

**DEVELOPMENT OF VALUE ADDED *KALAKAND*
USING PAPAYA PULP AND ALMOND**

काशी हिन्दू
विश्वविद्यालय



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IN

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Pulp And Almond**



By

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ABBREVIATIONS

| | |
|-------|-------------------------------|
| % | Percentage |
| °C | Degree Celsius |
| CD | Critical Differences |
| CF | Correction Factor |
| CV | Coefficient of Variation |
| DF | Degree of Freedom |
| F Cal | F Calculated Value |
| F Tab | F Table Value |
| gm | Gram |
| Kg | Kilogram |
| LR | Lactometer Reading |
| ml | Milliliter |
| MSS | Mean sum of square |
| NS | Non Significant |
| S | Significant |
| S.E. | Standard Error |
| SEm | Standard error of differences |
| SNF | Solid Not Fat |
| SS | Sum of square |
| Temp. | Temperature |
| TS | Total Solid |

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INTRODUCTION

Since times immemorial milk has been known to human beings as an almost complete food. Milk is an extremely complex biological fluid with scores of nutrient content contained in fluid characteristics of three physical phases: diluted emulsion, colloidal dispersion and solution. The chemical makeup of milk and its physiochemical behavior provide scientific basis for process of milk and manufacture of products (Sawant *et al.*, 2007).

India is the world's largest producer of milk by volume. Total milk production during 2016-2017 is 165.4 MT and per capita available milk is 355gm/day (NDDB, 2017). Milk is considered to be an appropriate source of valuable macronutrients (fat, protein, lactose) vitamins and micronutrients as minerals which can make it a wholesome food. It can serve as an excellent carrier product for extra nutrient and if enriched or fortified it can satisfy the nutritional needs of the people (Krupa *et al.*, 2011). The country accounts for more than 13% of world's total milk production and is also the world's largest consumer of dairy products. Dairying has been regarded as one of the activities that could contribute to alleviating the poverty and unemployment especially in the drought-prone and rain-fed areas. In India, about three-fourth of the population live in rural areas and about 38% of them are poor. Therefore, among these people, as well as the large vegetarian segment of the country's population, dairy products provide a critical source of nutrition and animal protein to millions of people in India.

Traditionally, in rural areas surplus milk has been converted into variety of traditional dairy products for preservation of milk in India. Traditional dairy products and sweets are an integral part of Indian heritage and have great social, religious, cultural, medicinal and economic importance. They have been developed over a long period with the culinary skill of homemakers and *halwais* (sweetmeat maker). In addition to preservation of milk solids for longer time at room temperature,

manufacture of traditional dairy products add value to milk and also provide considerable employment opportunity (Pal & Raju, 2007; Patil, 2011).

Traditional Indian dairy products or Indian Indigenous milk products can be defined as all milk products which are native of India and which were evolved over ages utilizing locally available fuels and cooking ware. The wide array of Indigenous milk products are poised to take strong industrial footing in the years to come with the development and application of mechanized manufacturing technologies and unit operations. A wide range of Indian milk sweets made in different parts of the country are very popular amongst all male and female, young and old population. No special event or a celebration is considered complete without serving and distributing the sweets to relatives and friends which are essentially made with the indigenous dairy products as a base.

Traditional Indian Dairy products are those products which are known in this country for ages. Milk and milk products formed the main food of Vedic Indians. Khoa sweets have been the item of choice for centuries in India. In early Buddhist and Jain eras, there is a mention that sweets were prepared from thickened milk named as Sihakesara and Morandeku. The rich people used to enjoy such sweets at the end of their meals. Buddha allowed his followers to carry some sweets during journeys, where it was difficult to get food stuff. In the Maurya period, the sweets were prepared from concentrated milk with the addition of honey, jaggery or sugar. In the post-Maurya period (AD 750 to 1200), milk was used in various forms. The milk was drunk when half of the quantity was evaporated. The milk was very much relished when the quantity of milk was reduced to one third of the original quantity. When milk was reduced to one-sixth of the original quantity, it was used for preparing sweets and when it was reduced to one-eighth, it was called Sarkara (Powder). The ancient medical literature states that the physical and mental happiness of individuals depend on the food they take.

Traditional milk products have greater commercial significance as they account for over 90% of the milk products consumed in the country (Aneja *et al.*, 2002). Out of total milk production 50-55% milk converted into different varieties of milk

products through processes such as heat acid coagulation, heat desiccation viz., *khoa*, *basundi*, *lal peda*, *rabri*, *kalakand* etc., fermented product viz., *dahi* and *shrikhand*, coagulated milk products viz., *paneer* and *chhana* and clarified products viz. butter oil, *ghee* etc. which are inherent in ancient traditions and have a strong social and cultural heritage in the Indian society. Out of which about 5.5% of total milk produced in the country used for *khoa* making (Bandyopadhyay *et al.*, 2006; Banerjee, 1997).

Milk based sweets are integral part of the dietary system of Indian sub-continent. These sweets are consumed on various auspicious occasions such as weddings, festivals and day to day celebrations. Traditional milk products in India have great commercial importance as they account for over 90% of all milk products consumed in the country (Aneja *et al.*, 2002). Food processing industry is of enormous importance for the development of our country because of the central linkage and synergies that it promotes between the two pillars of our economy, agriculture and industry. *Kalakandis* one of the traditional milk products which are made by desiccation of heat with caramelized flavor and granular texture prepared from acidified milk. It also accompanies reduction of water activity results in destruction of pathogenic micro-organism and inactivation of enzyme activity. The main reaction in preparation is denaturation and coagulation of milk proteins. The color of *kalakand* varies from off white to light caramel color. Being a whole milk concentrate, *kalakandis* a good source of proteins, minerals, energy giving fat and lactose. It is 4-6 times more nutritious than milk in terms of per unit weight and calorific value.

The association of fruits with dairy products has endorsed health perception in consumer's mind as consumers connect both these foods with health and wellness. Papaya (*Carica papaya* L.) is the fifth most important crop in India, which is cultivated to 106 thousand ha of land and production of 4196 thousand MT with average productivity of 39.6 MT/ha in 2010-11. The fruits are excellent source of vitamin A (2020 IU/100g), thiamine, riboflavin, nicotinic acid and ascorbic acid. Papaya (100g) contains 9 per cent of the dietary reference intake for Cu, 6-8 per cent

for Mg, but less than 3 per cent of the dietary reference intake for other minerals (Wall, 2006). Papaya also contains several unique protein-digesting proteolytic enzymes including papain and chymopapain which protects you by digesting and destroying the defence shields of different infective microbes and tumour.

The papaya (*Carica papaya* L.) is an evergreen plant found in tropical regions, originated from Central America and Mexico. Papaya is an herbaceous succulent plant that possesses a self-supporting stalk. It may be male, female, or hermaphrodite, reproducing by self-pollination by parietal placentation. For being used as an edible fruit, it is extensively cultivated for export and household utilization. Its fruit is a berry, produced from syncarpous superior ovary by parietal placentation. The papaya is a tropical fruit of which belongs to the genus *Carica*. It is also known as common man's fruit as it has reasonable price and high nutritive value. It is low in calories and rich in natural vitamins and minerals. Papaya when consumed regularly ensures good supply of vitamin A and C which are essential for good health especially for eyesight and prevent early stage night blindness in children. Papaya contains broad spectrum of photochemical including polysaccharide, vitamin, minerals, enzyme, proteins, alkaloids, glycosides, fat and oil, lactic acid, flavonoids, saponin, sterols etc. There are various medicinal and pharmacological uses of papaya fruit such as for stomach ache, dysentery and chronic diarrhea, relieve obesity, bleeding piles, wounds of urinary tract, skin disease psoriasis, anti-implantation activity, antibacterial activity etc. (Parle, 2011).

The fruit is a rich source for different types of enzymes. Papain, vegetable pepsin present in good amount in unripe fruit is an excellent aid to digestion, which helps to digest the protein in food at acid, alkaline and neutral medium. The celiac disease patients, who cannot digest the wheat protein gliadin, can tolerate it, if it is treated with crude papain, papaya has the property of tenderizing meat (Natarajan and Vidhya, 2014).

Almonds are the most popular nuts in the United States. A favorite of dieters, in recent years almonds have become famous for their versatility and health benefits. According to the U.S. Department of Agriculture, Americans' demand for

almonds has increased over 400 percent since 1980. In 2016, Americans ate an average of 1.8 lbs. (816 grams) of almonds each. There's good reason for the love affair. "Almonds have been studied extensively for their benefits on heart health, diabetes, and weight management," said Jenny Heap, a registered dietitian with the Almond Board of California. "The unique nutrient combination of almonds — plant-based protein, fiber and monounsaturated fats, plus key nutrients like vitamin E and magnesium — help make them a heart-healthy snack." A 2017 study published in *Nutrition Journal* found that Americans, especially children, who replaced snack foods with almonds or other tree nuts saw a major increase in consumption of nutrients. In the study of more than 17,000 children and adults, participants swapped all their snacks with almonds and. Researchers found that participants consumed fewer empty calories, solid fats, sodium, saturated fats, carbohydrates and added sugars. Good oils and fats increased significantly, as did magnesium, fiber and protein by a small margin. California is one of the world's most productive agricultural areas, and California's almond industry is an important and growing sector of the state's economy. California dominates the global almond market by growing about 80% of the world's almonds produced in any given year (USDA-FAS, 2015). Within California, the land area containing almond orchards in 2015 was nearly 450 thousand hectares (CDFA, 2016), representing an 81% increase over a decade prior. Almonds are the top economic-value export crop for California farms, accounting for 25 percent (\$5.1B USD) of California's farm exports in 2015 (CDFA, 2017) and indirectly contributing \$21.5 billion to California's economy in 2014 (Sumner et al., 2015). Almonds are known for their nutritional value, providing a dense supply of protein, fats, fiber, and micro-nutrients (Chen et al., 2006; King et al., 2008). The oils and fats in almonds may be useful in reducing blood cholesterol (Hyson et al., 2002) and reduced risk of cardiovascular disease (Estruch et al., 2013) and diabetes (Martínez- González et al., 2008). There have been previous estimates of nutritional water productivity calculated as energy, protein, calcium, fat, Vitamin A, and iron output per unit of water input (Renault and Wallender, 2000); our study considers these and other macronutrients and compares almonds to alternative dietary sources of these nutrients. Balancing the environmental impacts (e.g., from water use) of food production with nutritional benefits of foods is increasingly discussed in the press and

can be affected by various actors, ranging from governments to individual consumers. Successful and sustainable food products are likely to be those that demonstrate contributions to tasty and healthy diets, economic benefits at the scale of production and consumption, and are demonstrably less environmentally damaging to technically speaking, almonds are not true nuts at all. The edible part that we call a nut is actually a seed, and almonds themselves are drupes, according to the University of California Riverside's botany department. Sometimes called "stone fruits," drupes are characterized by a tough rind surrounding a shell that holds a seed. Peaches and apricots, close cousins to the almond, are common examples of drupes. Like these relatives, almonds grow on beautiful, flowering trees and thrive in warm, dry climates. The almond tree (*Prunus dulcis*), also related to cherries and plums, and is native to Western Asia and Southern Europe. According to the Agricultural Marketing Resource Center, Spanish missionaries brought almonds to the New World, but the nut's popularity did not rise until the 1900s. Today, the United States is the largest supplier of almonds in the world. California is the only state that produces almonds commercially. This may change, though, as the water supply in California declines.

Hence, the present work was undertaken to study the effect of different level of papaya pulp on quality of *kalakand* under the head of "Development of value added *kalakand* using Papaya pulp and almond "

The objectives of plan are as follows: -

1. Process optimization for development of papaya pulp incorporated *kalakand*.
2. Physico chemical properties of papaya *kalakand*.
3. Economical evaluation of papaya *kalakand*.



REVIEW OF LITERATURE

Since times immemorial milk has been known to human beings as an almost complete food. Milk is utilized in various forms like cream, Butter, cheese, concentrated milk (Khoa) and dried milk products. There is an ever increasing varieties of milk products being introduced in the market with an increased palatability and fascinating forms (Sawant, V. Y, et al.,2006).

India is the world's largest producer of milk by volume. Total milk production during 2016-2017 is 165.4 MT and per capita available milk is 355gm/day (NDDB, 2017). Milk is considered to be an appropriate source of valuable macronutrients (fat, protein, lactose) vitamins and micronutrients as minerals which can make it a whole some food. It can serve as an excellent carrier product for extra nutrient and if enriched or fortified it can satisfy the nutritional needs of the people (Krupa *et al.*, 2011). The country accounts for more than 13% of world's total milk production and is also the world's largest consumer of dairy products. Dairying has been regarded as one of the activities that could contribute to alleviating the poverty and unemployment especially in the drought-prone and rain-fed areas. In India, about three-fourth of the population live in rural areas and about 38% of them are poor. Therefore, among these people, as well as the large vegetarian segment of the country's population, dairy products provide a critical source of nutrition and animal protein to millions of people in India.

Milk is a white liquid produced by the mammary glands of mammals. It is the primary source of nutrition for infant mammals (including humans who are breastfed) before they are able to digest other types of food. Early-lactation milk contains colostrum, which carries the mother's antibodies to its young and can reduce the risk of many diseases. It contains many other nutrients including protein and lactose. Interspecies consumption of milk is not uncommon, particularly among humans, many of whom consume the milk of other mammals.

Kalakand:

Among the indigenous milk products, kalakand, occupies an important place and found to be an attractive product amongst all the classes of consumers. Kalakand is more popular in Northern and Eastern India, particularly with Bengali people. *Kalakand* is a milk sweet prepared by heating a mixture of *khoa* and sugar with continuous and stirring until characteristic grainy texture and caramelized flavour develops. Studies on preparation of kalakand fortified with sapota pulp are rare and hardly reported so far. In general there is a considerable scope for standardizing the process of kalakand preparation incorporated with sapota pulp in order to improve its quality and also to enhance consumer preference. Sapota is the most popular choice of fruits of the tropics. It is also known as the 'King of fruits' because of its palatability excellent taste, pleasant aroma and nutritive value.

Kalakand is a heat desiccated milk product, made by desiccation process with continuous stirring which is represented in the granular texture (Aneja *et al.*, 2002). In the preparation of *kalakand*, cow milk, buffalo milk or cow and buffalo milk in the ratio of 50:50 were selected and 0.05% citric acid solution was added in to the milk at the boiling stage with continuous stirring (Verma *et al.*, 2009). As the largest single dairy producing country, India's output continues to grow strongly in the 3-4 percent range, largely in response to internal demand growth and sustained by increasing productivity (Gupta *et al.*, 1990). India accounts for over half the total milk output of Asia. India is located amidst major milk deficit countries in Asia and Africa. Major importers of milk and dairy products are Bangladesh, China, Hong Kong, Singapore, Thailand, Malaysia, the Philippines, Japan, UAE, Oman, and other gulf countries, all located close to India. There is vast potential for the export of dairy products, the cost of milk production in India being the lowest.

Kalakand is prepared by using milk standardized to 6% fat and 9% SNF, a specific quantity of milk was taken in *karahi* and boiled with continuous stirring. After 10-15 min, 0.5 g/liter citric acid was added. When semi-solid stage was obtained, 60 gm/ liter sugar was added and stirred vigorously (De, 1980). The citric acid solution was added at a later stage when the concentrated mass started losing the side of the vessel (Aneja *et al.*, 2002).

Safflower milk was blended with buffalo milk in different proportion viz. T₀-100 per cent buffalo milk (BM), T₁-70(BM): 30 (SM), T₂-60 (8M) :40 (SM) and T₃-50 (8M) :50 (SM) were evaluated with respect to its sensory qualities, chemical composition and cost of production. The average chemical composition of *kalakand* prepared from different blends values ranged from 76.20, 72.60, 71.20 and 70.00 for total solids, 23.80, 27.40, 28.80 and 30.00 for moisture, 21.00, 20.10, 19.65 and 19.20 for fat and 15.00, 14.10, 13.75 and 13.30 for protein. The acceptability of products scores from 8.65, 7.75, 7.35 and 6.66 for 9 hedonic scale, respectively. All properties should decrease in the average value with increase in proportion of safflower in blends. The cost in for 1 kg *kalakand* from buffalo milk was higher i.e. 68.50 as compare to acceptable blends T₂ Rs. 53.72 (Dhanwade *et al.*, 2006).

The study was conducted to determine the effect of different levels of mango pulp inclusion (0, 10 and 20%) on the sensory properties of *kalakand*. Results revealed that the overall acceptability of 0, 10 and 20% mango pulp in *kalakand* were 8.94, 8.88 and 8.46, respectively. The proportion of total solids content increased with increasing level of mango pulp. Fat and protein contents of the *kalakand* significantly decreased with the inclusion of mango pulp. The carbohydrate and ash contents were increased by the addition of mango pulp. Product acidity decreased with increasing levels of mango pulp. The production cost of *kalakand* decreased with increasing levels of mango pulp (Swant *et al.*, 2007).

Artificial sweeteners like saccharin, acesulfame-k, sucralose and aspartame were used instead of sucrose in the manufacture of *kalakand*. *Kalakand* sweetened with artificial sweeteners scored significantly lower ($p < 0.05$) in various textural attributes at all periods of storage compared to control. Hardness in artificial

sweetened *kalakand* had lower values ranging from 28.6 to 55.9 N during storage as compared to control ranging from 51.3 to 75.3 N. The corresponding values for adhesiveness were 0.35 to 0.15 N and 0.42 to 0.22 N. Similarly, springiness also had lower values in artificially sweetened *kalakand* (3.6 to 1.74 mm) as compared to control (4.2 to 2.2 mm) at all days of storage. In cohesiveness, gumminess and chewiness of artificial sweetened *kalakand* the respective values were 0.25-0.20, 7.2-11.2 and 25.7-19.4 (Nmm), lower than the corresponding values for control sweetened with sucrose which were 0.27-0.22, 13.8-16.6 and 57.8-37.3 (Nmm) during storage. The lower hardness, adhesiveness, springiness and accordingly gumminess and chewiness in artificial sweetened *kalakand* samples could be attributed to lack of compactness. It was also evident from scanning electron microscopy that compactness of the network in *kalakand* decreased with the use of artificial sweeteners. The results of the sensory evaluation have shown the successful acceptance of the use of artificial sweeteners in the preparation of *kalakand*, thus providing an alternate variety to the health conscious consumers (Arora *et al.*,2008).

Kalakand fortified with 5, 10 and 15 per cent mango pulp was prepared by using cow and buffalo milk. Addition of mango pulp reduced the fat content while the total solids increased in the cow milk and buffalo milk *kalakand*. The highest acidity observed in plain *kalakand* showed decreasing trend with increasing level of mango pulp. From overall acceptability it is clear that buffalo milk was superior to cow milk for preparation of *kalakand* with or without mango pulp (Dongale, 2009).

Cow, buffalo and mixed samples of these two milk were standardized separately for 5% fat and 10% SNF and used for *kalakand* preparation adding citric acid at boiling, 50% concentration and dough stages. The average yield (28.67%), TS (72.40%), protein (15.92%) and ash (2.64%) contents were maximum (PO.05) in *kalakand* prepared with buffalo milk than other groups. The values of these components were also high in *kalakand* prepared at boiling stage than other stages of *kalakand* prepared at boiling stage than other stages of *kalakand* preparation. Flavour (7.74), body and texture (7.97) and colour and appearance (8.05) scores were

also high ($P < 0.01$) in *kalakand* prepared from buffalo milk than cow milk samples (Verma *et al.*, 2009).

Kalakand is one of the indigenous milk product obtained by heat desiccation/concentration of whole/standardized milk with subsequent addition of sugar and proper coagulant. It was seen that sensory scores for all sensory attributes of *Kalakand* was different as the *kalakand* made from cow milk and with high acidity has got lower acceptability whereas *kalakand* obtained from buffalo milk was more acceptable. Generally, Danedar type of *khoa* is used for preparation of *kalakand* and for the preparation of Danedar *khoa*, buffalo milk is more suitable than cow milk due to higher amount of fat. Likewise, addition of appropriate amount of coagulant i.e. citric acid and sugar is also very important as both these factors greatly affect the texture and taste of the product. Use of other coagulant may also suffer the overall quality and acceptability of the *Kalakand*. The milk standardized to 6% fat and use of 0.02% of citric acid increases the sensory quality of product. But milk with 7% fat has more sensory score and acceptability than the milk of 6% fat. *Kalakand* has unique importance in market as it is liked by all classes of peoples in the society. Various agencies like Hoteliers, Street Vendors, and Sweetmeat shops are engaged in marketing of *Khoa*, *Kalakand* and other sweets in Hingoli city. Quite large quantity of milk is produced around the Hingoli city. These producers convert their surplus milk into *khoa* and other milk based products such as *Kalakand*, *Peda*, and *Burfi* etc. and marketed in Hingoli city all around the year (Muley and Landge, 2012).

A study was conducted to use Maltodextrin as a fat replacer which being a carbohydrate, (very low in fat) is used for manufacturing dietetic *kalakand*. Three different levels of maltodextrin i.e. 1%, 2%, and 3% were used along with skim milk to manufacture *kalakand*. Skim milk and maltodextrin mixture were heated and partially coagulated by citric acid to get pat stage. Sugar @ 7% of milk is added along with Cardamom and Pista. The mixture was allowed to cool and set. It was cut and given shapes to get marketable *kalakand*. The product was analyzed for organoleptic attributes (colour and appearance, body and texture, flavour and taste and overall acceptability) by trained panelist using 9-point hedonic scale. Physicochemical (fat%,

total solids%, acidity%, moisture content and yield %) and microbiological analysis (SPC, yeast and moulds, coliform) analysis were done for estimating its nutritional content and safety. Based on the statistical analysis of data obtained from various parameters using different percentage of maltodextrin, experimental treatments were found superior to control as far as organoleptic attributes are concern (David, 2014).

An attempt to develop *Kalakand* by addition of an Ash gourd at different level of concentration using buffalo milk. The basic aim of study was to find out the sensory parameter of *Kalakand* prepared by addition of Ash gourd. The data collected on different aspects were tabulated and analyzed statistically using the methods of analysis of variance and critical difference. Organoleptic characteristics (flavour and taste, body and texture, colour and appearance, overall acceptability) were analyzed using 9-point hedonic scale. According to the analysis, treatment T₁ with 15% Ash gourd pulp was found to be the best among the three. Thus, as per acceptability of the product judged by organoleptic evaluation and therapeutic value, the treatment can be rated as T₁ > T₀ > T₂ > T₃ (David, 2015).

Aspartame was used in the manufacture of *kalakand* instead of sucrose. Sensory evaluation revealed that aspartame when used in the preparation of *kalakand* at a level of 0.065% scored the highest in terms of sweetness perception and resembled control. Aspartame sweetened *kalakand* possessed the same desirable sweetness, colour, body and texture/consistency and mouthfeel even after 7 days of storage at 6-8 degrees C. Significant increase in titratable acidity of control as well as aspartame sweetened *kalakand* was observed during storage. However, only a slight drop in pH was observed in all samples on storage. The titratable acidity was higher in aspartame sweetened products than the corresponding control samples. Lightness was less in control samples with sucrose than the aspartame sweetened *kalakand* during storage. Total plate counts were higher in aspartame sweetened *kalakand* than its corresponding control throughout the storage period. Total plate counts increased linearly for both aspartame sweetened *kalakand* and control. A solid phase extraction method was standardized for the isolation of aspartame in *kalakand*. HPLC analytical conditions were standardized for separation of aspartame and its degradation products

diketopiperazine and L-phenylalanine. HPLC analysis revealed that aspartame did not degrade in *kalakand* during storage establishing its stability in these products (Gawandeet *al.*, 2015).

2.8 Papaya and its medicinal uses

Fruits are one of the foremost nutritional and health-sustaining food resources available to humans. It is a well-accepted fact that consumption of whole fruit or processed fruit products are capable of supplying adequate amounts of essential minerals, vitamins, soluble and insoluble dietary fibers. In fact, processed fruit products such as juice, jam, purees, fruit powder (as a supplement), and others are also considered to retain the original organoleptic qualities and nutritional value. Although fruits can be of the climacteric or non-climacteric type, their cultivation has been shown to improve and support the economy of the grower as well as the region. In addition, of late, certain underused and underexplored fruits are also gaining much importance (mainly owing to their nutraceutical values). The majority of fruits worldwide are seasonal, and hence, a continuous supply of these types of fruit is of prime importance. Freshly harvested fruits have a shorter shelf life, and applications of various storage methods are required to maintain the overall quality and appeal.

Papaya (*Carica papaya* Linn. family Caricaceae) is a small tropical evergreen tree (plant), and is the only species in the genus *Carica* (Eustice et al., 2008). Papaya is common's man fruit, which is reasonably priced and has a high nutritive value. It is low in calories and rich in natural vitamins, and minerals. The comparative low calories content (32 Kcal / 100 g of ripe fruit) make this a favorite fruit of obese people who are into weight reducing regime. Papaya has low carotene compared to other fruit such as apples, guava, sitaphal and plantains, which helps to prevent damage by free radicals. Unripe green papaya is used as vegetable; it does not contain carotene but also all other nutrients are present. The fruit is a rich source for different types of enzymes. Papain, vegetable pepsin present in good amount in unripe fruit is an excellent aid to digestion, which helps to digest the protein in food at acid, alkaline and neutral medium. The celiac disease patients, who cannot digest the wheat protein gliandin, can tolerate it, if it is treated with crude papain, papaya has the property of

tenderizing meat. This knowledge is being put to use by cooking meat with raw papaya to make it tender and digestible (CSIR, 1992). As early as 1535, the existence of the papaya tree (*Carica papaya* L.) was described by the Spanish author de Oviedo in his book *La natural hystoria de las Indias*. In this book, the author notified the Spanish king regarding papaya fruits that were grown in the regions of southern Mexico and northern parts of Nicaragua. In addition, it was indicated that papaya seeds from these places were taken to the Caribbean islands, Panama, and some South American regions. Furthermore, owing to the unique taste and gaining popularity, papaya planting spread throughout the tropical countries, especially in Africa and Asia (De Oliveira and Vitória, 2011). Among a wide array of tropical fruits, the papaya is deemed to be one of the most economical fruits, which not only is cultivated roughly in 60 countries but also is marketed worldwide. The increase in demand and popularity of papaya fruit is also because of its pleasant flavor and mouthfeel of the edible pulp, nutritional value, and therapeutic values. Papaya fruits are consumed in various forms such as ripe, semi-ripe, or unripe raw. In the tropical regions, raw papaya is used as a vegetable, a snack food, and an ingredient in jellies, curry, salad, and pickles (Adetuyi et al., 2008; Chaiwut et al., 2010; Workneh et al., 2012; Annegowda et al., 2014). Ripe papaya is generally consumed directly by consumers. However, commercially ripe fruits find potential applications in the preparation of syrups, dried fruit, yoghurt, jam, jellies, nectars, and candy, among other foods. Papaya juice is also one of the most popular refreshing beverages (Workneh et al., 2012; Nakamura et al., 2013). Apart from the fruit, there is a high demand for papain, a digestive enzyme obtained from papaya, which holds great value as an added ingredient in the pharmaceutical, cosmetics, and food industries (for such applications as brewing and meat tenderizing). In the international fruit market, the demand for papaya has increased tremendously. Papaya production and importation worldwide during the year 2010 reached around 11.8 million tons and 243 million US dollars, respectively (Udomkun et al., 2014). Considering the growing trend, the Food and Agriculture Organization estimated that tropical fruit production worldwide would reach 82 million tons in 2014. Over the years, India and Brazil have been leading producers of papaya, and the United States is expected to have an import market of 134,445 tons, and with European Union countries expected to reach around 12%.

Papaya fruit is a rich source of nutrients such as provitamin A, carotenoids, vitamin C, vitamin B, lycopene, dietary minerals and dietary fiber. Danielone is a phytoalexin found in the papaya fruit. This compound showed high antifungal activity against *Colletotrichum gloesporioides*, a pathogenic fungus of papaya. Nutritionally, the major component of papaya fruit are carbohydrates (6.50 %) at the early stage of fruit development, glucose is the main sugar but during ripening sucrose content increases (Paul, 1993). The total dietary fiber content of ripe fruit varies from 11.9 to 21.5 gm/100gm (Saxholt *et al.*, 2008). The fat, protein and ash content in ripe papaya fruit is 0.47 %, 0.59 % and 0.45 % respectively. The edible portion of ripe papaya fruit contains both macro and micro minerals and these Na, K, Ca, Mg, P, Fe, Cu, Zn and Mn. The moisture content in papaya fruit is 91.2 to 92.3 per cent. The carotenoids are responsible for the flesh colour of the fruit mesocarp (Bari *et al.*, 2006).

- a) *Laxative*-Ripe papaya fruit is laxative which assures of regular bowel movement.
- b) *Void the heart attack or stroke*-The folic acid found in papayas are needed for the conversion of homocysteine into amino acids such as cysteine or methionine. If unconverted, homocysteine can directly damage blood vessel walls, is considered a significant risk factor for a heart attack or stroke.
- c) *Anti-inflammatory effects*- Protein enzymes including papain and chymopapain and antioxidant nutrients found in papaya; including vitamin C, vitamins E, and betacarotene, reduce the severity of the conditions such as asthma, osteoarthritis, and rheumatoid arthritis.
- d) *Rheumatoid arthritis*-Vitamin C - rich foods, such as papaya, provide humans with protection against inflammatory polyarthritis, a form of rheumatoid arthritis involving two or more joints (Arvind *et al.*, 2013).

Almond and its medicinal uses

Almonds are the most popular nuts in the United States. A favorite of dieters, in recent years almonds have become famous for their versatility and health benefits. According to the U.S. Department of Agriculture, Americans' demand for almonds has increased over 400 percent since 1980. In 2016, Americans ate an average of 1.8 lbs. (816 grams) of almonds each. There's good reason for the love affair. "Almonds have been studied extensively for their benefits on heart health, diabetes, and weight management," said Jenny Heap, a registered dietitian with the Almond Board of California. "The unique nutrient combination of almonds plant-based protein, fiber and monounsaturated fats, plus key nutrients like vitamin E and magnesium — help make them a heart-healthy snack." A 2017 study published in *Nutrition Journal* found that Americans, especially children, who replaced snack foods with almonds or other tree nuts saw a major increase in consumption of nutrients. In the study of more than 17,000 children and adults, participants swapped all their snacks with almonds and. Researchers found that participants consumed fewer empty calories, solid fats, sodium, saturated fats, carbohydrates and added sugars. Good oils and fats increased significantly, as did magnesium, fiber and protein by a small margin. California is one of the world's most productive agricultural areas, and California's almond industry is an important and growing sector of the state's economy. California dominates the global almond market by growing about 80% of the world's almonds produced in any given year (USDA-FAS, 2015). Within California, the land area containing almond orchards in 2015 was nearly 450 thousand hectares (CDFA, 2016), representing an 81% increase over a decade prior. Almonds are the top economic-value export crop for California farms, accounting for 25 percent (\$5.1B USD) of California's farm exports in 2015 (CDFA, 2017) and indirectly contributing \$21.5 billion to California's economy in 2014 (Sumner et al., 2015). Almonds are known for their nutritional value, providing a dense supply of protein, fats, fiber, and micro-nutrients (Chen et al., 2006; King et al., 2008). The oils and fats in almonds may be useful in reducing blood cholesterol (Hyson et al., 2002) and reduced risk of cardiovascular disease (Estruch et al., 2013) and diabetes (Martínez- González et al., 2008). There have been previous estimates of nutritional

water productivity calculated as energy, protein, calcium, fat, Vitamin A, and iron output per unit of water input (Renault and Wallender, 2000); our study considers these and other macronutrients and compares almonds to alternative dietary sources of these nutrients. Balancing the environmental impacts (e.g., from water use) of food production with nutritional benefits of foods is increasingly discussed in the press and can be affected by various actors, ranging from governments to individual consumers. Successful and sustainable food products are likely to be those that demonstrate contributions to tasty and healthy diets, economic benefits at the scale of production and consumption, and are demonstrably less environmentally damaging to technically speaking, almonds are not true nuts at all. The edible part that we call a nut is actually a seed, and almonds themselves are drupes, according to the University of California Riverside's botany department. Sometimes called "stone fruits," drupes are characterized by a tough rind surrounding a shell that holds a seed. Peaches and apricots, close cousins to the almond, are common examples of drupes. Like these relatives, almonds grow on beautiful, flowering trees and thrive in warm, dry climates. The almond tree (*Prunus dulcis*), also related to cherries and plums, and is native to Western Asia and Southern Europe. According to the Agricultural Marketing Resource Center, Spanish missionaries brought almonds to the New World, but the nut's popularity did not rise until the 1900s. Today, the United States is the largest supplier of almonds in the world. California is the only state that produces almonds commercially. This may change, though, as the water supply in California declines.

Chronic hypercholesterolemia is a critical risk factor in the development of cardiovascular disease (CVD), which is the most common cause of death worldwide (American Heart Association. 01 10, 2012, NCPE 2002). Furthermore, low-density lipoprotein (LDL) is the major atherogenic lipoprotein and the primary target of cholesterol lowering therapy because numerous clinical trials have demonstrated the efficacy of LDL-lowering therapy for reducing the risk of CVD. A recognized consequence of increased dietary saturated fatty acid (SFA) is hypercholesterolemia. Conversely, diets supplemented with almonds or almond products (i.e., oil and butter) have been shown to produce a moderate, yet significant decrease in plasma total cholesterol (pTC) (3–11%) and plasma LDL cholesterol (pLDL-c) (3–18%) (Wien,

M. A., 2003), which demonstrates a potential benefit from consuming almonds on improving cardiovascular health. For these reasons, studies of natural foods that have the potential to significantly improve circulating lipid profiles, especially reducing pLDL-c, are of particular importance.

The nutraceutical benefits of nuts provide promise for taking a dietary approach to addressing the increasing prevalence of CVD globally. The mechanisms by which nuts and nut-supplemented diets contribute to reduced pTC and pLDL-c have not been revealed, and, given the nature of these types of studies, elucidation of these mechanisms in humans is not likely. Thus, the intriguing question of how nuts induce a cholesterol-lowering benefit remains. Is the effect simply and strictly displacement or do nuts reduce *de novo* cholesterol synthesis? In the interim, theoretical studies that provide a better understanding of the effects of almond supplemented diets on plasma cholesterol will serve a meaningful purpose to this end and provide further insight on the impacts of dietary interactions among different foods. A modeling approach to better understand the impacts of dietary fats and nut consumption on plasma cholesterol has been realized (Kris-Etherton P. M., 1999). This highly innovative approach and significant contribution to the area of nut consumption and circulating lipids examined the effects of substituting saturated fat intake with monounsaturated and polyunsaturated fatty acids by varying the consumption of various nuts (Kris-Etherton P. M., 1999). This study acknowledged that the levels of dietary SFA may be manipulated by the consumption of nuts, which is an effective strategy for reducing pLDL-c concentrations, and for preventing a reduction in HDL-cholesterol and an increase in plasma triglyceride induced by low fat, high carbohydrate diets (Kris-Etherton P. M., 1999). However, this comprehensive and elegant meta-analysis examined all nuts and did not specifically focus on assessing covariate effects of dietary SFA and almond supplementation on changes in plasma cholesterol. Furthermore, we took an alternative approach to assessing almond consumption by examining consumption as a function of body mass. Most studies report nut consumption as a fixed variable without consideration for a potential effect of changes in body mass, which is a tenet of pharmacological studies. That is, we wanted to evaluate if a dose-dependent effect of almond consumption on plasma cholesterol (TC

and LDL-c) existed, which has not been presented previously. Thus, the current study was conceived in a manner to complement the significant contributions of those previously described (Kris-Etherton P. M., 1999). Therefore, we modeled the more recent data on the effects of almond-supplemented diets on plasma cholesterol to address the hypothesis that relative almond intake has a greater impact on reducing plasma cholesterol than dietary SFA.



MATERIALS AND METHODS

The present work was carried out in the laboratory of Department of Animal Husbandry and Dairying, Banaras Hindu University, Varanasi, India. *Kalakand* was manufactured using milk standardized to 6% fat and 9% SNF. The Milk was procured from the Dairy Farm, Banaras Hindu University, Varanasi, India. Sugar almond and papaya used for the manufacture of *Kalakand* was procured from the local market of Varanasi, India

3.1 Materials required

3.1.1 Milk

Cow milk which was standardized at 6% fat and 9% SNF was taken from the dairy farm of Banaras Hindu University, Varanasi, UP.

3.1.2 Sugar

Good quality sugar was obtained from the local market of Varanasi.

3.1.3 Citric acid

Citric acid was procured from Thermo Fisher Scientific India Pvt. Ltd.

3.1.4 Papaya

Good quality ripe papaya was obtained from the local market of Varanasi.

3.1.5 Almond

Almond was obtained from the local market of Varanasi

3.1.6 Equipment's used for preparation of *Kalakand*

Gas stove with cylinder assembly, Shallow iron *karahi*, Muslin cloth, Thermometer, Bamboo splints, Spoon and Bowl.

3.1.7 Equipment's used for analysis of *Kalakand*:

- (i) Kjeldahl apparatus, Kel plus-elite EX, India.
- (ii) Hot air oven, Perfit India.
- (iii) Electronics weighing balance, Metter Toledo.
- (iv) Muffle furnace, Snol, Lithuania.
- (v) Water bath, Vision Scientific, Korea.
- (vi) Centrifugal machine.
- (vii) Cheese butyrometer.

3.2 Process and testing used for manufacture of *kalakand*

- 3.2.1 Procurement of cow milk.
- 3.2.2 Preparation of sample of milk.
- 3.2.3 Testing of milk sample.
- 3.2.4 Standardization of milk.
- 3.2.5 Preparation of value added *kalakand* using papaya pulp and almond .
- 3.2.6 Estimating yield of *kalakand*.
- 3.2.7 Sensory evaluation of products sample for various physical traits.
- 3.2.8 Determination of chemical composition of value added *kalakand*.
- 3.2.9 Statistical analysis of papaya and almond *kalakand*.
- 3.2.10 Cost structure of papaya and almond *kalakand*.

3.2.1 Procurement of cow milk

For the purpose of present investigation, the fresh cow milk was collected daily in the morning from Banaras Hindu University Dairy farm.

3.2.2 Preparation of sample of milk

Samples are received after few days of drawl and contain preservative (0.4% formalin). Warm the sample to 37- 40°C by transferring it to the beaker and keeping it in a water bath maintained at 40 - 45°C. Stir slowly for proper homogenization. Mix sample thoroughly by pouring back into the bottle, mixing to dislodge any residual fat sticking to the sides and pour it back in the beaker. During mixing do not shake the bottle vigorously. Allow the sample to come to room temperature (26- 28°C) and withdraw immediately for analysis.

3.2.3 Testing of Milk Samples

The milk samples were tested for fat, specific gravity, acidity, total solid and solid -not-fat (SNF) as per given here under.

3.2.3.1 Determination of fat in milk

Milk fat was determined by Gerber's method using milk butyrometer. In this method 10 ml of commercial grade sulphuric acid (sp. Gr. 1.820-1.824 at 27 °C) was transferred into a milk butyrometer using automatic tilt measures take due care as not to wet the neck of butyrometer. Thoroughly mixed sample of milk was added slowly using 10.75 ml pipette followed by 1 ml amyl alcohol (sp. Gr. 0.803-0.805) using an automatic tilt measure.

The mouth of butyrometer was firmly stopped with help of stopper key and content were shaken well by applying gentle swirling motion till most of the organic constituents were dissolved. The content was warmed in water bath (maintained at

70±2 °C) for 5 minutes. The butyrometer after wiping it dry was subsequently loaded in Gerber's centrifugal and centrifuged for 5 minutes at 1200 rpm. Again, the butyrometer transferred into water bath (70°C) for 3 minutes. Before recording the reading that fat column was adjusted in such a way that it makes readable.

3.2.3.2 Determination of specific gravity

Specific gravity of milk was determined by the following procedure described in manual No. IS 1183 (1965). After the mixing the milk sample thoroughly but gently, avoiding foam formation they were transferred into a lactometer jar pouring it by sides. A clean dry lactometer was suspended into the milk and the reading was noted after the lactometer got stationary.

Temperature of milk sample was noted simultaneously and specific gravity was calculated at 20 °C as per formulation given below.

$$\text{Specific gravity} = 1 + \frac{CLR}{1000}$$

$$CLR = OLR \pm 0.5(MC) + \Delta T \times 0.1$$

Where,

CLR = Corrected Lactometer Reading

OLR = Observed Lactometer Reading

MC = Meniscus Correction

ΔT = Change in Temperature

When the temperature of milk sample was more than 20 °C (68 °F) the factor 0.1 was added for every 1°C increase in temperature or 0.1 subtracted for every 1°C decrease in the temperature from the standard.

3.2.3.3 Determination of acidity

For acidity determination 10 ml of representative milk sample was measured in porcelain dish (50-100 ml) and 1 ml of 0.5 percent phenolphthalein indicator was added to it.

Simultaneously, a milk sample was also taken in another porcelain disc for comparison. In one sample 1 ml of Rosaniline acetate was added again standard alkali (N/9 sodium hydroxide solution) until the colour of sample changed to a pink shade which matches to the tint of the sample in other porcelain dish containing Rosaniline solution. Percent acidity of the term of lactic acid was calculated by multiplying the volume of N/9 sodium hydroxide solution used by 0.1.

3.2.3.4 Determination of total solid

Total solid in milk were estimated by following the modified Richmond's formula as:

$$\%TS = 0.25 L + 1.21 F + 0.66(\text{at } 20\text{ }^\circ\text{C})$$

Where,

TS = Total solid percentage

L = Corrected lactometer reading

F = present fat in milk

3.2.3.5 Determination of solid-not-fat (SNF)

SNF content of milk was obtained by subtracting the percentage of fat from the percentage of total solid in milk as:

$$\% \text{ SNF} = \text{Total solid percentage of milk} - \text{Fat percentage in milk.}$$

3.2.4 Standardization of cow milk

It may be defined as the adjustment of one or more of the milk constituents to a nominated level. In market milk industry, this normally involves reducing the butterfat content by addition of skim milk or through the removal of cream.

For standardization of milk or cream for product manufacture, usually the proportions of the various ingredients of known composition to be mixed, is required to be estimated. This can be done by:

Pearson's Square method

Draw a square and place in the centre of it the desired fat percentage. Place at the left hand corners of the square, the fat percentage of the materials to be mixed. Next, subtract the number in Centre from the larger number at the left hand side of the square and place the remainder at the diagonally opposite right corners. The number on the right hand side now represent the number of parts of each of the original materials that must be blended to have the desired fat content in resultant mix. The number at the upper right corner to the parts of materials whose fat test was placed at the upper left corner and the number at the lower right corner. If the numbers on the right are added, the sum obtained will represent the parts of the finished product.

3.2.5 Manufacturing of Almond incarpoted Papaya *Kalakand*

Kalakand was manufactured using standardized milk (6% fat and 9% SNF). It was prepared by procedure standardized by Aneja *et al.* (2002) with slight modifications. Standardized milk was taken in a jacketed vessel and heated to simmering temperature (85-90°C) with continuous stirring by a wooden ladle in a circular motion with occasional scraping of the heating surface. After 10-15 minutes of boiling, 0.02 percent of citric acid (in the form of solution) was added to the milk for the purpose of formation of granules. After 1-2 minutes stirring add papaya pulp @ 5 %, 10%, and 15 %. Vigorous stirring was performed to obtain good quality product. The intensity of heating was reduced when semi-solid state was reached. To this preparation different level of @ 5%, 10 % and 15 % sugar (w/w) and 0.2%,0.5%

and 1.0% almond was added, while continuous stirring the product. The finished product was transferred to tray greased (single layer) with ghee for cooling and setting. After cooling and setting at room temperature the set product was cut into the square pieces of 1.5 cm³ size.

The process diagram for manufacturing of *Kalakand* is shown in Figure 3.1

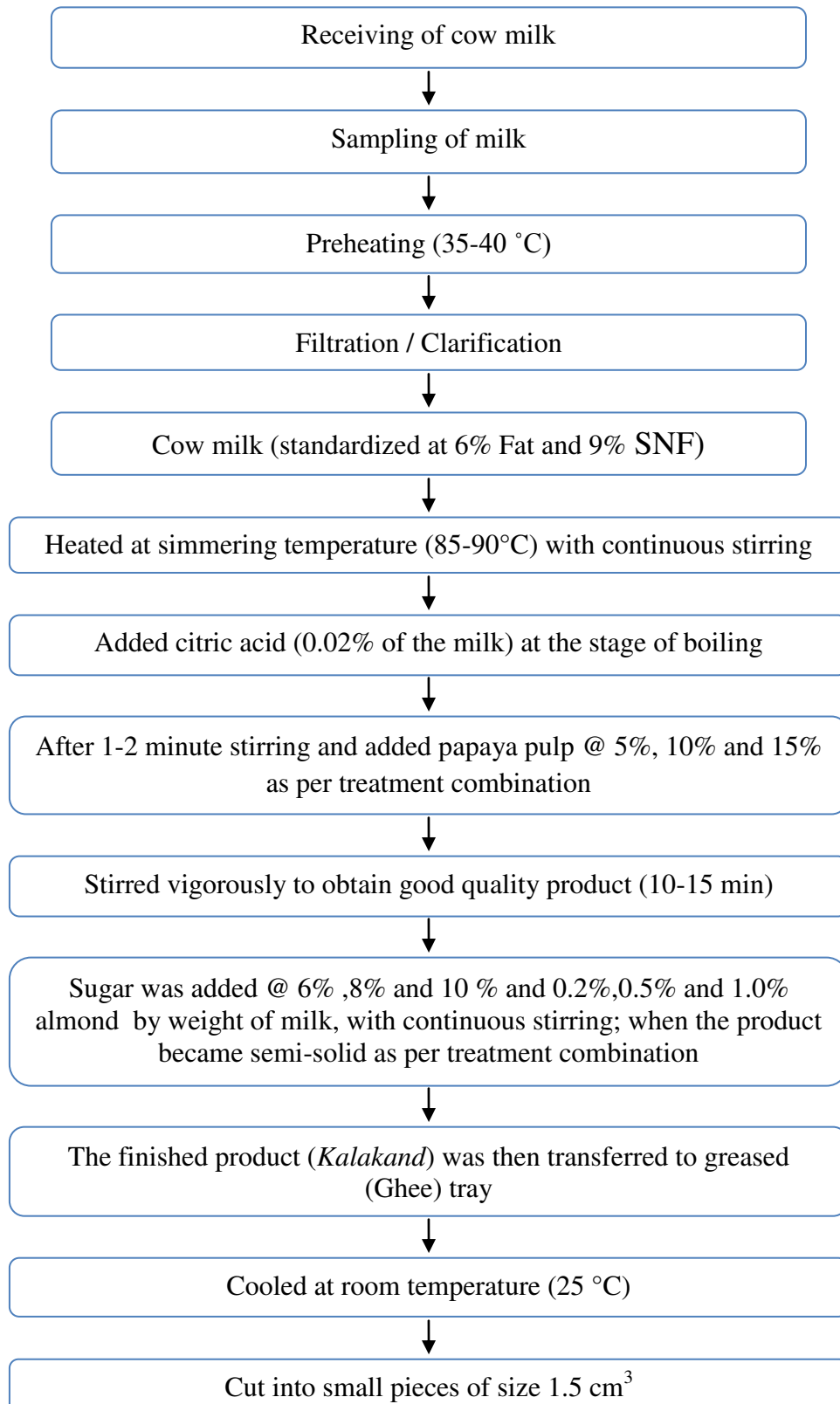


Figure 3.1: Process diagram for manufacturing the *Kalakand* using papaya pulp.

3.2.6 Estimation of yield

Product obtained under each treatment was weight separately after preparation and cooling. Its yield was expressed as total constitutes percentage of milk taken on fresh weight basis. The yield of *Kalakand* was calculated using following formula:

$$\text{Yield (\%)} = \frac{\text{Weight of product (gm)}}{\text{Weight of constitute in milk (gm)}}$$

3.2.7 Sensory evaluation of the products

The sample of *Kalakand* were drawn and evaluated for their sensory qualities immediately after preparation by a panel of judges selected from the Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

Judges panel

1. Prof. D. C. Rai
2. Prof. R. K. Pandey
3. Dr. V. K. Paswan

Nine-point hedonic scale was used to evaluate the product for various physical characteristics and for overall acceptability, sensory evaluation card for judging *Kalakand* was:

| Grade | Score |
|--------------------|--------------|
| Liked extremely | 9 |
| Liked very much | 8 |
| Liked moderately | 7 |
| Liked slightly | 6 |
| No comments | 5 |
| Dislike slightly | 4 |
| Dislike moderately | 3 |
| Dislike very much | 2 |
| Dislike extremely | 1 |

| Sample code | Color and appearance | Flavor | Body and texture | Sweetness | OAA |
|----------------------|-----------------------------|---------------|-------------------------|------------------|------------|
| T ₀ | | | | | |
| T ₁ | | | | | |
| T ₂ | | | | | |
| T ₃ | | | | | |

Remark, if any.

Signature of judge

Date.....

3.2.8 Analytical techniques for determination of chemical composition of *kalakand*

3.2.8.1 Fat content

Gerber's method for determination of fat content in cheese was used with some modification, which included: dispersion of 2-3 gm. of the sample in 10-12 ml of distilled boiled water, cooling of the content to room temperature use of 85 percent V/V H₂SO₄ instead of Gerber's acid in order to avoid blanking of fat column due to the presence of cane sugar and computation of the result for 3 gm. of sample.

Method

Three gm. of finally ground each prepared product was weighted in cheese butyrometer cup, 10- 12 ml Luke warm distilled water was added to this, 10 ml of sulphuric acid (H₂SO₄, sp.gr. 1.825) and 1 ml amyl alcohol (sp.gr. 0.825) was added to the cheese butyrometer. The butyrometer was stopped and then content was mixed well with occasionally shaking until the sample was completely dissolved. The butyrometer was then after, transferred to water bath maintained at a temperature at 70°C for 15 minute. Then the butyrometer was transferred immediately in the Gerber's centrifuged machine, it for the about 5 minute at speed 1000-1200 rpm. Butyrometer was again transferred to ware bath and maintained 70 °C for 5 minutes. The reading was noted to graduated stem of butyrometer fat column.

3.2.8.2 Protein content

The protein content of *Kalakand* was estimated by using Kjeldahl method described by Davis and Mac Donald (1953). Approximately 0.5-1 g of *kalakand* mix sample was taken in a clean dry Kjeldahl flask. Thereafter 10 ml pure nitrogen free sulphuric acid (H₂SO₄), 4 g of pure potassium sulphate (K₂SO₄) crystals and copper sulphate crystals (CuSO₄) were added into Kjeldahl flask. Then the Kjeldahl flask was transferred to digestion chamber for digestion of the content. Upon digestion, when the content of flask became carbon free, the Kjeldahl flask was allowed to cool down. To this flask, approximately 400 ml of distilled water added and then the

content transfer to distillation flask. Twenty-five ml of 4% Boric acid with Methylene red indicator was taken in conical flask. Approximately, 90 ml of 40% NaOH solution was then added to the distillation flask. The conical flask was placed below condenser to collect the condensate. The distillation head was fixed on distillation flask and condenser. The distillation process was continued until about 300 ml distillate was collected in the conical flask.

Following the usual precautions, the beaker was removed from the assembly. The evolved $N_2\%$ was determined by titrating condensate with 0.1 N HCl. Percentage protein was calculated by following formula:

$$\text{Nitrogen \%} = (\text{Sample titer} - \text{Blank titer}) \times \text{Normality of HCl} \times 14.01 \times 100 \text{Wt. of sample} \times \text{Aliquot taken for distillation} \times 1000$$

$$\text{Protein \%} = \text{Nitrogen \%} \times 6.25$$

3.2.8.3 Moisture

Moisture content was calculated as per the method of AOAC (2000). Approximately, 5g well mixed sample was accurately weighed into a cooled and tare aluminum dish. The sample was heated in an oven maintained at 105 ± 2 °C for 4 h. The dish was transferred to desiccators and upon cooling, weighed. Moisture content was calculated as under:

$$\text{Moisture \%} = \frac{(W_2 - W_1) \times 100}{(W_1 - W)}$$

Where,

W = Weight of empty dish (gm),

W_1 = Weight of dish with the sample (gm)

W_2 = Final weight of dish (gm).

3.2.8.4 Ash

Approximately, 3 g sample was accurately weighed into a silica crucible and kept for charring on hot plate for 2 h. After that the sample was kept for ashing in a muffle furnace at 550 ± 2 °C for 4 h. (AOAC, 2000).

3.2.8.5 Total solid

The method reported in IS: 2785 (1964) was used five gram of purified sand was taken to avoid churning of the sample during evaporation and 5 ml of distilled water used for uniform mixing before heating.

The following formula was used to calculated the total solid percentage in *Kalakand*.

$$\text{Total solids percentage} = 100 - \text{Moisture percent in product}$$

3.2.8.6 Carbohydrate

The following formula was used to calculated the carbohydrate percentage in *Kalakand*.

$$\text{Carbohydrate (\% by difference)} = \text{Total solid \%} - (\text{Fat \%} + \text{Protein \%} + \text{Ash \%})$$

3.2.9 Statistical Analysis

All the data were expressed as mean \pm standard deviation of mean and was calculated from three independent experiments. One-way analysis of variance (ANOVA) was applied and Duncan multiple range test was performed to measure the test of significance by post hoc test using SPSS 16.0 software (SPSS Italia, Bologna, Italy).

3.2.10 Cost structure of papaya and almond *kalakand*

Cost was calculated as per prevailing rates of milk and other ingredients used for the preparation of *kalakand* blended with different levels of papaya pulp and almond.

Plan of Work

The plan of work was as follows:

(A) Papaya pulp

1. 5 %
2. 10 %
3. 15 %

(B) Sugar

1. 5 %
2. 10 %
3. 15 %

(C) Almond

1. 0.2%
2. 0.5%
3. 1.0%

(D) T₀ Control sample

(E) Replication

1. R₁
2. R₂
3. R₂

(E) Total number of observation = $10 \times 3 = 30$

Treatment of different level combination of almond @0.2%,0.5% and 1.0%, papaya @ 5%,10%,and 15% replacement of milk and sugar @ 5%,10%,and 15% weight by milk are given in

Table 3.1: Treatment of different level combination of papaya and sugar

| Combination | Papaya pulp @ 10 % | Papaya pulp @15 % | Papaya pulp @ 20 % |
|----------------------------------|--|---|---|
| Sugar @ 6 % + Almond@0.2% | T ₁ Milk replace with Papaya pulp @10 % Sugar @ 6 % weight of milk | T ₂ Milk replace with Papaya pulp @ 15 % Sugar @ 6 % weight of milk | T ₃ Milk replace with Papaya pulp @2 0 % Sugar @ 6 % weight of milk |
| Sugar @ 8 % + Almond@0.5% | T ₄ Milk replace with Papaya pulp @10 % Sugar @ 8 % weight of milk | T ₅ Milk replace with Papaya pulp @ 15 % Sugar @ 8 % weight of milk | T ₆ Milk replace with Papaya pulp @20 % Sugar @ 8 % weight of milk |
| Sugar @ 10 % + Almond@1.0% | T ₇ Milk replace with Papaya pulp @10 % Sugar @ 10 % weight of milk | T ₈ Milk replace with Papaya pulp @ 15 % Sugar @ 10 % weight of milk | T ₉ Milk replace with Papaya pulp @20 % Sugar @ 10 % weight of milk |



RESULTS AND DISCUSSION

The present study was undertaken with the objective to optimize the process for *value added kalakand using papaya pulp and almond*. In the initial as well as starting stages of the study preliminary trial was conducted to screen the papaya for the manufacture of *almondenriched papaya kalakand*. After, the levels of these papaya and *almond* were optimized. *Almond* powder and papaya pulp were added in kalakand to increase functionality of product. The results obtained on different aspects of this investigation are presented have been illustrated in Tables and figures under following sub-headings:

- Process optimization for manufacturing of *Almondenriched papaya kalakand* on sensory basis.
- Effect of different variables on physico-chemical properties of *Almondenriched papaya kalakand*.
- Estimation cost of production for manufacture of *Almondenriched papaya kalakand*.

4.1 Parameters optimization:-

By using completely randomized Design (CRD), levels of variables viz. *Almond* powder and papaya pulp were selected through including control treatment total 30 experiments including control treatment. The sensory evaluation and textural scores as influenced by levels of papaya pulp *Almond* powder.

4.1.1 Chemical composition of control treatment of kalakand

The control kalakand was analyzed for proximate analysis. The kalakand showed 64-85 % total solids, 25.50% moisture content, 1.5-3.5 % ash, 5-26 % milk fat, acidity(% Lactic acid) 0.25-0.7 and 9-18% total protein.

4.2 Effect of different variables on sensory evaluation of optimized *Almond* enriched papaya Kalakand

4.2.1 Effect on colour and appearance:-

It is an very important property for any food material that increases the consumer`s demand as well as esthetic appeal. The effect of *Almond* powder and papaya pulp on sensory evaluation score on *Almond* enriched papaya kalakand is shown in table 4.2.1 and figure graph 4.2.1

Table 4.2.1(a): Effect of various combination of *Almond* powder and papaya pulp on colour and appearance of kalakand

| | R1 | R2 | R3 | TOTAL | MEAN |
|--------------|-------------|-------------|--------------|--------------|-------------|
| T0 | 8.36 | 8.77 | 8.33 | 25.44 | 8.48±0.25 |
| T1 | 8.56 | 8.86 | 8.99 | 26.35 | 8.78±0.22 |
| T2 | 8.48 | 8.29 | 8.21 | 24.93 | 8.31±0.14 |
| T3 | 7.63 | 7.05 | 7.3 | 21.98 | 7.32±0.29 |
| T4 | 7.04 | 8.45 | 8.45 | 23.94 | 7.98±0.81 |
| T5 | 7.64 | 8.02 | 7.54 | 23.2 | 7.73±0.25 |
| T6 | 6.87 | 6.67 | 6.98 | 20.52 | 6.84±0.16 |
| T7 | 8.01 | 8.16 | 8.3 | 24.36 | 8.12±0.15 |
| T8 | 8.15 | 7.25 | 7.16 | 22.54 | 7.51±0.55 |
| T9 | 6.26 | 6.39 | 6.20 | 18.81 | 6.27±0.10 |
| Total | 76.9 | 77.81 | 77.36 | 232.07 | |
| MEAN | 7.69 | 7.78 | 7.736 | | |

The ANOVA and F-value was determined to examine the goodness of fit for the developed model (Table 4.2.1.b). The F-value for model of colour and appearance was significant ($p < 0.5\%$). The hedonic score for the colour and appearance varied from 6.27 to 8.78 (table 4.2.1.a). It can be seen that hedonic score for the colour and appearance decreases with increasing three levels almond powder (0.2, 0.5% and 1.0 %). It was observed that highest score obtained by T₁ (8.78) most acceptable and lowest score was obtained by T₉ (6.27). The value of difference of T₀ and T₃, T₀ and T₅, T₀ and T₆, T₀ and T₈, T₀ and T₉ were 1.16, 0.75, 1.64, 0.97 and 2.21 and these values were more than the CD value (0.610). So T₁, T₂, T₄, and T₇ were at par with T₀ and T₃, T₅, T₆, T₈ and T₉ were significant with respect to T₀.

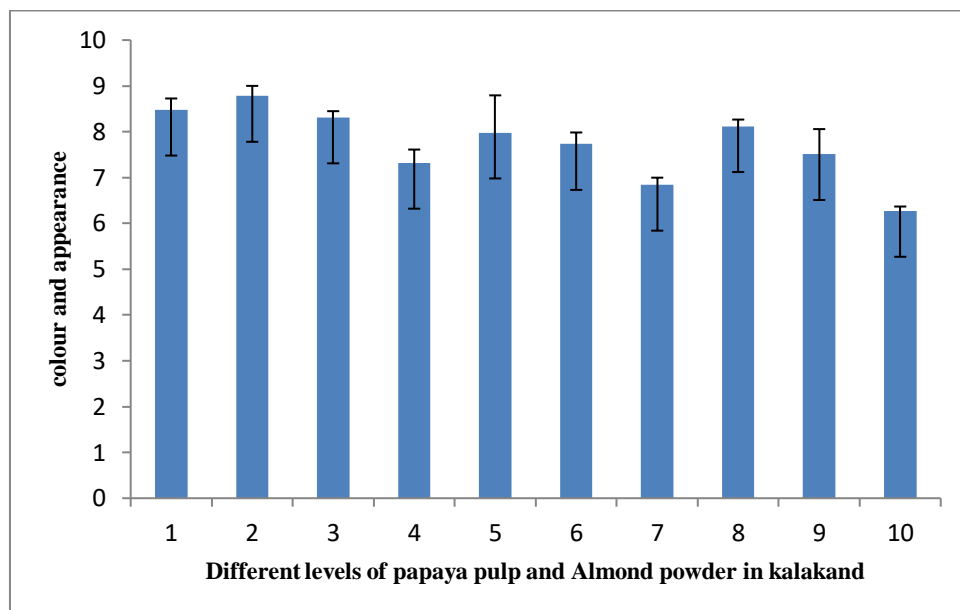


Figure 4.2.1 Effect of various Combinations of *Almond* powder and papaya pulp on colour and appearance of kalakand

4.2.2 Effect on flavour

Flavour (taste and smell) is the most important factor in acceptance of desserts. The ANOVA and F-value was determined to examine the goodness of fit for the developed 4.2.2. b). The F-value for model of flavour was significant ($p < 0.5\%$).

The value of difference of T₀ and T₁, T₀ and T₃, T₀ and T₄, T₀ and T₅, T₀ and T₆, T₀ and T₈, T₀ and T₉ were 0.7, 0.93, 1.13, 0.93, 1.34, 1.48, 1.36 and 1.37 and these values were more than CD value (0.699). So T₂ were at par with T₀ and T₁, T₃, T₄, T₅, T₆, T₇, T₈, and T₉ were significant with respect to T₀. The hedonic score for the flavour varied from 6.06 To 7.61 (Table 4.2.2.a).

Table 4.2.2(a): Effect of various combinations of Almond powder and papaya pulp on flavour of kalakand

| | R1 | R2 | R3 | TOTAL | MEAN ± STDEV |
|--------------|-------------|-------------|-------------|--------------|---------------------|
| T0 | 7.30 | 7.45 | 7.87 | 22.62 | 7.54±0.30 |
| T1 | 7.47 | 7.36 | 7.98 | 22.81 | 7.61±0.33 |
| T2 | 7.06 | 7.18 | 8.02 | 22.23 | 7.41±0.52 |
| T3 | 6.92 | 6.7 | 6.40 | 19.83 | 6.61±0.26 |
| T4 | 6.88 | 6.28 | 6.33 | 19.49 | 6.41±0.33 |
| T5 | 6.37 | 7.26 | 6.20 | 19.83 | 6.61±0.57 |
| T6 | 6.23 | 6.12 | 6.24 | 18.6 | 6.20±0.07 |
| T7 | 6.11 | 6.07 | 6.0 | 18.18 | 6.06±0.06 |
| T8 | 6.52 | 5.35 | 6.67 | 18.54 | 6.18±0.72 |
| T9 | 6.54 | 5.78 | 6.20 | 18.52 | 6.17±0.38 |
| TOTAL | 67.45 | 65.29 | 67.91 | 200.65 | |
| MEAN | 6.74 | 6.52 | 6.79 | | |

It can be seen that hedonic score for the flavour decreases with increasing levels of *Almond* powder (0.2, 0.5% and 1.0%). It was observed that highest score obtained by T₁ (7.6) was most acceptable and lowest score was obtained by T₇ (6.06).

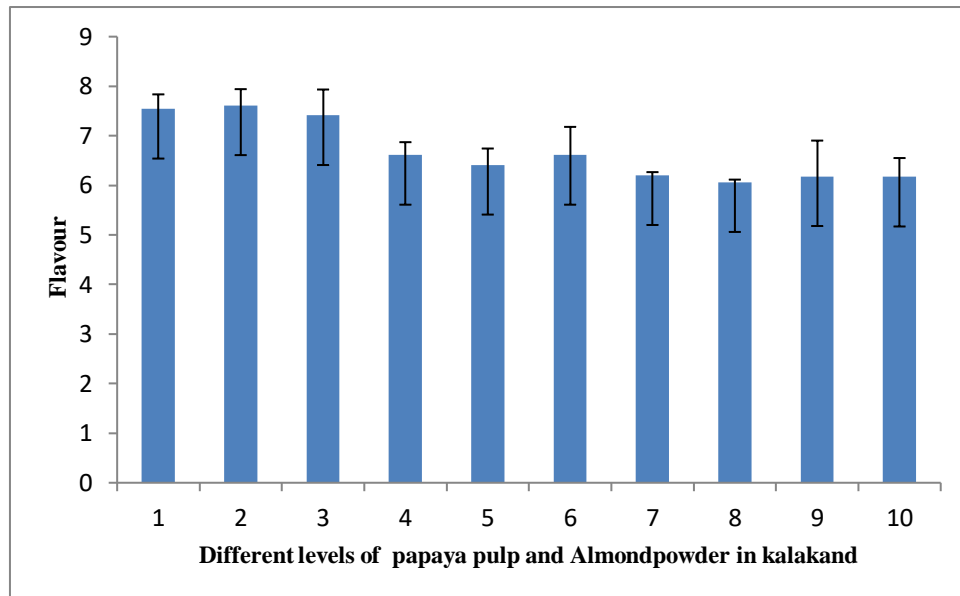


Figure 4.2.2: Effect of various combinations of *Almond* powder and papaya on flavour of kalakand

4.2.3 Effect on texture

Texture or mouth feel is important to customer acceptance point of view. The ANOVA and F-value was determined to examine the goodness of fit for the developed model (Table 4.2.3.b). The F-value for model of texture was significant ($p < 0.5\%$). The hedonic score for the texture varied from 6.17 to 8.57 (table 4.2.3.a). It can be seen that hedonic score for the texture decreases with increasing levels of *Almond* powder (0.2, 0.5 and 1.0 %). It was observed highest score obtained by T₀ (8.57) was most acceptable and lowest score was obtained by T₉ (6.17). The value of difference T₀ and T₃, T₀ and T₄, T₀ and T₅, T₀ and T₆, T₀ and T₇, T₀ and T₈, and T₀ and T₉ were 0.9, 0.94, 0.68, 0.7, 1.43, 1.47, 1.79 and 2.4 and these value were more than

the CD value 0.54. So T₁ were at par with T₀ and T₂, T₃, T₄, T₅, T₆, T₇, T₈, T₉ were significant with respect of T₀.

Table 4.2.3(a) Effect of various combinations of *Almond* powder and papaya pulp on texture of kalakand.

| | R1 | R2 | R3 | TOTAL | MEAN |
|--------------|--------------|-------------|-------------|--------------|-------------|
| T0 | 8.72 | 8.91 | 8.5 | 25.72 | 8.57±0.21 |
| T1 | 8.45 | 8.34 | 8.94 | 24.6 | 8.20±0.32 |
| T2 | 8.14 | 8.17 | 8.2 | 23.02 | 7.67±0.03 |
| T3 | 7.86 | 7.96 | 7.2 | 22.9 | 7.63±0.41 |
| T4 | 7.33 | 8.25 | 7.32 | 23.67 | 7.89±0.53 |
| T5 | 7.36 | 8.92 | 7.3 | 23.62 | 7.87±0.92 |
| T6 | 7.33 | 8.87 | 7.42 | 21.43 | 7.14±0.86 |
| T7 | 7.11 | 7.55 | 6.77 | 21.31 | 7.10±0.39 |
| T8 | 6.93 | 7.77 | 6.61 | 20.35 | 6.78±0.60 |
| T9 | 6.66 | 7.47 | 6.22 | 18.52 | 6.17±0.63 |
| TOTAL | 73.77 | 78.99 | 72.38 | 225.14 | |
| MEAN | 7.377 | 7.89 | 7.23 | | |

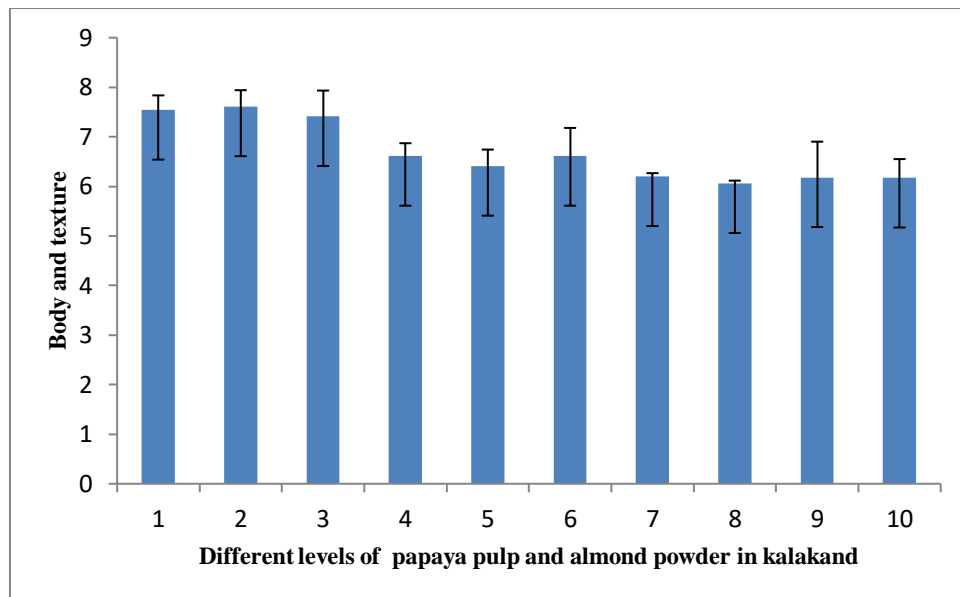


Figure 4.2.3: Effect of various combinations of *Almond* powder and papaya on body and texture of kalakand.

4.2.4 Effect on overall acceptability

Overall acceptability is one most indicator which are directly shows consumer demand and preference. The ANOVA and F-value was determined to examine the goodness of fit for the complete developed model (Table 4.2.5.b). The F-value for model of Overall acceptability was significant ($p < 0.5\%$). The hedonic score for the Overall acceptability varied from 6.80 to 8.74 (table 4.2.5.a). The value of difference of T_0 and T_5 , T_0 and T_6 , T_0 and T_8 , T_0 and T_9 were 1.1, 1.2, 1.07 and 1.58. These value were more than CD value (0.859). So T_1 , T_2 , T_3 , T_4 , and T_7 were at par with T_0 and T_5 , T_6 , T_8 and T_9 were significant with respect to T_0 . It can be seen in the table 4.2.5 that Overall acceptability score decreases with increasing levels *Almond* powder (0.2-1.0 %) and papaya pulp (5-15%). It was observed highest score obtained by T_1 (8.74) was most acceptable and lowest score was obtained by T_9 (6.80).

Table 4.2.4(a): Effect of various Combinations of *Almond* powder and papaya pulp kalakand on overall acceptability.

| | R1 | R2 | R3 | TOTAL | MEAN |
|--------------|-------------|--------------|--------------|--------------|-------------|
| T0 | 8.35 | 8.44 | 8.37 | 25.16 | 8.38 |
| T1 | 8.46 | 8.98 | 8.79 | 26.23 | 8.74 |
| T2 | 8.27 | 8.02 | 8.30 | 24.59 | 8.19 |
| T3 | 7.88 | 7.86 | 7.30 | 23.04 | 7.68 |
| T4 | 7.84 | 8.36 | 8.31 | 24.51 | 8.17 |
| T5 | 7.45 | 7.17 | 7.24 | 21.86 | 7.28 |
| T6 | 7.15 | 7.11 | 7.30 | 21.56 | 7.18 |
| T7 | 7.98 | 8.40 | 7.80 | 24.18 | 8.06 |
| T8 | 6.95 | 8.20 | 6.78 | 21.93 | 7.31 |
| T9 | 6.35 | 8.20 | 5.86 | 20.41 | 6.80 |
| TOTAL | 76.67 | 80.75 | 76.05 | 233.4 | |
| MEAN | 7.66 | 8.075 | 7.605 | | |

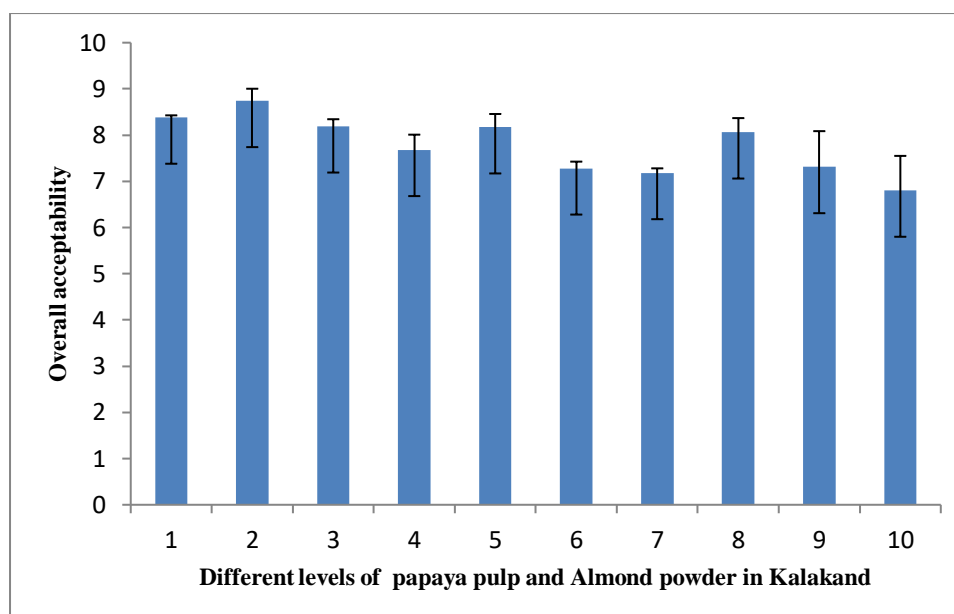


Figure 4.2.4 Effect of various combinations of *Almond* powder and papaya on overall acceptability of kalakand

4.3 Chemical composition of optimized kalakand

The control kalakand was analyzed for proximate analysis. The kalakand showed 73.5 % total solids, 26.50% moisture content, 2.2 % ash, 26 % milk fat, carbohydrate 35.50 % and 16% total protein.

4.3 Effect of different variables on physico-chemical properties of *Almond* enriched papaya pulp kalakand

4.3.1 Effect on moisture content

The control kalakand was analyzed for moisture content against different treatment of *Almond* powder enriched papaya kalakand as shown in the table 4.3.1.a. The ANOVA and F-value was determined to examine the goodness of fit for the developed model (Table 4.2.5.b). The F-value for model of moisture content was significant ($p < 0.5\%$). The value difference of T_0 and T_4 , T_0 and T_5 , T_0 and T_6 , T_0 and T_7 , T_0 and T_8 , T_0 and T_9 were 0.75, 0.73, 1.27, 1.86, 1.73 and 1.93. These value were more than CD value (0.62). So T_1 , T_2 and T_3 were at par with T_0 and T_4 , T_5 , T_6 , T_7 , T_8 and T_9 were significant with respect to T_0 . The moisture content of treatment is

increasing with increasing level of papaya while decreasing with increase in *Almond* powder level when is constant. Highest moisture level is reported in T₃(35.70%) and lowest in T₅(26.40%) which can be easily seen in the figure 4.3.1.

Table 4.3.1(a).Effect of various combinations of *Almond* powder and papaya pulp on moisture content of kalakand.

| | R1 | R2 | R3 | TOTAL | MEAN+STDEV |
|--------------|-------------|--------------|--------------|--------------|-------------------|
| T0 | 25.5 | 25.7 | 25.9 | 77.1 | 25.70±0.86 |
| T1 | 28.1 | 27.6 | 26.5 | 82.2 | 27.40±0.82 |
| T2 | 28.8 | 28.6 | 29.7 | 87.1 | 29.03±0.59 |
| T3 | 35.7 | 29.8 | 33.9 | 99.4 | 33.13±0.76 |
| T4 | 28.9 | 26.3 | 27.7 | 82.9 | 31.15±0.65 |
| T5 | 26.4 | 29.4 | 31.3 | 87.1 | 29.03±0.61 |
| T6 | 30.6 | 32.4 | 31.4 | 94.4 | 31.47±0.90 |
| T7 | 30.1 | 26.4 | 27.9 | 84.4 | 28.13±0.80 |
| T8 | 32.3 | 27.5 | 29.8 | 89.6 | 29.87±0.78 |
| T9 | 32.4 | 33.4 | 31.1 | 96.9 | 32.30±0.75 |
| TOTAL | 301 | 283.8 | 296.3 | | |
| MEAN | 30.1 | 28.38 | 29.63 | | |

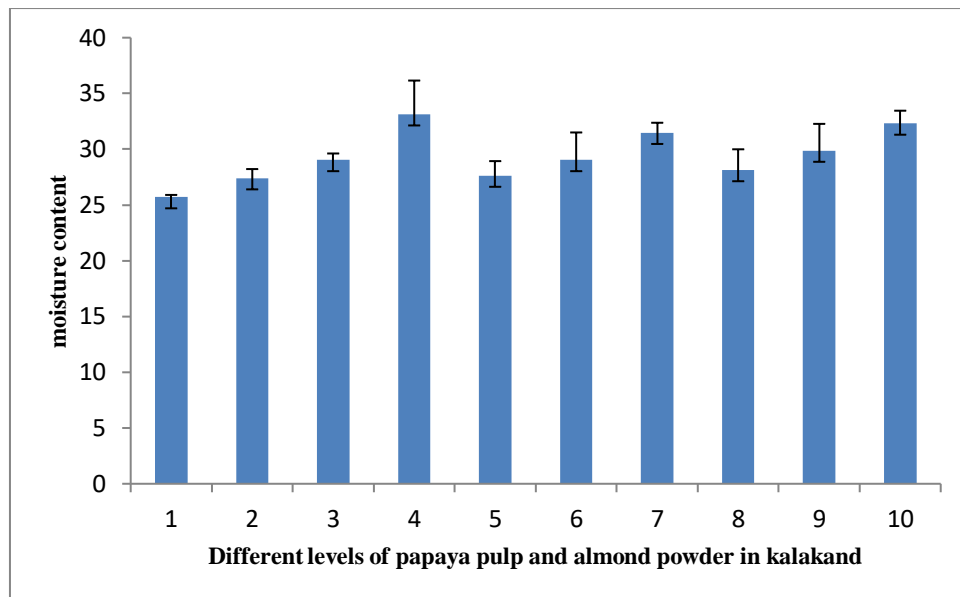


Figure 4.3.1. Effect of various combinations of *Almond* powder and papaya on moisture content of kalakand.

4.3.2 Effect on protein content

The control kalakand was analyzed for total protein against different treatment of *Almond* powder enriched Papaya Pulp kalakand as shown in the table 4.3.1.a, The ANOVA and F-value was determined to examine the goodness of fit for the developed model (Table 4.2.5.b). The F-value for model of total protein was significant ($p < 0.5\%$). The value of difference of T_0 and T_4 , T_0 and T_7 , T_0 and T_8 were 0.19, 0.33, and 0.19. These values were more than CD value 0.13. So T_1 , T_2 , T_3 , T_5 , T_6 , and T_9 were at par with T_0 and T_4 , T_7 and T_8 were significant with respect T_0 .

The protein content of papaya *kalakand* decreased in T_3 treatment (84.0 %) followed by T_6 (9.1%) and T_9 (9.3 %) because these treatments may contain higher amount of papaya level (20 %), this result may show that with increasing level of papaya in papaya *kalakand* the protein content will decrease. Highest protein content was reported in T_0 (15.08%) control sample. The value content for protein in papaya *kalakand* varies significantly in all the treatment. Protein content in papaya is lower than the plain *kalakand* so protein in *kalakand* decreased with increased level of papaya pulp in *kalakand*.

Table 4.3.2(a) Effect of various combinations of *Almond* powder and papaya on protein content of kalakand

| Treatment | R₁ | R₂ | R₃ | TOTAL | MEAN+STDEV |
|----------------------|----------------------|----------------------|----------------------|--------------|-------------------|
| T₀ | 15.08 | 17.1 | 16.03 | 48.21 | 16.07±0.95 |
| T₁ | 12.1 | 11.25 | 13.1 | 36.45 | 12.15±0.93 |
| T₂ | 10.8 | 10.1 | 10.3 | 31.2 | 10.40±0.36 |
| T₃ | 8.4 | 10.15 | 9.35 | 27.9 | 9.30±0.88 |
| T₄ | 13.6 | 10.9 | 12.4 | 36.9 | 12.30±0.86 |
| T₅ | 10.3 | 11 | 10.6 | 31.9 | 10.63±0.35 |
| T₆ | 9.1 | 9.4 | 9.7 | 28.2 | 9.40±0.30 |
| T₇ | 12.5 | 12.5 | 12.45 | 37.45 | 12.48±0.03 |
| T₈ | 9.9 | 10.2 | 10.5 | 30.6 | 10.20±0.30 |
| T₉ | 9.3 | 9.6 | 10.2 | 29.1 | 9.70±0.95 |
| TOTAL | 112.48 | 111.8 | 113.63 | | |
| MEAN | 11.248 | 11.18 | 11.363 | | |

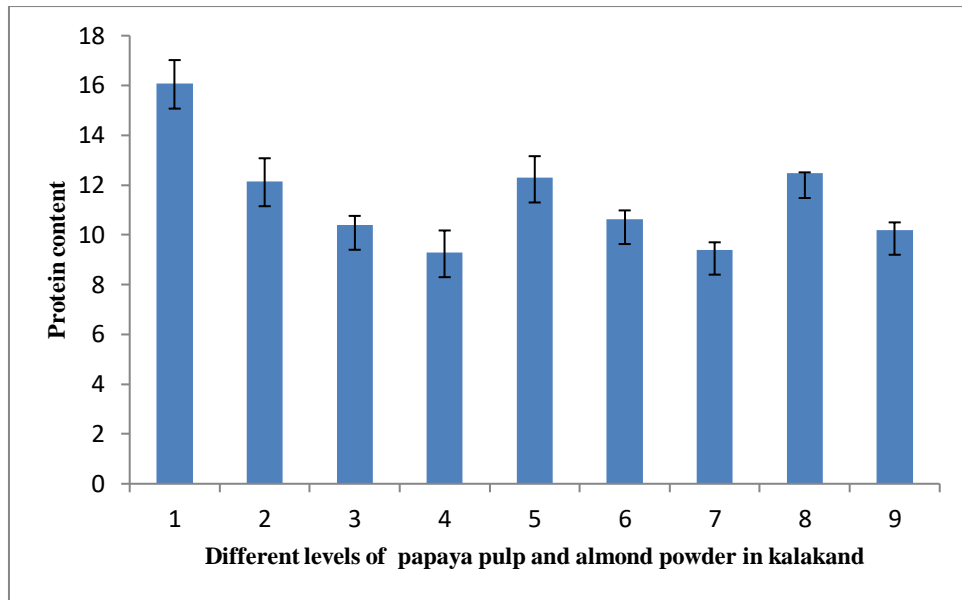


Figure 4.3.2: Effect of various combinations of *Almond* powder and papaya pulp on protein content of kalakand

4.3.3 Effect on fat content

The control kalakand was analyzed for fat content against different treatment of *Almond* powder enriched papaya kalakand as shown in the table 4.3.3.a. The ANOVA and F-value was determined to examine the goodness of fit for the developed model (Table 4.2.5.b). The F-value for model of fat content was significant ($p < 0.5\%$). The fat content of treatments is decreasing with increasing level of papaya and *Almond* powder. Highest fat content level is reported in T₄(23.7%) followed by T₁(23.6%) and lowest in T₆(15.3%) which can be easily seen in the figure 4.3.3. The value of difference of T₀ and T₆, T₀ and T₇, T₀ and T₈, T₀ and T₉ were value 0.26, 0.37, 0.51, and 0.61. These value were more than CD value 0.25. So T₁, T₂, T₃, T₄, and T₅ were at par with T₀ and T₆, T₇, T₈, and T₉ were significant with respect T₀.

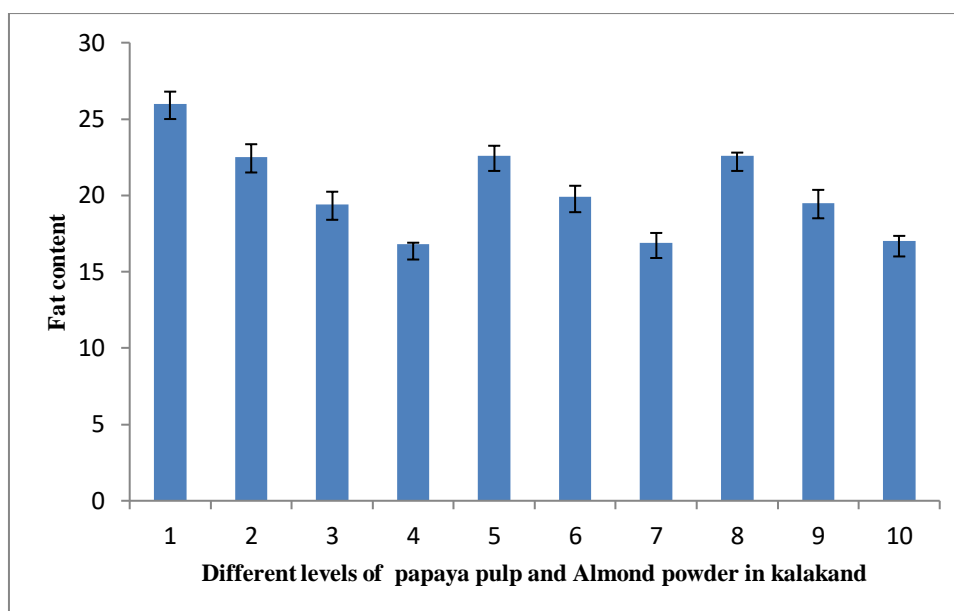


Figure 4.3.3.Effect of various combinations of *Almond* powder and papaya on fat content of kalakand.

Table 4.3.3(a) Effect of various combinations of *Almond* powder and papaya on fat content of kalakand.

| | R₁ | R₂ | R₃ | TOTAL | MEAN+STDEV |
|----------------------|----------------------|----------------------|----------------------|--------------|-------------------|
| T₀ | 25.1 | 26.6 | 26.3 | 78 | 26.00±0.79 |
| T₁ | 22.4 | 23.6 | 21.5 | 67.5 | 22.50±0.85 |
| T₂ | 18.3 | 20.7 | 19.2 | 58.2 | 19.40±0.84 |
| T₃ | 16.8 | 16.7 | 16.9 | 50.4 | 16.80±0.10 |
| T₄ | 21.5 | 23.7 | 22.6 | 67.8 | 22.60±0.65 |
| T₅ | 20.9 | 18.7 | 20.1 | 59.7 | 19.90±0.73 |
| T₆ | 15.3 | 18.5 | 16.9 | 50.7 | 16.90±0.64 |
| T₇ | 22.8 | 22.6 | 22.4 | 67.8 | 22.60±0.20 |
| T₈ | 20.5 | 18.4 | 19.6 | 58.5 | 19.50±0.86 |
| T₉ | 17.2 | 16.6 | 17.2 | 51 | 17.00±0.35 |
| TOTAL | 203.1 | 203.1 | 203.4 | | |
| MEAN | 20.31 | 20.31 | 20.34 | | |

4.3.4 Effect on Carbohydrate content

The control kalakand was analyzed for fat content against different treatment of *Almond* powder enriched papaya kalakand as shown in the table 4.3.4a. The ANOVA and F-value was determined to examine the goodness of fit for the developed model (Table 4.2.5.b). The F-value for model of fat content was significant ($p < 0.5\%$). The fat content of treatments is decreasing with increasing level of papaya and *Almond* powder. Highest fat content level is reported in T₉ (44.5%) followed by T₆ (40.9%) and lowest in T₁ (34.1%) which can be easily seen in the figure 4.3.3. The value of difference of T₀ and T₆, T₀ and T₇, T₀ and T₈, T₀ and T₉ were value 0.26, 0.37, 0.51, and 0.61. These value were more than CD value 0.25. So T₁, T₂, T₃, T₄, and T₅ were at par with T₀ and T₆, T₇, T₈, and T₉ were significant with respect T₀.

Table 4.3.4(a): Effect of various combinations of *Almond* powder and papaya pulp on carbohydrate content of kalakand

| Treatment | R ₁ | R ₂ | R ₃ | TOTAL | MEAN+STDEV |
|----------------|----------------|----------------|----------------|-------|------------|
| T ₀ | 30.5 | 30.9 | 30.75 | 92.15 | 30.72±0.20 |
| T ₁ | 34.1 | 35.8 | 35.3 | 105.2 | 35.07±0.87 |
| T ₂ | 37.1 | 39.2 | 38.8 | 115.1 | 38.37±0.87 |
| T ₃ | 41.5 | 42.7 | 41.5 | 125.7 | 41.90±0.69 |
| T ₄ | 34.2 | 35.5 | 35.5 | 106.2 | 35.40±0.75 |
| T ₅ | 39.5 | 38.1 | 39.1 | 116.7 | 38.90±0.72 |
| T ₆ | 40.9 | 43.1 | 42.1 | 126.1 | 42.03±0.85 |
| T ₇ | 35.6 | 35.9 | 36.2 | 107.7 | 35.90±0.30 |
| T ₈ | 37.9 | 40.2 | 39.3 | 117.4 | 39.13±0.75 |
| T ₉ | 42.9 | 44.5 | 42.1 | 129.5 | 43.17±0.83 |
| TOTAL | 378.2 | 381.9 | 381.65 | | |
| MEAN | 37.82 | 38.19 | 38.165 | | |

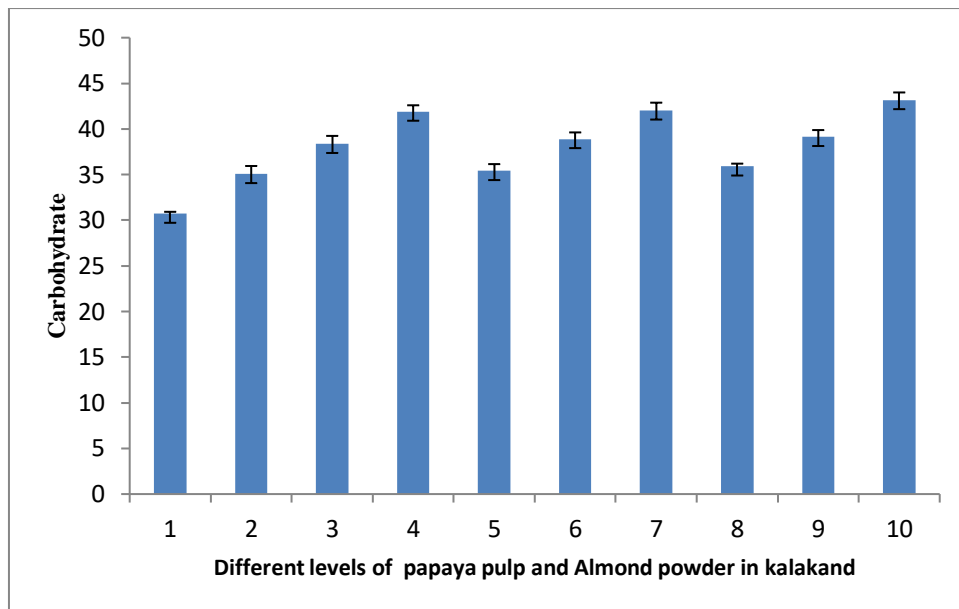


Figure 4.3.4: Effect of various combinations of *Almond* powder and papaya on carbohydrate content of kalakand

4.3.5 Effect on pH

The control kalakand was analyzed for pH against different treatment of *Almond* powder enriched papaya kalakand as shown in the table 4.3.1. a. The ANOVA and F-value was determined to examine the goodness of fit for the developed model (Table 4.2.5.b). The F-value for model of pH was significant ($p < 0.5\%$). The value of difference of T_0 and T_4 , T_0 and T_5 , T_0 and T_6 were 0.04, 0.06, 0.03, this value more than CD value (0.12). So T_1 , T_2 , T_3 , T_7 , T_8 and T_9 were at par with T_0 and T_4 , T_5 and T_6 were significant with respect to T_0 . The pH of treatments is decreasing with increasing level of papaya and *Almond* powder. Highest pH is reported in T_3 (6.37) followed by T_1 and T_0 (6.36) and lowest in T_9 (6.26) which can be easily seen in the figure 4.3.5

Table 4.3.5(a) Effect of various combination of *Almond* powder and papaya pulp pH of kalakand.

| | R1 | R2 | R3 | TOTAL | MEAN+STDEV |
|--------------|--------------|------------|-------------|--------------|-------------------|
| T0 | 6.34 | 6.37 | 6.37 | 19.08 | 6.36±0.45 |
| T1 | 6.36 | 6.38 | 6.34 | 19.08 | 6.36±0.56 |
| T2 | 6.31 | 6.34 | 6.35 | 19.00 | 6.33±0.58 |
| T3 | 6.34 | 6.43 | 6.34 | 19.11 | 6.37±0.52 |
| T4 | 6.34 | 6.3 | 6.32 | 18.96 | 6.32±0.53 |
| T5 | 6.29 | 6.31 | 6.3 | 18.90 | 6.30±0.38 |
| T6 | 6.385 | 6.32 | 6.29 | 18.99 | 6.33±0.67 |
| T7 | 6.27 | 6.27 | 6.27 | 18.81 | 6.27±0.50 |
| T8 | 6.34 | 6.25 | 6.28 | 18.87 | 6.29±0.61 |
| T9 | 6.37 | 6.03 | 6.4 | 18.8 | 6.26±0.58 |
| TOTAL | 63.345 | 63 | 63.26 | 189.60 | |
| MEAN | 6.345 | 6.3 | 6.32 | | |

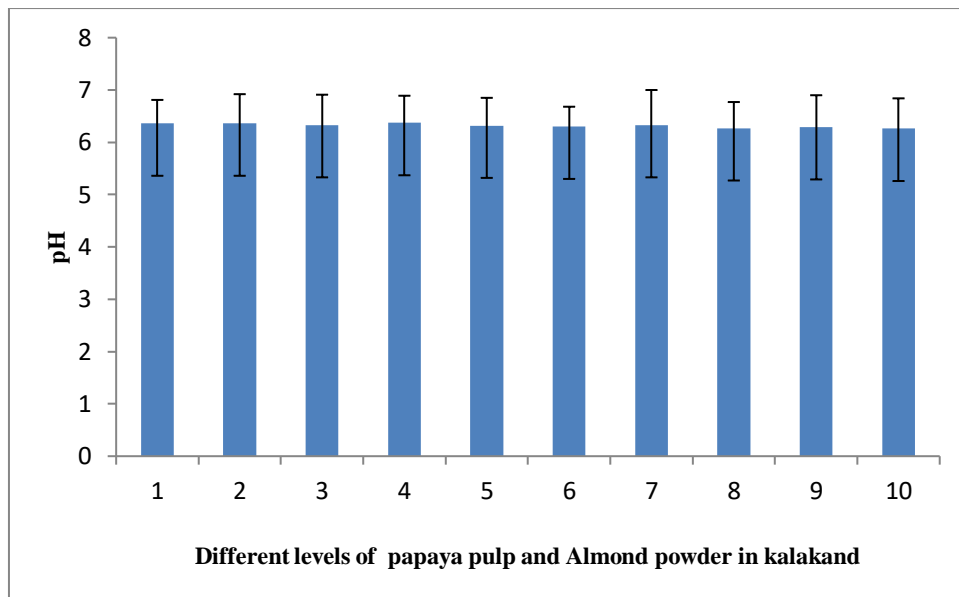


Figure 4.3.5 Effect of various combination of *Almond* powder and papaya on pH of kalakand.

4.3.6 Total solid content of value added papaya *kalakand* (%)

The value presented in table 4.3.6(a) and Fig. depicts that the average total solids in *kalakand* was the lowest in T₆ treatment (67.9%) followed by T₃ (68.5%) and T₅ (69.6 %). The value recorded in T₀ (76.3 %) treatment was non significantly higher ($p < 0.05$) than the values recorded in rest of all the treatment. Total solid decrease with increased level of papaya in *kalakand* due to papaya pulp has higher moisture content and low percentage of total solid.

Maximum and minimum total solid content was recorded in treatment T₀ (76.3 %) and T₁ (74.53 %). Contrary to the findings Arora *et al.* (1991) who reported comparatively lower total solids (74.88%) in the *kalakand* prepared from cow milk than buffalo milk.

Table 4.3.6(a) Effect of various combination of *Almond* powder and papaya pulp on total solid content of kalakand

| Treatment | R₁ | R₂ | R₃ | TOTAL | MEAN+STDEV |
|----------------------|----------------------|----------------------|----------------------|--------------|--------------------|
| T₀ | 74.3 | 76.1 | 75.4 | 225.8 | 75.27± 0.91 |
| T₁ | 72.4 | 74.3 | 73.6 | 220.3 | 73.43± 0.96 |
| T₂ | 70.9 | 69.5 | 72.1 | 141.6 | 70.80± 1.84 |
| T₃ | 68.5 | 69.3 | 67.8 | 205.6 | 68.53± 0.75 |
| T₄ | 72.9 | 73.6 | 73.9 | 220.4 | 73.47± 0.51 |
| T₅ | 69.6 | 69.9 | 68.8 | 208.3 | 69.43± 0.57 |
| T₆ | 67.9 | 69.2 | 68.6 | 205.7 | 68.57± 0.65 |
| T₇ | 73.2 | 71.8 | 74.2 | 219.2 | 73.07± 1.21 |
| T₈ | 70.2 | 70.6 | 71.6 | 212.4 | 70.80± 0.72 |
| T₉ | 69.8 | 69.1 | 68.4 | 207.3 | 69.10± 0.70 |
| TOTAL | 638.8 | 713.4 | 714.4 | | |
| MEAN | 70.98 | 71.34 | 71.44 | | |

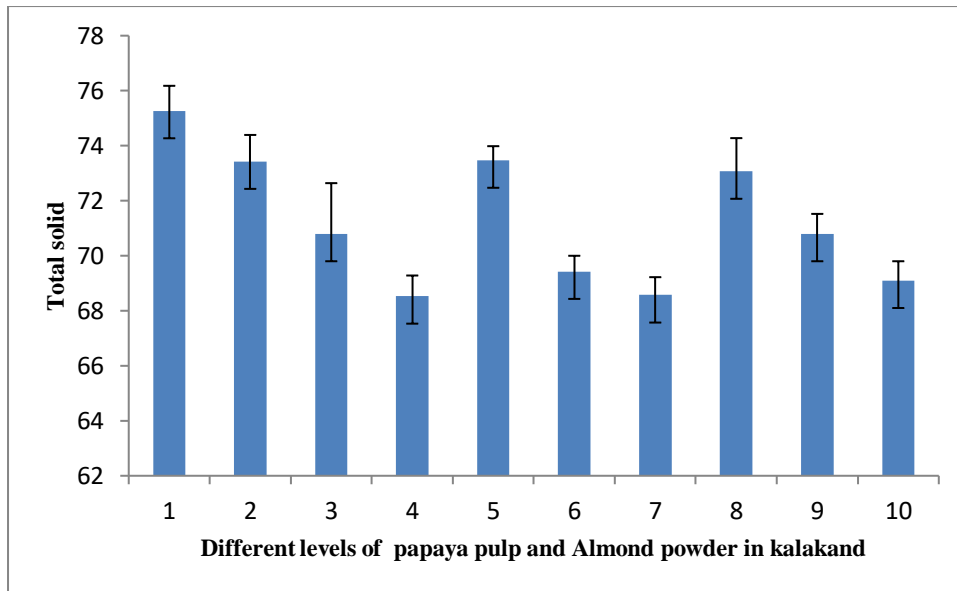


Figure 4.3.6 Effect of various combination of *Almond* powder and papaya on total solid content of kalakand.

4.4 Cost of production of optimized Almond enriched papaya kalakand

This is major aspect for any product because consumer acceptability depends upon cost of production. There is need of assessment of cost of production of papaya *kalakand* prepared from one liter of milk. Looking the nutritional value and health benefit of the papaya *kalakand* can be recommended for the preparation of *kalakand*.

Treatment T₈ were optimized on the bases of sensory evaluation, this treatment may content 15 % of papaya replace with milk and 10 % sugar w/w of milk.

Table 4.4.1 Indicate that the cost of production of control sample of *kalakand* and optimized product (T₈) on the bases of sensory evaluation.

| S.No. | Item | <i>Kalakand</i> Milk 1 kg Control | | Papaya <i>kalakand</i> Milk 1Kg Optimized product (T ₈) | |
|-------|-----------------------------------|---|---------------|--|---------------|
| | | Amount used | Total (Rs) | Rs./Kg | Total (Rs) |
| 1. | Expenditure | | | | |
| I | Milk @ Rs. 40/Kg | 1000 ml | 40 | 850 ml | 34 |
| II | Sugar @ Rs.40/kg | 60 gm | 2.4 | 100 gm | 4 |
| III | Papaya @ Rs. 50/kg | 0 gm | 0 | 150 gm | 7.5 |
| IV | Almond @ Rs.700/kg | 0gm | 0 | 10gm | 7 |
| 2. | Operating cost | | | | |
| I | LPG @ Rs. 1100/ 14.4 kg | 75 gm | 5.7 | 75 gm | 5.7 |
| II | Citric acid@ 240/ 500 gm | 5 gm | 2.4 | 5 gm | 2.4 |
| III | Maintenance and Service | | 5 | | 5 |
| 3. | Total production cost (1+2) | | 55.5 | | 58.6 |
| 4. | Yield in gm | 240 gm | | 260 gm | |
| 5. | Market price of <i>kalakand</i> | Rs.320/kg | | Rs.320/kg | |
| 6. | Total Income (S.No. 4 x S. No. 5) | 76.8 | | 83.2 | |
| 7. | Net profit (6 -3) | 21.3 | | 24.6 | |

$$\text{Benefit cost ratio} = \frac{\text{Net profit}}{\text{Total cost}}$$

1. Benefit cost ratio of control sample = $\frac{21.3}{55.5} = 0.38$
2. Benefit cost ratio of optimized almond enriched papaya *kalakand* sample = $\frac{24.6}{58.6} = 0.41$

This result may show that value added *kalakand* made with papaya are given more benefits than control (T₀) *kalakand* normally made by milk without added papaya pulp.

The total manufacturing cost per kg of sweets decreased very marginally with increase in size of production. Among the treatments share of net profit was highest (41%) from T₈ followed by T₀ (38%). Similar observation was made by Singh and Kalra (2004).

SUMMARY AND CONCLUSION

In the present scenario the *Kalakand* is gaining more popularity in the country. Looking the importance of *kalakand* the present investigation pertaining to manufacture was carried out in the Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during the year 2017-2018.

The different treatment combinations tried were value added *Kalakand* made by using standardized milk with three levels of papaya pulp @ 10 %, 15 % and 20 % and sugar @ 6 %, 8 % and 10%. The levels of fat and SNF were 6% and 9 % in the milk respectively. Citric acid 0.05% solution in water was added in all the samples at dough stage during preparation of the products. The treatment combinations were replicated thrice during entire phase of investigation.

The observations recorded during the course of present investigation were summarized and results are presented in the form of tables and graphs:

The fat content was highest in control group T₀ (26.00 %) than papaya incorporated rest of groups. The differences in the values recorded in groups were significantly lower ($p < 0.05$) than the average value recorded in control group (26.00 %). This result show that with increasing level of papaya pulp fat content of *kalakand* decreased.

The protein content was highest and lowest in control group T₀ (16.07%) and T₃ (9.30 %). This result show that with increasing level of papaya pulp protein content of *kalakand* decreased. The differences in the values recorded in different groups of treatment were significantly lower ($p < 0.05$) than the average value recorded in control group (16.07 %).

The highest moisture content was recorded in in group T₃ (33.13 %).The differences among the treatment were significant (p<0.05). This result may show that with increasing level of papaya pulp moisture content of *kalakand* increased.

The average total solid in *kalakand* was highest in T₀ (75.27 %) treatment. The values recorded in T₀ group was not significantly higher (p<0.05) than the values recorded in rest of the treatment.

The average carbohydrate content in *kalakand* was highest in T₉ (43.17 %) group. The differences among the treatment were significant (p<0.05). This result may show that with increasing level of papaya pulp and sugar carbohydrate content of *kalakand* increased.

The colour and appearance score of *Kalakand* was the highest in T₁ group (8.78) than rest of groups. The differences in the values between the groups were significant. Maximum acceptability of colour and appearance was observed in *kalakand* with papaya pulp level at 15 % in replacement of milk and sugar level at 10 % w/w of milk.

The flavour score of *Kalakand* was the highest in T₁ (7.61) than other papaya incorporated treatment. The differences in the values were significant.

The highest body and texture score was found in T₀ (8.57) group followed by T₁ (8.20) and minimum in groups T₉ (6.17). The variation among these groups were significant. Maximum overall acceptability was observed in *kalakand* with papaya pulp level at 15 % in replacement of milk and sugar level at 10 % w/w of milk.

The total manufacturing cost per kg of sweets decreased very marginally with increase in size of production. Among the treatments share of net profit was highest (41%) from T₈ followed by T₀ (38%).

It can be concluded that the papaya pulp could be successfully added in milk for preparation on good quality *Kalakand*.

It can be concluded that *Kalakand* can be prepared with the addition of papaya pulp @ 10 %, 15 % and 20 % and 0.2%, 0.5% and 1.0% almond in replacement of milk up to a satisfactory level of the consumer acceptance. The maximum acceptability of *kalakand* on the basis of sensory evaluation with level of papaya 15 % , almond 1.0% replace of milk and sugar 10 % w/w of milk.

This lead to development of value added papaya *kalakand* as compared to plain *kalakand*. It could be a health benefits substitute of the plain *Kalakand*.



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Appendix

Table 4.2.1(b): Analysis of variance for colour and appearance of different combination of *Almond* powder and papaya pulp of kalakand

| S.V | d.f | s.s | Mss | cal.F | tab. F(0.05) | F-test |
|------------|------------|------------|------------|--------------|-------------------------|---------------|
| Treat. | 9 | 16.06807 | 1.785341 | 13.91283 | 2.3928141 | S |
| Error | 20 | 2.5664666 | 0.128323 | | | |
| Total | 29 | 18.634536 | | | | |