DEVELOPING MULTIPURPOSE CONVENIENCE MIX FROM SELECTED BANANA VARIETIES

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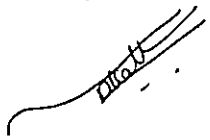
DECLARATION

I here by declare that this thesis entitled **"Developing multipurpose convenience mix from selected banana varieties"** is a bonafied 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 of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.



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CERTIFICATE

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Dedicated to my daughter Dinu

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LIST OF ABBREVIATIONS

µg	microgram
C	Convenience mixes
cfu/g	Colony forming unit per gram
et al	and others
Fig	Figure
g	grams
g/100g	gram per 100 gram
Kcal/100g	Kilocalories per 100 gram
meq/g	milli equivalents per gram
mg	milligram
min	minutes
ml	millilitre
PET	Poly Ethylene Terephthalate
Rb	Robusta
Rk	Rasakadali
Rs	Rupees

Introduction

1. INTRODUCTION

Population in India is increasing at a fast rate which has crossed one billion mark as per 2001 census. The non availability of adequate nutritious food for the fast growing population is a challenging problem. The task of feeding the country's population can be achieved by reducing the post harvest loss along with the increase in food production.

India with its wide variability of climate and soil, produces a large range of horticultural crops such as fruits, vegetables, tropical tuber crops, medicinal plants and plantation crops (Sharma, 2004). India has emerged as the largest producer of fruits in the world (Chadha, 1997). The country produces 50 million tonnes of fruits and 85 million tonnes of vegetables per year, but just 20 percent of this goes for processing, while over 25 percent is spoiled due to improper handling and storage, and the rest is consumed in the fresh form (CFTRI, 2002).

Bananas are the main fruit in the international trade and the most popular one in the world. In terms of volume, they are the first exported fruit, while they rank second after citrus fruit in terms of value. Banana is a very delicate commodity on economic, social, environmental, and political grounds. Food and Agriculture Organisation (FAO, 2003) statistics states that worlds total export of banana accounted for 15.5 million tonnes. Bananas are also a very important staple commodity for many developing countries together with wheat, rice or corn. Banana by itself makes a wholesome food and it contains almost all essential nutrients including minerals and vitamins (Shanmugasundaram *et al.*, 2005).

Considerable efforts are needed to make new products from banana as it has a short shelf life under the prevailing temperature and humidity conditions. Moreover, the area of food processing is developing rapidly and an entirely new range of value added processed products has been manufactured and marketed. The demand for convenience foods is increasing day by day due to changing life styles. Considering

today's need and relevance of convenience food, the present study entitled "Developing multipurpose convenience mix from selected banana varieties" is planned with the following objectives:

(i) To develop multipurpose nutritious convenience mix utilising banana flour.

(ii) To ascertain its nutritional quality, shelf stability and organoleptic quality and

(iii) To test the suitability of the mix for product development.

Review of Literature

2. REVIEW OF LITERATURE

IMPORTANCE OF BANANA

Fruits are parts of plants, which can be consumed either raw or in processed form. Tropical and subtropical fruits and vegetables are becoming more important food items in both producer and non producer countries. According to Kumar *et al.*(2003) fruit has been a major food for mankind from time immemorial and fruit constitute an important item in our diet.

Kaur and Kapoor (2002) are of the opinion that diets rich in fruits and vegetables are associated with a lower incidence of disease risks, including cardiovascular and cancer. They also argues that processing or cooking can enhance the health promoting effects of fruits and vegetables. Sharma (2004) reported that India with its wide range of soil and agro-climatic conditions grows different kinds of horticultural crops and is considered as one of the horticulturally rich countries of the world.

Dubey (1998) opined that fruits are known to provide the vigor and vitality.The chief energy constituent in fruit is carbohydrate mainly as sugars. He further reported that fruits contain the indigestible material called fibre which adds bulk to stools, and thus acts as a mild laxative. Mehta *et al.*(2002) remarked that fruits not only meet the quantitative needs of foods but also supply vitamins and minerals, which improve the quality of diet and maintain health. Therefore it is necessary to ensure their availability throughout the year in fresh, processed or preserved forms.

"Alexander the Great" found bananas growing in the Valley of Indus River as early as 327BC (Jesson, 1945). Banana is a commercially important fruit crop in the world trade (Ramana and Jayaraman,1994). It is the only tropical fruit which is exported in large quantities, where the total export being the order of 6 to 7 million tonnes per annum. Chadha (2003) remarked that banana and plantain are widely

grown in India with great socio-economic significance, interwoven with cultural heritage of the country. Owing to its multifaceted uses it is referred as "Kalpatharu" which means "a plant of virtues".

Banana and plantain are the fourthmost important crop after rice, wheat and corn in the developing world (NAAS, 2001) and is one of the most important fruit crops grown throughout Kerala (Shanmughavelu *et al.*,1992).

Banana is a unique crop providing food for millions of people in the developing countries of the tropics. Banana reach their greatest importance as staple food crop in parts of East Africa where annual consumption is over 200kg/capita/year (Valmayor, 1994). Easy availability of the crop round the year, high nutritive value and low market price have made banana a unique commodity.

NUTRITIONAL SIGNIFICANCE

Banana is the cheapest, plentiful and most nourishing of all fruits. According to Abdulkhader *et al.*(1990) Banana contains nearly all the essential nutrients including minerals and vitamins, and is having some medicinal properties also. Potty (2005) stated that nutritionists, physicians, food scientists and biochemists are unanimous in their view that banana is one of the most nutritious and health giving natural food as it contains high levels of sugar such as glucose, sucrose, and fructose, dietary fibre, vitamins, minerals, phytochemicals and are free of allergens and easily digestible.

Bose and Mitra (1990) reported that bananas have a special value in the human diet, as they are rich sources of energy, and contain nearly all the nutrients including minerals and vitamins. Two medium sized bananas provides energy for 90 minutes strenuous work.

Banana contain high amount of sugar normally 1 to 2 percent in the pulp of green fruit, which increase to 15 to 20 percent in the ripe fruit. Less than 20 percent of the sugar is in reducing form in some varieties like red banana. While in others 40 to 90 percent sugar is in reducing form (Potty,2005). Forsyth (1980) reported that 80 percent solids in ripe banana contains glucose, fructose and sucrose. Because of the

presence of this heavy concentration of sugars, it is considered as a convenient source of energy (Kotecha and Desai,1995).The high level of natural sugar in fresh and dried form is released quickly into the blood stream which helps in protein metabolism, red blood cell formation and functioning of the central nervous system. Studies at KAU (2001) showed that karpooravalli was found to be the richest source of total sugar and reducing sugar.

The protein content in different varieties of banana showed wide variations. In the raw stage Robusta has a lower protein content of 0.5 per cent and Kunnan 1.74 per cent (KAU, 2001).The fat content is very low in banana which varies from 0.1 to 0.7 percent.

Banana and plantains are rich in minerals also. They are high in potassium (Morton,1987) especially red banana provides 350 to 500 mg of potassium per 100g (Potty, 2005). According to Rao (2002) potassium is also known as "the salt of intelligence". It is a vital mineral for muscle and nerve function which help to regulate blood pressure, increased learning ability, and regulates water balance in the body. Banana is also rich in phosphorous, which helps to overcome the brittleness of bone and teeth and problems afflicting muscle and nerve functions (Potty, 2005). Banana is rich in vitamin C, nicotinic acid, and vitamin B6 which helps the body to heal and defend against infections, enhances the absorption of iron and formation of connective tissue and blood, prevents diarrhoea, eczema, anaemia and related disorders(Shanmughasundaram *et al.*, 2005)

NEED FOR PROCESSING

Foods are perishable commodities and are there for processed to preserve them from deterioration, while providing the consumer with palatable, wholesome, nutritious and tasty food in a convenient form, throughout the year (Anand, 2000).

Shaw *et al.*(1993) defined processing as the treatments between harvest to consumption, which include handling, transportation, refrigeration, holding, washing, trimming, bleaching, freezing, canning, drying, irradiation, chemical

preservation, packaging and storage. Where as Rao (1989) defined processing as adding value to conventional and innovative basic food items through various combinations and permutations providing protection, preservation, packaging, convenience and disposability.

Food processing is very important for the prosperity of India. Food processing industry helps to avoid post harvest losses of agricultural produce. In India, the value addition of food production is only 7 percent compared to 23 percent in China, 45 percent in Philippines and 88 percent in United Kingdom (Mallaya, 2003).

Sethi (1996) remarked that all future thrust in research should be aimed at developing simple technologies which could be easily adopted to conserve and preserve perishable commodities and minimize both their qualitative and quantitative losses, so that the gap between the production and availability of horticultural crops is slowed down. Ray and Athwali (2000) reported that more and more people are going for processed foods and it is estimated that over 10 per cent of total expenditure incurred in the household for foods is spent on processed foods.

Premnath *et al.* (2004) reported that increased awareness about sound health and quality life and increased problems of nutritional insecurity among all sections of the society around the globe, particularly the developing countries brought about a sudden shift from food grain production and consumption pattern to diversified and value added production and consumption. There is considerable change in the life style of an average Indian due to various reasons viz urbanization, increase in percapita income, explosion of mass media, increase in working women's population, security of household laborers as well as technological developments and invasion of consumerism (Nirmal *et al.*, 1999).

Post harvest loss can be considered as a social evil, which eats up the grower's margin and pushes up the consumer prices. Percapita availability of fruits in India is 85 gram and that of vegetables is 75 gram, which is still lower than the

recommended levels (Kapoor and Kaur, 2004). Kaur and Kapoor (2002) are of the opinion that fresh foods which are in excess supply during season and storage during the rest of the year is a phenomenon, which invites attention to the development of technologies for appropriate processing and packaging. Huge variety of under utilized fruits available are not easily marketed in the fresh form hence should be processed into value added products so that the consumers all over the world get an opportunity to enjoy the fruit at least in the processed form (Roy,2001). Bhoumik and Epison (1992) has stated that there is a vast potential to tap the under exploited fruits, vegetables and tubers in the country. There is a need to make new products from indigenous raw materials having nutritional values to open new channel for export market.

Kumar and Pramod (1993) reported that considerable efforts are needed to make new products from under exploited fruits and vegetables competitive in the world market with respect to nutritional and microbial quality as well as zero level chemical residues.

Banana is a unique crop providing foods for millions of peoples in the developing countries of the tropics. It is the fourth most important global food commodity after rice, wheat and milk products in terms of gross value of production (Valmayor, 1994).

Purseglove (1992) is of the opinion that bananas are highly perishable and must reach distant markets within a short time after harvest. Singh and Uma (1996) reported that with an expansion of banana production in India, large quantity of fruits are expected to be surplus because of high standards imposed particularly on the appearance of fruits in banana export industry.

Salunkhe and Desai (1984) reported that banana being a highly perishable fruit suffers from a high post-harvest losses to the extend of 30 to 40 per cent. Brathwaite and Badrie (2001) argues that banana industry has to diversify their markets in procured products, thus giving added value to the fresh fruits.

VALUE ADDITION IN BANANA

According to Nirmal *et al.* (1999) value added products are raw or pre processed commodities whose value has been increased through the addition of ingredients or processes that make them more attractive to the buyer or more valuable by the consumer. Value added processing of agricultural commodities makes an important contribution to agricultural development and farm income of the country.

According to Joseph (2001) value addition to food products chiefly in terms of cost value is a consequence of acceptability of enhancement. Value added processed products in India accounts for 2 per cent by volume and 10 per cent by volume to total production (Anvita *et al.*,1993). Thus food industry can play a significant role in India's economy by converting new agricultural commodities to value added finished products.

Banana is widely consumed fruit, but the amount of procured fruits has been insignificant in comparison with the international market of fresh fruits. India is the largest producer of banana in the world with a total production of 16 to 81 million tonnes from an area of 0.68 million hectare (Singh and Gopalakrishnan, 2002). Even though India is the largest producers of the fruits and vegetables, only about 1.5 to 2.0 percent of the produce is processed for consumption (Patel, 2005). By considering this large production of the banana in the country and the perishable nature of banana, there is a vast scope for the development of several value added products from banana. Here is an attempt made to review literature regarding some value added products from banana.

Banana flour

According to Shanmugavelu *et al.* (1992) good quality flour can be prepared from banana. For that, the green fruit is peeled, sliced and sulphured until brittle and dried in an oven at 70 degree Celsius or in sun for 24 to 36 hours. The dried slices are ground in to free flowing flour. A study has also been conducted at KAU (1984)

for the preparation of good quality banana flour. And it was seen that the flour developed were found to contain many of the nutrients that were required for the general well being of the body (Aravindakshan *et al.*,1992).

A method for the preparation of flour from ripe banana was also described by Shanmugavelu *et al.*(1992). According to that, raw bananas are allowed to ripen in the laboratory in an incubator at 18 to 20 degree Celsius and a RH of 68 to 75 percent, till the fruit becomes soft. The macerated pulp from the fruit was then dried at 60 degree Celsius under 58 cm of vacuum. After 9 hours the dried product is pulverized and sieved.

Babha Atomic Research Centre (2004) has also developed a method for preparing banana powder utilizing the banana pulp, which was left after the preparation of banana juice.

Banana Puree

Nakasone and Paul (1998) and Robinson(1999) were reported that banana puree is the canned ripe pulp without sugar and preservatives is the most important product from banana. It is widely used as a raw material for other value added products like baby foods, bakery items, drinks and other confectionaries.

Jonas (1994) described the contribution of banana puree to the flavor of wide variety of food products and its functional properties.

A process for banana puree preservation was described by Garcia *et al.* (1985), which required a mild heat treatment plus the addition of sodium bio sulphate, citric acid and petroleum sorbate. Another method as suggested by Rajasekhar (1991) involves the blanching of peeled bananas in boiling water till the center reached 190° F and the blanched banana were cooked and converted to puree.

Banana puree can be preserved by several means like refrigerated storage (Brekke *et al.*,1969) and microwave blanching (Premkumar and Khurdia, 2002). Guerrero *et al.* (1994) described a method for preservation of banana puree based on hurdle effect.

Chadha (1997) is of the opinion that commercial banana varieties in India have not been exploited for product like banana puree and vast potentiality of banana for processing remained unexploited. The world banana puree market has a share of 1,20,000 metric tonnes (Singhal, 1999). According to Premkumar and Khurdia (2002) the non availability of quality puree from Indian bananas for export industry is an important missing link in post-harvest technology of export of bananas.

Banana Figs

Banana figs are made from drying the entire ripe fingers. They are prepared especially from the sweet variety like karpuravally. Here the fruit is peeled, cut into halves or slices, treated with potassium meta bisulphate and dried in oven at 50 to 60 seconds or in the sun (Shanmugavelu *et al.*,1992). According to Dupaign (1974) the weight of the figs is about 19 percent of the bunch weight and drying should be terminated at moisture content of 33 percent.

Jacob (1982) reported that the figs can be stored for four months in the cardboard cartons lined with polythene. It can be consumed directly as a snack or tit-bits in cakes, ice creams and deserts.

Banana can be dehydrated by osmosis in sugar syrup at 70 percent concentration (Bongeswar and Sreenivasan, 1977). The fruit will be reduced to about 50 percent of its original weight by osmosis. Flavor, colour, appearance and texture attributes are maximally retained by this.

Banana Chips

Chips are one of the most famous product from banana. Tamilnadu Nendran available throughout the year in Kerala is good for chips making rather than the local Kerala variety (KAU,1997). Robusta is also comparable to Nendran for chips making (Shanmughavelu *et al.*,1992). Satyavati *et al.* (1998) reported that Nendran bananas harvested between 85 to 95 days after the emergence of the inflorescence are most suitable for deep fat frying into chips. Chips from bananas from 85 days maturity and onwards has attained the normal colour, size, aroma and taste.

Banana Cheese

Bramuell and Badrie (2002) developed fruit cheese from banana and was found that it is highly acceptable.

Banana Gellified Milk

According to Chaffai (1990) banana gellified milk can be prepared, which is a type of flavoured gellified milk and is consumed widely as a dessert. It was made with pasteurized or sterilized milk, sucrose, flavouring materials like chocolate, vanilla and banana.

Canned Banana

Ripe banana can be canned in syrup. According to Lal *et al.* (1998) banana can be canned alone or on combination with other fruits. They reported that varieties like pachabale, chandrabale, nendran, changanapurikodan, poovan, and vannan are suitable for canning.

Weaning Food

Weaning food-using banana was in practice from olden times. Weaning food prepared from banana flour, ragi flour, and soybean flour was well accepted and tolerated by babies of 6 months to one year (KAU, 1987). Banana based weaning food mix with good shelf-life and acceptability has been developed by Sheela, (1998) and Susan, (1992). Porridge made with banana flour is a widely used weaning food and mashed banana with milk and sugar can be applied as an excellent supplementary food to children.

Beverages

Beverages from banana are not popular in the country. But in the western countries good quality beverages are preparing from banana. Preparation of quality beverages will help to promote the banana processing industry. According to Manan *et al.* (1993) fruit based beverages are not only rich in essential minerals, vitamins and other nutritive factors but also are delicious and have a universal appeal.

Banana essence

After several years of research, United Brands developed the first commercial all-natural banana essence extracted from ripe fruit. It was a clear, colourless liquid with excellent aroma and no additives or preservatives. It is used to drinks, desserts, toppings, juices and products for which banana puree is used. Robinson (1999) reported that banana essence is extracted from ripe fruit was a clear, colourless liquid which had an agreeable, concentrated aroma and was used in desert juices and drinks.

Banana Juice

Kaur and Kurdiya (1993) reported that fruit based beverages are becoming more popular in the market with the growing consciousness of people regarding the nutritive value of fruits. An enzymatic method has been developed by Jaleel *et al.* (1978) to obtain clear and sparkling juice from banana pulp having the taste and flavor of original fruit. Robusta was identified as the best variety for clarified juice preparation other than the varieties nendran, poovan and palayankodan (KAU, 1992). Teotia *et al.* (1991) reported that the juice recovered from over ripe fruits is higher (67.6 per cent) than normal, using pectinase enzyme. Soft drinks can be prepared by the clarification and evaluation of banana juice (KAU, 1987).

Wine

Although a large quantity of hard liquor are produced and consumed in India, fruit wine production is negligible in spite of tremendous increase in the fruit production (Joshi *et al.*, 1999). According to Kordylas (1990) the peel and pulp of ripe bananas contains appreciable amounts of fermentable sugars which can be used for alcoholic fermentation. Fermentation is the process in which yeasts convert the sugar in the fruit juice into alcohol, CO_2 and small amounts of various by-products and fruit wines refer to the fermented juice of fruits other than grapes (Cariri, 1992). Brathewaite et *al.* (2001) prepared quality wines by utilizing the excess banana and to investigate the effect of pectolase, sodium meta bisulphate, and length of

fermentation on the quality attributes of the prepared wines. Jakson and Badrie, (2003) also prepared wine from banana to which 15 percent peel added was identified as the best. Wine from over-ripe fruit is comparable to that from normal fruits when considering the sensory quality. Methods for wine production from banana have been optimized by Kotecha *et al*, (1994) also.

Beer

In Uganda "Waragi" is made in distilleries from banana beer. It was reported in 1971 that this national drink was approved by United States regulatory agencies for importation to the extend of 3000 cases annually (Anon,1990). According to Simmonds (1966) large quantities of beer are made from banana in Uganda and Tanzania. Sharock (1996) also reported about the production of banana beer in Africa, which is having low alcohol content (Stover, 1987).

Vinegar

Adams (1978) reported that vinegar can be prepared from ripe or rejected bananas by the addition of starch (2 percent), sugar (16 percent) and bakers yeast.

Alcohol

Maldonado *et al.*(1975) reported that mashed ripe bananas with added water, cane sugar (16° Brix) and mineral salts yielded as much alcohol as orange and black berry and more than pineapple and tamarind fruit.

By products from Banana

With the increase in the production of processed fruit products, the amount of fruit waste generated is increasing enormously. Large amount of these wastes pose the problem of disposal without causing environmental pollution. These wastes can be disposed effectively by manufacturing useful by products from them (Francis, 1995).

Schieber *et al.* (2003) opined that waste accumulated during the processing of fruits and vegetables could serve as a potential source of natural activities and functional food ingredients (Kalsi and Dhawan, 2001).

The large amount of unmarketable fruits available in all banana growing regions in India go as waste due to improper post harvest handling and lack of perceiving technology for value addition (Waskar and Roy, 1993).

Very few processed products from banana are marketed primarily due to difficulties in retaining the characteristics like colour, flavor and texture of banana pulp during processing (Palmer, 1993).

A valuable by product that can be obtained from fruit waste is peel. Peel designates those water-soluble pectinic acid of varying methyl ester content and degree of neutralization which are capable of forming gels with sugar and acids under suitable conditions (GITCO, 1999)

According to Simmonds (1996) the use of corms, shoots and male buds as food is wide spread in Africa and Asia but not in western hemisphere.

Dried banana fibers from the leaf sheath are used throughout the tropics for making weak rope and fibre containers. The tropical products research institute in London has reviewed the properties and small scale extraction and processing of banana fibre (Jarman , 1979).

Starch

Starch accumulates in the pseudostems reaches a maximum at the time of inflorescence and shooting remains constant untill harvest. When the psuedostem is cut down, starch must be extracted quickly as it declines rapidly within 2 days (Shandha and Sidhappa, 1979).

Convenience Foods

Technological developments in the field of food processing equipment and packaging materials have brought about revolution in the development of convenience foods. Manohar *et al.* (2005) are of the opinion that convenience foods can be designed to suit all segments of the population including armies, airways, railways and even patients with suitable supplements. According to Henry (1993) canned foods can be called as first mass-produced convenience foods.

Convenience foods have emerged as a newest of products in the international market (Anvita *et al.*, 1993). According to Arya (1984) convenience foods refer to a very heterogeneous group of foods varying in comparison, shape, size, and method of processing even with regards to their function in diet.

Premavalli *et al.* (2003) suggests that convenience mixes form an integral component of the operational ration packs supplied to armed forces. According to Devariya (1996) convenience foods are of three types, solid foods (eg: freeze dried products bakery items, confectionaries) concentrates, (eg: Jams, Jellies, Shrikhand, condensed milk, yoghurt, fruit pulp concentrates) and liquids (eg: sterilized milk, fruit juices and soups). While Manohar *et al.* (2005) classified convenience foods as ready to eat foods, ready to use foods and beverages; which are further divided into ready to drink and ready to serve beverages. A number of convenience foods from banana are available in the market. They include infant food mixes, wafers and other value added products. Thilak's Banaveeta, Banatone, Babyvita, Navami's Bana powder, Babyvita banana powder, Navami's Banania and Beads are some of the convenient foods from banana. Banana flour and mixes can be used efficiently for making savoury products, sweat meat items and health foods.

Materials and Methods

3. MATERIALS AND METHODS

The present study entitled "Developing multi purpose convenience mix from selected banana varieties" comprises of

3.1 Selection of banana varieties.

3.2 Processing and preparation of flour from banana.

3.3 Formulation of multipurpose convenience mix from banana flour.

3.4 Quality assessment of banana flour and the developed convenience mixes.

3.5 Product development.

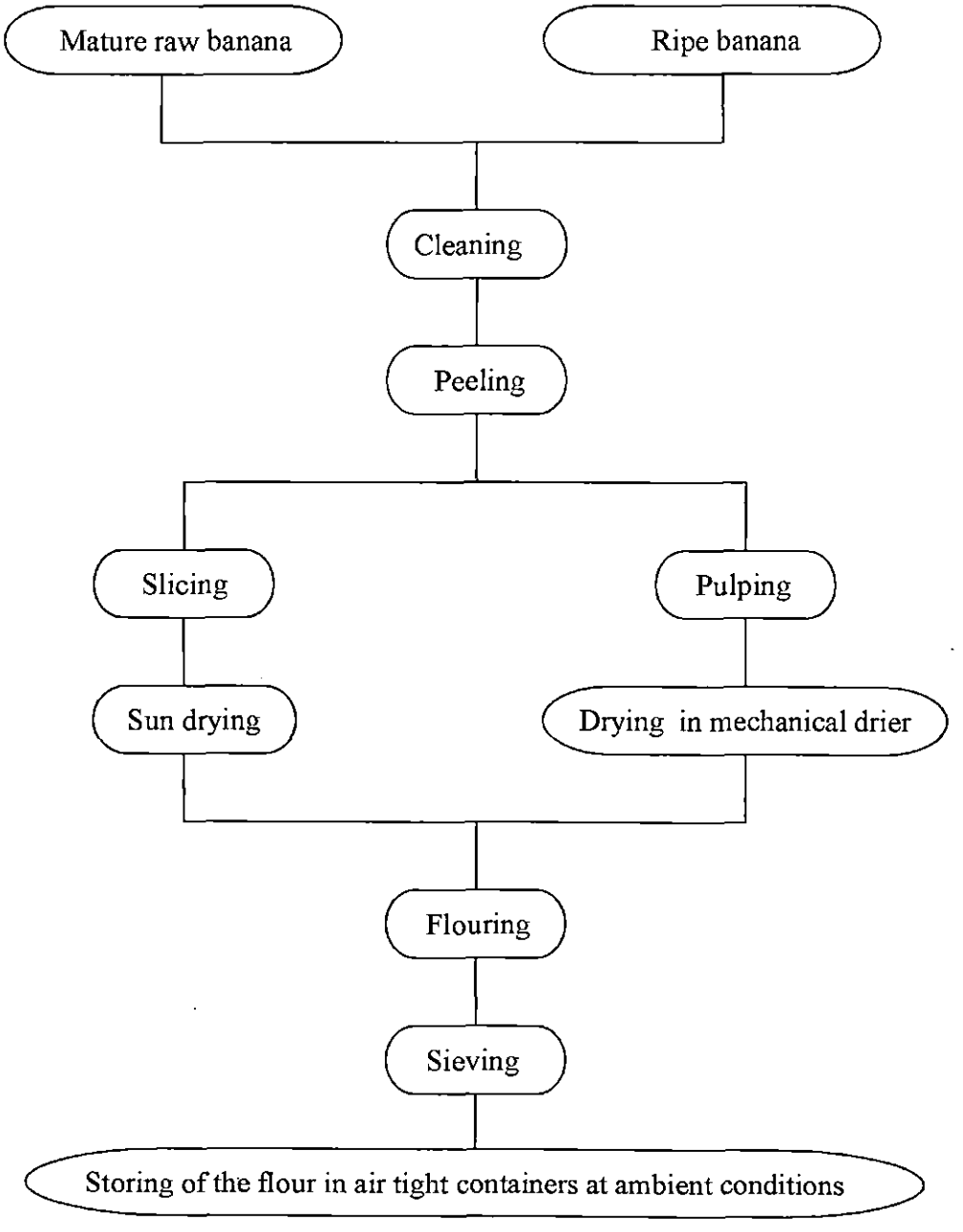
3.1 SELECTION OF BANANA VARIETIES

Robusta (*Musa* AAA) and Rasakadali (*Musa* AB) varieties of banana were selected for the present investigation since these varieties are gaining commercial importance (Indira,2003). Raw and ripe fruits were used for processing and development of the convenience mix.

3.2 PROCESSING AND PREPARATION OF FLOUR FROM BANANA VARIETIES

Robusta (Rb) and Rasakadali (Rk) required for the present study were procured from Instructional Farm, College of Agriculture, Vellayani. Raw as well as ripe fruits were used for the processing of flour. The method of preparation of flour from raw and ripe banana is depicted in the flow chart (Fig.1).

Fig 1. Flow chart showing the processing of flour from banana



To obtain good quality flour from ripe banana the pulp was mixed with minimum amount of cereal starch (10 to 15 per cent) as binding material.

3.3 FORMULATION OF MULTIPURPOSE CONVENIENCE MIX FROM BANANA FLOUR.

Different combinations of convenience mixes were formulated separately from raw as well as ripe flour of Robusta and Rasakadali. The standardization of developed convenience mixes was done by keeping the banana flour as base material and by blending it with ingredients such as rice flour, maida, black gram flour, bengal gram flour, extruded soya flour, milk powder and flavorings in different proportions. A total number of twenty four mixes were formulated and products were prepared initially to test the suitability of the mix for product development. Based on the acceptability of the products prepared, three types of mixes each made from Robusta and Rasakadali were selected for further study and they were designated as savoury mix, sweetmeat mix and health mix. Raw banana flour was used in the preparation of savoury mix, ripe banana flour was used in sweet meat mix and raw as well as ripe banana flour was utilized in the preparation of health mix.

The composition of multipurpose convenience mixes viz. savoury mix, sweetmeat mix and health mix are presented in Table 1.

Table 1 Different combinations of formulated convenience mixes

Convenience mixes	Name of mix	Ingredients	Proportion
RbC_1	Savoury mix	Rb (raw) flour +Soya flour + Riceflour + Black gram flour	60 : 10 : 20 : 10
RbC_2	Sweet meat mix	Rb (ripe) flour + Soya flour + Rice flour + Maida	50 : 10 : 20 : 20
RbC_3	Health mix	Rb (raw) flour + Milk powder + Soya flour + Bengal gram flour	40 : 40 : 10 : 10
RbC_4	Health mix	Rb (ripe) flour + Milk powder + Soya flour + Bengal gram flour	40 : 40 : 10 : 10
RkC_1	Savoury mix	Rk (raw) flour + Soya flour + Rice flour + Black gram flour	60 : 10 : 20 : 10
RkC_2	Sweet meat mix	Rk (ripe) flour + Soya flour + Rice flour + Maida	50 : 10 : 20 : 20
RkC_3	Health mix	Rk (raw) flour + Milk powder + Soya flour + Bengal gram flour	40 : 40 : 10 : 10
RkC_4	Health mix	Rk (ripe) flour + Milk powder + Soya flour + Bengal gram flour	40 : 40 : 10 : 10

C_1, C_2, C_3, C_4 –Convenience mixes Rb-Robusta Rk-Rasakadali

Robusta was used in combinations RbC_1, RbC_2, RbC_3 and RbC_4. While Rasakadali was used in the combinations RkC_1, RkC_2, RkC_3 and RkC_4.Combinations RbC_1, RkC_1, RbC_3 and RkC_3 were with raw banana flour and combinations RbC_2, RkC_2, $RbC_4$and RkC_4were with ripe banana flour.

3.4 QUALITY ASSESSMENT OF BANANA FLOUR AND THE DEVELOPED CONVENIENCE MIXES.

The quality parameters such as sensory characteristics, chemical composition, nutritional quality, functional quality, and shelf- stability of the banana flour and the developed mixes were assessed using standard techniques. Insect infestation and microbial growth analysis of the stored flour was studied initially and also after three months of storage.

3. 4.1 Sensory characteristics of the flour

Sensory characteristics like colour, flavour and texture were recorded. Colour is an important visual attribute, which helps one to judge the overall quality of a product. Hence colour of the banana flour and the developed mixes were examined visually soon after preparation and also after three months of storage.

Flavour of the banana flour and the developed mixes were recorded initially and also after three months of storage. Fineness and coarseness of the banana flour and the developed mixes were also evaluated soon after preparation and also after three months of storage.

3.4.2 Chemical composition

The banana flour and the developed mixes were analysed for moisture, total fibre, acidity, total soluble solids (TSS), reducing sugar and polyphenol content. Table 2 depicts the details of analysis and methods followed.

Table 2 Chemical composition of banana flour and convenience mixes.

Constituents	Methods
Moisture	Sadashivam and Manickam (1992)
Total fibre	Sadashivam and Manickam (1992)
Acidity	Thyagaraja *et al.* (1992)
TSS	Ranganna (2001)
Reducing sugar	Ranganna (2001)
Polyphenols	Ranganna (2001)

3.4.3 Nutritional quality assessment

The banana flour and the developed mixes were analysed for protein, calcium, and iron. Energy content of the flour and mixes were computed from the nutritive value table (Gopalan *et al.*, 1991). The methods followed for the analysis of nutritional quality are detailed in the Table 3.

Table 3 Nutritional composition of the banana flour and convenience mixes

Constituents	Methods
Protein	Thimmaih (1999)
Calcium	Tandon (1993)
Iron	Jackson (1973)
Energy	Gopalan *et al.*(1991)

3.4.4 Functional quality analysis

Functional quality analysis helps in qualitative evaluation of a new product. Functional qualities like change in weight, processing loss, bulk density, yield ratio, water absorption of banana flour and the developed mixes were studied.

3. 4.4.1 Processing loss

The processing loss was calculated by the difference between the weight of the food ingredients "as purchased" (Ap Wt) and that of the edible portion. (Ep wt).

The ratio of processing loss was calculated using the formula

$$\text{Processing loss} = \frac{\text{Ap Wt - Ep Wt}}{\text{Ap Wt}}$$

Two stage processing loss occurred during the processing of banana. They were loss occured during peeling and loss occured during drying and flouring.

Processing loss (On Peeling) =

$$\frac{\text{Weight of banana as purchased (Ap wt)- Weight of peeled Banana(Epwt)}}{\text{Weight of banana as purchased. (Ap wt)}}$$

Processing loss (On flouring) =

$$\frac{\text{Weight of peeled banana (Ap wt)-Weight of flour (EpWt)}}{\text{Weight of Peeled banana (Ap wt)}}$$

3.4.4.2 Yield ratio

Yield ratio of flour from Robusta and Rasakadali was also calculated. A product should have maximum yield ratio and minimum processing loss after processing. Yield ratio was calculated using the formula

$$\text{Yield ratio of the banana flour} = \frac{\text{Weight of the banana flour}}{\text{Weight of edible portion}}$$

3. 4.4.3 Change in weight

Change in weight was calculated in per cent weight loss of banana

Change in weight =

$$\frac{\text{Weight of peeled banana - Weight of dried banana}}{\text{Weight of peeled banana}} \times 100$$

3.4.4.4 Water absorption index

Water absorption index is the quantity of water absorbed by a known quantity of flour. Twenty grams of the flour was taken in a glass beaker and100 ml of water was added to it. The water was drained off after 10 minutes. The weight of the hydrated sample was recorded. The water absorption index was calculated by the difference between the hydrated sample and weight of raw sample.

Water absorption index = Weight of hydrated sample - Weight of raw sample

3.4.4.5 Bulk density

Bulk density is the ratio of the weight of the sample to the weight of an equal volume of water. Bulk density is used as an index for comparing the volume of different foods. The sample was taken at a height of 20 cm in a 50 ml beaker. It was leveled without compressing. The weight of the sample with the beaker was recorded. The sample was then removed from the beaker and water was filled to the same level. (20ml). The weight of the water with beaker was recorded and calculated using the formula

$$\text{Bulk density} = \frac{\text{Weight of the sample.}}{\text{Weight of equal volume of water}}$$

3.4 .5 Shelf stability of banana flour and convenience mixes

According to Thakur *et al.*(1995) chemical and sensory changes are influenced by storage period and containers used for storage. The fresh banana flour from Robusta and Rasakadali and eight combinations of convenience mixes formulated were stored in poly ethylene terephthalate (PET) and polypropylene covers for a period of three months.

The moisture content and peroxide value of stored samples were assessed after the storage period.

3.4.5.1 Insect infestation in stored banana flour

Insects are responsible for the quality deterioration of the flour by spoilage and contamination with their droppings during the storage period. Insect infestation was examined at monthly intervals.

3.4.5.2. Total microbial growth

The stored banana flour and the developed mixes were assessed for the presence of various micro-organisms that included bacteria, fungus and yeast after the storage period of three months. Serial dilution of the samples followed by spread plating was employed to estimate the population of viable micro-organisms in the flours and mixes (Johnson and Curl, 1972). One gram each of the banana flour and the developed convenience mixes were transferred aseptically to 9 ml sterile water blank and suspended thoroughly by mixing. Further progressive serial dilution up to 1000 fold of the suspension was done in sterile distilled water by serially transferring 1ml samples each in to 9ml water blanks.

Nutrient agar (NA), potato-dextrose agar (PDA), and yeast extract malt extract (YEMA) medium were used for culturing of bacteria, fungi and yeast respectively. Plates were poured and allowed for solidification 0.1ml of the

suspension from each dilution was then transferred on to the solidified agar medium using a sterile pipette and spread evenly with a sterile glass spreader. The whole procedure was done aseptically in a laminar air floor chamber. Plates were then kept for incubation at 28° C. Colonies appearing in the plates were recorded after 2 days in the case of bacteria and after 4 days for fungi and yeast. The microbial load of the samples was then expressed as cfu/g of the flour or mixes.

3.5 SUITABILITY OF THE MIX FOR PRODUCT DEVELOPMENT

The selected convenience mixes were tested for suitability of making different products from savoury, sweet meat and health mixes. The acceptability of the products were examined by a panel of judges using a score card. Parameters like appearance, colour, flavor, texture and taste of the products were studied. The cooking time, cost and the keeping quality of the products were also assessed.

3.6 STATISTICAL ANALYSIS

In order to obtain meaningful interpretation, the generated data was subjected to suitable statistical analysis (Arora and Malhan, 1998).

Results

4. RESULTS

The results of the present investigation entitled "Developing Multipurpose Convenience mix from selected banana varieties" are detailed in this chapter under the following heads:

4.1 Processing and preparation of flour from banana

4.2 Formulation of multipurpose convenience mix from banana flour

4.3 Quality assessment of banana flour and the developed convenience mixes

4.4 Product development from convenience mixes.

4.1 PROCESSING AND PREPARATION OF FLOUR FROM BANANA VARIETIES

Since the objective of the study is to develop convenience mix, raw as well as ripe forms of Robusta and Rasakadali varieties were primarily processed in to flour. The method of processing of flour from banana is shown in the flow chart (Fig.1) given in chapter III. Raw fruits of Robusta and Rasakadali were cut in to chips and were dried in sun light. The flour was prepared from the dried chips with the help of a mixer, sieved and stored in air tight containers till use.

In order to obtain good quality flour from ripe banana, the fruit pulp was mixed with minimum amount of cereal starch as binding material. Robusta was mixed with rice flour (10-20 percent) and dried to get the flour. In the case of Rasakadali the fruit pulp was mixed with 3-10 percent rice flour and dried. It was seen that 15 percent rice flour added to Robusta fruit pulp and 10 percent rice flour added to Rasakadali fruit pulp yielded good quality flour.

4.2 FORMULATION OF MULTIPURPOSE CONVENIENCE MIX FROM BANANA FLOUR

Convenience foods are foods that have undergone major processing by the manufacturer such that they require minimum cooking before consumption. (Manohar *et al.*, 2005). In the present investigation, different formulations of convenience mixes were standardized keeping banana flour as the base material and blending it with ingredients such as rice flour, maida, extruded soya flour, blackgram flour, bengal gram flour, milk powder and flavorings.

Three types of multi purpose convenience mixes were formulated with flours from Robusta and Rasakadali. Savoury mix(RbC_1 and RkC_1), sweet meat mix(RbC_2 and RkC_2) and health mix(RbC_3, RbC_4, RkC_3 and RkC_4) were the three types of mixes formulated. Savoury mix (RbC_1 and RkC_1) was prepared from the raw banana flour from Robusta and Rasakadali by mixing soya flour, rice flour and black gram flour in the proportion 60:10:20:10. Sweet meat mix (RbC_2 and RkC_2) was prepared from ripe banana flour from Robusta and Rasakadali, by mixing soya flour, rice flour and maida in the proportion 50:10:20:20. Where as health mix (RbC_3, RkC_3, RbC_4 and RkC_4) was prepared from both raw as well as ripe banana flour from Robusta and Rasakadali along with milk powder, soya flour and Bengal gram flour in the proportion 40:40:10:10. Thus there were two variations of savoury mix RbC_1 and RkC_1, two variations of sweet meat mix RbC_2 and RkC_2 and four variations of health mix RbC_3, RkC_3, RbC_4 and RkC_4.

4.3 QUALITY ASSESSMENT OF BANANA FLOUR AND THE DEVELOPED MIXES

4.3.1. Sensory characteristics

The sensory characters like colour, texture, and flavour of banana flour and developed convenience mixes were assessed by observation. The colour of the flour and mixes varied from pure white to light brown. Raw flour from both Rb and Rk had creamy white colour, while flours from ripe fruits of both Robusta and

Rasakadali were light brown in colour. All the flours were having acceptable flavour. Regarding the texture, soft-fine texture was observed for both Rasakadali and Robusta flour.

4.3.2. Chemical composition of banana flour and the developed convenience mixes

Chemical characteristics like moisture, total fibre, acidity, total soluble solids (TSS), reducing sugar, and polyphenol of the banana flour and the convenience mixes were analysed. The methods followed are detailed in Table 2.

Moisture

The moisture content of the banana flour and convenience mixes were analysed.The results are presented in Table 4.

Table 4 Moisture (per cent) of banana flour and convenience mixes.

Particulars	Rb	Rk	Mean
Raw flour	3.520	2.380	2.950
Ripe flour	3.260	2.540	2.900
C_1	2.310	2.270	2.290
C_2	3.170	2.340	2.755
C_3	4.090	4.030	4.060
C_4	3.840	3.170	3.505

C_1,C_2,C_3,C_4 – Convenience mixes
** Significant at one percent level

$F_{1,24}$V-1781.78** CD(0.05)M-0.0488
$F_{5,24}$M-1371.63** CD(0.05)V.M-0.0690
$F_{5,24}$V.M-172.48**

The moisture content of raw flour from Robusta was 3.52 per cent and that of Rasakadali was 2.38 per cent which differs significantly. Moisture content of ripe flour from Robusta (3.26 per cent) and that from Rasakadali (2.540per cent) was also significantly different from each other.

Moisture content was noted high in RbC_3 (4.090 per cent) and RkC_3 (4.030 per cent). Lower moisture content was observed in RbC_1 (2.310 per cent) and RkC_1 (2.270 per cent). Significant difference was observed between RbC_2 and RkC_2 and also between RbC_4 and RkC_4.

Total fibre

The total fibre content of the flour from Robusta and Rasakadali and the convenience mixes are depicted in the Table 5

Table 5 Fibre content of banana flour and convenience mixes.

Particulars	Rb(g/100 g)	Rk (g/100g)	Mean
Raw flour	0.301	0.300	0.3005
Ripe flour	0.190	0.110	0.150
C_1	0.370	0.320	0.345
C_2	0.308	0.290	0.299
C_3	0.260	0.210	0.235
C_4	0.200	0.190	0.195

C_1, C_2, C_3, C_4 - Convenience mixes.
** Significant at one percent level

$F_{1,24}V$-1647.21** CD(0.05)M-0.00305
$F_{5,24}M$-4950.40** CD(0.05)V.M-0.00432
$F_{5,24}V.M$-209.79**

The fibre content of raw flour from Robusta was 0.301g/100g and Rasakadali 0.300g/100g. Fibre content of ripe flour from Robusta and Rasakadali was

0.190g/100g and 0.110g/100g respectively and are significantly different, while Rb (raw) and Rk (raw) were on par.

In the case of convenience mixes, highest fibre content was observed in RbC_1 (0.370g/100g) and lower in RbC_4 (0.190g/100g). Significant difference at one percent level was observed between the mixes of two varieties, Robusta and Rasakadali.

Acidity

The Acidity of banana flour and the developed convenience mixes is presented in Table 6.

Table 6. Acidity (per cent) in banana flour and convenience mixes

Particulars	Rb	Rk	Mean
Raw flour	0.450	0.323	0.387
Ripe flour	0.580	0.510	0.545
C_1	0.127	0.064	0.096
C_2	0.256	0.128	0.192
C_3	0.192	0.064	0.128
C_4	0.212	0.256	0.234

C_1, C_2, C_3, C_4 - Convenience mixes

$F_{1,24}V$-676.55** CD(0.05)M-0.01812

$F_{5,24}M$-2141.63** CD(0.05)V.M-0.01529

$F_{5,24}V.M$-82.09**

** Significant at one percent level

Acidity was more in Rb (ripe) (0.580 percent) and Rk (ripe) (0.510 percent) compared to raw flour from Robusta (0.450 percent) and Rasakadali (0.323 percent).

When the convenience mixes were considered higher percent of acidity was noted in RbC_2 (0.256 percent) and RkC_4 (0.256 percent) and lower percent of acidity was noted in RkC_1 (0.064 percent) and RkC_3 (0.064 percent). On statistical analysis of the data, significant difference was observed between mixes of two varieties.

Total soluble solids (TSS)

The TSS content was assessed in raw as well as ripe Robusta and Rasakadali. The results are depicted in the Table 7

Table 7. TSS in Robusta and Rasakadali

Particulars	TSS (° Brix)
Rb (raw)	2.2
Rb (ripe)	23.3
Rk (raw)	3.1
Rk (ripe)	26.7

The highest TSS content was noticed in Rk (ripe) (26.7 ° Brix)and Rb (ripe) (23.3 ° Brix), while that of Robusta (raw)was 2.2 ° Brix and Rk (raw) was 3.1 ° Brix

Reducing sugar

Table 8 depicts the reducing sugar content in raw and ripe flours of Robusta and Rasakadali and in the developed convenience mixes.

Table 8 Reducing sugar in banana flour and convenience mixes

Particulars	Rb (g/100 g)	Rk (g/100 g)	Mean
Raw flour	1.27	0.12	0.695
Ripe flour	14.28	11.62	12.95
C_1	1.35	0.16	0.755
C_2	10.00	9.62	9.810
C_3	2.27	2.04	2.155
C_4	5.49	3.87	4.680
Mean	5.77	4.57	

C_1, C_2, C_3, C_4 - Convenience mixes

$F_{1,24}$V-52.168**

$F_{5,24}$M-627.086** CD(0.05)M-0.5964

$F_{5,24}$V.M-4.698** CD(0.05)V.M-0.8435

** Significant at one percent level

Reducing sugar in Rb (ripe) was observed to be 14.28g/100g and in Rk (ripe) 11.62 g/100g.The statistical analysis of the data revealed significant difference between Rb(ripe) and Rk (ripe).

In the case of convenience mixes, highest reducing sugar content was observed in RbC_2 (10.00g/100g) and in RkC_2 (9.62g/100g) and were on par. RbC_3 (2.27g/100g) and RkC_3 (2.04g/100g) were also on par.

Polyphenol

The polyphenol content of the flour from Robusta and Rasakadali and convenience mixes were analysed. The results are presented in Table 9

Table 9. Polyphenol in banana flour and convenience mixes

Particulars	Rb (µg/100g)	Rk (µg/100g)	Mean
Raw flour	420.00	235.00	327.5
Ripe flour	230.00	100.00	165.00
C_1	150.00	195.00	172.50
C_2	125.00	126.67	125.83
C_3	400.00	350.00	375.00
C_4	320.00	310.00	315.00

C_1, C_2, C_3, C_4 - Convenience mixes

$F_{1,24}$V-1218.69**

$F_{5,24}$M-512.58** CD(0.05)M-5.604

$F_{5,24}$V.M-512.58** CD(0.05)V.M-7.925

** Significant at one percent level

Polyphenol content was more in raw flour of Robusta (420.00µg/100g) than raw flour from Rasakadali (235.00µg/100g). In the case of ripe flour Robusta had more polyphenol (230.00µg/100g) than Rasakadali (100.00µg/100g).

Polyphenol in the convenience mixes were studied and found that RbC_3 had more polyphenol (400.00µg/100g) followed by RkC_3 (350.00µg/100g). Lower polyphenol content was observed in RbC_2 (125.00µg/100g) and RkC_2 (126.67µg/100g) which were on par to each other. While significant difference was observed between the corresponding convenience mixes of two varieties Robusta and Rasakadali.

4.3.3 Nutritional Quality Assessment

Protein, Calcium and Iron content of the banana flour and the developed convenience mixes were analysed. Energy content of the banana flour and

convenience mixes were computed from the table of nutritive value of the Indian foods (Gopalan *et al.*,1991).

Energy

The energy content of the banana flour and convenience mixes were computed and shown in the Table 10.

Table 10 Energy content of banana flour and convenience mixes

Particulars	Rb (kcal/100g)	Rk(kcal/100g)
Raw flour	256.00	188.16
Ripe flour	351.48	331.76
C_1	300.50	259.80
C_2	357.54	347.68
C_3	381.20	354.06
C_4	419.39	411.50

C_1, C_2, C_3, C_4 - Convenience mixes

In the case of banana flour the energy content ranged from the highest value of 351.48kcal (Rb(ripe)) to lowest value of 188.16kcal (Rk (raw)) flour. Among the mixes highest energy content was observed in RbC4 (419.39kcl/100g) followed by RkC_4 (411.50 kcal/100g), RkC_3 (354.06 kcal/100g) and RbC_3 (381.2 kcal/100g).

Protein

The results of the analysis the protein content of the banana flour and convenience mixes are detailed in Table 11 (Fig.2).

Table 11. Protein content of banana flour and convenience mixes

Particulars	Rb (g/100g)	Rk(g/100g)	Mean
Raw flour	3.33	2.45	2.89
Ripe flour	2.28	2.10	2.19
C_1	9.63	9.11	9.37
C_2	8.93	8.76	8.87
C_3	17.51	17.34	17.43
C_4	16.63	16.11	16.37

C_1, C_2, C_3, C_4 - Convenience mixes

** Significant at one percent level

$F_{1,24}$V-2523.31** CD(0.05)M-0.0289
$F_{5,24}$.M-422182.7** CD(0.05)V.M-0.0409
$F_{5,24}$V.M-209.71**

In the case of banana flour, protein content was observed to be high in raw flour from Robusta (3.33g/100g) followed by Rasakadali (2.45g/100g). The protein content in developed convenience mixes showed highest value in RbC_3 (17.51g/100g) followed by RkC_3 (17.34g/100g), RbC_4 (16.63g/100g) and RkC_4(16.11g/100g). Significant difference at one percent level was noted between RbC_1 and RkC_1,RbC_2 and RkC_2, RbC_3 andRkC_3 and RbC_4 and RkC_4.

Calcium

The Calcium content of the banana flour and the developed convenience mixes were analysed. The results are presented in Table 12 (Fig.3).

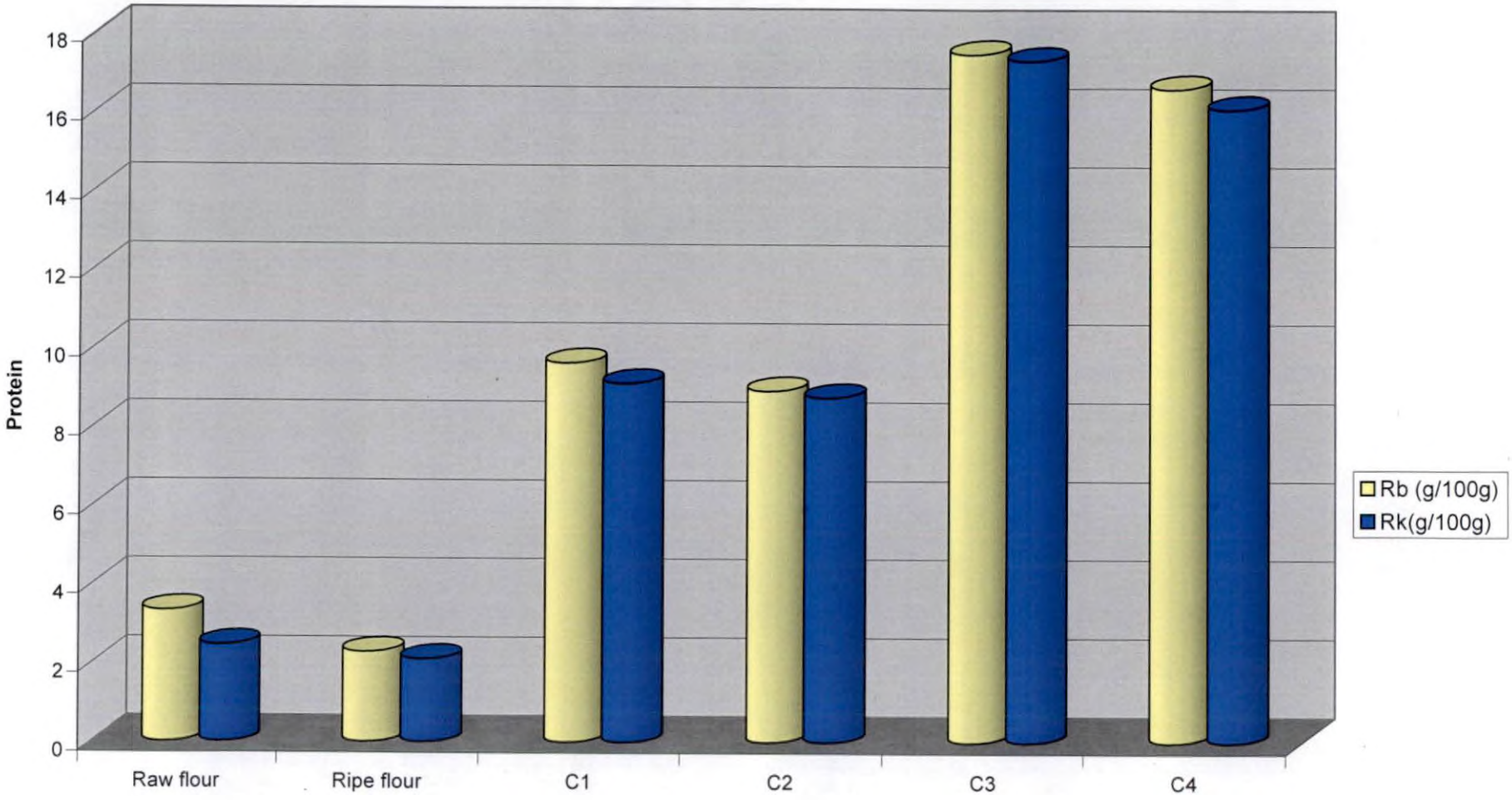


Fig.2. Protein content of banana flour and convenience mixes

Table 12. Calcium content in banana flour and convenience mixes

Particulars	Rb(mg/100g)	Rk(mg/100g)	Mean
Raw flour	43.31	35.00	39.10
Ripe flour	26.66	31.66	29.16
C_1	51.66	58.30	54.98
C_2	38.33	40.00	39.17
C_3	308.33	301.66	304.99
C_4	291.60	298.33	294.97

C_1, C_2, C_3, C_4 - Convenience mixes

** Significant at one percent level $F_{1,24}$V-14.824** CD(0.05)M-0.7929
$F_{5,24}$M-244185.3** CD(0.05)V.M-1.1213
$F_{5,24}$V.M-153.346**

Raw flour from Robusta was having 43.31mg/100g calcium and that from Rasakadali was 35.00mg/100g. Lower calcium level was observed in ripe flour from Robusta (26.66mg/100g) and Rasakadali (31.66mg/100g). As far as the convenience mixes were concerned, higher calcium content was observed in RbC_3 (308.33mg/100g). RkC_3 (301.66mg/100g). RbC_4 (291.60mg/100g) and RkC_4 (298.33mg/100g) were also having higher calcium level. Statistical analysis of the data revealed significant difference between the convenience mixes of Robusta and Rasakadali.

Iron

The banana flour and the convenience mixes were analysed for Iron content. The results are detailed in Table 13.

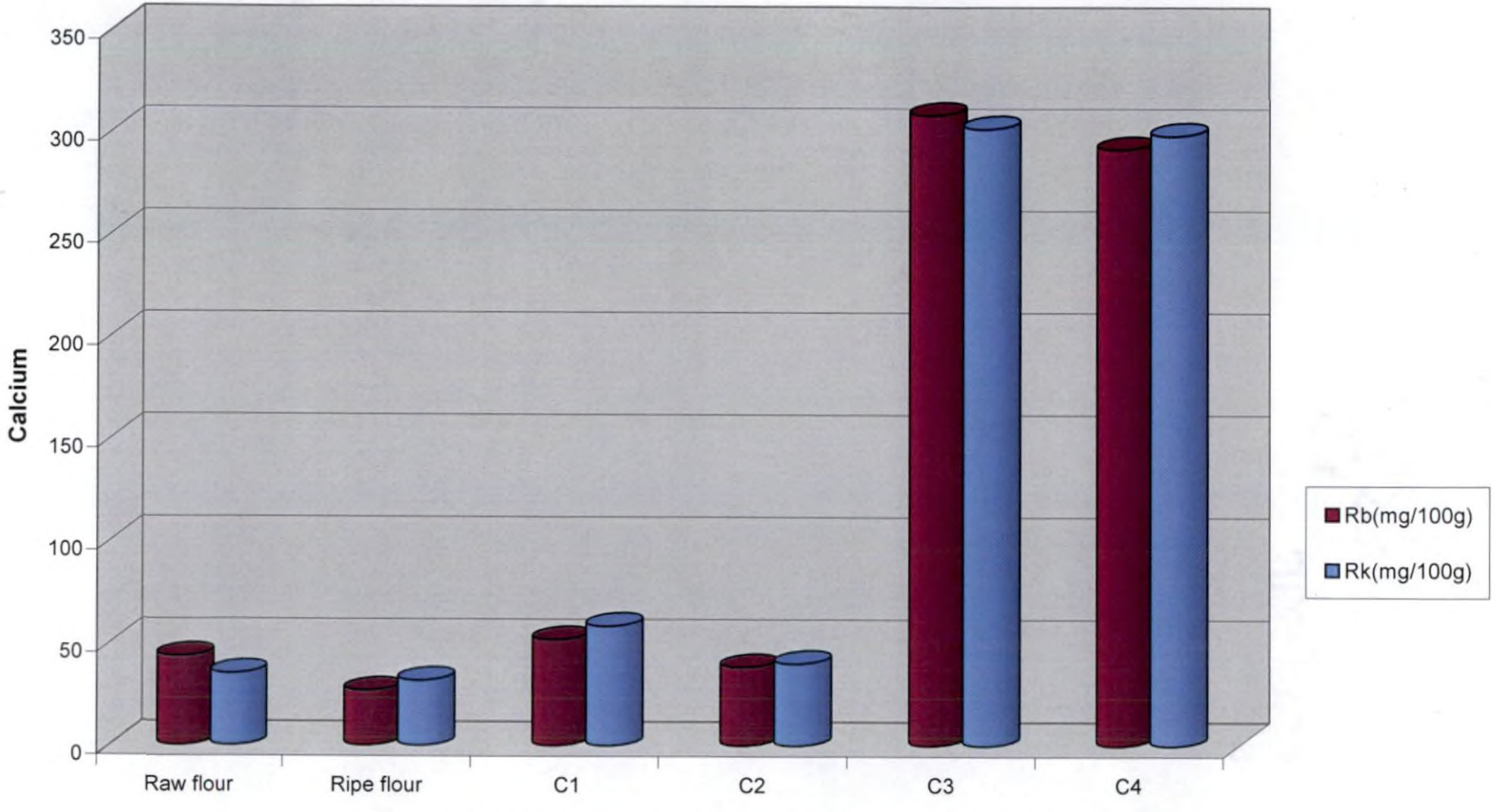


Fig.3. Calcium content of banana flour and convenience mixes

Table 13 Iron content in banana flour and convenience mixes

Particulars	Rb (mg/100g)	Rk(mg/100g)	Mean
Raw flour	1.00	0.67	0.835
Ripe flour	1.33	1.50	1.415
C_1	1.67	1.17	1.420
C_2	2.17	2.33	2.250
C_3	3.33	3.57	3.450
C_4	4.00	4.67	4.335

C_1, C_2, C_3, C_4 - Convenience mixes

$F_{1,24}$V-14.824** CD(0.05)M-0.0223

$F_{5,24}$M-31293.15** CD(0.05)V.M-0.0108

$F_{5,24}$V.M-760.978**

** Significant at one percent level

In the present investigation, iron content in the ripe flour from Robusta and Rasakadali was 1.33mg/100g and 1.5mg/100g respectively. Raw flour from Robusta and Rasakadali was having 1.00mg/100g and 0.67mg/100g iron respectively. Among the convenience mixes, highest iron content was observed in RkC_4 (4.67mg/100g) and RbC_4 (4.00mg/100g). Statistical analysis of the data revealed significant difference between RbC_1 and RkC_1, RbC_2 and RkC_2, RbC_3 and RkC_3,and RbC_4 and RkC_4.

4.3 4 Functional Quality Analysis

Functional qualities like processing loss, yield ratio, change in weight of banana flour were studied. Bulk density and water absorption index of the banana flour and the convenience mixes were also recorded.

Processing loss

The two stages of processing loss in banana were identified as peeling stage and drying and flouring stage.

Processing loss (On peeling)

Processing loss on peeling was recorded for raw as well as ripe Robusta and Rasakadali. The results are presented in Table 14.

Table 14 Ratio of processing loss (on peeling) of Robusta and Rasakadali

Particulars	Rb	Rk	Mean
Raw banana	0.397	0.206	0.302
Ripe banana	0.333	0.148	0.241

$F_{1,8}$V-42355.25** CD(0.05)C-0.00211
$F_{1,8}$C-4459.095** CD(0.05)V.C-2.9791
$F_{1,8}$ V.C-10.80952*
** Significant at one percent level
* Significant at five percent level

In the raw stage, maximum processing loss (on peeling) was observed for Robusta (0.397) than Rasakadali (0.206).In the ripe stage processing loss was comparatively less and it was found that 0.333 for Robusta and 0.148 for Rasakadali.

Processing loss (on flouring)

Processing loss during the preparation of flour was also recorded for raw as well as ripe Robusta and Rasakadali.

Table 15 Ratio of processing loss (on flouring) of Robusta and Rasakadali

Particulars	Rb	Rk	Mean
Raw flour	0.752	0.664	0.708
Ripe flour	0.667	0.654	0.661

$F_{1,8}$V-828.077** CD(0.05)C-0.004047
$F_{1,8}$C-732.59** CD(0.05)V.C-0.005723
$F_{1,8}$ V.C-456.671*
** Significant at one percent level
* Significant at five percent level

Processing loss on flouring was higher for Robusta than Rasakadali in raw as well as ripe stage. Statistical analysis showed significant difference between raw and ripe flour.

Yield ratio

The yield ratio of banana flour from raw as well as ripe Robusta and Rasakadali were recorded and are presented in Table 16.

Table 16 Yield ratio of flour from Robusta and Rasakadali.

Particulars	Rb	Rk	Mean
Raw flour	0.248	0.333	0.291
Ripe flour	0.335	0.346	0.341

$F_{1,8}$V-895.97**
$F_{1,8}$C-837.046** CD(0.05)C-0.00384
$F_{1,8}$ V.C-498.42** CD(0.05)V.C-0.00543
** Significant at one percent level

From the table it was observed that highest yield ratio was recorded for Rk (ripe) (0.346) and lowest yield ratio was for Rb (raw) (0.248). Analysis of the data showed significant difference between raw and ripe flour from Robusta and Rasakadali.

Change in weight

Change in weight will give a general idea about the drying loss of banana.

Table 17. Rate of change in weight of banana

Banana flour	Change in weight (percent)
Rb (raw)	72
Rb (ripe)	61
Rk (raw)	64
Rk (ripe)	61

Moisture loss occurs in banana on drying. Table 17 represents the rate of change in weight. It was observed that maximum change in weight was in Rb(raw) (72 percent), compared to Rk(raw) (64 percent). While in the case of dried fruit pulp, Robusta and Rasakadali in both the variety, the weight loss was same (61 percent).

Water Absorption Index

Water Absorption Index of the banana flour and convenience mixes were calculated and the results are presented in Table 18.

Table 18 Water absorption index of banana flour and convenience mixes.

Particulars	Rb	Rk	Mean
Raw flour	41.97	46.10	44.03
Ripe flour	48.40	50.30	49.35
C_1	44.27	45.00	44.63
C_2	46.07	44.63	45.07
C_3	19.20	16.47	17.83
C_4	17.06	17.10	17.08

C_1, C_2, C_3, C_4 - Convenience mixes

** Significant at one percent level $F_{1,24}V$-7.6376** CD(0.05)M-0.4461

$F_{5,24}V.M$-68.48** CD(0.05)-VM-0.6308

$F_{5,24}M$-9305.461**

Water absorption index of the raw flour from Robusta and Rasakadali was 41.97 and 46.10 respectively. While in the case of ripe flour from Robusta and Rasakadali, it was 48.40 and 50.30 respectively. RbC_3, RkC_3, RbC_4 and RkC_4 were observed to be having water absorption index of 19.20,16.47,17.06 and 17.10 respectively. Significant difference was observed between the mixes of two varieties, except RbC_4 and RkC_4.

Bulk density

Bulk density of banana flour and convenience mixes were also calculated and are the results are depicted in Table 19

Table 19. Bulk density of banana flour and convenience mixes

Particulars	Rb	Rk	Mean
Raw flour	0.895	0.959	0.927
Ripe flour	0.959	0.943	0.951
C_1	0.887	0.951	0.919
C_2	0.935	0.919	0.927
C_3	0.879	0.879	0.879
C_4	0.919	0.927	0.923

C_1, C_2, C_3, C_4 - Convenience mixes
** Significant at one percent level

$F_{1,24}$V-63.386** CD(0.05)M-0.00770
$F_{5,24}$V.M-49.184** CD(0.05)V.M-0.01097
$F_{5,24}$M-77.401**

Considering banana flour, bulk density of raw flour from Robusta and Rasakadali was 0.895 and 0.959 respectively. Ripe flour from Robusta and Rasakadali was having a bulk density of 0.959 and 0.943 respectively. As far as convenience mixes were concerned, higher bulk density was observed in RkC_1 (0.951) and lowest bulk density was noted in RbC_3 and RkC_3 (0.879). Significant difference at one percent level was observed between RbC_1 and RkC_1 and RbC_2 and RkC_2 .

4.3.5 Shelf stability of banana flour and convenience mixes

The shelf stability of banana flour and the convenience mixes were studied after a storage period of 90 days and the suitability of storage container were tested by storing them in polyethylene teraphthalate (PET) containers and polypropylene covers.

4.3.5.1 *Assessment of shelf life qualities*

Sensory qualities like colour, flavour and texture of the stored banana flour and convenience mixes were assessed by observation in comparison with same characteristics before storage. It was observed that there was no change in any of the sensory characters like colour, flavour and texture after the storage period.

The moisture content and peroxide value of the stored flour were also analysed after the storage period of three months.

Moisture

Moisture content of the banana flour and the convenience mixes stored both in PET containers as well as in polypropylene cover were assessed after three months of storage and the data are presented in Table 20.

Table 20 Moisture (percent) in banana flour and the convenience mixes stored in PET containers and in polypropylene covers

Particulars	Moisture (per cent) in PET containers					
	Raw flour	Ripe flour	C_1	C_2	C_3	C_4
Rb	3.92 (3.52)	4.66 (3.26)	2.49 (2.31)	4.19 (3.17)	5.06 (4.09)	5.44 (3.84)
Rk	2.67 (2.38)	3.91 (2.54)	2.42 (2.27)	3.29 (2.34)	4.83 (4.03)	4.94 (3.17)
Mean	3.30	4.29	2.46	3.74	4.94	5.24
Particulars	Moisture (per cent) in Polypropylene cover					
	Raw flour	Ripe flour	C_1	C_2	C_3	C_4
Rb	4.22 (3.52)	4.83 (3.26)	2.78 (2.31)	4.45 (3.17)	5.32 (4.09)	5.543 (3.84)
Rk	2.78 (2.38)	4.24 (2.54)	2.71 (2.27)	4.05 (2.34)	5.22 (4.03)	5.44 (3.17)
Mean	3.50	4.54	2.75	4.25	5.27	5.44

C_1, C_2, C_3, C_4 - Convenience mixes

M –Mixes C-Containers F 5,48 CVM=228.95** CD(0.05)CVM=0.03

Initial values are given in the parenthesis

** Significant at one percent level

From the table it was observed that there was significant difference in the moisture content of the banana flour and the convenience mixes, stored in PET containers and in Polypropylene covers. The extent of increase in moisture content was more in Polypropylene covers compared to PET containers. And that too, highest moisture content was noticed in RbC_3 (5.53) which was stored in polypropylene covers. And the lowest moisture content was noticed in RkC_1 (2.42) which was stored in PET containers.

Peroxide value

Peroxide value gives an indication about the extent of peroxidation taking place in the stored food materials. In the present investigation peroxide value was not detected in banana flour and convenience mixes before storage. Peroxide value could not detect in the stored banana flour since they have low fat content. The extent of peroxidation in the stored items were estimated and the values obtained are depicted in the Table 21.

Table 21 Peroxide value of convenience mixes stored in PET containers and in Polypropylene cover.

Peroxide value (PET containers)(meq/100g)				
Particulars	C_1	C_2	C_3	C_4
Rb	0.48	0.41	0.63	0.65
Rk	0.46	0.40	0.61	0.62
Mean	0.47	0.41	0.62	0.64
Polypropylene cover.				
Particulars	C_1	C_2	C_3	C_4
Rb	0.501	0.409	0.69	0.70
Rk	0.56	0.42	0.67	0.66
Mean	0.50	0.45	0.68	0.68

F3,32 CVM=9702.85

Peroxide value could not detect in the banana flour, since they have low fat content. While observing the data in the table, it was clear that the values obtained for the mixes stored in PET containers were lesser than the mixes stored in polypropylene covers. Peroxide value was found to be high in RbC_4 stored in polypropylene cover (0.70 meq/100g) in comparison with others.

4.3.5.2 *Insect infestation in stored banana flour and convenience mixes*

The incidence of insect attack in stored banana flour and convenience mixes was assessed monthly for a period of three months. Banana flour and convenience mixes stored in both PET containers and polypropylene covers were completely free of insect infestation.

4.3.5.3 *Assessment of microbial growth in banana flour and convenience mixes*

Microbial growth in the stored items were assessed after the storage period of three months. Media used for the assessment of bacteria, yeast and fungi were nutrient agar(NA), yeast extract malt agar(YEMA) and potato dextrose agar(PDA) respectively. It was observed that in all the media, fresh samples were free of any of the micro organisms. Among the stored samples, microbial growth was observed.

Table 22 depicts the details regarding the microbial load present in the stored banana flour and convenient mixes.

Table 22 Microbial load in banana flour and convenience mixes

Particulars	Microbial load (cfu/g)					
	PET containers			Polypropylene cover		
	Bacteria	Fungus	Yeast	Bacteria	Fungus	Yeast
Rb(raw)	$3.86x10^3$	ND	$2.5x10^1$	$6.88x10^3$	ND	$2.5x10^1$
Rb(ripe)	$3x10^1$	ND	ND	$1.75x10^2$	ND	$2x10^1$
RbC_1	$3.55x10^3$	ND	$3.5x10^2$	$4x10^4$	ND	$7.5x10^2$
RbC_2	$1.9x10^2$	$1.5x10^1$	ND	$2.75x10^2$	$2.5x10^1$	$2x10^1$
RbC_3	$3.33x10^2$	ND	ND	$1.49x10^3$	ND	$5.5x10^1$
RbC_4	ND	ND	ND	3.5x101	ND	ND
Rk(raw)	$3.57x10^3$	ND	$3x10^1$	$5.68x10^3$	$3x10^1$	$1x10^1$
Rk(ripe)	ND	ND	ND	1x101	1.65x101	ND
RkC_1	$3.4x10^3$	$1.5x10^1$	$1.7x10^1$	$5.05x10^3$	$1x10^1$	$19x10^1$
RkC_2	$1.5x10^2$	ND	ND	$1.5x10^1$	$1.5x10^1$	ND
RkC_3	$1x10^1$	ND	ND	$4.5x10^1$	ND	ND
RkC_4	ND	ND	ND	$2.5x10^1$	ND	ND

ND-Not Detected

From the table it is obvious that microbial load was comparatively high in Robusta than Rasakadali. When considering the raw flour and ripe flour, more microbial growth was observed in the raw flour than ripe flour. When the mixes were considered, highest microbial load was observed in the mix C_1 (RbC_1 and RkC_1) and lowest in C_4 mix (RbC_4 and RkC_4). Considering the storage containers PET

container was found ideal for storing flour and mixes than polypropylene covers, which was more prone to microbial growth.

Raw flour from Robusta ($6.88x10^3$) and Rasakadali ($5.68x10^3$) stored in polypropylene cover were observed to have higher bacterial load than that in PET containers. Fungal and yeast count were negligible in all the flours and mixes.

4.4 SUITABILITY OF THE MIX FOR PRODUCT DEVELOPMENT

The developed convenience mixes were tested for the suitability for making different products. The three types of convenience mixes, savoury mix, sweet meat mix and health mix were used for the preparation of savoury items, sweet meat products and health drinks respectively.

Savoury products are usually salty and / or pungent ,soft or crisp in texture, with attractive flavour. "Murukku" a spicy crisp product was prepared from the savoury mix and acceptability was tested among selected panel of judges using a score card.

Sweetmeat products are usually sweet in taste, soft or crisp in texture and have acceptable flavour. "Unniyappam" a traditional sweet product was prepared from the sweet meat mix and acceptability was tested among selected panel of judges using a score card.

Health drink was prepared from health mix by adding flavourings and tested for acceptability among selected pannel members. Suitability of the convenience mixes stored in PET containers and polypropylene covers were tested separately for their acceptability.

Parameters like appearance, colour, flavour, texture, taste and doneness of the developed products were assessed by using a score card of four point scale (Appendix I,II and III)

4.4.1 Murukku from savoury mix

Murukku was prepared from the savoury mixes such as RbC_1 and RkC_1 which were stored both in PET container and polypropylene cover (Appendix IV). The prepared items were then subjected to scoring by the judges in order to note its acceptability. Data are presented in Table 23. (Fig.4).

Table 23 Rank means of organoleptic parameters of Murukku.

Products	Rank means					
	Appearance	Colour	Flavour	Texture	Taste	Doneness
RbC_1(p)	32.46	32.81	32.77	33.27	32.77	33.62
RbC_1(c)	27.69	29.81	27.35	26.04	27.23	28.08
RkC_1(p)	24.08	23.19	24.50	25.69	24.19	23.27
RkC_1(c)	21.77	20.19	21.38	21.00	21.81	21.04
χ^2	4.543	7.392	4.839	5.35	4.789	6.589

(p) PET container (c) poly propylene cover

From the analysis of the data on scores obtained for murukku ,significant difference was not found with respect to organoleptic parameters such as appearance, colour, flavour, texture and doneness. Similar values obtained for different parameters indicate that, variety as well as storage containers had little influence on the product quality.

4.4.2 Unniyappam from sweet meat mix.

Unniyappam, which is one of the favourite sweet items of Keralites was prepared from the sweet meat mix (Appendix IV). RbC_2 and RkC_2 stored in PET container as well as in polypropylene cover ,were used to prepare Unniyappam. The data are presented in Table 24. (Fig.5).

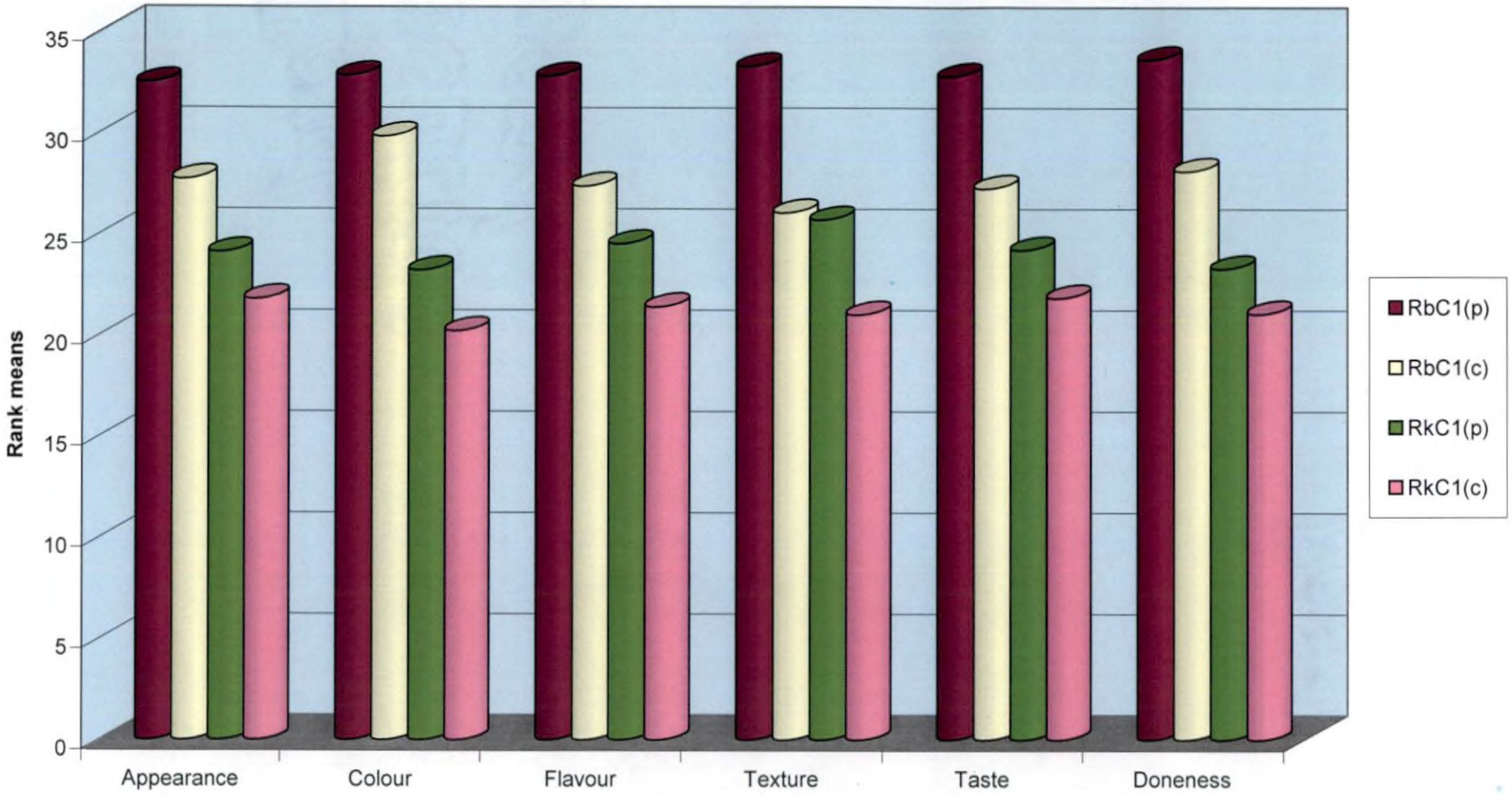


Fig.4. Rank means of organoleptic parameters of murukku

Table 24. Rank means of organoleptic parameters of Unniyappam

Products	Rank means					
	Appearance	Colour	Flavour	Texture	Taste	Doneness
$RkC_2(c)$	27.69	27.96	25.04	28.19	27.58	27.69
$RbC_2(c)$	20.12	21.19	20.31	19.65	20.04	17.88
$RkC_2(p)$	35.23	32.73	34.65	35.73	33.23	33.58
$RbC_2(p)$	22.96	24.11	26.00	22.42	25.15	26.85
χ^2	9.488*	$5.511_{(NS)}$	7.897*	10.879*	$6.824_{(NS)}$	9.596*
CV	11.6506					

NS Not Significant * Significant at five percent level

(p) PET container (c) poly propylene cover

From the statistical analysis of the scores obtained for different products, $RkC_2(p)$ was found to be more acceptable with respect to appearance colour, flavour, texture, doneness and taste.

The appearance of four products, $RkC_2(p)$ was significantly superior from $RbC_2(c)$ and $RbC_2(p)$. $RkC_2(c)$ was on par with RbC_2 (c). As far as the colour of the product was concerned there was no significant difference between $RkC_2(c)$, $RbC_2(c)$, $RkC_2(p)$,and $RbC_2(p)$. When the parameter flavour was considered RkC2(p) was significantly superior from $RbC_2(c)$ and $RbC_2(p)$.

In the case of texture, $RkC_2(p)$ varied from $RbC_2(c)$ and $RbC_2(p)$ while $RkC_2(p)$ was on par with $RkC_2(c)$. As far as the parameter taste was considered significant difference was not observed. In the case of doneness, $RkC_2(p)$ was observed to be superior than $RbC_2(c)$, while $RkC_2(p)$ was on par with $RkC_2(c)$ and $RbC_2(p)$. In short $RkC_2(p)$ was found to be most acceptable.

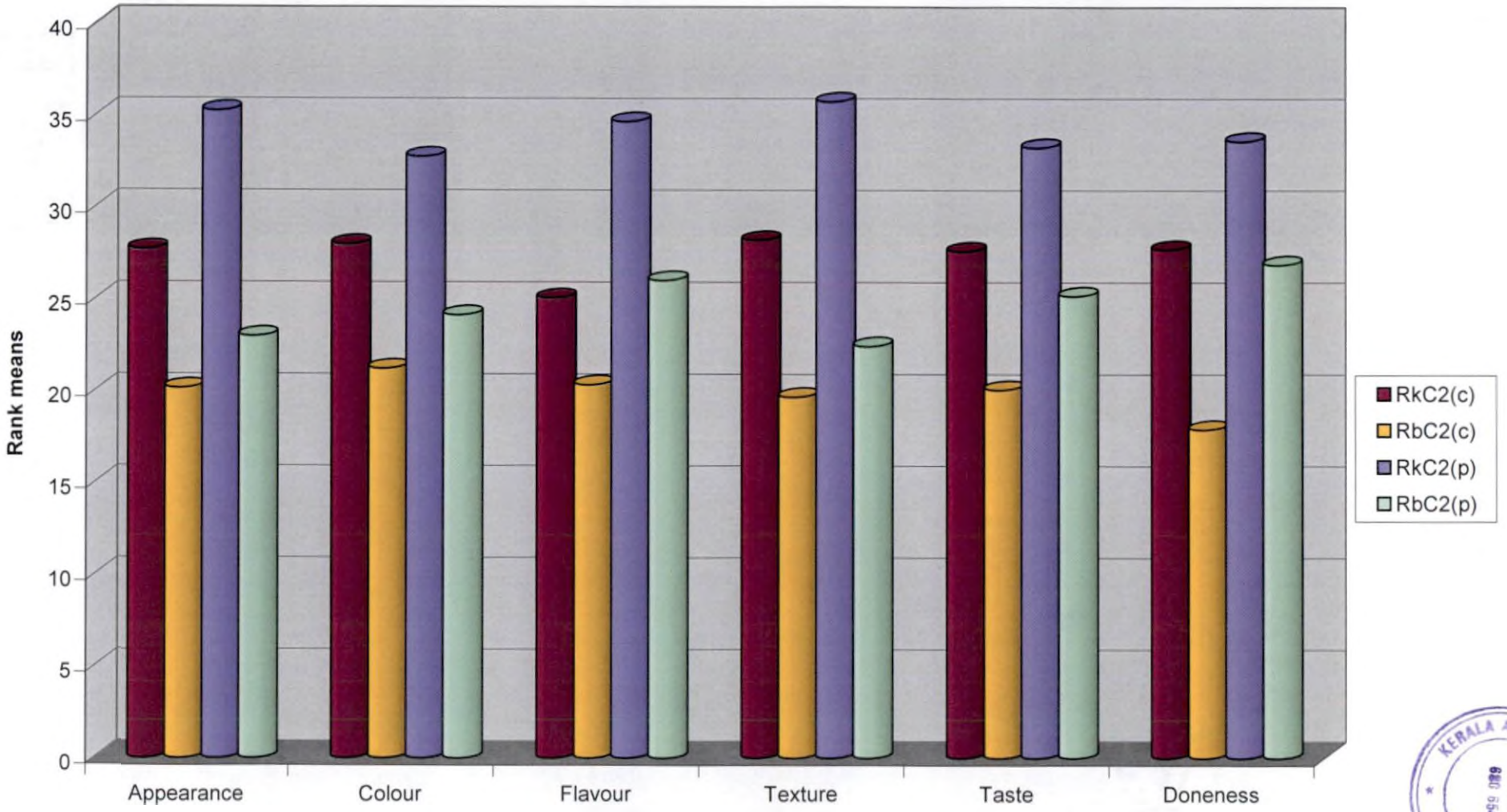


Fig.5. Rank means oforganoleptic parameters of unniyappam

4.4.3 Health drink from health mix

Health drink is considered as a functional food and is basically a food derived from naturally occurring raw materials that is taken as part of daily diet. (Neelofar, 2004). In the present study, health mixes such as RbC_3, RkC_3 (both from raw banana flour),RbC_4 and RkC_4 (both from ripe banana flour) were used to prepare health drink .10g of the health mix was used to prepare 200 ml of drink. The mix was mixed with sugar and boiling water. A pinch of vanilla powder was used as flavouring agent.(Appendix IV). Health drinks both from raw flour and ripe flour were prepared and subjected to acceptability test among selected judges. Data is presented in Table 25 (Fig.6)

Table 25 Rank means of organoleptic parameters of Health drink.

Products	Rank means				
	Appearance	Colour	Flavour	Consistancy	Taste
RbC_3(p)	31.4	34.81	36.27	48.96	44.04
RbC_4(p)	60.38	57.27	58.92	52.69	57.19
RkC_3(p)	46.88	45.19	49.03	39.96	45.04
RkC_4(p)	73.31	74.58	75.85	69.81	78.42
RbC_3(c)	41.31	42.81	41.27	34.92	38.96
RbC_4(c)	55.69	53.81	55.54	48.96	57.19
RkC_3(c)	41.31	43.88	30.65	58.62	31.35
RkC_4(c)	70.08	67.65	72.46	66.08	67.81
χ^2	25.832*	21.799*	32.054*	18.164*	30.139*
CV	23.191				

(p) PET container (c) Polypropylene cover * Significant at five percent level

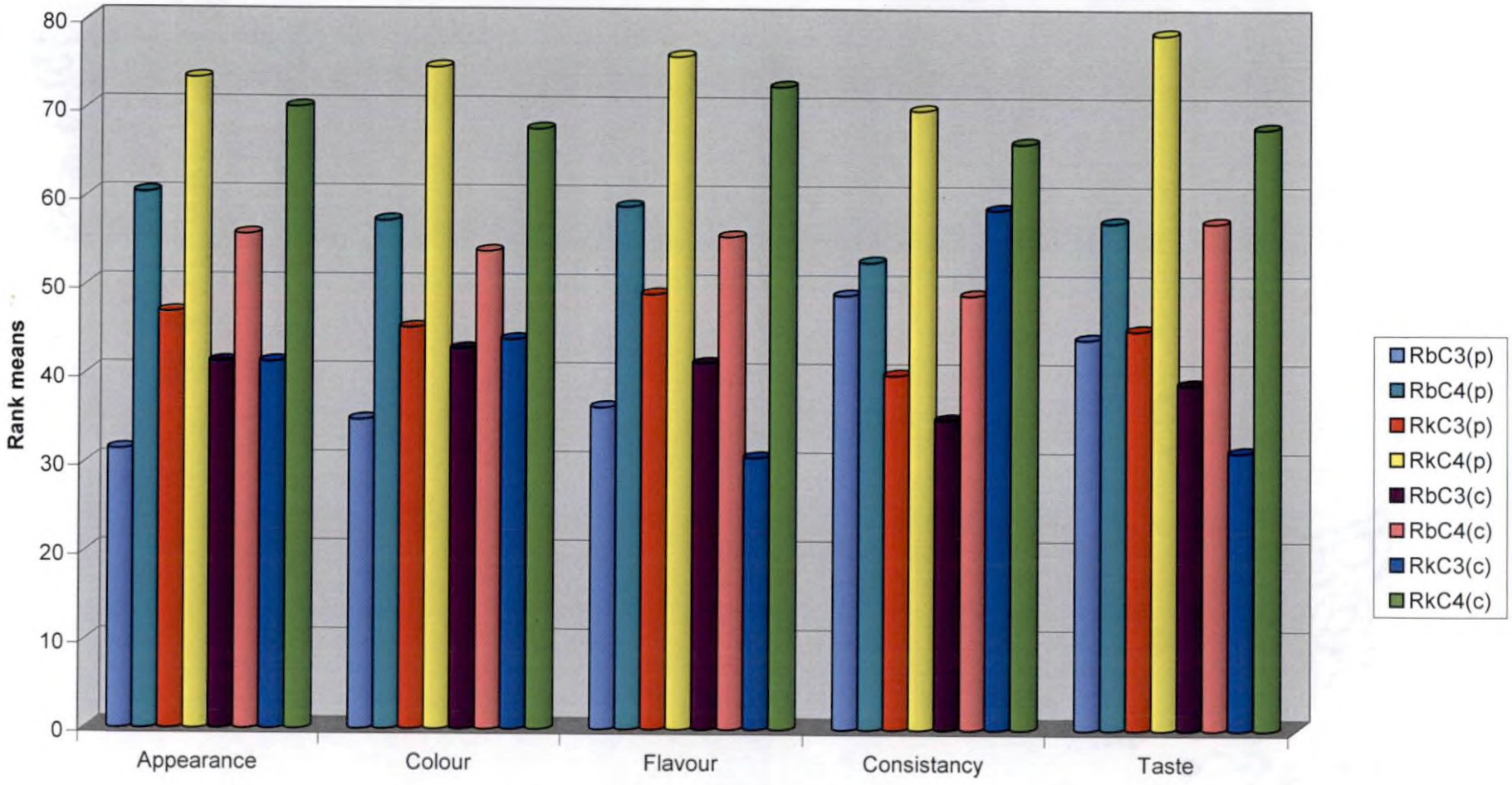


Fig.6. Rank means of organoleptic parameters of health drink

From the analysis of the score obtained for health drink, it was obvious that,$RkC_4(p)$ was more acceptable than any other formulation with respect to appearance, colour, flavour, consistency and taste. Considering the rank means of appearance of different products, $RkC_4(p)$ was noted significantly superior from $RbC_3(p)$, $RkC_3(p)$, $RbC_3(c)$ and $RkC_3(c)$. While $RkC_4(p)$ is on par with $RbC_4(p)$, $RbC_4(c)$ and $RkC_4(c)$.

As inferred from the CV value $RkC_4(p)$ showed significant difference with $RbC_3(p)$, $RkC_3(p)$, $RbC_3(c)$, while it was on par with $RbC_4(p)$, $RbC_4(c)$, and $RkC_4(c)$ as far as the colour was concerned.

Considering the parameter flavour $RkC_4(p)$ varied significantly superior from $RbC_3(p)$,$RkC_3(p)$, $RbC_3(c)$and $RkC_3(c)$, while it is on par with $RbC_4(p)$, $RbC_4(c)$and $RkC_4(c)$.

In the case of consistancy $RkC_4(p)$ was found significantly superior from $RkC_3(p)$ and $RbC_3(c)$. $RbC_3(p)$, $RbC_4(p)$, $RbC_4(c)$, $RkC_3(c)$,and $RkC_4(c)$ were on par with $RkC_4(p)$.Taste plays an important role in the acceptability of any new product. As in the case of taste, $RkC_4(p)$ showed significant difference from $RbC_3(p)$, $RkC_3(p)$, $RbC_3(c)$and, $RkC_3(c)$. While $RbC_4(p)$, $RbC_4(c)$,and $RkC_4(c)$,were on par with $RkC_4(p)$.

The overall acceptability of the products Murukku, Unniyappam and Health drink were presented in appendix V,VI andVII . From the statistical analysis of the scores and overall acceptability scores, savouy mix prepared from raw Robusta flour stored in PET containers ($RbC_1(p)$) was suitable for making for Murukku. Sweet meat mix prepared from Rasakadali flour and stored in PET containers ($RkC_2(p)$) was good for making Unniyappam and the health mix prepared from Rasakadali and stored in PET container ($RkC_4(p)$) was ideal for making health drink.


Health drink from health mixes
Murukku from savoury mix
Unniyappam from sweet meat mix

Cooking time

The time required for the preparation of each product was observed in order to determine the ease of preparation. The time taken for cooking Murukku, Unniyappam and Health drink is shown in the table 26.

Table 26. Ease of preparation of products.

Products	Convenience mix	Time required (Minutes)
Murukku	RbC_1	5.00
	RkC_1	6.30
Unniyappam	RbC_2	3.30
	RkC_2	4.00
Health drink	RbC_3	2.00
	RkC_3	
	RbC_4	
	RkC_4	

The time required for cooking (frying) Murukku and Unniyappam was very short that is 3.30 to 6.30 minutes. Compared to Murukku less time was taken to fry Unniyappam. In the case of health drink, the time required was 2.00 minutes and it was prepared directly by mixing with boiling water.

Cost

In order to realize the economic feasibility of the developed convenience mixes[Savoury mix,(RbC_1 and RkC_1),Sweet meat mix (RbC_2 and RkC_2) and health mix (RbC_3, RkC_3,RbC_4 and RkC_4)] the cost was calculated.

The cost of the convenience mixes and the products developed are presented in table 27.

Table 27 Cost of convenience mixes and products.

Convenience mix/products		Cost of convenience mixes Rs /kg	Cost of the products Rs /kg
Savoury mix(Murukku)	RbC_1	34.30	52.50
	RkC_1	40.10	59.00
Sweet meat mix (Unniyappam)	RbC_2	33.00	69.00
	RkC_2	39.70	76.00
Health mix (Health drink)	RbC_3	99.20	127.00
	RkC_3	103.10	131.50
	RbC_4	100.60	129.00
	RkC_4	105.90	134.50

The cost of the developed convenience mixes ranged from, 33.00(RbC_2) to 105.90 (RkC_4) .The cost of the sweet meat mix (RbC_2 and RkC_2) was found to be less than the savoury mix (RbC_1 and RkC_1) and health mix(RbC_3, RkC_3, RbC_4 and RkC_4). The high cost of health mix may be due to the presence of milk powder in the mix.

The cost of the products ranged from Rs 52.58 (Murukku from RbC_1) to Rs 134.53 (Health drink with RkC_4). An overhead charge of 10 percent was added to all the products while computing the cost.

Keeping quality of the product

The keeping quality of Murukku, Unniyappam and Health drink were observed and recorded. Every day the organoleptic qualities were observed and recorded. The

change in appearance, colour, flavour, texture and taste of the product were recorded daily.

Unniyappam prepared from Robusta mix (RbC_2) showed better keeping quality than Rasakadali mix (RkC_2). Unniyappam from Robusta mix stood as fresh for seven days without any considerable change in any of the parameters like appearance, colour, flavour, texture and taste. While Unniyappam from Rasakadali mix (RkC_2) stood fresh for five days.

Murukku prepared from both Robusta and Rasakadali mix (RbC_1 and RkC_1) was fresh for two weeks. After which the crisp texture was changed.

Discussion

5. DISCUSSION

The results of the present investigation entitled "Developing multipurpose convenience mix from selected banana varieties" are discussed below.

5.1 PROCESSING OF BANANA

Banana and plantain are the fourth most important food crop and has been used as a fruit from time immemorial (NAAS, 2001). Even if India is the largest producer of banana (Rai, 2002),large quantities of banana are being wasted due to improper post harvest handling and lack of processing technology for value addition (Kumar *et al.*,2003). Hence it has to be preserved to provide the consumer with palatable, wholesome, nutritious and tasty foods in a convenient form, throughout the year (Wasker and Roy, 1993)

In the present investigation Robusta and Rasakadali varieties of banana were selected since these varieties are gaining commercial importance (Indira,2003).

Product diversification is the need of the hour due to rapid changes in socio-economic and living styles of the people dwelling in the rural and urban areas; as a result more and more convenient foods are entering the market (Kulkarni,1992). Consumers prefer nutritionally sound and minimally processed convenience foods with longer shelf life (Neetha *et al.*,2001).

In order to develop convenience mixes from selected banana varieties the raw and ripe banana were first processed in to flour. Rai (2002) is of the opinion that banana flour is prepared from unripe fruits and banana powder is from ripe fruits. Shanmugavelu *et al.* (1992) states that the banana powder contain many nutrients required for the general wellbeing of the body.

5.2 FORMULATION OF MULTIPURPOSE CONVENIENCE MIX

As suggested by Sohrab (1995) people are opting a busy life and many of the basic foods are modified to processed convenience foods. Frost and Sullivan (1990) have defined convenience foods as those products in which all or a significant portion of their preparation has been transferred from the consumers kitchen to the processing plant. Sandra and Andrews (1991) are of the opinion that convenient foods are convenient to use. According to Tirumaran (1993) the introduction of locally processed and preserved nutritious ready to use foods will reduce the time spent in drudgery by the farm women along with income generation and improved nutritional standards.

In the present investigation three types of convenience mixes were formulated by keeping banana flour as the base material and these convenience mixes were standardized from different combinations of ingredients. The first one was "savoury mix" using raw banana flour, black gram flour, rice flour and soya flour in the proportion of 60:10:20:10. The second mix was "sweetmeat mix" which was developed using ripe banana flour from Robusta and Rasakadali along with maida, soya flour and rice flour in the proportion of 50:20:10:20. The third one was "health mix" using raw as well as ripe banana flour from Robusta and Rasakadali, milk powder, soya flour and bengal gram flour in the proportion of 40:40:10:10. According to Srivastava (1992) nutritional and functional quality can be improved by combining cereals and pulses .

In all the three mixes locally available food materials were added as suggested by Munday *et al.*, (1989) the use of locally available protein rich resources which includes wheat, rice and soyabean are good for manufacturing low cost protein supplements. In all the mixes, soya flour was added. Soya protein, a high quality plant based protein was incorporated in food supplements developed by Nirmala (2002) and Dhanya (2005). Milk powder was added in health mix, to improve the nutrient content and taste. Neelofar (2004) and Chellammal(1995) had

also used milk powder in the mixes to improve the taste and nutrient content of the mix. Susan (1992) developed a weaning food with banana, sesame, horse gram, skim milk powder and sugar which was well accepted by children.

Varshney (2001) is of the opinion that a health food has to be 100 per cent natural, free from additives like synthetic colour, flavour or any preservative. Srilakshmi (2003) is of the opinion that health foods help the consumers to attain health in a convenient and natural way. The developed convenience mixes were subjected to quality assessment.

5.3 QUALITY ASSESSMENT OF BANANA FLOUR AND THE DEVELOPED CONVENIENCE MIXES

Setty (1989) has defined the quality of a food as a combination of the attributes that determine the degree of acceptability of the product. These include nutritional value, microbiological safety, cost, convenience and organoleptic qualities.

Thus the banana flour and developed mixes were assessed for qualities like sensory characters, chemical composition, nutrient content and functional quality..

5.3.1 Sensory characteristics

Characters like colour, texture and flavour of banana flour and convenience mixes are to be assessed. According to Fergus (1993) colour influences the food acceptability, choice and preference. The colour of the raw banana flour was creamy white while ripe banana flour was light brown in colour. The colour of convenience mixes ranged from creamy white to light brown. Raw banana flour was finer than ripe flour.

According to Birch *et al.* (1988) flavour is the mingled but unique experience of sensation produced by a material taken in the mouth perceived principally by the senses of basic smell and by other cutaneous smell in the mouth. In the present

investigation the flours and mixes were found to have a pleasant flavour, especially the mixes, RbC_3,RkC_3, RbC_4 and RkC_4. This might be due to the presence of skim milk powder in these mixes. Dijkhuizen (2000) had supported the addition of skim milk powder which improves the flavour of the supplements.

5.3.2 Chemical composition

Suitable laboratory techniques were followed to test its chemical constituents like moisture, total fibre, acidity, TSS, reducing sugar, and polyphenols. As suggested by Saxena (2003) laboratory analysis is one of the best methods to assess the quantity of different constituents present in the products.

The moisture content of the banana flour ranged from 2.380 to 3.520 per cent. From the analysis of the data significant difference was observed between the raw flours and ripe flour of Robusta and Rasakadali.

Moisture content in the flour and mix gives a clear indication about the shelf stability. As suggested by Shankar (1993) lower moisture content will give longer shelf stability. In the present study moisture content of the raw flour from Robusta and Rasakadali was 3.52 per cent and 3.26 per cent. While Patel and Nagar (1974) reported 2.57 per cent and 1.05 per cent in Robusta flour and Rasakadali flour respectively.

Moisture content in the convenience mix was found to be more in the mixes RbC_3 (9.090 percent) and RkC_3 (4.030 percent). Neelofar (2004) had reported the moisture content in therapeutic health mix as 8.58 percent and in malted health drink mix as 9.09 percent. While Shruthi (2005) reported the moisture content of health drink mix developed from jackfruit seed flour as 4.25 per cent in malted health drink mix and 6.21 per cent in spiced health drink mix.

The fibre content of the banana flour and the convenience mixes were found to be very low. Malleshi (1995) has stated that the indigestible fibre content of a complementary food should be low, because the fibre may interfere with the

absorption of nutrients. Raw flour from Robusta and Rasakadali was noted to have similar fibre content.

The fibre content of the convenience mixes ranged from 0.190 to 0. 370 g/100g. A wheat based product developed by Rajapaksa (2003) had a fibre content of 1 to 2g per 100g. The fibre content of banana is 0.4g per 100g (Gopalan *et al.*, 1992). The low fibre content of the banana flour and mixes in the present study might be due to the loss of fibre on processing.

Forsyth (1980) had reported that the presence of malic acid, citric acid and oxalic acid are responsible for the acidity in banana. In the present study the acidity of flour ranged from 0.323 to 0.580 per cent and in the mixes, 0.064 to 0.256 percent. The highest acidity was reported for Robusta ripe flour (0.58 percent) which was in agreement with the findings of Shanmugasundaram *et al.* (2005). Patel and Nagar (1974) were also of the same opinion . Research reports at Kerala Agricultural University(KAU,1986) showed that drying do not change the percent of acidity in banana.

As reported by Mehta *et al.*, (2002) total soluble solids (TSS) is an important criteria influencing the acceptability of the product.The TSS content of the raw and ripe pulp of Robusta and Rasakadali were found out. It was found that TSS of Rb (ripe) pulp was 23.3°Brix and Rasakadali 26.7°Brix. Similar values of TSS were also reported by Shanmugasundaram *et al* (2005) which were 23.5°Brix for Robusta, 21.5°Brix for Rasthali and 20.0°Brix for Poovan.

In the present investigation, ripe flour of Robusta had high reducing sugar (14.28g/100g). Banana is highly susceptible to enzymatic browning. Jackish (1985) reported the presence of phenolic compounds in banana. Ahmed (1996) reported that the brown colour was more intense for Singapuri variety of banana followed by Chapa,Kathali and Martamam.In the present study highest polyphenol content was noted in Rb(raw) 420µg/100g compared to Rk(raw) 235µg/100g .

5.3.3 Nutritional quality assessment

Potty (1993) is of the opinion that the nutritive value of a food is an important parameter for the development of any new food. The proximate composition of banana flour and developed convenience mixes on moisture free basis varied depending upon major food ingredients used in their preparation.

Nutrients like protein,iron,and calcium in the banana flour and developed mixes were analyzed in the laboratory. Saxena (2003) suggested that laboratory analysis is one of the best methods to assess the quantity of different nutrients present in the products.

On computation of energy value of mixes the energy content of RbC_3, RkC_3, RbC_4 and RkC_4 were 381.2 kcal, 354.06 kcal, 419.39 kcal, and 411.50 kcal per 100g respectively. A banana based food supplement developed by KAU was observed to be having 300 kcal/100g of energy (Susan 1992). Shruthi (2005) reported the energy content of malted health drink mix and spiced health drink mix as 318.00 kcal and 314.00 kcal respectively. Neelofar (2004) also reported similar energy value of 335 kcal in malted health drink mix and 323kcal in therapeutic health drink mix.

The protein content of raw flour from Robusta and Rasakadali were 3.33g and 2.45g per 100g. A study conducted at KAU (1984) revealed that the protein content of flour from Monthan, Palayankodan, Kunnan, Padathi, Nendran, and Poovan were 3.72, 3.75, 3.59, 3.56, 2.50 and 2.00g per 100g respectively. Sarathathevy *et al.* (1993) reported the protein content of the flour from Monthan as 3.2g per 100g.

In the present study, the protein content of Rb(ripe) flour was 2.28g and Rk (ripe) was 2.10g per 100g respectively. Patel and Nagar (1974) reported that the protein content of Robusta powder was 2.38g per 100g. It was noted that the values obtained in the present study were in tune with earlier studies.

The protein content in the developed convenience mixes were high due to added protein rich ingredients. Highest protein content was detected in RbC_3(17.5g)

and RkC_3 (17.34g) per 100g. Shruthi (2005) reported that protein content of spiced health mix as 19.25g and malted health drink mix as 19.13g per100g. Neelofar (2004) reported 19.12g protein in malted health drink mix and 15.66g in therapeutic health drink. A banana based food supplement developed by KAU had 18.6g protein per 100g.

In the present study, the calcium content of banana flour ranged from 26.66mg to 43.31mg per 100g. Patel and Nagar (1974) reported 18.78 mg of calcium in Robusta powder and 20.43mg calcium in Rasakadali powder. According to Singh *et al* (2004) the calcium content of banana flour is 44mg per 100g.

Calcium content was observed high in convenience mixes RbC_3 (308.33 mg), RkC_3(301.66mg), RbC_4 (291.60mg) and RkC_4(298.33mg) per 100g. Milk powder which is rich in calcium content was more in these mixes. Chellammal (1995) reported that addition of skim milk powder to the product increases its calcium content. Neelofar (2004) reported that calcium content was 432 mg in therapeutic health drink mix and 566mg of calcium in malted health drink mix.

In the present study, the iron content of the raw flour from Robusta was found to be 1.00mg and that of Rasakadali 0.67mg per 100g. while that of ripe flour from Robusta , the value was found to be 1.33mg and Rasakadali 1.50mg respectively. Here also the mixes like RbC_3, RkC_3, RbC_4 showed highest level of iron content (3.33mg, 3.57mg,4.00mg, 4.67mg). Neelofar (2004) reported an iron content of 1.76mg in therapeutic and 1.95mg in malted health drink mix.

5.3.4 Functional qualities

Functional qualities helps to qualitative assessment and acceptability of any new product.To assess the functional qualities processing loss, change in weight, yield ratio, water absorption index, and bulk density were calculated.

Processing loss was observed on two stages, first was on peeling and second was on flouring. Processing loss (on peeling) was more for Rb(raw) 0.397, while less

loss was found to Rk (ripe) 0.148. The loss on flouring was also more for Rb(raw) 0.752, and less loss was for Rk (ripe) 0.654.Yield ratio of Rb(raw) was 0.248 while highest yield ratio was noted in Rk(ripe) 0.346. Sarathathevy *et al* (1993) reported the yield ratio of Monthan as 0.255.

The rate of change in weight was observed more in Rb(raw) (72 percent) where Rk(ripe) was having a lower rate of change in weight.(61 percent).Water absorption index of RbC_3, RkC_3, RbC_4 and RkC_4 was 19.20, 16.47, 17.06 and 17.10 respectively. Ranganna (2001) suggested that bulk density indicates the weight of substance held in a unit volume. According to Potter(1988) Bulk density is one of the most common simple measurements which can be used for analysis of solid foods. In the present study bulk density was found more for Rb (ripe) and Rk (raw) (0.959).

5.3.5 Shelf life quality

Assessment of shelf life quality is important since it determines the suitability of a particular ingredient for product development (Livingstone *et al.*, 1993). Varsanay (1993) reported that the mechanism and kinetics of the food deterioration can be controlled by storage techniques applied. Factors like raw material quality, storage temperature, storage containers, process employed and the environment in which it is processed affects the shelf life quality (Shankar, 1993).

In the present investigation the banana flour and the convenience mixes were stored in PET containers and polypropylene covers at ambient condition, in order to assess the shelf life quality of flour and mixes and also to study the suitability of storage containers. Hence the moisture content and peroxide value of the banana flour and convenience mixes were analysed.

In the case of moisture which is an important parameter in the shelf life quality assessment, was found to increase significantly with storage and the increase was more noted in mixes stored in polypropylene cover than in PET container. Solanki (1986) reported an increase of moisture content from 5.16 to 5.39

per cent in the developed Ready To Eat mixes after a storage period of 28 days. An increase in the moisture content of the flaked rice-based wafers has been reported by Kulkarny *et al* (1992). Pandey (2002) reported that most of the stored products are considered to be safe when stored at particular moisture content.

The extend of peroxidation in the stored mixes was estimated and found that rate of peroxidation was not affected the quality of the stored mix. The estimated peroxide value was very low for flour and mixes. That may be due to the lower fat content in the mix. Higher peroxide value was detected in the mix RbC_3, RkC_3 RbC_4 and RkC_4. In short the stored mixes were suitable for product development without affecting the quality parameters .In a product (sevian) prepared from colocasia mash admixed with besan found that the peroxide value changed from nil to 1.07 meq when stored for one month (Banerjee and Tripathi, 2000).

Neelofar (2004) reported a peroxide value of 0.32meq in therapeutic and 0.54meq in malted health drink mix. Shruthi (2005) reported peroxide value of malted health drink mix as 0.016meq and spiced health mix as 0.089meq.

Insect infestation and microbial growth analysis of the stored banana flour and convenience mix

The incidence of insect attack was not observed in banana flour and the convenience mixes stored in PET containers as well as in polypropylene covers. Darshana (2004), Augustine (1999), Liya (2002) and Sini (2002) also observed the absence of insect attack in different tuber flours.

Microbial assessment of the banana flour and convenient mixes was carried out because as suggested by Leela *et al.* (1993) processed foods and other food materials provide ample scope for contamination with spoilage and pathogenic micro organisms, thus necessitating microbiological quality assessment as an integral part of processing. According to Shankaran (1993), several factors such as raw material quality, storage temperature, storage containers, process employed and the

environment in which it is processed will have an effect on the microbiological quality of the processed foods.

Serial dilution method (Johnson and Kurl, 1972) followed by spread plating was employed to detect the presence of microorganisms. In the present investigation the microbial load was found more in raw flour compared to ripe flour. Ripe banana was dried in mechanical device, where as raw banana was dried in sun light. Fungal growth and yeast growth was negligible in all the samples.

When comparing the two storage containers, microbial load was found more in polypropylene cover, than PET containers. This fact is an accordance with the findings of Chellammal (1995) who reported that products stored in polythene covers and steel containers had more fungal contamination than the products stored in glass and plastic containers. This findings are also supported by Darshana (2004) and Neelofar (2004).

Highest bacterial load was observed in Rb (raw) ($6.88x10^3$ cfu/g) followed by Rk (raw) $5.68x10^3$, RkC_1 ($5.05x10^3$) and RbC_1 ($4\ x10^4$) which were stored in polypropylene cover. Still these values are within the ISI specification, which stated in SPI 8 part XI 1981 (ISI,1981) prescribed bacterial count per gram should not exceed 50,000 and the count for yeast and mould should not exceed 10/g (Nimmy1996).

Bryan (1974) suggested that the presence of micro organisms is not the result of contamination of raw materials, but due to effect of processing and storage methods. In a storage study of rice and cowpea based weaning food, the bacterial count was 20,000 as reported by Roman *et al.* (1987).

5.4 SUITABILITY OF THE MIX FOR PRODUCT DEVELOPMENT

The development of complementary food should be governed by six major principles namely good supplementary value, acceptability, ease of preparation, low cost, shelf life and local availability of ingredients(Devadas,1998). It is proved that

the developed convenience mixes – savoury mix, sweetmeat mix and health mix were rich in nutrients, good shelf stability and was reasonable in cost. These convenience mixes were tested for making different savoury and sweet recipes. Savoury mix(RbC_1 and RkC_1) was used for preparing Murukku, Sweet meat mix(RbC_2 and RkC_2) was used for Unniyappam and health mix(RbC_3,RkC_3,RbC_4 and RkC_4) were used to prepare health drinks. These items , Murukku, Unniyappam and Health drink were easy to prepare from the mix and tested for its acceptability, keeping quality and ease of preparation.

The Murukku, Unniyappam and Health drink were subjected to scoring by judges to note its acceptability. A four point score card was used for acceptability test. Parameters like appearance, colour, flavour, texture and taste were considered in evaluating the quality aspects.

The Murukku prepared from RbC_1(p) (3.66), RbC_1(c) (3.44), RkC_1(p) (3.27), and RkC_1(c) (3.09) got almost similar scores. Murukku was found to have two weeks keeping quality.

Unniyappam prepared from RkC_2(p) (3.83) was found more acceptable than from RkC_2(c) (3.55), RbC_2(c) (3.23) and RbC_2(p) (3.36). On analyzing the data, significant difference between the products was observed with respect to parameters like appearance ,colour, flavour, texture taste and doneness. But in the case of colour and taste significant difference was not observed. The Unniyappam prepared under the present investigation was found to be highly acceptable. Unniyappam prepared from Robusta mix was found to have more keeping quality when compared with Unniyappam with Rasakadali mix. Time taken for the preparation was also very less.

Health drink was prepared from the health mixes such as RbC_3, RbC_4,RkC_3 and RkC_4. Health drink prepared from RkC_4(p) (3.80) was found to be more acceptable. The overall acceptability score obtained for different health mixes like RbC_3(p), RbC_4(p), RkC_3(p), RbC_3(c), RbC_4(c), RkC_3(c)and RkC_4(c) was 2.92, 3.41,

3.09, 2.92, 3.33, 2.95, and 3.68 respectively. The flavour and taste was good for health drink with appealing colour. It takes only two minutes for preparation and instant preparation and consumption is recommended.

Economic viability of the convenience mixes and products developed

In order to realize the economic feasibility of the convenience mixes and products developed out of the convenience mixes, cost per kg was computed separately. All the products developed under the present study were found to be reasonable in price. The cost of convenience mixes, sweet meat mix was cheaper, and health mix was costly. This change in value may be due to the difference in the value of ingredients used in convenience mixes.

When the cost of the developed products were assessed, Murukku was reasonable in cost and health drink was costlier. Even though the cost of health drink was high the nutritional and organoleptic qualities could compete with the market products. The cost of Murukku and Unniyappam was found less when compared to the market products.

In the present investigation the results revealed that the three types of mixes developed from Robusta and Rasakadali varieties of banana were rich in nutrients with good shelf life. The products Murukku, Unniyappam and Health drink prepared from the convenience mix had got good sensory quality and were well accepted. The recommendation of the present study is to transfer the technology to large scale processors to harness the potentials in the food processing industry.

Summary

6. SUMMARY

The study entitled "Developing multipurpose convenience mix from selected banana varieties" was conducted at College of Agriculture, Vellayani. In the present investigation, Robusta and Rasakadali varieties were selected. In order to develop convenience mix, raw as well as ripe forms of Robusta and Rasakadali were primarily processed into flour. Raw fruits of Robusta and Rasakadali were cut in to chips and dried in sun light. Flour was prepared from the dried chips with the help of a mixer, sieved and stored in air tight containers. In the case of ripe banana the fruit pulp was mixed with minimum amount of rice flour as binding material. Fruit pulp from Robusta was mixed with 15 percent rice flour and Rasakadali with 10 percent rice flour.

Three types of multipurpose convenience mixes were formulated with flours from Robusta and Rasakadali. Savoury mix (RbC_1 and RkC_1), sweet meat mix (RbC_2 and RkC_2) and health mix (RbC_3, RbC_4, RkC_3, and RkC_4) were the three types of mixes formulated. Savoury mix (RbC_1, and RkC_1) was prepared from the raw banana flour from Robusta and Rasakadali, by mixing soya flour, rice flour and black gram flour in the proportion 60:10:20:10. Sweet meat mix (RbC_2 and RkC_2) was prepared from ripe banana flour from Robusta and Rasakadali by mixing soya flour, rice flour, and maida in the proportion 50:10:20:20. Where as health mix (RbC_3, RbC_4, RkC_3 and RkC_4) was prepared from both raw as well as ripe banana flour from Robusta and Rasakadali along with milk powder, soya flour, and bengal gram flour in the proportion 40:40:10:10. Thus there were two variations of savoury mix RbC_1 and RkC_1, two variations of sweet meat mix RbC_2 and RkC_2 and four variations of health mix RbC_3, RkC_3, RbC_4 and RkC_4.

The sensory characters like colour, texture and flavour of banana flour and developed convenience mixes were assessed by observation. The colour of flour and

mixes varied from pure white to light brown. and had acceptable flavour and fine texture. Chemical characteristics like moisture, total fibre, total soluble solids (TSS),reducing sugar, and polyphenol of the banana flour and the convenience mixes were analysed.

Moisture content of the raw flour from Robusta was found to be 3.520 per cent. Among convenience mixes, RbC_3 was observed to be having higher moisture (4.090 per cent). Low fibre content was noted in ripe flour from both the variety. When convenience mixes were considered RbC_1 was having high fibre (0.370g/100g). Acidity was more in Rb(ripe) flour (0.580 percent) followed by Rk(ripe)flour (0.510g/100g). Acidity was comparatively low in convenience mixes. The TSS content of the ripe Robusta and Rasakadali was observed 23.3° Brix and 26.7° Brix respectively.

Reducing sugar of flour from ripe Robusta and Rasakadali was found to be high,14.28g/100g and 11.62g/100g respectively. Among the convenience mixes, RbC_2 had high reducing sugar (10.00g/100g) followed by RkC_2 (9.62g/100g). Polyphenol was observed to be more in Rb(raw)(420.00µg/100g), while among the mixes, higher polyphenol content was noted in RbC_3 (400.00µg/100g).

Energy was found to be more in RbC_4 (419.39 kcl/100g) and RkC_4 (411.50kcl/100g), followed by RbC_3 (381.2kcl/100g), and RkC_3 (354.06kcl/100g).

Protein, Calcium and Iron content of the banana flour and the developed convenience mixes were analysed. Protein content was more in RbC_3 (17.51g/100g) and RkC_3(17.34g/100g). RbC_4 and RkC_4 were also having higher protein content,16.63g/100g and16.11g/100g. Calcium was found to be higher in RbC_3(308.33mg/100g), RkC_3(301.66mg/100g), RbC_4(291.60mg/100g) and RkC_4 (298.33mg/100g). Iron was also found more in these mixes like RbC_3 (3.33mg/100g), RkC_3(3.57mg/100g), RbC_4 (4.00mg/100g and RkC_4 (4.67mg/100g).

Processing loss was calculated at two stages that is loss occurs on peeling and loss during drying and preparation of flour. In both the stages, processing loss was found to be more for Rb(raw), while minimum for Rk(ripe).Yield ratio was found more for Rk(ripe) (0.346) and minimum for Rb(raw)(0.248). When the change in weight was calculated, maximum change in weight was noted for Rb(raw) (72 per cent). Change in weight of 61 percent was noted for Rb (ripe) and Rk (ripe) . Water absorption index and bulk density of the banana flour and the convenience mixes were also calculated.

The shelf stability of the banana flour and convenience mixes were studied by storing them in PET containers and Poly propylene covers for a period of three months. Moisture and peroxide value of the stored samples were analysed after the storage period. On storage, an increase in moisture content was observed and the increase was more in samples stored in Polypropylene covers.

Peroxide value was not observed in fresh banana flour and convenience mixes, and also in stored banana flour. Peroxide value in the stored convenience mixes were analysed, and it was noted that the extent of peroxidation was more in mixes stored in polypropylene cover. Therefore, PET container was found ideal for storing the samples.

The incidence of insect attack in stored banana flour and convenience mixes was assessed monthly for a period of three months and found that the stored samples were completely free of insect infestation. Microbial growth was also assessed initially and after three months of storage. Media used for the assessment of load of bacteria, fungus and yeast were nutrient agar (NA),potato dextrose agar (PDA),and yeast extract malt agar (YEMA) respectively. It was observed that, in all the media fresh samples were free of of micro organisms. Among the stored samples, raw flour from Robusta ($60.88x10^3$) and Rasakadali ($5.68x10^3$) stored in polypropylene cover observed higher bacterial load. Growth of yeast and fungus was nil.

The developed convenience mixes were tested for the suitability for making different products. Murukku was prepared from the savoury mix,Unniyappam from sweet meat mix and health drink from health mixes. The suitability of storage containers were tested separately. The products prepared were subjected before a panel of judges in order to test acceptability.

From the statistical analysis of the acceptability scores, it was observed that savoury mix prepared from raw Robusta flour stored in PET containers $RbC_1(p)$ was suitable for making Murukku. Sweet meat mix $RkC_2(p)$ was good for making Unniyappam and the health mix $RkC_4(p)$ was ideal for making health drink. In short $RbC_1(p)$, $RkC_2(p)$,and $RkC_4(p)$ were found suitable for product development.

The time required for the preparation of each product was observed in order to determine the ease of preparation. Minimum time was taken for the preparation of health drink (2.00 minutes) and maximum time was spent for murukku (6.30 minutes) from RkC_1 On computation of cost of the products developed murukku prepared from RbC_1 was found less cost (59.00 Rupees/kg) and maximum cost was observed for health drink (RbC_4) (134.5 Rupees/kg). Keeping quality of the products developed were also recorded. Murukku prepared from both Robusta and Rasakadali mix stood as fresh for two weeks. Unniyappam from Robusta mix was stood fresh for seven days while that from Rasakadali mix stood as fresh for five days.

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DEVELOPING MULTIPURPOSE CONVENIENCE MIX FROM SELECTED BANANA VARIETIES

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Abstract

ABSTRACT

The present study entitled "Developing multipurpose convenience mix from selected banana varieties" comprised of the selection of banana varieties, preparation of flour from raw as well as ripe banana, quality assessment of banana flour and developed mixes and testing the suitability of the convenience mixes for the product development.

In the present study Robusta and Rasakadali varieties of banana were selected Flour was prepared from raw as well as ripe banana. Raw flour was prepared by drying in sun light and ripe flour by drying in the mechanical drier. In order to obtain good quality flour from ripe banana, certain amount of cereal starch (10 to 15 per cent) was added to fruit pulp.

The three types of convenience mixes formulated were savoury mix (RbC_1 and RkC_1), sweet meat mix (RbC_2 and RkC_2) and health mix (RbC_3, RkC_3, RbC_4 and RkC_4). Savoury mix was prepared from raw banana flour, soya flour, rice flour and black gram flour in the proportion 60:10:20:10. Sweet meat mix was prepared from ripe banana flour, soya flour, rice flour and maida (50:10:20:20) and health mix from raw as well as ripe banana flour, milk powder, soya flour and bengal gram flour (40:40:10:10).

Sensory characters like colour, texture and flavour, chemical characteristics like moisture, fibre, acidity, TSS, reducing sugar and polyphenols, nutritional characteristics like protein, calcium and iron, functional qualities and shelf life qualities of the banana flour and convenience mixes were assessed. Energy was computed from the nutritive value book of Indian foods (Gopalan *et al.*, 1992).

Convenience mix RbC_3 was observed to be having higher moisture content (4.090 per cent). Higher fibre content was noted in RbC_1 (0.370g/100g). Acidity was observed more in Rb (ripe) flour(0.580 per cent). Reducing sugar was found high in

Rb (ripe) and Rk (ripe) flour (14.28g/100g) and (1.62g/100g) respectively. Rb(raw)flour was having highest polyphenol content of 420.00µg/100g Energy when computed was found more in RbC_4 (419.39kcl/100g) and RkC_4 (411.50kcl/100g). Mixes RbC_3, RkC_3, RbC_4 and RkC_4 were observed to be high in protein, calcium, and iron content.

Processing loss was calculated in two stages, that is loss occurred on peeling and loss during drying and the preparation of flour. In both the stages maximum processing loss was observed in Rb(raw) and minimum in Rk(ripe). While yield ratio was found more in Rk (ripe) and less in Rb (raw). Functional qualities like change in weight, water absorption index and bulk density were also calculated.

Shelf life qualities like moisture and peroxide value was noted after the storage period of three months. Suitability of storage containers were tested, by storing the banana flour and convenience mixes in PET containers and polypropylene covers. Increase in moisture content and also peroxide value was detected more in samples stored in polypropylene covers. While peroxide value cannot be observed in fresh as well as in stored banana flour. Stored samples were free of insect infestation. Microbial growth was also assessed initially and after the storage period .Fresh samples were found to be free of microbs, while stored samples were having microbial load. Rb(raw), and Rk(raw) stored both in polypropylene cover were found to be having comparatively higher bacterial load.Fungal growth and yeast count was found negligible in all the samples.

The developed products were then tested for making products. Murukku was prepared from savoury mix, unniyappam from sweet meat mix and health drink from health mixes. The products prepared were then subjected before a panel of judges in order to test the acceptability. It was observed that RbC_1(p) was good for making murukku,.RkC_2(p) was found good for making unniyappam and RkC_4(p) was found ideal for health drink.

Ease of preparation, cost and keeping quality of the products were also recorded. Time of preparation was found less in the case of health drink (2 minutes). Murukku prepared from RbC_1 was found economically feasible (59.00 Rupees/kg). Keeping quality was observed more for murukku (2 weeks).

Appendices

APPENDIX- I

Score card for organoleptic qualities of Murukku

Tested by:.....
Age
Date:..../...../2006

		Score	Products			
			1	2	3	4
Appeareance						
	Excellent	4				
	Good	3				
	Fair	2				
	Poor	1				
Colour						
	Golden brown	4				
	Light brown	3				
	Brownish black	2				
	Black	1				
Flavour						
	Excellent	4				
	Good	3				
	Fair	2				
	Poor	1				
Texture						
	Crisp and brittle	4				
	Crisp and hard	3				
	Very hard	2				
	Spongy and elastic	1				
Taste						
	Excellent	4				
	Good	3				
	Fair	2				
	Poor	1				
Doneness						
	Well cooked	4				
	Cooked	3				
	Raw taste	2				
	Charred	1				

APPENDIX- II

Score card for organoleptic qualities of Unniyappam

Tested by:.....
Age
Date:..../...../2006

		Score	Products			
			1	2	3	4
Appeareance						
	Excellent	4				
	Good	3				
	Fair	2				
	Poor	1				
Colour						
	Golden brown	4				
	Light brown	3				
	Brownish black	2				
	Black	1				
Flavour						
	Very acceptable	4				
	Acceptable	3				
	Moderately acceptable	2				
	Not acceptable	1				
Texture						
	Soft and porous	4				
	Soft	3				
	Less soft	2				
	Hard	1				
Taste						
	Excellent	4				
	Good	3				
	Fair	2				
	Poor	1				
Doneness						
	Well-cooked	4				
	Cooked	3				
	Raw taste	2				
	Charred	1				

APPENDIX- III

Score card for organoleptic qualities of the Health drink

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Tested by:.....
Age:
Date:.... /...../2006

		Score	Items							
			1	2	3	4	5	6	7	8
Appearance										
	Excellent	4								
	Good	3								
	Fair	2								
	Poor	1								
Colour										
	Very acceptable	4								
	Acceptable	3								
	Moderately acceptable	2								
	Not acceptable	1								
Flavour										
	Very acceptable	4								
	Acceptable	3								
	Moderately acceptable	2								
	Not acceptable	1								
Consistancy										
	Thin and free flowing	4								
	Very thick and slow flowing	3								
	Thick and sticky	2								
	Thin and watery	1								
Taste										
	Excellent	4								
	Good	3								
	Fair	2								
	Poor	1								

APPENDIX IV

Recipes

1. Murukku

Savoury mix - 50g
Salt - a pinch
Oil - for frying

Carefully mix about 10 ml of boiled water with salt. Add this salt water to savoury mix. Knead and prepare dough. Fill this dough in the mould for murukku and press in to clear shapes. Deep fry in oil for 5 to 7 minutes. Serve hot.

2. Unniyappam

Sweet meat mix - 80g
Jaggery - 50g
Oil - for frying

Prepare a syrup from jaggery. Add the jaggery syrup in to sweetmeat mix carefully and prepare dough of slightly thick consistency. Place the dough undisturbed for 30 minutes. Heat oil in the pan specialized for Unniyappam. Pour the dough in each mould and fry for 3 to 4 minutes. Serve hot.

3. Health drink

Health mix - 10g
Sugar - 7g
Vannila powder - a pinch

Take boiling water in a glass, mix health mix with 200 ml water and add sugar and vanilla powder. Serve hot.

APPENDIX- V

Overall Acceptability of Murukku

Parameters	Products			
	$RbC_1(p)$	RkC_1 (p)	$RbC_1(c)$	RkC_1 (c)
Appearance	3.615	3.385	3.231	3.077
Colour	3.692	3.538	3.308	3.153
Taste	3.615	3.385	3.231	3.077
Doneness	3.692	3.462	3.231	3.077
Flavour	3.692	3.462	3.308	3.077
Texture	3.692	3.385	3.308	3.077
Overall acceptability	3.666	3.436	3.269	3.089

APPENDIX- VI

Overall Acceptability of Unniyappam

Parameters	Products			
	$RkC_2(c)$	$RbC_2(c)$	$RkC_2(p)$	$RbC_2(p)$
Appearance	3.538	3.154	3.846	3.308
Colour	3.538	3.308	3.769	3.384
Flavour	3.462	3.231	3.846	3.384
Texture	3.538	3.153	3.846	3.250
Taste	3.615	3.308	3.846	3.384
Doneness	3.615	3.231	3.846	3.461
Overall acceptability	3.551	3.231	3.833	3.362

APPENDIX- VII

Overall Acceptability of Health drink

Products	Parameters					
	Appearance	Colour	Flavour	Consistancy	Taste	Overall acceptability
RbC_3 (p)	2.615	2.842	2.769	3.308	3.078	2.923
RbC_4(p)	3.462	3.462	3.385	3.385	3.385	3.415
RkC_3(p)	3.077	3.077	3.077	3.153	3.077	3.092
RkC_4(p)	3.769	3.846	3.769	3.769	3.846	3.800
RbC_3 (c)	2.923	2.923	2.923	2.923	2.923	2.923
RbC_4 (c)	3.308	3.384	3.308	3.308	3.384	3.338
RkC_3(c)	2.923	3.076	3.538	3.538	2.692	2.953
RkC_4(c)	3.692	3.692	3.692	3.692	3.615	3.677