k. cal to 3.69 k. cal/g for gari. According to Akinnele (1965) the moisture content of gari and other processed products has been found to change under different humid conditions.

Department of Agricultural Research (1966) analysed the hydrocyanic acid content and the moisture content of gari. Hydrocyanic acid content of gari is found to be less than 0.01 mg/100 g by Cooke (1978). Ogunsua (1980) had reported that when gari is prepared from cassava tubers pH decreased

from the initial 6.2 to 3.4 after 4 days. This finished gari had no hydrocyanic acid. According to Ketiku et al. (1978) the hydrocyanic acid content was reduced during fermentation of cassava. It was reduced from 90.1 mg - 25.8 mg/kg. Olarewaju et al. (1975) stated that all the white gari samples contains hydrocyanic acid content in the range of 20 ppm whereas the yellow samples containing palmoil had practically no hydrocyanic acid. Maduagwu (1979) has estimated hydrocyanic acid content in 500 samples of gari. Most sample contained detectable amounts ranging from 0.8 - 3.8 mg/kg. Only 0.4 per cent contained no cyanide. Meuser et al. (1980) have stated that hydrocyanic acid content was less than 10 ppm and moisture content less than 12 per cent. Wood (1965) has shown that hydrocyanic acid was liberated from the ground tissues by autolysis. Oke (1968) explained that hydrocyanic acid content was reduced in gari during fermentation.

According to Etejere et al. (1985) detoxification of fresh cassava roots was partially achieved through cell rupture during cutting, grating, soaking, and standing in earthern pots for 3-5 days, heating, drying and boiling. Ikediobi et al. (1982) reported that the addition of exogenous linamarase detoxified cassava more rapidly after 24 hrs of fermentation. Obigbesan et al. (1980) have stated that

there was practically no difference in the hydrocyanic acid content of gari prepared from sweet and bitter cassava varieties. Maduagwu et al. (1981) have stated that the loss of hydrocyanic acid from grated cassava roots selected from both bitter and sweet variety was similar.

Ogunsua et al. (1979) have explained that during fermentation the ascorbic acid content was reduced. There was a conversion of large part of the ascorbic acid to dehydro ascorbic acid during the process. According to Favier et al. (1971) ascorbic acid content was almost completely lost.

Riboflavin was sometimes improved by fermentation and Ankrah (1972) has stated that the level of riboflavin remained almost unchanged over four days of fermentation. McDowell et al. (1983) have reported that Beta carotene was less in white gari compared to yellow gari. Data showed that Beta carotene content vary from 0.01 mg/100 g in white gari to 1.13 mg/100 g in yellow gari, the corresponding vitamin A content were 17 and ·833 IU/100g.

Phillips et al. (1959) have stated that protein deficiency was seen in West African parts due to less protein content of gari which was their staple.

Oyenirun (1981) has stated that if the gari contained high moisture content it is contaminated by mould such as Aspergillus, Mucor and Pencillium during storage. According to Adenkule et al. (1974) gari was contaminated by Aspergillus, Pencillium and Cladosporium. Many of the isolated species were shown to have toxigenic potentiality in rats. Ekundayo (1984) has stated that the spoilage of packaged gari in storage for 10 weeks were studied. The microbial flora of freshly roasted gari consisted initially of Psedomonas sp., Bacillus, Pencillium, Aspergillus, Saccharomyces sp. After storage at 15-21°C the micro organism present consists of all the sp. occuring in fresh gari and in addition Candida and Geotrichum.

Perrisse et al. (1956) have shown that gari seems to be the best form of consuming cassava. Ndiokwere (1984) had stated the crude protein content and minerals for various Nigerian foodstuffs. The protein content of cassava and its products varied from 1.46 - 2.73 per cent.

Prema et al. (1982) have revealed, the recipies from cassava and a detailed survey was also conducted. It was found that there exists a lack of ability to innovate new recipies therefore lab experiments were conducted with cassava substituting potato in well known Indian preparation. Palomer et al. (1980) have stated that cassava and sweet potato flour were processed and used to substitute wheat flour from the 20 to 100 per cent level in some bread. Based on cost analysis root crop flour is a good substitute for wheat flour. Yoshi and Garcia (1974) have studied the processing of cassava into fermented foods. The suitability of cassava as a substitute in making putu was investigated upto 50 per cent substitution. A study by Suzuki et al. (1981) have revealed that rats fed with cassava starch with soybean protein diet shown a positive calcium balance and higher haemoglobin values. Collins et al. (1981) stated that soyflour increased the chemical score of the essential amino acids of cassava but the EAA composition was still below than the FAO interferance protein. A study by Ojofeitimi (1977) has stated that rats were used to assess the nutritive value of cassava gari plantain and yam flour supplemented with cotton seed flour and defatted soyflour. The nutritive quality of the staple foods was greatly

improved by supplementation. Adeyanju (1979) revealed that increased economic benefits were obtained by increasing fermented cassava in the ration of sheep compared with the control. Ofosu (1977) has reported that the product standardization of gari may be based on certain characters such as moisture content, particle size, swelling capacity, hydrocyanic acid content and acidity.

MATERIALS AND METHODS

MATERIALS AND METHODS

The study on formulating fermented cassava food products was based on the following assessments,

1. Estimation of hydrocyanic acid content in different varieties of cassava.

2. Standardization of the method of preparation of gari with respect to time, variety and pH of the final product.

3. Determination of nutrients such as protein, starch, crude fibre, moisture and ash in raw cassava and gari prepared from them.

4. Estimation of hydrocyanic acid in gari prepared at different time intervals.

5. Hygienic quality of gari.

6. Standardization of different recipes from gari and to popularize the most acceptable product.

1. Hydrocyanic acid content in different varieties of cassava.

Different locally available popular varieties of cassava tubers which are rich in hydrocyanic acid were selected for the study. These varieties were analysed for

the hydrocyanic acid content using the method of Indira and Sinha (1969), details of which are presented in Appendix I.

The different varieties of cassava selected for hydrocyanic acid estimations were as follows.

i. Manihot esculenta crantz variety-M_4
ii. Manihot esculenta crantz variety-H_{165}
iii. Manihot esculenta crantz variety-Kalikalan
iv. Manihot esculenta crantz variety-Panniyur
v. Manihot esculenta crantz variety-Nyarukku
vi. Manihot esculenta crantz variety-Pravuvella

2. Standardization of method of preparation of gari with respect to time, variety and pH of the final product.

The selected varieties were used for the preparation of gari. Two varieties such as M_4 and Kalikalan were selected from the six varieties for the study because of the following criteria.

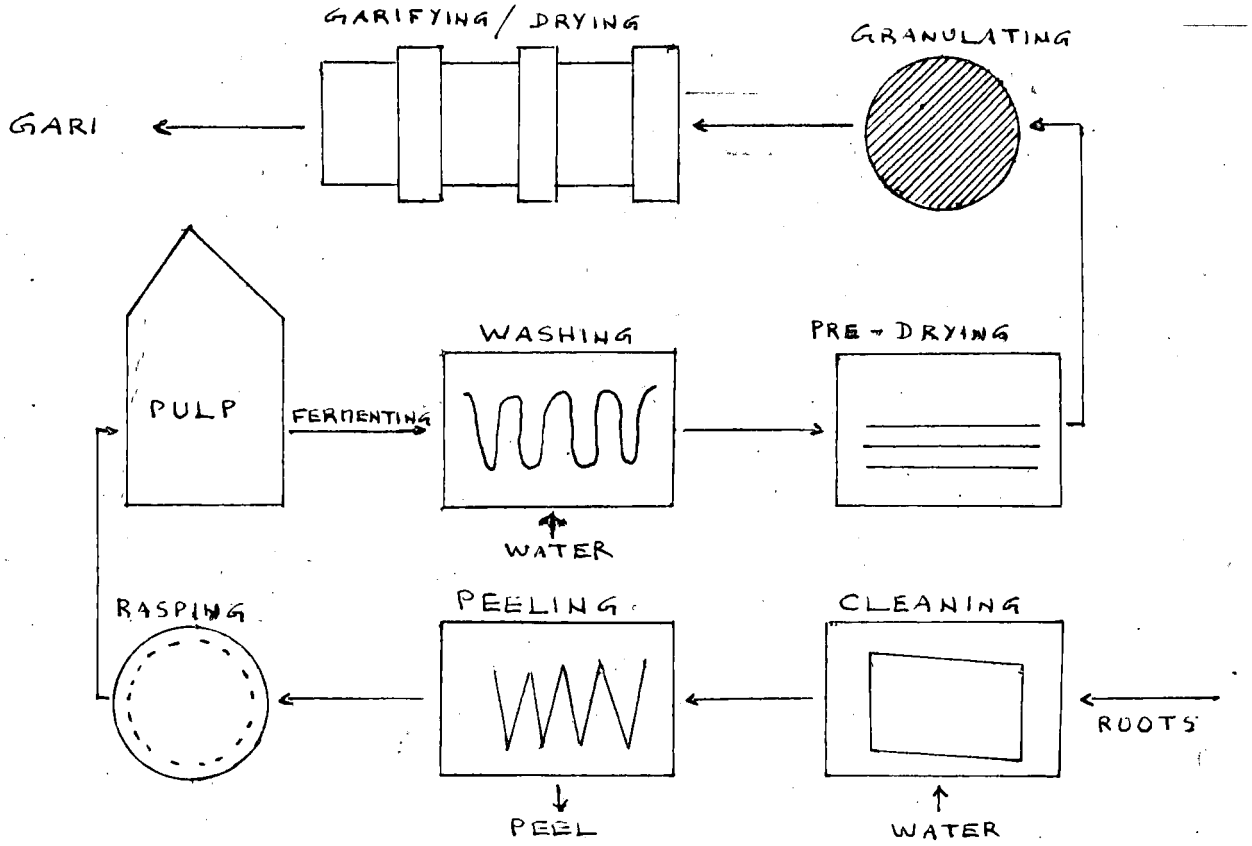
i. Locally available
ii. Having high hydrocyanic acid content

Method of gari preparation was standardized with respect to yield, time of fermentation and pH level. Gari was prepared at different times such as 12, 24, 36, 48, 60, 72, 84 and 96 hours of fermentation.

Preparation of gari consisted of different steps (Fig.1) such as peeling, grating, pressing, fermentation, drying, frying and sifting of the final product (Oke, 1973).

Tubers without any wound or damage were selected. Both the outer and inner skin were removed from the roots. The peeling normally resulted in a loss of 13-20 per cent of the original weight. The peeled tubers were grated and the mass was left for fermentation (Fig.2) for about 3 to 4 days. During the fermentation process the contents were wrapped in thick cloth (Fig.3). A heavy stone was placed on top of the cloth bundle. This step helped to eliminate the liquid. The extruded juice which contained most of the cyanogenic glucoside were discarded. The content was dried (Fig.4) for two days. The dried products were then fried in iron pan. The end product (Fig.5) was granular, free flowing and had slight sour odour.

FIG. 1.



STEPS FOR PREPARATION OF GARI.

FIG. 4. FERMENTED CASSAVA KEPT FOR DRYING

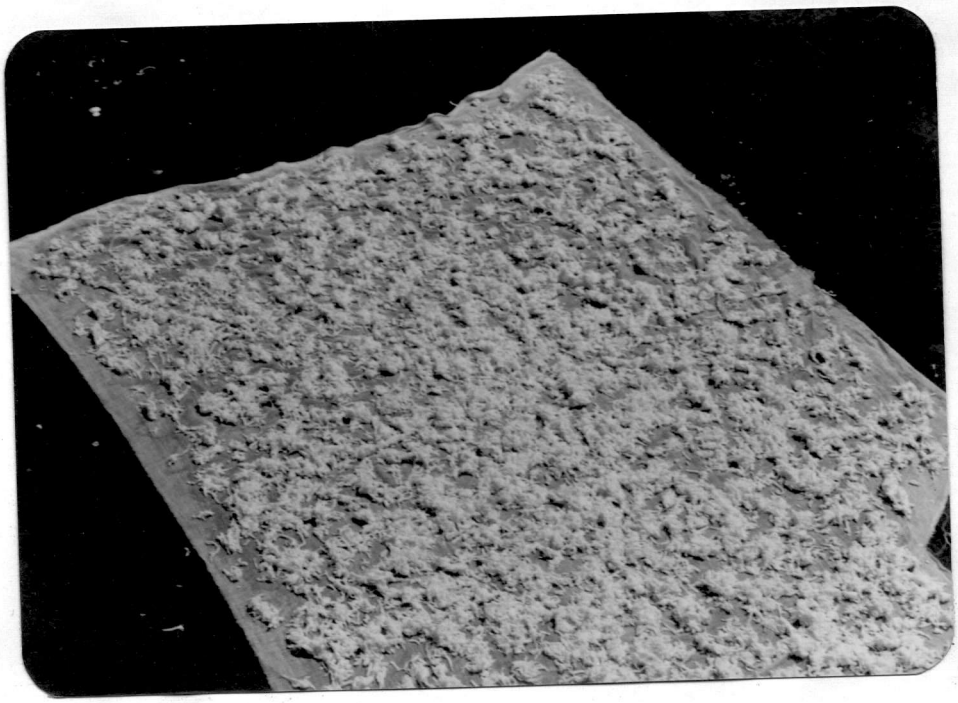


FIG. 5. GARI-THE END PRODUCT

FIG. 2. CASSAVA KEPT FOR FERMENTATION

FIG. 3. FERMENTED CASSAVA WRAPPED IN THICK CLOTH

pH was estimated by using pH meter at different times. (method given in Appendix II). Yield of the product was the main criteria for the selection of optimum method.

3. Estimation of various nutrients such as protein, starch, crude fibre, moisture and ash in cassava and in final product, gari.

Estimation of various nutrients for the two varieties M_4 and Kalikalan and also in gari prepared from these varieties with different times of fermentation such as 12, 24, 36, 48, 60, 72, 84 and 96 hours. Protein estimation was carried out by Macro kjeldahl method reported by Hawk and Oser (1965) (method given in Appendix III).

Samples were analysed for starch by the method reported by Aminoff et al. (1970) (method given in Appendix IV).

The samples were analysed for crude fibre by the method of Chopra and Kanwar (1978) (method given in Appendix V).

Samples were analysed for ash content using the procedure of Chopra and Kanwar (1978) (method given in Appendix VI).

Moisture estimation was done in hot air oven (method given in Appendix VII).

4. Estimation of hydrocyanic acid in gari prepared at different time intervals.

Gari samples were analysed for the hydrocyanic acid content using the method of Indira and Sinha (1969) (method given in Appendix I).

5. Hygienic quality of gari.

Microbial analysis was done for fresh gari and for gari stored for 6 months and 12 months. The shelf life study on gari was conducted due to following reasons.

i. No previous study has been conducted on the keeping quality of gari for a period of one year.

ii. To find out the keeping quality of gari in tin containers.

Hygienic quality of any food product can be tested by analysing the presence of coliform bacteria. So the hygienic quality of the prepared gari was tested by microbial assay (method given in Appendix VIII).

6. Standardization of different recipes from gari and popularizing the most acceptable product.

Standardization of recipes are essential to strive for the same high quality, everytime a product is stored (Crusius, 1984). As a first step, source of recipes such as journals, magazines etc., were referred and recipe which seemed correct and practical in method and proportion was selected. One important factor considered was suitability for clientle. This was determined by cost and the amount and kind of labour involved in the preparation of recipe. The recipes tried in the laboratory are given in Appendix IX.

Present trial recipes were selected because of the following reasons.

i. Economically, the selected recipes were within the range of all clientle. These recipes were prepared by using low cost ingredients and when compared with the same recipe prepared with wheat flour, the total cost was very less.

ii. The technology to be transferred was simple and appropriate. The preparation of different recipes required only less labour and can be easily popularized because only ordinary cooking methods such as frying, roasting etc., were used for the preparation of recipes.

iii. The ingredients used in the recipes were locally available and commonly used by all.

The modified recipes were tested several times at the laboratory level. The trials were repeated several times until satisfactory results were obtained. After obtaining satisfactory results acceptability of these food preparations made from gari was tested by administring the triangle test. Members of the taste panel were selected from a group of 30 healthy women in the age group of 19-30.

The score cards for assigning mark for the recipes were developed. Details of triangle test and evaluation card for the triangle test are presented in Appendix X. From the thirty women who participated in the triangle test, ten women were selected as judges for the present acceptability trials.

The acceptability trials on the panel members were done using the scoring method. A score card developed to assess the acceptability of the recipe is presented in Appendix XI.

Major quality attributes included in the score card were appearance, flavour, texture, taste and overall acceptability on a five point Hedonic Scale. Each of the above mentioned quality was assessed by a five point rating scale. The judges were requested to take the second sample after washing their mouths. Each quality was assessed by the panel members after testing the same sample several time, if needed. The panel members were permited to take their own time and judge the samples leisurely. The testing was conducted in the afternoon between 3-4 p.m. since this time was considered as the ideal time for conducting the acceptability studies (Swaminathan, 1974). The panel members were requested to give scoring based on two sets of response, the first giving preference ranks and its second on assessment of secondary qualities.

The recipes which got the maximum score in the laboratory trials were selected to conduct field trials.

Selection of Villages:

Villages listed below were selected for the study.

i) Kalliyoor in Nemom block.

ii) Venganoor in Athiyannoor block.

iii) Vizhinjam in Athiyannoor block

iv) Ullur in Trivandrum rural block.

v) Vattiyoorkavu in Trivandrum rural block.

Reasons for selecting the Villages:

i) The present technology needs constant monitoring and feed back. Hence acceptability to the areas was an important factor.

ii) N.E.S. blocks, Athiyannoor and Trivandrum rural are the adopted blocks of the Kerala Agricultural University for the conduct of Home Science education as well as for other extension education programme of the University. A good rapport had already been established through several extension education programmes.

iii) The rural women need expertise at their door steps and such facilities could be extended by the University only in the adopted areas at present.

iv) Development programmes should not aim as being ends in themselves instead, they should bring out the leadership qualities inherent in the women, so that they will act as key communicators, for the continuation of the programmes. Projects with these objectives can be implemented by the University only in the adopted areas.

Popularizing fermented cassava products

Conduct of demonstration

Before the conduct of the demonstration education classes, fermented cassava products were taken to the rural mothers. Demonstrations were arranged through the presidents of the local Mahilasamajam of the particular five villages. Approximately 30 women from each village participated in the demonstrations. The preparation of the food products from gari such as diamond cuts, orotti and pakkoda were demonstrated among the women. After the preparation of the products the women were permitted to taste the products (Fig. 6) and they were persuaded to give their views. The opinion of the women were recorded in the score card by the investigator. Care was taken to avoid discussions among women about their views.

FIG. 6. ACCEPTABILITY TRIAL FOR WOMEN IN THE FIELD

RESULTS

RESULTS

A study was conducted to formulate fermented cassava food products. The results of the study are presented and discussed under the following headings.

1. Hydrocyanic acid content in different varieties of cassava.

2. Standardization of the method of preparation of gari with respect to time, variety and yield of the final product.

3. Estimation of various nutrients such as protein, starch, crudefibre, moisture, pH and ash and comparison of hydrocyanic acid in gari and cassava.

4. Hygienic quality of gari.

5. Standardization of different recipes from gari and popularizing the most acceptable product.

1. Hydrocyanic acid content in different varieties of cassava.

Hydrocyanic acid content in different varieties of cassava is presented in table 1.

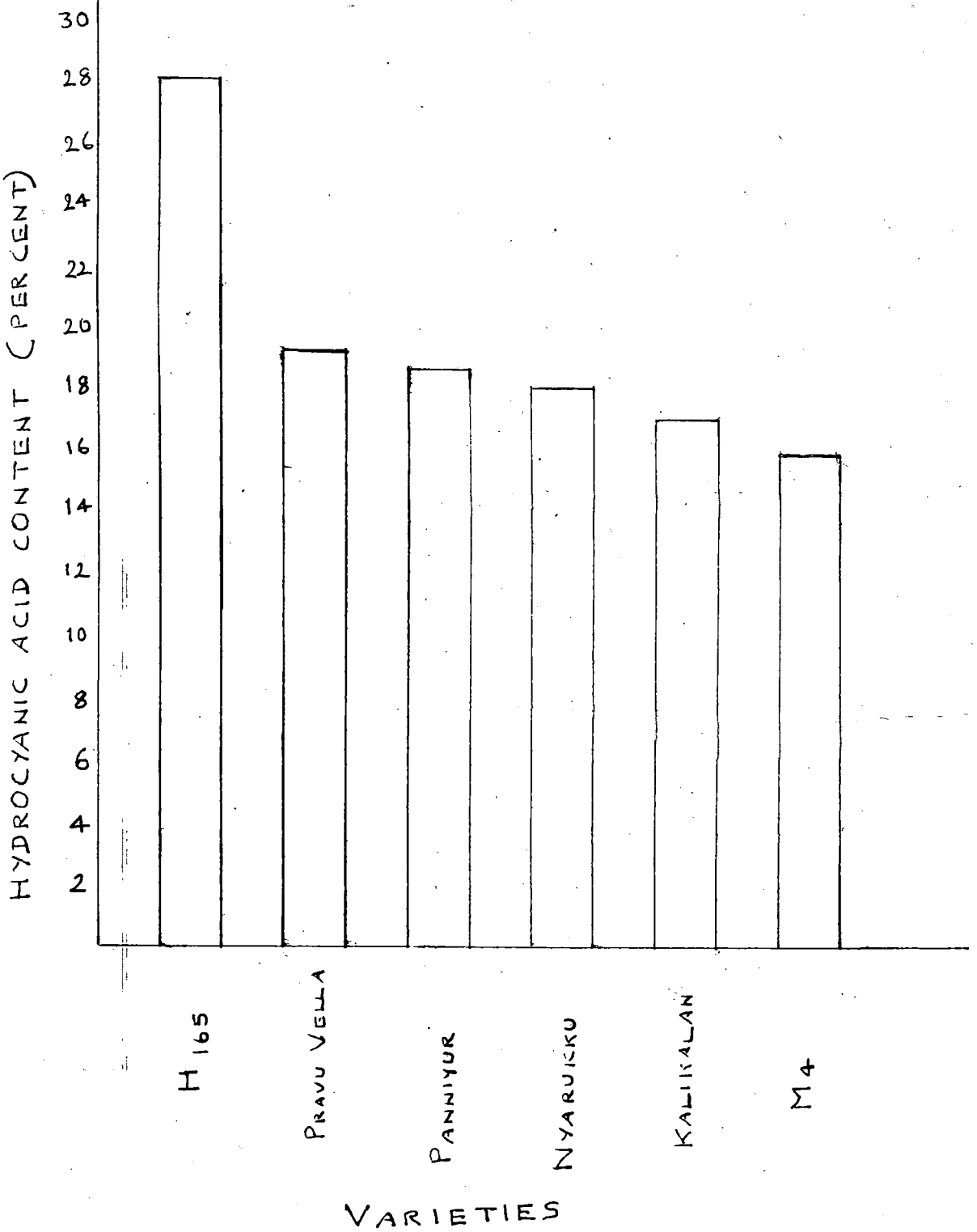
Table 1

Hydrocyanic acid content in different varieties of cassava

Variety	HCN content (mg per cent)
H_{165}	28.1
Kalikalan	17.34
M_4	15.81
Nyarukku	17.63
Panniyur	18.29
Pravuvella	18.58

As indicated in table 1, the variety H_{165} had maximum hydrocyanic acid content of 28.1 per cent and M_4 contained least amount of hydrocyanic acid. Other three varieties contained hydrocyanic acid in between H_{165} and M_4 (Fig.7).

FIG. 7.



HYDROCYANIC ACID CONTENT IN DIFFERENT VARIETIES OF CASSAVA.

2. Standardization of the method of preparation of gari with respect to time, variety and yield of the final product.

The yield of gari from different varieties of cassava is presented in table 2.

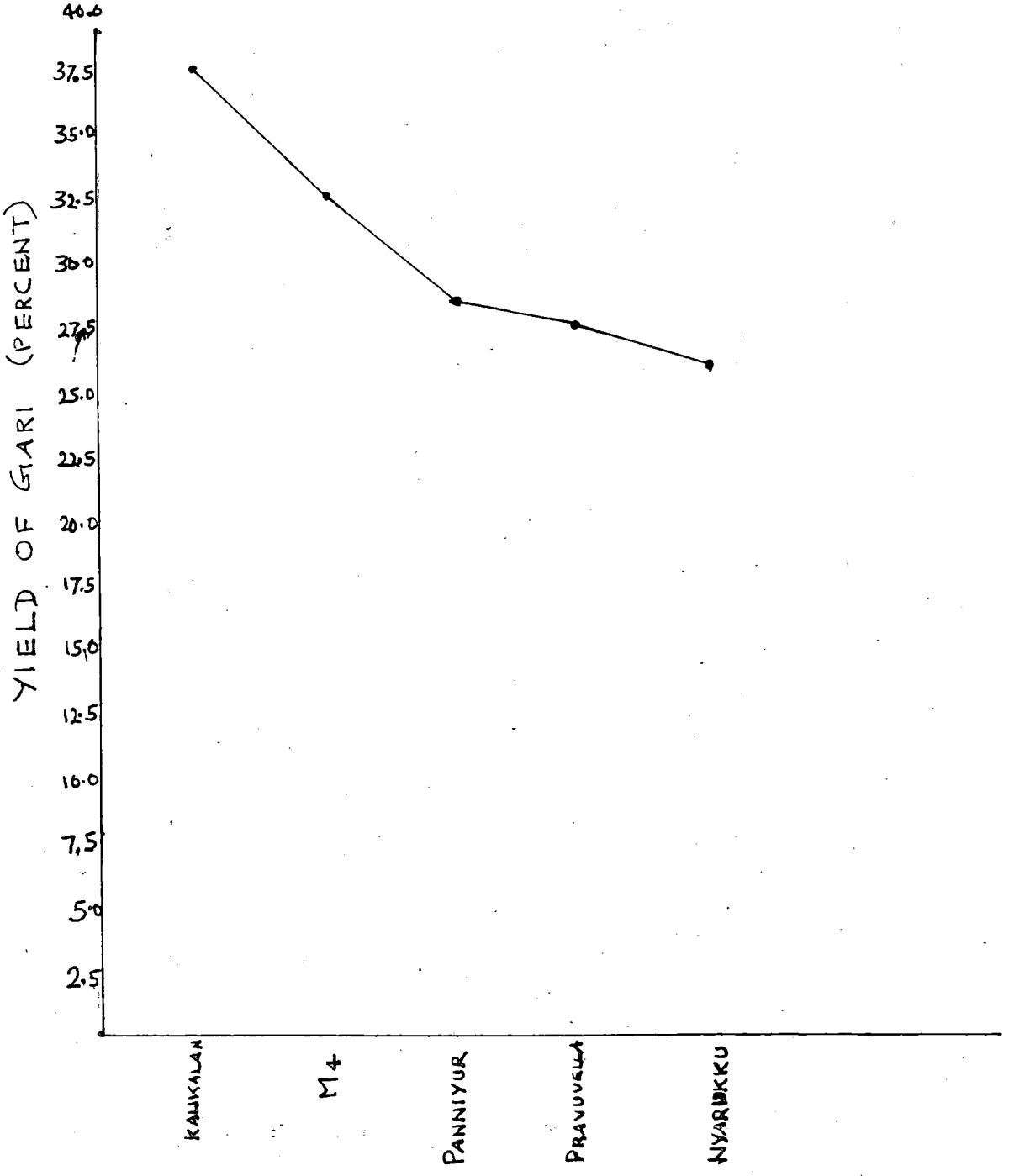
Table 2

Yield of gari from different varieties of cassava

Variety	Weight of cassava (g)	Weight of gari(g)	Per cent
Kalikalan	200	75	37.5
M_4	200	65	32.5
Panniyur	200	57	28.5
Nyarukku	200	52	26.0
Pravuvella	200	55	27.5

Table 2 indicates that the yield of gari was higher in case of kalikalan (37.5 per cent) (Fig.8). Next comes M_4 variety (32.5 per cent). M_4 variety is used common in Kerala and yield of gari was also comparatively higher. Hence kalikalan and M_4 were selected for the study.

FIG. 8.



YIELD OF GARI FROM DIFFERENT VARIETIES OF CASSAVA

The yield of gari from kalikalan and M_4 at different time intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours of fermentation are determined and presented in table 3.

Table 3

Yield of gari from kalikalan and M_4

Time interval (hours)	Weight of raw cassava (g)	Weight of gari (M_4) in g	Per cent	Weight of gari(kalikalan) in g	Per cent
12	2000	613	30.6	691	34.5
24	2000	570	28.5	644	32.2
36	2000	537	26.8	593	29.6
48	2000	524	26.2	574	28.7
60	2000	627	31.4	700	35.0
72	2000	650	32.5	750	37.5
84	2000	623	31.1	711	35.5
96	2000	610	30.5	683	34.1

As revealed in table 3, the yield of gari was higher at 72 hours of fermentation and after 72 hours

it decreased upto 96 hours. Compared to M_4, the yield of gari from kalikalan was higher at different time intervals.

3. Estimation of various nutrients such as protein, starch, crudefibre, moisture, pH and ash of cassava as well as gari.

The protein content of cassava and gari prepared from M_4 and kalikalan at different time intervals is presented in table 4.

Table 4

Protein content of cassava and gari (M_4 and kalikalan)

Time interval (hours)	Protein content	
	M_4 g/100 g	Kalikalan g/100 g
Cassava	2.6	1.6
Gari		
12	2.0	1.0
24	1.8	0.8
36	1.6	0.7
48	1.5	0.5
60	1.3	0.3
72	1.3	0.3
84	1.2	0.3
96	1.0	0.2

CD value (.05): 0.4293

As revealed in the table, the protein content of raw cassava was as high as 2.6 per cent. But due to fermentation, the protein content of cassava was decreased and attained a minimum of 1.0 per cent.

The protein content of kalikalan was 1.6 per cent which was higher than gari prepared from it. The protein content of gari was inversely proportional to the time taken for fermentation.

The starch content of the cassava and gari prepared from M_4 and kalikalan at different time intervals is presented in table 5.

Table 5

Starch content of cassava and gari (M_4 and kalikalan)

Time interval (hours)	Starch content	
	M_4 (per cent	Kalikalan (per cent)
Cassava	61.14	65.84
Gari		
12	44.27	45.85
24	43.16	44.27
36	41.42	43.16
48	40.12	41.75
60	39.50	40.75
72	38.90	40.12
84	38.00	39.50
96	37.22	38.83

CD value (.05): 1.189

Table 5 revealed that the starch content of raw cassava was higher. Starch content decreased due to fermentation and the time of fermentation.

Likewise starch content of raw kalikalan was higher (65.84 per cent). It was decreased to a minimum of 38.83 per cent as the time of fermentation increased.

Between the two varieties the starch content of kalikalan was higher than the starch content of M_4. Likewise, the starch content of gari prepared from kalikalan was higher than gari prepared from M_4.

The crudefibre content of the cassava and gari prepared from M_4 and kalikalan at different time intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours is presented in table 6.

Table 6

Crudefibre content of cassava and gari (M_4 and kalikalan)

Time interval (hours)	Crudefibre	
	M_4 (g/100 g)	Kalikalan (g/100 g)
Cassava	0.2	0.6
Gari		
12	1.0	1.0
24	1.0	1.2
36	1.6	2.0
48	1.8	2.2
60	2.0	2.6
72	2.0	2.8
84	3.0	3.0
96	3.4	3.6

CD(0.05): 0.3373

Table 6 denotes that crude fibre content of cassava (M_4) was increased from 0.2 to 3.4 during the process of fermentation. According to the increase in time of fermentation the crudefibre content was also increased.

Same results were observed for kalikalan also. The crudefibre content increased due to fermentation. As the time of fermentation increased the crudefibre content also increased to a maximum of 3.6 per cent.

When compared the two varieties viz., M_4 and kalikalan, kalikalan contained higher amount of crudefibre. Likewise gari from kalikalan contained a higher amount of crudefibre than gari from M_4.

Table 7 indicates the ash content of cassava and gari prepared at different time intervals.

Table 7

Ash content of cassava and gari (M_4 and kalikalan)

Time interval (hours)	Ash content	
	M_4 (per cent)	Kalikalan (per cent)
Cassava	2.38	2.32
Gari		
12	1.00	0.80
24	1.00	1.00
36	1.04	1.02
48	1.06	1.04
60	1.10	1.08
72	1.20	1.20
84	1.24	1.22
96	1.28	1.26

CD value (0.05): 0.1563

As revealed in the above table, the ash content was decreased due to fermentation. Cassava contained 2.38 per cent of ash. It was decreased to a minimum of 1.0 per cent at 12 hours of fermentation and after that as the fermentation hours increased the ash content was also increased.

The ash content of kalikalan was higher (2.32 per cent). At the time of fermentation the ash content was decreased to 0.8 per cent at 12 hours of fermentation and then it was increased to a maximum of 1.26 per cent.

The table reveals that the ash content was higher in the variety M_4 than kalikalan. Likewise ash content of gari from M_4 was higher than kalikalan.

Table 8 indicates the moisture content of cassava and gari prepared at different time intervals.

Table 8

Moisture content of cassava and gari (M_4 and kalikalan)

Time interval (hours)	Moisture	
	M_4 (per cent)	Kalikalan (per cent)
Cassava	52	48
Gari		
12	14	14
24	14	14
36	14	14
48	12	14
60	12	14
72	12	12
84	12	12
96	12	12

CD value (0.05): 2.137

Table 8 indicates that the moisture content was maximum for raw cassava. Due to fermentation and drying the moisture content was decreased. It was least for the gari at 48, 60 and 72 hours.

The moisture content of kalikalan was higher (48 per cent) at raw stage. It was decreased during fermentation. The moisture content was least at 72, 84 and 96 hours.

It was clear that the moisture content of cassava was higher for both varieties. There was not much difference in moisture content of gari prepared from these varieties.

Table 9 indicates the pH of cassava and gari prepared from M_4 and kalikalan at different time intervals.

Table 9

pH of cassava and gari (M_4 and kalikalan)

Time interval (hours)	pH	
	M_4	Kalikalan
Cassava	7.0	6.2
Gari		
12	4.6	4.1
24	4.5	4.0
36	4.4	4.0
48	4.3	4.0
60	4.5	3.6
72	4.5	3.4
84	4.6	3.4
96	4.9	3.4

CD value (.05): 0.364

Initially cassava had a pH of 7.0 that is neutral. Due to fermentation the acidity increased and the pH attained a minimum of 4.3 at 48 and then increased to 4.9 at 96 hours of fermentation.

Acidity was increased and gari had a pH of 4.1 at 12 hours of fermentation for kalikalan. The acidity increased to a maximum of 3.4 upto 96 hours of fermentation.

The hydrocyanic acid content of cassava and gari prepared from both kalikalan and M_4 is presented in table 10.

Table 10

Comparison of hydrocyanic acid in cassava and gari

Sample	Hydrocyanic acid mg (per cent)
Cassava (M_4)	15.81
Gari (M_4)	0
Cassava (kalikalan)	17.34
Gari (kalikalan)	0

From the above table it was clear that due to fermentation the hydrocyanic acid content was reduced. Hydrocyanic acid was not present in gari prepared from both M_4 and kalikalan varieties.

4. Hygienic quality of gari.

The hygienic quality of gari was tested by presumptive test for Coliform bacteria.

Table 11

Hygienic quality of gari

Sample	Presence of *E.coli*
Fresh gari	Nil
6 months old gari	Nil
12 months old gari	Nil

From table 11, it was revealed that there was no growth of E.coli upto 1 year old gari. The sample of gari was free of coliform bacteria.

5. Standardization of different recipes from gari and to popularize the most acceptable product.

Different recipes such as pakkoda, orotti, diamond cuts, gari balls and laddu are prepared in the laboratory and preference of the panel members for these different recipes are tested and the results are given in table 12.

Table 12

Preference of panel members for different recipes from gari N*= 10 (per cent)

Criteria	Pakkoda	Orotti	Diamond cuts	Gari balls	Laddu
Highly acceptable	50	60	70	15	—
Acceptable	30	20	20	10	5
Slightly acceptable	20	20	10	10	15
Slightly unacceptable	—	—	—	15	15
Unacceptable	—	—	—	50	65

* Number of panel members

As revealed in table 12, the recipes from gari are found to be highly acceptable among 50-70 per cent of the panel members.

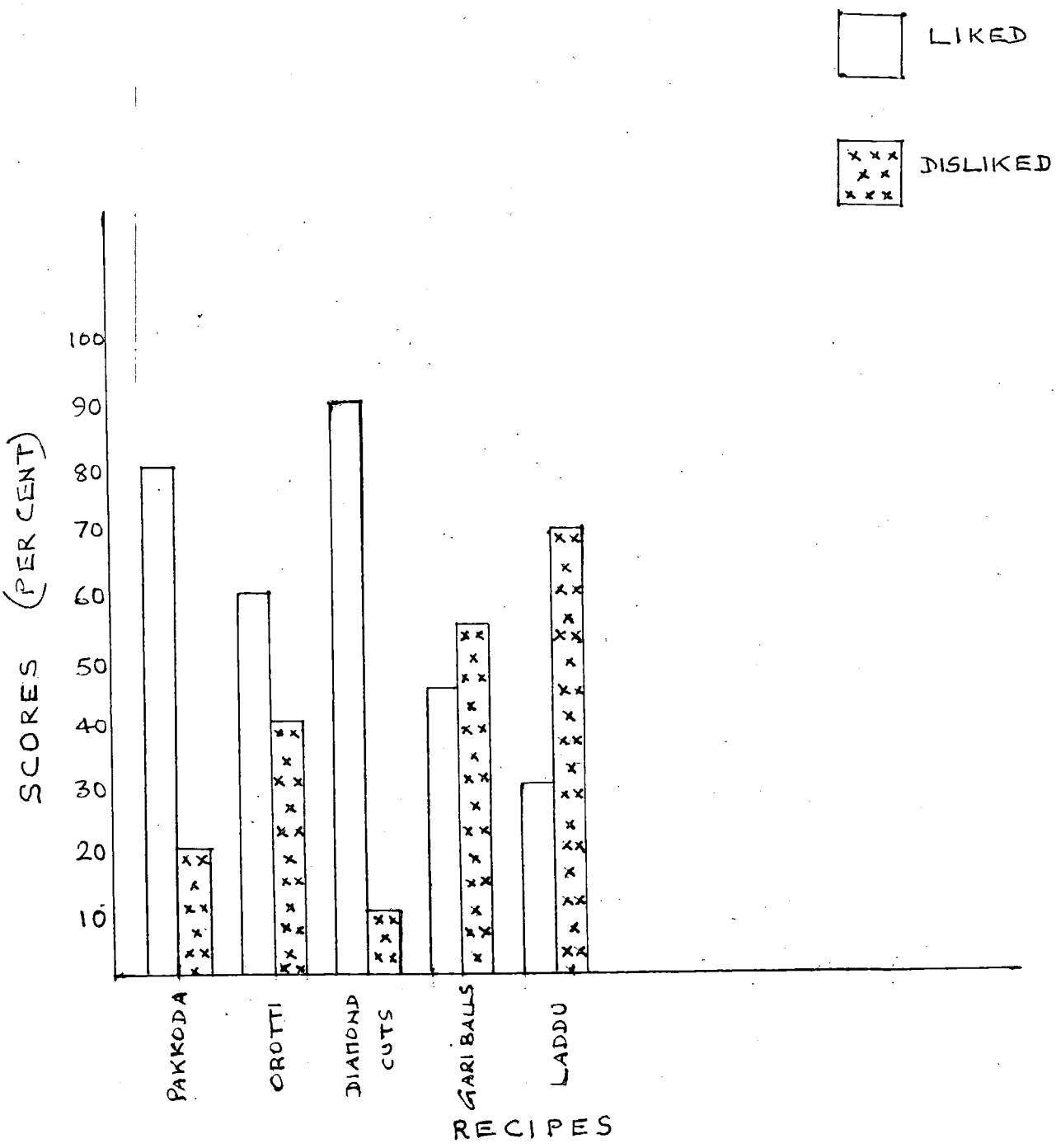
Acceptability trials of the recipes are conducted at the laboratory level with the help of panel members and the results are presented in table 13.

Table 13

Acceptability trial of recipes at the laboratory level

Recipes	Laboratory level	
	Liked (per cent)	Disliked (per cent)
Pakkoda	80	20
Orotti	60	40
Diamond cuts	90	10
Gari balls	45	55
Laddu	30	70

FIG. 9.



ACCEPTABILITY TRIAL OF RECIPES AT THE LABORATORY LEVEL

From the above table it was clear that all the recipes tested were found to be acceptable for all the panel members in the laboratory level (Fig. 9).

Table 14 denotes the scores obtained for appearance.

Table 14

Preference of panel members for appearance (per cent)

Criteria	Pakkoda	Orotti	Diamond cuts	Gari balls	Laddu
Very good	--	80	80	--	--
Good	70	20	20	--	--
Fair	30	--	--	50	--
Poor	--	--	--	40	80
Very poor	--	--	--	10	20

From table 14, it was revealed that the preparations made using fat as the cooking medium was better than those made in sugar medium.

Preference of the panel members for flavour for different recipes was ascertained and results are given in table 15.

Table 15

Preference of panel members for flavour (per cent)

Criteria	Pakkoda	Orotti	Diamond cuts	Gari balls	Laddu
Very pleasant	--	80	35	--	--
Pleasant	80	20	65	--	--
Neither pleasant nor unpleasant	20	--	--	--	20
Unpleasant	--	--	--	25	40
Not at all pleasant	--	--	--	75	40

From the table 15, it was concluded that preparations made with fat as cooking medium was better in flavour than those made in sugar medium.

Preference of the panel members for texture for different recipes were tested and results are given in table 16.

Table 16

Preference of the panel members for texture (per cent)

Criteria	Pakkoda	Orotti	Diamond cuts	Gari balls	Laddu
Very good	40	55	85	—	—
Good	10	45	10	—	—
Fair	50	—	5	40	—
Poor	—	—	—	60	75
Very poor	—	—	—	—	25

As revealed in table 16, texture of gari preparations in the medium of fat was better than those made in the sugar medium.

Preference of the panel members for taste for different recipes were tested and the results are given in table 17.

Table 17

Preference of panel members for taste (per cent)

Criteria	Pakkoda	Orotti	Diamond cuts	Gari balls	Laddu
Excellent	--	60	60	--	--
Very good	65	35	35	--	--
Good	35	5	5	50	--
Fair	--	--	--	50	55
Poor	--	--	--	--	45

From table 17, it was revealed that preparations using fat was more acceptable than those prepared in sugar medium as far as taste is concerned.

Table 18 denotes the average scores obtained for pakkoda, orotti, diamond cuts, gari balls and laddu at the laboratory level.

Table 18

Average scores obtained for the recipes in the laboratory level (per cent)

Criteria	Pakkoda	Orotti	Diamond cuts	Gari balls	Laddu
Appearance	74	96	96	48	36
Flavour	76	96	87	25	36
Texture	78	91	96	48	35
Taste	73	93	93	50	31
Overall acceptability	86	82	92	45	32

Table 18 explains that diamond cuts are highly acceptable by more than 90 per cent of the members. Pakkoda, Orotti and Diamond cuts attained maximum scores in the laboratory level.

Statistical analysis of the result obtained from the five recipes at the laboratory level is presented in table 19.

Table 19

Statistical analysis of the recipes at laboratory level

Recipe	1 vs 2	1 vs 3	1 vs 4	1 vs 5	2 vs 3
t value	0.27	0.81	3.22**	12.5**	0.53

Recipe	2 vs 4	2 vs 5	3 vs 4	3 vs 5	4 vs 5
t value	3.33**	5.78**	3.66**	6.22**	0.87

** Significant at 1 per cent level.

Statistical analysis reveals that there was no significant difference between the first three recipes viz., pakkoda, orotti and diamond cuts. Likewise there was no significant difference between gari balls and laddu. But there was significant difference between first three recipes and the last two ones.

Positive approach of the panel members for the recipes are presented in table 20.

Table 20

Positive approach of the panel members towards the recipes (per cent)

Recipes	Appearance		Flavour		Texture		Taste		Overall acceptability	
	Very good	Good	Very pleasant	Pleasant	Very good	Good	Excellent	Very good	Highly acceptable	Acceptable
Pakkoda	--	70	--	80	40	10	--	65	50	30
Orotti	80	20	80	20	55	45	60	35	60	20
Diamond cuts	80	20	35	65	85	10	60	35	70	20
Gariballs	--	--	--	--	--	--	--	--	15	10
Laddu	--	--	--	--	--	--	--	--	--	5

As revealed in the above table, positive approach of the panel members were towards gari preparations made with fats and oils. Diamond cuts obtained a maximum score followed by orotti and pakkoda.

Table 21 reveals the negative approach of the panel members towards recipes.

Table 21

Negative approach of the panel members towards the recipes (per cent)

Recipes	Appearance		Flavour		Texture		Taste		Over all acceptability	
	Poor	Very poor	Unplea-sant	Not at all pleasant	Poor	Very poor	Fair	Poor	Slightly unacce-ptable	Unacce-ptable
Pakkoda	—	—	—	—	—	—	—	—	—	—
Orotti	—	—	—	—	—	—	—	—	—	—
Diamond cuts	—	—	—	—	—	—	—	—	—	—
Gariballs	40	10	25	75	60	—	50	—	15	50
Laddu	80	20	40	40	75	25	55	45	15	65

The above table makes it clear that the panel members had a negative approach towards the preparations made from sugar medium like gari balls and laddu.

The recipes prepared in the medium of fats and oils viz., diamond cuts, pakkoda and orotti (Fig.10) were the most acceptable ones and hence were selected for field trials.

Five villages were selected for the popularization of the recipes and 30 women from each village were selected for ranking the three recipes. As a total 150 women were requested to taste the recipes and the results are pointed in the score card.

General acceptability of recipes at the field level are presented in table 22.

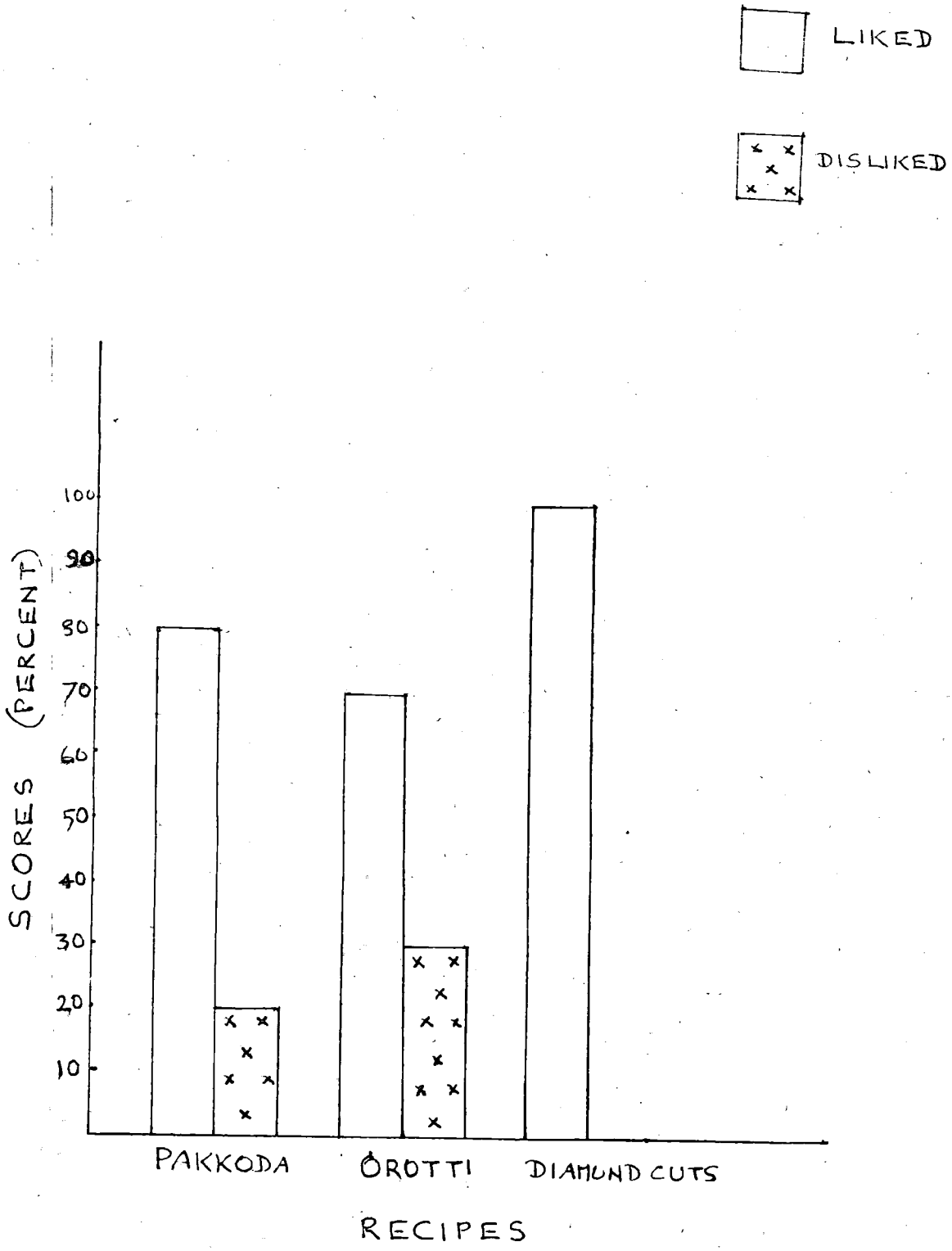
Table 22

Acceptability trial of recipes at the field level (per cent)

Recipes	Liked	Disliked
Diamond cuts	100	--
Pakkoda	80	20
Orotti	70	30

FIG. 10. RECIPES SELECTED FOR FIELD TRIALS

FIG. 11.



ACCEPTABILITY TRIAL OF RECIPES AT THE FIELD LEVEL

As revealed in table 22 all the three recipes were found to be acceptable among 70-100 per cent of the women (Fig.11).

Scores obtained for appearance during the field trials for different recipes was tested and the results are given in table 23.

Table 23

Scores obtained for appearance during field trials (per cent)

Criteria	Diamond cuts	Pakkoda	Orotti
Very good	100	52	28
Good	--	48	72
Fair	--	--	--
Poor	--	--	--
Very poor	--	--	--

From table 23, it is revealed that among the three recipes tested diamond cuts obtained a maximum score (100 per cent) followed by pakkoda (52 per cent) and orotti (28 per cent).

Scores obtained for flavour for different recipes was tested at the field trials and the results are given in table 24.

Table 24

Scores obtained for flavour during field trials (per cent)

Criteria	Diamond cuts	Pakkoda	Orotti
Very pleasant	100	65	26
Pleasant	--	35	74
Neither pleasant nor unpleasant	--	--	--
Unpleasant	--	--	--
Not at all pleasant	--	--	--

The above table, concludes that diamond cuts obtained maximum score for flavour followed by pakkoda and orotti.

Scores obtained for texture for different recipes were tested at the field trials and the results are given in table 25.

Table 25

Scores obtained for texture during field trials (per cent)

Criteria	Diamond cuts	Pakkoda	Orotti
Very good	100	50	35
Good	--	50	65
Fair	--	--	--
Poor	--	--	--
Very poor	--	--	--

From the above table it is clear that diamond cuts attained a maximum score of 100 followed by pakkoda and orotti.

Scores obtained for taste for different recipes were tested at the field trials and the results are given in table 26.

Table 26

Scores obtained for taste during field trials (per cent)

Criteria	Diamond cuts	Pakkoda	Orotti
Excellent	100	67	34
Very good	—	33	66
Good	—	—	—
Fair	—	—	—
Poor	—	—	—

Above table reveals that maximum score was obtained for diamond cuts followed by pakkoda and orotti.

Overall acceptability for diamond cuts, pakkoda and orotti was tested and the results are given in table 27.

Table 27

Overall acceptability for different recipes (per cent)

Criteria	Diamond cuts	Pakkoda	Orotti
Highly acceptable	100	76	26
Acceptable	—	24	74
Slightly acceptable	—	—	—
Slightly unacceptable	—	—	—
Unacceptable	—	—	—

As revealed in the above table, diamond cuts was highly acceptable to all the women. This was followed by pakkoda (76 per cent) and orotti (26 per cent).

Table 28 denotes the average scores obtained for pakkoda, orotti and diamond cuts at the field level.

Table 28

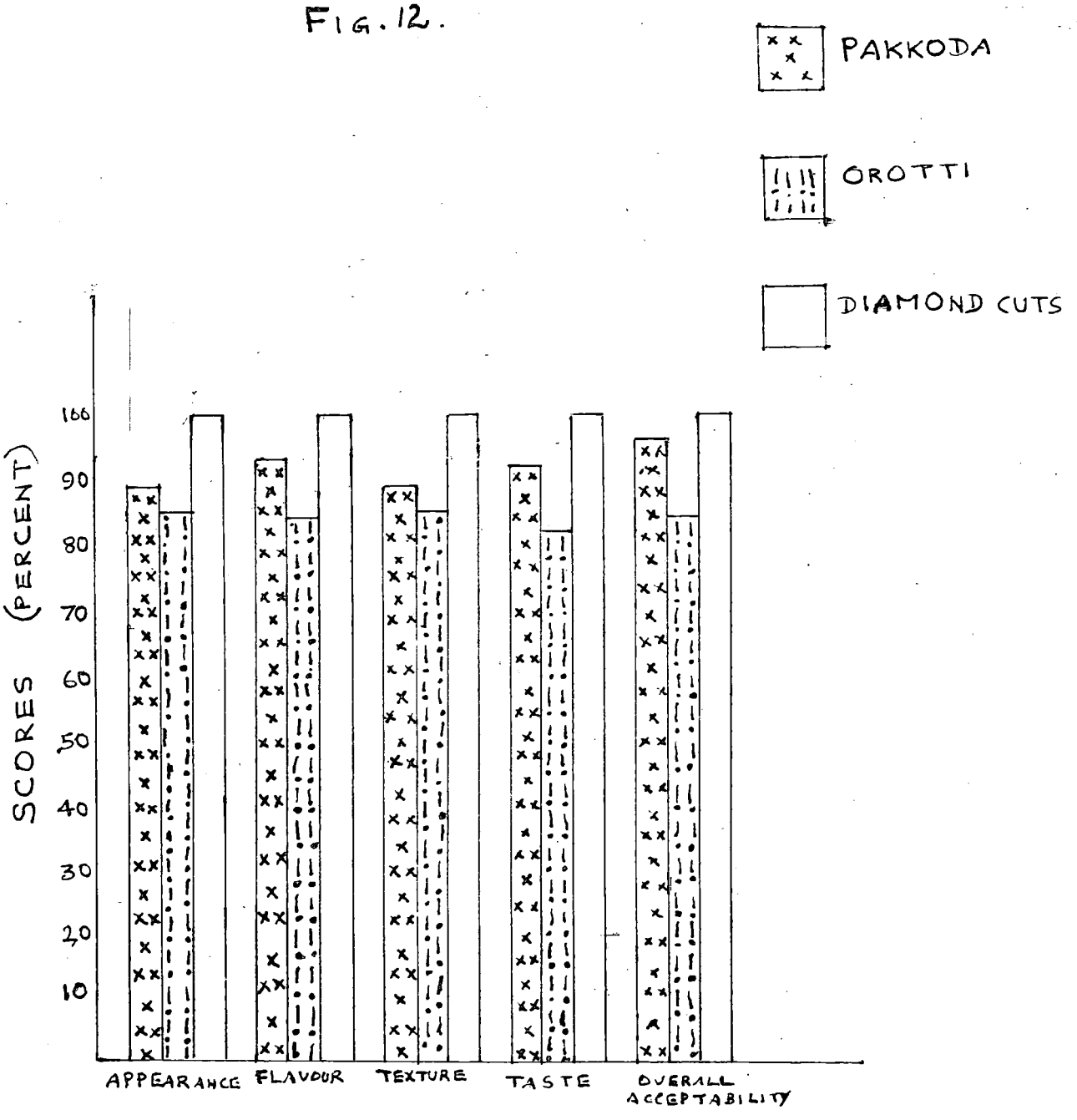
Average scores obtained for the recipes in the field level (per cent)

Criteria	Diamond cuts	Pakkoda	Orotti
Appearance	100	89	85
Flavour	100	93	84
Texture	100	89	85
Taste	100	92	82
Overall acceptability	100	94	84

Table 28 explains that diamond cuts was highly acceptable to 100 per cent of the women followed by pakkoda and orotti. To conclude all the three recipes attained maximum scores in the field level (Fig.12).

Statistical analysis of the different recipes viz., pakkoda, orotti and diamond cuts was presented in table 29.

FIG. 12.



AVERAGE SCORES OBTAINED FOR THE RECIPES IN THE FIELD LEVEL

Table 29

Statistical analysis of the recipes at field level

Recipe	1 vs 2	1 vs 3	2 vs 3
t value	2.0**	2.1**	5**

** Significant at 1 per cent level

Table 29 reveals that there was significant difference for the overall acceptability between the three recipes, pakkoda, orotti and diamond cuts.

DISCUSSION

DISCUSSION

The study on formulating fermented cassava food product include various aspects like estimation of hydrocyanic acid content in high yielding varieties of cassava, standardization of preparation of gari with respect to time and yield, estimation of various nutrients and developing different recipes from gari and popularizing the same among rural women. The results of the study were already given and the details of the results are discussed below.

Hydrocyanic acid content in different varieties of cassava was analysed and the preparation of gari was standardized with respect to yield and variety.

When the hydrocyanic acid content of different varieties such as M_4, H_{165}, Kalikalan, Panniyur, Nyarukku and Pravuvella were estimated, there was considerable difference in the hydrocyanic acid content of freshly peeled varieties. Among the varieties,

H_{165} contained a high amount of hydrocyanic acid. But the variety was not used for further study because this study was mainly based on local varieties. Due to its high bitterness H_{165} was not grown by the local people. M_4 which is a sweet variety and has a least amount of hydrocyanic acid is acceptable for consumption. Hydrocyanic acid content of the other popular varieties like kalikalan, panniyur, Nyarukku and pravuvella were in between the two varieties M_4 and H_{165}. Muthuswamy et al. (1973) states that varietal differences in the hydrocyanacid is common and it ranged from 5 to 125 ppm with an average of 41.21 ppm on a fresh weight basis. Mahendranathan (1971) also suggests that the flesh of the sweet type contained about 70 ppm, while the bitter type about 200 to 300 ppm. Studies conducted on the cyanide content of cassava consumed in Ubangi area of Zaire have been reported that the whole roots of both cultivars average 74.5 ppm HCN whereas whole roots of sweet cultivars averaged 32.9 ppm HCN (Simons Gerand et al., 1980).

Fermentation of gari was done for the complete removal of hydrocyanic acid. According to Ogunsua (1980) when gari was prepared from cassava tubers it had no hydrocyanic acid. Preparation of gari consists of different steps such as peeling, grating, pressing, fermentation, drying, frying and sifting of the final product. The yield of gari prepared from different varieties of cassava was different. When the yield of gari from different varieties of cassava was compared, the variety kalikalan gave maximum amount (75 g) followed by M_4 (65 g). H_{165} yielded only less amount of gari when compared to other varieties, like Nyarukku, Panniyur and Pravuvella. So on the basis of yield, the two varieties kalikalan and M_4 were selected for further estimation.

Gari was prepared at different time intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours and the yield of gari from the varieties Kalikalan and M_4 were estimated. From the estimation it was clear that initially during fermentation at 12 hours the amount of gari prepared from M_4 and Kalikalan were higher and after 12 hours upto 48 hours the amount of gari prepared was decreased. From 48 hours onwards and upto 72 hours the amount of gari was increased in both varieties.

After 72 hours that is after 3 days when the fermentation continued the amount of gari prepared was reduced. When compared between the two varieties kalikalan and M_4, the yield of gari was higher in kalikalan. The maximum amount of gari was produced at 72 hours (750 g /2 kg) from kalikalan and (650g /2 kg) from M_4.

The various nutrients were estimated for gari and also for raw cassava. Estimation of protein was done by macro kjeldahl method. Cassava is a foodstuff which contained only less amount of protein. This was the main cause for the occurence of kwashiorkor in small children. Cock (1985) has reported that in Kerala, cassava provided more amount of calories per adult equivalent and the total protein intake of the population was low. During fermentation the amount of protein which was already low was further reduced. The protein content of raw cassava was 2.6 g for M_4. During 12 hours fermentation, the protein was reduced to 2.0 g and after that for 24 hours and 36 hours the protein content was reduced in the rate of 0.2 g. After 36 hours it was reduced to 1.5, then 1.3 for 60 hours and during 72 hours

the protein content remained constant. But from 72 hours onwards the protein content was reduced further to 1.2 g and 1.0 g for 84 and 96 hours respectively.

For the variety kalikalan, initially raw cassava contained a protein content of 1.6 g which was reduced to 1 g, 0.8 g, 0.7 g, 0.5 g and 0.3 g for 12, 24, 36, 48 and 60 hours respectively. After 60 hours there was no reduction in the protein content of gari upto 84 hours.

At 96 hours of fermentation the protein content was reduced to 0.2 g. Longe (1980) had explained that during fermentation protein might be lost.

When compared varieties kalikalan and M_4, kalikalan had less amount of protein than M_4. During fermentation, the rate of reduction in protein was similar for both kalikalan and M_4. After the fermentation period, the protein content was reduced so much. Hence the combination of other protein rich foods is essential for preparing balanced diet with gari. A study by Gopalan (1979) revealed that the combination of fish with cassava contained excellent proteins as well as iodine and thereby balanced the diet.

Statistical analysis of the protein content of gari and cassava (Appendix XII) revealed that there was significant difference among the treatments. There was significant difference between kalikalan and M_4 for protein content at 5 per cent level. When compared by different time intervals from 12 to 96 hours, there was significant difference between them. The pattern of change was similar in both varieties, so there was no significant difference between the time interval and varieties.

Analysis of starch content of gari and cassava showed that initially raw cassava (M_4) contained 61.14 g of starch/100 g. This was reduced due to fermentation. Free sugars are removed by the process of fermentation. The starch content of 12 hours gari was 44.27 which was significantly reduced to 43.16 at 24 hours and 41.42, 40.12, 39.5, 38.9, 38.0, 37.22 g for 36, 48, 60, 72 and 96 hours respectively. As the time of fermentation increased the starch content decreased.

Starch content of gari from kalikalan and also raw kalikalan was estimated. Initially raw cassava contained a starch content of 65.04 g which was reduced after fermentation. At 12 hours the starch content of gari from kalikalan was 45.85 g. The starch content of gari at different time interval was 44.27, 43.16, 41.75, 40.75, 40.12, 39.5 and 38.83 g for 24, 36, 48, 60, 72, 84 and 96 hours respectively.

When compared, the two varieties kalikalan and M_4 the starch content of cassava was higher in kalikalan than M_4. The starch content of gari was also higher in kalikalan compared to gari from M_4.

The statistical analysis of the starch content (Appendix XII) showed that there was significant difference at 5 per cent level between the different treatments. When compared the starch content of the two varieties, there was significant difference between kalikalan and M_4. The different time intervals from 12 to 96 hours of fermentation with 12 hours interval also had significant difference for both varieties.

The interaction of variety to time interval revealed no significant difference. That means the pattern of change in starch content of the two varieties with time interval was similar. The comparison between raw kalikalan to gari prepared from it showed significant difference in the starch content. Likewise there was significant difference between gari from M_4 and M_4 in starch content.

So totally the amount of starch was reduced due to fermentation. Longe (1980) suggests that during fermentation free sugars might be lost.

Crude fibre content of M_4 and gari at different intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours were estimated and the results showed that during fermentation the crudefibre content was increased. Initially, M_4 contained a crudefibre content of 0.2 g. This amount of crudefibre was increased to 1.0 g at 12 hours of fermentation. After 12 hours of fermentation, there was constant increase in crudefibre upto 24 hours.

There was an increase of 1.6 g at 36 hours and 1.8 g for 48 hours. During 60 hours fermentation the crude fibre content was 2.0 g and it remained constant upto 72 hours. The crudefibre content was 3.0 g at 84 hours and increased to 3.4 g at 96 hours.

The variety kalikalan and the gari prepared from kalikalan at different time intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours were estimated for crude fibre content. The crudefibre content of raw cassava was 0.6 g. This low amount of crudefibre was increased to 1.0 g at the time of 12 hours fermentation. At 24 hours of fermentation there was only slight increase from 1.0 to 1.2 g in crudefibre. There was a great increase in the crude fibre content to 2.0 g at the time of 36 hours. Then from 36 to 48 hours of fermentation there was only slight increase in the crude fibre content from 2.0 to 2.2 g. It was increased slightly from 48 hours onwards upto 96 hours, the rate of increase was 2.0, 2.8, 3.0 and 3.6 g at 60, 72, 84 and 96 hours of fermentation.

The comparison of crude fibre content of kalikalan and M_4 and the gari prepared at different time interval from M_4 and kalikalan was estimated and found out that initially kalikalan contained a higher amount of crude fibre compared to M_4. At 12 hours of fermentation the crude fibre content of both varieties was 1.0 and after 12 hours there was a sudden increase in case of kalikalan compared to M_4 and it attained a maximum of 3.6 g at 96 hours of fermentation. In the case of M_4 the crude fibre content was 3.4 g at 96 hours of fermentation.

Statistical analysis of the crudefibre content (Appendix XII) had showed that there was significant difference between the various treatments at 5 per cent level. When compared to the two varieties M_4 and kalikalan there was significant difference between them. The different time intervals of gari was compared and there was significant difference between them. The comparison of variety to different time intervals had shown that there was significant difference between them. The comparison of raw cassava (M_4) to gari prepared from it at different time intervals showed that there was significant difference between them. Likewise the comparison of kalikalan (raw) and gari prepared from it at different time intervals showed that there was significant difference between them.

The ash content of M_4 and gari prepared at different time intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours were made and data show that the ash content of raw cassava was 2.38 per cent and it was decreased due to fermentation. Initially at 12 hours of fermentation, the ash content was 1.0 per cent. During 24 hours, the ash content remained constant. After 24 hours it was increased to 1.04, 1.06, 1.1, 1.2, 1.24 and 1.28 per cent at different time intervals like 36, 48, 60, 72, 84 and 96 hours respectively. At 12 hours of fermentation the ash content was decreased but after that it was increased to 1.28 per cent at the end of 96 hours of fermentation.

The ash content of the variety kalikalan and gari from kalikalan at different time intervals such as 12, 24, 36, 48, 60, 72, 84 and 96 hours were estimated. The ash content of kalikalan was 2.32 per cent which was reduced to 0.8 per cent at the time of 12 hours fermentation. After that a slight increase in ash content was observed and denoted as 1.0, 1.02, 1.04, 1.08 per cent for the time of fermentation of 24, 36, 48 and 60 hours respectively.

At the time of 72 hours of fermentation there was a sudden increase from 1.08 to 1.2 per cent. After that there was only a slight increase in the ash content to 1.26 per cent at the time of 96 hours fermentation.

When the two varieties M_4 and kalikalan were compared, M_4 contained a higher amount of ash than kalikalan. Gari prepared from M_4 at different time intervals also contained a higher amount of ash content than kalikalan at different time intervals.

The statistical analysis of ash content (Appendix XII) denoted that there was a significant difference between the different treatments. When compared the two varieties kalikalan and M_4 and the gari prepared at different time intervals show that there was no significant difference between the two varieties. Both varieties are more or less similar in their ash content. The different time intervals of gari prepared from cassava were compared and revealed that there was significant difference between the ash content at different time intervals. The comparison of the interaction of variety

and time intervals expressed that there was no significant difference between them. That means the rate of change in ash content for both varieties at different time intervals was similar. The comparison of raw M_4 with gari prepared from M_4 at different time intervals had shown that there was significant difference between cassava and gari. Likewise the comparison of gari from kalikalan at different intervals and cassava explained that there was significant difference between raw cassava and gari.

During fermentation the ash content of cassava was reduced (Longe, 1980).

The moisture content of M_4 and gari from M_4 at different time intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours were estimated and found that M_4 contained a high moisture content of 52 per cent. This high amount of moisture was the main reason for the sudden deterioration of cassava after harvesting. So the reduction in moisture content was the main criteria for the preparation of cassava products. Estimations denoted that the moisture content of gari prepared at 12 to 36 hours of fermentation

contained a moisture content of 14 per cent. After that the moisture content was reduced to 12 per cent upto 96 hours. This results obtained is similar to Meuser et al. (1980) who observed that moisture content of gari was equal to or less than 12 per cent. Bourdoux et al. (1982) also states the same view.

The estimation of moisture content for gari from kalikalan at different time intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours were done. The moisture content of kalikalan was 48 per cent. This was reduced to 14 per cent at 12 hours of fermentation. After that the moisture content was same (14 per cent) upto 60 hours of fermentation. The moisture content was reduced to 12 per cent at the time of 96 hours of fermentation.

The comparison of kalikalan and M_4 and gari prepared from M_4 and kalikalan showed that moisture content of M_4 was higher (52 per cent) and the moisture content was lower in kalikalan (48 per cent). But the fermented product (gari) from both M_4 and kalikalan contained similar amount of moisture.

Statistical analysis of the treatments (Appendix XII) showed that there was no significant difference in moisture content. When compared, the both varieties M_4 and kalikalan and gari prepared at different time intervals from M_4 and kalikalan there was no significant difference. That means the moisture content of gari prepared from kalikalan was more or less similar to the moisture content of gari prepared from M_4. When viewed, the moisture content of different time intervals there was no significant difference. The interaction of variety to time intervals had also no significant difference. Gari prepared from kalikalan significantly differ from raw cassava (kalikalan). Likewise the moisture content of gari at different time intervals prepared from cassava (M_4) and M_4 had significant difference between them.

The estimation of pH was done with the help of pH meter for M_4 and gari prepared from M_4 at different time intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours. M_4 contained a pH of 7.0 per cent that means neutral pH. This pH was decreased to acidity due to fermentation.

Initially at 12 hours gari the pH was 4.6. This was further reduced to 4.5, 4.4 and 4.3 at 24,36 and 48 hours. After 48 hours of fermentation the pH slightly increased to 4.5 and remained constant upto 72 hours. During 84 hours the pH increased slightly to 4.6 and at the time of 96 hours the pH increased to 4.9.

The estimation of pH for the variety kalikalan and gari prepared from kalikalan at different time intervals have revealed that raw cassava contained a pH of 6.2. During fermentation acidity increased and attained a maximum of 3.4. Initially at 12 hours of fermentation the pH was 4.1. This was reduced to 4.0 at 48 hours. During 60 hours the pH of gari was 3.6. After 72 hours the pH of gari from kalikalan was 3.4. This pH was continued upto 96 hours of fermentation.

While comparing both varieties M_4 and kalikalan, initially in raw cassava the pH was 7.0 in M_4 and 6.2 in kalikalan. After fermentation the acidity was increased

more in kalikalan than in M_4. In the case of M_4, there was a change in the acidity but in variety kalikalan the pH was reduced as the time of fermentation increased. Ogunsua (1980)'s view supports this results when gari was prepared from cassava tubers pH decreased from 6.2 to 3.4 after 4 days.

The statistical analysis of pH of gari prepared from M_4 and kalikalan at different time intervals (Appendix XII) showed that there was significant difference between the treatments at 5 per cent level. While the comparison of the two varieties kalikalan and M_4 was viewed, it showed that there was significant difference between the varieties and gari prepared from these two varieties. The different time intervals from 12 to 96 hours did not significantly different from each other. The interaction of variety to time interval had significant difference. The pattern of change in both varieties are not similar to change in time interval. When compared raw cassava (M_4) to gari prepared from M_4 at different intervals there was significant difference for them. The comparison of kalikalan to gari prepared from kalikalan also had significant difference.

Estimation of hydrocyanic acid in both varieties kalikalan and M_4, the gari prepared from kalikalan and M_4 at different time intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours showed that in all these treatments hydrocyanic acid content was completely removed. The raw cassava contained a high amount of hydrocyanic acid. This finding is in line with the results obtained by previous studies of Bourdoux et al. (1982) and Mahungu and Hahn (1981). Hydrocyanic acid content was reduced to zero in both varieties kalikalan and M_4 during fermentation. Obigbesan et al. (1980) and Maduagwu et al. (1981) have reported that there was practically no difference in the hydrocyanic acid content of gari prepared from sweet and bitter varieties and the loss of hydrocyanic acid from grated cassava roots selected from both bitter and sweet variety was similar.

Gari contained only less amount of moisture content that is within the range of 12-14 per cent. There was no chance for the growth of microorganism in gari. The hygienic quality of any food product was mainly due to the absence of coliform bacteria. So the presence of coliforms were identified by using fermentation tubes.

Freshly prepared gari, gari stored for 6 months and gari stored for 12 months were selected for the study.

The results revealed that there was no growth of E.coli upto 1 year old gari. This makes the hygienic quality of gari as good and so it can be safely used even for children. It can be assumed that the shelf life of gari is more than one year without any contamination.

Various recipes such as diamond cuts, pakkoda, orotti, gari balls and laddu were prepared at laboratory scale. This recipes were prepared at several times and acceptability trials were done. 10 judges were selected for laboratory trials and they were within the age group of 19-30 years. They were asked to taste the recipes and scores were obtained in the five point rating scale. After testing the first recipe they were asked to wash their mouth before testing the second one.

The preference of the panel members for different recipes were tested and the results revealed that, diamond cuts achieved a higher acceptability point of

70 per cent followed by orotti and pakkoda which obtained a score of 60 per cent and 50 per cent respectively. Gari balls achieved a score of 15 per cent. Laddu was unacceptable to 65 per cent of panel members. Gari balls were unacceptable to 50 per cent of panel members. Only 10 per cent of panel members felt that diamond cuts and orotti were unacceptable, the remaining panel members stated that orotti and diamond cuts are acceptable to them. The overall acceptability test revealed that gari prepared with fat medium was more acceptable than the preparation made in sugar medium. When cooked in fat medium the strong sour odour of gari was less and also the texture of the product was crisp.

Preference of the panel members for flavour for different recipes were tested and the results revealed that 80 per cent of the panel members denoted that orotti was very pleasant in flavour and remaining 20 per cent had said that the flavour was 'pleasant'. In case of diamond cuts 35 per cent of the panel members denoted that diamond cuts had very pleasant flavour and 65 per cent of the members indicated that it had pleasant flavour.

70 per cent of the members revealed that pakkoda had pleasant flavour and only 30 per cent of the members viewed that it had neither pleasant nor unpleasant flavour. 25 per cent of the panel members viewed that gari balls had unpleasant flavour and 75 per cent of the members viewed that gari balls was not at all pleasant. In case of laddu 20 per cent of the panel members viewed laddu had neither pleasant nor unpleasant flavour, 40 per cent revealed that laddu had unpleasant flavour and 40 per cent of the panel members viewed that it had no pleasant flavour. It was concluded that orotti attained maximum score for flavour followed by diamond cuts and pakkoda, laddu had only least score for flavour.

Preference of the panel members for texture for different recipes were studied and the results depicted that diamond cuts scored higher grade for texture. 85 per cent of the panel members had given a grade of 'very good' to the texture of diamond cuts, 10 per cent of the panel members had given a grade of 'good' and 5 per cent had given a grade of 'fair'. In the case of orotti, 55 per cent of the panel members had given a

grade of 'very good' for texture. However 45 per cent of the panel members had given a grade of 'good'. 40 per cent of the panel members had given a grade of 'very good' for pakkoda; 10 per cent had given a grade of 'good' and 50 per cent of the panel members had given a grade of 'fair'. The results revealed that diamond cuts rank first in texture followed by orotti and pakkoda. Gari balls had obtained a grade of 'fair' by 40 per cent of the panel members. 60 per cent of panel members viewed the texture of gari balls as 'poor'. In the case of laddu 75 per cent of the panel members had given a grade of 'poor' and remaining 25 per cent of the panel members had given a grade of 'very poor'. The texture of laddu was very poor among the recipes tested.

Preference of the panel members for taste for different recipes were tested and the results were obtained. It revealed that diamond cuts and orotti were given a grade of 'Excellent' by 60 per cent of the panel members. Only 35 per cent of the panel members said that diamond cuts and orotti were 'very good' and remaining 5 per cent had given a grade of 'good' to orotti and diamond cuts. In the case of pakkoda, 40 per cent of the panel members had given

a grade of 'Excellent', 10 per cent a grade of 'very good' and 50 per cent of the panel members had given a grade of 'good' 40 per cent of the panel members had given a grade of 'Fair' and 60 per cent had given a grade of 'poor' to gari balls. 75 per cent of the panel members viewed that laddu was poor and 25 per cent of the panel members said that laddu was 'very poor'. It was concluded that both diamond cuts and orotti attained a maximum score followed by pakkoda, gari balls and laddu in their taste.

Average scores for different recipes were calculated and the results revealed that more than 90 per cent of the panel members said that diamond cuts were highly acceptable to them followed by orotti (80-100 per cent) and pakkoda (70-90 per cent). Gari balls attained a score of 40-50 and laddu had a score of 30-40. As a result it was revealed that preparations in the medium of fats and oils were more acceptable than those prepared in the medium of sugar.

Statistical analysis of the recipes prepared at laboratory scale revealed that there was significant

difference between the recipes prepared from sugar and fat medium. Among the recipes prepared in fat and oils there was no significant difference. Likewise in case of recipes prepared from sugar there was no significant difference between them.

Positive approach of the panel members for the recipes revealed that diamond cuts, orotti and pakkoda were highly acceptable to more than 60 per cent of the panel members. The panel members had a negative approach for the recipes prepared with sugar medium like gari balls and laddu. The main reason suggested for the negative approach to sugar medium was mainly due to the sour odour of the recipe.

Five villages were selected for the popularization of the recipes. 30 women were selected from each of the villages for acceptability trials. Diamond cuts, orotti and pakkoda which attained maximum scores in the laboratory level were popularised in the villages. The results revealed that compared to laboratory trials, field trials obtained a higher score. At field trials, diamond cuts scored a higher grade (100 per cent) followed by pakkoda (80 per cent) and orotti (70 per cent).

The appearance score for different recipes revealed that 100 per cent of the women had given a grade of 'very good' to the appearance of diamond cuts. In the case of pakkoda, 52 per cent of the women had given a grade of 'very good' and 48 per cent had given a grade of 'good'. Orotti had obtained a grade of 'very good' by 28 per cent of the women and 72 per cent of the women viewed orotti as 'good'.

Preference of the women for flavour for different recipes were tested and the results revealed that 100 per cent of the women denoted that the flavour of diamond cuts were very pleasant. 65 per cent of the women revealed that pakkoda was very pleasant and remaining, 35 per cent had given a grade of 'pleasant'. In case of orotti 26 per cent of the women denoted that orotti had very pleasant flavour and 74 per cent of the women indicated that it has pleasant flavour.

Preference of the women for texture for different recipes were tested and the results depicted that 100 per cent of the women had given a grade of 'very good' to the texture

of diamond cuts. 50 per cent of the women had given a grade of 'very good' and 50 per cent of the women had given a grade of 'good' to the texture of pakkoda. In the case of orotti, 35 per cent of the women had given a grade of 'very good' for texture and remaining 65 per cent had given a grade of 'good'.

Preference of the panel members for taste for different recipes revealed that 100 per cent of the women had given a grade of 'Excellent' for diamond cuts. 67 per cent of the women had given a grade of 'Excellent' and 33 per cent of the women had given a grade of 'very good' to pakkoda. In case of orotti, 34 per cent of the women had given a grade of 'Excellent' and remaining 66 per cent had given a grade of 'very good'.

The overall acceptability of different recipes at the field level revealed that, diamond cuts attained a higher acceptability point of 100 per cent followed by pakkoda and orotti which obtained a score of 76 and 26 per cent.

Statistical analysis of the recipes prepared at field level revealed that there was significant difference between the three recipes viz., diamond cuts, orotti and pakkoda at 1 per cent level.

It is clear that diamond cuts were highly acceptable by 100 per cent of the rural women followed by pakkoda and orotti.

SUMMARY

SUMMARY

Kerala is the only State in India where cassava is used as a subsidiary staple. Cassava has got two defects such as its poor keeping quality and rich hydrocyanic acid content. If these two problems are overcomed it can be used as an ideal staple food.

The present investigation was therefore undertaken to assess the effectiveness of fermented cassava food product (Gari) on the

1. Hydrocyanic acid content
2. the change in the various nutrient contents after fermentation
3. the acceptability of the recipes prepared from gari and to popularise the most acceptable products.

Hydrocyanic acid content is the main reason for the bitterness in cassava and therefore the local bitter varieties, though they are high yielding are not acceptable

to people. As a first step six local varieties of cassava were assessed for its hydrocyanic acid content. The fermented cassava product gari was prepared from these varieties. Two varieties kalikalan which is high yielding and M_4 the local variety were selected for further studies since the yield of gari was higher in these two varieties when compared to others. Gari was prepared at different time intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours. It was observed that the yield of gari was higher at 72 hours of fermentation in both varieties.

The various nutrient content of gari such as protein, starch, crudefibre, ash, the moisture content pH and also the hydrocyanic acid content were estimated and compared with that of raw cassava. It was found that the protein and starch content were reduced after fermentation. In kalikalan the protein content was 0.2 per cent and in M_4 it was 1 per cent after the processing of fermentation. But the crudefibre content was increased after fermentation. It was noted that

the ash content was lowered after fermentation. There was a sudden reduction in the ash content at 12 hours of fermentation but after that there was a steady increase and attained a maximum of 1.26, and 1.28 per cent for kalikalan and M_4 at 96 hours of fermentation.

The moisture content of gari was estimated in hot air oven. It was found that the moisture content was reduced significantly due to the processing of drying and frying in the preparation of gari. The moisture content of raw kalikalan and M_4 were 48 and 52 per cent and it was reduced to 12 per cent after processing into gari.

When the pH was analysed, it was noted that raw cassava was neutral and the fermented product was acidic in nature. This might be due to the hydrolysis of various nutrients and also due to the organisms responsible for the fermentation. The acidic nature of gari might have produced the sour odour in the recipes prepared.

The estimation of hydrocyanic acid content revealed that it was completely removed after fermentation. Raw cassava contained a higher amount (17.34 per cent in kalikalan and 15.81 per cent in M_4) of hydrocyanic acid which had become zero after fermentation in both varieties. The traditional methods of processing cassava such as sun drying, soaking in water, and discarding cooking water etc. could remove the hydrocyanic acid content to only some extent, while the fermented cassava products could remove the hydrocyanic acid completely.

The hygienic quality of gari was further estimated and it was found that the coliform bacteria was absent in fresh as well as 6 and 12 months old gari and it was safe for consumption.

The acceptability of gari was assessed in the laboratory through various recipes such as, diamond cuts, pakkoda, orotti, gariballs and laddu in which gari was used as base. The organoleptic qualities were assessed by 10 judges. The overall acceptability of the recipes

revealed that diamond cuts were preferred by 70 per cent of the panel members followed by orotti and pakkoda (60 and 50 per cent), only 15 per cent of the panel members preferred gariballs and none of them preferred laddu. Preference of the panel members for the different criterias like appearance, flavour, texture and taste also showed the same results. Diamond cuts ranked first followed by orotti and pakkoda. It was noted that recipes prepared in fat medium attained maximum scores when compared to recipes prepared from sugar medium. The strong sour odour of gari was said to be one of the reasons for not preferring the sweet preparations.

The three recipes diamond cuts, orotti and pakkoda were prepared among rural women in five villages as a step of popularizing gari. The rural women were requested to assess the acceptability of the recipes. Similar results were observed in rural areas also. The over all acceptability showed that diamond cuts were preferred by 100 per cent of the rural women followed by pakkoda and orotti (76 and 26 per cent respectively). The study showed that gari is acceptable among rural women.

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* Original not seen.

APPENDICES

APPENDIX I

Estimation of Hydrocyanic acid

Preparation of alkaline sodium picrate:

1.25 g picric acid and 6.25 g sodium carbonate was disolved in 250 ml distilled water.

Procedure:

One gram of fresh tuber sample (without rind) was homogenised with distilled water in a mortar with pestle and transferred into a 500 ml conical flask immediately (volume of homogenate being 25 ml). A whatman No.1 filter paper strip (10x2 cm) soaked in alkaline picrate dried and suspended under a suitable rubber cork (with the bent pin) was placed in the mouth of the flask and locked tightly (18 hours) and elute the filter paper strips in 60 ml distilled water for one hour. Absorbency was recorded in a colorimeter using a green filter (515-550 nm). The amount of Hydrocyanic acid was calculated from a standard curve drawn using KCN solution.

Standardisation

Reagents:

1. Alkali sodium picrate solution.
2. Standard solution of KCN. Dissolve 0.241 g of pure KCN in distilled water and make up to one l which is equivalent to one mg of HCN (1000 ppm)

Prepare 1000 ppm HCN (primary standards) as mentioned in the preparation of reagents. From the primary standard prepare 5, 7.5, 10, 12.5, 15, 20, 25, 30, 40, 45 and 50 ppm HCN solution. Take 1 ml each of the above secondary solution in 500 ml conical flask and add 25 ml of distilled water and the amount of HCN was determined by the above mentioned method.

APPENDIX II

Determination of pH

Principle:

The fixed quantity of sample is equilibriated with the fixed volume of distilled water and the resultant pH of the sample water system is measured with the help of pH meter.

Apparatus: pH meter

Procedure:

Preparation of buffer solution: prepare two buffer solutions preferably with tablets of pH 4 and 9.2 as per directions given along with the buffer tablets.

Switch on the instrument and give five minutes time for warming up. Raise the electrode and clean it with distilled water Finally wipe it with clean tissue paper. Adjust the temperature control knob. Take the first buffer (pH 4) immerse the electrode and switch on to read the pH. When the pH does not confirms to read to pH of the buffer solutions adjust the pH mainly to pH 4. Switch back to Zero or neutral or standard position. Clean the electrode and wipe it clean with tissue paper. Dip the electrode in second buffer solution (pH 9.2) and switch on the instrument to read pH. The pH read with exactly 9.2, provided the instrument is correct.

Raise the electrode, wash it with distilled water and wipe it clean with tissue paper. Put the solution of unknown pH (sample) for pH measurement in place of the buffer solution. Repeat it for the duplicate and replicate and find the correct pH.

APPENDIX III

Estimation of protein by Macro kjeldahl method

Reagents:

1. Digestion mixture 98 parts of K_2SO_4 and 2 parts of $CuSO_4$.
2. 40 % NaoH
3. N/10 NaoH (0.1 N) - 4g in 1000 ml
4. N/10 H_2SO_4 (0.1 N) - 3 ml in 1000 ml
5. Methyl red indicator - 1 g of the indicator dissolved in 60 ml of alcohol and water added to make to 100 ml.

Procedure:

The sample (0.5 - 2.0 g) is weighed in to a dry kjeldahl flask. About 5 g of digestion mixture and 20 ml of pure conc. H_2SO_4 are added to the same sample and the mixture digested by heating for 4 to 5 hours. Glass beads are added to prevent bumping. After contents of the flask become clear, the digestion is continued for atleast 1 hour. The contents for the kjeldahl flask are cooled diluted with distilled water and the mixture made alkaline by adding excess of 40% NaoH. A small quantity of Porceline disc is added to prevent bumping during distillation. The NH_3 liberated is distilled into a receiver containing 25 ml of N/10 H_2SO_4. The excess of acid in the receiver is back titrated against N/10 NaoH using 3 drops of methyl indicator.

A reagent blank is similarly digested and distilled. This titre value is substrated from the value obtained for the sample to get the true titre value.

Calculation:

$$\frac{(\text{Test - Blank Value}) \times 0.0014 \times 6.25 \times 0.096 \times 100}{0.1 \times \text{wt of the sample used}}$$

APPENDIX IV

Estimation of starch

Principle:

This method is based on the reduction of potassium ferricyanide to potassium ferrocyanide by reducing sugars in presence of alkali.

$$2K_3 Fe(CN)_6 + 2 KOH - 2 K_3 Fe(CN)_6 + H_2O + \tfrac{1}{2} O_2$$
$$CH_2 OH (CHOH)_4 + \tfrac{1}{2}O_2 - CH_2 OH (CHOH)_4 COOH$$

Starch is converted to reducing sugars by hydrolysis with 2N Hcl and the total reducing sugars are estimated.

Reagents required:

1. Potassium ferricyanide 0.05 N) Dissolve 16.463 g of $K_3Fe(CN)_6$ in distilled water and make up to 1000 ml.
2. 2.5 N NaoH: Dissolve 100 g of NaoH in distilled water and make up to 1000 ml.
3. 2N Hcl: Dilute 100 ml of conc. Hcl (AR) to 600 ml with distilled water.
4. Standard glucose solution (0.05 N) Disolve 9.01 g of pure glucose in distilled water and diluted to 1000 ml.
5. Methylene blue 1 % aqueous solution.

Procedure:

Take 1 g of fresh tapioca tuber or 0.5 g of dried and ground material in a 100 ml conical flask. Add 20 ml of 2 N Hcl and heat on a water bath for 2 hours. Place a small funnel on the mouth of the conical flask while heating. After hydrolysis, cool and make upto 100 ml with distilled water. Filter if necessary.

Take 10 ml of 0.05 N K_3 Fe $(CN)_6$ in a 100 ml conical flask add 5 ml of 2.5 N NaoH and heat over a wire guaze with lasser burner. Adjust the burner so that the solution boils gently. When the solution starts boiling add a few drops of methylene blue and titrate the filtered sugar solution against K_3 Fe $(CN)_6$ solution while hot. Add the sugar solution drop by drop till the blue colour fades and the solution becomes colourless. Note the volume of sugar solution added.

Standardisation:

Titrate 0.05 N glucose solution (in a similar manner as described above) against 10 ml of 0.05 N K_3 Fe $(CN)_6$. Repeat until two titre values agree.

Calculation:

1 ml of 0.05 N glucose contains 9.01 mg of glucose. Let the blank titre value be x ml.

Therefore x ml contains x x 9.01 mg of glucose. To reduce 10 ml of 0.05 N K_3 Fe $(CN)_6$ solution x x 9.01 mg of glucose was necessary.

$$\% \text{ of starch} = \frac{X \times 9.01}{\text{titre value}} \frac{100}{W} \times \frac{100}{1000} \times \frac{19}{20}$$

Where

W = wt of sample taken

19/20 is the conversion factor for converting reducing sugar to starch.

APPENDIX V

Estimation of crude fibre

Reagents required:

1. 0.255 N H_2SO_4 : 0.9 ml of H_2SO_4 in 99.1 ml of water
2. 0.313 N NaoH : 0.8 g NaoH in 99.2 ml of H_2O
3. Ether

Procedure:

About 2.5 g of moisture and fat free sample are weighed into a 500 ml beaker and 200 ml of boiling 0.255 N H_2SO_4 was added. The mixture is boiled for 30 mts. Keeping the volume constant by the addition of water at frequent interval (a glass rod is inserted in the beaker helps smooth boiling). At the end of this period, the mixture is filtered through a muslin cloth and the residue washed with hot water till free from acid. The material is then transferred to the same beaker and 200 ml of boiling 0.313 N NaoH added. After boiling for 30 minutes (Keeping the volume constant as before) the mixture is washed with hot water till free from alkali followed by washing with some alcohol and ether. It is then transferred to a crucible, dried overnight at 80 to 100°C and weighed. The crucible is heated in a muffle furnace at 600°C for 2 or 3 hours, cooled and weighed again. The difference in weight represent the weight of crude fibre.

$$\text{Crude fibre (g/100 sample)} = \frac{100-(\text{moisture}+\text{fat})\times \text{wt of fibe}}{\text{wt of sample tuber}}$$

APPENDIX VI

Estimation of ash

Reagents required:

1. 0.255 N H_2SO_4 : 0.9 ml of H_2SO_4 in 99.1 ml of water
2. 0.313 N NaoH : 0.8 g NaoH in 99.2 ml of H_2O
3. Ether

Procedure:

About 2.5 g of moisture and fat free sample are weighed into a 500 ml beaker and 200 ml of boiling 0.255 N H_2SO_4 was added. The mixture is boiled for 30 mts. Keeping the volume constant by the addition of water at frequent interval (a glass rod is inserted in the beaker helps smooth boiling). At the end of this period, the mixture is filtered through a muslin cloth and the residue washed with hot water till free from acid. The material is then transferred to the same beaker and 200 ml of boiling 0.313 N NaoH added. After boiling for 30 minutes (keeping the volume constant as before) the mixture is washed with hot water till free from alkali followed by washing with some alcohol and ether. It is then transferred to a crucible, dried overnight at 80 to 100°C and weighed. The crucible is heated in a muffle furnace at 600°C for 2 or 3 hours, cooled and weighed again Cooled and weighed again and this weight represents the weight of ash.

APPENDIX VII

Estimation of moisture

Procedure:

5 g of accurately weighed material was placed in a silica dish (previously weighed after drying in an air oven). The dish with the sample was dried in an electric oven at 105°C for 6 hours, cooled and weighed, until consecutive weights agree. The percentage moisture was expressed as oven dry basis.

$$\text{Moisture } \% = \frac{\text{Initial wt - Final wt}}{\text{wt of the sample}} \times 100$$

APPENDIX VIII

Test for Coliform Bacteria

Presumptive test:

1. Inoculate 1 ml of water and 1 ml of each of the 1:10 and 1:100 dilutions into fermentation tubes containing lactose broth.

2. Inoculate tubes at 35 ± 0.5 c for 24 hr and examine for gas. The presence of gas indicates a positive presumptive test. Incubate negetive tubes for another 24 hr; the presence of gas then also indicates a positive presumptive test. The absence of gas after 48 hr of incubation constitues a negative test.

Lactose broth:

Peptone	20 g
Nacl	5 g
Water	1000 ml
Sodium tauro glycocholate	5 g
Lactose	20 g
pH	7.4

Added 10 ml 1% aqueous solution of neutral red.

APPENDIX IX

The recipes tried in the laboratory

1. Gari Pakkoda

Gari (boiled & chopped)	250 g
Salt	to taste
Brinjal (cut into piece)	1 no
Potato (cut into piece)	1 no
Green chillies	4-5 nos
Chilli powder	2 g
Cumin seeds	2 g
Baking soda	a pinch
Oil	enough for frying
Bread Cramps	100 g
Onion (cut into small pieces)	100 g
Drumstick leaves	50 g

Method of preparation:

i. Mix all the ingredients with the boiled gari

ii. Take portions and fry deep in oil

2. Gari Orotti

Boiled and mashed gari	150 g
Wheat flour	25 g
Coconut scrapings	½ cup
Chopped onion	25 g
Mustard	1 g
Coconut oil	5 g

Red chillies	2 nos
Chopped green chillies	10 g
Chopped ginger	10 g
Curry leaves	a few
Salt	to taste

Method of preparation:

i. Mix mashed gari, wheat flour, coconut scrapings and salt and keep for 5 minutes.
ii. Heat oil and fry the remaining ingredients in oil and add to the above mixture.
iii. Prepare small balls and flatten then.
iv. Cook on hot tawa with oil until brown on both side.

3. Gari Diamond cuts

Gari flour	200 g
Wheat flour	200 g
Chilli powder	5 g
Oil	5 g
Salt	to taste
Oil	for frying.

Method of preparation:

i. Mix wheat flour, gari flour, chilli powder, salt and a little water to form a fine dough.
ii. Make small balls and roll out as for the chappathis.
iii. Cut into diamond shaped pieces. Fry in hot oil till golden brown in colour.

4. Gari Balls

Gari flour	2 cups
Jaggery powder	¾ cup
Ground nuts (fried)	½ cup
Banana	1
Baking powder	½ tsp
Salt	a pinch
Oil	enough for frying

Method of preparation:

i. Mash banana
ii. Add the remaining ingredients
iii. Add enough water to form a thick pour batter and mix well
iv. Cook the batter in spoonful of hot oil till golden brown in colour.

5. Gari Laddu

Gari flour	350 g
Green gram flour	150 g
Ground nut	150 g
Jaggery	200 g

Method of preparation:

i. Roast ground nuts. Remove the brown skin and grind into powder.
ii. Roast green gram flour and gari flour.
iii. Prepare jaggery syrup.
iv. Add all the flours and mix well.
v. Make balls of even size while the mixture is hot.

APPENDIX X

Evaluation card for triangle test

In the triangle test three sets of sugar solution of different concentrations were used. Of the three sets, two solutions were of identical concentrations and the women were asked to identify the third sample which is of different concentration.

Name of the products : Sugar solution

Note: Two of the three samples are identical

Identity the odd sample

S.No.	Code No. of samples	Code No. of the identical samples	Code No. of the odd samples
1	X Y Z		
2	A B C		

APPENDIX XI

Score Card

Criteria		A	B	C	D	E
1. Appearance						
Very good	(5)					
Good	(4)					
Fair	(3)					
Poor	(2)					
Very poor	(1)					
2. Flavour						
Very pleasant	(5)					
Pleasant	(4)					
Neither pleasant nor unpleasant	(3)					
Unpleasant	(2)					
Not at all pleasant	(1)					
3. Texture						
Very good	(5)					
Good	(4)					
Fair	(3)					
Poor	(2)					
Very poor	(1)					
4. Taste						
Excellent	(5)					
Very good	(4)					
Good	(3)					
Fair	(2)					
Poor	(1)					
5. Overall acceptance						
Highly acceptable	(5)					
Acceptable	(4)					
Slightly acceptable	(3)					
Slightly unacceptable(	(2)					
Unacceptable	(1)					

APPENDIX XII

a. Statistical analysis of the protein content

Source	D.F	M.S.S.	F
Treatments	15	0.9914	14.76992**
Variety	1	10.8299	161.329**
Time interval	7	0.5689	8.4750**
Variety Treatments	7	8.574	0.1277
$Variety_1$ Vs C_1	1	3.450	51.399**
$Variety_2$ Vs C_2	1	3.154	46.98**

** Significant at 5 per cent level

b. Statistical analysis of starch content

Source	D.F.	M.S.S.	F
Treatments	15	19.183	37.211**
Variety	1	23.273	45.146**
Time intervals	7	37.689	73.108**
Variety treatments	7	9.263	0.1797
$Variety_1$ Vs C_1	1	1155.516	2241.472**
$Variety_2$ Vs C_2	1	1551.879	3010.338**

** Significant at 5 per cent level

c. Statistical analysis of the crude fiber

Source	D.F.	M.S.S.	F
Treatments	15	2.219	53.53**
Variety	1	1.267	30 .57**
Time interval	7	4.456	107.48**
Variety. Treatments	7	0.1189	2.8686
$Variety_1$ Vs C_1	1	8.4017	202.65**
$Variety_2$ Vs C_2	1	7.7067	185.888**

** Significant at 5 per cent level

d. Statistical analysis of ash content

Sources	D.F.	M.S.S.	F
Treatments	15	4.948	5.5536**
Variety	1	1.689	1.8960
Time interval	7	9.702	10.89**
Variety. Treatments	7	6.588	0.739
$Variety_1$ Vs C_1	1	4.267	478.989**
$Variety_2$ Vs C_2	1	4.117	462.102**

** Significant at 5 per cent level

e. Statistical analysis of moisture content

Source	D.F.	M.S.S.	F
Treatments	15	2.75	1.6522
Variety	1	0.75	0.4506
Time intervals	7	3.321	1.9956
Variety. Treatments	7	2.464	1.4806
$Variety_1$ Vs C_1	1	4004.167	2405.829**
$Variety_2$ Vs C_2	1	3174	1907.038**

** Significant at 5 per cent level

f. Statistical analysis of pH

Source	D.F	M.S.S.	F
Treatments	15	0.6955	14.3867**
Variety	1	7.679	158.864**
Time interval	7	0.1060	2.1942
Variety. Treatments	7	0.2871	5.939**
$Variety_1$ Vs C_1	1	16.1704	334.4917**
$Variety_2$ Vs C_2	1	16.1704	334.4917**

** Significant at 5 per cent level

ABSTRACT

The present investigation was undertaken to formulate fermented cassava food product and to assess the effectiveness of gari in various recipes.

The hydrocyanic acid content of cassava was completely eliminated by fermentation. The fermented product, gari was analysed for the various nutrient contents and compared with that of raw cassava. The hydrocyanic acid content of six local varieties of cassava were estimated in the laboratory and out of that two varieties kalikalan and M_4 were selected for further studies. Gari was prepared from these two varieties at different time intervals like 12, 24, 36, 48, 60, 72, 84 and 96 hours. It was found that the yield of Gari was higher at 72 hours of fermentation.

The analysis of the different nutrients showed that the less amount of protein present in raw cassava was further reduced during fermentation in both varieties.

Same results were observed in the case of starch content while the crudefibre content was increased after fermentation. The ash content was also lower than that of raw cassava.

The moisture content which was one of the reasons for the early deterioration of cassava tubers was considerably reduced after the processing of gari. This might be one of the reasons for the longer keeping quality of the product.

When the hygienic quality of gari was tested it was found that there was no growth of coliform bacteria in fresh gari as well as in 6 and 12 months old gari. The acidic nature of gari might have prevented the growth of micro organisms.

To assess the acceptability of gari different recipes such as diamond cuts, pakkoda, orotti, gariballs and laddu were prepared in the laboratory. The organoleptic

qualities of the recipes were judged by 10 panel members. It was found that recipes prepared in fat medium like diamond cuts, pakkoda and orotti were highly acceptable. These 3 recipes were prepared among rural mothers in five villages and they were requested to assess the organoleptic qualities of the recipes. Among the 3 recipes tested it was found that diamond cuts attained a maximum score among rural women.