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ORIGINAL ARTICLE

Processing and Quality Evaluation of Green Papaya (*Carica papaya* L.) Leaf Tea

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Abstract

This research was aimed to develop papaya leaf tea from green papaya leaf. Papaya leaf tea was prepared by drying of fresh papaya leaves. Analysis of chemical composition indicates that there was no loss in proximate composition during drying except the vitamin C content which was degraded. The dried papaya leaf tea contains 4.7% moisture, 26.2% protein, 2.6% fat, 10.8% ash, 55.7% total carbohydrate and 35.5 mg/100g vitamin C. Papaya leaf tea was prepared using brewing time of 1, 2 and 5 minutes. Sensory evaluation was performed by using 9 point hedonic score and 10 panelists. The result showed that papaya leaf tea prepared with 2 minutes brewing time possesses the best sensory properties.

Key words: Processing, Quality, Papaya leaf, Tea.

1. Introduction

Papaya leaf has a numberless of benefits. In some parts of Asia, the young leaves of the papaya are steamed and eaten like spinach. Fresh, green papaya leaf is an antiseptic, whilst the brown, dried papaya leaf is the best as a tonic and blood purifier (Atta, 1999). Recent reports have claimed possible beneficial effects of papaya leaf juice in treating patients with dengue viral infections (Yunita *et al*., 2012). The extracts of both the leaves and fruit are known to contain several proteins and alkaloids with important pharmaceutical, medical, and industrial applications. Interestingly, papaya fruit juice and leaf extract have demonstrated anti-cancer (Rahmat *et al*., 2002). In a recent study it is found that, the powder from papaya leaves has substances responsible for the release and production of thrombocytes/platelets (Sathasivam *et al*., 2009).

Papaya leaves can be used as an anti-hypertensive agent (Koffi *et al*., 2009). Phytochemical screening revealed the presence of bioactive compound saponins, cardiac glycoside, alkaloids and absence of tannins in the in the papaya leaf. Green papaya leaf is a source of essential nutrients while yellow papaya is a source of iron. Therefore, pawpaw leaves can be manipulated in the herbal treatment of various diseases and as a potential source of useful elements for drugs formulation (Ayoola and Adeyeye, 2010).

The extracts of papaya leaves accelerate the increase in platelet counts and shorten the hospitalization period during dengue fever (Yunita *et al*., 2012). Till now there is no approved vaccine or drug against this dengue virus. Papaya leaves can be used as complementary drug in dengue fever. Young leaves of papaya have antioxidant properties and have a depressing action on heart (Maisarah *et al*., 2013).

Papaya leaf can be used for the processing of green tea. Nwofia *et al*. (2012) referred that papaya leaf can be used for the preparation of tea and mentioned different medicinal values of papaya leaf tea. Aqueous extract of papaya leaf tea plays an important role as a tumor destroying agent. Papaya leaf tea is the most powerful anti-cancer agent. Doctors and researchers from US and Japan have discovered that enzymes found in papaya leaf tea have dramatic cancer fighting properties against a broad range of tumors. In a bid to promote good health and make a genuine effort in assisting the prevention of cancer papaya leaf tea is very effective (Otsuki *et al*., 2010). A recent study by Purdue University showed that Papaya Leaf Tea consists of over 50 active ingredients found to kill fungi, worms, parasites, bacteria, and many forms of cancer cells (McLaughlin, 2008). In addition to its long list of cancer fighting substances, papaya leaves boast large doses of important nutrients that support the immune system, including vitamins A, C, and E. Most importantly, it contains vitamin B-17, which in concentrated form is already used as part of traditional chemotherapy treatments. Papain, an important enzyme in papaya leaves is also a powerful digestive aid. It breaks down proteins naturally and eases the burden of digestion on the pancreas and stomach. Scientific research shows that papain is most active at higher tea temperatures.

Two kinds of papaya leaf tea may be prepared-fresh green tea and brown dried leaf tea; the first one is an antiseptic whilst the later one acts as a tonic and blood purifier (Atta, 1999).

In fact, Papaya leaf is available everywhere and has not been considered for industrial uses in Bangladesh. Even, Processing of papaya leaf tea has not been tried before and hence there is limited information. Preparation of papaya leaf tea may impart value addition to this easily accessible material. Moreover, it may be a successful raw material for industrial scale production due to its low-cost economy. Considering these features this research has been taken to develop papaya leaf tea. The objectives of this research are (i) To process tea from green papaya leaf; and (ii) To assess the quality and predict the optimum brewing time for the prepared leaf tea.

2. Materials and Methods

The experiment was performed in the laboratory of the Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh, Bangladesh. Green papaya leaves of same maturity level were collected from local area. Only two leaves were collected from each tree. Other ingredients and materials were collected from the local market and departmental laboratories.

2.1 Processing of Papaya Leaf Tea

Papaya leaf tea was processed by drying of papaya leaf. Papaya leaf of same maturity level was collected first. The leaves were washed and kept in room temperature for two hours. Then the leaves were cut into small pieces and weighed. The leaves were placed in an open place for two hours afterward. The leaves were cut again even into smaller pieces. To remove further moisture leaves were put into a cabinet dryer on trays at 60^0 C. After four hours of drying the trays were put into a hot air oven at 110^0 C to remove the rest moisture for ten minutes. The weight of leaves was taken to calculate the yield. Then the leaves were crushed by the hand, packed in polythene bags and stored in cool and dry place. The flow chart of processing of papaya leaf tea is presented in Fig 1.

2.2 Proximate Analysis of Papaya Leaf, Papaya Leaf Tea

The of Papaya Leaf, Papaya Leaf Tea were analyzed using standard method such as moisture content, protein, ash, fat by AOAC (2005), Vitamin C content by of Ranganna (2004) while carbohydrate content was calculated by difference (Pearson, 1981).

2.3 Sensory Evaluation of Papaya Leaf Tea

For statistical analysis of sensory data of papaya leaf tea, three different samples were evaluated for color, flavor, taste and overall acceptability by a panel of 10 members. The judges were selected randomly from the teachers and students of the Department of Food Technology and Rural Industries. Three samples of papaya leaf tea of different brewing time 1, 2 and 5 minutes were presented to 10 panelists and were asked to assign scores on a 9 point hedonic scale (Ranganna, 2004**)** with the ratings of: 1=dislike extremely; 2=dislike very much; 3 dislike moderately; 4=dislike slightly; 5= neither like nor dislike; 6=like slightly; 7= like moderately; 8= like very much; 9=like extremely. The scores given by the panelists were analyzed by statistical software (MSTATC).

Fig 1: Flowchart showing processing protocol of papaya leaf tea.

3. Results and Discussion

3.1 Proximate Composition of fresh Papaya Leaves

Proximate composition of fresh is shown in Table 1. The moisture content of papaya leaves was found 81.5%. The value was lower than the value (83.3%) found by Saran and Choudhary (2013) and within the range (81.27-85.17%) of the value found by Nwofia *et al.* (2012). The protein content of papaya leaves was found 5.1%.The value was close to the value found by Saran and Choudhary (2013) who reported 5.6% protein and within the range of the value found by Nwofia *et al.* (2012) which ranged from 5.84-10.80%.

The fat content of papaya leaves was found 0.5%. The value was close to the values found by Saran

and Choudhary (2013) and lower to the value of Nwofia *et al.* (2012), who reported 0.4% and 1.27-3.15% fat, respectively.

Table 1: Proximate composition of fresh papaya leaves

Parameter	Fresh Leaves	
	Wet Basis	Dry Basis
Moisture (%)	81.5	439.7
Protein (%)	5.1	27.5
Fat (%)	0.5	2.7
Ash (%)	2.1	11.3
Total Carbohydrate (%)	10.8	58.3
Vitamin C (mg/100g)	235	1268.2

The ash content of papaya leaves was found 2.1%. The value was higher than the value found by Saran and Choudhary (2013) and within the range of the value found by Nwofia *et al*. (2012). They found 1.4% and 1.43-2.25% ash, respectively. Total Carbohydrate content of papaya leaves was found 10.8%. The value was higher than the values described by Saran and Choudhary (2013) and Nwofia *et al.* (2012), who reported 8.3% and 3.88-8.27% total Carbohydrate, respectively. Vitamin C content of papaya leaves was found 235 mg/100g of leaves. The value was higher than the value found by Duke (1983) who reported 140 mg/100g of vitamin C in papaya leaves. The variation in the mentioned proximate composition may be due to the differences in variety, maturity and growing condition as well as post harvest storage conditions of leaves.

3.2 Drying of papaya leaves

Papaya leaves were dried using mechanical dryer (GALLENKAMP cabinet dryer, model OV-165, size-3, made in England). The dryer consists of a chamber in which trays of samples were placed. Air was blown by a fan passed over a heater and trays containing the sample to be dried. The velocity of air was recorded (0.6 m/s) by an anemometer.

3.4 Effect of Thickness on Drying Rate

The effects of thickness on drying rate of papaya leaves was investigated at 60^0 C temperature and at a constant air velocity (0.6 m/s) during mechanical drying. Different values of time (hr) versus moisture ratio (MR) were plotted on a semi-log graph (Figure 3a) and following equations were obtained.

The equations at 60^0 C temperature:

$MR = 1.0884\ e^{-1.009t}$ (For 3 mm, t = hr) …….. (1)

$MR = 1.0344\ e^{-0.782t}$ (For 5 mm, t = hr) …….. (2)

$MR = 1.1236\ e^{-0.679t}$ (For 7 mm, t = hr) …….. (3)

From equations 1 to 3 and Figure 3(a), it is obvious that, there is a clear effect of thickness on drying time. Drying time was increased with the increase in thickness. It is also observed that the drying rate constant decreases by increasing the sample thickness. From Fig 3(a), it is seen that the drying rate constant was 1.01 hr^{-1} for 3 mm thickness but that value was decreased to 0.78 hr^{-1} and 0.68 hr^{-1} for 5 mm and 7 mm thickness, respectively. This is due to lower thickness of the bed as the drying is a Fickian diffusion process and these rate constants are thickness dependent (Islam, 1980; Brooker *et al*., 1974; and iqbal and Islam, 2005). Different values of drying rate constant for 3 different thicknesses (3mm, 5mm and 7mm) were plotted on a log-log graph (Fig 4) and a power law relationship was developed:

$m = 0.0281L^{-0.47}$ …….. (4)

Where, m = drying rate constant (min^{-1}), L = sample thickness (mm).

Fig 3(b) and equation (4) shows the relationship between sample thickness and drying rate constant. From the above equation and figure, it is found that the value of 'n' is 0.47. This value is less than 2 as defined by power law equation. Several researchers have found different 'n' value for different products, for example: Alamgir (2000) indicated the n value of 0.333 for drying of coconut slices, Shafiqul (2003) calculated 'n' value of 1.57 and 1.59 for dehydration of Bangladeshi onion and Indian onion respectively, Iqbal and Islam (2005) found 'n' value 0.287 and 0.4105 for cauliflower and cucumber respectively, Sarker (2009) found the n value of 0.261 and 0.4586 for drying of High Yielding Variety (HYV) and Local Variety (LV) of potato, Mizan (2002) found 'n' value of 0.97 for sweet potato and so on. There are various factors that can affect this variation of 'n' value such as: product composition and structure; simultaneous heat and mass transfer effect; thickness and airflow rate that demonstrate the importance of internal and external mass transfer resistance. Islam (1980) indicated (while working with potato) that if these factors are maintained properly, 'n' value could be obtained as accurate as 2 that predicted by the power law.

3.5 Effect of Drying Temperature on Vitamin C Content of Papaya Leaves

Fresh papaya leaves were dried at 60^0 C temperatures in a mechanical dryer having a constant loading density. A graph of vitamin C concentration ratio (C_t/C_0) versus time (hour) was plotted on a semi-log coordinate (Figure 4) to observe the effect of -

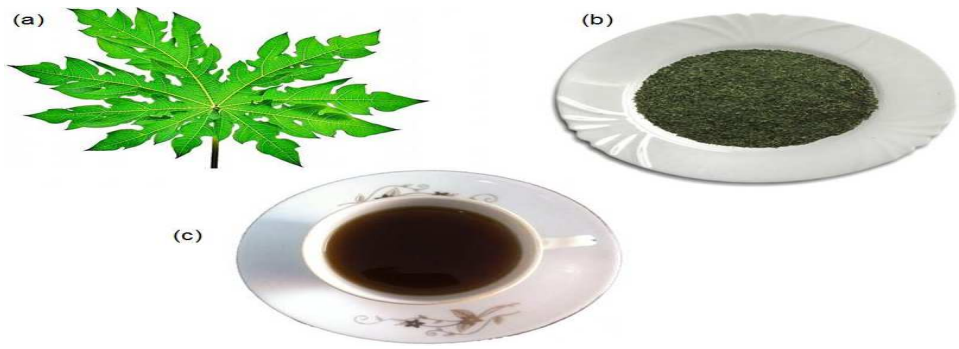

Fig 2: Appearance of (a) papaya leaf (b) papaya leaf tea (c) brewed papaya leaf tea.

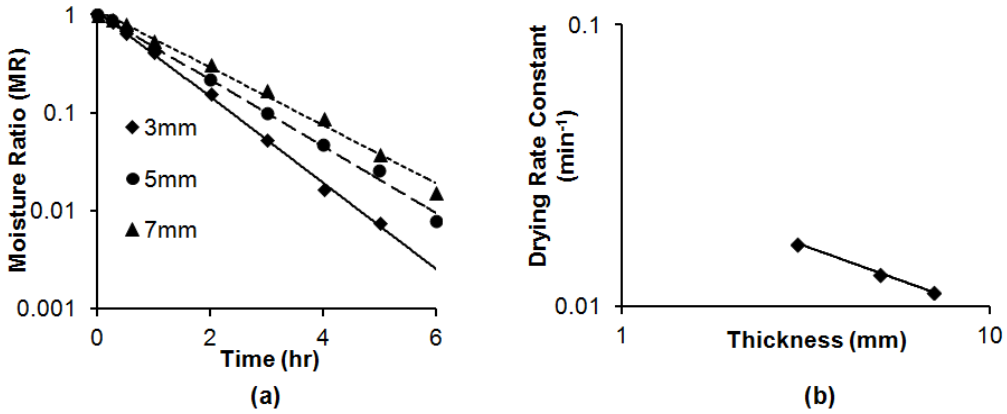

Fig 3: Effect of thickness on drying of papaya leaves at 60^0C.

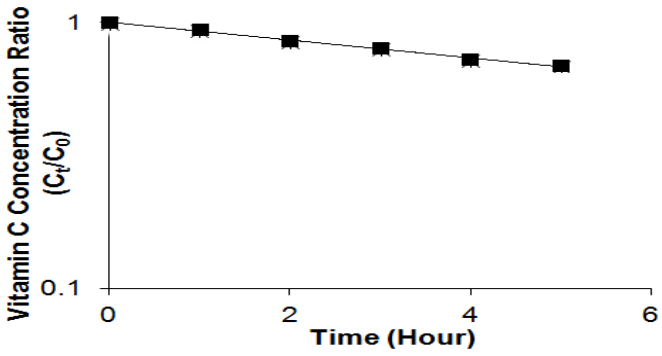

Fig 4: Effect of temperature on vitamin C degradation of papaya leaves at 60^0C.

temperature on vitamin C concentration ratio (C_t/C_0). Following regression equation was obtained.

$C_t/C_0 = 1.0028\ e^{-0.077t}$
(t = time in hour) ……. (5)

From Fig 4 it is observed that the K value (reaction rate constant, hr^{-1}) is 0.077 hr^{-1}. The degradation of vitamin C is much higher at the beginning of processing and the rate falls continuously as process time progresses. According to Heldman (1974) this behavior is attributed to exponential decay.

3.6 Proximate Composition of dried papaya Leaves

Proximate composition of dried papaya leaves (shown in Fig 2) are given in Table 2. Table 2 presents the proximate composition of dried papaya leaves. The moisture content is found 4.9% on dry basis. The ash content estimated in dried leaves is 11.3% which is very similar to the result reported (11.4%) by Maisarah *et al*. (2014). Crude protein content of the dried leaves is 27.5% which is lower than that obtained for freeze-dried products by Maisarah *et al*. (2014). The ash and total carbohydrate contents (11.3% and 58.4%, respectively) is comparable with the results obtained by Maisarah *et al*. (2014) who reported the same values as 11.4% and 38.4%. Vitamin C content (37.3 mg/100g) was found to be lower than the results (85.6 mg/100g) obtained by Maisarah *et al*. (2014). The variation is attributed to the drying method as drying has been carried out in this study using cabinet drier while the later has been done by freeze drying. The composition may also differ due to the maturity stage, and postharvest storage condition, climatic conditions and surrounding soil environment as well.

Table 2: Proximate composition of dried papaya leaves

Parameter	Processed (dried) Leaves	
	Wet Basis (%wb)	Dry Basis (%db)
Moisture (%)	4.7	4.9
Protein (%)	26.2	27.5
Ash (%)	10.8	11.3
Total Carbohydrate (%)	55.7	58.4
Vitamin C (mg/100g)	35.5	37.3

3.7 Sensory Evaluation of Papaya Leaf Tea

Brewing time of green tea affects its taste and flavor (Lee and Chambers, 2009). To optimize the brewing time three samples were analyzed for sensory properties. Papaya leaf tea (4 g) was brewed in 250 ml water on gas cooker. Three different brewing time of 1, 2 and 5 minutes were used to prepare three samples. The samples were served to a 10 member taste panel for organoleptic taste testing. The mean scores for color, flavor, taste and overall acceptability of three different samples are presented in Table 3.

A one way analysis of variance (ANOVA) was carried out to analyze the color, flavor, taste and overall acceptability of papaya leaf tea. Then, Duncan's Multiple Range Test (DMRT) was used to find significant differences between the sample if exist.

The first judgment of any product is done by seeing. So, color is one of the most important sensory attributes which add to the aesthetic value of a product. Result (Table 3) shows that there was significant difference in color. The sample S_2 secured the highest mean score (7.7) and ranked as 'like moderately'. There was no significant difference of color between the samples S_1 and S_2. The samples S_1 and S_2 Secured 6.9 and 6.6 mean score respectively and both the samples were ranked as 'like slightly'.

Table 3: Mean scores for color, flavor, taste and overall acceptability of papaya leaf tea.

Sample	Sensory Attributes			
	Color	Flavor	Taste	Overall Acceptability
S_1	6.9^b	4.5^b	4.2^{ab}	5.4^b
S_2	7.7^a	5.7^a	4.7^a	6.1^a
S_3	6.6^b	3.6^c	3.9^b	4.5^c
LSD	0.4882	0.4679	0.5454	0.4679

Mean values with the different alphabets in the column are significantly different at ($p<0.05$).

Where, S_1 = Papaya leaf tea of 1 minute brewing time, S_2 = Papaya leaf tea of 2 minute brewing time, S_3 = Papaya leaf tea of 5 minute brewing time

Table 3 shows that there was significant difference in flavor of the three samples. The sample S_2 secured the highest mean score (5.7) and ranked as 'neither like nor dislike'. The samples S_1 and S_2 Secured mean score 4.5 and 3.6 and ranked as 'dislike slightly' and 'dislike moderately' respectively. Similar observation was found for taste and overall acceptability of the tasted samples and the sample S_2 secured the highest mean score and was more acceptable than other samples.

The papaya leaf tea of brewing time 2 minutes (shown in Fig 2) secured the highest score for color, flavor, taste, and overall acceptability. Papaya leaf tea of 1 minute brewing time got the second highest score and papaya leaf tea of 5 minutes brewing time secured the lowest score. So, papaya leaf tea of 2 minutes brewing time possesses the best sensory properties followed by the papaya leaf tea of 1 and 5 minutes brewing time respectively. The mean scores given in Table 3 seem to be low (5.7, 4.7 and 6.1 for flavor, taste and overall acceptability for the best sample 'S_2'). This may happen as the panelists are not familiar with the taste and flavor of the papaya leaf tea.

4. Conclusion

Papaya leaf tea can be prepared from green papaya leaf by mechanical drying. This study shows the possibility of production of papaya leaf tea. The production will be economically feasible because of the low-cost and availability of the raw material. Papaya leaf tea of 2 minutes brewing time shows the best sensory properties. So, a brewing time of two minute may be recommended and regular intake of papaya leaf

tea may be used as preventive measure of cancer due to its powerful anti-cancer agent.

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