Chapter 5
Discussion
DISCUSSION

5.1 NUTRIENT CONTENT OF THREE CULTIVARS OF PAPAYA FRUIT

5.1.1 Proximate analysis

5.1.2 Micronutrient analysis

5.2 EFFECT OF PROCESSING ON NUTRIENT CONTENTS OF THREE CULTIVARS OF PAPAYA FRUIT

5.2.1 Proximate analysis

5.2.2 Micronutrient analysis

5.3 EFFECT OF PROCESSING ON PHYSICO-CHEMICAL PROPERTIES OF THREE CULTIVARS OF PAPAYA FRUIT

5.4 EFFECT OF PROCESSING ON RHEOLOGICAL PROPERTIES OF THREE CULTIVARS OF PAPAYA FRUIT

5.5 PRODUCT DEVELOPMENT

5.6 SHELF LIFE ASSESSMENT OF MOST ACCEPTED PRODUCTS

5.6.1 Microbiological analysis

5.6.2 Peroxide value

5.6.3 Moisture content
In the present study nutritional composition of three cultivars of papaya fruit (Red Lady, Sinta and F1) was analyzed, thereafter the cultivar sample were processed (blanched and dried) and once again nutritionally analyzed to find out the difference between processed and unprocessed papaya samples. Four value added products were also developed namely, besan ladoo, biscuits, khamman dhokla premix powder and murrukku by incorporating dry papaya powder in different proportions (10%, 15%, 20%, 25% and 30%), which were assessed by a panel of 15 semi trained members for sensory attributes, using 5 point rating scale.

In this chapter an effort has been made to discuss the analyzed results with the reported results by various Scientists. The secondary data on nutrient composition of papaya is limited and scarce therefore researches being carried out on other fruits and vegetables have been used to support the results obtained in the present study.

5.1 NUTRIENT CONTENT OF THREE CULTIVARS OF PAPAYA FRUIT

The three cultivars of papaya fruit (Red lady, Sinta and F1) were analyzed proximate and micronutrient composition using standard techniques. The analyzed values were then compared with the nutrient values given by ICMR, 1989. The nutrients values for different cultivars of papaya fruit are given in Table 4.1 (cultivar Red lady), Table 4.4 (cultivar Sinta) and Table 4.7 (cultivar F1).

5.1.1 Proximate Analysis

Moisture content analysis of the three papaya cultivars Red lady, Sinta and F1 revealed values in the range of, 90.23g±0.10/100g to 89.21g±0.04/100g, in
comparison to ICMR value of 90.8g/100g (Table 4.1, Table 4.4 and Table 4.7). A study carried out by Maisarah et al., 2014 mentioned moisture content in riped papaya to be 85.7g/100g, which has been found to be slightly less than that analyzed in the present study. Similar value of moisture content (89.05g/100g) was reported in a study conducted by Boghani et al., 2012. In another study, carried out by Nwofia et al., 2012, moisture content of papaya fruit was reported to be in the range of 90.33g/100g to 87.47g/100g. A study conducted on various papaya cultivars, by Marisa 2006, also exhibited moisture content to be in the range of 87.7g/100 to 86.0g/100g, which was slightly less than the values obtained for papaya sample (Table 4.1, Table 4.4 and Table 4.7).

Carbohydrate content calculated for the three cultivars of papaya fruit ranged from 6.49g±0.10/100g to 5.06g±0.73/100g (Table 4.1, Table 4.4 and Table 4.7). Almost similar results (6.50g/100g) were observed in a study conducted by Nwofia et al., 2012. However, a higher value of carbohydrate (9.81g/100g) in papaya fruit have been reported by Mahapatra et al., 2012 and 9.37g/100g by Boghani et al., 2012.

Mean protein content in Red lady cultivar of papaya fruit found to be lower (0.40g±0.01/100g) in comparison to ICMR reference value of 0.8g/100g, whereas that of, cultivars Sinta and F1 (0.80g ± 0.005/100g and 0.80g ± 0.01/100g, respectively) were similar to that of ICMR values (Table 4.1, Table 4.4 and Table 4.7). Similar results of protein content have been reported in studies by Chukwuka et al., 2013 (0.64g/100g), Boghani et al., 2012 (0.43g/100g), Mahapatra et al., 2012 (0.61g/100g). A study conducted by Nwofia et al., 2012 has reported protein content
in the range of 0.4 to 1.17g/100g. On the other hand, on dry weight basis three cultivars of papaya protein content to be found from range of 5.17g ± 1.40/100g to 8.96g ± 1.37/100g. Almost similar protein content of this range reported by Maisarah et al., 2014 (6.1g/100g) on dry weight basis. This difference could be attributed to different cultivars of papaya fruit, which has been seen, in the present study.

Mean fiber content of three cultivars of papaya fruit obtained in the present study, was found to be similar (0.86g ± 0.08/100g to 0.92g ± 0.21/100g) to that reported by Nowfia et al., 2012 (0.83g/100g). However, Boghani et al., 2012, reported higher value for fiber (1.02%). The difference in fiber content could be due to difference in selected cultivars for the study.

Mean ash contents of the selected cultivars of papaya were found in the range of 1.06g±0.80/100g to 3.68g±1.00/100g (Table 4.1 to 4.7). When these values were compared with the values reported in other researches, similar results were found to be reported by Chukwuka et al., 2013 (2.83g/100g). Contrary to this, lower value of ash content has been reported by Nwofia et al., 2012 (0.37g/100g) and by Boghani et al., 2012 (0.31g/100g). Further, higher value of ash has reported by Maisarah et al., 2014 (5.8g±0.20/100g).

### 5.1.2 Micronutrient Analysis

In the present study micronutrient analysis of the selected three cultivars (Red lady, Sinta, F1) of papaya fruit was carried out using standard techniques. Mean calcium content was estimated to be, in the range of 15.96mg±0.28/100g to
16.38mg±0.36/100g (Table 4.1, Table 4.4 and Table 4.7). These values were found to be comparable to ICMR reference value of 17mg/100g. Almost similar results were reported by Chukwuka et al., 2013 (14.69mg/100g), Marisa (2006) (16.06mg/100g), Nwofia et al., 2012 has reported slightly higher value of calcium (22.71mg/100g) in papaya fruit. On dry weight basis calcium content ranged from 171.58mg±4.78/100g to 183.13mg±4.03/100g. Karuna & Kaushal (2014) reported less calcium value (153.91mg/100g) on dry weight basis, in comparision to present study.

The mean potassium content of the three cultivars of papaya fruit was found to range from 74.36mg±0.50/100g to 74.39mg±0.50/100g and mean magnesium content from 13.92mg±1.20/100g to 14.25mg±0.35/100g (Table 4.1, Table 4.4 and Table 4.7). These values were higher than the ICMR reference values of 69mg/100g and 11mg/100g, given for potassium and magnesium, respectively. However, when compared with researches carried out by other scientists, almost similar findings of potassium and magnesium content have been reported by Chukwuka et al., 2013 (56.27mg for potassium and 10.40mg/100g for magnesium), Marisa (2006) (89.70mg for potassium and 19.24mg/100g for magnesium) but, on the other hand Karuna & Kaushal (2014) reported less potassium content in papaya fruit (711.23mg/100g) on dry weight basis in comparison to present study potassium values range i.e. 846.79mg ± 10.09/100g to 874.18mg ± 5.45/100.

The estimation of vitamins, as given in Table 4.2, Table 4.5 and Table 4.8, revealed mean β-carotene content of the three cultivars of papaya fruit to be 663.81µg ± 8.76/100g for Red lady, 878.9µg ± 20.70/100g for Sinta and 726µg ±
19.43/100g for F1 which were found to be less in comparison of the reference value of 880µg/100g reported by ICMR, 1989. However, almost similar results has been reported by Nurul & Asmah (2012) (793.83µg/100g), on the other hand, Maisarah et al., 2014 (520.00µg100g), Marisa (2006) (145.9µg to 410.03µ/100g) reported lower values of β - carotene in their studies in comparison to present study. Nwofia et al., 2012, on the other hand, reported higher value (6207 IU/100g (3724.30µg/100g) of β - carotene in papaya fruit.

The mean Vitamin C content was found to be in higher range (68.08mg±7.69/100g to 72.59mg±1.99/100g) in three cultivars of papaya fruit when compared with ICMR value of 57mg/100g. Higher value of vitamin C has also been reported by Chukwuka et al., 2013 (112.00mg/100g). However, Maisarah et al., 2014 (45.75mg/100g), Nwofia et al., 2012 (41.07mg to 43.41mg/100g ), Marisa (2006) (45.40mg to 45.03mg/100g) and Zaman et al., 2006 (42.40mg to 41.02mg/100g) have reported less vitamin C content in papaya fruit sample than the sample in the present study.

5.2 EFFECT OF PROCESSING ON NUTRIENT CONTENTS OF THREE CULTIVARS OF PAPAYA FRUIT

5.2.1 Proximate Analysis

On account of lesser studies that have been conducted on papaya fruit to assess effect of processing on nutrient composition of the fruit, researches carried out on other processed fruits and vegetables were referred to compare the results obtained in the present study. The selected cultivars (Red lady, Sinta and F1) of papaya fruit were subjected to blanching process and the nutrients analyzed were
calculated on dry weight basis. The findings revealed no significant change on processing in moisture content of unblanched and blanched samples (Table 4.10 - 4.12). Akter et al., 2010 carried out a study on effect of blanching and drying on dried persimmons peel powder and Adeniji & Tenkouano (2008) carried out a study on hybrid banana pulp and peel have reported results which are in accordance to present study.

On the other hand, the protein, fat and carbohydrate contents were found to reduce significantly (p≤0.05) after blanching in comparison to unblanched samples of papaya fruit. The protein content was in the range of 5.17g±1.40/100g to 8.96g±1.37/100g of unblanched samples and in blanched samples, it ranged from 4.54g±1.13/100g to7.57g±0.931/100g (dry weight basis) Similar results have also been reported by Adegunwa et al., 2011 was carried out a study on four verities of leafy vegetables and Akter et al., 2010 who carried out a study on dried persimmon fruit peel powder. The reason for reduction in protein content reported by researcher Eze & Akubor (2012), was high temperature processing, of vegetables and fruits.

Fat content of the blanched samples also reduced significantly in all the three cultivars of papaya fruit, and ranged from 3.84g/100g to 6.21g/100g in comparison to unblanched samples, where the values of fat content, ranged from 6.14g/100g to 8.29g/100g, respectively (Table 4.10 - 4.12). Similar results have been reported by Oloyede et al., 2014 who investigated the effect of processing on Struchium sparganophora (Linn) Kize fruit, Eze & Akubor, 2012 who conducted a study on okra vegetable, Nkafamiya et al., 2010 who carried out a study on non – conventional leafy vegetables Mepba et al., 2007 on green leafy vegetables.
Further, carbohydrate content too, found to decrease significantly with blanching process in the three cultivars of papaya fruit ranged and from 27.30g/100g to 27.93g/100g in blanched samples and in the unblanched samples the range was found to be 62.82g/100g to 56.79g/100g (dry weight basis) (Table 4.10-4.12). Some of the other researches carried out by Ilelaboye et al., 2013 was carried out a study on green leafy vegetables and have reported reduction of carbohydrate content. Eze & Akubor (2012), Nkafamiya et al., 2010 explored a study on non-conventional leafy vegetables, Mepba et al., 2007 carried out a study on processing treatments on edible leafy vegetables. The reason attributed by researchers that for the same is blanching leads to thermal hydrolysis which causes formation of simple disaccharides and monosaccharides that are relatively soluble and could leach out in water.

On the other hand, ash and fiber content were found to increase significantly (p≤0.05) in blanched samples of three cultivars of papaya fruit (Table 4.10-4.12). Ash content was found to range from 54.74g/100g to 59.81g/100g in blanched samples, which was significantly higher when compared to the unblanched samples (11.47g/100g to 54.63g/100g). Akande et al., 2014 investigated a study on effect of blanching on negro pepper, Eze & Akubor (2012) carried out a study on okra vegetable and Adegunwa et al., 2011 carried out a study on vegetables, have also reported similar results. A study by Adegunwa et al., 2011 reported, increased content of ash in blanched vegetables and the reason reported is trapping of some inorganic salt during processing.
Further, fiber content of blanched samples of the three cultivars of papaya fruit too was found to be significantly higher than the unblanched samples. The values ranged from 22.03g/100g to 19.15g/100g, in blanched samples comparison to unblanched samples where the fiber value ranged from 4.87g/100g to 10.31g/100g (dry weight basis). Similar results have been reported Akande et al., 2014, by Osum et al., 2013 who conducted a study on vitex doniana leaf and leaf products, Ilelaboye et al., 2013, conducted a study on green leafy vegetables, by Nkafamiya et al., 2010 who carried out a study on non-conventional leafy vegetables. The researches have reported that heat treatment leads to solubilization of dietary fiber causing alteration in its physiological properties. This seems to be in agreement with the present study where level of fiber content was found to increase after blanching.

5.2.2 Micronutrient analysis

Micronutrient contents of the selected cultivars of papaya fruit were found to be affected by blanching process before drying. The results of mineral content estimation on dry weight basis revealed, calcium and magnesium content to be more in blanched sample. On the other hand, potassium content found to be high in unblanched sample. Calcium and magnesium contents of blanched samples of papaya cultivars (Red lady, Sinta and F1), ranged from 181.05mg ± 9.91/100g to 196.65mg ± 3.82/100g and 153.63mg ± 3.27/100g to 159.52mg ± 4.03/100g, respectively, comparison to unblanched samples (Table 4.10 to 12). This is accordance with the results reported by Ahmed & Ali (2013) who conducted a study on fresh and processed white cauliflower and a study on frozen and non-frozen fruits and vegetables by Kyureghian et al., 2010. The reason attributed was that these minerals (calcium and magnesium) are not lost by leaching during blanching process.
as they are bound to the plant tissues. Sometimes these minerals get absorbed by fruits and vegetables during blanching process from the water. In cold water calcium bicarbonate and magnesium bicarbonate are present in soluble form but due to boiling process these compounds are precipitated and form solid calcium carbonate and solid magnesium carbonate which are insoluble and precipitation get started of these minerals in water (www.lenntech.com). The potassium content however was, found to be significantly less in blanched samples in all the three cultivars of papaya fruit and ranged from 802.15mg ± 9.78/100g to 834.05mg ± 6.26/100g, when compared with their respective unblanched samples (Table 4.10 - 4.12). The studies carried out by Akande et al., 2014, Ahmed & Ali, 2013 on white cauliflower, Kyurengian et al., 2010 on fruits and vegetable and Rickman et al., 2007 on fruits and vegetables seems to be in agreement with the present findings and the attributed reason was that potassium being extremely mobile is easily lost by leaching out in water during blanching process as it has high solubility in water.

The analysis of vitamin content of three papaya cultivars (Red lady, Sinta, F1), revealed β-carotene content to be significantly high in blanched samples than the unblanched samples (Table 4.10 - 4.12). Kyurengian et al., 2010, Dutta et al., 2004 conducted a study on carrots, Puuponen- Pimia et al., 2003 carried out a study on vegetables, Howard et al., 1999 conducted a study on fresh and processed vegetables have been reported similar results. The reason attributed seems to be greater chemical extractability and loss of moisture as well as soluble solids and inactivation of certain oxidative enzymes, resulting in the breakdown of some structures leading to a higher bioavailability of β-carotene indicating that carotenoids, in plants, are bound by protein. Blanching help to release bound
carotenoids and render them to be easily extractable. On the other hand, due to blanching process, vitamin C content found to significantly get reduced in the selected varieties of papaya, which ranged from 116.95mg ± 3.08/100g to 122.88mg ± 1.59/100g in comparison to unblanched samples (120.53mg ± 5.90/100g to 140.42mg ± 4.00/100g) (Table 4.10- 4.12). Similar results have been reported by Ahmed & Ali (2013) who carried a study on white cauliflower, Osum et al., 2013 conducted a study on vitex domiana leaf, Gamboa- Santos et al., 2012 carried out a study on effect of blanching on carrots, Adegunwa et al., 2011, Akter et al., 2010 conduct a study on dried persimmons peel powder and Mepba et al., 2007 on green leafy vegetables. In these studies, researchers have reported vitamin C loss during blanching process because of its heat sensitiveness and leaching out behavior in water.

5.3 EFFECT OF PROCESSING ON PHYSICO-CHEMICAL PROPERTIES OF THREE CULTIVARS OF PAPAYA FRUIT

On blanching, the mean content of reducing sugar, in the three cultivars of papaya fruit, was found to be more and ranged from 9.80g ± 0.74/100g to 9.98g ± 0.64/100g in comparison to the content obtained for unblanched samples, ranging from 8.6g ± 0.27/100g to 8.98g ± 0.30/100g (Table 4.13- 4.15). Effect of blanching on reducing sugar has been reported by Take et al., 2012 in dried green chilli powder and another researcher Prajapati et al., 2011 in anola fruits as similar to present study.

Mean acidity on the other hand, was found to be significantly (p≤0.05) less in blanched samples of all the three cultivars of papaya fruit, and ranged from 11.5g
Discussion

± 0.14/100g to 10.52g ± 0.29/100g in comparison to acidity of unblanched samples, which ranged from 12.1g ± 0.83/100g to 11.24g ± 0.40/100g (Table 4.13- 4.15). Prajapati et al., 2011 on anola fruit, Mahendran & Prasannath (2008) on banana fruit and Rossi et al., 2003 have reported similar findings in a study carried out on blueberries. The attributed reasons by Prajapati et al., 2011 for loss of acids during blanching were heavy leaching of acid in water, conversion of acids into sugar and some other compounds or its utilization in the process of respiration.

pH content, in blanched samples of papaya, was found to be slightly high, which when compared with the unblanched sample, however was found to be not significant (p≤0.05) (Table 4.13- 4.15). Similar results have been reported by Mahendran & Prasannath (2008) in ripened banana and by Rossi et al., 2003 in fruits and vegetables.

5.4 EFFECT OF PROCESSING ON RHEOLOGICAL PROPERTIES OF THREE CULTIVARS OF PAPAYA FRUIT

The rheological properties of the selected cultivars of papaya fruit samples were found to be affected by blanching process. Bulk density of papaya fruit samples was found to become less on blanching in all the three cultivars, however the difference was no significant (p≤0.05) (Table 4.16- 4.18). The values of bulk density of blanched samples of papaya fruit ranged from 0.76gcm⁻³±0.008 to 0.79gcm⁻³±0.01, in comparison to unblanched samples, which ranged from 0.87gcm⁻³ ±0.03 to 0.90gcm⁻³±0.02. Adejumo et al., 2013 reported similar results for bulk density in yam flour sample.
Estimation of colour in blanched and unblanched samples of all three cultivars of papaya fruit was conducted using Transmittance method (Rangana, 2010). Colour value in samples, on blanching was found to be significantly high (4.80 ± 0.35 per cent to 2.84 ± 0.47 per cent). In a study by Tunde-Akintunde et al., 2011 on bell pepper has reported results in accordance to present study. Barett et al., 2000 in one of their studies on corn and brocalli to reported similar findigs. The retention of colour could be attributed to destruction of enzymes or their inactivation. Also, blanching lossens the tissues, which is helpful in fixation of natural colour in fruits and vegetables.

5.5 PRODUCT DEVELOPMENT

Various products were developed in the present study by incorporating dry papaya powder. Sinta cultivar of papaya was selected for incorporating as it showed high β-carotene retention among all three cultivars on blanching. Four food products (besan ladoo, biscuits, khamman dhokla premix and murrukku) were selected for value addition. To these, papaya powder was incorporated in five different proportions of 10%, 15%, 20%, 25% and 30%. Sensory evaluation of papaya incorporated food products was carried out using 5 - point rating scale. Results revealed all four products to be best acceptable with 10% incorporation of papaya powder. The sensory attributes overall acceptability mean scores were 4.4 ± 0.82 for besan ladoo, 4.6 ± 0.48 for biscuits, 4.4 ± 0.50 for khamman dhokla and 4.6 ± 0.87 for murrukku (Table 4.19 – 4.22).
Due to fewer studies on papaya incorporated products, studies revealed to product development by incorporating other β-carotene rich fruits and vegetables have been taken to support the results of present study.

In a study by Jauharah et al., 2014, biscuits and muffins were formulated by adding young corn powder (rich in β-carotene) in proportions of 10%, 20% and 30%. Sensory evaluation of these biscuits and muffins, conducted using 7-point hedonic scale, revealed best acceptance for biscuits and muffins with 90:10 ratio i.e. wheat flour 90g and young corn powder 10g. The scores for both the products having 10% corn powder was 5.27±1.02 for biscuits and 5.12±1.22 for muffins, respectively.

Gayas et al., 2012 too carried out a study on carrot pomace, a rich source of β-carotene, incorporated biscuits. Sensory attributes of all the biscuit samples, revealed highest overall acceptability scores for 5% and 7.5% of carrot pomace incorporation with scores of 8.75 and 8.00, respectively.

Another study carried out by Pakalwad et al., 2010, using 9 point hedonic scale, 10% proportion of papaya pulp in papaya shake was found to be most acceptable. The most acceptable proportion of 10%, scored highest (8.56) for overall acceptability in comparison to 15% (8.23) and 20% (8.08). This finding is accordance to the study.

The texture analysis of the three formulated products i.e. besan ladoo, biscuits and murukku (with 10 per cent papaya powder) was conducted using TA.HD Plus Textural Analyzer instrument. The results of texture (hardness) analysis
revealed, hardness of *besan ladoo* to decrease on incorporation of papaya powder (2707.96g mm) when compared with that control ladoo (1901.44g mm). However, hardness or fracturability of control and papaya incorporated biscuits were found to be similar (7302.21g mm). In accordance to the present findings, Jauharah et al., 2014 too reported no difference in hardness of control and young corn incorporated biscuits. The hardness of *murukku* too was observed to be high in papaya incorporated (10%) sample (1019.47g mm) in comparison to control *murukku* sample (846.12g mm) (Table 4.23).

5.6 SHELF LIFE ASSESSMENT OF MOST ACCEPTED PRODUCTS

Shelf life assessment is important for providing the information about significant period for consumption of the developed products, with maintained high quality (Sewald & Devries, www.medallianlabs.com). The developed products (*basen ladoo*, biscuits, *khamman dhkla* premix and *murukku*) with the most acceptable proportion (10%) of dry papaya powder were selected for assessment of their shelf life. This was assessed on microbiological count, peroxide value and moisture content in the developed products over a period of 45 day.

5.6.1 Microbiological Analysis

The results of the total viable count and fungal count showed no significant change in the product developed by adding 10% of papaya powder. According to the analysis, *basen ladoo*, biscuits, *khamman dhokla* premix and *murukku* showed negligible count of bacteria and fungi. Bacterial count in time duration of 45 days in *basen ladoo*, biscuits and *khamman dhokla* premix was found to not affect the quality of products and were of good quality for consumption. However, in case of
murrukku growth of bacteria only after 30th day was seen. Similar result has been reported by Kadam et al., 2012 for products prepared by incorporating guava fruit. Another, study on mushroom fortified biscuits indicated least bacterial population (0.7 × 10^2 CFU per gram) and also least fungal growth in biscuits with 10% mushroom powder incorporation biscuits, at 15th day and 45th day of storage (Desayi, 2012).

5.6.2 Peroxide Value

Peroxide value estimations of the food products indicate the quality of food effected by oil and extent of degradation of the lipids occurred due to cooking and storage. Results of peroxide value indicated that product murrukku showed significantly higher peroxide values on the day one (5.0meq ± 0.08/1000g) as well as on the 45th day (8.53meq ± 0.44/1000g) in comparison to other developed products. Khamman dhokla showed no peroxide value, because of no use of oil in it but besan ladoo and biscuits indicated elevation in peroxide value, however it was slight. Moreover, all the products were found to be safe for consumption with the permissible limit of peroxide values. Wannahari & Nordin (2012) and Richard (2009), reported peroxide value in palm oil, measured by oxidation of oil, not to exceed 10meq/1000g level for consumption.

5.6.3 Moisture Content

Micro-organisms can grow on products having high water content because of this reason fruits and vegetables are very susceptible for microbiological spoilage at room temperature. In the present study, of all the developed products prepared with incorporation of 10% papaya powder, khamman dhokla premix was found to have
Discussion

highest moisture content (Table 4.25). The reason attributed could be that no cooking was involved for making this premix. However, in case of murukku, biscuits and besan ladoos some or the other cooking methods were used for their preparation, which have led to evaporation of moisture to a great extent. Storage of all the four products was done in airtight containers to prevent bacterial contamination and moisture from the environment. In FAO Corporate Document Repository report, it is mentioned that water removal from the food/food products can stop the multiplication of bacterial cells thus reduce chances of contamination.