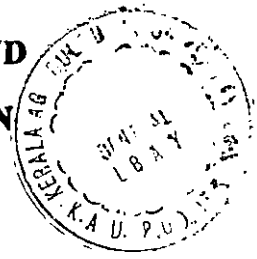
FEASIBILITY OF UTILIZING INDIAN ALMOND (*Terminalia catappa* L.) FOR VALUE ADDITION



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Thesis submitted in partial fulfillment of the requirement

for the degree of

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(Food Science and Nutrition)

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Department of Home Science

COLLEGE OF AGRICULTURE

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DECLARATION

I here by declare that the thesis entitled **"Feasibility of utilizing Indian almond (*Terminalia catappa* L.) for value addition"** is a bonafied record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associationship, fellowship or other similar title, of any other university or society.

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CERTIFICATE

Certified that the thesis entitled **"Feasibility of utilizing Indian almond (*Terminalia catappa* L.) for value addition"** is a record of research work done independently by Mrs. MANJUSHA.P.M. (2007-16-103) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, association ship or fellowship to her.

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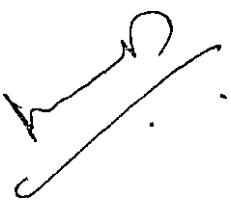

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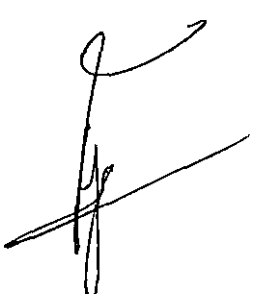

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Manjusha.P.M

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LIST OF ABBREVIATIONS

IA	-	Indian almond
cm	-	Centimeter
et al.	-	And others
Fig	-	Figure
Gm	-	Gram
Kg	-	kilogram
Max.	-	Maximum
Ml	-	milliliter
Mg	-	Milligram
No.	-	Number
Rs	-	Rupees
Viz.	-	Namely

INTRODUCTION

1. INTRODUCTION

Nuts and oil seeds are fruits consisting of an edible usually fat containing kernel surrounded by a hard or brittle shell. Nuts form an important source of nutrients for both humans and wildlife. Even though not all, a large number of nuts are edible and they are used in cooking or eaten raw, sprouted or roasted as a snack food or pressed for oil that is used in cookery. The crunchy and unique flavour of many nuts suggest wider dietary properties. The nuts or kernels from the fruits of many trees have abundant potential as a nutritious food source in the domestic sector as well as in the commercial field. As an important item in the diets of many people around the world, they serve to supplement the nutrients provided by cereals, legumes and vegetables. Some of these nuts are used in medicinal and cosmetic preparations too. It is reported that these products if supplemented in the diets of malnourished population especially growing children, would prove to be useful for overcoming the still existing national problem of protein energy malnutrition (Malhotra et al., 2004).

Terminalia Catappa L. a tropical nut belonging to the Combretaceae family is found throughout the warmer parts of India. This is a large, spreading tree distributed throughout the tropics in coastal environments. The tree's origin is controversial and is suspected to be India, Malay Peninsula, or New Guinea. Common names include Indian almond, Malabar almond, Sea almond and Umbrella tree. In Kerala it is widely seen all over the State both in sandy and rocky shores and also in forests.

Typically one to five fruits develop on the basal part of the flower spike. The fruit is a sessile, laterally compressed, ovoid to ovate, smooth-skinned drupe. During maturation, it changes color from green through yellow to bright red or dark purplish red at full maturity. Fruits are produced from about 3 years of age and the nutritious tasty seed kernel is eaten immediately after extraction (Evans, 1999). The fruit is edible, fleshy, green (unripe) and yellow or red (when ripe). The exocarp is relatively

thin and smooth, and the endocarp is hard. When cracked, a kernel is obtained and this can be consumed as well. The large nutty fruits resembling and tasting very much like commercially grown almonds, unlike almonds can be eaten raw too. The nuts may be consumed fresh shortly after extraction from the shell or else preserved by smoking and consumed up to a year later. In some areas the nuts are mainly a snack food consumed by children and the fleshy fruit is also consumed sometimes. In other areas tropical almond nuts are highly regarded as a human food source but are mostly wasted. Despite its eating quality and feasibility to be used as a substitute for almonds in a wide range of confectionary and processed foods, its long keeping quality and abundant availability throughout the year, the potential for its value addition is not yet tapped.

The nuts are reported to have many medicinal properties too. Almost every part of Indian almond plant has some medicinal properties. In Taiwan, the nut of tropical almond is considered to have aphrodisiac and antibacterial properties. *Terminalia catappa* plant extract is used in cosmetics, dermatological and pharmaceutical compositions. Today the therapeutic value of the Indian almond is gaining much research importance. Fruits and nuts of Indian almond trees are reported to contain phytochemicals and tannins which are indicative of the potential in the treatment of diabetics (Nagappa et al., 2003). Presence of antiasthmatic compound and anticataract property of Indian almond is also reported. Epidemiological and metabolic studies have shown that regular consumption of nuts may protect from the risk of heart disease and diabetes.

Studies on the nutritional profile of the nuts of Indian almond reported that the nut is a rich source of macro and micro nutrients particularly Carbohydrates, Proteins, Fibre, Fat, vitamin-A, vitamin-B, vitamin-C, Nitrite, Calcium, Phosphorus, Iron etc. Hence encouraging people to incorporate these nuts in one form or other in their daily diet can definitely contribute useful amounts of essential nutrients from this abundantly wasted nut.

It was reported that substituting with abundantly available protein rich nut could even replace more expensive animal protein at affordable price. Such attempts will help in solving the protein malnutrition still prevailing in developing countries. Even though these nuts are abundantly available in Kerala not many studies are done in the state regarding the quality characteristics or other profitable potentials of the nuts.

Ignorance of the nutritive properties of this edible nut and the lack of awareness of the wide commercial prospects and the multiple uses of each part of the tree could be one of the reasons for the poor utilization. Authentic documentation of the known characteristics, multiple properties, traditional uses, preparations and processing techniques of the fruits and nuts of Indian almond is a must for any future effort in this sector.

Considering the nutritional needs of the people and the great wastage of Indian almond, the present study entitled 'Feasibility of utilizing Indian Almond (*Terminalia catappa* L.) for value addition ' is proposed. The major objective of the study is to assess the quality characteristics of the Indian almond nut as well as the feasibility for value addition, to prevent wastage and to increase its utilization. The difficulty to recover the kernel from the hard stony and fibrous fruit poses a problem for its utilization. Therefore, exploring the possibility of developing a simple tool or technology to separate the kernel could be a boon to the farm households, women and children alike. Such an attempt is also proposed in this study.

REVIEW OF LITERATURE

2. Review of Literature

The literature related to the present study 'Feasibility of utilizing Indian Almond (*Terminalia catappa* L.) for value addition ' is reviewed under the following heads.

2.1 Important properties of Fruits, Nuts/Kernels in human nutrition and health
2.2 Indian almond – Origin, geographical distribution
2.3 Nutritional profile of Indian almond
2.4 Therapeutic value of Indian almond
2.5 Nutritious and tasty nuts of Indian almond as food
2.6 Processing and Product development

2.1 Important properties of Fruits, Nuts / Kernels in human nutrition and health

According to Malhotra et al. (2004) Nuts and Oil seeds are fruits consisting of an edible usually fat containing kernel surrounded by a hard or brittle shell. Nuts play an important role in the diets of many people in the world. They serve to supplement the nutrients provided by cereals, legumes and vegetables. Nuts have been the food of man from the earliest times and still are the mini-articles of diet in many parts of the world.

Nuts, fruits and vegetables play a significant role in human nutrition, especially as source of vitamins, minerals and dietary fiber. (Wargovich, 2000). Nayar (2009) reported that a small serving daily of a variety of nuts can contribute a good amount of vitamins, minerals, dietary fibers and phytochemicals that the typical diet lacks.

He also reported that as part of a low fat, high fiber diet, nuts can help to reduce the risk of certain types of heart disease, cancers and birth defects. Nuts are one of the best sources of plant protein. Nuts offer a good source of protein, which is necessary for the body, but doesn't have the negative side-effects on the heart such as red meat and other typical sources of protein. Nuts are energy dense foods. They are rich in fat particularly monounsaturated fat, which decreases LDL cholesterol and increases HDL cholesterol (Prior and Cao, 2000). Iyengar (1998) reported that Zinc is an indispensable element in enzyme and protein synthesis in human body and nuts contain high levels of Zinc (20-100 mg/kg).

Studies done on the nutritional properties of the nut based selected preparations from different parts of the country concluded that they are nutritionally rich in varying proportions. It is reported that these products if supplemented in the diet of malnourished population especially growing children would prove to be useful in overcoming the still existing national problem of protein energy malnutrition (Malhotra et al., 2004).

Nuts are not only rich in nutrients but they contain many factors which could be responsible for protection against cancer, heart disease, diabetes, lipid profile etc. Fruits, nuts, and vegetables in the daily diet have been strongly associated with reduced risk for some forms of cancer, heart disease, stroke, and other chronic diseases (Prior and Cao, 2000). According to Sabate (1999) the frequency of nut consumption may have an inverse association with the risk of heart disease for men, women and the elderly. In a study done by Hu and Stampfer (1999), nut eaters were found to have an increase of five to six years of life that's free from coronary disease. Growing evidence shows that nuts have bioactive constituents like plant protein, dietary fiber and some micronutrients that elicit protective effects on heart. Sabate et al. (2001) reported that the consumption of 1-4 servings of nuts per week was associated with about 40 percentage reduction in risk of coronary heart disease.

The constituents of nuts other than fattyacids have additional cholesterol lowering effects (Kris Etherton et al., 1999). According to Sabate et al. (2001) the beneficial effects of nuts include improvement of serum lipid profiles with a predicted 16 percentage reduction in LDL cholesterol and presence of relatively high amounts of Nitric oxide precursor Arginine, dietary fiber and antioxidant Vitamin-E.

A review of the beneficial effects of vegetarian foods including nuts, also has shown that such foods lead to improved control of blood-glucose concentration, lower insulin requirements and better weight control for diabetic patients. (Segasothy and Phillips, 1999). Furthermore, nuts due to their high fiber content promote satiety and therefore prevent many individuals from overeating (Sabate, 2003).

The nuts or kernels from the fruits of many trees have abundant potential as a nutritious food source in the domestic sector as well as in the commercial field. Despite the popularity as edible nuts, many of these nuts remain unused. Some of these nuts are used in medicinal and cosmetic preparations too.

2.2 Indian almond – Origin, geographical distribution

Terminalia catappa L. is a large tropical tree in the Family Combretaceae. Terminalia catappa tree's origin is controversial, and could have been India, Malay peninsula, or New Guinea. Common names of the tree include Indian almond, Bengal almond, Singapore almond, Malabar almond, Tropical almond, wild almond, Sea almond, and Umbrella tree. *Terminalia catappa* or Indian almond is a large deciduous stately tree, originally from India, growing up to 90 feet tall with horizontal whorls of branches offering clusters of foot long; obviate leaves that turn pink-red to red - yellow before falling.

Chyau et al. (2000) reported that *Terminalia catappa* L. (Indian almond), here after referred as IA, originally from southern Asia, the deciduous tree has been widely planted throughout the tropical world as an ornamental shade tree.

Chen et al. (2000) reported that IA is widely distributed in coastal areas of the Indian Ocean, tropical Asia and the Pacific Ocean. On small islands of the South Pacific, IA is mostly cultivated as part of multistorey tree crop systems. IA plant is naturally widespread in subtropical and tropical zones of Indian and Pacific Oceans and planted extensively throughout the tropics.

IA is a medium size tree whose branches form layers of canopy. The leaves of this tree have been reported to have medicinal values. The fruit is edible fleshy green and is yellow or red when ripe. The exocarp is relatively thin and smooth, and the endocarp is hard. When cracked, a kernel is obtained and this can be consumed as well (Chen et al. 2000). The nuts are edible both as raw and cooked, although eating quality and kernel size are variable.

In Kerala, Indian almond is widely seen throughout the state both inland coastal areas and in forests. It is also grown as an ornamental garden tree in households and in parks and in schools for beauty and not for the fruits and the fruits and nuts are usually eaten by birds and at times by children.

2.3 Nutritional profile of Indian almond

Studies done by Christian and Ukhun (2006) on the nutritional profile of the nuts of IA reported that the nut is a rich source of macro and micro nutrients particularly Carbohydrates, Proteins, Fibre, Fat, Vitamin-A, Vitamin-B, Vitamin-C, Nitrite, Calcium, Phosphorus, Iron etc. The result of the study shows that the nut can contribute useful amounts of essential nutrients to the diet of man. The study also

shows that Carbohydrates present are easily digestible; nuts provide the necessary calories in the diets of most people of the world and promote the utilization of dietary fats and reduce wastage of proteins. The results show that tropical almond nut is an energy rich food too. The nut is also a good source of oil and has low water content.

Osagie (1998) reported that the seed is very rich in protein (19 – 22%) and oil (50 – 52 %). The study conducted by Ezeokonkwo and Dodson (2004) reported that the crude protein content of the seed is high (25.81 %) and the amino acid analysis showed a good pattern of the essential amino acids like Leucine, Isoleucine, Valine, Phenylalanine, Tryptophan, Methionine, Lysine, Threonine, Histidine etc. The protein quality of the seed was evaluated by in vivo bioassays using weanling male Sprague Dawley rats. The results showed that IA seed protein has a good pattern of the essential amino acid, is highly digestible, can support growth and positive nitrogen balance and thus has a high quality dietary protein.

Ezeokonkwo (2007) in his study on Comparative Effects of Dry- and Moist-Heating Treatments on the Biochemical Characteristics of IA seed reported that there were no significant differences in crude Protein, Fat, Ash, and Carbohydrate content of the seeds with respect to processing. Roasting had a better effect on the total dietary fibre (TDF) and gross energy level of the seeds than boiling. There were no significant differences in the effects of both processes on the amino acid, fatty acid and sugar profiles of the seeds. Roasting improved the Potassium, Phosphorus, Copper and Iodine, reducing the Magnesium, Calcium, Zinc and Iron contents. Boiling improved the Sodium and Selenium and reduced the Potassium, Magnesium and Calcium levels.

2.4 Therapeutic value of Indian almond

Today the therapeutic value of the Indian almond is gaining much research importance. Fruits and nuts of Indian almond are reported to contain phytochemicals and tannins which are indicative of the potential in the treatment of diabetics (Nagappa et al., 2003). Epidemiological and metabolic studies have shown that regular consumption of nuts may protect against risk of heart disease and diabetes. Karen et al (2004) revealed that a daily supplement of almonds can induce favourable nutrient modifications for chronic disease prevention to an individual's habitual diet.

Besides nuts, almost every part of the tree is used in one way or other. Masuda and Yonemori (1999) reported that the various extracts of leaves and bark of IA plant have anticancer and antioxidant effect. Ratnasooriya and Dharmasiri (2000) reported that the kernel of IA has aphrodisiac activity and so may be useful in the treatment of certain form of sexual inadequacies such as premature ejaculation. It has been reported that in the traditional medicine, the leaves, bark, and fruits of IA are used in dysentery; for dressing of rheumatic joints; and also to treat coughs, asthma. Fruits are said to be helpful in the treatment of leprosy, headaches and in reducing travel nausea. Leaves help to get rid of intestinal parasites; helps in the treatment of eye problems, rheumatism, wounds; and stop bleeding during teeth extraction. Fallen leaves are used to treat liver diseases while young leaves are used for colic. Juice of young leaves are employed in the preparation of ointment for leprosy, scabies and are also used internally for colic and headache. Aqueous and ethanolic extract of leaves were reported for their hepatoprotective activity (Tang et al. 2004).

Several uses are reported to each part of the tree. Chitmanat (1998) reported that not only leaves but the kernels and bark of the tree are also used in Brazil, India, Mexico, Pakistan, Philippines, Samoa, and Southeast Asia to treat many diseases like bleeding from tooth extraction, colic, cough, diarrhea, dysentery, eye problems,

headache, intestinal parasites, leprosy, liver disease, mouth problems, nausea from travel, rheumatism, scabies, skin diseases, stomach upsets, throat problems and wounds. The medicinal qualities of the plant are supported by current research investigating the plant's antioxidative, antiparasitic, antibacterial and antifungal potentials. The fruit is also helpful in the treatment of Leprosy and headaches and the leaves are specifically used in getting rid of intestinal parasites, treatment of eye problems, wounds, and liver problems.

The leaves of IA plant are widely used as a folk medicine in Southeast Asia for the treatment of dermatitis and hepatitis. More and more pharmacological studies have reported that the extract of IA leaves and fruits have anticancer, antioxidant, anti-HIV reverse transcriptase, anti-inflammatory, antidiabetic effects and hepatoprotective activities (Fan et al. 2004). Juice of young leaves are employed in preparation of ointment for leprosy, scabies and also used internally for colic and headache. But the effective components and related mechanisms remain unknown (Mohale et.al, 2009).

Almonds can help lower cholesterol. Specifically, they reduce low-density lipoprotein (LDL) cholesterol while preserving the beneficial high-density lipoprotein (HDL) cholesterol. Gustafson (1999) reported that the main factors behind the almond's successful assault on cholesterol are its fatty acid composition.

Morioka et al. (2005) reported that IA has a potent short-term chemo preventive effect on biomarkers of colon carcinogenesis. IA is a well known herb in Ayurvedic system of medicine.

2.5 Nutritious and tasty nuts of Indian almond as food

Naik et al. (2004) indicated that enriching the traditional foods by nutritious under exploited foods is essential today to bridge the nutritional gap and to ensure sustainable nutritional security. It has been reported that in Kerala 75.5 percent of children were found to be suffering from mild to moderate forms of malnutrition. Therefore there is a need to develop indigenous protein enriched supplement that has low dietary bulk but at the same time high protein content, calorie dense, easily digestible, nutritionally adequate and acceptable to the local children.

Knowledge of the nutritive value of local dishes and local food materials is necessary to encourage the increase in cultivation and consumption of this highly nutritive nut. The consumption of nuts will help to supplement the nutrients of the staple carbohydrate foods of the poor who cannot afford enough proteins foods of animal origin (Achu et al., 2005). In some areas these nuts are mainly a snack food consumed by children and the fleshy fruit also consumed sometimes. In other areas tropical almond nuts are highly regarded as a human food source (Evans, 1999).

The nuts of IA are edible, taste like almonds and are eaten raw although the flesh is troublesome to separate from the hard stone. Unlike the commercial almond, the Indian almond can be eaten raw. Oil extracted from the dried nuts is edible and is used in cooking.

Many plant proteins usually in the form of protein extracts or seed flours are being investigated and tested for new products such as low cost formulated foods which are nutritious, attractive and acceptable to consumers just like conventional foods from meat, fish and dairy products. As early it has been reported that substituting with abundantly available protein rich nut could even replace more

expensive animal protein at affordable price. Such attempts will help in solving the protein malnutrition still prevailing in developing countries.

It was also reported that the most promising additional sources of proteins available for improving diets in the less developed countries are various edible oil seeds, nuts and their meals. Besides being good source of Protein and Energy, Almond serves as good sources of minerals and vitamins. The development and utilization of products from an indigenous protein source would solve present protein deficiency problems to some extent.

Walter and Sam (2002) reported that Children sometimes consume the outer flesh of IA fruits. In Philippines a wine is made by fermenting mature fruits. The oil-rich kernels make a tasty and nutritious food while the outer flesh is widely consumed by children. The nuts may be consumed fresh after extraction from the shell or else preserved by smoking and consumed up to one year later.

Considering the nutritional and therapeutic properties of the IA kernels attempts to prepare weaning or health foods using these nuts as a major ingredient will be beneficial to all in need. Many such attempts have been successfully made by Kerala Agricultural University using locally available and traditionally accepted agricultural produce. In KAU Shruthi (2005) made jack seed based health mixes, Nasheeda (2006) made banana based health drinks, Dhanya (2005) prepared rice based complementary foods for infants and Seema (2002) made a health drink for children 'Sree brahmyem' using Brahmi and kodangal. These attempts made to produce value added products from abundantly available and comparatively cheaper farm produce certainly improve the health and wealth of farmers.

2.6 Processing and Product development

Foods are perishable commodities and are therefore processed to preserve them from deterioration while providing the consumer with palatable, wholesome, nutritious and tasty food in convenient form throughout the year (Anand, 2000). According to Mallaya (2003) food processing is very important for the prosperity of India. Food processing industry helps to avoid post harvest losses of agricultural products in India. Value addition of the food production is only 7 percent in India compared to 23 percent in China, 45 percent in Philippines, though we have gone a long way in improving our food production.

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

2.6.1 Shelf life studies

Shelf life studies and acceptability studies are important in product development. According to Bhattachargee and Bhole (1999) food packaging and storage is the vital step to ensure product quality because it provides protection against deterioration and damage during storage, transportation and distribution. They studied the keeping quality of wheat in different packaging materials and recommended that it would be stored safely in polythene bags for a period up to 35 days and in jute bags up to 14 days from the standpoint of insect infestation and the development of free fatty acid in stored wheat flour.

Shelf life of snack products made from bajra were conducted. The products were stored in five different types of containers viz glass, tin, plastic and polythene bags of 200 and 400 gauge. No significant change could be found in chemical attributes.

2.6.2 Acceptability studies

Scientific methods of sensory analysis of food are becoming increasingly important in evaluating the acceptability of food products. When the quality of food is assessed by means of human sensory organs, the evaluation is said to be sensory analysis. Organoleptic qualities play important role in evaluating the quality of food products. For judging consumer acceptability organoleptic evaluation of any food product is essential.

Organoleptic qualities such as colour, flavour, taste, texture and appearance are assessed by a panel of selected judges. The combinations which get the highest score is selected for formulation of products. In sensory method palatability is evaluated by a panel of judges is essential to every standardization procedure because they answer all important questions of the food tastes, smell, looks and feels. Parameters like aroma, odour and taste are very important quality characteristics which are evaluated by sensory perception (Kawale, 1997).

MATERIALS AND METHODS

3. Materials and Methods

The present study entitled 'Feasibility of utilizing Indian Almond (*Terminalia catappa* L.) for value addition' is carried out with an objective to evaluate the feasibility of utilizing Indian almond for value addition and product development. In order to assess the quality characteristics, the chemical and nutritional composition and also the organoleptic qualities of the kernels were studied specifically.

The methodology followed is presented under the following headings.

3.1 Collection of Indian almond for the study
3.2 Assessment of Quality characteristics of the fruit and kernel
3.3 Processing and product development using Indian almond kernels
3.4 Product preparation incorporating Indian almond flour
3.5 Formulation of Indian almond based health drink mix
3.6 Development of a suitable device for the recovery of kernel

3.1 Collection of Indian almond for the study

Indian almonds are available throughout the year. The Indian almond (IA) required for the study were collected from the College of Agriculture campus Vellayani. There are more than 15 fruiting trees in the campus and all the nuts required for the study were collected from the campus. The fallen fruits were collected and dried under sun for one to two weeks and stored in plastic containers. The dried almonds were then broken using a specifically designed cutter. The extracted kernels were dried for two to three days up to the moisture content of 3.78 % and stored in glass bottles at ambient and refrigerated condition to study the quality characteristics.

Plate I **Indian almond (*Terminalia catappa* L.)**

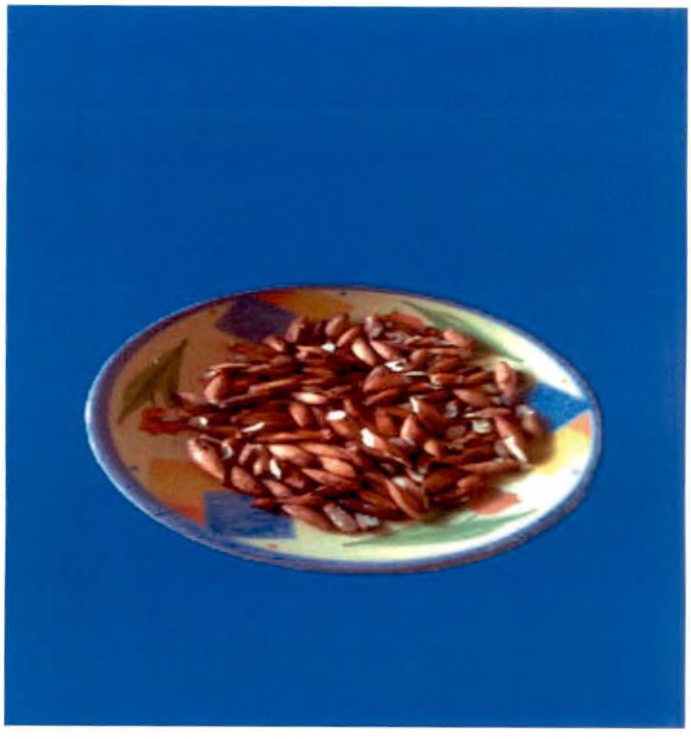

Plate 2 **Indian almond kernels**

3.2 Assessment of Quality characteristics of the kernel

Quality characteristics like fruit characteristics of fruit and kernel, nutritional and chemical composition of kernels and organoleptic evaluation of IA kernels were done using suitable methods.

3.2.1 Fruit characteristics of Indian almond

Physical characteristics like length, breadth, weight and volume of fruits and kernels of Indian almond were assessed using suitable devices and methods.

3.2.1.1 Fruit and Kernel length

The length of the fruits and kernels of IA were measured using Vernier Calipers. To find out the length of the fruits and kernels, each one was gripped vertically between the jaws of Vernier Calipers. Division of Vernier scale coinciding the main scale reading gives the length of the fruit and kernel. A random sample of twenty fruits and kernels were taken and the values were recorded in centimeters. Average length of the fruit and kernel was then calculated.

3.2.1.2 Breadth of Fruit and Kernel

Breadth of the fruits and kernels were also measured separately using Vernier Calipers. For finding breadth, the fruits and kernels were gripped horizontally between the jaws of Vernier Calipers. A random sample of twenty fruits and kernels were taken and expressed in centimeters and the average was taken as the breadth.

3.2.1.3 Weight of fruits and kernels

The fruits and kernels of Indian almond were weighed separately using electronic weighing balance and their average was worked out and expressed in grams. A random sample of twenty fruits and kernels were weighed and the average was taken.

3.2.1.4 Volume of fruits and kernels

For measuring the volume, the fruits and kernels were dipped separately in a measuring cylinder with water up to noted level and the rise in the water level was taken. The reading was then subtracted from the initial level of water and expressed as the fruit and kernel volume in meter cube. The volume of twenty randomly selected fruits and kernels were measured and the average was computed.

3.2.2 Chemical composition of Indian almond

The chemical and nutritional composition of the IA kernels were ascertained by estimating selected nutrient and non-nutrient content using standard laboratory techniques.

Moisture, dietary fibre, protein, fat, ash, the chemical components like rancidity, acidity and the minerals Calcium and Iron were determined as per standard methods.

Table1. Methods used for the determination of chemical composition of Indian almond

Sl.No	Components	Methods used
1	Moisture	Sadashivam and Manickam (1992)
2	Total fibre	Sadashivam and Manickam (1992)
3	Protein	Kjeldal method [Thimaih (1999)]
4	Fat	Soxlet method [Sadashivam and Manickam (1992)]
5	Calcium	EDTA Titrimetric method [Tandon (1993)]
6	Iron	Jackson (1973)
7	Vitamin-C	Colourimetric method [Sadashivam and Manickam (1992)]
8	Acidity	Thyagaraja et al. (1992)
9	Rancidity	Sadashivam and Manickam (1992)
10	Ash	AOAC (1980)

Total Carbohydrates value was obtained by subtracting the total of Moisture, Protein, Fat, Dietary Fibre and Ash content from 100. Total calories were calculated by multiplying Protein, Carbohydrates and Fat content by the factor 4, 4 and 9 (Gopalan et al. 1992).

3.2.3 Organoleptic evaluation of Indian almond kernels

In order to find out the acceptability of variously processed IA kernels such as roasted, sun dried and oven dried kernels along with fresh kernel were evaluated using sensory evaluation. For the conduct of sensory evaluation panel of judges are to be selected. A panel of ten judges was selected after initial screening through Duo-Trio test. The method used for the selection of judges is given in Appendix I. The score card used for the evaluation of Indian almond kernels is given in Appendix IIa. The major quality

attributes included in the score card are appearance, colour, flavour, texture, taste and over all acceptability.

3.3 Processing and Product development using Indian almond kernels

3.3.1 Preparation of flour from Indian almond kernels

The fruits were sun dried for two weeks until could feel the movement of nuts inside the fruits and the kernels were extracted from the dried fruits using the simple handy device which was developed for the study. The kernels were dried in the oven for 20 minutes at 60^0C until the outer thin brown skin can be removed using fingers. The skin was removed and the kernels were powdered using a mixer. The powdered kernels were then sieved using 60 mesh sieve to get fine flour. The flour prepared from the kernels were stored in air tight containers at refrigerated conditions for further study.

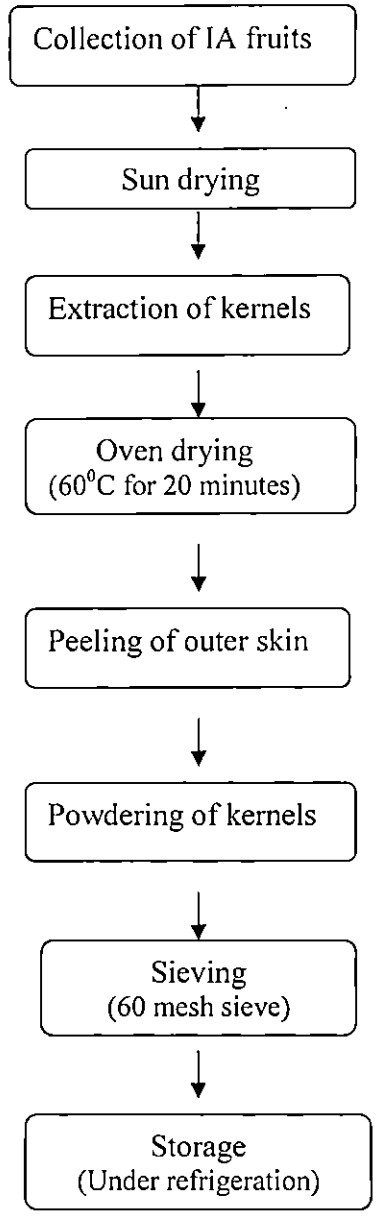

Fig. I Flow chart showing the preparation of kernel flour

3.3.2 Quality assessment of the kernel and flour

The quality parameters such as sensory characteristics and shelf stability of the kernel and developed flour were assessed using standard techniques. Insect infestation (Nasheeda, 2006) and microbial growth analysis (Johnson and Curl, 1972) of the flour too was studied initially and also after one month of storage.

3.3.2.1 Sensory characteristics of the kernel and developed flour

IA kernels and flour were stored in glass bottles under ambient and refrigerated conditions for a period of one month and was evaluated for changes in qualities before and after storage.

Sensory characteristics like appearance, colour, flavour, texture, taste and over all acceptability were assessed by a panel of judges. Organoleptic qualities of the developed flour soon after preparation were evaluated using score card (Harrington, 1991) every day till it became rancid.

3.3.2.2 Shelf stability of the kernel and developed flour

The flour was stored in glass bottles under ambient and refrigerated conditions to assess the shelf life quality. Shelf stability of the IA kernel and developed flour was assessed by analyzing the moisture content and peroxide value of the stored flour on weekly basis up to one month (Sadashivam and Manickam, 1992).

3.3.2.3 Insect infestation in stored kernel and flour

Insect infestation on stored IA kernel and flour were recorded by visual examination on storage period of one month.

3.3.2.4 Microbial growth in stored kernel and flour

Micro flora present in IA kernel and flour in fresh condition and after one month storage was examined. Serial dilution plate technique suggested by Johnson and Curl (1972) was used to assess the microbial growth.

3.4 Product preparation incorporating Indian almond flour

Feasibility of incorporating the developed IA flour into conventional ready to serve preparation following different cooking methods like boiling, roasting, frying and baking were tried out. The recipes viz soup, beverage and snacks were tried and their acceptability were assessed through sensory evaluation. The nutritive value and cost of the products were also computed. Different proportions of the IA flour was either incorporated or substituted in the selected popular conventional recipes and the most acceptable proportion was selected.

3.4.1 Soup

Standard vegetable soup recipe was selected and the same was prepared incorporating Indian almond flour. This was compared with control and organoleptic qualities were evaluated. Method of preparation of soup is given in Appendix III.

3.4.2 Milk shake

In the present study different proportions of the flour were blended with the other ingredients in the standard recipe. Each proportion was prepared separately and presented simultaneously before the judges along with control to identify the best proportion. The best combination was identified based on the over all acceptability score. Method of preparation of Milk shake is presented in Appendix III.

3.4.3 Maladu

For the preparation of maladu IA flour incorporated into the standard recipe was roasted and added to other ingredients.

Different proportions of the Indian almond flour were mixed with other ingredients in the standard recipe and maladu was prepared. The prepared products were evaluated by a panel of selected judges. Based on the acceptability score the best combination was identified and was taken as the final product. Method of preparation of Maladu is given in the Appendix III.

3.4.4 Pakkavada

Different proportions of the IA flour was incorporated in to the standard recipe. The prepared products were evaluated by the panel of selected judges. Based on the overall acceptability score, the best combination was identified and it was taken as the final product. The method used for the preparation of Pakkavada is presented in the Appendix III.

3.4.5 Biscuit

Different proportions of Indian almond flour was blended with other ingredients as in the standard recipe. The prepared products along with control were evaluated by the panel of selected judges. Based on the evaluation score the best combination was identified and taken as the final product. Method of preparation of IA incorporated biscuit is presented in the Appendix III.

3.4.6 Cake

Cake was prepared by incorporating different proportions of Indian almond flour

along with the other ingredients in the standard recipe and was evaluated and compared with control by the panel of selected judges. Indian almond flour was incorporated by reducing the quantity of maida. Based on the acceptability score, the best combination was identified and it was taken as the final product. Method of preparation of almond incorporated cake is presented in the Appendix III.

3.4.7 Curry

Indian almond incorporated tomato curry was prepared. IA flour was boiled with the other ingredients as in the standard recipe. Curry was prepared and evaluated by the panel of selected judges. The prepared curry was compared with the control product prepared without adding the kernel flour. Based on the acceptability score, the final product was selected. The method used for the preparation of almond incorporated curry is presented in Appendix III.

3.4.8 Quality assessment of the prepared products

After standardizing the products quality assessment of the prepared products viz Soup, Milk shake, Maladu, Pakkavada, Biscuit, cake and curry were done through organoleptic evaluation and calculating the nutritive value of the prepared products using nutritive value table (Gopalan et al., 1992). The major nutrients such as Energy, Carbohydrate, Protein, Fat, Iron and Calcium were thus determined. In order to assess the economic feasibility of the developed products the cost of the products prepared were also computed.

3.5 Standardization of Indian almond based Health Mix

First step for the standardization procedure is the collection of recipes from the standard cookery books, journals and magazine. Necessary modifications in the basic recipes are to be made next at the laboratory level and the recipes were finalized. Next

step is the preparation of the products according to the recipe formulated. The prepared products are to be then tested by the panel of selected judges. The preparations are to be repeated and scored in order to get a standardized product. Following the above procedure a health mix was formulated and standardized here.

3.5.1 Formulation of a health mix

The USDA (1956) has recommended 'Four food group plan' consisting of milk group, meat group, vegetable and fruit group and cereal group for daily intake. Also as per the food guide pyramid recommended for vegetarians, nuts have a prominent place in daily diet. These two were taken up as the basis for formulating a complex food suitable for all age groups. Similarly as illustrated by PAG (1975) in the form of 'Food Square' in order to formulate an adequate multimix four components are essentially needed – a basic staple, an energy rich supplement, a protein supplement and mineral and vitamin supplement. Following the above principles a health mix was standardized by selecting ideal components from each group. While selecting the ingredients for the health mix, preference was given to locally popular, easily available, economically viable nutritious food materials. Accordingly, the raw materials selected for the preparation of health mix included almond flour, soya flour, ragi, banana flour, amaranth and milk powder. Indian almond flour being a rich source of protein and minerals can serve as a rich base for health mixes. So in this study IA flour was used as the base material. Soya is protein rich plant based food which is available in the local market. Ragi and banana flour are two locally popular and nutritionally rich food materials used in the diet of children, adolescents and aged. Amaranthus is rich in minerals and is also locally available. Skimmed milk powder added will give good texture and taste to the health mix.

3.5.2 Procurement of raw materials

Indian almond needed for the study were collected from the campus of College of

Agriculture Vellayani. The other ingredients viz Ragi, Banana powder, Soya flour, Amaranthus and Milk powder were purchased from local market and processed.

3.5.3 Formulation of health mixes

Indian almond was selected as the base material for the preparation of health mix. Soya, Ragi, Banana powder, Amaranths and milk powder were the other ingredients combined with the kernel flour.

Six combinations of health mix were worked out by varying the proportion of IA flour and milk powder. Three combinations were prepared incorporating ragi and the other three combinations were prepared using banana powder. However care was taken to see that IA flour contributed not less than 50 percent of the health mix, since the objective of the study is to develop Indian almond based health mix. The proportions of ingredients of the six combinations of the health mix formulated are presented in the given Table 2.

Table 2. Different combinations of formulated health mixes

Sl.No	Combinations	Ingredients	Proportion used in 100 g
1	C1	IA flour+Soya+Ragi+Amaranthus+ Milk powder	10:2:2:1:5
2	C2	IA flour+Soya+Ragi+Amaranthus+ Milk powder	11:2:2:1:4
3	C3	IA flour+Soya+Ragi+Amaranthus+ Milk powder	12:2:2:1:3
4	C4	IA flour+Soya+Banana powder+ Amaranthus+Milk powder	10:2:2:1:5
5	C5	IA flour+Soya+Banana powder+ Amaranthus+Milk powder	11:2:2:1:4
6	C6	IA flour+Soya+Banana powder+ Amaranthus+Milk powder	12:2:2:1:3

3.5.4 Quality Characteristics of health mix

3.5.4.1 Selection of best combination of health mix

From the six combinations of health mix finally two most acceptable mixes were selected using organoleptic evaluation, chemical and amino acid score and by computing the nutritive value of the six combinations of health mixes. The most acceptable combinations with superior nutritional quality having high content of amino acid and chemical score and which obtained high organoleptic acceptability score was selected as the final health mix combination.

3.5.4.2 Organoleptic evaluation of the health mixes

In order to identify the most acceptable mix from the six combinations, an attempt was made to evaluate the acceptability through organoleptic evaluation. The over all acceptability score of each combination was found out separately by adding the individual scores obtained for five characters namely appearance, colour, flavour, taste and texture. The organoleptic evaluation was done by a panel of 10 judges. The panel of judges consisted of adolescents and adults.

The maximum score for a mix as per scoring system adopted was 25. The total mean score of the six combinations were compared and two mixes which obtained highest scores were selected finally for the preparation of health mix.

3.5.4.3 Chemical and Amino acid score of the health mixes

In order to select an ideal health mix among the different combinations, amino acid score and chemical score were also worked out utilizing the following formulae.

$$\text{Amino acid score} = \frac{\text{Mg of amino acid in 1g test protein}}{\text{Mg of amino acid in the requirement pattern (egg \ milk)}} \times 100$$

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

3.5.4.4 Nutritional quality of the mixes

The nutritive values of the six combinations were worked out using nutritive value table (Gopalan et al. 1992). The nutritional superiority of the mixes were evaluated based on the content of the major nutrients such as Energy, Protein, Carbohydrates, Fat, Iron and Calcium.

Using the organoleptic qualities, chemical score, amino acid score and nutritional quality, two mixes were finally selected. In the selected mixes, one is ragi added and the other is banana added. Nutrient and non nutrient content of the selected health mixes were also determined through standard laboratory techniques. Selected health mixes were analyzed for Moisture, Total fibre, Protein, Fat and Minerals - Calcium and Iron, Vitamin-C and Acidity. Energy and Carbohydrate of the health mixes were worked out using nutritive value table (Gopalan et al. 1992).

The health mixes selected were compared for nutritive value with the popular health foods available in the market.

3.5.5 Different products prepared incorporating the health mix

As the health mixes developed and standardized have good keeping quality, it was decided to try out a few popular recipes with the mix. Different products were tried and acceptability was rated through sensory evaluation done on a panel of selected judges. The products prepared included health drink, health porridge, milk shake, maladu and Pakkavada. The detailed recipes are presented in the Appendix III. Also the feasibility of incorporating the mix in popular breakfast items like Chapathi, Dosa and Puttu were tried out and acceptability was evaluated.

3.5.6 Development of Health drink

One of the objectives of the present study is to find out the feasibility of preparing a health drink using IA. Accordingly health drink was standardized using the developed health mix. Health drink was prepared using different proportions of the standardized health mixes. And the proportion incorporated in the most acceptable drink was selected. Before finalizing health beverage different methods of preparations were also tried out. The methods tried for the preparation of health beverage included mixing the health mix in hot water or cold water or boiling for three minutes.

The prepared health drinks were rated for organoleptic quality and the most acceptable drink which secured highest score was selected finally.

3.5.7 Cost of the health beverages selected

In order to assess the economic feasibility of the developed health drinks the cost was calculated on the basis of the market value of ingredients used to prepare 1 litre of the products plus overhead charges incurred for preparation.

3.5.8 Comparison of health drinks prepared with other beverages available in the market

The standardized health drinks were compared with other popular health drinks available in the market to assess the acceptability variation. The prepared health drinks were compared with Horlicks and Almond mix available in market and organoleptic qualities were rated by a panel of judges.

3.5.9 Acceptability evaluation of the health drink

As the objective was to standardize a health drink for children, sensory evaluation was also done among a group of 10 mothers and 15 preschool children to find out their acceptability of the drink.

3.6 Development of suitable device for the recovery of kernel

For the conduct of the present study an improvised simple and easy to handle device for recovering the kernel from the fruit was developed and used for the project.

As part of the study two tools were developed. First one is a handy device made by placing a freely moving knife on a wooden surface. The Vertical movement of the knife helps to cut the IA fruit in to two halves.

Another tool was made using 'Rute and Pine mechanism'. Here rotary movement is changed in to horizontal movement. Case, Pillar, Base, Punch, work table, Handle etc are the main parts of the device. The whole device is fixed on a table. The method of recovering kernel using the device is by placing the Indian almond on the work table using left hand and giving a down ward pressure using right hand on the handle. The outer hard shell of the Indian almond fruit will be cracked and the kernel can be taken out.

3.6.1 Effectiveness of the developed tool

Effectiveness of the developed tools were compared by checking the kernel recovery in unit time from each tool. Number of kernels extracted in one hour using each device is determined. The kernel recovery from each tool was checked by five people

and the average value was taken and compared to determine the effectiveness of the developed tool and to identify the best of the two. Also the cost for the fabrication of the two tools were calculated and compared.

3.7 Statistical analysis

In order to obtain meaningful interpretation, the generated data was subjected to suitable statistical analysis. The statistical tool followed was Kruskal - wallis non parametric test (Siegol and Castellin, 1988). As the data are nominal or categorical in nature, they being scores of 1,2,3 and 4, no parametric test like t-test, or ANOVA could be administered on it. Thus to compare the scores obtained on an organoleptic evaluation of the Indian almond based preparations with a non almond preparation, the Kruskal-wallis one way analysis of variance by Ranks was resorted. The objecticve was to ascertain whether the scores were identical in value across the samples ie, if r_c is the median for the control group and r_t, is the median value of the almond based preparations, $t = 1,2,3$. We would like to test $H_0 : r_t = r_c$, against $H_1 : r_t \neq r_c$. Using the above methods, the results obtained were analyzed and discussed in detail.

RESULTS

4. RESULTS

The present study entitled 'Feasibility of utilizing Indian Almond (*Terminalia catappa* L.) for value addition' is carried out with an objective to evaluate the feasibility of utilizing Indian almond for value addition and product development. The result of the study is presented in this chapter.

4.1 Assessment of Quality Characteristics of the Fruit and Kernel

Quality characteristics like fruit characteristics of IA fruit and kernel, nutritional and chemical composition of IA kernels and also organoleptic evaluation of the kernels were done using suitable methods.

4.1.1 Fruit characteristics of Indian almond

Physical characteristics like length, breadth, weight and volume of fruits and kernels were measured and the average values were taken. The results are presented in Table 3.

Table3. Fruit characteristics of Indian almond

Samples	Mean values			
	Length (cm)	Breadth (cm)	Weight (g)	Volume (ml)
Fruits	5.52	3.55	5.90	5.05
Kernels	2.62	1.40	0.54	0.22

The mean values of the different dimensions like length, breadth, weight and volume of Indian almond fruits revealed that the length of Indian almond fruit varied from 4.5 - 6.3 cm with an average length of 5.52cm while the breadth varied from 3 - 5.5 cm with an average of 3.55 cm. When the weight and volume was measured, it was found to vary from 4.8 - 7.53 g and 4.1 - 6.0 ml with an average of 5.90 g and 5.05 ml respectively.

The length of Indian almond kernels ranged from 2.4-2.9 cm with an average length of 2.62 cm. The breadth of the kernels ranged from 1.1-1.8 cm with an average of 1.40 cm where as the weight of kernels ranged from 0.4-0.63 g with an average value of 0.54 g. The volume of kernels ranged from 0.1-0.4 ml. The average volume of the kernels was 0.22 ml.

4.1.2 Chemical Composition of Indian almond kernels

Moisture, Total fibre, Protein, Fat, Calcium, Iron, Vitamin-C, Acidity and Ash content of the kernels were determined and the results are presented in the Table 4. Carbohydrates and Calories present in IA kernels was also computed.

Table 4. Chemical Composition of Indian almond kernels

Sl.No	Components	Mean values per 100g
1	Protein (g)	21.58
2	Fat (g)	25.90
3	Moisture (%)	3.78
4	Total fibre (g)	3.57
5	Acidity (%)	0.23
6	Vitamin-C (mg) (fresh kernel)	5.88
7	Calcium (mg)	320.00
8	Iron (mg)	4.00
9	Ash (%)	0.04
10	Carbohydrate (g)	45.00
11	Calories (Kcal)	500.00

Results of the study show that Indian almond kernels are rich in protein and fat. It consists of 21.58 g Protein and 25.9 g Fat. The kernels also contain considerable amount of Calcium and Iron ie, 320 mg of Calcium and 4.00 mg of Iron in 100 g of kernels. It can also be observed that the kernels are a rich source of fiber 3.57 g while the moisture content is found to be 3.78 percent.

The results also revealed that 100g of IA kernels contain 45 g of carbohydrate and 500 Kcal of Energy.

4.1.3 Comparison of nutritional qualities of IA kernels with other nuts

The values obtained from the analysis of IA kernels were compared with other nuts. Comparison of nutritional qualities of IA kernels with other locally popular nuts is presented in the Table 5.

Table 5 Comparison of nutritional qualities of IA kernels with other nuts

Different nuts	Moisture (%)	Protein (g)	Fat (g)	Fibre (g)	Calcium (mg)	Iron (mg)
Indian almond	3.78	21.58	25.90	3.57	320.00	4.00
Almond	5.20	20.80	58.90	1.70	230.00	5.09
Cashew nut	5.90	21.20	46.90	1.30	50.00	5.81
Ground nut	3.00	25.30	40.10	3.10	90.00	2.50
Walnut	4.50	15.60	64.50	2.60	100.00	2.64

Source: Gopalan et al. (2003)

When compared with other popular nuts moisture and fat content is very low in IA. Compared to other nuts IA is rich in fibre and minerals - calcium and iron. It can be noted from the table that Indian almond is comparatively high in protein (21.58 g) than the other popular nuts.

4.1.4 Organoleptic evaluation of Indian almond kernels

In order to assess the sensory qualities of Indian almond kernels, they were subjected to organoleptic evaluation by a panel of 10 selected judges. Five

characteristics namely appearance, taste, colour, flavour and texture of kernels dried under different conditions like roasted, sun dried, oven dried along with fresh kernels were evaluated by sensory evaluation using a 5 point scale. The mean score obtained for organoleptic evaluation done for each treatment was tabulated and the results are presented in the Table 6.

Table 6. Organoleptic Characteristics of processed IA kernels

Sl. No	Kernels	Mean Scores					Overall accept-ability score
		Appeara -nce	Taste	Colour	Flavour	Texture	
1	Fresh kernel	4.38	4.22	4.00	3.72	4.00	4.06
2	Roasted kernel	3.83	4.33	3.77	4.33	4.27	4.11
3	Sun dried	4.11	4.11	4.16	3.88	4.22	4.10
4	Oven dried	4.38	4.83	4.11	4.66	4.44	4.48

*Max.Score 5

From the table it is found that the overall acceptability score of different kernels ranged from 4.06 to 4.48 out of the maximum score of 5. Oven dried kernel has secured highest score of 4.48 with a percentage of 89.60 percent and the least score was obtained for fresh kernel 4.06 with a percentage of 81.20 percent while other two samples roasted and sun dried kernel scored better than fresh kernels.

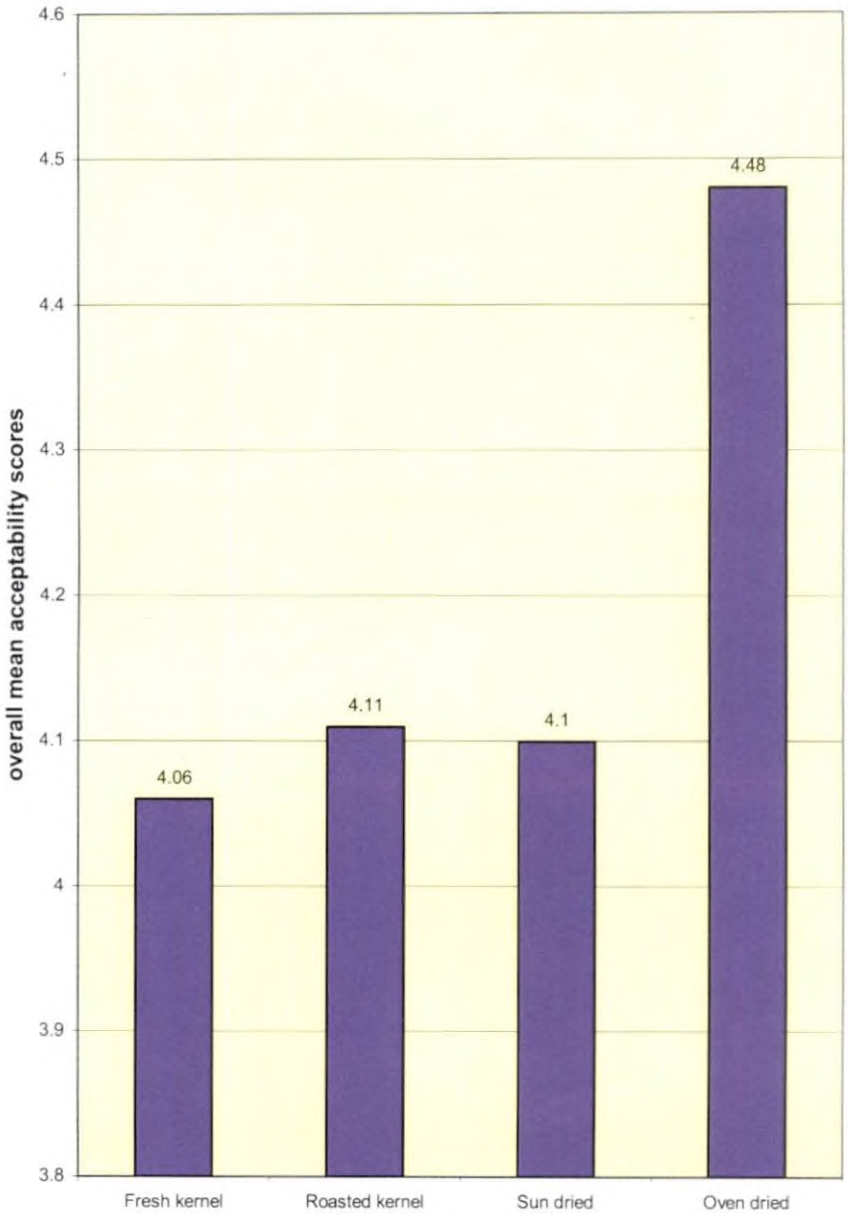

Fig. 2. Overall acceptability scores of IA kernels

4.2 Processing and Product development using Indian almond kernels

Another objective of the study was to try out the feasibility of product development from Indian almond. IA kernels were processed in to flour. The quality of the flour thus prepared was assessed and the feasibility of product development using IA flour was tried.

Quality assessment of developed flour

Sensory characteristics and shelf stability of the developed flour were assessed using standard techniques. Insect infestation and microbial growth analysis of the stored flour was also studied periodically up to one month and the results of each parameter is discussed next.

4.2.1 Shelf life quality of developed flour

4.2.1.1 Shelf stability of the kernel and developed flour

Shelf stability of the developed flour was assessed by analyzing the moisture content and peroxide value of the flour stored for a period of one month in glass bottles under ambient and refrigerated condition. The result of the study is presented in Table 7.

Table 7. Effect of storage on Moisture content and Peroxide value of kernel and flour

Ambient condition	Constituents	Kernel		Flour	
		Fresh	After one month of storage	Fresh	After one month of storage
	Moisture (%)	3.90	3.92	3.70	3.82
	Peroxide value (%)	ND	ND	ND	3.43
Refrigerat-ed condition	Moisture (%)	3.80	3.81	3.70	3.75
	Peroxide Value (%)	ND	ND	ND	ND

- ND – Not detected

When fresh kernel and kernel stored for one month was compared, not much difference was seen in the moisture content or peroxide value of the kernels stored in room temperature and under refrigerated condition. But in the case of kernel flour, difference could be noted in the moisture and peroxide value after storage at ambient condition. Even though no difference was seen in the case of peroxide value of the flour when kept under refrigeration, difference could be observed in the case of moisture content.

4.2.1.2 Changes in Sensory Characteristics of the kernel flour on storage

According to Thakur et al. (1998) chemical and sensory changes are influenced by storage period and containers used for storage. The almond flour was stored in glass bottles under ambient and refrigerated conditions for a period of one month and sensory evaluation was carried out on weekly basis up to one month. The mean acceptability score obtained for IA kernel and the flour are depicted in Table 8.

Table 8. Acceptability Score of Indian almond kernels and flour stored at ambient and refrigerated condition

Sl. No	Conditions	Mean acceptability score on weekly basis				
		7th day	14th day	21st day	28th day	35th day
1	**Ambient Condition** (Av.Temp. $30^0_{C,}$ RH 80%) Almond kernel	4.6	4.6	4.6	4.2	4.0
2	Almond flour	4.4	4.4	4.0	3.0	2.4
1	**Refrigerated condition** (Av.Temp. 4^0C) Almond kernel	4.8	4.8	4.8	4.8	4.6
2	Almond flour	4.6	4.6	4.6	4.6	4.2

*Max score 5

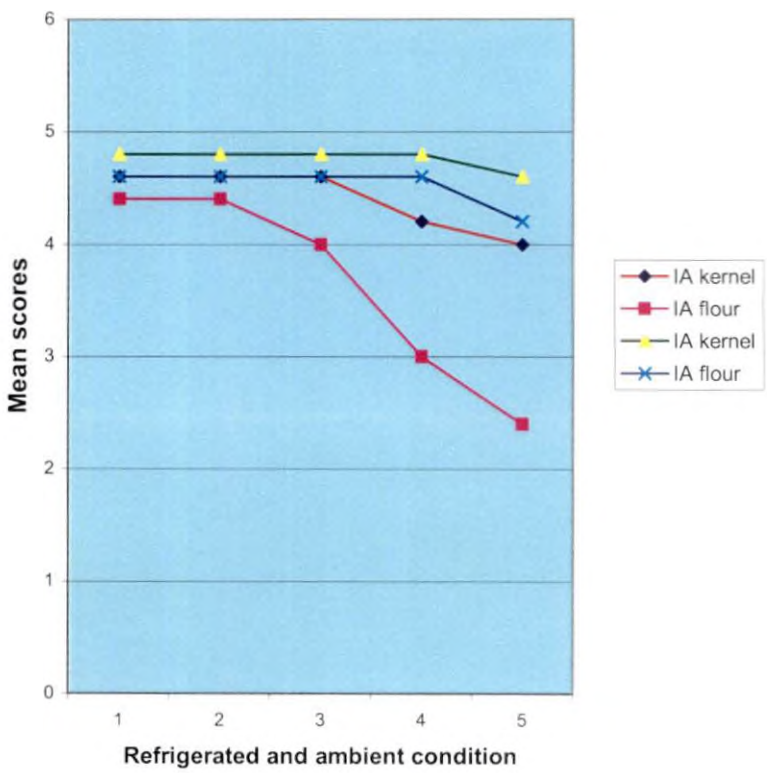

Fig. 3 Acceptability score of IA kernel and flour at ambient and refrigerated conditions

From the table it is clear that there is conspicuous difference between the acceptability score of kernel and flour in refrigerated and ambient condition. The acceptability scores of both kernels and flour seemed to diminish with storage. The difference is more for flour than kernels.

4.2.1.3 Insect infestation in stored kernel and flour

The incidence of insect attack was not observed in the kernel and flour even after one month of storage in glass bottles and refrigerated condition.

4.2.1.4 Microbial growth in stored kernel and flour

Observations on the microbial growth in kernel and flour after one month storage revealed that in all media fresh samples were free of microbes where as microbial growth was observed in stored sample after one month.

Table 9 depicts the details regarding the microbial load present in the Indian almond flour and kernels.

Table 9 Microbial load in Indian almond kernels and flour after one month storage

Sl.No	Particulars	Microbial load (cfu/g)		
		Bacteria	Fungus	Actinomycet
1	Kernel (Fresh)	ND	$1x10^{-5}$	ND
2	Kernel (stored)	$2 x10^{-6}$	$3x10^{-5}$	ND
3	Flour (Fresh)	$1x10^{-6}$	$1x10^{-5}$	ND
4	Flour (stored)	$4x10^{-6}$	$5x10^{-5}$	$2x10^{-3}$

- ND - Not detected

From the table it is clear that microbial load was comparatively high in stored samples both in kernel and flour. In fresh sample of flour, one bacterial colony and one fungal colony was found which had increased to four colonies of bacteria to five colonies of fungus and two colonies of actinomycet after one month storage. In fresh kernels bacterial and actinomycet colonies were absent and only one colony of fungi was found. After the storage period of one month the microbial load of the kernel sample showed two colonies of bacteria and three colonies of fungus but actinomycet colony was not detected.

4.3 Product preparation incorporating Kernel flour

Feasibility of incorporating the developed Indian almond flour into conventional ready to serve preparations following different cooking methods like boiling, roasting, frying and baking were tried and their acceptability was rated through sensory evaluation. A few of the most popular and easy to prepare recipes following different cooking methods were identified for this experiment. The recipes selected were a soup, a drink - milk shake, a sweet – maladu (roasted), a snack – pakkavada (fried), confectionary - cake and biscuit (baked) and a curry (boiled). Parameters like appearance, colour, flavour, taste, texture and over all acceptability of the products were studied. And the best product from each preparation was identified statistically using Kruskalwallis non - parametric test. The nutritive value and cost of the products were also computed.

4.3.1 Soup

Organoleptic evaluation of soup prepared with kernel flour and the soup with out kernel flour was done by sensory evaluation carried out by a panel of 10 selected judges. The parameters like appearance, colour, flavour, texture and taste were rated and the results of the statistical analysis is presented in Table 10.

Table 10 Comparison of Organoleptic Evaluation of Soups prepared

Soups	Rank means of organoleptic qualities					
	Appearance	Taste	Colour	flavour	Consistency	Overall
15 % flour	13.50	13.00	11.30	14.00	12.00	12.80
Control	7.50	8.00	9.70	7.00	9.00	8.20
χ^2	8.142863*	5.21978	0.475005	10.23078*	1.727282	5.15914

* CV 10.24713

*significant at 5 percent level

It can be observed that the IA flour incorporated soup secured better values than the control sample in all the qualities studied. But statistically significant difference was seen only in the case of appearance and flavour. The difference is significant at 5 percent level.

4.3.2 Milk shake

Milk shake is a milk added beverage which has thirst quenching properties. Srivatsa et al. (1998) reported that though beverages are low in food value, their popularity persists due to its thirst quenching properties. Different proportions of Indian almond flour viz 10 g, 15g and 20g were incorporated for preparing the milk shakes. The prepared milk shake was compared for organoleptic qualities with control to identify the best proportion. Best combination was identified based on the scores given by the panel of judges and the result of the statistical analysis is presented in Table 11.

Table 11 Comparison of organoleptic characteristics of Milk shake prepared with different proportion of kernel flour

Milkshakes	Rank Means					
	Appear-ance	Taste	Colour	flavour	Consistency	Overall
10% flour	21.00	15.95	21.50	19.00	21.60	19.81
15% flour	19.00	18.10	17.50	21.00	17.80	18.68
20% flour	21.00	26.75	19.50	21.00	26.70	22.99
Control	21.00	21.20	23.50	21.00	15.90	20.52
χ^2	1.054094	7.482099*	3.823556	.4193708	8.736524*	4.370276

* CV 10.24713

*significant at 5 percent level

From the table it can be noted that the milk shake prepared with 20 percent of the flour is higher in all the qualities except colour. The ranks for colour and appearance for the first sample is higher where only 10 percent of the flour was added. But in the case of the sample where 15 percent of the flour was added, the ranks for all the characteristics except taste and flavour was lower than the other two. However, statistically significant difference was seen only in the case of taste and consistency at 5 percent level.

4.3.3 Maladu

Maladu is a traditional confectionary of South Indians prepared using roasted bengal gram, sugar and ghee. Roasted bengal gram flour was substituted partially with different proportions of roasted kernel flour 30 percent and 50 percent

respectively. Maladu was prepared along with other ingredients following the standard recipe. The prepared products were evaluated by the panel of selected judges and the best combination was identified. Statistical analysis of the results is presented in the Table 12.

Table 12. Comparison of Organoleptic characteristics of Maladu prepared with different proportions of kernel flour.

Maladu	Rank Means					
	Appear-ance	Taste	Colour	flavour	Texture	Overall
30% flour	11.90	15.00	13.15	16.00	14.85	14.18
50% flour	21.10	18.00	17.40	17.50	18.40	18.48
Control	13.50	13.50	15.95	13.00	13.25	13.84
χ^2	8.578392*	2.52173	3.4574	3.24799	2.466826	4.054468

*CV 7.716528

*significant at 5 percent level

The table reveals that the maladu prepared using 50 percent kernel flour secured highest score. The statistical analysis revealed significant difference at 5 percent level in the case of appearance. But for the qualities taste, colour, flavour and texture there is no significant difference between the two products and control even though the preparation with 50 percent scored better in all the qualities.

4.3.4 Pakkavada

Pakkavada is a savoury fried preparation using the ingredients Bengal gram flour, Rice flour, kernel flour, salt and spices. Different proportions of kernel flour 15 percent and 25 percent were substituted with equal amount of bengal gram, rice flour and was blended with other ingredients as in the standard recipe and frying was the cooking method used. The prepared products were evaluated by a panel of 10 selected judges. Statistical analysis of the results is tabulated and presented in the Table 13.

Table 13. Comparison of Organoleptic characteristics of Pakkavada prepared with different proportions of kernel flour.

Pakkavada	Rank Means					
	Appea-rance	Taste	Colour	flavour	Texture	Overall
15% flour	11.00	13.00	17.10	14.20	16.25	14.31
25% flour	18.50	22.00	19.90	20.50	13.35	16.85
Control	17.00	11.50	9.50	11.80	16.90	13.34
χ^2	6.444442*	11.2850**	9.99809*	7.0842*	1.19083	7.200510*

*CV 7.716528

*significant at 5 percent level

**significant at one percent level

The above table indicates that the preparation with 25 percent g of kernel flour is more acceptable than other combinations. The least acceptable Pakkavada is the one with 15 percent of kernel flour. The chi-square values point out that in the case

Plate 3 Soup

Plate 4 Milkshake

Plate 5 Maladu

Plate 6 Pakkavada

of appearance, colour and flavor, the products differed at five percent level and as for taste significant difference was observed at one percent level. Also in the case of texture there is no significant difference between the three products but the scores reveal that by adding more kernel flour texture of the product was affected unfavourably.

4.3.5 Biscuit

Bakery products, especially soft dough biscuits command wide popularity among the people of all age groups in rural as well as urban areas in India (Agarwal, 1990). As reported by Arnold (1982) biscuit is essentially a bakery confectionary dried down to low moisture content. Soft flour form the major ingredient in biscuit preparation. Here the soft flour is substituted with different proportions of kernel flour to see whether the flour is suitable for baking purpose.

Maida used in the biscuit preparations were substituted with different proportions of kernel flour 20 percent and 30 percent and were blended with other ingredients as in the standard recipe. This was compared with the control sample prepared with out including kernel flour. As in other preparations the prepared products were evaluated by a panel of selected 10 judges. Based on the acceptability the best combination was identified. The results of statistical analysis are presented in the Table 14.

Table 14. Comparison of Organoleptic qualities of Biscuits prepared with different proportions of kernel flour.

Biscuits	Rank means					
	Appea-rance	Taste	Colour	flavour	Texture	Overall
20% flour	12.20	11.50	12.50	13.50	11.00	12.14
30% flour	22.10	25.00	19.80	18.00	21.50	21.28
Control	12.20	10.00	14.20	15.00	14.00	13.08
χ^2	10.6782**	25.2535**	4.74072	1.81249	10.4722**	10.59146*

*CV 7.716528

*significant at 5 percent level

**significant at one percent level

From the table it is clear that when more quantity of flour was added all the sensory characteristics and overall acceptability scores improved remarkably. Chi-square values also showed a significant difference at one percent level for appearance taste and texture. The product in which 30 percent of Indian almond flour was added identified as the best preparation based on the results.

4.3.6 Cake

Cakes are not only sweet but also light and delicate among all the baked products. Good quality cakes can be prepared by using maida, sugar, eggs, fat, baking powder and flavor compounds.

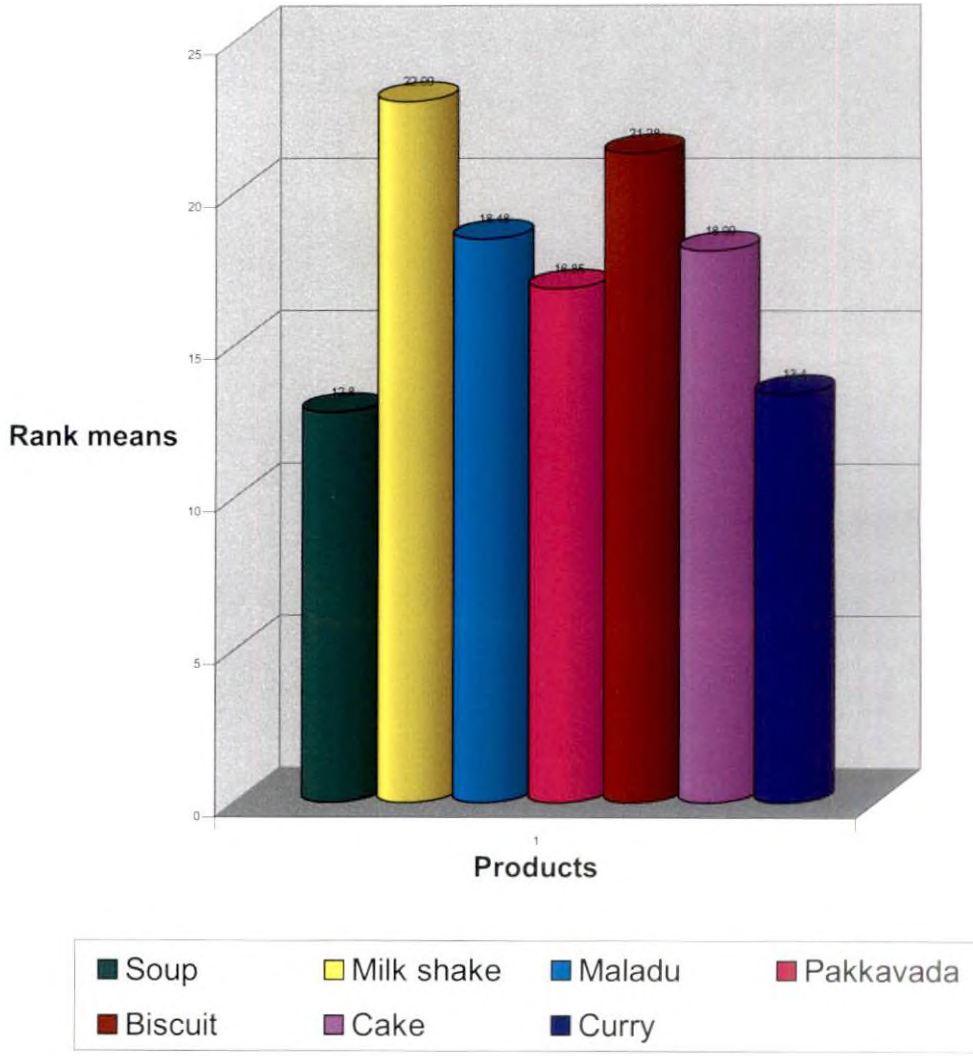

Fig. 4 Overall acceptability scores of prepared products

In the preparation of cake, varying proportions of IA flour was substituted with maida and other ingredients in the standard recipe for cake. This was compared with the product prepared with out including kernel flour. The prepared products were evaluated by the panel of selected judges. Based on the acceptability score the best combination was identified. The result of statistical analysis is presented in the Table 15.

Table 15. Comparison of organoleptic qualities of cakes prepared using Indian almond flour

Cakes	Rank Means					
	Appea-rance	Taste	Colour	flavour	Texture	Overall
15% flour	17.50	20.10	15.90	18.00	18.95	18.09
20 % flour	15.20	16.70	16.00	16.50	15.80	16.04
control	13.80	9.70	14.60	12.00	11.75	12.37
χ^2	1.396959	9.708096*	0.2267919	3.366071	4.442057	3.823623

*CV 7.716528

*significant at 5 percent level

The table reveals that more acceptability was observed in cakes where only 15 percent kernel flour was added. Significant difference in taste and notable difference in flavour and texture could be seen for the sample and so it was identified as the best of the two.

4.3.7 Curry

The main ingredients used for the preparation of curry included Indian almond flour, tomato, onion, green chilies, butter and spices. Using the ingredients curry was prepared and this was compared with the curry prepared without adding the kernel flour. Then the prepared products were evaluated by the panel of selected judges. The results of statistical analysis are presented in Table 16.

Table 16 Comparison of organoleptic qualities of curry prepared

Curries	Rank Means					
	Appe-arance	Taste	Colour	flavour	Consis-tency	Overall
15% flour	13.5	15.0	11.0	14.0	13.5	13.4
control	7.5	6.0	10.0	7.0	7.5	7.6
χ^2	6.8400*	15.000**	0.372557	9.4040*	8.1428*	7.9518973*

*CV 5.185673

*significant at 5 percent level

**significant at one percent level

From the table it is observed that there is great difference in the organoleptic characteristics of kernel flour incorporated curry and the curry prepared without kernel flour. Chi-square values in the case of appearance, flavour and consistency showed significant difference between two products at five percent level, where as in the case of taste, the difference was significant at one percent level. In the case of colour the difference was only slight. From the table, it is clear that Indian almond incorporated curry is more acceptable than the control.

Plate 7 Biscuit

Plate 8 Cake

Plate 9 Curry

4.3.8 Nutritive value of the developed products

The nutritional quality of all the prepared products such as soup, milk shake, maladu, Pakkavada, Biscuits, cake and curry were computed. The major nutrients like Energy, Carbohydrate, Protein, Fat and the minerals Calcium and Iron were computed and presented in the Table 17 (Gopalan et al., 1992).

Table 17. Nutritive value of products prepared incorporating IA kernel flour

Sl.No	Kernel flour incorporated Products (100 g)	Energy (k.cal)	Protein (g)	Carbohydrate (g)	Fat (g)	Calcium (mg)	Iron (mg)
1	Soup	453.00	9.93	15.00	9.94	227.00	2.05
2	Milk shake	224.00	6.65	26.00	7.36	169.20	7.57
3	Maladu	1166.00	22.79	147.00	43.48	198.60	29.37
4	Pakkavada	467.00	18.68	50.00	8.14	111.50	17.18
5	Biscuit	886.00	14.68	153.00	106.83	31.00	2.22
6	Cake	1546.00	26.78	174.00	65.07	154.40	14.20
7	Curry	221.00	4.59	17.00	27.36	107.00	9.22

From the table it is clear that the addition of Indian almond flour to the standard recipes has enhanced nutritional quality of the preparations. From the results of the study it can be noted that the incorporation of the kernel flour has improved acceptability and nutritive value of the products indicating the feasibility of preparing value added products from IA.

4.3.9 Cost of the developed products

The cost of the developed products were calculated on the basis of the market value of ingredients used to process 100 g of the products. The cost calculated include the cost of raw materials and overhead charges needed for processing each item. Indian almond fruits though abundantly produced are not available in the local market. Even though it is as nutritious and delicious like popular cashew nut and almond, it is not utilized profitably but is wasted in large quantity. The market price of 1 kg of cashew nut and almond is Rs.450/- and Rs.500/- respectively. Considering the abundant wastage and the need for improving its utilization, the price for IA kernel was fixed at a lower rate of Rs.350/ kg. The cost of the same products using almond and cashew nut were worked out and compared with Indian almond based products. Comparison of cost of different products prepared with Indian almond flour, almond flour and cashew nut flour are presented in the Table 18.

Table 18. Comparison of Cost of IA based products with other popular nut based product.

Sl.No	Products	Cost of IA Preparations (Rs)	Cost of almond Preparations (Rs)	Cost of Cashew preparations (Rs)
1	Soup(1 serving)	19.00	24.00	22.00
2	Milk shake (1 serving)	15.00	19.50	18.00
3	Maladu (1 kg)	230.00	310.00	280.00
4	Pakkavada(1kg)	120.00	150.00	130.75
5	Biscuit(1kg)	200.00	250.00	230.00
6	Cake(1 kg)	200.00	230.00	220.00
7	Curry(1 serving)	16.00	20.00	18.00

From the table it is clear that compared to almond based and cashew based preparations the cost of IA based are less indicating that IA based preparations are economically feasible too.

4.4 Development of Health mix

Market for functional drinks specifically endowed with nutritional and health benefits are reported to be growing at a great rate not matched to other food sectors. Sharma (2004) reported that functional drinks comprising of enriched beverages, sports drinks, energy drinks and nutraceutical are increasingly attracting the attention of 18-44 year old consumers looking for a healthy life. It was proposed to try out the feasibility of developing a health beverage using the highly nutritious Indian almonds. Indian almond is an unexploited nut whose value addition is not yet tapped. In the present scenario of fast growing food industries, newer and newer consumer foods are engulfing the market where Indian almond can also contribute with products of good consumer appeal with lesser cost. When more and more people particularly women go out for work, a health mix which is tasty, convenient, easy to prepare and at the same time nutritious will be the best choice. Hence it was proposed to develop a health mix which can be converted to health beverage at any time. The details of the mix prepared are discussed next.

4.4.1 Formulation of health drink mix

Studies done by Christian and Ukhun (2006) on the nutritional profile of the nut of Indian almond reported that the nut is a rich source of macro and micro nutrients particularly Carbohydrates, Proteins, Fibre, Fat, Vitamin-A, Vitamin-B, Vitamin-C, Nitrite, Calcium, Phosphorus, Iron etc. In the present study also similar results obtained. Hence Indian almond kernels were put to effective utilization by

converting the nuts to flour and developing nutrient rich health mix incorporating the nut flour.

The health mix was prepared using Indian almond as the basic ingredient. Other ingredients used for the formation of health mix include soya, ragi, banana powder, amaranth and milk powder. The ingredients were selected based on 'Food square' and the food group 'Basic four'.

Six combinations of health mix were first formulated incorporating IA flour as the base. From among the six combinations two most acceptable mixes selected using organoleptic evaluation, chemical and amino acid score and by computing the nutritive value. The results are presented next.

4.4.2 Organoleptic evaluation of the health mixes

In order to identify the most acceptable mix from the six combinations formulated, they were prepared and compared for organoleptic qualities. Organoleptic evaluation was carried out using a score card. The organoleptic evaluation was done by a panel of 10 judges. Statistical analysis of the results are given in Table 19.

Table 19. Comparison of organoleptic qualities of various combinations of Health mix

Combin-ations	Rank means of organoleptic qualities					
	Appe-arance	Taste	Colour	Flavour	Texture	Overall
C1	23.20	21.25	31.50	21.40	30.15	25.50
C2	35.10	34.00	37.50	31.70	40.60	35.78
C3	20.30	24.00	22.50	31.30	22.90	24.20
C4	32.20	31.25	40.50	40.00	37.65	36.29
C5	26.10	23.00	19.50	24.30	22.90	18.36
C6	26.10	29.50	31.50	24.30	28.80	28.04
χ^2	23.1465**	19.7330**	14.9502**	16.7764**	11.7096**	17.2632**

*CV 15.30809

**significant at one percent level

From the table it is clear that combination 2 and combination 4 were more acceptable in all the sensory characteristic studied, revealing a significant difference at one percent level. The ingredients used in combination 2 is IA flour, soya, ragi, amaranthus and milk powder in the proportion 11:10:10:5:20. In the combination4 soya, banana powder, amaranthus and milk powder were used in the proportion 10:10:10:5:25.

4.4.3 Chemical and Amino acid Score of the health mixes

A health mix should be acceptable as well as nutritionally rich. Here the amino acid score and chemical score of the health mix was worked out to identify the best. Amino acid and chemical score of the 6 combinations are presented in Table 20.

Table 20. Chemical and Amino acid score of the health mixes formulated.

Sl.No	Combinations	Chemical Score	Amino acid score
1	C1	93.98	84.53
2	C2	85.24	77.75
3	C3	76.5	69.54
4	C4	88.35	80.19
5	C5	79.59	73.39
6	C6	70.83	65.16

As revealed in the table, the highest chemical and amino acid score was obtained for combination 1. The second and third place was secured by combination 4 and combination 2 respectively. Hence combination 2 and combination 4 which has secured first two places in organoleptic evaluation too was selected as the best two combination for further analysis.

4.4.4 Nutritional quality of the mixes

The nutritive values of the 6 combinations were computed using nutritive value table (Gopalan et al. 1992). The nutritional superiority of the mixes were evaluated based on the content of the major nutrients such as Energy, Protein, Carbohydrates, Fat, Iron and Calcium. The nutritive values of the 6 combinations are presented in the Table 21.

Plate 10 Health mix

Plate 11 Health drink

Table 21. Nutritive value of Health Mixes of different combinations (100g)

Sl.No	Combinations	Energy (k.cal)	Protein (g)	Carbohydrate (g)	Fat (g)	Calcium (mg)	Iron (mg)
1	C1	560.00	26.15	61.00	13.01	575.50	27.10
2	C2	582.00	25.39	62.00	13.93	523.00	29.56
3	C3	603.00	24.63	64.00	14.99	470.50	31.94
4	C4	542.00	25.55	61.00	12.90	543.70	27.42
5	C5	564.00	24.73	59.00	13.81	491.20	29.75
6	C6	585.00	24.03	60.00	14.88	438.70	32.18

The over all picture of nutritive value of health mixes reveal that all the mixes formulated are nutritionally very rich with only slight variation from each other. The combination 2 and combination 4 rated as high in other two qualities is comparatively rich in nutrient composition also. As can be observed from the table, they are ranked first, second or third in all the nutrients. Thus the two combinations which scored high values were finally selected.

4.4.5 Comparison of nutritional qualities of IA based health mixes with other health foods available in market

Nutritional qualities of the two selected Indian almond based health mixes were compared with the nutritive value of the other health foods available in the market. The results are presented in the Table 22.

Table.22 Nutritional qualities of IA based Health mixes with other Health foods available in market

Sl.No	Health mixes (100g)	Energy (kcal)	Protein (g)	CHO (g)	Fat (g)	Ca (mg)	Fe (mg)
1	Combination I	582.00	25.39	62.00	13.93	523.00	9.06
2	CombinationII	542.00	25.55	61.00	12.90	543.70	6.92
3	Pedia Sure	496.00	14.90	54.00	24.70	486.00	7.00
4	Horlicks	595.00	21.00	64.00	29.00	579.00	21.00
5	Complan	419.00	18.00	62.00	21.60	800.00	13.50
6	Ensure	406.00	15.00	56.00	13.50	224.00	3.50

The results show that the nutritive values of the IA based health mixes are comparable with other health foods available in the market. Compared to other health foods IA based health mixes are high in Energy, Protein and low in Fat. The cost of two combinations of health mix prepared was Rs.11.50\- and Rs.10.00\- respectively.

4.5 Product standardization using health mix

4.5.1 Preparation and standardization of a Health drink

A health drink suitable for children and adult were prepared using the two selected mixes and standardized. Standardization and product development play a key role in the growth of food industries. Poduval and Pillai (1998) opined that one of the foremost purpose of standardization 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 product then to the dealer and finally to the retailers and consumers.

Using the selected two health mixes different methods of preparing health drinks were tried out. The methods tried for the preparation of health drink include addition of health mix in hot water, cold water and also boiling the mix for three minutes. The most acceptable method of preparation of health drink was boiling and that was selected for the final preparation of health beverage.

4.5.2 Acceptability evaluation of the health drinks

Acceptability of the health drink was assessed through sensory evaluation done on a group of 10 mothers and 15 children. Acceptability of the standardized health drinks were assessed through hedonic rating scale. The rating scale used was a 9 point scale.

Average mean score obtained for health drink combination I was 7.60 as against 7.7 for combination 2. Both the drinks secured more than 80 percent in hedonic ratings. Both the drinks are rated as highly acceptable both by mothers and children.

4.5.3 Comparison of health drinks prepared with other beverages available in the market

The prepared health drinks were compared with other popular health drinks available in the market like Horlicks and Flavoured almond drink. The maximum score given for each organoleptic quality is 5. The mean score obtained for the different drinks for the organoleptic evaluation is presented in the Table 23.

Table 23. Comparison of Organoleptic qualities of drinks with other Popular health drinks

Sl. No	Beverages	Mean scores					Overall
		Appea-rance	Taste	Colour	Flavour	Texture	
1	IA Beverage						
	Combination I	4.60	3.60	4.00	4.00	4.30	4.10
	Combination II	4.60	4.30	4.60	4.00	5.00	4.50
2	Horlicks	4.00	3.60	4.00	4.00	4.00	3.92
3	Flavoured almond mix	5.00	4.00	5.00	5.00	4.00	4.60

- Max score 5

The drink prepared from almond mix available in market scored more. Where as health drink prepared using the Indian almond health mixes scored slightly less. And health drink prepared with combination 4 scored better than health drink with combination 2. The suggestions and comments given by the judges stated that as colour and flavour is added in flavoured almond mix, the drink was more acceptable. The original colour and flavour of IA based drink with no additional flavour or colour added was also highly acceptable. The judges recommended that flavour like cardamom can be added to enhance flavour and taste but no need to add colour as the natural colour of the product is quite acceptable.

4.5.4 Cost of the health drinks prepared

In order to assess the economic feasibility of the developed health beverages the cost was calculated on the basis of the market value of ingredients used and also the overhead charges needed to prepare 1 litre of health drink and the cost of one serving of drink was worked out. The cost of two combinations of health mix prepared was Rs.11.50\- and Rs.10.00\- respectively. The cost of milk and sugar was added with the cost of health mix to calculate the cost of health drink.

The results shows that the cost needed to prepare 200 ml (1 serving) of Indian almond incorporated health drink I & II is Rs.16.50/- and Rs.15.00/- respectively.

4.5.5 Popular recipes tried out with health mix

Feasibility of incorporating the health mixes in popular recipes were tried out by incorporating the selected health mixes in standard popular recipes and the acceptability of the products were rated through sensory evaluation done by a panel of selected judges. The products prepared included health porridge, milk shake, maladu and Pakkavada. The maximum score given for each organoleptic quality is 4 and the maximum total score is 20. The total score obtained for the different products prepared incorporating health mixes are presented in the Table 24.

Table reveals that comparing the different products prepared from health mix health porridge was more acceptable than other products. The lowest score was obtained for Pakkavada. But comparing all the products secured good score 70 percent indicating that the products prepared using the health mixes are highly acceptable.

Table 24 Mean scores of products prepared using health mixes

Sl. No	Products	Mean scores					Overall acceptabi-lity	Score (%)
		Appe-arance	Taste	Colour	flavour	Texture		
	Max score	4	4	4	4	4	5	100
1	**Health Porridge**							
	Combination I	3.3	3.6	3.3	3.7	3.7	3.52	88.00
	Combination II	3.6	3.3	3.6	3.3	3.2	3.4	85.00
2	**Milk shake**							
	Combination I	3.2	3.2	3.2	2.8	3.0	3.08	77.00
	Combination II	3.0	3.8	3.1	3.1	3.2	3.24	81.00
3	**Maladu**							
	Combination I	3.1	2.9	2.9	3.0	3.2	3.02	75.50
	Combination II	3.0	3.3	3.3	3.5	3.2	3.26	81.50
4	**Pakkavada**							
	Combination I	2.3	2.3	3.5	2.5	3.1	2.74	68.50
	Combination II	2.9	2.8	3.3	2.8	3.4	3.04	76.00

4.6 Development of suitable device for the recovery of kernel

For the conduct of the present study an improvised simple and easy to handle device for recovering the kernel from the fruit was developed and used for the project. As part of the study two tools were developed T1 and T2. First one is a portable device made by placing a freely moving knife on a wooden surface. Another tool developed using Rute and Pine mechanism has to be fixed on a table or plat form.

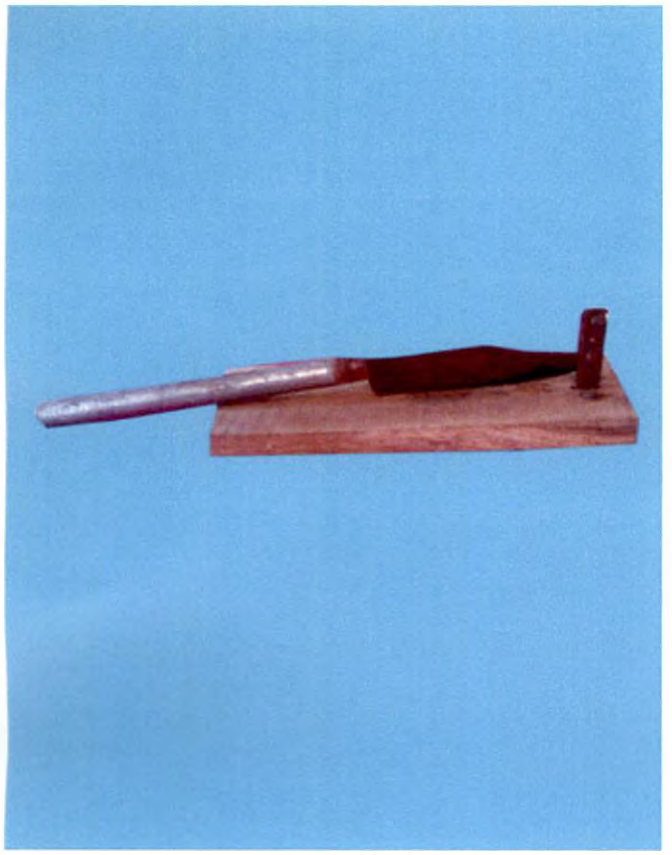

Plate 12 Handy device (Tool I)

Plate13 Tool I in operation

Plate 14 Tool II

Plate 15 Tool II in operation

4.6.1 Effectiveness of the developed tool

Both tools developed are easy and safe to operate and can be easily handled. Effectiveness of the developed tools were determined by checking the kernel recovery in unit time from each tool. Number of kernels extracted in one hour using each device was determined. The kernel recovery from each tool was checked by five persons and the average values were taken.

Table 25 Kernel recovery from the developed tool

Tools	No. of Kernel recovery in 1 hour
T1	62
T2	65
t value	1.978

Results of the study shows that the kernel recovery of the handy device T1 is found to be 62 kernels per hour and using the device T2 the kernel recovery is 65 kernels per hour. Tool T2 can extract more kernels than T1 but damage of kernels is less in handy device T1. From the opinion of the people the tool which is easier to operate is the handy device T1. How ever, t value shows there is no significant difference in kernel recovery of two tools T1 and T2.

DISCUSSION

5. DISCUSSION

The results of the present study entitled 'Feasibility of utilizing Indian Almond (*Terminalia catappa* L.) for value addition' are discussed in this chapter. The objectives of the research study was to find out the physical and quality characteristics of Indian almond kernel and to find out its feasibility in product development. Accordingly the study was carried out and the results presented in the previous chapter is discussed in this chapter.

5.1 Assessment of Quality characteristics of the fruit and kernel

Quality characteristics like fruit characteristics of fruit and kernel, nutritional and chemical composition of kernels and organoleptic evaluation of IA kernels were done using suitable methods and the details are discussed below.

5.1.1 Fruit characteristics of Indian almond Fruit and kernel

Physical characteristics like length, breadth, height, weight and volume of randomly selected 20 Indian almond fruits and kernels were assessed using suitable methods. In the case of fruits the length varied from 4.5 - 6.3 cm with an average length of 5.52cm. And the breadth varied from 3 - 5.5cm with an average of 3.55 cm. When the weight and volume was measured, it was found to vary from 4.8 - 7.53 g and 4.1 - 6.0 ml with an average of 5.90 g and 5.05 ml respectively.

In the case of kernels the length ranged from 2.4 - 2.9 cm with an average length of 2.62 cm. The breadth of the kernels ranged from 1.1 - 1.8 cm with an average of 1.40 cm, where as the weight of kernels ranged from 0.4 - 0.63 g with an average value of 0.54 g. The volume of kernels ranged from 0.1 - 0.4 ml with an average volume of 0.22 ml.

A study done by Thomson and Uwamariya. (1999) in Pacific Island Agroforestry reported that the length of IA fruits ranges from 3.5 - 7.0 cm, the length and weight of seeds ranges from 2.6 - 3.8 cm and 0.1 - 0.9 g respectively.

The observation of the fruit and kernel revealed the following the fruits of Indian almond are edible and oval in shape, green in colour when raw and turns to yellow and red as the fruit ripens. Inside the thick fleshy outer covering there is a fibrous covering to the hard shell. The kernel is inside the hard shell. Even though the fruit is of medium size the kernel is small unlike cashew nuts or almond. The kernels creamish white in colour with a brownish outer skin. It is 4.5 – 6.0 cm long round and elongated with tapering ends. It is smaller and thinner than cashew nuts or almond and can be eaten raw or processed. When 1 kg of cashew nut consist of 900 nuts while that of 1kg of IA kernels consist of approximately 2000 nuts.

The maximum length of the fruits and kernels collected for the study was 2.9 cm and 1.8 cm. Studies report that kernels with a maximum length of 3.8 cm are also available. Similarly in the case of weight of kernels also, when the maximum was 0.63 g for kernels under study, Kernels with weight of 0.9 g also reported. This indicates that there will be slight variation in the weight of kernels obtained from different regions or from different varieties.

5.1. Chemical composition of Indian almond

Moisture, Total fibre, Protein, Fat, Calcium, Iron, Vitamin-C, Acidity and Ash content of the IA kernels were determined using standard laboratory techniques. From these values total carbohydrates and total calories present in IA kernels were also computed.

The nutritive value of a food is an important parameter for the development of any new food. Nutrients like calcium, iron, protein and fat in the Indian almond flour were analyzed in the laboratory. Saxena (2003) suggested that laboratory analysis is one of the best methods to assess the quantity of different nutrient present in the products.

The results of the chemical and nutritional analysis revealed the quality characteristics of the kernel. The kernel is very low in moisture content of (3.78 %) when compared to other nuts and other food materials. This certainly adds to the keeping quality of the kernel suggesting the feasibility for preparing value added products with long shelf life. Another notable characteristic is the high fibre content of the kernels. It is 3.57 % equalent to coconut (fresh 3.6 and dry 3.8 %) and higher than popular nuts like almond, cashew nut, ground nut and higher than most of the vegetables, fruits and grams. The minerals Calcium and Iron content of Indian almond was found to be 320 mg and 4.0 mg respectively.

The results reveal that the IA kernels are fairly rich source of carbohydrates (45g). It can be seen that except in cereals, pulses, dried fruits, most of the vegetable and fruits have comparatively lower carbohydrate. Similarly in the case of energy like other nuts IA kernel also a rich source of Energy (500 kcal). IA kernels are rich in fat (25.9 g). It is proved that the fat present in nuts have the capacity to reduce the serum cholesterol level. More analysis is needed to find the type of fat present in Indian almond. When comes to the protein content, nuts in general are equalent or better than pulses and animal foods. In the case of IA kernels also the analysis revealed a fairly good content of protein ie, 21.90 g in 100 g of kernels. The minerals calcium and iron content of Indian almond was found to be 320 mg and 4.00 mg respectively. Similar results are reported by Christian and Ukhun (2006). It was reported that tropical almond nut (*Terminalia catappia* L.) contains 320 mg of

calcium, 49 mg of iron, moisture percentage was 2.84, crude fibre 1.98 % and Total Acidity percentage was 0.090.

Research studies done by The Tree Nut Group of International Nut Council reported that a small serving daily of variety of nuts can contribute a wide variety of vitamins, minerals, dietary fibers and phytochemicals that the typical diet lacks. The high fibre, low fat nuts can help to reduce the risk of certain types of heart disease, cancers and birth defects.

The nutritional qualities of IA kernels were next compared with the other locally popular nuts. When compared with other popular nuts moisture and fat content is very low in Indian almond. Due to low moisture percentage we can store the kernels for more days. NIN (1984) reported that the water content is relatively low in Indian almond when compared with other common nuts such as cashew nut, almond nut (prunus amygdalus), groundnut etc. This indicates that the IA kernel will have good keeping properties too. Compared to other nuts Indian almond is rich in fibre and minerals Calcium and Iron.

Earlier study reveal that 100 g of cashew nut contains moisture 5.9 %, protein 21.2 g, fat 46.9 g, and fibre 1.3 g. Minerals like Calcium and Iron content in cashew is 50.90 mg and 5.81 mg respectively. The fat content in Indian almond is comparatively very low but high in other nutrients. The fat present in IA is of good quality. All nuts are considered as protein rich but here in the case of IA nuts, their protein content is rather high when compared to all the other popular nuts except ground nut. Soya bean considered as magic bean due to the high nutritional qualities is also compared with IA nuts for its nutritional composition. It is surprising to observe that when Soya bean has more protein and low fat, IA kernels are rich in carbohydrate, energy, fibre and minerals like calcium and iron. This indicates that IA kernels can be recommended as one of the best quality nuts along with the other

popular nuts. The American vegetarian food guide pyramid recommended nuts as a food to be included in daily diet.

It can be noted from the table that Indian almond is comparatively high in Protein than the other popular nuts. This agrees with the report given by Osagie (1998). Study by Ezeokonkwo and Dodson (2004) reported that the crude protein content of the IA seed is high (25.81 %) and the amino acid analysis showed a good pattern of the essential amino acids like leucine, isoleucine, valine, phenylalanine, tryptophan, methionine, lysine, threonine, histidine etc.

Compared to other popular nuts the carbohydrate content of IA kernels is high ie, 45.13 g. IA kernels are rich in energy too. 100 g of IA kernels give 499 kcal.

5.1.3 Organoleptic evaluation of Indian almond kernels

Organoleptic quality viz eating quality consists of judging quality of foods by means of human sensory organs eyes, nose and mouth. Sensory evaluation is designed to reflect common preferences to maintain the quality of food at a given standard, for the assessment of process variation, cost reduction, product improvement, new market development and market analysis (Manay and Shadakshraswamy, 2001).

Organoleptic quality plays an important role in evaluating the quality of a food product. For evaluating consumer acceptability, organoleptic evaluation of the food product is essential. Sensory evaluation technology is a method using skilled management and trained panelists to provide information on the acceptability of the product profile, consumer acceptability and consistency.

Earlier research and studies point out that incorporating nuts in the daily diet also contribute to the texture, flavour, aroma and taste of the food. Organoleptic

evaluation of fresh IA kernels and after different treatments were carried out by a panel of judges. The results indicates that oven drying has improved all the sensory attributes. Also the improved scores obtained by powdered kernels suggest the feasibility of developing flour from the kernels for further value addition.

The result of organoleptic evaluation of Indian almond kernels showed that the kernels scored high acceptability of 60% or more in all the attributes studied by obtaining a very high over all acceptability score. However, when differently treated kernels like roasted kernel, sun dried kernel and oven dried kernel were screened for acceptability, the highest score was obtained for oven dried kernels. The score obtained for oven dried kernels were 4.48 out of 5.00. Roasted kernels were also nearly as acceptable as oven dried kernel. Oven dried kernels secured higher score than sun dried kernels. So oven drying can be considered as the best and most acceptable method of processing the nuts. Also, the results pointed out that the acceptability of the nut increased on drying. Storage also seem to be improved the taste and colour. Also the kernels can be roasted and eaten or added to other preparations to enhance the taste and nutritive value.

The tasty kernels or nuts of tropical almond have traditionally been incorporated, albeit in modest quantities, into the diet of people in coastal areas throughout much of the Asia-Pacific region. In some areas the nuts are mainly a snack food consumed by children, with the fleshy fruit also sometimes being consumed. In other areas tropical almond nuts were highly regarded as a human food source (Evans, 1999). But in Kerala even where the nuts are abundantly available people are not aware of its delicious taste or high nutritional and therapeutic quality.

5.2 Processing and preparation of flour from kernels

Processing is a method of reducing post harvest loss of perishable foods like fruits, vegetables, oil seeds etc. Processing helps in increased shelf life and also value addition. Processed products are of immense value as technologies developed to increase the shelf life. Here an attempt was made to process Indian almond for product development. The kernels were first processed in to flour and the feasibility of preparing products using the flour was then tried out.

When the keeping quality of the kernels were studied it was found that the kernels can be stored for a period of two months without much difference in the acceptability. The moisture content of Indian almond kernels are comparatively lower than the other nuts, it has longer shelf life than other nuts. Therefore there is more scope for product development with shelf life stability using Indian almond. Hence it was decided to test the feasibility of processing the kernels with an objective to develop tasty preparation using the abundantly wasted but tasty and nutritionally rich IA kernels.

Drying and powdering is one form of processing that can add to the shelf life of a food. In this study the results of various drying methods given to kernels like sun drying, oven drying, roasting were studied. Oven dried kernels were found to be the most acceptable form. The developed flour was stored in air tight containers for further use. The shelf life of the flour was also tested to see how long this could be stored.

5.2.1 Quality assessment of the developed flour

It is necessary to assess the quality of a new product before developing into various products. Here the flour obtained was next assessed for its sensory

characteristics, nutritional and chemical composition, shelf stability, insect infestation and microbial growth.

According to Thakur et al. (1998) chemical and sensory changes are influenced by storage period and containers used for storage. The almond flour is stored in glass bottles under ambient and refrigerated conditions for a period of one month. Sensory characteristics like appearance, colour, flavour, texture, taste and over all acceptability were assessed using score card with the help of a panel of judges.

Organoleptic qualities of the developed flour were thus evaluated every day from the time the flour was prepared till it became rancid. The results revealed that under ambient condition for a period of two weeks the score was high (above 85 percent) revealing that the flour was highly acceptable through out the period and there was no deterioration during the period of two weeks storage. After that the flour showed deterioration and the score became lower in the organoleptic qualities and acceptability. In refrigerated conditions the flour was highly acceptable (85 percent) for a period of four weeks after that the flour become rancid. After repeated experiments and evaluation it could be concluded that the fresh flour could be stored for two weeks at ambient condition and for four weeks under refrigeration with out any change in sensory characteristics like appearance, taste, flavor and texture. Similar results were obtained in a study carried out on cashew kernels by Jisha et al. (2007). The study concluded that organoleptic characteristics of cashew kernel deteriorate with increase in humidity on exposure to air and moisture.

5.2.2 Shelf stability of the developed flour

Assessment of shelf life quality is important since it determines the suitability of a particular ingredient for product development (Livingston et al., 1993).

Shankar (1993) reported that factors like raw material quality, storage temperature, storage containers, process employed and the environment in which it is processed affects the shelf life quality.

Shelf stability of the developed flour was checked by analyzing the moisture content and peroxide value of the flour stored in glass bottles for a period of one month under ambient and refrigerated condition. The result of the study shows that peroxide value is not detected in the fresh samples. In the case of moisture, an important parameter in the shelf life quality, it was found to increase significantly with storage. Pandey (2002) reported that most of the stored products are considered to be safe when stored at particular moisture content. The moisture content of the fresh samples was found to be 3.7 percent, and the moisture content of the flour after storage in ambient condition was 3.82 percent and in the refrigerated condition 3.75 percent.

The extent of per oxidation in the stored flour were estimated. Peroxide value was high in the flour stored at ambient condition. The peroxide value of flour at ambient condition for a period of one month was found to be 3.43 percent where as in refrigerated condition peroxide value was not detected. The result of the study shows that shelf life is more for the flour stored in air tight glass bottles under refrigerated condition and that the flour thus stored can be kept for one month under refrigerated condition without any change in organoleptic qualities. The low moisture content of the flour is a good quality in improving shelf life of the flour. This is certainly an added quality in product development.

5.2.3 Insect infestation in stored flour

Insect infestation cause losses in terms of quality and quantity of food commodities and changes in the chemical composition affecting the nutritive value of

the products (Swaminathan, 1984). Insects are responsible for enormous wastage in stored products. They destroy a substantial quantity by spoilage and contamination with their droppings. No incidence of insect attack was observed in the Indian almond flour. Glass bottles consisting of Indian almond flour at ambient and refrigerated conditions were completely free of insect infestation even after storage period of one month. The studies conducted by Nasheeda (2006) in banana flour, Liya (2002) and Sini (2002) in tuber flours also observed the absence of insect attack after the storage period. The low moisture content of the IA flour enhance its storage period showing the flour has better shelf life quality than the flour obtained from other nuts.

5.2.4 Microbial growth in stored flour

Microbial growth in the Indian almond flour and kernels were also assessed after and before the storage period of one month. According to Shankaran (1993) several factors such as raw material quality, storage temperature, storage containers, and process employed and the environment in which it is processed will have an effect on the microbiological quality of processed foods.

Serial dilution method (Johnson and Curl, 1972) followed by spread plating was employed to detect the presence of microorganisms. In the present investigation as assured, the microbial load was found more in stored flour compared to the fresh flour. It was observed that in all media fresh samples were free of microbes. Among the stored samples microbial growth was observed after a period of one month.

Highest bacterial growth was observed in Indian almond flour stored for a period of one month ($4x10^{-6}$). Microbial analysis of kernel showed that the fresh kernels were not attacked by bacteria. But the kernel stored for one month showed two colonies of bacteria. In fresh kernels and flours microbial growth was lower

compared to the stored kernels and flours. According to Nimmy (1996) prescribed bacterial count per gram should not exceed 50, 000 and the count for yeast and mould should not exceed ten per gram. Here it was much lower than the acceptable count confirming the long shelf life quality of the flour.

5.3 Product Development

Most plant foods are seasonal and due to its perishable nature most of them are wasted abundantly. Indian almond is one such unexploited nut which is largely wasted. Many are not aware of the nutritious or therapeutic values of the nut. If value added products using Indian almond are developed and popularized, its consumption can be improved and wastage reduced.

The development of complementary food should be governed by the principles namely good supplementary value, acceptability, ease of preparation, low cost, long shelf life and local availability of ingredients (Devdas, 1998). Feasibility of incorporating the developed Indian almond flour into conventional ready to serve preparations following different cooking methods like boiling, roasting, frying and baking were tried and the preparations like soup, drink and snacks were prepared and their acceptability was rated through sensory evaluation. A four point score card was used for acceptability test. Parameters like appearance, flavour, texture, taste and overall acceptability were considered in evaluating the quality aspects. Different proportions of the flour were incorporated or partially substituted for other materials in the selected standard recipe and the most acceptable combination was selected. The recipes selected were a soup, a drink - milk shake, a sweet - maladu, a snack - pakkavada, baked items - cake and biscuit and boiled item - a curry. Results indicate that all the products prepared were highly acceptable, in fact as acceptable or better than the respective controls.

Product diversification is the need of the hour due to rapid changes in socio economic and living styles of people dwelling in the rural and urban areas, as a result more and more convenient foods are entering the market.

Indian almond flour (15 percent) incorporated vegetable soup was prepared and compared with standard vegetable soup with out almond flour. Soup is a liquid food that is made by combining ingredients such as meat or vegetable stocks in hot or boiling water until the flavor is extracted, forming a broth. Almond incorporated soup was more acceptable than the control sample. This indicates that incorporation of IA flour contributes to the texture, flavor and taste. Considering the protective and therapeutic values of the soup incorporating the kernel flour can be recommended for aged and invalids too.

Milk shake is a milk added beverage which has thirst quenching properties. Srivatsa et al. (1978) reported that though beverages are low in food value their popularity persists due to its thirst quenching properties. Milk shake was prepared incorporating 20 percent, 15 percent and 10 percent of Indian almond flour and sensory evaluation was done. Among the three proportion tried, the best combination was identified based on the over all acceptability score. From the study it was found that the milk shake prepared with 20 percent almond flour is more acceptable than other combinations of milk shake. The least acceptable milk shake contained only 10 percent of almond flour. Statistical analysis indicated significant difference in taste and consistency between the products. Once again the results proved that Indian almond flour has enhanced the taste and consistency of the products.

Maladu is a traditional confectionary of South Indians prepared using Roasted\puffed Bengal gram, sugar and ghee. Maladu prepared with different proportions of IA flour (30 percent and 50 percent) substituted for bengal gram were compared for sensory qualities and blended with other ingredients as in the standard

recipe and the confectionery maladu was prepared. Maladu prepared by incorporating 50 percent of almond flour was most acceptable. Though comparatively more score was obtained in all attributes studied significant difference was seen only for appearance indicating that kernel flour has enhanced the appearance more than other qualities.

Pakkavada is a popular easy to prepare savoury using the cooking method deep frying. The ingredients used for the preparation are bengal gram powder, rice flour, IA flour, salt and spices. The preparation with 25 percent Indian almond flour was more acceptable than other preparations as it scored more in all the quality characteristics studied. Statistical analysis showed significant difference in all the qualities except texture. For texture the score is much lower than the other combinations. The texture was slightly harder than the other two. The high fibre in the flour may be one of the reasons for its hardness.

During last two decades, snack and convenience food market has witnessed a very rapid growth all over the world. As reported by Arnold (1982) biscuit is essentially a bakery confectionary dried down to low moisture content. It is made from soft flour, mostly rich in fat and sugar and with high energy content. Bakery products, especially soft dough biscuits command wide popularity in rural as well as urban areas in India among the people of all age groups (Agarwal, 1990). Different proportions of Indian almond flour 20 percent and 30 percent were partially substituted for maida and blended with other ingredients as in the standard recipe. This was compared with the product prepared with out incorporating almond flour. The biscuit prepared with 30 percent IA flour was more acceptable. Statistically significant difference was obtained for all the qualities except colour and flavour. It could be noted that substituting with more IA flour has not affected the taste or texture. But in a study where biscuit fortified with different proportions of beetroot powder was prepared, the hardiness and breaking strength increased with increased

addition of beetroot powder (Mridula et al. 2009). But here no such difference was noted. In fact when more kernel flour was added more acceptable was the texture and taste.

Almond incorporated cakes were prepared and the acceptability score was rated through sensory evaluation. Cakes are not only sweet but also light and delicate among all the baked products. In the preparation of cake different proportions of Indian almond flour 15 percent and 20 percent was partially substituted with the flour used in the preparation of cake and then the mixture was blended with other ingredients in the standard recipe. Results revealed that where only 15 percent of kernel flour was added, the cake was more acceptable in all the qualities except colour when compared with the cake 20 percent IA flour was added. However, additional kernel flour has enhanced all the qualities and the cake was more acceptable than the control sample confirming the fact that whether biscuit or cake method of baking is quite suitable and the baked products using the IA flour is very much acceptable.

Indian almond incorporated tomato curry was prepared and it was compared with control. Almond incorporated curry secured the highest score. Almond incorporated curry secured highest score in all the sensory attributes studied, revealed a significant difference at 5 percent level than the control. This confirms that IA flour not only adds to the nutritive quality but also enhances aroma, taste, consistency and acceptability of the product.

In a similar study jackfruit seed flour prepared from under utilized jack fruit seed was successfully used to produce value added acceptable products (Prathima et al. 2009). Jack fruit seed flour substituted products like soup, custard with fruit salad and baby corn manjurian were found to be as acceptable as their respective controls. But in the present study delicious kernel flour revealed significant improvement in the

organoleptic qualities in all the products studied using different cooking methods revealing higher acceptability. This confirmed the feasibility of preparing value added products from IA kernels which not only add to the acceptability but also the nutritive value.

5.3.1 Nutritive value of the developed products

The nutritional quality of the developed products such as soup, milk shake, maladu, Pakkavada, Biscuit, cake and curry were evaluated based on the content of major nutrients such as Energy, Carbohydrate, Protein and fat using the nutritive value table (Gopalan et al., 1992). From the nutritive value computed it is confirmed that the addition of Indian almond flour to the standard recipes has certainly added their nutritional quality.

5.3.2 Cost of the developed products

The cost of the developed products were calculated on the basis of the market value of ingredients used to process 100 g of the products. The cost calculated includes the cost of raw materials and overhead charges needed for the processing. And these products are compared with the same preparations using cashew nuts and almond, which is on par with the IA kernels in taste and nutritive value. The cost of the product prepared using IA kernels are much cheaper but not much difference could be noticed than the control samples with out adding IA flour. The abundantly available Indian almond not only enhances the quality of the product but is also cheaper compared to other nuts. The cost of the same products using almond and cashew nut were worked out and compared with Indian almond based products. Results shows that compared to almond based and cashew based preparations the cost of IA based are much less. So the IA based preparations were economically feasible too. Thus the experimental trials confirm that flour from the extracted kernels can be

used successfully in producing value added products which is tasty, nutritious and economically viable too.

5.3.3 Formulation of health drink mixes

The Indian almond is rich in nutrients and is available throughout the year and is cheaper compared to other protein rich nuts. Hence it was proposed to develop a health beverage using the nuts which is suitable for all groups including children, invalids, adults and aged. In order to prepare a health beverage, first it was decided to prepare an instant mix initially which has keeping quality and can be made into a beverage or other preparations whenever necessary. A convenient mix like this can be a blessing to today's busy population particularly woman and aged. Accordingly, Indian almond based health mix was formulated and standardized.

Standardization of recipes is an essential thrive for the development of high quality products. Poduval and Pillai (1998) opined that one of the foremost purpose of standardization is to facilitate the movement of materials and products though all stages of production in any industrial activity starting from the raw material to the finished product, then to the dealer and finally to the retailers and consumers.

Studies done by Christian and Ukhun (2006) on the nutritional profile of the nut of Indian almond reported that the nut is a rich source of macro and micro nutrients particularly Carbohydrates, Proteins, Fibre, Fat, Vitamin-A, Vitamin-B, Vitamin-C, Nitrite, Calcium, Phosphorus, Iron etc. Also studies have proved the therapeutic and protective properties of IA fruits and kernels. In the present study Indian almond kernels were put to effective utilization by converting them to flour and incorporating flour in formulating nutrient rich health mixes.

Due to rapid industrial growth and urbanization there has been an ever increasing reliance on formula foods, health mixes and instant foods both in

developed and developing countries (Mathur, 1991). Health mixes also provide energy, essential vitamins and minerals required for growth of children and adolescents, as well as for pregnant and lactating mothers. It is a complete food in itself which can be taken by all categories of people including vulnerable groups. Such a health mix was popularized and standardized.

According to Thirumaran (1993) the introduction of locally processed and preserved nutritious ready to use foods will reduce the drudgery of the farm women along with income generation and improved nutritional standards. In the present study it was decided to develop a health mix which can be converted to a health drink whenever required. Such a convenient mix will be more acceptable.

Six combinations of health mix were first formulated incorporating IA flour as the base. The standard nationally and internationally recommended food group plans were taken as the basis for the formulation of the mixes. The four food group plan, the Food square and the Food guide pyramid recommended for vegetarians formed the basis for selection of food materials for the formulation of the health mix combinations. From among the six combinations two most acceptable mixes were selected using organoleptic evaluation, chemical and amino acid score and by computing the nutritive value.

5.3.3.1 Preliminary processing of raw materials

Indian almond flour

IA flour was prepared in the laboratory by powdering dried kernels of Indian almond.

Soya flour

Incorporation of defatted soya flour in diets will not only enhance the protein content of the diet but also would raise its nutritive value (Anila et al. 1994). Soya flour required for the study was prepared from soya chunks, which is purchased from local market. First the soya chunks were dried in oven for 15 minutes at 60^0C and powdered using a mixer. Then sieved using 60 mesh sieve to get fine flour.

Ragi

Ragi is not only rich in energy and carbohydrate but also is a good source of minerals iron and calcium. Ragi was introduced due to its nutritional quality and digestive properties. Ragi was purchased from local market, removed the dirt, washed, dried and powdered. Then sieved to get fine flour. More over, ragi is rich in minerals and fibre and it also easily digestible. Hence ragi was selected as one of the ingredients for the health mix.

Banana powder

Banana has a special value in the human diet, as they are rich source of energy and contain all the nutrients including minerals and vitamins (Bose and Mitra, 1990). Hence banana was also selected as one of the ingredients for the preparation of health mix. Raw banana was purchased from local market peeled, sliced, dried and powdered.

Amaranthus

For vitamin and mineral supplement, locally available green leafy vegetable amaranthus was selected. Fresh amaranthus was purchased from local market and cleaned thoroughly. The leaves were removed from the stalk and dried in the oven.

The thoroughly dried amaranthus leaves were powdered using a mixer and sieved through muslin to get fine flour.

Milk powder

Milk powder was selected particularly to enhance the flavour, taste, nutritive value and texture of the health mix. Skimmed milk powder needed for the study was purchased from the local market. Skimmed milk was selected as it is low in fat.

In all the six mixes locally available food materials were added. As suggested by Manday et al.(1989) the use of locally available protein rich resources which includes wheat, rice and soyabean are good for manufacturing low cost protein supplements. In all the mixes defatted soya flour was added. Soya protein, a high quality plant based protein was successfully incorporated in food supplements developed by Nirmala (2002) and Dhanya (2005). Here skimmed milk powder was also added to improve the nutrient content and taste at the same time to control fat. Dijkhaizen (2000) had supported the addition of skimmed milk powder to improve the flavour of the supplements. Neelofar (2004) in her research work had also used milk powder in the mixes to improve the taste and nutrient content of the health mixes prepared and standardized.

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

5.3.4 Selection of best combination of health mix

From the six combinations of health mix the most acceptable was selected. Each combination was organoleptically tested by a panel of judges for quality attributes such as appearance, colour, taste, flavour, texture and over all acceptability. Colour influences the acceptability, choice and preference of food. The natural colour of the prepared health mixes ranged from cream to yellowish colour. This was found to be quiet acceptable and so no artificial colour was added to the health mixes.

According to Birch et al. (1988) flavour is mingled but unique experience of sensation produced by a material taken in the mouth perceived principally by the senses of basic smell and by other cutaneous smell in the mouth. Earlier it has proved that addition of IA flour has enhanced the flavour of the value added products prepared incorporating the flour. The health mixes prepared also have a pleasant aroma

The results of the organoleptic evaluation of the health mixes show that highest score was obtained for the health mix combination with ingredients IA flour, ragi powder, soya flour, amaranths and skim milk powder in the proportion of 11:2:2:1:4 and combination with the ingredients IA flour, banana powder, soya flour, amaranths and skim milk powder in the proportion of 10:2:2:1:5.

Chemical score and nutritive value of the health mixes were computed to determine the quality of the health mixes. Amino acid and chemical score were computed since they would give an indication of the protein quality which can be used as a proxy for biological assays. The chemical score of the selected health mix combinations were found to be 85.24 and 88.35.

The nutritional superiority of the mixes was evaluated based on the content of the major nutrients such as Energy, Protein, Carbohydrates, Fat, Iron and Calcium. Results of the study shows that the selected two health mixes were nutritionally superior than the other combinations. The nutritional qualities of these two mixes were then compared with other health mixes available in the market and this was found to be on par with or better in all the nutrients studied. This suggests that the IA based health mixes formulated can be taken as a health food like any other food.

5.4 Development of Health drink

Sharma (2004) reported that functional drinks comprising of enriched beverages, sports drinks, energy drinks and nutraceuticals are increasingly attracting the attention of 18-44 year old consumers looking for a healthy life style. But a variety of other drinks which are abundantly available in the market very attractive to see but not good for health and more popular among the adolescents and youngsters. If enriched beverages or health drinks which are tasty and appealing are made available in the market and popularized for its health benefits can attract the young population too. Hence using the two selected health mixes health drinks were prepared and standardized.

5.4.1 Standardization of Health drink

Standardization of recipes is an essential thrive for the development of high quality products. Poduval and pillai (1998) opined that one of the foremost purpose of standardization is to facilitate the movement of materials and products though all stages of production in any industrial activity starting from the raw material to the finished product then to the dealer and finally to the retailers and consumers.

Different methods of preparation of health drinks were tried out. The methods tried for the preparation of health drink include mixing of health mix in hot water or cold water or boiling for three minutes. The most acceptable method of preparation of health drink was found to be boiling and that was selected for the final preparation of health drink and accordingly a health drink was standardized from each of the two selected health mix combination.

5.4.2 Comparison of health drink prepared with other beverages available in the market

The prepared health drink was organoleptically tested by a panel of judges for quality attributes such as appearance, colour, flavour, taste and over all acceptability. Then the prepared health drinks were compared with other health drinks available in the market. The health drinks prepared were compared with Horlicks and flavoured almond drink available in the market. The drink prepared from almond mix available in market scored more where as health drink prepared using the Indian almond health mixes scored slightly less. The health drink where banana flour was added scored better than health drink where ragi flour was added. The suggestions and comments given by the judges stated that as colour and flavour is added in the flavoured almond mix, the drink was more acceptable. The Indian almond based drinks with its original colour and flavour with no additional flavour or colour added was equally acceptable. But the judges recommended that flavour like cardamom or vanilla can be added to enhance flavour and can be used as flavoured drink, but there is no need to add colour, as the original colour is quite acceptable.

5.4.3 Acceptability evaluation of the health drinks

If a food supplement satisfies all the nutritional characters, it will not be popular if it lacks acceptability. Hence the drinks were further evaluated by ten

mothers and fifteen children. Results of the study show that the health drinks were very much acceptable to both the children and mothers.

5.4.4 Cost of the standardized health drinks

In order to assess the economic feasibility of the developed health drinks the cost was calculated on the basis of the market value of ingredients used and also the overhead charges needed to prepare 1 litre of health drink and then the cost of one serving of drink was worked out. The results shows that the cost needed to prepare 200 ml of Indian almond incorporated health drink I & II was Rs.16.50/- and Rs.15.00/- respectively. The cost of other health drinks available in a market range from Rs. 20-25/- per cup and this indicates the scope for profitable commercial potential.

5.5 Different products prepared incorporating the health mix

Feasibility of incorporating the health mixes in popular recipes were also tried out by incorporating the selected health mixes in standard popular recipes and the acceptability of the products were organoleptically tested by a panel of judges. The products prepared included Health porridge, Milk shake, Maladu and Pakkavada. All the products were very much acceptable though prepared health porridge was more acceptable than other products. The lowest score was obtained for Pakkavada.

Also the suitability of incorporating the health mixes in popular break fast preparations were tried out and the results indicates that popular preparations like dosa, puttu, idiappam, kozhukkatta can be prepared. But in the case of chapathi it was found that it was slightly leathery and not so soft. Results indicate that the standardized health mixes can be used in preparing a variety of dishes successfully. The health mix can be strongly recommended for invalids or aged because the health

mix not only enhances taste and nutritional quality but also renders variety in their diet.

5.6 Development of suitable device for the recovery of kernel

The difficulty to recover the kernel from the hard stony and fibrous Indian almond fruit poses a problem for its utilization. Hence exploring the possibility of developing a simple tool or technology to separate the kernel could be a boon to the farm households, women and children alike.

For the conduct of the present study an improvised simple and easy to handle device for recovering the kernel from the fruit was developed and used for the project. As part of the study two tools were developed. First one was a handy device made by placing a freely moving knife on a wooden surface. Another tool was made using Rute and Pine mechanism. This was fixed on a table. The first one as a portable device while the second one is fixed on a table.

5.6.3 Effectiveness of the developed tool

Effectiveness of the developed tools were determined by checking the kernel recovery in unit time from each tool. Number of kernels extracted in one hour from each device is determined. The kernel recovery from each tool is checked by five persons and the average values were taken. The results of the study shows that using the tool we can extract above 60 kernels in one hour ie, 1 kernel in one minute. The number can be increased with practice. Also the tools prepared were easy and safe to handle and can be safely operated by children, women and adults alike.

The research study done to find out the quality characteristics of IA and the feasibility of preparing value added products using IA revealed fruitful results.

Assessing the quality characteristics of IA kernels proved that the kernels are nutritionally very rich, is delicious and has good keeping quality. The most feasible method of extraction of the kernel without breaking was standardized and two tools were fabricated to help in the extraction of kernels and to reduce the labour. Using the tool one kernel can be extracted in every minute which can be increased with practice. IA kernel flour was standardized and value added products were prepared by incorporating different proportion of the developed flour. Assessment of the quality characteristics of the products revealed that they are highly acceptable, nutritionally rich and economically feasible. Also a health mix using the kernel flour was standardized. Using the health mix also different products were tried and they were found to be highly acceptable.

SUMMARY

6. SUMMARY

The study entitled 'Feasibility of utilizing Indian Almond (*Terminalia catappa* L.) for value addition' was conducted at College of Agriculture, Vellayani. The major objective of the study was to assess the quality characteristics of Indian almond kernel and to find out the feasibility of utilizing the kernel for product development.

Physical characteristics and the nutritional and chemical composition of the fruits and kernels were determined. Also characteristics like organoleptic quality and nutritional composition were assessed through standard techniques. Fruit characteristics like length, breadth, weight and volume of both fruits and kernels of Indian almond were studied and the results show that the average length of Indian almond fruit is 5.52 cm and breadth 3.55 cm while average weight of Indian almond fruit is found to be 4.17g. When the volume was measured, the average volume was found to be 5.05 ml. In the case of kernels the average length is 2.62 cm while average breadth is 1.4 cm. The average weight is 0.54 g and the average volume of the Indian almond kernel is found to be 0.22 ml.

The chemical and nutritional composition of the Indian almond kernels were ascertained by estimating selected nutrient and nonnutrient content. Standard laboratory techniques were followed to assess the Moisture, Total fibre, Protein, Fat, Calcium, Iron, Vitamin-C and Acidity of the kernel. The result of the study reveals that the moisture percentage of Indian almond kernel is 3.78%, total fibre 3.57 g, percentage of protein in the sample is found as 21.58 g and the fat content as 25.9 g. The ash content is 0.04%. Micro nutrient analysis reveals that minerals like Calcium and Iron were 320 mg and 4.00 mg respectively. Total Carbohydrate and Calories were computed and the results are found to be 45.00 g Carbohydrate and 500.00 kcal

of Energy. The nutrient content of the IA kernels were comparatively higher than other popular nuts.

In order to assess the organoleptic qualities of Indian almond kernel, they were subjected to organoleptic evaluation using a score card by a panel of 10 judges. Five characters namely appearance, taste, colour, flavour and texture of the kernels such as fresh kernel, roasted kernel, sun dried kernel, and oven dried kernel were evaluated using sensory evaluation. Overall acceptability score of different kernels ranged from 4.06 to 4.48 out of the maximum score of 5. Oven dried kernel has secured highest score of 4.48 and the least score was obtained for fresh kernel 4.06. Thus the results revealed that fresh kernels as well as dried kernels were equally acceptable.

Since the objective of the study is to try the feasibility of product development from Indian almond, it was primarily processed in to flour. In order to develop product from Indian almond the fruits of Indian almond were collected and sun dried for two weeks. Then the kernels from the fruits were extracted using the handy device developed for the purpose. The extracted kernels were then dried in hot air oven for 20 minutes at 80^0 C. Then the brown colour covering of the kernels were removed and the kernels were powdered with the help of a mixer. The flour was next sieved and stored in air tight containers. The quality parameters such as sensory characteristics and shelf stability of the developed flour were assessed using standard techniques. Insect infestation and microbial growth analysis of the stored flour was studied initially and also after one month of storage to assess the shelf life while sensory characteristics were studied through organoleptic evaluation done by a panel of judges.

From the study it was found that the shelf life of the kernel flour in ambient condition was two weeks. After two weeks the organoleptic qualities were reduced.

Shelf life of almond kernel in ambient condition is three weeks and after that the organoleptic qualities started reducing. For a period of one month we can store the kernel flour under refrigerated conditions and the kernels can be stored for more than five weeks under refrigerated conditions.

Shelf stability of the developed flour was checked by analyzing the moisture content and peroxide value of the flour stored for a period of one month in glass bottles under ambient and refrigerated condition. Peroxide value is detected only in flour stored for one month. Under refrigerated condition peroxide value was not detected even after one month of storage. Moisture content increased in kernels and flour after storage under ambient and refrigerated conditions. The results indicated that refrigerated condition is more suitable for the storage of Indian almond due to absence of rancidity. The incidence of insect attack was not found during or after one month's storage period. But the microbial load was found more in stored flour compared to the fresh flour. Bacterial growth was observed to increase with storage and higher growth was observed in almond flour stored for a period of one month ($4x10^{-6}$).

Feasibility of incorporating the developed Indian almond flour into conventional ready to serve preparations like soup, beverage and snacks were tried and their acceptability was rated through sensory evaluation. The scores obtained were statistically analyzed. The results reveal that the prepared products are highly acceptable. Cost and nutritive value of the products were computed and it was found that the prepared products were nutritionally rich and economically feasible.

Standardization of a health beverage is another objective of the study. In the present study Indian almond kernels were put to effective utilization by converting them to flour and formulating nutrient rich value added health mixes which can be used at any time to prepare a health drink. Using the flour 6 combinations of health

mix were prepared with Indian almond as the basic ingredient. Other ingredients used for the formation of health mix included Soya, Ragi, Banana powder, Amaranthus and Milk powder. The ingredients were selected based on 'Food square' and the food group 'Basic four'. From among the six combinations, two most acceptable mixes were selected using organoleptic evaluation, chemical and amino acid score and by computing the nutritive value. The suitability of preparing a drink using the two selected combinations were next tried out. For the preparation of health drink different cooking methods were tried out. The most acceptable method of preparation was boiling and that was selected for the final preparation of health beverage. Then the cost of the health drinks prepared was also computed. Results showed that health beverages prepared were economically feasible indicating commercial prospects.

The selected health drinks were compared with other popular health drinks available in the market. Here the prepared health drinks were compared with Horlicks and flavoured Almond mix available in market using sensory evaluation done by a judging panel. Good acceptability scores were obtained for the health drink prepared using Indian almond health mix.

Acceptability evaluation of the health drink was carried out through sensory evaluation done on a group of 10 mothers and 15 children. Results of the study showed that the health beverages were equally acceptable to both children and mothers. The drinks were found to be very tasty, highly nutritious and easy to prepare using the health mix. Also the drinks were equally acceptable when hot or as cool drinks.

Using the two selected health mixes with ragi and banana, different popular recipes like health porridge, milk shake, maladu and pakkavada were prepared and acceptability was rated through sensory evaluation. The results of the study showed that the prepared products were highly acceptable indicating that the health mix can

not only be used for the preparation of a health drink but also can be used for the preparation of other recipes.

The difficulty to recover the kernel from the hard stony and fibrous fruit poses a problem for the utilization of Indian almond. As part of the study two tools were fabricated. First one is a portable device made by placing a freely moving knife on a wooden surface. Another tool is made using Rute and Pine mechanism which is fixed on a table. Effectiveness of the developed tools was determined by checking the kernel recovery in unit time from each tool. Number of kernels extracted in one hour from each device was determined. The kernel recovery from each tool was checked by five persons and the mean value was taken. The results of the study showed that using the tool above 60 kernels could be extracted and both the tools developed are easy to operate and can be handled easily and safely by children, women and adults.

Indian almond though edible is abundantly wasted nut that still remains unexploited and under exploited. The result of the study shows that the nut is a rich source of nutrients such as protein, fat, fibre and also rich in the minerals iron and calcium. The flour and health mixes prepared were also nutritionally rich. Using the Indian almond kernels, delicious highly acceptable and nutritional products can be prepared. Processing of Indian almond should be taken up to commercial level in order to avoid wastage. The tool prepared will be an added boon to reduce the drudgery in extracting the kernels. The technologies developed need to be transferred and popularized to get the expected results. Steps should be taken in the direction to popularize the nuts and its products. Also further research can be taken up to popularize the therapeutic qualities of IA kernels.

REFERENCES

7. REFERENCES

Achu, M.B., E. Fokou, C. Tchiegang, M. Fotso and Tchouanguep., F.M. 2005. Nutritive value of some cucurbitaceae oilseeds from different regions in Cameroon. Af. J. Biotechnol., 4: 1329-1334.

Agarwal, S.R. 1990. Prospects for small scale biscuit industry in the nineties. Indian Fd Ind. 29(3): 19-21.

Anand, K.J. 2000. Food processing in India. Indian Fd. Ind. 19(6): 85-90.

Anila, E., Frvir, E.L. and Priya,S. 1994. Importance of antinutritional components in soya bean foods.Crit. Rev. Sci. Nutr. 34(1): 31-37.

A.O.A.C. (1980). Official methods of Analysis 13th ed. Association of Official Agricultural chemists, Washington, D.C., 20044.

Arnold, E.B. 1982. Dictionary of Nutrition and Food Technology. Butterworth and Co. Ltd. Trowbridge, Wilts, 350 p.

Bhattachargee , M. and Bhole, N.G. 1999. The keeping quality of wheat flour in different packaging materials. Food Nutr.Bull. 6:81-83.

Birch, G., Lee, C.K. and Ray, A. 1988. The chemical basis of bitterness in sugar derivatives. Sensoring properties of foods. Applied Science Publications Ltd, London, P.17.

Bose, T.K and Mitra, S.K. 1990. Fruits – Tropical and Subtropical. Naya Prakash. Calcutta. P. 243.

Chen, P.S., Li, J.H., Liu, T.Y. and Lin, T.C. 2000. *Terminalia catappa* and its major tannin component, punicalagin, are effective against bleomycin-induced genotoxicity in Chinese hamster ovary cells. *Cancer Lett.* 152:115-122.

Chitmanat, C. 1998. Targeted Screeing of Medicinal and Aromatic Plants. ISHS Acta Horticulturae 678, III WOCMAP Congress on Medicinal and Aromatic Plants, Vol.4 Economics and Law

Christian Agatemor., and Mark, E. Ukhun., 2006. Nutritional potential of the Nut of Tropical Almond (Terminalia Catappa L.)., Pakistan J. Nutrition 5(4) :334-336,2006.

Chyau, C. C., Ko, P. T., Mau, J. L. and Ka, M. D. 2000. Antioxidant activities of Terminalia catappa L. leaf extract. Dept. of Food Nutrition, Hung- Kuang Institute of technology, Tachung 433, Taiwan, ROC

Devdas, R.P. 1998. Local strategies to support child nutrition. Nutr. Res. 18 (2): 233-239.

Dhanya, J. 2005. Developing rice based complimentary food for infants. M.Sc. thesis, Kerala Agricultural University, Thrissur, p.105.

Dijkhaizen. 2000. Processed complimentary foods in the World food programme. Food and Nutrition Bulletin. 21: 62-64.

Evans, B. R. 1999. Edible nut trees in Solomon Islands: A variety collection of *Canarium, Terminalia* and *Barringtonia.* ACIAR Technical Report 44. Australian Centre for International Agricultural Research, Canberra, Australia.

Ezeokonkwo, C. A. and Dodson, W. L. 2004. The potential of Terminalia catappa (Tropical almond) seed as a source of dietary protein.*J.food quality* , vol. 27, pp. 207219

Ezeokonkwo, C.A. 2007. Comparative Effects of Dry- and Moist-Heating Treatments on the Biochemical Characteristics of Terminalia catappa L. Seed. Food Science and Technology International, Vol. 13, No. 2, 165- 171.

Fan,Y.M., Xu, L.Z., Gao, J., Wang, Y., Tang, X.H., Zhao, X.N., Zhang, Z.X. 2004. Phytochemical and antiinflammatory studies on *Terminalia catappa.* Fitoterapia, 75(3-4): 253 – 260

Gopalan, C., Ramasastri, B.V. and Balasubramanyam, S.C. 2003. Nutritive value of Indian Foods. NIN. ICMR, Hyderabad, P.47.

Gopalan, C., Ramasastri, B.V. and Balasubramanyam, S.C. 1992. Nutritive value of Indian Foods. NIN. ICMR, Hyderabad, P.47.

Gustafson, 1999. Almonds. Weider Publications, P.34.

Harrington, K. 1991. Sensory evaluation or getting the taste right. Dairy Ind. Int.56: 31-32

Hu, F.B., Stampfer, M.J.1999. Nut consumption and risk of coronary heart disease: a review of the epidemiologic evidence. *Current Atherosclerosis Reports* 1:204-209.

Iyengar, v.1998. Zinc as a nutrient. Indian cashew J.,vol XXIII,No.2, 3-5.

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice Hull of India (Pvt) Ltd, New York, p. 62-65.

Jisha, K.G., Rekha, R. and Padma, N. 2007. Changes in Protien, Carbohydrates and Lipid content of Cashew kernels during storage under two humidity conditions. Ind. Cashew.J. Vol.XXIII No.2. P.11-13.

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

Karen,J.S., Sabate,J., Sujatha, R and Fraser,E. 2004 Long-term almond supplementation without advice on food replacement induces favourable nutrient modifications to the habitual diets of free-living individuals. British *Journal of Nutrition*, 92, 533-540

Kawale, N.P.1997. Quality control through standardization. Lecture delivered to the participation of short course on 'Recent developments in grain processing', 4-23 August 1997. College of Home science, Acharya, N.G., Ranga Agricultural university, Hyderabad, 6p.

Kris-Etherton, P.M., Yu-Poth, S., Sabate, J., Ratcliffe, H.E., Zhao, G., and Etherton, T.D. 1999. Nuts and their bioactive constituents: Effects on serum lipids and other factors that affect disease risk. *The American Journal of Clinical Nutrition* 70*(3S)*:504S-511S.

Leon, S.Y.1990. Desiccated coconut, copra, dehydrated edible coconut meat, coconut flour, coconut as Food. Coconut Research and Development Foundation, INC.,Philippine, pp.76-86.

Livingstone, A.S., Feng, J.J and Malleshi, N.G. 1993. Development and Nutritional quality evaluation of weaning foods based on malted, popped and roller dried wheat and chick pea. Int. J. Fd. Sci. Tech, 28: 35-43.

Liya, S. 2002. Value addition and evaluation of Nutritional quality of Taro. M.Sc. thesis, Kerala Agricultural University, Thrissur, p. 114.

Malhothra, S. R., Sigh, S., Sharma, A., and Bhama, S. 2004. Nutrient composition of selected traditional sweets based on nuts and oilseeds commonly consumed in Himachal Pradesh. J. Food Sci. Technol., Vol.41, No.2, 205-207.

Mallaya, R.R. 2003. Recent trends in Food industry with special reference to fruits and vegetables. Indian Fd. Ind. 22(1): 45-48.

Manay, N.S. and Shadakshara Swamy, M. 2001. Food facts and principles. Second edition, New Age Intenational (p) Ltd., New Delhi, 525 p.

Manday, K.L., Godbar, J.S., Dabanaj, S.N. and Rao, R. 1989. Processing characteristics of long grain grown under sprinkler of food irrigation. Cereal chen. 66(1):42-46.

Masuda, T., Yonemori, S. (1999). Evaluation of the antioxidant activity of environmental plants: Activity of the leaf extracts from seashore plants. Journal of Agricultural and Food Chemistry. April 47(4): 1749-1754.

Mathur, T.R. 1991. Importance of functional foods in Indian diets. Indian Fd. Pack. 45: 12-16.

Mohale,D.S., Dewani, A.P., Chandewar A.V., Khadse, A.S. Tripathi1,S.S and Agrawal,C.D.2009. Brief review on medicinal potential of Terminalia catappa. J.Herbal medicine and Toxicology. 3 (1) 7-11

Morioka, T ., Suzui, M ., Nabandith, V ., Inamine, M ., Aniya, Y .,Nakayama, T ., Ichiba, T., Yoshimi, N 1. 2005. Modifying effects of Terminalia catappa on azoxymethane-induced colon carcinogenesis in male F344 rats. European Journal of Cancer Prevention.14(2):101-105.

Mridula, D., Naveen, K.M.,Dilip, J., Tyagi, S.K. and Rai, D.R. 2009. Effect of addition of beetroot powder on physical properties and acceptability of defatted soya flour fortified biscuit. Ind.J.Nutr. Dietet. 46, 59-69.

Naik, R. K., Bharate, p., Kulkarvi, L. and Rokhade, C. 2004. Value addition to under utyle food for nutritional security. In: Scientific programme, Abstracts of talks and Abstracts of posters, Nutrition Society of India, XXXVI Annual food; 5–6, Nov: 2004, Mysore, City of Mysore. P.91. Abstract No. C.N.70.

Nagappa,A.N., Thakurdesai, P.A.,VenkatRao, and Jiwan Singh. 2003. Antidiabetic activity of Terminalia catappa Linn fruits. J. Ethnopharmacology, vol.88 :45-50

Nasheeda, K. 2006. Developing multi purpose convenience mix from selected Banana varieties. M.Sc.thesis, Kerala Agricultural University, Thrissur, p 268.

Nayar, K.G. 2009. Foods for thought, Nuts for you. Indian cashew J.,vol XXIII,No.2, P1.

Neelofar, I.K. 2004. Developing value added and diversified products from coconut (Cocos nuciferaL.). Ph.D. thesis, Kerala Agricultural University, Thrissur, p.268.

Nimmy, T. 1996. Sanitary quality and adulterants in selected processed foods. M.Sc. thesis, Kerala Agricultural University, Thrissur, p.98.

NIN, ICMR, 1984. Nutritive value of Indian Foods. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India.

Nirmal, C. Punia, D. and Punia, R.K.1999. Emergency preference of processing foods among the working and non working women. Dairiying foods and Home Science. 28(1): 45-48.

Nirmala, C. 2002. Impact of soya enriched food supplement on nutritional status of women beneficiaries of ICDS. Ph.D. thesis, Kerala Agricultural University, Thrissur, p.295.

Osagie, A.U. 1998 Antinutritional factors. In: *Nutritional Quality of Plant Foods.* (A.U.Osagie and O.U. Eka eds). Published by Post Harvest Research Unit, University of Benin, Nigeria. Pp. 221 –224.

PAG. 1975. PAG Guidelines on protein rice mixture for use as supplementary foods. PAG Guidelines No.8. Protein Advisory Group Compendium, 256 p.

Pandey, H. 2002. The complete technology at book on snack foods. National Institute of Industrial Research. New Delhi, 304 p.

Poduval, S. and Pillai, A.M. 1998. Technologies on Coconut processing Constraints and Future strategies. National Seminar on status and prospects of coconut based industries. 20th to 21 st May 1998 at Goa. Small industries service Institute, Goa, pp.48-53.

Prathima, B., Venkatesh, I. and Padma, M. 2009. Value added products from jack fruit. Ind.J.Nutr. Dietet. 46, 72-75.

Prior, R.L. and Cao, G. 2000. Antioxidant phytochemicals in fruits and vegetables; diet and health implications. HortScience 35:588-592.

Ratnasooriya, W.D. and Dharmasiri, M.G. 2000. Effect of *Terminalia catappa* seeds on sexual behaviour and fertility of male rats. *Asian J. Androl.* **2**: 213 – 219.

Sabate, J. 1999. Nut consumption, vegetarian diets, ischemic heart disease risk, and all-cause mortality: Evidence from epidemiologic studies. *The American Journal of Clinical Nutrition* 70(*3S*):500S- 503S.

Sabate,J., Radak,T., and Brown,J. 2001. The role of nuts I cardiovascular disease prevention. In: Wildman REC.,ed. Handbook of Neutraceuticals and functional foods Boca raten, FI : CRC Press, 477- 95.

Sabaté, J. 2003. Nut consumption and body weight. *American Journal of Clinical Nutrition* 78 (3 Suppl):647-650.

Sadasivam, S. and Manickan, A. 1992. Biochemical methods for Agricultural Sciences. Wiley Eastern Ltd. New Delhi, p 8.

Saxena, R. 2003. Effect of processing on phenolic contents and anti oxidant activity of commonly consumed foods. Proc. of Nineth Asian Congress of Nutrition, February 23-27, 2003 (ed. Gopalan, C.) New Delhi, pp 160-162.

Seema, B. 2002. Impact of Neerbrahmi (Bacopa monnieri) and Kodangal (Centella asiatica) as supplements on health status and mental abilities of preschool children. Phd thesis, Kerala Agricultural University, Thrissur, p 130.

Segasothy, M. and Phillips, P.A. 1999. Vegetarian diet: Panacea for modern lifestyle diseases? *Quarterly Journal of Medicine* 92(*9*):531- 544.

Shankar, G. 1993. Role of moisture, temperature, humidity during storage of food grains. Proc. Of Third International Food Convention, 20-23 October 1992. Central Food Technology Research Institute, Mysore, pp 11-16.

Shankaran, R. 1993. Microbial standards for processed foods and rapid methods for microbiological quality assurance. Proceedings of the Third International Food Congress., 20-23 October 1992. Central Food Technology Research Institute, Mysore, pp. 79-83.

Sharma, G.S. 2004. Infant feeding: some facts on child development. Wiley Eastern Ltd., New Delhi, pp. 62-90.

Shruthi, P. 2005. Utilization of jack fruit (Artocarpus heterophyllus L.) for product development. Ph. D thesis, Kerala Agricultural University, Thrissur, P.308.

Siegol, S. and Castellin, N.J.1988. Non parametric Statistics for the Behavioural Sciences. Second Edition, Me GRAW–HILLBOOK company, Newyork,Singapore. 206-210.

Sini, S. 2002. Value addition and evaluation of nutritional quality in elephant foot yam (Amorphophallus palonifolius) MSc Thesis. Kerala Agricultural University, Thrissur, 121 p.

Srilakshmi, B. 2003. Food Science. Third edition. New Age International (Pvt.) Ltd, New Delhi, p.401.

Srivatsa, A.N., Sabapathy, S.N. and Arya, S.S. 1998. Preservation of tender coconut water in pouches and cans, national consultation for improving the productivity and utilization of coconut 10-12 mg, 1998. Coconut Development Board, Kochi, pp. 17-24.

Swaminathan, M. 1984. Principles of Nutrition and Dietetics. The Bangalore printing and Publishing Company Ltd., Bangalore, 556 p.

Tang, X. H., Gao, J., Dou, H., Wang, Y.P. Xu, , L.Z. , Zhu, Z. R. and Xu, Q. 2004. Protective effect of the extract of Terminalia catappa leaves on acute injury induced by D-GalN in mice. Zhongguo. Zhong. Yao. Zo. Zhi. 29:1069.

Tandon, F.C.S. 1993. Methods of analysis of soil, plant, water and fertilizers. Fertilizer development and consultation organization Ltd, New Delhi, p 14.

Thakur, B.R., Mohan, M.S. and Arya, S.S. 1998. Studies on preservative action of some conjugated fatty acids in mango pulp. India Fd. Packer. 49 (6): 37-44.

Thimaiah, S.K. 1999. standard Methods of Biochemical Analysis. Kalyani publishers, New Delhi, p 545.

Thirumaran, A.S. 1993. Processing and evaluation of nutritive ready to use foods suitable for farm families. Ph. D, thesis. Mother Theresa university, Coimbatore. P.89-90.

Thomson, L., and A. Uwamariya. 1999. *Terminalia catappa* Linn. In: CAB International. The Forestry Compendium: A Silvicultural Reference Tool. Module 1.1 computer laser optical disk. CABI, Wallingford, UK.

Thyagaraja, N., Otani, H. And Hosona, A. 1992. Studies on microbial changes during the fermentation of idli. Lebenson wiss Technol. 25 (1). 77-79.

USDA. 1956. Essentials of an adequate diet. Agriculture Information Bullettin, 160.

Varshney, S.C.2001. Role of function of foods in diets. Bev. Fd. Wld. 28(7): 13-14.

Walter, A., and C. Sam. 2002. Fruits of Oceania. [trans., P. Ferrar from Fruits d'Océanie.] ACIAR Monograph No 85. Australian Centre for International Agricultural Research, Canberra, Australia.

Wargovich, M.J. 2000. Anticancer properties of fruits and vegetables. HortScience. 35:573-575.

APPENDICES

APPENDIX- I

(Duo-Trio test) Method used for selection of Judges

A panel of ten judges was selected after initial screening through Duo-Trio test. The test employs three samples, two identical and one different. The panel was first given one of the pair of identical samples as known as reference sample R and then the other two successively in random orders, and was asked to match one of these with the first. The persons who identified the matching samples correctly were selected as judges.

APPENDIX- II

Score cards used for organoleptic evaluation

APPENDIX- IIa

Score card for assessing organoleptic qualities of IA kernels

Tested by

Date

Quality parameters		Score	Samples			
			1	2	3	4
Appearance	Excellent	5				
	Very good	4				
	Good	3				
	Fair	2				
	Poor	1				
Taste	Excellent	5				
	Very good	4				
	Good	3				
	Fair	2				
	Poor	1				
Colour	Excellent	5				
	Very good	4				
	Good	3				
	Fair	2				
	Poor	1				
Flavour	Excellent	5				
	Very good	4				
	Good	3				
	Fair	2				
	Poor	1				
Texture	Excellent	5				
	Very good	4				
	Good	3				
	Fair	2				
	Poor	1				

APPENDIX- IIb

Score card for organoleptic evaluation of the prepared products

Tested by

Date

Quality parameters		Score	Products		
			1	2	3
Appearance	Excellent Good Fair Poor	4 3 2 1			
Taste	Excellent Good Fair Poor	4 3 2 1			
Colour	Very acceptable Acceptable Moderately acceptable Not acceptable	4 3 2 1			
Flavour	Very acceptable Acceptable Moderately acceptable Not acceptable	4 3 2 1			
Texture	Very acceptable Acceptable Moderately acceptable Not acceptable	4 3 2 1			

APPENDIX- IIc

Tested by

Date

Score card for organoleptic evaluation of Health mixes

Quality parameters		Score	Products					
			C1	C 2	C 3	C 4	C 5	C 6
Appearance	Excellent Very good Good Fair Poor	5 4 3 2 1						
Taste	Excellent Very good Good Fair Poor	5 4 3 2 1						
Colour	Excellent Very good Good Fair Poor	5 4 3 2 1						
Flavour	Excellent Very good Good Fair Poor	5 4 3 2 1						
Texture	Excellent Very good Good Fair Poor	5 4 3 2 1						

APPENDIX- IId

Tested by

Date

Acceptability evaluation of health drinks

Quality parameters	Score	Code H1	Code H2
Like Extremely	9		
Like very much	8		
Like moderately	7		
Like slightly	6		
Neither like nor dislike	5		
Dislike slightly	4		
Dislike moderately	3		
Dislike very much	2		
Dislike extremely	1		

APPENDIX- III

Recipes

1. **Soup**

IA flour	-	15 g
Vegetables	-	2 cup
Onion	-	10 g
Oil	-	1 tbs
Corn flour	-	2.5 g
Water	-	2 cup
Salt, pepper	-	To taste

Heat oil in a pan. Add onion and sauté for five minutes. Now add the IA flour and further saute for five minutes. Then add seasonings and vegetables. Boil and simmer till the vegetables are cooked. Puree the mixture in a grinder and serve hot.

2. **Milk shake**

IA flour	-	20 g
Milk	-	200 ml
Sugar	-	10 g
Cardamom	-	2 No.

Boil the milk. Blend the boiled milk, IA flour and sugar in a mixer. Add the powdered cardamom. Serve chilled.

3. Maladu

IA flour	-	50 g
Porikadala flour	-	50 g
Sugar	-	80 g
Ghee	-	½ cup
Cardamom (powder)	-	1 tsp

Powder the Indian almond, porikadala and sugar separately. Mix flours, sugar and cardamom powder well. Heat ghee and slowly add to the above mixture till right consistency to make balls is reached. Remove from fire and make balls when hot.

4. Pakkavada

Roasted IA flour	-	25 g
Roasted Bengal gram flour	-	50 g
Roasted Rice flour	-	25 g
Red chilly powder	-	2 pinch
Asafoetida powder	-	1 pinch
Salt	-	To taste
Ghee	-	¼ tsp
Oil	-	For frying

Mix the flours with chilly powder, asafetida powder and salt. Add ghee and mix well. Knead the above to a smooth dough using hot water. Press it through the ribbon mould of a seva press into hot oil and fry it till golden brown.

5. Biscuit

IA flour	-	30 g
Maida	-	70 g
Ghee	-	100 g
Sugar	-	100 g

Cream ghee and sugar until fluffy. Add sifted maida and IA flour to the above mixture. Mix gently to get a light batter. Pre - heat oven 350^0 F for 10 minutes. Take a spoon full of batter and place it on the greased tray. Bake approximately for 12 minutes or until lightly golden on top.

6. Cake

IA flour	-	15 g
Maida	-	85 g
Ghee	-	50 g
Egg	-	2 No.
Sugar	-	100 g
Baking powder	-	1 pinch

Mix IA flour and maida well. Sift it twice. Then add the ingredients egg, ghee, baking powder and sugar. Blend all the ingredients well. Pour the mixture to a greased mould. Then bake for 30 minutes.

7. **Curry**

IA flour	-	15 g
Tomato	-	2 medium sized
Chopped onion	-	1
Chopped green chilies	-	2
Ghee	-	1 tsp
Ginger	-	1 piece
Red chilly powder	-	¼ tsp
Garam Masala	-	¼ tsp
Turmeric powder	-	2 pinch
Salt	-	to taste

Pour ghee in to a pan and heat. Add chopped onions, turmeric powder and fry till onion turns slightly golden. Then add green chillies, ginger to pan and continue frying. Add IA flour and chopped tomatoes with some water and fry till the tomatoes become smooth. Finally add salt, red chilly powder and Garam masala. Stir well until well cooked.

8. **Health drink**

Health mix	-	15 g
Sugar	-	5g
Milk	-	50 ml
Water	-	100ml
Cardamom powder	-	1 pinch

15 g health mix was added in 100 ml of water and boiled for three minutes. Then add boiled milk, sugar and cardamom powder. This drink can be serve hot or cold.

ABSTRACT

FEASIBILITY OF UTILIZING INDIAN ALMOND (*Terminalia catappa* L.) FOR VALUE ADDITION

MANJUSHA.P.M

Abstract of the

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Abstract

The study entitled 'Feasibility of Utilizing Indian Almond (*Terminalia catappa* L.) for value addition' was conducted at College of Agriculture, Vellayani. The major objective of the study was to assess the quality characteristics of Indian almond kernel and to find out the feasibility of utilizing the kernel for product development.

The Indian almond (IA) required for the study were collected from the college campus Vellayani. Physical characteristics like length, breadth, weight and volume of fruits and kernels were measured. The average length, breadth, weight and volume of fruits were found to be 5.52 cm, 3.55 cm, 5.90 g and 5.05 ml respectively. In the case of kernels it is 2.62 cm, 1.40 cm, 0.54 g and 0.22 ml respectively. Results of chemical composition of Indian almond kernels show that Indian almond kernels are rich in protein and fat. The kernels also contain considerable amount of minerals calcium and iron i.e., 320 mg of calcium, 4.00 mg of iron, 45.00g Carbohydrate and 500.00 kcal of Energy.

The sensory qualities of fresh and processed Indian almond kernels assessed and oven dried kernels have secured the highest score. IA kernels were primarily processed in to flour. The quality of the flour prepared was assessed. The acceptability scores of both kernels and flour seemed to diminish with storage. In the case of kernel flour, difference could be noted in the moisture and peroxide value after storage at ambient condition. Even though no difference was seen in the case of peroxide value of the flour when kept under refrigeration, difference could be observed in the case of moisture content. The incidence of insect attack was not observed in the kernel and flour stored for a period of one month. Feasibility of incorporating the developed Indian almond flour into conventional ready to serve preparations like soup, a drink -milk shake, a sweet – maladu (roasted), a snack – pakkavada (fried), confectionary - cake and biscuit (baked) and a curry (boiled) were

tried out. Results of the organoleptic evaluation of the products show that the prepared products were very much acceptable.

Six combinations of health mix were first formulated incorporating IA flour as the base. From among the six combinations two most acceptable mixes selected using organoleptic evaluation, chemical score and by computing the nutritive value. Other ingredients used for the formation of health mix include soya, Ragi, Banana powder, amaranth and milk powder. The ingredients were selected based on 'Food square' and the food group 'Basic four'.

Nutritional qualities of the selected two health mixes were compared with the nutritive value of the other health foods available in the market. The results show that the nutritive values of the IA based health mixes are comparable with other health foods available in the market in nutrient composition and taste.

Using the selected two health mixes different methods of preparing health drinks were tried out. The most acceptable method of preparation of health drink was boiling and that was selected for the final preparation of health beverage.

As part of the study two simple easy to handle tools were developed. Effectiveness of the developed tools were determined by checking the kernel recovery in unit time using each tool. Results of the study show that 62-65 kernels can be recovered in one hour using the tools.

The results proved that the kernels nutritionally very rich, is delicious and has good keeping quality. The most feasible method of extraction of the kernel without breaking was standardized and two tools were finalized to help in the extraction of kernels and to reduce the labour. Assessment of the quality characteristics of the products revealed that they were highly acceptable, nutritionally rich and economically feasible.