DEVELOPMENT AND QUALITY EVALUATION OF READY TO COOK (RTC) DEHYDRATED BANANA BLOSSOM

MIDHILA MAHENDRAN

(2011-16-101)

Thesis submitted in partial fulfilment of the requirement for the degree of

Master of Science in Home science

(Food Science and Nutrition)

Faculty of Agriculture

Kerala Agricultural University, Thrissur

DEPARTMENT OF HOME SCIENCE

COLLEGE OF AGRICULTURE, VELLAYANI,

THIRUVANANTHAPURAM – 695 522

2013

DECLARATION

I hereby declare that this thesis entitled **"Development and quality evaluation of ready to cook (RTC) dehydrated banana blossom"** is a bonafide record of research done by me during the course of research and the thesis has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title , of any other University or Society.

Vellayani

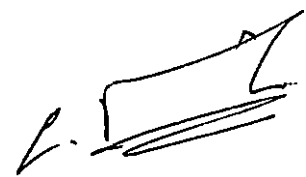
Date : 11|10|13

Midhila Mahendran

(2011-16-101)

CERTIFICATE

Certified that this thesis, entitled " **Development and quality evaluation of ready to cook (RTC) dehydrated banana blossom"** is a record of research work done independently by **Midhila Mahendran (2011-16-101)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associate ship to her



Vellayani

Dr. C. Nirmala

Date : 11/10/19

(Chairman, Major Advisor)

CERTIFICATE

We the undersigned members of the advisory committee of **Miss. Midhila Mahendran (2011-16-101)** a candidate for the degree of **Master of Science in Home science** agree that this thesis entitled **"Development and quality evaluation of ready to cook (RTC) dehydrated banana blossom"** may be submitted by **Miss. Midhila Mahendran (2011-16-101),** in partial fulfilment of the requirement for the degree.

Dr. C. Nirmala
Assoc Professor & Major Advisor
Department of Home Science
College of Agriculture, Vellayani,
Thiruvananthapuram, 695 522

Dr P.V. Nandini
Professor & Head
Department of Home Science
College of Agriculture, Vellayani
Thiruvananthapuram, 695 522

Dr Suma Divakar
Asst. Professor(S. S)
Department of Home Science
College of Agriculture, Vellayani
Thiruvananthapuram, 695 522

Dr Sumam Susan Varghese
Professor
Department of Soil Science &
Agricultural Chemistry, CoA, Vellayani
Thiruvananthapuram, 695 522

EXTERNAL EXAMINER.

Dr. Kanchana.
Prof. & Head. (Food Science & Nutrition)
TNAU, Madurai.

ACKNOWELDGEMENT

*I am grateful to **"Almighty God"** who provided me the strength to fulfil the task in a satisfactory manner. I am indebted for numerous blessings that he showed upon my life.*

*I feel great pleasure and deep sense of gratitude to **Dr. C. Nirmala,** Associate Professor for her valuable and affectionate guidance, constant encouragement and unfailing patience throughout the course of this research work and in the preparation of the thesis. This work would not have been possible without her help and support.*

*My utmost and sincere thanks to **Dr. P. V. Nandini,** Professor and Head for her whole hearted co-operation and help during the course of study and period of investigation.*

*I extend my sincere gratitude to **Dr. Suma Divakar,** Asst.Professor (S.S), for her valuable guidance, constant encouragement and unfailing patience throughout the course of this research work and in the preparation of the thesis.*

*I avail this opportunity to pay my sincere thanks to **Dr. Sumam Susan Varghese,** Professor for her keen interest, immense help, constructive suggestions and timely support and co- operation rendered throughout my research endeavor .*

*I accost my sincere thanks to **Dr. Mary Ukkru**, Professor, for the critical scrutiny of manuscript, friendly approach and whole hearted help extended during the phase of my course study and completion of my thesis.*

*My heartfelt thanks to **Dr. Prasanna Kumari, Dr. Soffi Cheriyan, Dr. Rari John, Dr Geetha**, for their keen interest, immense help, constructive suggestions and timely support and co- operation rendered throughout my research endeavor .*

*My deep sense of gratitude to **Mr. C. E. Ajith Kumar** programmer, Department of Agriculture Extension for executing the statistical analysis of the data.*

I also extend my acknowledgement to all ***teaching*** *and* ***non teaching staffs*** *of the Department of Home Science for the help rendered to me during the course of study.*

From depth of my heart I thank my dearest friends ***Sreedevi, Anju, Robita, Shonima*** *for their indispensable help, love, moral support, constant encouragement and sincerity.*

My loving thanks to my seniors ***Krishnendu chechi, Agey chechi, Athulya chechi, Suma chechi, Krishnasree chechi Krishnaja chechi, Poornima chechi, Saranya chechi, Reshmi chechi*** *for their loving support and encouragement throughout my research work.*

Words are failed to express my love and gratitude from my deep heart to my deep heart to my dearest ***Achan , Amma , Mobin Chettan and Shakkeela chechi*** *for the love, support, patience and constant encouragement throughout my research work and life.*

I deeply acknowledge with full heart the personal sacrifice, incessant encouragement, timely persuasion and moral support by ***Joofiya, Ansha, Roshna, Mubarak, Arun, Bineer, Uncle and Aunty*** *and they wished my success always.*

At last I thank all those who extended help and support to me during the course of my work.

Midhila Mahendran

DEDICATED TO MY FAMILY

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

LIST OF PLATES

LIST OF ABBREVIATIONS

b.b	banana blossom
cfu/g	colony forming unit per gram
et al	and others
Fig	figure
g	gram
g/100g	gram per 100 gram
Kcal/100g	kilocalories per 100 gram
meq/g	milli equivalents per gram
mg	milligram
min	minute
RTC	Ready to cook
T_0	Initial period
T_1	First month
T_3	Third month

INTRODUCTION

Introduction

Man has exhibited much thought and foresight in cultivating a variety of grains, fruits, vegetables, nuts and oil seeds for use as food. The selection of foods best suited for promoting good health has been found out by trial and error by continued use (Swaminthan, 1998). Plant foods can be health promoting beyond its traditional nutritive value and gaining acceptance among consumers and health professionals (Tiwari, 2007).Non availability of adequate nutritious food for the fast growing population is a challenging problem. Development of processed product such as instant products and mix adds convenience, save time and labour and provide hygienic products of standard and uniform quality with enhanced shelf life. The consumers are longing for ready to cook and eat products due to less time they can spend in cooking. For a developing country like India, less expensive and cost effective post harvest method need to be evolved.

Among the vegetable kingdom bananas form the largest group. Banana blossom is an in-expensive yet very nutritious flower, consumed as vegetable. Banana is mainly used as fruits. Banana family is musacea and is related to the heliconias and travellers palm. Banana is really not a "tree" but a Herbaceous perennial (Graft, 2009). The banana production in India in 2012- 2013 is 30.28 million tonnes. Tamil Nadu is the top banana producing state (8016.35 thousand tonnes) followed by Maharashtra (4100.00 thousand tonnes) and Gujarat (4047.77 thousand tonnes). Total production of banana in Kerala was 472.93 tonnes (Anon, 2010). Nationally Kerala occupies 50 per cent of the total area of banana and maximum quantity of the fruit is sold locally. Small quantity is exported to Middle East, targeting the Indian community. India ranks first in production and third in area among fruit crops (Sharad, 2010).

Hung and Joshith (2007) reported that vegetables are important components of healthy diet and their sufficient daily consumption could help to prevent major diseases. Insufficient intake of fruits and vegetables is estimated to cause around 14% of gastrointestinal cancer death, 11% of ischemic heart disease deaths and about 9% of stroke death globally. Vegetable consumption prevents certain type of cancer and also reduces the risk of obesity. Increased awareness about the sound health and quality life and increased problem of nutritional security brought about a sudden shift from food

grain production and consumption pattern to diversified and value added food production and consumption (Premnath *et al* 2004). Sufficient vegetable consumption helps in managing body weight because most vegetables are high in water, fibre and low in fat (He and Nowson, 2009).

Vegetables ensure nutritional security, better land use, higher net return per area and help in improving the eco-system and economic status (Pathak, 2002). In order to avoid the wastage and build a resource for use in the out of season days food has to be stored and preserved. Wastage of food grains, vegetables and fruits at post harvest stages can be preserved if appropriate processing technologies were developed (Gurvani, 2004). The development of processed product help in generating employment, support growers, upgrade local nutrition and increase the gross national product (Anand, 2001). Food processing and production have been traditional occupation of country man from time immemorial, as it is evident from ancient mythological and historical literature.

Banana flower is the male sterile flower of banana plant. It is long pointed, deep crimson yellow or pink coloured and consists of tightly packed leaves or bracts that wrap around rows of thin stemmed male flowers.

The large production banana contributes large number of banana blossom which serves as vegetable in different countries including India. This valuable vegetable is a crude source of micro mineral elements and many non-nutrient components such as antioxidants, phenols and saponins. Banana blossom is a by-product of interest in which only a few of scientific data were currently found regarding chemical compositions and biological activity. It was reported containing phenols, flavanoids, tannins and saponins (Decena, 2010).

Banana blossom from Nendran, Palayankodan, Rasakadali, Red banana, Kunnan and Monthan were used as vegetables. Vegetables are highly perishable items and require special processing techniques to prevent post harvest losses. Processed foods are foods designed to save consumers time in the kitchen, reduce post harvest losses (Shibly *et al*, 2009). Ray and Athwali (2000) reported that more and more people were going for

processed foods and is estimated that over 10 per cent of the total expenditure is being spend for processed foods.

Easy availability of banana blossom throughout the year, high nutritive value and low market price have made it unique commodity. Due to its high moisture content, the shelf life is comparatively shorter, hardly 2 to 3 days. Despite of its valuable economic and medicinal importance presents investigation- "Development and quality evaluation of ready to cook (RTC) dehydrated banana blossom" was undertaken with the objectives to develop and evaluate the nutritional, functional, organoleptic and shelf life qualities of selected varieties of banana blossom.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The literature of present study entitled "Development and quality evaluation of ready to cook dehydrated product from banana blossom" is presented below

2. 1. Importance of banana plant as vegetable

2. 2. Nutritional significance of banana blossom

2. 3. Bioactive compounds in banana blossom

2. 4. Culinary uses of banana blossom

Vegetables are plant parts or parts of plant that are used as food. It makes the food more attractive by their colour, flavour and texture.(Srilakshmi, 2009). It is reported that the need to increase fruits and vegetable consumption is receiving much attention owing to their known beneficial effects on health (Agarwal, 2009).

2. 1. Importance of banana plant as vegetable

Banana and plantain is the fourth most important crop after rice, wheat and corn in the developing world (NAAS, 2001). Nadakarni *et al.*, (2010) stated that banana is a largely cultivated and widely consumed fruit all over the world.

FAO (2008) reported that bananas are cultivated in more than 120 countries in the tropics and subtropics. Tamil Nadu is the largest banana producing state in India followed by Maharashtra, Gujarat, Assam and Andhra Pradesh.

Datta (2009) remarked that banana and plantain are widely grown in India with great socio economic importance, interwoven with cultural heritage of the country. Owing to the multifaceted uses it is referred to as "Kalpatharu", which means "Plant of Virtues." Sukhla and Bhavesh (2011) opined that banana provide food and livelihood security to millions of people besides being served as an inevitable item in socio religious rituals. Maharashtra is the leading producer of banana followed by Tamil Nadu, Gujarat, Karnataka, Andhra Pradesh. Banana is grown throughout the year and is well within the reach of a common man. That's why it is called as "Poor man's apple". Banana is a

unique crop providing food for millions off people in the developing countries of the tropics. Banana reaches their greatest importance as a staple food crop in the parts of East Asian where annual consumption is over 200kg/capital year (Valmayor, 1994).

Parts of banana plant such as flower, pseudostem and rhizome are reported to be used as food material and known to have nutritional and medicinal properties. (Nadakarni *et al.*, 2010).

Banana stem is thick and fibrous and has the taste of banana. Banana rhizome of young plants is used in different preparations as fresh root vegetable or the rhizome is dehydrated, powdered and used (Sharma, 2012).

FAO (2008) reported that all banana plant parts are beneficial for stomach and use of them is part of Ayurveda lifestyle prevailing in Kerala and India. Banana fruits are rich in different minerals and components like vitamin A, vitamin B6, vitamin C and potassium. Banana leaves are used as natural plates in Kerala. The core stem of the plant, called vazhaippindi is used to prepare a side dish called thoran, which is recommended for persons with diabetes. Similarly vazhakoombu, the flower of plantain plant is used as nice tasting vegetables. The cone is collected after the flower ceases to produce fruit.

Monthan, Padatty, Peyan, Annan, are the vegetable varieties of banana and Nendran, Palayankodan, Rasakadhali are some of the varieties is used as vegetable as well as fruit. Some of the parts of banana plant such as pseudostem, flower and rhizome are known to have medicinal properties. Pavunny (2004) reported that 80% of banana plant is used as food material.

Banana flower otherwise known as (banana blossom, banana heart, banana bud, vazhaikoombu), banana stem (central core, pindi) and banana rhizome (banana root) are the banana plant parts used as vegetable. Simmonds and Stover (2000) reported that the male bud of banana, after removing the fibrous outer bracts is eaten as boiled vegetable in south East Asia. Banana blossom of 'Saba' banana variety is used for cooking. They also stated that the banana blossom of Musa Balbisiana were preferred as a vegetable in many areas of Southern Asia and use of banana corms, shoots and male buds as food in widespread in Africa.

Cauliflower stalks and cabbage heads are good for human use (Nand, 2003). Banana flower bud is used as vegetable and the end of inflorescence of banana is cooked as vegetable in Bengal (Singh and Uma, 1997).

Banana flower is the male sterile flower of banana plant. It's long pointed and has a deep crimson yellow or pink colour and consists of tightly packed leaves or bracts that wrap around rows of thin stemmed male flowers. It grows on the end of the stem holding a cluster of bananas. Banana flowers can be sliced and served in meat stews, soups; rice or noodle dishes, and cooked vegetable dishes. Or the banana flower can be used as a decorative food "plate" or holder for prepared salad ingredients as they are placed into the leaf for serving (Sharma, 2012).

Banana stem is thick and fibrous and has the taste of banana. It can be eaten raw or cooked. It forms an integral part of most South Indian dishes. Banana stem appearing as waste of banana plant is supposed to be good for health. After tree has given fruit, its stem can be taken out and consumed in various form as salads, raitas, and vegetable and as soup.

According to Maletto *et al* (2003) banana peel is used as food. Chung *et.al* (2006) reported that bioprotein can be made from banana skin by fermentation process at laboratory level. In southern China banana skin is used in the preparation of meals (Jianhi *et al.*, 2000). According to Pavunny (1996) jelly is prepared from banana peel rind.

Banana rhizome of young plants is used in different preparations as fresh root vegetable or the rhizome is dehydrated, powdered and used. The food value of banana and its plant parts has been appreciated for a very long time and continuous efforts are being made to broaden and extend the form in which bananas are utilized.

Banana and its plant parts contain ample proportion of nutritive constituents which are easily digested and it is available at reasonable cost.

2. 2. Nutritional significance

Banana plant parts are very rich in different types of bioactive compounds which provide nourishment and promote good health. In Sri Lanka, where they are called Kehel,

a popular dish made with banana flowers, tamarind, and spices is called *Kehel mnwa seeni sambol* or banana flower curry. South Indians make yet another simple recipe with banana blossom in which chopped banana blossom is steamed with salt, tempered with mustard seeds, urud dhal, curry leaves and asafoetida and topped with grated coconut. Use of grated coconut, condiments and spices in the banana blossom recipe is well accepted by Keralites.

2. 2. 1. Banana flower and its nutritional significance

Bilton (2007) reported that banana flower is a good source of dietary fibre, vitamin A, vitamin C, iron. Taylor (2010) reported that banana blossom is an excellent source of protein even though banana lack protein content. Pilch (2010) conducted a study on the banana products and reported that banana flower like banana fruit is an excellent source of potassium. Rossario (2000) opinioned that banana blossom is a quite popular ingredient in particular dishes served in Philippines. Considering as a vegetable this part of banana plant is also a good source of certain beneficial components.

Walker (2005) reported that banana blossom of banana plant is being consumed as vegetable in various parts of Srilanka, Malaysia,Indonesia and Philippines. Villa (1993) reported that banana flower can be consumed as boiled vegetable and can be used as ingredient in an assortment of cuisines. Evengelista (1998) reported that banana flower is one of the most important part of banana plant. Aside from being a mere ingredient in vegetable preparations, it is also processed and exported as canned banana bud.

According to Koshy (1989) reported that high levels of carbohydrate was observed in banana at the flower bud development stage. As per the African Journal of Biotechnology, banana flower nutrition per 100g contains 51 kcal, 1.6g of Protein, 0.6g of Fat, 9 .9g Carbohydrate, 5.7g of Fiber, 56mg of Calcium, 73.3mg of Phosphorous, 56.4mg of Iron, 13mg of Copper, 553.3 mg of Potassium, 48.7mg of Magnesium and 1.07mg of Vitamin E (Annenne, 2010)

2. 2. 3. Health and nutritional significance of banana stem

Musa stem juice has good antiurolithiatic property. Potassium nitrate and magnesium nitrate are the major constituents present in Musa AAB stem juice and was confirmed by chemical test and ultra violet spectroscopy from the two weeks of in-vitro studies it was found out that the size of kidney stone reduced to a greater extend (Prashob, 2011).

The use of central core in naturopathy is well known. Feroti *et al.*, (2003) opinioned that banana stem juice could be used as isotonic drink however water, sugar, sodium addition is necessary.

Padma (2011) reported that banana stem contain potassium and vit B6 which help in the production of chemicals such as haemoglobin and insulin. It improves the body's ability to fight against infection. It is effective in functioning of muscles including cardiac muscles, prevents high blood pressure, helps in nerve impulses and maintains fluid balance in body. Banana flower is used as a nutritious food item in South India. It has a lot of medicinal values, like blood purification.

Banana blossom is a good reservoir of vitamin E and flavanoids (Nathasha, 2010). Sweety (2010) reported that banana stem is rich in fiber and helps in weight reduction. Due to rich content it gives satiety value. Even though it can be taken in form of juice. eating as a whole provide more benefits.

Pari (2008) reported that banana stem juice is a diuretic and helps in detoxifying action. Sweety, 2010 reported that banana stem can be used to treat kidney stones. Singh (2011) reported that banana stem can be used as laxative for constipation. The rich fiber content prevents constipation and it cools the body.

Della (2011) and a group of dental students in Gadjah Mada University in Indonesia reported that the banana stem helps in wound healing. It can be applied to wound as it speeds healing by 30-60 per cent.

Dwivedi (2010) reported that banana stem is effective against arthritis, sunburn and insect bite. Jacob (2011) opinioned that banana stem is more consumed in tropical regions due to its cooling effect.

Poonguzhali (2002) conducted a rat study and reported that banana stem extract from musaceae family are useful in treating patients with hyperoxaluric urolithiasis. The result shows that the urinary oxalate excretion was significantly reduced.

Amutha and Shalini., (2012) conducted a study on the wound healing propery of compounds from musa paradisiacal on albino rats reported that the banana stem extract contain triterpenes, alkaloids, flavanoids and biomolecules, phenyl phenonalenone were reported to have wound healing property.

Draize (2003) reported that banana stem is found to be effective against lead poisoning. The powdered form known as ACITAN is used as a nutrient supplement. Banazano (2010) reported that due to high fiber content banana stem consumption will help to reduce the risk of cardiovascular diseases. The fiber content was 28.8g/100g.

2. 3. Bioactive compounds in banana blossom.

Bioactive compounds are extra nutritional constituents that typically occur in small quantities in foods. They vary in chemical structure and functions (Kris, 2011). The bioactive compounds will reduce the risk of cardiovascular diseases. The phytochemical extracts of 100g banana flower extract showed the presence of alkaloids, glycosides, steroids, saponins, tannins and flavanoids. The analysis shown that the banana flower contains Alkaloid-1.56g, Saponin-1.43g, Total phenol-5.83g, Tannins-5.83g (Keen, 2004).

Syamala, 2011 reported that methanol extracts of banana flowers possess antioxidant properties and thereby stabilize the free radicals formed as a result of various metabolic processes in the body. If the free radicals are not neutralized, their unstable electrons react with the DNA and proteins of human cells and alter their properties. This can lead to several chronic conditions, including cancer and heart disease. The authors of a study published in October 2010 issue of the journal "Food Science and Biotechnology" recommend the use of banana flower extracts to make health supplements due to antioxidant potential.

Mahmood *et al.* (2011) reported that the flower have potential use in pharmaceutical cosmetic and food products. Zhan *et al.* (2010) conducted a study on the antioxidant property of banana flower reveals that the extract of banana flowers is good sources of antioxidants including phenolics and flavanoids. Vitamin E and Saponin were also analysed. Also reported that it can be used as food additive.

Ratna *et al.* (2011) reported that banana flowers are found to be the potential source of antioxidant. The antioxidant present is Butylated hydroxytoluene(BHT) of 7.63mg/ml. Sumathy *et al.* (2011) conducted a study to evaluate the bioactivity and to screen the phytochemicals that are present in banana flower. The report showed that banana flower showed good antimicrobial activity.

Michael (2010) reported that the glycosides in banana blossom are effective in treatment of cognitive heart failure and cardiac arrhythmias. Leonards (2006) conducted a study to find the toxicity level of banana flower of Musa accuminata consumed as vegetable and reported that there is no toxic substance present in banana flower.

Guerero (2009) reported that there is decrease in antioxidant activity of cooked sample of banana blossom in relation to the raw sample. This is due to the possible disruption of antioxidant activity of a sample which is caused by onset destruction of cell wall due to the heat applied.

Dietary fibre

According to Eastwood and Kritchevsky. (2009) dietary fiber is the indigestible portion of plant foods having two components- soluble and insoluble fiber. Liu (2005) reported that dietary fibre intake lowers the risk of coronay heart diseases, stroke, hypertension, diabetes, obesity and certain gastrointestinal disease.

Ching *et al.* (2001) conducted a study on the fiber content of banana flower and reported that banana flowers are the richest source of fiber and its consumption helps in reducing the risk of CVD, diabetes, hypertension.

Ethnomedical survey around the world revealed that the flower of Musa.sp have been used to treat many illness. Banana flowers have been traditionally used to treat menorrhagia, dysentery, diabetes mellitus (Singh, 2011)

Leonard (2007) reported that banana flowers relieve heart pain, diarrhea, stomach cramps and infantile malnutrition. Pari (2008) reported that banana flowers are effective in treating anaemia. Jayasree *et al.* (2012) conducted a rat study on banana flower flavanoids as insulin receptor tyrosine kinase activators as a cure for diabetes mellitus reported that they are the richest source of flavanoids that exhibit anti diabetic activity.

Pari (2008) reported that banana flower of *musa.spp* contain bioactive compounds such as dopamine, nor-adrenaline, serotonin and anti-hyperglycemic factor. Chandralia (2000) reported that banana flower promote laxation, avoid constipation. Green (2002) reported that banana flower is rich in potassium which is effective in regulating water balance, acidity levels and blood pressure.

The flavanoid in bananan blossom, Leucocyanidin is found to increase the thickness mucus membrane layer of stomach (Lewis *et al.*, 2004). Pari (2008) reported that banana blossom contain a class of phytochemicals known as saponin which lowers tha LDL or bad cholesterol. It boosts our immunity against infection and will inhibit the growth of cancer cells.

2. 4. Culinary purpose of banana plant parts

Like banana blossom, banana stem and rhizome can be consumer either as vegetable preparations or its extracts could be used as home remedy for curing diseases.

2. 4. 1. Banana flower

Banana blossom salad (nom hoa chuoi or gou hoa chuoi) is a pretty well- known dish in Vietnam and there are a variety of receipes for it like banana blossom salad with chicken, banana blossom salad with shrimp or with tofu (Dharman, 2012). Banana blossom pickle is a preserved product developed from banana blossom (Kamala, 2012). Pavunny (1996) developed pickles and vattals from banana blossom. Vattal is prepared from banana blossom along with rice and spices.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The present study entitled "Development and quality evaluation of ready to cook (RTC) dehydrated banana blossom comprises of:

1. Selection and collection of banana blossom
2. Slicing and dehydration of banana blossom
3. Standardisation and product development
4. Quality assessment of dehydrated banana blossom

3. 1. Selection and collection of banana blossom

Banana blossom of three varieties viz Nendran (Musa AAB), Rasakadali (Musa AA) and Palayankodan(AAB) were selected for the study. Evenly matured banana blossoms were collected from Instructional Farm, College of Agriculture, Vellayani and Sangamythri, Organic farm, Pallichal.

3. 2Slicing and dehydration of banana blossom

Freshly harvested banana blossoms were washed under running water after removing 3-4 outer most fibrous bracts. Fresh weight of each banana blossom was recorded in order to determine the final yield of the processed product after dehydration. The blossoms were sliced into 1mm thick size and directly put into plain water and separate solutions like buttermilk, citric acid, KMS and salt. Three hundred gram of sliced banana blossom was immersed in one litre water/solution. The immersion time required for retaining maximum sensory quality characteristics were determined.

After immersion the slices were drained. The drained slices were divided into three portions for further study. One portion was dried to get dehydrated slices; second portion was dried and powdered to get banana blossom powder. The third portion of pre-treated slices were standardised to get ready to cook product.

As a next step, the drained slices were spread out uniformly in trays and dried in hot air oven. The drying time and temperature was assessed. Dehydrated slices, flour and RTC product was packed in aluminium Foil pouches and kept for shelf life study at room temperature.

3.3. Standardisation of product.

Formulation of ready to cook (RTC) dehydrated product from banana blossom.

Banana blossom is well known for its nutritive value and its uses in cuisines in different countries. In Thailand, it is often accompanied by a hot and spicy dip called Nam Prik. In northern Thailand banana flowers are lightly steamed, along with other vegetables and served with a dipping sauce made from red curry paste, fish sauce, sugar and lemon juice, known as *Nam prik ong*. In Philippines banana flowers are the main ingredient in *linabog* or *labog*, a dish made with coconut milk, spices and dried fish. The preparation of banana blossom recipe involves simple yet tedious process like cutting/slicing/chopping flower and draining the bitter sap between the bracts. So in this context developing a convenient RTC product with all its sensory qualities is getting tremendous value among homemakers.

Using banana blossom, coconut, spices and condiments a RTC product was standardised by trial and error method. Different formulations were tried out using different proportions of ingredients. The dehydrated product was reconstituted, evaluated for its sensory parameters and finally an acceptable product was developed.

3.4. Quality evaluation of dehydrated banana blossom slices, dried powdered banana blossom flour and RTC product.

Physical characteristics, chemical composition, nutritional quality, sensory characteristics and shelf stability of dried banana blossom slices, dried powdered banana blossom flour and RTC product were ascertained using standard techniques. Microbial analysis was done initially and 3 months after storage.

3. 4. 1. Physical characteristics of dehydrated banana blossom slices, dried powdered banana blossom flour and RTC product.

Processing loss, bulk density and rehydration ratio of the developed RTC product was studied.

3. 4. 1.1. Processing loss (PL)

The processing loss was calculated by difference between the weight of the food ingredients as purchased (ApWt) and that of edible portion (EpWt).

The ratio of the processing loss can be calculated using the formula

$$PL = \frac{ApWt - EpWt}{ApWt}$$

In the present study, during the processing of banana blossom (b.b) two stages of loss occurred, they were loss occurred during drying and powdering.

$$PL(\text{on peeling}) = \frac{\text{Wt of banana blossom-Wt of peeled banana blossom}}{\text{Wt of banana blossom}}$$

$$PL(\text{on powdering}) = \frac{\text{Wt of sliced b.b-Wt of dried powdered b.b}}{\text{Wt of sliced b.b}}$$

3. 4. 1. 2. Bulk Density

Bulk density is the ratio of the weight of the sample to the weight of an equal volume of water. The bulk of flours, whole grains can be calculated. The sample was taken at a height of 20 cm in a 50 ml beaker. It was levelled 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. The weight of the water with beaker was recorded and calculated using the formula.

$$\text{Bulk Density} = \frac{\text{Wt of the sample}}{\text{Wt of equal volume of water}}$$

3. 4. 1.3. Rehydration ratio

Rehydration ratio of dried slices, dried powdered banana blossom flour and RTC mix was recorded. About 10g of sample was mixed with 100 ml of distilled water and stirred for 5 minutes. The contents were filtered using a filter paper. The rehydrated sample was weighed (Ranganna, 2001)

Rehydration ratio = Weight of the sample

Drained weight of the sample

3. 4. 2. Chemical Composition

Chemical composition of dried slices, flour and RTC mix was analysed using standard procedures.

Moisture (percent)	Sadasivam and Manikkam (1992)
Total Phenol (µg)	Ranganna (2001)
Oxalate (µg)	Sadasivam and Manikkam (1992)
Fiber(g)	Sadasivam and Manikkam (1992)
Total Ash (mg)	NIN (2009)

3. 4. 3 Nutritional quality assessments

Nutritional composition of the products were determined using standard techniques

Energy (Kcal)	Gopalan *et al* (2009)
Protein (g)	Bradford (1976)
Sodium (mg)	Thimmiah (1999)
Potassium (mg)	Thimmiah (1999)
Calcium (mg)	Jackson (1973)
Iron (mg)	Jackson (1973)
Peroxide value	Sadasivam and Manikkam(1992)

3. 4. 4. Sensory quality evaluation

Sensory quality evaluation plays an important role in acceptability study of a new product. Sensory characteristics like appearance, colour, flavour, texture, taste and overall acceptability of the dried slices, dried powdered banana blossom flour and RTC

mix were assessed by a panel of judges. The qualities were assessed using a score card on a four point scale (Jellinick, 1985).

4.5 Shelf life study

The shelf life of the developed product was evaluated initially and after three months of storage in terms of moisture, peroxide value and microbial growth.

Total microbial growth

The stored product samples were assessed for the presence of various micro organisms viz bacteria, fungus and yeast after the storage period of three months. The serial dilution of samples followed by spread plating was employed to estimate the population of viable micro - organisms in the flours and mixes (Johnson and Curl, 1973).The procedure adopted for serial dilution was as follows. 1ml from each sample was taken in a conical flask containing 99ml sterile water, making the dilution of 10^{-2}. From this 1 ml of the dilution was further transferred into test tube containing sterile water, so that dilution becomes 10^{-3}. Likewise further dilutions of 10^{-4}, 10^{-5}, and 10^{-6} were made.

Nutrient agar (NA), Potato Dextrose Agar (PDA), Eiosin Methylene Blue (EMB) and Ken knight's reagent (KEN) medium were used for culturing of bacteria, fungi and yeast respectively. Plates were poured and allowed for solidification 0.01 ml of the suspension from each dilution was 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 flow chamber. Plates were kept for incubation at 28°C. Colonies appearing in the plates were recorded after 2 days in the case of bacteria and after four days for fungi and yeast. The microbial load of the samples was then expressed as cfc/g of the flour or mixes.

3. 4. 6. Reconstitution of RTC product.

The developed RTC product was tested for its acceptability by reconstituting it as thoran (poriyal). The acceptability of the RTC product was tested by a panel of judges

using score card. Parameters like appearance, colour, flavour, texture and taste were studied. Cooking time and the volume expansion was also noted for the product.

Consumer preference of the reconstituted RTC product was conducted among 50 subjects using hedonic rating.

4.7 Statistical analysis

In order to obtain suitable interpretation, the generated data was subjected to statistical analysis - Anova test.

RESULTS

4. RESULT

The results of present investigation entitled "Development and quality evaluation of ready to cook (RTC) dehydrated product from banana blossom" are detailed in this chapter under the following headings

4. 1. Slicing and dehydration of banana blossom

4. 2. Standardisation and product development

4. 3. Quality assessment of dehydrated banana blossom

4. 1. Slicing and dehydration of banana blossom

Since the objective of study is to develop dehydrated ready to cook (RTC) product from banana blossom, suitable pre-treatments and dehydration methods as mentioned in the methodology had been adopted. The banana blossom of 3 varieties viz, Nendran, Rasakadali and Palayankodan were selected. Three products viz dried slices, flour and RTC product was standardised from banana blossom.

Table 4 depicts the mean weight of banana blossom with and without outer bracts. The freshly purchased banana blossom was weighed initially and washed under running water and the weight was noted. Then the outer most 4-6 bracts were removed and again the weight was recorded.

The weighed blossoms were sliced and directly put into solutions. Table 1. shows the type of solution used for pre-treatment, its concentration, treatment time and outcome of the product.

Table 1. Pre-treatment of sliced banana blossom

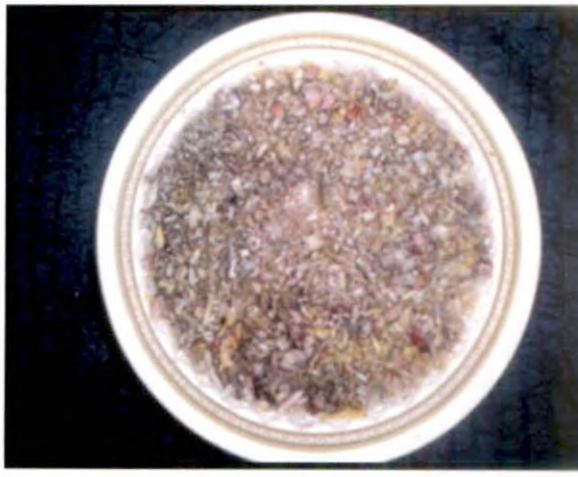
Sl .No	Solution	Concentration	Time	Remark
1	Plain water	100 ml	30 min	Browning occurred
2	Citric acid	2%	30 min	Less browning
3	Buttermilk	5%	30 min	Browning occurred
4	Salt	5%	30 min	Browning occurred
5	Potassium metabisulphite (KMS).	2%	30 min	Browning occurred

The above table indicates the pre-treatment methods adopted for minimising browning, as it is an important draw back in banana blossom. So in-order to prevent the extend of browning pre-treatments were given using different solutions like citric acid, butter milk, salt and KMS at different concentrations of 2 per cent, 5 per cent, 5 per cent and 2 per cent respectively. Plain water was also used as a treatment method. The immersion time was set uniform for each treatment as 30 minutes. The observations of pre-treatments showed that the banana blossom treated with citric acid at 2 per cent was found to have less browning when compared to other treatment methods. So this method was followed for product development (Fig 1).

4. 1. 1. Development of dried slices of banana blossom.

Banana blossom of three varieties viz Nendran, Rasakadali and Palayankodan were chopped and gently immersed into two per cent citric acid solution in a vessel. Then it was kept for 30 minutes and drained well. The squeezed slices were spread uniformly

Salt solution (5%)



Plain water

KMS (2%)

Citric acid (2%)

Fig 1. Different pre- treatment methods

in trays and dried at 60°C. When it got dried well, cooled and packed air tight in aluminium foil pouches.

4. 1. 2. Development of banana blossom flour

Banana blossom of 3 varieties viz Nendran, Rasakadali and Palayankodan were chopped and gently immersed into 2% citric acid solution in a vessel. Then it was kept for 30 minutes and drained well. The squeezed slices were spread in trays and dried at 60°C. The dried slices were cooled, powdered and sieved. The flour is packed in aluminium foil pouches.

4.1. 3 Development of ready to cook (RTC) product

The newly emerging era of fast foods, convenient foods and instant foods are becoming increasingly popular among Indian households (Rajpur, 2007). According to Solanki (2000) there is an urgent need to develop low cost ready to cook mix to improve the nutritional status as well as to save time. Significant progress had been made by food industries in our countries in recent years in the area of development of food products (Rao, 1993).

In the present study different combinations of dehydrated RTC product were standardised keeping banana blossom as the major ingredient and coconut, cumin, red chilli, salt, turmeric and garlic in varying proportions and dried. The details pertaining the development of RTC product with different combinations are presented in Table 2.

Nendran dried slices

Nendran RTC product

Nendran flour

Fig. 1. Flow chart for product development

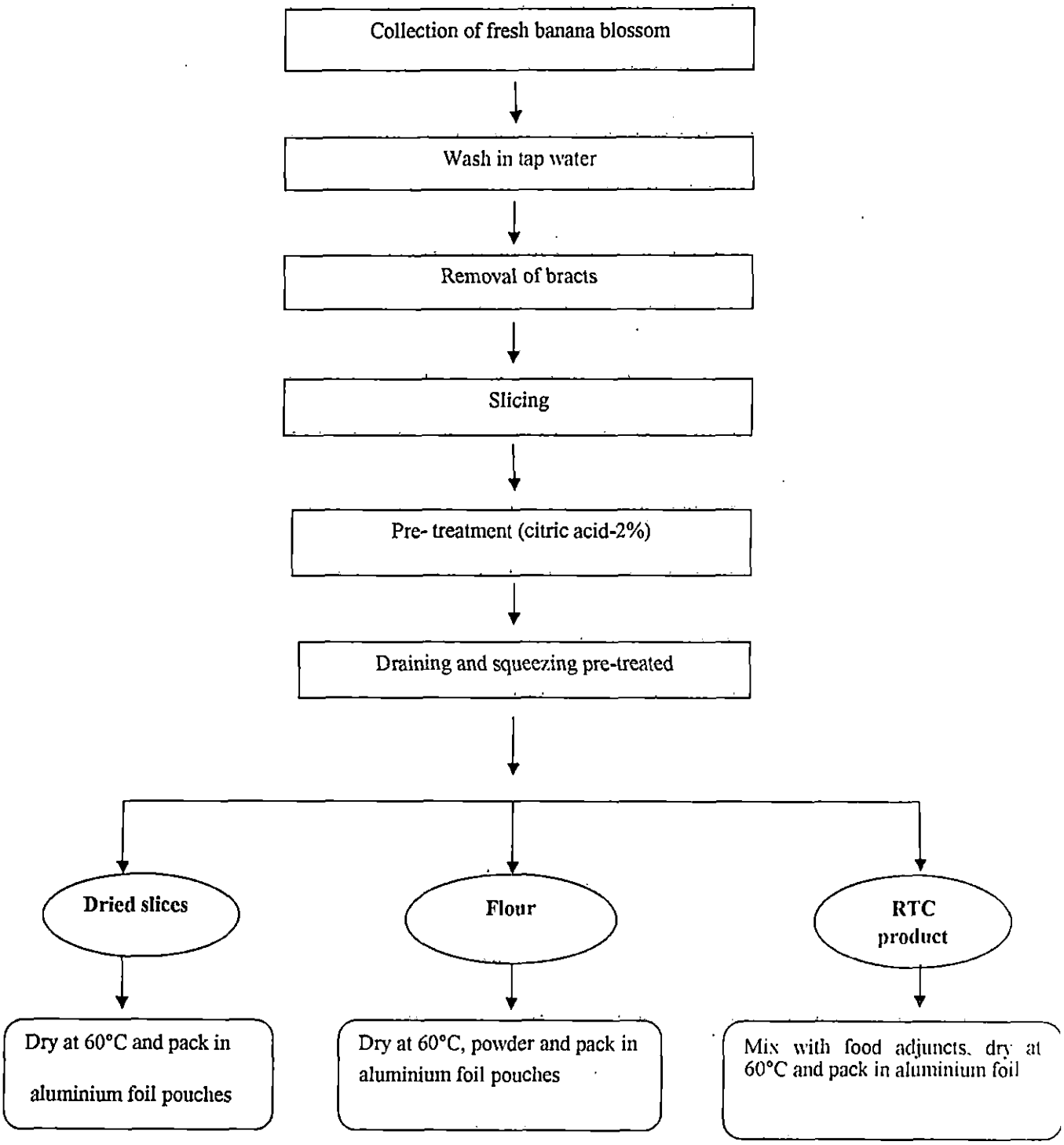


Table 2. Different combinations of RTC product from banana blossom of Nendran variety.

Sl. No	RTC product	Ingredients	Proportion of ingredients (g).
1	NP_1	Nendran banana blossom+ coconut + cumin + Garlic + Red chill + Salt + Turmeric powder	1 kg : 100 : 50 : 50 : 20 : 20
2	NP_2	Nendran banana blossom+ coconut + cumin + Garlic + Red chill + Salt + Turmeric powder	1 kg : 150 : 50 : 20 : 20 : 20
3	NP_3	Nendran banana blossom+ coconut + cumin + Garlic + Red chill + Salt + Turmeric powder	1 kg : 200 : 50 : 20 : 20 : 20
4	NP_4	Nendran banana blossom+ coconut + cumin + Garlic + Red chill + Salt + Turmeric powder	1 kg : 250 : 50 : 20 : 20 : 20
5	NP_5	Nendran banana blossom+ coconut + cumin + Garlic + Red chill + Salt + Turmeric powder	1 kg : 300 : 50 : 20 : 20 : 20

NP- Nendran products 1, 2,3,4,5

** RTC product from Rasakadali and Palayankodan was also formulated using the same combinations.

Coconut forms one of the major ingredients of most of Kerala cuisines due to its delicious taste and aroma and hence the product was named 'thoran mix' (poriyal mix). The coconut was added in different proportions such as 100g, 150g, 200g, 250g and 300g per kilogram sliced pre-treated banana blossom.

The ultimate aim of the dehydrated mix is to reconstitute with minimum cooking time and energy to serve as fresh as possible. The tedious job involved in the pre- preparations of fresh banana blossom makes home makers to choose vegetables which are easy to prepare. More over the polyphenol content in fresh banana blossom leaves a black stain

on hands during cutting and preparation. A beauty conscious home maker prefers a ready to use product. A dehydrated RTC product could be recommended with good shelf life.

4. 1. 4. Reconstitution of RTC product

The developed RTC product was reconstituted by trial and error method. Initially the measured quantity of RTC mix was soaked in boiled water for 10 minutes. It was observed that at least 10 minutes soaking time to be given to attain maximum rehydration and the mix become very soft and tender. It was noted that 3-4 times of boiled water was required to make the product tender. After soaking, it was seasoned and served hot. The recipe is given in Appendix I

The standardised dehydrated slices, flour and RTC products were subjected to shelf life study. The reconstituted RTC product was also subjected to sensory quality evaluation.

Overall acceptability is an important parameter to evaluate the acceptability of the products. The overall acceptability score covering five sensory characteristics have been computed by taking average score values of the individual sensory qualities viz appearance, colour, flavour, texture and taste. Hedonic rating was also adopted for screening the best combination in each variety of banana blossoms.

4. 3. Quality assessment of dehydrated slices, flour and RTC product

Quality is a very important parameter for judging the edible nature of any food product (Sharma, 2006). It is the ultimate criterion for the desirability of a food product. It has been variously defined as "the quality characteristics of food that is acceptable to consumers including external factors such as appearance, texture, and flavour, and internal standards such as physical, chemical, and microbial attributes" . The requirements necessary to satisfy the needs and expectations of the consumer, including food safety and the totality of characteristics of an entity that bears on its ability to satisfy stated and implied needs (Peri, 2006).

4.3.1 Organoleptic evaluation

Sensory analysis is a scientific discipline that applies principles of experimental design and statistical analysis to the use of human senses viz sight, smell, taste, touch and hearing for the purposes of evaluating consumer products (IFT, 2005). The sensory parameters such as colour, flavour, texture, taste, and overall acceptability of any food product depends on the extent of oxidation of fats and oils in the food due to the formation of peroxides, aldehydes and ketones (Gupta, 2005). Although sensory evaluation of foods is the most important quality assessment, taste evaluations are not practical for routine quality control. It is always preferable to have a quantitative method for which rejection points may be established by sensory means (Jonnalagadda *et al*, 2001). The discipline requires panels of human assessors, on whom the products are tested, and recording the responses made by them. When food is assessed by human sensory organs, the evaluation is said to be sensory analysis (Simi, 2002). Numerical scoring is used to evaluate particular characteristics of one or more samples indicating the rating as excellent, very good, fair and poor (Manay and Swamy, 2000). The oraganoleptic evaluation of RTC product is done by panel of 10 judges using a 4 point scale and the data is presented in Table 3.

Table 3 . Mean sensory scores of developed RTC product

Variety	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Nendran RTC product	3.90	4.00	3.80	3.80	4.00	3.90
Rasakadali RTC product	3.80	4.00	3.80	3.70	3.75	3.80
Palayankodan RTC product	3.70	4.00	3.90	3.80	3.85	3.80

Appearance

The first impression of food is usually visual and a major part of willingness to accept a food depends on its appearance. The scores obtained for the parameter appearance of RTC product developed from three varieties of banana blossom viz Nendran, Rasakadali and Palayannkodan. The highest score was recorded for Nendran product.

Colour

Colour is one of the important visual attribute that has been used to judge the overall quality of foods for a very long time. If the colour is unattractive, a potential consumer may not be impressed by any other attributes. The colour of product developed from three varieties of banana blossom did not exhibit any difference.

Flavour

Odour preference is generated by stimulation of sensory cells by specific volatile compounds present in foods. The flavour of RTC product developed from three varieties of banana blossoms differs in score.

Texture

Texture constitutes a physical property of food stuffs apprehended by the eye, skin and muscle senses located in the mouth. The texture of RTC product developed from three varieties of banana blossom differs in scores.

Taste

The taste is the major attribute which determine the acceptability of a food. Taste is the sensation produced when a substance in the mouth reacts chemically with receptors of taste buds. Maximum score was noticed in taste of the RTC product developed from Nendran of banana blossoms.

Overall acceptability

The overall mean score of product developed from three varieties of banana blossom ranged from 3.80 to 3.90.

4. 3. 2. Functional qualities of developed products.

The functional qualities help in the quality assessment and acceptability of any product. The functional qualities like processing loss, bulk density and rehydration ratio of three products were noted

4. 3. 2. 1. Processing loss

Processing loss was noted in drying and flouring of banana blossom viz Nendran, Rasakadali and Palayankodan. The results are presented in Table 4.

Table 4. Mean weight of banana blossom with and without outer bracts.

Sl no	Variety	Fresh weight	Weight after removing outer bracts
1	Nendran	713	423
2	Resakadali	327	134
3	Palayankodan	441	278

The initial weights of banana blossoms were noted after purchasing. The outer most hard bracts of 4-6 numbers (to get yellow soft blossom) were removed and weight was noted again and found that the mean weight of Nendran, Rasakadali and Palayankodan were 423g, 134g and 278g respectively. The initial weight losses after removing bracts are given in Appendix II

Processing loss in drying

The processing loss will affect the qualitative and quantitative characters of food. It was noted that when one kilogram of sliced pre-treated banana blossom was dried 180g of Nendran, 190g of Rasakadali and 200g of Palayankodan was obtained. A loss of 92 per cent for Nendran, 91 per cent for Rasakadali and 90 per cent for Palayankodan was observed.

Processing loss on flouring

Two hundred gram each of the dried banana blossom of three varieties were weighed accurately and then it was powdered and sieved and weight of flour was noted. It was noted that on flouring 108.56 g of Nendran, 117.24g of Rasakadali and 118.51g of Palayankodan flour was obtained. So a loss of 45.72, 41.38 and 40.15 per cent of drying and flouring was seen in three varieties respectively.

4. 3. 2. 2. Bulk density

Bulk density is a property of flours. It is defined as the mass of many particles of the material divided by the total volume they occupy. The total volume includes particle volume, inter-particle void volume and internal pore volume. The bulk density of banana blossom flour is given in Table 5.

Table 5. Bulk density of banana blossom flour

Variety	Bulk density
Nendran	0.91
Rasakadali	0.97
Palayankodan	0.96

The bulk density of Rasakadali flour was found to be highest and Nendran flour was found to be the lowest.

4. 3. 2. 3. Rehydration ratio

Rehydration ratio is the weight of dehydrated sample to drained weight of rehydrated sample.

Table 6. Rehydration ratio of the developed products.

Variety	Dried slices	Flour	RTC product
Nendran	0.28	0.40	0.25
Rasakadali	0.33	0.50	0.28
Palayankodan	0.33	0.50	0.33

The rehydration ratio of Rasakadali and Palayankodan flour was found to be highest and lowest rehydration ratio was recorded for Nendran RTC product.

4. 3. 3. Chemical composition

Food is made of chemicals. Chemicals are all potentially significant, as they determine the nutritional value, eating properties and suitability for use in particular products and processes (Huton, 2002). Chemical components present in dried slices, flour and RTC product was analysed and presented.

Moisture

Moisture content of the food material is an important factor as it affects the physical and chemical aspects of food which relates with the freshness and stability of the food.

The total moisture content of the developed products viz dried slices; flour and RTC product were shown in Table 7.

Table 7. Total moisture content (%) of developed products.

Variety	Dried slices	Flour	RTC product
Nendran	4.25	4.28	4.19
Rasakadali	5.18	4.89	5.10
Palayankodan	6.14	6.71	6.70
Mean	5.19	5.20	5.33
CD (0.05) V - 6.81 M - 6.81 VM - 0.11			

V- Variety, M- Method, VM- Variety × Method

The ANOVA table indicated that the varietal difference of moisture content varied significantly with three different products. Likewise there was significant difference in moisture content of the three varieties viz Nendran, Rasakadali and Palayankodan and three products viz dried slices, flour and RTC product.

The highest moisture content was noted for dehydrated Palayankodan flour (6.71%) and the lowest moisture content was observed for Nendran RTC product (4.19%). There was not much significant difference indicated for dried slices (5.19%) and flour (5.20%) of the three varieties.

Total Fibre

Fibre is the indigestible portion of food derived from plants. Fibres can act by changing the nature of the contents of the gastrointestinal tract and by changing how other nutrients and chemicals are absorbed.

The total fibre content of the products like dried slices, flour and RTC product from three varieties were shown in the below Table 8.

Table 8. Total fibre content (g/100g) of the developed products

Variety	Dried slices	Flour	RTC product
Nendran	11.55	11.21	10.48
Rasakadali	17.08	13.37	13.98
Palayankodan	13.15	12.19	10.72
Mean	13.92	12.26	11.73
CD(0.05) V- 0.4796 M- 0.4796 VM- 0.8304			

The ANOVA table revealed that the varietal difference of total fibre content varied with products. The statistical data elicited that there was significant difference between the variety such as Nendran, Rasakadali and Palayankodan and products like dried slices, flour and RTC product at 5 per cent level.

The maximum fibre content was noted for RTC product from Rasakadali (13.98g/100g) and minimum fibre content was recorded for RTC product from Palayankodan (10.72g/100g) variety. There was significant difference between the fibre content of dried slices (13.92g/100g), flour (12,26g/100g) and RTC product (11.73g/100g).

Total Minerals

Total minerals is a measure of the total amount of minerals present within a food, whereas the mineral content is a measure of the amount of specific inorganic components present within a food, such as Ca, Na, K and Cl.

The total mineral content of the developed products viz dried slices, flour and RTC products from three varieries viz Nendran, Rasakadali and Palayankodan are depicted in Table 9.

Table 9. Total mineral content (g/100g) of the developed products.

Variety	Dried slices	Flour	RTC product
Nendran	4.70	4.29	5.47
Rasakadali	4.90	5.30	6.00
Palayankodan	4.76	4.59	5.59
Mean	4.79	4.73	5.69
CD (0.05) V - 0.186 M- 0.186 VM- 0.323			

From the table it was noted the total mineral content varies on varietal as well as product basis. There was significant difference in total minerals content of three products viz dried slices, flour and RTC products at 5 per cent level.

The statistical data revealed that the total mineral content was highest for RTC product from Rasakadali variety (6.00g/100g) and lowest for flour of Nendran variety (4.29g/100g).

The mean mineral content in dried slices (4.79 g/100g) and flour (4.73g/100g) could not elicit significant difference in the total mineral content.

Phenol

The Table 10 gives the phenol content of three products viz dried slices, flour and RTC product from three varieties viz Nendran, Rasakadali and Palayankodan.

Table 10. Phenol content (mg/100g) of the developed products.

Variety	Dried slices	Flour	RTC product
Nendran	52.86	58.07	48.67
Rasakadali	47.26	54.03	49.67
Palayankodan	48.00	50.67	49.89
Mean	52.98	50.65	49.40
CD(0.05) V- 7.7080 M- 7.7080 VM-13.3508			

Statistical analysis of data revealed that the phenol content did not show variation in variety as well as product basis. There was no significant difference between phenol content of three products viz dried slices, flour and RTC product at 5 per cent level.

The maximum phenol content was noted for Nendran dried slices (58.07mg/100g) and the minimum was recorded for Rasakadali flour (47.26mg/100g). The mean value showed that the phenol content of three products varies significantly. The phenol content of dried slices and RTC product were 52.97 mg/100g, 50.65 mg/100g and 49.41 mg/100g respectively.

Oxalate

The oxalate content of three products viz dried slices; flour and RTC product are shown in Table 11.

Table 11 . Oxalate content (mg/100g) of the developed products

Variety	Dried slices	Flour	RTC product
Nendran	240.00	236.67	236.67
Rasakadali	440.00	400.00	466.67
Palayankodan	366.66	326.67	406.67
Mean	348.88	321.11	370.00
CD(0.05) V- 16.17 M -16.17 VM-28.01			

Statistical data analysis showed that there is no significant difference in the oxalate content on varietal as well as product basis. The maximum oxalate content was recorded for Rasakadali RTC product (466.67mg/100g) and minimum was noted for Nendran flour (236.67mg/100g) and Nendran RTC product (236.67mg/100g)

The mean value elicited significant difference in the oxalate content of three products viz dried slices (348.88mg/100g), flour (321.11mg/100g) and RTC product (370.00 mg/100g) at 5 per cent level.

4. 3. 4. Nutritional components

Energy

Energy is essential for rest, activity, growth and maintenance of sound health. Sheng *et al* (2010) reported that energy value of fresh banana blossom observed to be 51 kcal/100g.

The energy content of the products developed from three varieties of banana blossom viz Nendran, Rasakadali and Palayankodan is elicited in Table 12.

Table 12. Calorific value of developed products of banana blossom

(Kcal/100g)

Variety	Dried slices	Flour	RTC product
Nendran	253	248	288
Rasakadali	240	219	282
Palayankodan	207	183	251

The energy content was found to be maximum for Nendran RTC product (288kcal/100g) and minimum for Palayankodan flour (183kcal/100g).

Protein

Protein is one of the most important nutrients required by the body to carry out a wide range of functions essential for the maintenance of life. Proteins are essential component of tissues and cells of the body (Gopalan *et al*, 2009)

The protein content of the products like dried slices, flour and RTC product from three varieties of banana blossom are depicted in Table 13.

Table 13. Protein content of developed products of banana blossom (g/100g)

Variety	Dried slices	Flour	RTC product
Nendran	13.05	12.65	17.38
Rasakadali	13.58	13.50	17.40
Palayankodan	13.34	13.58	18.12
Mean	13.32	13.58	17.63
CD(0.05) VM- 4.41			

From the table it was observed that there was no significant difference in the protein content on variety as well as product basis.

The protein content was found to be maximum for Palayankodan RTC product (18.12g/100g) and minimum protein content was noted for Nendran flour (12.65g/100g). The mean value elicited that there was no significant difference in the protein content of the product viz dried slices (13.32g/100g), flour (13.58g/100g) and RTC product (17.63g/100g).

Calcium

Calcium is essential for living organisms, in particular in cell physiology. As a major material used in mineralization of bone, teeth and shells, calcium is the most abundant metal by mass in many animals.

The calcium content of the developed products viz dried slices, flour and RTC products from three varieries viz Nendran, Rasakadali and Palayankodan were depicted in Table 14.

From the table it was noted that the calcium content varies on varietal as well as product basis. There was no significant difference in calcium content of three products viz dried slices, flour and RTC products.

Table 14. Calcium content (mg/100g) of the developed products.

Variety	Dried slices	Flour	RTC product
Nendran	121.67	158.33	171.00
Rasakadali	199.33	206.33	223.33
Palayankodan	121.00	134.56	136.50
Mean	147.33	166.41	176.94
CD (0.05) V- 17.71 M- 17.71 VM -30.67			

The statistical analysis of data showed that calcium content was highest for Rasakadali RTC product (223.33mg/100g) and lowest for Palayankodan dried slices (121.00mg/100g).

The mean calcium content of dried slices (147.33mg/100g), flour (166.41mg/100g) and RTC product (176.94mg/100g) elicit significant difference.

Magnesium

Magnesium is highly required for cellular metabolism, essential for intracellular enzyme, metabolism of carbohydrate and the structure of DNA and RNA.

The magnesium content of the developed products viz dried slices; flour and RTC product from three varieties are recorded in Table 15

Table 15. Magnesium content (mg/100g) of the products developed.

Variety	Dried slices	Flour	RTC product
Nendran	14.52	21.70	21.81
Rasakadali	23.63	25.96	29.89
Palayankodan	20.43	25.01	23.00
Mean	19.53	24.23	24.90
CD(0.05) V- 4.16 M- 4.16 VM- 7.21			

From the table it was that noted the magnesium content varies on varietal as well as product basis. There was no significant difference at 5 per cent level was observed in magnesium content of three products viz dried slices, flour and RTC products.

Statistical analysis of data revealed that the magnesium content was maximum for Rasakadali RTC product (29.89mg/100g) and minimum was noted for Nendran dried slices (14.52mg/100g).

The mean value revealed that there was significant difference between the magnesium content of dried slices (19.53mg/100g) and flour (24.23mg/100g). Also there was significant difference between magnesium content of dried slices (19.53mg/100g) and RTC (24.90mg/100g) product. But there was no significant difference between magnesium content of flour (24.23mg/100g) and RTC product (24.90mg/100g).

Sodium

The sodium content of the developed products viz dried slices, flour and RTC product from three varieties viz Nendran ,Rasakadali and Palayankodan are recorded in the Table 16.

Table 16. Sodium content (mg/100g) of the developed products.

Variety	Dried slices	Flour	RTC product
Nendran	226.00	286.67	267.33
Rasakadali	116.33	161.55	146.66
Palayankodan	122.68	177.33	146.33
Mean	155.01	208.52	186.78
CD V- 9.92 M- 9.92 VM-17.18			

From the table it was noted that the sodium content varies on varietal as well as product basis. There was significant difference in sodium content of three products viz dried slices, flour and RTC products.

The maximum sodium content was noted for Nendran flour (286.67mg/100g) and minimum was recorded for Rasakadali dried slices (116.33mg/100g).

The mean value elicited significant difference between the sodium content of dried slices (155.01mg/100g), flour (208.52mg/100g) and RTC product (186.78mg/100g)

Potassium

Potassium is an essential macro-mineral in human nutrition; it is the major cation inside animal cells, and it is thus important in maintaining fluid and electrolyte balance in the body. Potassium is also important in preventing muscle contraction and the sending of all nerve impulses in animals through action potentials.

The potassium content of the developed products viz dried slices, flour and RTC product from three varieties viz Nendran ,Rasakadali and Palayankodan are depicted in Table 17.

Table 17 . Potassium content (mg/100g) of the developed products.

Variety	Dried slices	Flour	RTC product
Nendran	427.36	481.80	452.23
Rasakadali	587.63	565.33	583.66
Palayankodan	471.66	479.33	481.20
Mean	495.56	498.62	505.70
CD(0.05) V- 163.53 M-163.53 VM-283.23			

From the table it was noted that the potassium content varies on varietal as well as product basis. There was significant difference in potassium content of three products ($F_{4,18}$=3.1698, P<0.05) viz dried slices, flour and RTC products.

The maximum potassium content was noted for Rasakadali dried slices (587.63mg/100g) and minimum was recorded for Nendran dried slices (427.36mg/100g).

The mean value shown that there was significant difference between the sodium content of dried slices (495.56mg/100g) and RTC product (505.70mg/100g). But there was no significant difference noted for dried slices (495.56mg/100g) and flour (498.62mg/100g).

Iron

Iron is a necessary trace element found in nearly all living organisms. Iron is essential for the proper growth and development of the human body. It helps to metabolize proteins and plays a role in the production of haemoglobin and red blood cells. Iron deficiency can lead to conditions like iron deficiency anaemia.

The iron content of the developed products viz dried slices, flour and RTC product from three varieties viz Nendran ,Rasakadali and Palayankodan were recorded in the Table 18.

From the table it was noted the iron content varies on varietal as well as product basis. There was significant difference in iron content of three products viz dried slices, flour and RTC products.

The highest iron content was noted for Palayankodan RTC product (140.22mg/100g) and least was recorded for Nendran dried slices (81.41mg/100g).

Table 18. Iron content (mg/100g) of the developed products

Variety	Dried slices	Flour	RTC product
Nendran	81.41	117.45	131.00
Rasakadali	134.08	130.33	136.82
Palayankodan	124.67	135.67	140.22
Mean	113.39	127.82	136.01
CD(0.05) V-7.70 M-7.70 VM- 13.35			

The mean value elicited significant difference between the iron content of dried slices (113.39mg/100g), flour (127.82mg/100g) and RTC product (136.01mg/100g) at 5 per cent level.

Shelf stability of banana blossom dried slices, flour and RTC product

Changes brought about in food by way of breakdown of protein, carbohydrate and fats and also of amino acids called microbial spoilage (Saimon, 2000).

Product quality is judged by the degree of difference from the standard. Assessment of shelf life quality is important since it determines the suitability of a particular ingredient for the product development. Shelf life is the recommendation of time that products can be stored, during which the defined quality of a specified proportion of the goods remains acceptable under expected conditions of distribution, storage and display (Azanha and Faria, 2005).

Product quality depends on exposure to light and heat, transmission of gases (including humidity), mechanical stresses, and contamination by things such as micro-organisms. Product quality is often influenced by concentration of a chemical compound, a microbiological index, or moisture content (Gyesley, 2003).

The shelf life quality of developed products were analysed by assessing the moisture content , peroxide value and microbial growth up to a period of three months and also by assessing the sensory parameters.

Organoleptic changes of RTC product.

Sensory evaluation plays an important role in determining the acceptability and shelf stability of food products. Table 19 shows the organoleptic evaluation of developed RTC product

Appearence

Appearance is the criteria for the desirability of any food products. The Table 19 explains the appearance of the developed RTC product with coconut from three banana blossom varieties viz Nendran, Rasakadali and Palayankodan during storage. The ANOVA table revealed that there was decrease in score after one month storage of developed RTC product from three varieties of banana blossom.

Statistical analysis of data showed that there was significant difference in the scores during the initial period and first month of storage at 5 per cent level. The mean value showed that there was no significant difference in appearance on varietal basis.

Colour

Table 19 explains the colour of the developed RTC product from three banana blossom viz Nendran, Rasakadali and Palayankodan during storage.

The ANOVA table revealed that there was decrease in colour after one month storage of developed RTC product from three varieties of banana blossom.

Table 19. Organoleptic evaluation of RTC product with coconut

Variety	Appearance			Colour			Flavour			Texture			Taste			Overall acceptability		
	T_0	T_1	Mean	T_0	T_1	Mean	T_0	T_1	Mean	T_0	T_1	Mean	T_0	T_1	Mean	T_0	T_1	Mean
Nendran	3.90	3.60	3.75	4.00	3.50	3.75	3.80	1.20	2.50	3.80	3.70	3.75	4.00	1.05	2.52	3.90	2.60	3.25
Rasakadali	3.80	3.60	3.70	4.00	3.50	3.75	3.80	1.25	2.50	3.70	3.50	3.60	3.75	1.25	2.50	3.80	2.90	3.35
Palayankodan	3.70	3.50	3.60	4.00	3.70	3.85	3.90	1.20	2.50	3.80	3.70	3.75	3.85	1.50	2.67	3.80	2.70	3.25
CD(0.05) T – 0.2198				CD(0.05) T – 0.2198			CD(0.05) T – 0.1937						CD(0.05) T –0.1941			CD T–0.2268 VT–0.3362		

T_0 – initial period, T_1 – first month

Statistical analysis of data showed that there was significant difference in the scores during the initial period and first month of storage . The mean value showed that there was no significant difference in colour on varietal basis.

Flavour

Table 19 reveals the flavour of the developed RTC product from three banana blossom varieties during storage.

The ANOVA table revealed that there was decrease in flavour after one month storage of developed RTC product from three varieties of banana blossom.

Statistical analysis of data showed that there was significant difference in the scores during the initial period and first month of storage .The mean value showed that there was no significant difference in flavour on varietal basis.

Texture

Table 19 explains the texture of the developed RTC product from three banana blossom varieties viz Nendran, Rasakadali and Palayankodan during storage.

The ANOVA table reveals that there was decrease in score after one month storage of developed RTC product from three varieties of banana blossom.

Statistical analysis of data showed that there was no significant difference in the scores during the initial period and first month of storage.

Taste

Table 19 explains the taste of the developed RTC product from three banana blossom varieties viz Nendran, Rasakadali and Palayankodan during storage.

The ANOVA table revealed that there was decrease in score after one month storage of developed RTC product from three varieties of banana blossom.

Statistical analysis of data showed that there wass significant difference in the scores during the initial period and first month of storage at per cent level. The mean value showed that there was no significant difference in taste on varietal basis.

Overall acceptability

Table 19 explains the overall acceptability of the developed RTC product with coconut from three banana blossom varieties viz Nendran, Rasakadali and Palayankodan during storage.

The ANOVA table revealed that there was decrease in score after one month storage of developed RTC product from three varieties of banana blossom.

Statistical analysis of data showed that there was significant difference in the scores during the initial period and first month of storage at 5 per cent level. The mean value showed that there was no significant difference in flavour on varietal basis.

It was observed that there was a decrease in sensory scores of the RTC product from three varieties of banana blossom. The RTC product was developed using the ingredients banana blossom, coconut, cumin, red chilli, salt, garlic and turmeric powder. The content of coconut in the product caused rancidity and contributed off flavour and taste to the product. Due to occurance of rancidity developed products with addition of coconut it got least score within the first month of storage. Hence an alternate product was developed without coconut and evaluated the shelf life qualities. The results of organoleptic qualities of the RTC product without coconut are elicited in Table 20.

Appearence

The scores obtained for the appearance of the RTC product developed from banana blossom of three varieties viz Nendran, Rasakadali and Palayankodan during the initial period ranged between 3.9 to 4.0. Rasakadali and Palayankodan were on par in appearance during the initial period. The score decreased gradually during the third month of storage. The highest score of 3.85 was recorded for Rasakdali RTC product.

The statistical data showed that there was no significant difference in the appearance on varietal basis but there was significant difference in the appearance of product during the storage period at 5 per cent level.

Table 20. Organoleptic evaluation of RTC product without coconut

Variety	Appearance			Colour			Flavour			Texture			Taste			Overall acceptability		
	T_0	T_3	Mean	T_0	T_3	Mean	T_0	T_3	Mean	T_0	T_3	Mean	T_0	T_3	Mean	T_0	T_3	Mean
Nendran	4.00	3.75	3.87	4.00	3.60	3.80	3.80	3.60	3.70	3.80	3.60	3.70	4.15	3.60	3.87	3.90	3.50	3.70
Rasakadali	3.90	3.85	3.87	4.00	3.70	3.85	3.90	3.60	3.75	3.90	3.40	3.65	4.10	3.40	3.75	3.80	3.50	3.65
Palayankodan	3.90	3.65	3.77	4.00	3.85	3.92	3.90	3.30	3.60	4.0	3.50	3.75	4.05	3.60	3.82	3.80	3.50	3.65
CD(0.05) T – 0.2355				CD(0.05) T – 0.3149			CD(0.05) T – 0.3756						CD(0.05) T –0.3433			CD(0.05) T– 0.2268		

T_o – initial period, T_3 – third month

Colour

Table 20 explains the colour of the RTC product developed from banana blossom of three varieties viz nendran, rasakadali and palayankodan. During the initial period of storage the colour of three varieties was found to be on par (4.00) and the score decreased during the third month of storage. A highest score of 3.92 was recorded for Palayankodan variety. There was no significant difference in the score on varietal basis. There elicited significant difference in the score of colour during the three months of storage

Flavour

The flavour of the RTC product developed from banana blossom of three varieties viz Nendran, Rasakadali and Palayankodan were depicted in the Table 20. The Anova table reveals that there was no significant difference in the flavour of the RTC product. During the initial period of shelf life study the score of flavour ranged between 3.8 to 3.9 and the score was found to be decreased during the third month of storage.

The statistical data showed significant difference in the flavour during the storage period.

Texture

Table 20 depicts the score obtained for texture of the RTC product developed from banana blossom of three varieties viz Nendran, Rasakadali and Palayankodan. The highest score was obtained for Palayankodan RTC product during the initial period among the three varieties. The score decreased significantly during the third month of storage. There was no significant difference in the texture of the RTC product developed from the three varieties of banana blossom.

Taste

Taste of the RTC developed product from the banana blossom of three varieties viz Nendran, Rasakadali and Palayankodan was depicted in Table 20. The highest score was obtained for the Nendran RTC product during the initial period of storage and the score decreased gradually. It was observed that during the third month of storage the highest score was obtained for Nendran and Palayankodan RTC product.

There was no significant difference in the taste of the RTC product on varietal basis. There was significant difference in the taste of the RTC product during the storage period.

Overall acceptability

From the Table 20 it is clear that the overall acceptability score was found to be highest for RTC product developed from Nendran variety during the initial period of storage. The score decreased gradually during the third month of storage. But there was no significant difference in the overall acceptability of the product on varietal basis. But there was significant difference in the overall acceptability during storage period.

Moisture content of stored products

Moisture content is one of the most commonly measured properties of food materials. Knowledge of the moisture content is often necessary to predict the behaviour of foods during processing. For estimating the moisture content the developed products were packed in aluminium foil pouches, sealed air tight and stored at ambient condition. The moisture content was recorded periodically up to 3 months and the data is shown in Table 21.

Table 21 . The moisture content (%) of the developed products on storage

Variety	Initial	First month	Second month	Third month
Nendran				
Dried slices	4.25	4.28	4.28	4.30
Flour	5.06	5.14	5.15	5.19
RTC product	4.64	4.69	5.12	5.18
Rasakadali				
Dried slices	5.48	5.58	5.76	5.88
Flour	5.10	5.49	5.50	5.50
RTC product	5.36	5.45	5.78	6.14
Palayankodan				
Dried slices	6.25	6.30	6.50	6.70
Flour	6.70	6.78	6.78	6.80
RTC product	6.73	6.81	6.86	6.94

CD (0.05)

V- 0.14

M- 0.14

VM- 0.25

The statistical data showed that the moisture content of developed products varied from 4.25 to 6.73 per cent during the initial period. The highest moisture content was recorded for Palayankodan RTC product (6.73 per cent) and the lowest was observed for Nendran dried slices (4.25 per cent). There was significant difference in the moisture content on varietal basis during storage at 5 per cent level.

Table 21 indicates the moisture content of developed products during storage. The statistical data showed that the moisture content of developed products varied from 4.25 to 6.73 per cent during the initial period. The highest moisture content was recorded for Palayankodan RTC product (6.73 per cent) and the lowest was observed for Nendran dried slices (4.25 per cent). There was significant difference in the moisture content on varietal basis during storage at 5 per cent level.

At the end of first month the moisture content of developed products ranged from 4.28 to 6.81 per cent. The highest moisture content was noted for Palayankodan RTC product (6.81 per cent) and lowest was noted for Nendran dried slices (4.28 per cent). During the end of second month the moisture content ranged between 4.28 to 6.86 per cent.

During the end of third month the moisture content ranged between 4.30 to 6.94 per cent. The highest moisture content was noted for Palayankodan RTC product and lowest was recorded for Nendran dried slices.

The ANOVA table indicated that there was significant difference in the moisture content on varietal as well as product basis at 5 per cent level.

Peroxide value of stored products

Peroxide value gives an indication about the extent of per oxidation taking place in stored food materials. The acceptability of a food product depends on the extent to which deterioration has occurred and oxidative rancidity is a major cause of food deterioration This in turn represents a major cause of loss of nutritional quality as well as cause of concern for food safety, as the oxidized fats in a very high dosage have been shown to

have toxic effects (Sen and Sen, 2009). The peroxide value was recorded for a period of 90 days.

Table 22. Peroxide value (meq/kg) of developed products during storage.

Variety	First month	Second month	Third month
Nendran RTC product	0.32	0.41	0.51
Rasakadali RTC product	0.24	0.25	0.31
Palayankodan RTC product	0.32	0.25	0.43
Mean	0.29	0.26	0.42
CD (0.05) V-6.60 VM-5.96			

The peroxide content was not observed for dried slices and flour from three varieties. During the first month of storage the peroxide content of RTC product ranged between 0.24meq/kg (Rasakadali) to 0.32 meq/kg (Palayankodan). The highest peroxide content was noted for Nendran and Palayankodan RTC product (0.32 meq/kg). The least peroxide content was noted for Rasakadali RTC product (0.24 meq/kg).

During the second month the peroxide content ranged between 0.25 meq/kg to 0.41 meq/kg. The highest was recorded for Nendran RTC product (0.41 meq/kg) and lowest was noted for Rasakadali and Palayankodan RTC product (0.25 meq/kg).

During the third month the peroxide content ranged between 0.31 meq/kg to 0.51 meq/kg. The highest peroxide value was obtained for Nendran RTC product (0.51 meq/kg) and least was recorded for Rasakadali RTC product (0.31 meq/kg).

Statistical data showed that there was significant difference in the peroxide content on varietal basis as well as during each stage of storage at 5 per cent level.

Total microbial population of developed products.

Microbial population in developed food products is important as it determines the quality and safety of food products. The microbiological safety of food is achieved by as far as possible ensuring the absence of pathogenic microorganisms and by all means preventing their multiplication (Beckers, 1988). Food products that have been subjected to an adequate heat-treatment during processing are free of vegetative pathogens. So it is regarded as safe. Microbial analyses of stored products were done to ascertain the shelf life of the products. The products were stored at ambient condition for 3 months. The microbial evaluation was done initially and at 30 days interval up to 3 months. The growth of bacteria, fungi, actinomycetes and E-coli were determined using Nutrient Agar (NA), Potato Dextrose Agar with Rose Bengal (PDARB), Ken Knight's Agar (KEN) and Eosin Methylene Blue (EMB). This was done by serial dilution of the samples followed by pour plating techniques suggested by Johnson and Curl (1972)

Processed foods which are stored and consumed after a period of storage require certain microbial criteria to be employed to ensure their quality and safety. Many organisms causing food borne illness may grow significant effect on the quality of final product. A high microbial load and temperature higher than the recommended for a particular food can reduce the shelf life of a product. According to Shankaran (2000) several factors such as raw material quality, storage temperature, storage containers, processing methods, the environment in which it is processing etc will affect the microbiological quality of processed foods. Since ready to cook foods provide ample scope for contamination with spoilage and pathogenic microorganisms, the microbial quality was assessed.

Table 23. Microbial profile of stored products during 90th day(cfu/g).

Variety	Products	Bacterial colonies		Yeast colonies	
		10^{-2}	10^{-3}	10^{-5}	10^{-6}
Nendran	Dried slices	-	-	-	-
	Flour			1×10^{-3}	1.9×10^{-4}
	RTC product	-	-	-	-
Rasakadali	Dried slices	-	-	-	-
	Flour	-	-	1×10^{-2}	1.7×10^{-4}-
	RTC product	-	-	-	-
Palayankodan	Dried slices	-	-	-	-
	Flour			1×10^{-3}	2×10^{-2}
	RTC product	-	-	-	-

During the storage period no bacterial colonies were found to be appeared in the developed products from three varieties viz Nendran, Rasakadali and Palayankodan. But Yeast colonies were seen in 10^{-5} and 10^{-6} dilution. Even though yeast was detected, it was present only in permissible limit. No pathogenic organisms could be detected in the development of products.

Consumer preference of developed RTC product

The consumers now days are more conscious of a large range of food products available in the market. Novel foods are rapidly increasing in number in markets. Consumer acceptance of a new product is based largely on its convenience, appearance, sensory value and economic value and health benefits. Here an RTC product was developed from banana blossom of three varieties viz Nendran, Rasakadali and Palayankodan. Fifty female adults were selected randomly from neighbour house and students of College of Agriculture Vellayani, The study was conducted for three consecutive days by selecting 15 to 20 adults per day.

Consumer preference was done using five point Hedonic rating scale. The result of Hedonic rating showed in Table 24.

Table 24. Hedonic rating of developed RTC product (per cent).

Parameter	Nendran RTC product	Rasakadali RTC product	Palayankodan RTC product
Like very much	40 (20)	24 (12)	36 (18)
Like moderately	38 (19)	30 (15)	32 (16)
Neither like nor dislike	14 (7)	20 (10)	16 (8)
Dislike slightly	4 (2)	16 (8)	12 (6)
Dislike	4 (2)	10 (5)	4 (2)

*Figures in parenthesis denote number of consumers.

From the above table it is understood that Nendran RTC product was liked very much by maximum number of subjects. Rasakadali RTC product was disliked by 13 per cent of subjects.

DISCUSSION

5. DISCUSSION

The results of the present investigation entitled "Development and quality evaluation of Ready to cook (RTC) dehydrated product from banana blossom are discussed below:

5. 1. Slicing and dehydration of banana blossom

5. 2. Standardisation and product development

5. 3. Quality assessment of dehydrated banana blossom

5. 1. Slicing and dehydration of banana blossom

Banana blossom of banana plant is often consumed as a vegetable in many Asian countries such as Srilanka, Malaysia, Indonesia, India and Philippines (Walker, 2005). The utilization of banana blossom may be restricted due to cumbersome preparation procedures. Developing a processed product with good sensory qualities and prolonged shelf life would bring benefit to consumers in preparation as well as promotion of intake of fiber rich vegetable intake. This will also allow exploring more marketing niches in the countries. Although dehydration is considered as a low cost preservation process to produce ready to cook food items, not many studies on preservation of the banana blossom have been reported (Kordylas, 2000).

Pai (2007) reported that there is a need to make new products from indigenous raw materials having nutritional value which open up new channels for domestic and export market. Hence research in this field should be focused to develop nutrient packed food supplements from locally available resources. Saha and Dunkwal (2009) opined that instant food means simple, fast and convenient food which is easy and fast to prepare. In this context an RTC product from banana blossom was developed.

Banana blossom from Nendran, Rasakadali and Palayankodan varieties were collected, initial mean weight was recorded and it varies from 713g, 327g and 441g respectively. The outer most 4-6 fibrous bracts were removed and then sliced. The sliced banana blossom was pre-treated to prevent browning.

5. 1. 1. Pre-treatment of sliced banana blossom

In the present investigation different solutions at different concentrations were adopted for pre-treatments to prevent browning in banana blossom. The sliced banana blossom was pre-treated with citric acid solution (2%), salt solution (5%), butter milk (5%), KMS (2%). Plain water was also taken as a treatment method. The treatment done with citric acid for 30 min was found to have better appearance and acceptability. The pre-treated banana blossom was spread uniformly in trays and dried at 60°C.

According to Kanchana *et al* (2010) banana blossom treated with 0.2% citric acid solution for 30 minutes followed by 6 hours dehydration gave acceptable product with respect to appearance, flavour and overall quality.

It was noted that when one kilogram of sliced pre-treated banana blossom was dried at 60°C, the yield of dried product was 180g of Nendran 190g of Rasakadali and 200g of Palayankodan respectively.

5. 1. 2. Standardisation of product.

Standardisation plays a key role in product development which facilitates growth of food industries. According to Poduval (2002), one of the fore most purpose of standardisation is to facilitate the movement of materials and products through all stages of production in any industrial activity starting from the raw material to the finished products, than to the dealer and finally to the retailers and consumers. Liaqt *et al* (2009) found that the recipe standardisation is important to achieve optimal accuracy in determining the nutrient estimation. In the present investigation the product was standardised by varying the ingredients. The product developed with 100g coconut is chosen initially as the best combination by sensory evaluation.

5. 2. Quality assessment of developed products

Food quality is a complex concept that is frequently measured using objective indices related to the nutritional, microbiological or physicochemical characteristics of food or in terms of the opinion of designated experts (Cardello, 1995). The quality of the food is a combination of the attributes that determine the degree of acceptability of the product.

These include nutritional value, microbiological safety, cost, convenience and organoleptic qualities.

Nambiar and Parnami (2008) reported that development of nutritious and organoleptically acceptable recipes with locally available food is a challenge for the food scientist and the benefits such food – based strategies to prevent micronutrient malnutrition are manifold.

In the present investigation, products developed from banana blossom were assessed for its organoleptic qualities, chemical composition, nutrient content, functional qualities and shelf life qualities.

5. 2. 1. Organoleptic qualities of RTC product.

Organoleptic evaluation has been defined as a scientific method used to evoke, measure, analyse and interpret those responses to products as perceived through the sense of sight, smell, touch, taste and hearing (Stonel and Sidel, 2002). Sensory evaluation of developed RTC product revealed that there are differences in each attributes. The mean value is shown in the figure.

The aesthetic, safety, sensory characteristics and acceptability of foods are affected by colour (Dorko and Penfield, 1993). Bajaj *et al* (2002) found that flavour imparts recognizable character to the food products.

5. 2. 2. Functional qualities

Functional properties determine the overall behaviour of food during production, processing, storage and consumption (Agunbbiade, 2006). Functional qualities help to qualitative assessment and acceptability of any new product. To observe the functional qualities processing loss, rehydration ratio and bulk density were ascertained.

Ranganna (2001) suggested that bulk density indicates the weight of substances held in unit volume. According to Potter (1998) bulk density is one of the most common simple measurement which can be used for the analysis of powdered food. Induruwa *et al.*, (2009) opined that the bulk density is one of the important physical parameters, which indicates the quality of food products and higher the bulk density lower will be the

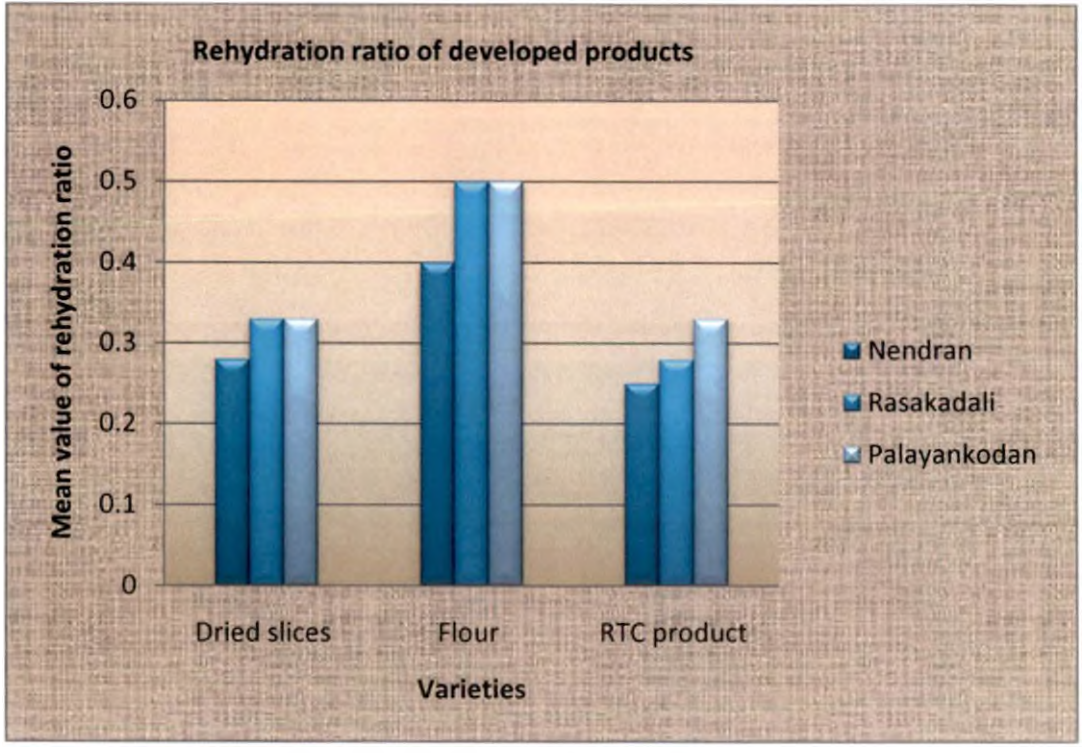


Fig. 2. The rehydration ratio of developed products

package volume. In the present study the bulk density of flour of Rasakadali variety was found to be highest and was observed as 0.97mg/100g. Saranya, (2012) reported that the enriched soup mix (ESM) developed from moringa pulp has a bulk density of 0.31-0.35mg/100g. Wagner (2000) observed that the appearance of the orange and grape fruit powders prepared by foam mat drying can be improved by increasing bulk density. Suma (2008) reported that the bulk density of dehydrated fruit drink mix from banana varieties Nendran and Palayankodan was 0.663mg/100g and 0.453mg/100g.

Rehydration characteristics were used as a quality index of dried producst (Vrac and Gurner, 1994). Rehydration is used to express the ability of dried material to absorb water. The rehydration ratio of banana blossom from Palayankodan (50 per cent) and Rasakadali flour were found to be highest among the developed products. Saranya (2012) reported that the rehydration ratio of soup mix developed from moringa ranged from 0.17 to 0.19.

5. 2. 3. Chemical composition

Saxsena (2003) opined that laboratory analysis is one of the best methods to assess the quality of different constituents present in the products. The chemical and nutrient content, especially mineral content in banana blossom will be different for different varieties. This will also depend on the soil condition in which the banana plant is being grown. Stability of the original quality of any processed food product is of paramount importance during storage and it should be checked to detect the acceptability of the product. Sharma (2006) has viewed that chemical estimation of food products is a useful criterion to judge the quality .lesser or higher amount of certain chemicals in food make them acceptable or non acceptable.

Moisture can cause adverse effects in the quality of food. Moisture is an important parameter in dehydrated foods, which directly influences the microbial activity, non enzymatic browning, solubility, hygroscopicity. The moisture content of dried slices of banana blossom ranged from 4.19 to 6.71 percent. There is no significant difference observed between dried slices and flour. Sheng *et al* (2010) reported that the moisture content of fresh banana blossom was 90 percent. The flower from two different cultivars

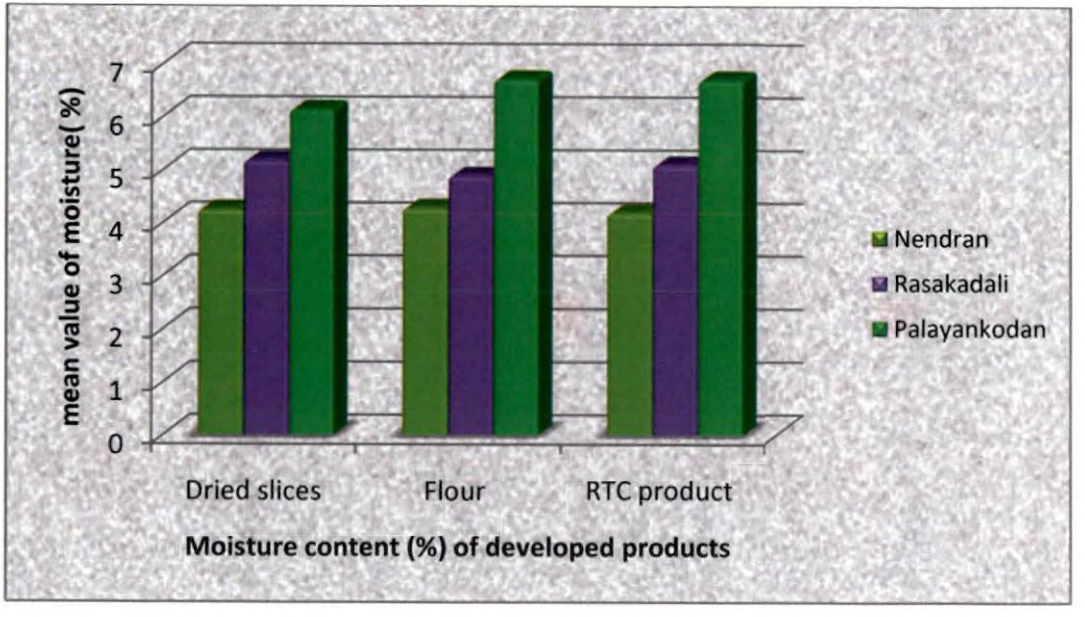


Fig. 3. Moisture content of developed products

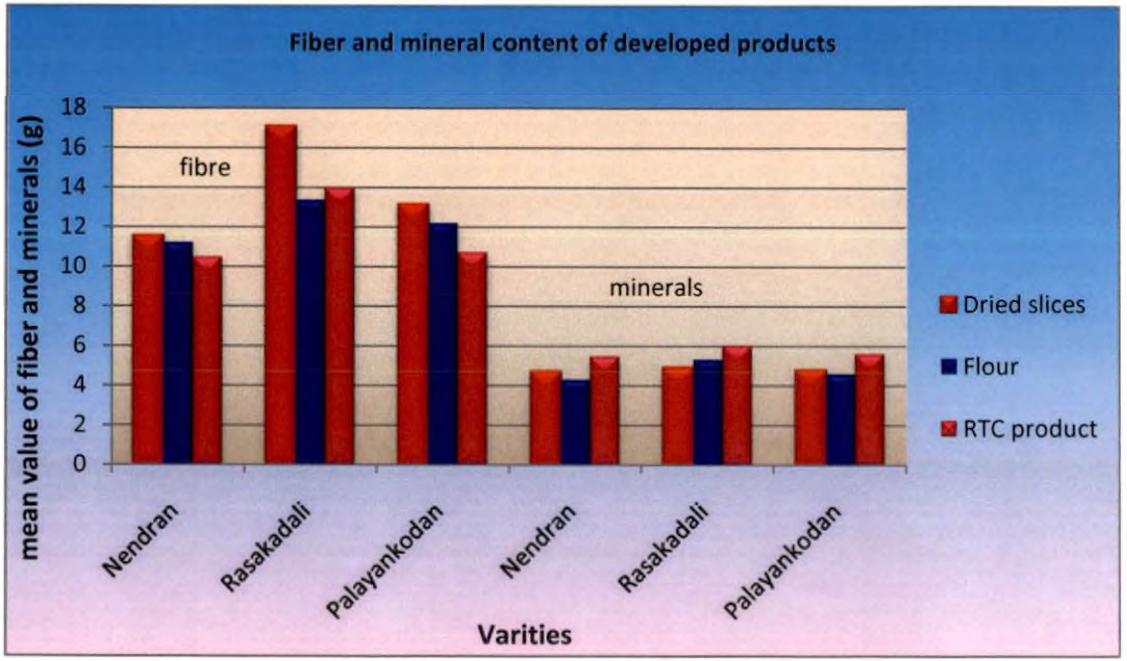


Fig. 4. Fiber and mineral content of developed products

contained 89.42 - 90.58 g moisture per 100 gram sample, which were similar to results of other banana species (91.8 - 92.2 g/100 g) from the Thailand (Somsub *et al.*, 2008). All these flowers had high moisture levels, implying they have very short shelf life.

Kanchana *et al* (2010) reported that the moisture content of dried banana blossom ranged from 5.18 to 8.19 per cent. Saranya (2012) reported that the moisture content of soup mix developed from moringa ranged between 3.9 to 4.7 per cent. Nasheeda (2006) reported that Robusta and Rasakadali banana flour contain 3.52 and 3.26 per cent moisture content. Jaya and Dass (2009) reported that 3-5 per cent moisture content was observed in vaccum dried pineapple powder. Evelein (2005) reported that 1.09 to 1.19 per cent of moisture was present in spray dried banana powder.

The interest in foods rich in dietary fiber increased in the recent decades and this has led to the development of a large market for fibre rich products and ingredients (Sudha *et al.*, 2007). Total fiber content of the developed products from banana blossom of three varieties viz Nendran, Rasakadali and Palayankodan ranges from 10.72g/100g to 13.98g/100g. Margerata *et al* (2003) reported that the total fiber content of dehydrated banana blossom ranges from 14g/100g to 16g/100g. Sheng *et al* (2010) reported that the presence of 5.7g of fibre in fresh banana blossom. The fibre content of convenience mix developed from Robusta and Rasakadali ranged from 0.190 to 0.370 g/100g (Nasheeda, 2006). Spray dried banana flour contain 1.79 to 2.22 g/100g fibre (Evelein, 2005). Saranya (2012) reported that high fiber content was found in moringa fruit pulp with moringa leaf incorporated soup mix.

The total mineral content of the developed products ranged from 4.73g/100g to 4.79g/100g. Kanchana *et al* (2010) reported that the total ash content ranges from 8.53g/100g to 8.97g /100g in dehydrated banana blossom product. Suma (2008) reported that the fruit drink mix developed from banana ranged from 1.67 to 3.20g. Evelin (2005) observed that total minerals in spray dried pineapple ranged between 2.62 to 3.22 g/100g

The phenol content of developed products ranged between 47.26mg/100g (Rasakadali flour) to 58.06 mg/100g (Nendran dried slices).. The browning in banana blossom is due to the phenol content. Suma (2008) reported that the polyphenol content

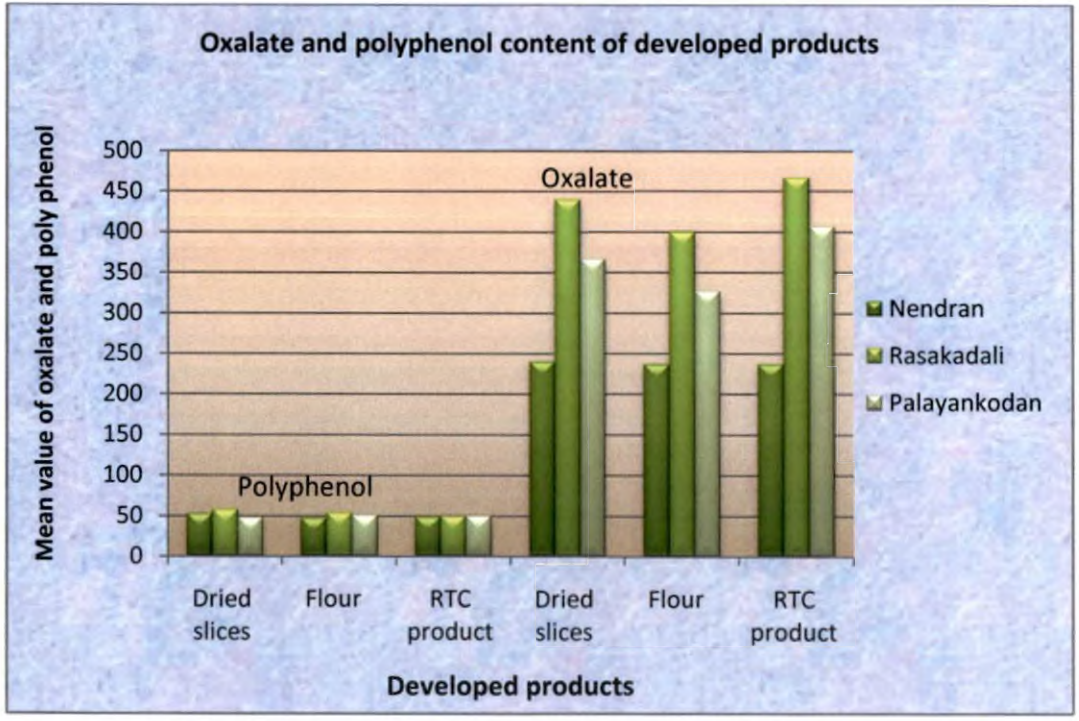


Fig. 5. Oxalate and phenol content of developed products

of Nendran based fruit drink mix was found to be high (13.50mg/100g) compared to Rasakdali flour.

The oxalate content of banana blossom ranged between 236.67mg/100g (Nendran flour and RTC product) – 446.67 mg/100g (Rasakadali RTC product). The oxalate content gives the banana blossom bitter taste.

5. 2. 4. Nutritional composition

Kalia and Sood (1996) defined nutritional quality as the combination of a product that has significance in determining the degree of acceptability of the product to a user. Nutrients are invisible chemicals in the foods which are necessary for keeping the body healthy.

The energy content of developed products ranged between 183Kcal/100g – 288Kcal/100g. Gopalan *et al* (2009) reported that fresh plantain flower contain 34Kcal/100g. Saranya(2012) reported that the soup mix developed with moringa pulp alone using drying-blending process found to have highest energy value (429Kcal/100g).

Protein is one of the important nutrients required by body to carry out a wide range of functions essential for the maintenance of life (Ensminger, 1994).The protein content of developed products ranged from 13.05g/100g to 17.63g/100g. Banana flower also contains high quality protein because of its well balanced essential amino acid content (Sheng et al., 2010). The protein content of instant mix was reported as 22.64g/100g (Abeysinghe and Illeperuma, 2006).

The calcium content of the developed products ranged from 121.00mg/100g to 223.33mg/100g. Kanchana et al (2010) reported that the calcium content of dehydrated banana blossom ranged between 262.00mg/100g to 282.19mg/100g.

The magnesium content of the developed products ranges from 24.90mg/100g to 24.34mg/100g. The magnesium content of developed products viz savoury and sweet vermicelli was found to be 0.3 to 0.4 mg/100g and percentage loss of 2.5 and 3.2mg/100g could be seen after processing (Syama ,1997).

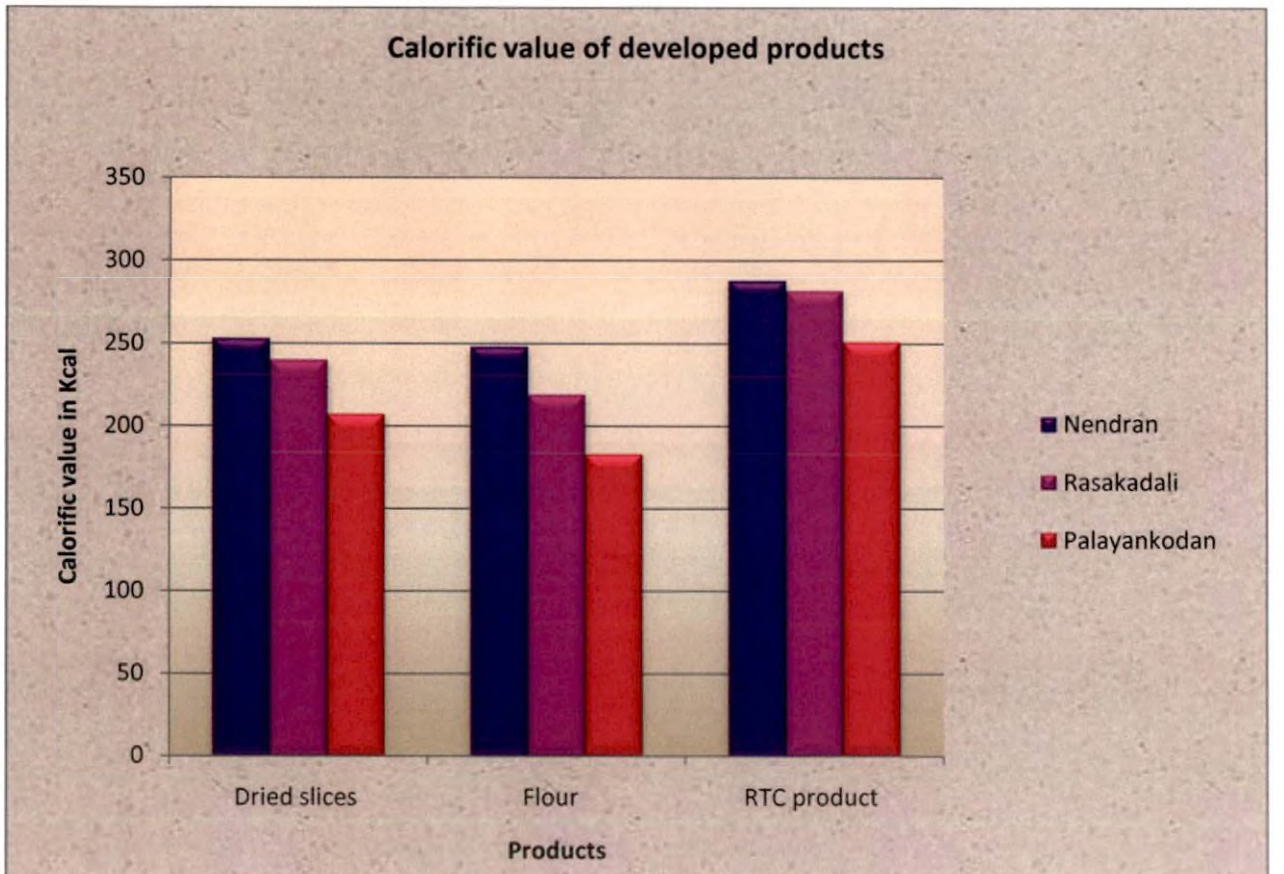


Fig. 6. Calorific value of developed products

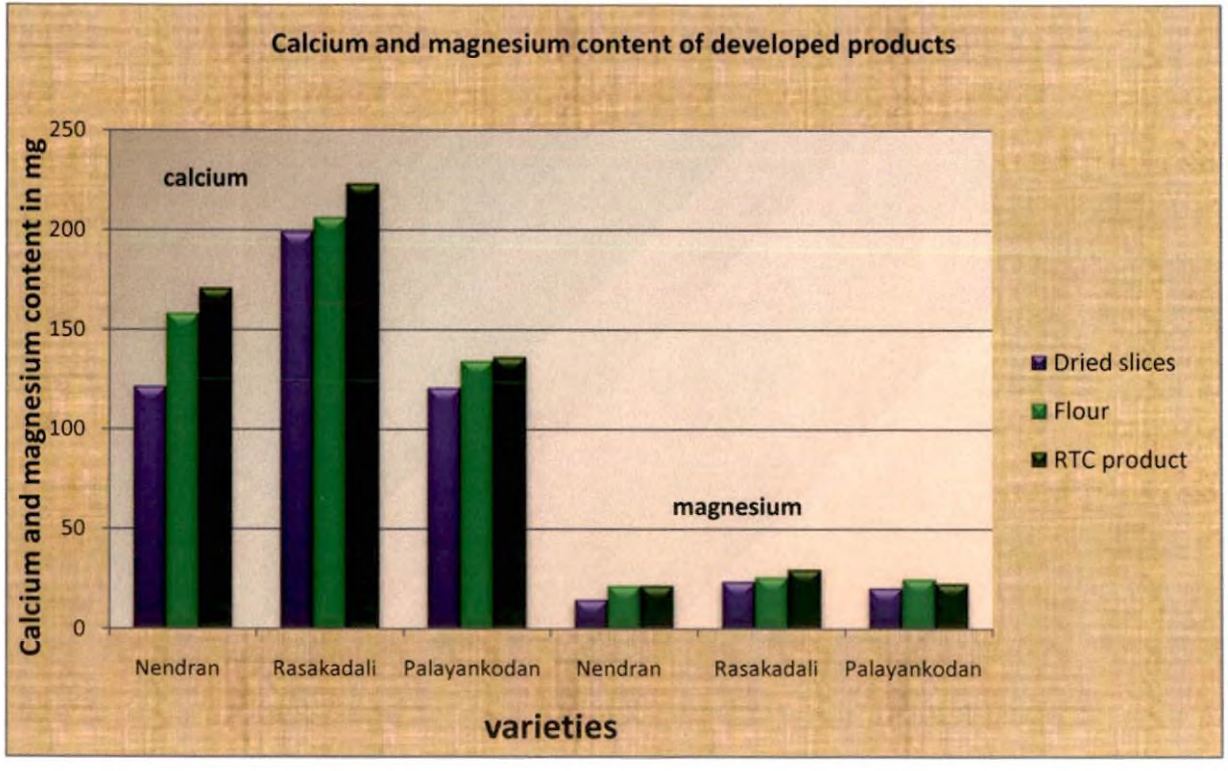


Fig. 8. Calcium and magnesium content of developed products

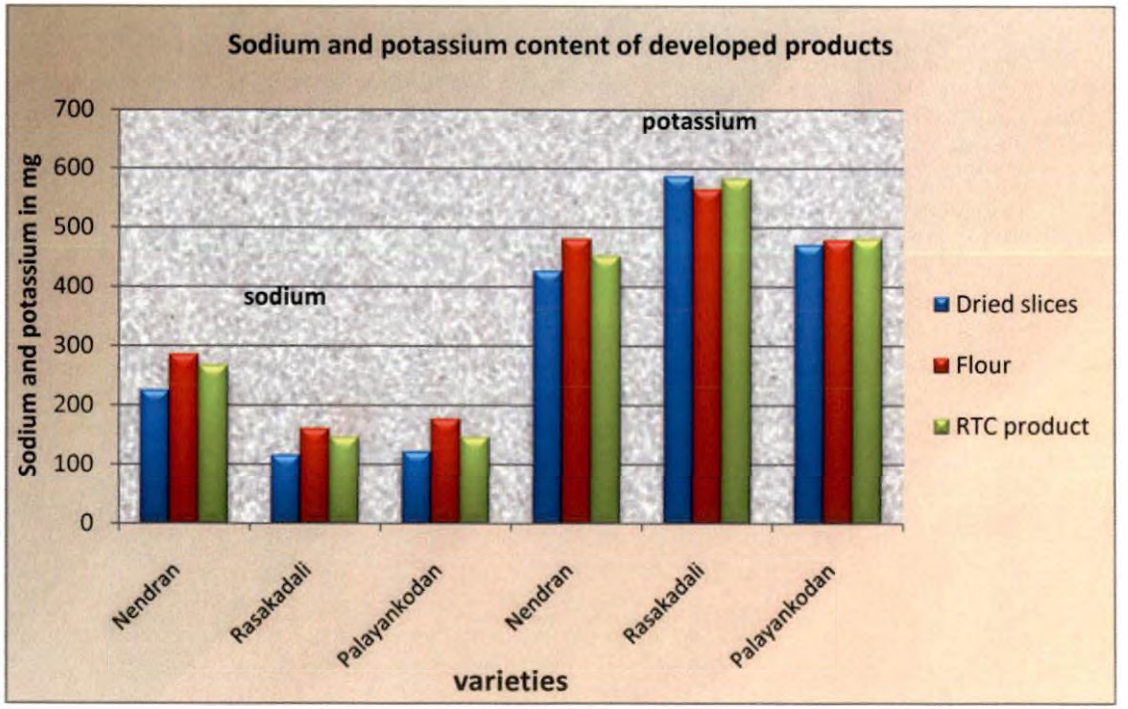


Fig. 7. Sodium and potassium content of developed products

The sodium content of developed product ranges from 116.33/100g to289.67mg/100g. Gopalan et al (2009) reported that fresh banana blossom contain 20.1mg/100g of sodium.

The potassium content of developed products ranged from 427.36mg/100g to 587.63mg/100g. Potassium and phosphorus was the most abundant minerals in banana flower, followed by calcium, magnesium and sulphur (Ngamsaeng et al., 2006). Sheng et al (2010) reported that the banana blossom contain 553mg/100g of potassium content.

The iron content of the developed product ranges between 101.46mg/100g to 429.91mg/100g. The fresh banana blossom contains 1.6mg/100g of iron (NIN, 2009).

5. 2. 5. Shelf stability of banana blossom dried slices, flour and RTC product

The shelf life can be defined as the length of time that a package or a material in a container will remain in a sellable or acceptable condition under specified conditions of storage (Kumar, 2001). In present investigation moisture, acidity, peroxide value and microbial growth were examined periodically up to a period of three months.

Organoleptic changes of stored RTC product

Monitoring the storage behaviour in terms of sensory analysis is an easy and important method of testing the acceptability of the products.

The acceptability of the product was examined during the initial period and after 90 days of storage. The sensory attributes such as appearance, colour, flavour, texture and taste was found to be decreased after three months storage. Among the RTC product from three varieties Nendran were found to be superior during the initial period. But there is no variation observed among the three products after three months storage period. Saranya (2012) reported that the appearance of the ESM decreased after three months storage period.

Moisture is one of the important parameter which determines the shelf life quality of food product. Low moisture is highly important for longer storage period (Shankar, 1993).

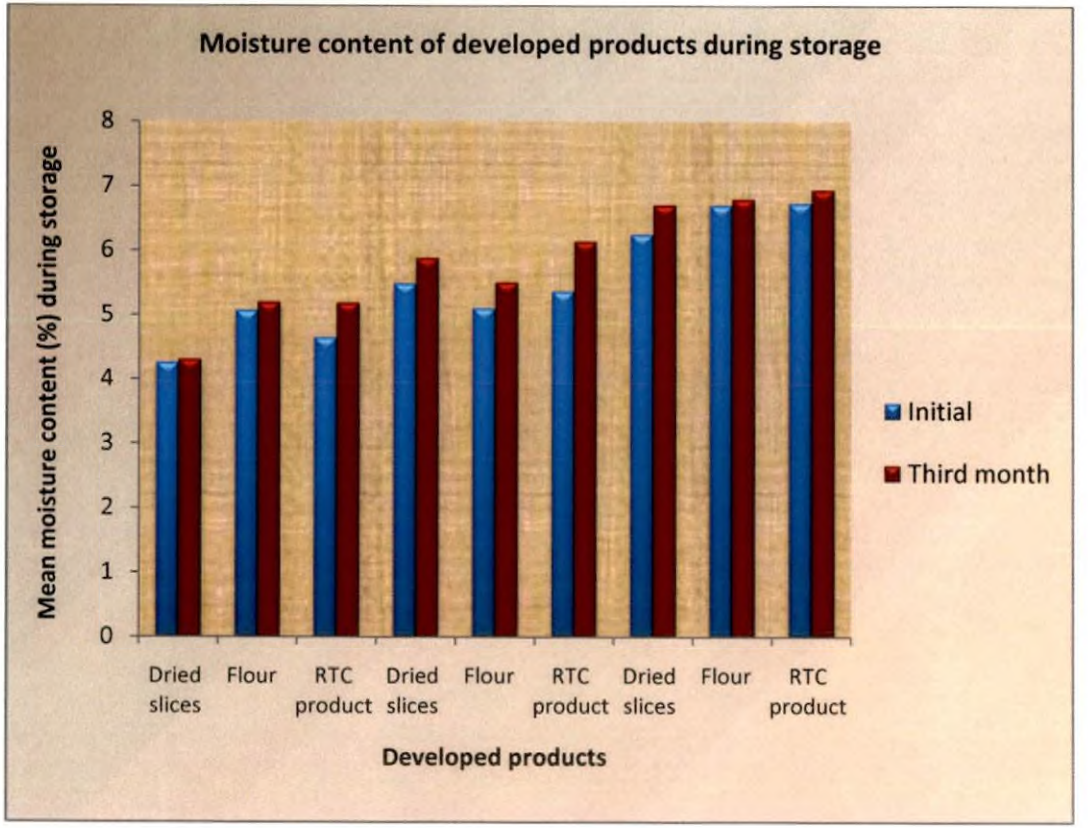


Fig. 11. Mean moisture content of developed product during storage

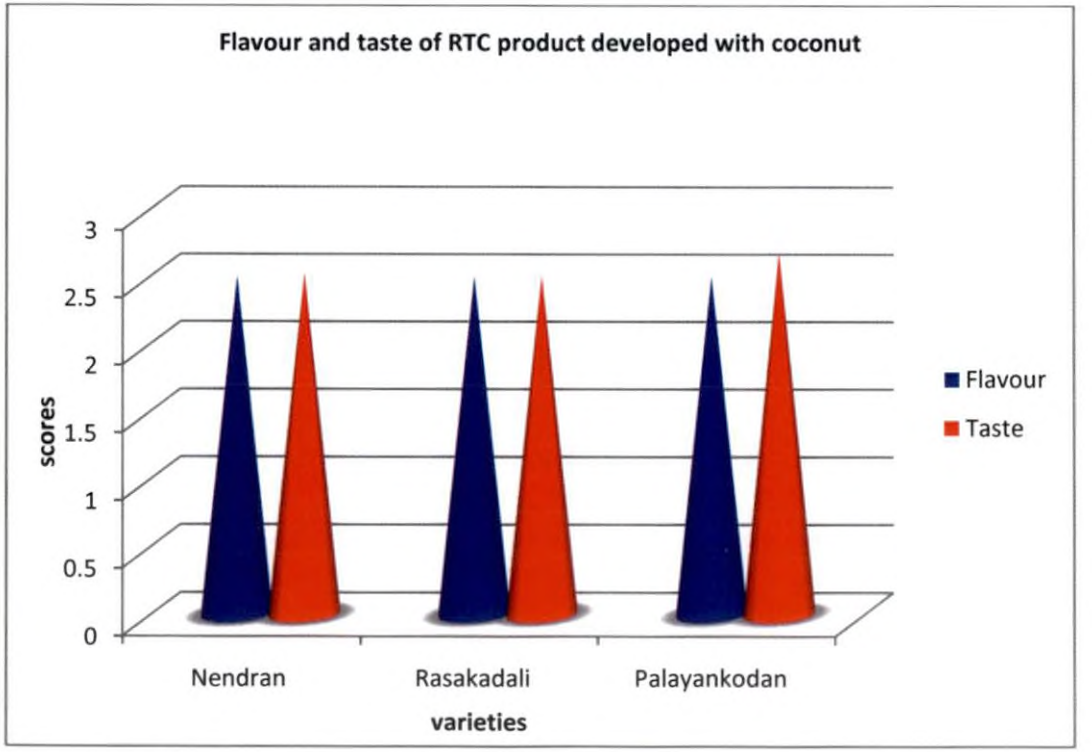


Fig. 9. Flavour and taste of RTC product developed with coconut

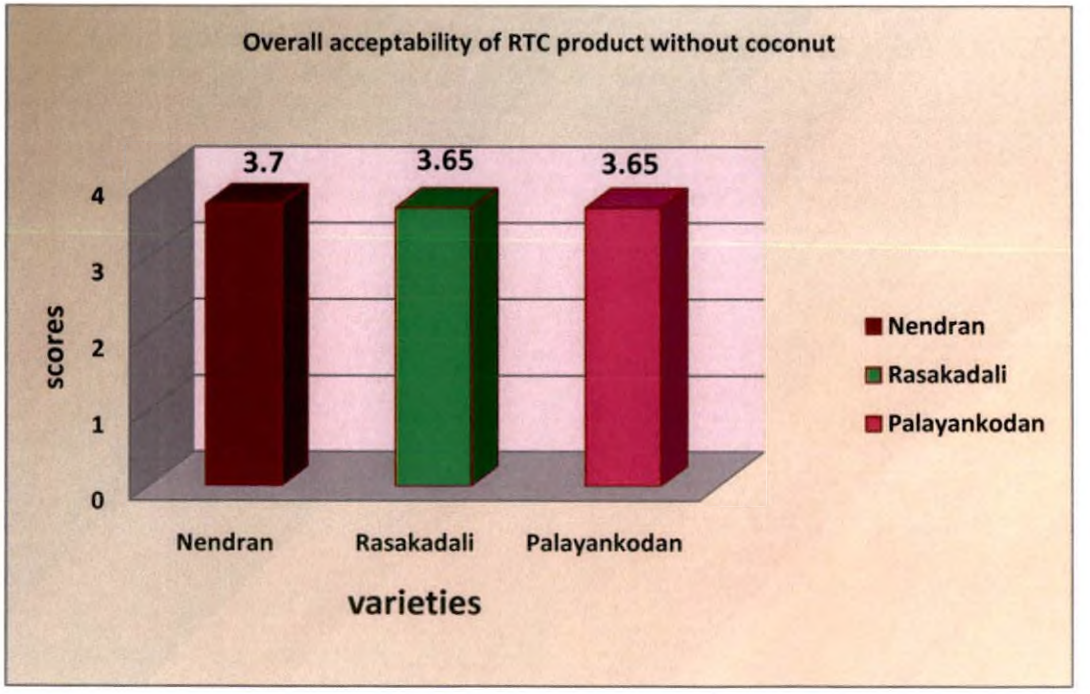


Fig. 10. Overall acceptability of RTC product developed without coconut

During the first month the moisture content of developed products ranged from 4.28 to 6.81. The highest moisture content was noted for Rasakadali RTC product (6.81 per cent) and lowest was noted for Nendran dried slices (4.28 per cent). During the end of third month the moisture content ranged between 4.30 to 6.94 per cent. The highest moisture content was noted for Rasakadali RTC product and lowest was recorded for Nendran dried slices. But the increase in moisture content does not influence the quality of the developed products because the increase in moisture content was negligible.

Syama (1997) reported that the moisture content of stored vermicelli was found to increase. Initial moisture content of sweet vermicelli was 10.28 per cent and found to increase to 11.27 per cent during storage period. Saranya (2012) reported that the moisture content of stored ESM was found to enhanced gradually during the storage period. But the increase in moisture content does not influenced the quality of the RTC product.

The primary products of lipid oxidation are hydro peroxides which are generally present as peroxides. Thus it seemed reasonable to determine the concentration of peroxide as a measure of extend of oxidation and thus rancidity. The nature of auto oxidation degradation depends on the extent of un-saturation of lipids (Sharma, 2006).

In the present study the peroxide value was recorded only for the RTC product developed with addition of coconut. Peroxide value was observed during the first month of storage itself. During the first month of storage the peroxide content of RTC product ranged between 0.24meq/kg to 0.32 meq/kg. The highest peroxide content was noted for Nendran and Palayankodan RTC product (0.32 meq/kg). The least peroxide content was noted for Rasakadali RTC product (1.24 meq/kg). During the third month the peroxide content ranged between 0.31 meq/kg to 0.51 meq/kg. The highest peroxide value was obtained for Nendran RTC product (0.51 meq/kg) and least was recorded for Rasakadali RTC product (0.31 meq/kg). There was an increase in peroxide value with increase in storage time owing to the oxidative deterioration of lipids in the coconut.

Krokida (2001) reported that the peroxide value increases during storage. Neelofer (2004) reported that the peroxide value of therapeutic and malted health drink

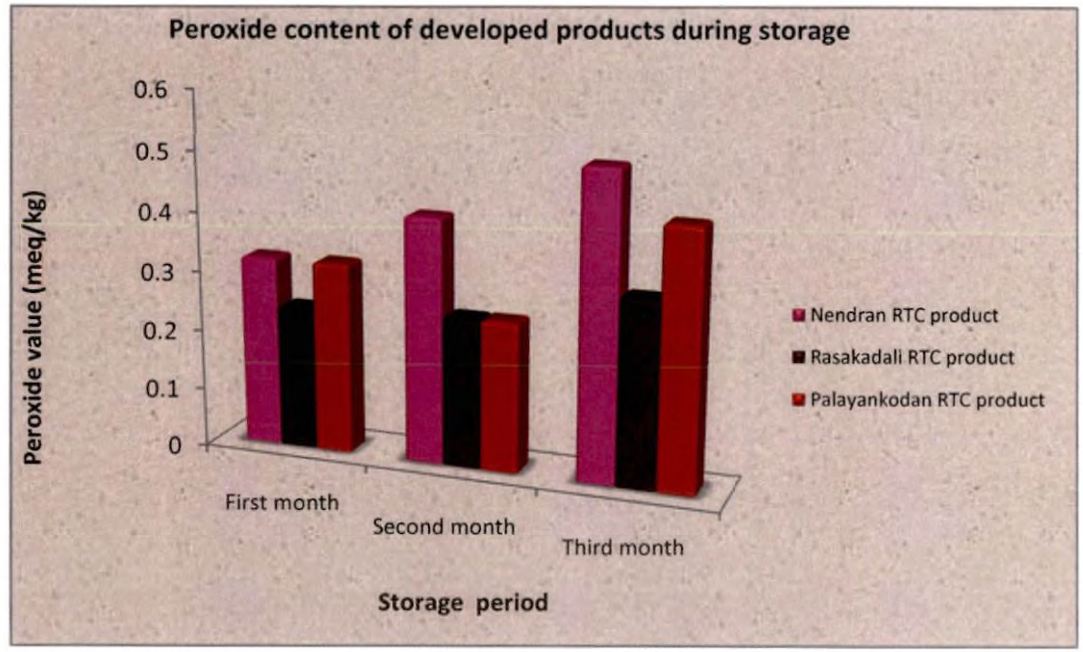


Fig. 12. Peroxide content of developed products during storage

mix were 0.32 meq/100g and 0.54meq/100g. Saranya (2012) reported that the negligible amount of peroxide content was observed for the ESM developed from moringa. Similarly rancidity occurred for wheat pappad and the peroxide value ranged between 0.20 meq/100g – 0.79 meq/100g (Mannan *et al*, 1993).

Total microbial population of stored products

Microbial quality is one of the most critic quality parameters in a dyanamic system such as food. There are different threats in food quality originating from microbial sources. Spoilage causing organisms causes off odour and off taste and lead to economic losses (Rao, 1993). The concept of spoilage by microorganisms are the primary cause of the end of shelf life and that hence reducing initial microbial populations is a strategy to extend shelf life (Zagory, 2003).

Serial dilution followed by spread plating was employed to detect the presence of microorganisms. In the present investigation the yeast growth was noted in the flour of banana blossom from three varieties during storage. No microbial growth was seen in any product; that might be due to the pre-treatment done with citric acid and low moisture content in the developed products. Citric acid inhibits the growth of microorganisms in pre-treated dry fish (Sara, 2008). Nasheeda (2006) reported that the bacterial population of banana powder packed in poly propylene covers ranged between 5.68 – 6.88× 103 cfu/g. Suma (2008) reported that the bacterial count in fruit drink mix developed from banana ranged between 5.42 – 8 $\times 10^6$ cfu/g, where as fungal growth was recorded to be in the range 2.59 – 4.26 $\times 10^4$ cfu/g. Deepthi (2004) reported that the diascoria flour and taro flour products were free from bacterial attack. But fungus and yeast were observed after three months storage. Chellammal and Prema (1997) reported that sweet potato noodles stored in glass and plastic had no bacterial growth.

Consumer preference study showed that Nendran RTC product was liked very much by 40 per cent consumers and 38 per cent liked moderately.

SUMMARY

SUMMARY

The present investigation entitled "Development and quality evaluation of ready to cook (RTC) dehydrated banana blossom" was carried out for development of dehydrated RTC product from selected varieties of banana blossom and using other from locally available resources. The objective of the study was to analyse the organoleptic, nutritional, chemical and physical properties of the developed products. The experiment was carried out in the Department of Home Science, College of Agriculture, Vellayani, Thiruvananthapuram during the period of 2011-2012. Major findings of the study are summarized below.

In the experiment, fresh banana blossom of three varieties Nendran, Rasakadali and Palayankodan were collected, weighed, washed, bracts were removed and sliced. Inorder to prevent browning and get an acceptable product, sliced banana blossom was pre-treated and dried at 60°C in a hot air oven. Three products viz dried slices, flour and RTC product were packed in Al foil pouches and kept for shelf life studies.

The organoleptic evaluation of the RTC product was done using a four point scale score card. Sensory qualities of the RTC product from three varieties of banana blossom viz Nendran, Rasakadali and Palayankodan were analysed. The highest score was recorded for Nendran RTC product even though the three varieties were acceptable. The functional qualities like bulk density and rehydration ratio of the developed products were assessed. The bulk density of the flour ranged between 0.91 to 0.97g/ml and the rehydration ratio of the developed products ranged between 0.25 to 0.50.

The nutritional components of developed products were assessed. The calorific value was highest for Nendran RTC product (288Kcal/100g) and lowest for Palayankodan flour (183Kcal/100g). The protein content was found to be highest for Palayankodan RTC product (18.12g/100g) and lowest protein content was observed for Nendran flour (12.65g/100g). Among the products developed the calcium content was highest for Rasakadali RTC product (223.33mg/100g) and lowest calcium content was noted for Palayankodan dried slices (121.00mg/100g). The magnesium content was observed to be highest for Rasakadali RTC product (29.89mg/100g) and least was

observed for Nendran dried slices (14.52mg/100g). The sodium and potassium content was comparatively less in the products developed from banana blossom. The sodium content was maximum for Nendran flour (286.67mg/100g) and minimum was noted for Rasakadali dried slices (116.33mg/100g). The potassium content was observed to be more in rasakadali dried slices (587.63mg/100g) and less in Nendran dried slices (427.36mg/100g). The iron content was comparatively higher for Palayankodan RTC product (140.22mg/100g) and lower for Nendran dried slices (81.41mg/100g).

The chemical analysis of the developed products viz dried slices, flour and RTC product from three varieties viz Nendran, Rasakadali and Palayankodan showed that the moisture content was highest for Palayankodan flour (6.71 per cent) and lowest for Nendran RTC product (4.19 per cent). The total fiber content was observed to be maximum for Rasakadali dried slices (17.08g/100g) and minimum was noted for Nendran RTC product (10.48g/100g). Total mineral content was more in Rasakadali RTC product (6.00g/100g) and less for Nendran flour (4.29g/100g). The phenol content was highest for banana blossom. The highest phenol content was noted for Rasakadali dried slices (58.07µg/100g) and least was noted for Nendran flour (47.26µg/100g). The oxalate content was observed to be highest for Rasakadali RTC product (466.64mg/100g) and lowest for Nendran RTC product (236.67mg/100g).

The shelf stability of the developed products was studied by storing the products packed in aluminium foil pouches for three months. Organoleptic qualities, change in moisture content and peroxide value were assessed. The organoleptic evaluation showed the storage period. Among the three varieties Nendran RTC product noted highest sensory scores.

The peroxidation of products was increased during each month. The peroxide content was highest for Nendran RTC product (0.51 meq/kg) and lowest for Rasakadali RTC product (0.31meq/kg).

The microbial evaluation of the developed products dosenot shows any microbial growth during three months storage. The yeast growth was found to be observed in the

flour from three varieties viz Nendran, Rasakadali and Palayankodan blossom after 90th day of storage.

The consumer preference of the developed RTC product was assessed after reconstituiting the product using Hedonic rating. All the three varieties of RTC products were equally acceptable while highest preference was obtained for Nendran RTC product.

REFERENCES

References

Abeysighe, C. P. and Illeperuma, C. K. 2006. Formulation of an MSG (Monosodium Glutamate) free instant vegetable soup mix. J. Nat. Sci. foundation Sri Lanka. 34(2): 91-95.

Agarwal, W.N. 2009. Traditional vegetables and health benefits. *Afr. J. Biotech.* 14(5): 456-458.

Amutha, K. and Shalini, R. V. 2012. Studies on burn wound healing property of compounds from Musa paradisiacal. *Am. J. Bio-pharm. Biochem. and life Sci.* 17(5): 59-60

Anand, S. 2011. In vitro antioxidant activity of different cultivars of banana flower extracts available in India. 12(8): 175-179.

Annenne, P. 2010. Indian cuisine-All about banana flower. Health. 20(4). 14-17.

Anon, C. 2010. Vegetables grown in country. Science Reporter. 40: 23-25.

Augunbiade, S. O., Olanlokum, J. O. and Olaofe, O. A. 2006. Quality of chips produced from rehydrated plantain and banana. *Pakist. J. Nutr.* 5(5): 417-473.

Azanha, A. B. and Faria, M. 2005. "Use of mathematical models for estimating the shelf-life of cornflakes in flexible packaging". *Packaging Technology and Science* 18 (4): 161–222.

Bajaj, R., Nagi, H, P. and Padda. G. 2002. Flavor, its isolation, concentration and encapsulation. *Bev. Fd. Wld.* 9(7): 11-16.

Banazano, A. 2010. Health benefits of banana stem. Asia. *Pac. J. Clin. Nutr.* 12(1): 36-42.

Beckers H. J. (1988) Microbiology and food hygiene in mass catering. Cater Health 10(1) 3-5.

Bilton, P. 2007. Banana flower or banana blossom. Culinary uses and nutritional value. *J. Fd and Nutr.* 9(20): 48-54.

Bradford, M. M. 1976. A rapid and sensitive method for quantifying of microgram qualities of protein utilizing the principle of protein – dye binding. *Ann. Biochem.* 72: 248.

Cardello, A. V. 1995. Food quality: relativity context and consumer expectations. *Fd. Quality and preference* 6(1): 163-170.

Chandralia, 2000. Beneficial effect of high dietary fibre intake in patients with type 2 diabetes mellitus. 342(12): 1392-1398

Chellamal, S. and Prema, L. 1997. Product development from sweet potato, the natural resource of Kerala. Proceedings of the Ninth Kerala Science Congress 27-29 january 1997 (edi Iyengar, P.K., Kurien, K.V., Nair, V.G and Vijayakumar, T). State committee on Science, Technology and Environment, Thiruvananthapuram, 32-33.

Ching, L., Grover, J. K. and Yadav. S, (2001). Medicinal plants of India with antidiabetic potential. *J. Ethnopharmacol.* 81: 81-100.

Chung, L. S., Anderson, H. and Meyers. S. 2006. Alpha-tocopherol content in 62 edibletropical plants. *J. Agric. Food Chem.* 49: 3101-3105.

Datta. 2009. Banana (Musa) fruit of kerala. Health and fitness. 123-129

Decena, A. N. 2010. Preservatives: Antioxidants - The ultimate answer to oxidation.

Della, 2011. Banana extract has so many benefits. *J. fd Sci.* 12(4): 12-14

Deepthi, K. 2004. Formulating extruded food based on dioscoria and taro. M.Sc. thesis, Kerala Agricultural University, Thrissur, p.45-47.

Dharman, P. L. 2012. Banana flower taste and recepie. P. 4

Dorko, C. L. and Penfield, M. P. 1993. Melt point of encapsulated sodium bicarbonate: effect of refrigerated butter and muffin baked in conventional and microwave oven. *J. Fd. Sci.* 58(3): 574-578.

Draize, J. H. 2003. Methods of study of irrigation and toxicity of substances applied to the skin and mucous membrane . *J. Pharm. Experimental therapeutic.* 82(1): 3370-3390

Dwivedi, 2010. Resistant starch as a curative. Arogyamasika . 14(5). 12-14

Eastwood, L. and Kritchevsky, F. 2009. Health benefits of dietary fiber. *Nutr. Rev.* 67(4): 188-205.

Ensminger, K. 1994. Preparation, evaluation and storage of papads made from rice flakes. *Bev.Fd. Wld.* 19(5):13-15.

Evangelista, 1998. Reduction of polyphenols in Banana Buds. BS. Thesis, University of the Philippines. P138-140.

Evelien, M. A. 2005. Development of juice based beverage and ripe fruit powder from banana (Musa spp). Phd. Thesis. Kerala Agricultural University, Thrissur.

FAO. 2008. FAOSTAT Database. www,faostat.fao.org.

Feroti, H. L., Lashen, P. and Ganro, P. 2003. Effect of banana flower and pseudostem on antioxidant and lysosomal enzyme activities in streptozotocin- induced diabetic rats. *J. Biochem.* 13(2): 412-413.

Gopalan, C., Ramasastri, B. V. and Balasubharamanyan, S. C. 2009. Nutritive value of Indian foods. NIN. ICMR. Hyderabad, p. 47

Graft, P. L. 2009. Amino acid content of banana plant parts. *Trends in Food Sci Technol.* 20: 78-91.

Green, L. 2002. Serum potassium level and dietary potassium intake as risk factots for stroke. *J. Neuro.* 59(3): 314-320.

Guerero, 2009. The science of flavonoids springer science and business media. LLC. Spring Street. pp 1-3

Gupta, K. M. 2005. Bailey's Industrial Oil and Fat Products. Sixth Edition, Six-volume set. John Wiley and Sons Inc. 1-30.

Gurvani, 2004. Studies on preparation, packaging and storage of wheat papada. Beverage and food world. 20(3): 19-21

Gyesley, S. W. (2003). *Total Sysstems Approach to Predict Shelf Life of Packaged Foods.* P 13

He, F. J. and Nowson, C. 2009. Fruits and vegetable consumption. *Lancet.* 367(9507): 320-326

Hung, H, C., Joshith, P. 2009. Fruit and vegetable intake and risk of major chronic disease. J. Natl. Cancer. Inst. 96(28): 1577-1584

Huton ,T. 2002. Dietary Significance in Food Manufacturing. Fd sci and nutr. 18(5). P 23-26

IFT, 2005. The wide scope of sensory evaluation. Food Technol. 34(5).p 13-15

Induruwa, C. S., Indrasena, I. K. and Liyanage, P. D. 2009. Relationship between Bulk Density and Maturity of Fresh and Dried Clove (Euginea caryophyllus) Buds. Division of post harvest technology, Central Research Station, Department of Export Agriculture, p13.

Jackson, M. L. 1973. Standard methods of biochemical analysis. Kalyani publishers, New Delhi, p 62-65.

Jacob, T. 2011. The horizon of banana stem. *J. Nutr. Biochem.* 15(9): 321-324.

Jaya, S. and Dass, H. 2009. Glass transition and sticky point temperatures and stability/mobility diagram of fruit powder food. Bioprocess. Technol. 2: 89-95

Jayasree, N., Aashish, B. and Sarfaraz, L. 2012. Molecular docking study of banana flower flavonoids as insulin receptor tyrosine kinase activators as a cure for diabetes mellitus. Bio information. 8(5): 216-220

Jellinick, G. 1985. Sensory evaluation of food theory and practices. Ellis Horwood. Ltd. Chichester, England. P. 240.

Jianhi, P. S., Chen. Y. Y: and Li. G. H. 2000. Analysis on the development of banana industry in China. *J. Fruit Sci.* 20: 415-420 (in Chinese).

Johnson, L. F. and Curl, E. A.1972. Methods for Research on the Ecology of Soil Borne Plant Pathogens. Burgess Publication Co, New York, p.133.

Johnson, M. L and Curl, T. 1973. Standard methods of biochemical analysis, Kalyani publishers, New Delhi, p 62-65.

Jonnalagadda, P. R., Bhatt, R.V., Sudershan, R.V. and Naidu, A.N. 2001. Suitability of chemical parameters in setting quality standards for deep fried snacks. *Food Quality and Preference*. 12: 223-228.

Kalia, A. and Sood, S. 1996. Food Preservation and Processing. Kalyani Publishers, New Delhi, 222 p.14

Kamala, S. L. 2012. Banana blossom culinary uses P. 2

Kanchana. S., Wickramarachchi. and Senaratne. L. 2010. Preservation of fiber - rich banana blossom as a dehydrated vegetable. *ScienceAsia* 31 (2005): 265-271

Kapoor, S. and Kavi, H. 2004. Antioxidants and disease. More questions than answer. *J. Nutr. Res.* 20: 449-459.

Keen, C. L. 2004. Bioactive compounds in nutrition and health research methodologies for establishing biological function: the antioxidant and anti-inflamatory effect of flavanoids on atherosclerosis. *J. Nutr. Biochem.* 24(5): 511-538.

Kordylas, J. M. 2000. Processing and preservation of Tropical and Subtropical Foods. Education low priced bools. Hampshire, England, pp. 244-253.

Koshy, M. N, 1989. Banana bud differentiation in banana. Msc (Hort) Thesis. Kerala Agriculture University. Thrissur.p24-28.

Kris, E. 2011. Bioactive compounds in foods, their role in prevention of cardiovascular disease and cancer. *Am. J. Med. Suppl.* 98(6): 71-88.

Krokida , H. 2001. Processed fruits and vegetables are healthier. *J. Inidan. Hort.* 47:35-37

Kumar, A. J. K. 2001. Shelf life determinants in dry bakery products. *Indian fd Ind.* 20: 69-72.

Leonard, S. 2007. Medicine at your feet: Healing plants of Hawaian Kingdom. 2007. 1-15

Lewis, H., Shaw, L. and Friger, J. 2004. A natural flavanoid and synthetic analogues protect the gastric mucosa from aspirin induced rats. *J. Nutr. Biochem.* 15(4): 78-83.

Liaqat, P., Khan, M. N. and Mohammad, F. 2009. Consumer acceptance of standardized mixed/ composite foods for optimal accuracy in nutrient estimation. *Pakist. J. Nutr.* 8(8): 1301-1303.

Liu, S. 2005. Effect of dietary fiber intake on coronary heart disease. *Am. J. Clin. Nutr.* 2003. 78: 383-390.

Mahmood, H., Khatoon, F., and Warsi, N. 2011. Gastroprotective effect of ethanolic extract of banana flower. *J.Chem. Pharm.Res.* 13: 318-319.

Maletto, J., Robinson, M. and Karikari, S.K. 2003. Starch and sugar transformation during the ripening of plantain and bananas. *J. Sci. Fd Agric.* 32: 1021-1026.

Manay, N. S. and Swamy, S. 2000. Food Facts and Principles. Second edition, New Age International (P) Ltd., Publishers, New Delhi, 525 p.

Mannan, J. K., Kulkarni, S. G. and Shukla, F. C. 1993. Studies on preparation and storage of pulp, squash, nectar and RTS beverage from two varieties of apricot grown in kumaon region of Utter Pradesh. Bev. Fd. Wld. 18(3): 9-12.

Margereta,L., Odugbemi,K. and Frison. 2003. Medicinal plant is antimicrobials. University of Lagos press. 53-64.

Matz, S. A. 1962. Food Texture. The AVI publishing company Inc., Connecticut, 34p.

Meyers, N. 2006. Hypoglycaemic effect of banana blossom. *J. Clin. Nutr.* 29(1): pp142-149.

Michael,H.G.,2010. Phytochemical screening, element analysis and acute toxicity of aquous extraxt of banana blossom. *J. Med. Plant. Res.* 4(1): 322-326

NAAS.2001. contortium to sequence banana genome in 5 years. Agricultural News-11(1). National Academy of Agricultural Sciences. IARI campus, New Delhi.

Nadakarni,K., Feng,J.G and Surabhi,L. 2010. Handling of Banana. *Farm and Home J.* 8:4-7.

Nambiar, V. S., and Parnami, M. 2005. Polyphenol content of three Indian varities. MSc (FS&N) thesis, Kerala Agricultural University, Thrissur, p81.

Nand, L. 2003. Bacteriological quality of pork kabab stored under marketing conditions. *J. Fd Sci. Technol.* 29(4): 309-313.

Nasheeda, K. 2006. Developing multipurpose convenient mix from selected banana varieties. Msc (FS $ N) thesis, Kerala Agriculture University. Thiruvananthapuram.

Nathasha, W. 2010. Inverse correlation between plasma vitamin E and mortality from ischemic heart disease in cross-cultural epidemiology. *Am. J. Clin. Nutr.* 53: 326-334.

Neelofar, I. K. 2004. Developing value added and diversified product from Coconut (cocus nucifera, L.). Ph.D thesis, Kerala Agricultural University, Thrissur.

Ngamsaeng, A., Wanapat, M. and Khampa. S. (2006). Evaluation of local tropical plants by in vitro Rumen fermentation and their effects on fermentation end-products. *Pak. J. Nutr.* 5: pp414-418.

NIN. 2009. Manual for analysis. National Institute of Nutrition, Hyderabad, p. 135.

Padma, H. 2011. Studies on the muscle-paralyzing components of the juice of the banana plant. *Arch. Int. Pharmacodyn. Ther.* 324: pp105-113.

Pai, J. S. 2007. Health foods- future of Indian Food Industry. *Indian Fd. Indu.* November-December, p35.

Pari, L. 2008. Hypoglycaemic effect of Musa Sapientum L, in alloxan-induced diabetic rats. *J. of Eth Pharm* . 68(1): pp321-322.

Pathak, S. 2002. Effect of storage temperature and period on quality of dehydrated

Pavunny, 2004. Bananas third edtn. Longman scientific publisher Pvt. Ltd, New York. p.406

Pavunny, S. 1996. Value added products of banana. *J. Indian Hort.* 12(3): 62-64.

Peri, C. 2006. "The universe of food quality." Food Quality and Preference 17(1-2): 3-8.

Pilch, R. 2010. Quality evaluation of banana flower. *Indian Food. Ind.* 17(5): 282-283

Poduval, S. 2002. Diversification and value addition in coconut. Sustainable production and utilization of coconut (eds. Singh, H.P. and Mathew, M. T.). coconut Development Board. Kochi. p 43-44.

Poonkuzhali, L. 2002. Influence of banana stem extract on urinary risk factors for stones in normal and hyperoxaluric rats. *Br. J. Urol.* 74(1): pp23-25

Potter, N. 1998. Food Science. AVI Publishing Company, INC, West Bengal fort Connecticut, p. 113.

Prashob, V. N. 2011. An approach to sensory evaluation of horticultural commodities. *Hort Sci.* 15, pp48-50

Premnath, J., Patel, R. and Srivasthava, T. 2004. Meeting global trade. The Hindu Survey of Indian Agriculture. pp. 9-13

Rajpur, R. 2007. Vegetable and disease prevention. *J. Clinic. Nutr.*10: 145-149.

Ranganna, S. 2001. Hand Book of Analysis and Quality for Fruit and Vegetable products.(IInd ed). Tata Mc Graw Hill. Publishing company Ltd., India, p. 112.

Rao, C. 1993. The market for processed foods in India. *Indian FD.* Ind. 8: pp10-12.

Ratna, R., Dutta, S. and Sen, S. 2011. In vitro antioxidant activity of different cultivars of banana flower extracts available in India. 12(8): pp 175-179.

Ray, L. S. and Athwali, M. D. 2000. Index of nutritional quality of some selected Indian snacks. *Indian. J. Nutr. Dietet.* 14: pp 38-114.

Rossario, R. 2000. Utilization of banana buds as extenders in beef patties. BS Thesis, University of Philippines. 13(5): pp123-125.

Sadasivam, S. and Manikkam, A. 1992. Biochemical methods of agricultural sciences. Wiley eastern Ltd. New Delhi. P. 8.

Saha, H. and Dunkwal. M (2009). Studies on products of the browning reaction.Antioxidative activities of browning reaction products prepared fromglucosamine. *Jpn. J. Nutr.* 44(6): pp307-315.

Saimon, P. 2000. Preparation of banana powders by means of osmotic drying and packaging. *J. Fd. Sci. Technol.* 38: pp525 - 528.

Sara, D. 2008. Effect of Acetic and Citric Acids on the Growth of microbes in fish. *Bull. Fac. Fish.* Hokkaido Univ. 42(6): pp80-85.

Saranya, S. 2012. Development and quality evaluation of enriched Moringa (*Moringa oleifera* Lam) based soup mix (ESM). MSc thesis, Kerala Agricultural University, Thrissur, p49.

Saxsena, R. 2003. Effect of Processing in Phenolics Content and Antioxidant Activity of Commonly Consumed Foods. Proc. Of Ninth Asian Congress of Nutrition, February 23-27, 2003 (ed. Gopalan, C), New Delhi, pp160-162.

Sen, S., and Sen, D. P. 2009. Oxidised fatty acid content of heat damaged frying oils and Indian deep fat fried products. *JOTAI*, pp89-91.

Shankar, G. 2000. Role of moisture, temperature and humidity during storage of food grains. Third international food convention., 20-23 october 2000. (edn. Gopal., G., Seth, P. and Rathore,J. S.). Central Food Technology Research Institute, Mysore, pp11-16.

Shankaran, 1993. Microbial standards of processed foods and rapid methods of microbial quality assurance. Proceedings of the Third International Food convention., 20-23

october 1992 (edn Gopal, G., Seth, P. and Rathore,J. S.). Central Food Technology Research Institute, Mysore, pp79-83.

Sharad,N. 2010. Sulfites in foods: Uses, analytical methods, residues, fate, exposure assessment, metabolism, toxicity and hypersensitivity. Advanced Food Research 30, 1-76.

Sharma, A. 2006. A text book of Food science and Technology. International book distributing co., Lucknow. P. 56.

Sharma. 2012. Fruits and vegetable consumption. Lancet. 307(9507):320-326.

Sheng , Z., Wei, H. and Hua-Ting Dou. 2010. Dietary alpha – linolenic acid and mixed tocopherols and packaging influence lipid stability in broiler chicken breast and leg muscle tissue. J. Fd. Sci. 60: 1013-1018.

Shibly,N., Emega, T. and Eline, F. 2009. Dietary fibre components and pectin chemical features of peels during ripening of banana and plantain varieties. *Biores Technol.* 99: 4346-4354.

Shukla, R., Bhavesh, C. 2011. Attitude of banana farmers towards contract farming in South Gujarat, India. Ind. *J. Agri. Res.* 45(8): 331-335

Simi,S. 2002. Value addition and evaluation of nutritional quality in elephant yam. (Amorphpphallus Paeoniifolius (Dennst) M.Sc. thesis. Kerala Agricultural University, thrissur, p 121.

Simmonds,N. W and Stover. P. 2000. Banana . Longman, London, U. K. p.253.

Singh, H. P. 2011. Biochemical studies on developing and ripening banana. *J. Prog. Hort.* 51(12): 5-6.

Singh, H. P. and Uma, S. 1997. Banana food and fruit crop. Indian Hort. 42: 18-22.

Solanki, S. 2000. Formulation and shelf life study of malted ready to eat mixes. Indian. J. Nutr. Dietet. 23:35-39.

Somsub. W., Kongkauchuichai. R. and Sungpang. P. 2008. Effects of three conventional cooking methods on vitamin C, tannin, myo-inositol phosphates content in selected Thai vegetabls. J. *Fd. Compos. Anal.* 21: 187- 197.

Srilakshmi, B. 2009. Vegetables and fruits. Food Science. 4th edition. 170-174.

Stonel, H and Sidel, J. L. 2002. Sensory evaluation practices. Fd. Quality preference 13: 355-367.

Sudha, M. L., Vetrimani, R. and Leelavathi, K. 2007. Influence of fiber from different cereals on the rheological characteristics of wheat flour dough and on biscuit quality. *Fd. Chem.* 100: 1365-1370

Suma, C. 2008. Development of banana dehydrated fruit drink mix (FDM). M.Sc. thesis, Kerala Agricultural University, Thrissur, p.74-76.

Sumathy, S., Jyothy,S. and Surani,S. 2011. Invitro activity and phytochemical screening of Musa Accuminata flower. Pharmacology online.2(1): 118-127

Swaminathan, M.1998. Principles of Nutrition and Dietetics. The Bangalore Printing and Publishing co. Ltd., Bangalore, p. 512

Sweety, N. 2010. Amazing health benefits of banana stem. Health Mad. *Intr. J. Nutr.* 27(9): 1693-1700

Syama, M. 1997. Feasibility of formulating Ready To Eat product based on cassava. KAU. P. 60.

Syamala, N. 2011. Degenerative diseases and antioxidants. *J. Clinc. Nutr.* 18(3). 23-26.

Taylor, 2010. Medicinal properties of banana blossom. J. Pharm. Pharmacol. 18. 33-39.

Thimmaiah, S. K. 1999. Standard Kalyani publishers, New Delhi, p 545.

Tiwari, H. 2007. Evaluation of the antimicrobial potential of medicinal plants from the Ivory Coast. *Phytotherapy Research*. 16(5): 497-502.

Valmayor, R. V. 1994. Nematodes and weevil borer conference rational. *Banana Nematodes and weevil Borers in Asia and Pacific.* (eds. Valmayor, R. V. Siloyoi, B) INIBAP – ASPNET, Los Bonas, Philippines, 298-302.

Villa, Z. 1993. Antioxidant activity of Burdock (Arctium lappa Linne): its scavenging effect on free-radical and active oxygen. *J. Am. Oil Chem. Soc.* 75: 455-461.

Vrac, N. and Gurner, M. 1994. Effect of fluidized bed drying on properties of dehydrated apples. *Nahrug*. 38: 149-157.

Wagner, J. R. 2000. Bulk density and reconstituition rates of foam mat dried grape fruit powders. J. Hort. 13(2): 311-315.

Walker, A. 2000. Le Bananees plantain is GABON. *Rec. Appl. Ags. Trop*. 11: 18-17.

Zagory, D. 2003. Effect of post processing, handling and packaging on microbial population. Post harvest news and information on fresh fruit and vegetable quality and food safety. *Post harvests Biol. Tech*. 15: 313.

Zhan- Wn- Shing., Wei-Hong-Ma. and Hua-Ting-Dou. 2010. Antioxidant properties of banana flower of 2 cultivars in China using 2,2-diphenyl-1-picryl hydrazine reducing power, 2,2-aznobis and inhibition of lipid per oxidation assays. *African.J. of Biotech* 2(3): 4470-4474.

ABSTRACT

DEVELOPMENT AND QUALITY EVALUATION OF READY TO COOK (RTC) DEHYDRATED BANANA BLOSSOM

MIDHILA MAHENDRAN

(2011-16-101)

Abstract of the

Thesis submitted in partial fulfilment of the

requirement for the degree of

Master of Science in Home science

(Food Science and Nutrition)

Faculty of Agriculture

Kerala Agricultural University, Thrissur

DEPARTMENT OF HOME SCIENCE

COLLEGE OF AGRICULTURE, VELLAYANI,

THIRUVANANTHAPURAM – 695 522

2013

ABSTRACT

The study entitled "Development and quality evaluation of ready to cook (RTC) dehydrated banana blossom" was carried out with objective to develop RTC product based on banana blossom and to evaluate its nutritional, functional, and organoleptic and shelf life quality. The banana blossom of three varieties viz Nendran, Rasakadali and Palayankodan were selected for the study.

The banana blossom was weighed, washed, removed outer bracts, sliced and pre-treatment was done using different solutions like citric acid, butter milk, salt and potassium metabisulphite (KMS). The pre- treated slices were divided into three portions and developed three products from each portion viz dried slices, flour and RTC product in hot air oven at 60°C.

The results of functional properties revealed that bulk density was highest for Rasakadali flour (0.79) and rehydration ratio was found to be highest for Rasakadali and Palayankodan blossom flour (0.50).

Sensory scores revealed that all the three RTC products were acceptable. Significant difference was found in the nutrient content of three products from three varieties of banana blossom. Calorific value was observed to be highest for Nendran RTC product (288 Kcal/100g). Palayankodan RTC product was found to have maximum protein content (18.12g/100g) among the developed products. In case of minerals, the calcium (223.33mg/100g), magnesium (29.89mg/100g) and potassium (583.66mg/100g) was highest in Rasakadali RTC product. Sodium content was detected to be highest in Nendran RTC product (286.67mg/100g) while low sodium content was noted for Rasakadali and Palayankodan blossom products. Highest iron content was observed for Palayankodan RTC product (140.22mg/100g).

The moisture content was found to be highest for Palayankodan flour (6.71 per cent) The fibre, total minerals and oxalate was observed to be highest in Rasakadali RTC product (13.98g/100g, 6.00g/100g, 466.67mg/100g) and the phenol was found to be highest for Rasakadali dried slices (58.07mg/100g). Significant difference in the chemical components was observed on varietal as well as product basis.

The developed products were packed in Al foil pouches and kept for shelf life studies. Slight increase in the moisture and peroxide content of developed products during storage period There is significant difference in the peroxide value and moisture content of the developed products on varietal as well as product basis.

The microbial evaluation showed yeast growth on 90th day in flour of three varieties. Consumer preference showed Nendran RTC product as superior.

All the developed RTC product from three varieties of blossom were organoleptically acceptable, Nendran RTC product was found to be superior while Rasakadali blossom product was found to be nutritionally superior.

APPENDICES

APPENDIX - I

Recipe (For five servings)

Ingredients	Amount (g)
Developed RTC mix	50
Boiled water for soaking	250 – 300 ml
Seasoning	
Cooking oil	2 tsp(10ml)
Mustard	1 tsp(5g)
Bengal gram dhal/black gram/ /parboiled rice(optional)	1 tsp (5g)
Curry leaves	1 sprig
Red chilli	1 no
Chopped onion	1 tsp
Salt	To taste

Method of preparation

Soak RTC mix in boiled water for 10 minutes. Heat oil in a frying pan, add mustard. When it crackles, add other seasonings and fry well. Add soaked RTC mix and mix well. Serve hot.

APPENDIX – II

Weight of Nendran banana blossom

Sl No	Nendran		Rasakadali		Palayankodan	
	With bracts (g)	Without bracts (g)	With bracts (g)	Without bracts (g)	With bracts (g)	Without bracts (g)
1	910	500	420	280	400	180
2	800	500	290	190	420	200
3	510	340	360	280	900	580
4	880	300	300	240	440	280
5	600	300	200	160	320	210
6	900	600	380	270	450	300
7	800	580	320	250	260	180
8	300	170	400	340	580	350
9	960	690	180	120	340	260
10	470	250	420	360	300	240

APPENDIX – V

Score card for oraganoleptic qualities of RTC product

Particulars	Criteria	Score	I	II	III
Appearence	Excellent Very Good Fair Poor	4 3 2 1			
Colour	Excellent Very Good Fair Poor	4 3 2 1			
Flavour	Excellent Very Good Fair Poor	4 3 2 1			
Texture	Acceptable Highly fibrous Fibrous Soft	4 3 2 1			
Taste	Excellent Very Good Fair Poor	4 3 2 1			
Overall acceptability		4			