Changes in Proximate Composition, Vitamin C and β-Carotene Contents of Oven Dried Pawpaw (*Carica papaya*) Fruit as Influenced by Pre-treatment Methods

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Abstract- A common way of maintaining essential nutrients in fruits and vegetables is through novel food processing techniques such as pre-treatment. This study investigated the influence of pre-treatment methods on the proximate composition, vitamin C and β-carotene contents of oven dried pawpaw. Fresh, ripe pawpaw fruit were peeled, sliced and pre-treated with three pre-treatments – ascorbic acid dip (0.45% w/v), honey dip (0.25% v/v) and steam blanching (100 °C). The fruit slices were soaked in ascorbic acid and honey solutions for 4 min while steam blanching was done for 2 min. Untreated pawpaw sample served as the control. The treated and control samples were dried at an average temperature of 65 °C. Results showed that vitamin C of dried pawpaw samples pre-treated with honey dip had the highest retention of vitamin C (116.05 mg/100g) compared to ascorbic acid treated (98.90 mg/100g), steam blanched (109.02 mg/100g), and control samples (77.02 mg/100g). In terms of β-carotene, pawpaw sample treated with ascorbic acid solution had the highest value of 12.68 mg/100g. The use of honey and ascorbic acid solutions as treatments prior to drying can improve the retention of nutrients such as vitamin C and β-carotene in dried fruits.

Keywords- Pre-treatments, proximate properties, vitamin C, β-carotene

1 INTRODUCTION

Pawpaw (*Carica papaya L.*), also referred to as papaya, is a deep yellow or orange colour, sweet fruit which belongs to the family Caricaceae and commonly cultivated throughout the tropical and subtropical regions of the world. It is a nutrient-packed fruit which is mainly cultivated in Nigeria for fresh consumption though it possesses a whole lot of other uses both in food and other industries. The ripe, soft, sweet tissue of pawpaw fruit can be consumed fresh or eaten in fruit salads, blended as smoothies or juice and can also be incorporated into yoghurt and creams. Additionally, pawpaw is widely consumed because of its richness in antioxidants, vitamins A and C, dietary fibre, low caloric value as well as for nutraceutical and pharmacological properties. More so, it is also a cheap source of several essential amino acids and minerals such as magnesium, iron, copper, manganese and potassium (Nguyen et al., 2019). Though regarded as an economical fruit, it is however climacteric and affected by specific temperatures which in turns causes rapid changes in its respiratory rate.

Drying is the oldest and one of the most widely used preservation methods in food processing for the removal of moisture content from a food material. Freeze-drying, vacuum drying, osmotic drying, cabinet or tray drying, fluidized-bed drying, spouted bed, Ohmic, microwave drying are few examples of recent drying methods (Sagar and Kumar, 2010). These technologies have been successfully evolved in both liquid (fruits and vegetables) and solid (meats) food materials thereby giving value to storability, transportability and accessibility of food products. Drying can be used to preserve fruits and vegetables such as pawpaw fruit to a safe level where it can no longer be attacked by spoilage microorganisms (Adepoju and Osunde, 2017).

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However, adequate care must be exercised to ensure maximum retention of nutrients and bioactive compounds in fruit. To achieve this, pre-treatments are often used prior to fruit drying.

Pre-treatments are recommended techniques commonly used prior to drying to enhance nutrients retention and reduction in microbial attack in fruits, vegetables and other food products (Bolarinwa and Ajetunmobi, 2020). There is a significant correlation between the qualities of dried products and pre-treatment methods used prior to drying (Sahoo et al., 2015). This is because pre-treatments effectively enhance drying process by reducing the drying time; inactivating the enzymes responsible for unacceptable darkening and off-flavours, thus preserving products' colour, improving retention of the antioxidant compounds, the crispness of dried products and rehydration capacity (Deng et al., 2019). Several Studies have used different pre-treatments for the drying of various fruits and vegetables. Examples are lemon juice, salt solution, and hot water blanching for mango (Dereje and Abera, 2020); blanching for papaya (Nguyen et al., 2019); osmotic pre-treatment with and without addition of calcium chloride for mango (Sanjinez-argandoña et al., 2018); and ascorbic acid dip, honey dip and steam blanching for mango fruit (Adepoju and Osunde, 2017).

Vitamin c and β-carotene are essential nutrients for humans and could be used for judging quality assessment of dried fruit such as pawpaw. Despite several studies on drying pre-treatment methods, there has been little or no reports on the combined effect of honey dip, blanching and ascorbic acid pre-treatments on vitamin c and β-carotene of pawpaw using oven drying as a method of drying. Hence, this study aimed at investigating the proximate composition, vitamin c and β-carotene contents of oven dried pawpaw (*Carica papaya*) fruit as influenced by pre-treatment methods (ascorbic acid dip,

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honey dip, and steam blanching at a boiling temperature of 100 °C).

2 Materials and Methods

2.1 Materials

Fresh ripe pawpaw fruits, ascorbic acid and honey used for the pre-treatments were purchased from local fruit market and a standard pharmaceutical outfit both in Minna, Niger State, Nigeria. Other purchased materials were steamer pot, weighing balance (± 0.01), cutting boards and trays, knives, bowls, hand gloves and towels. The fruits were inspected, sorted, washed, hand-peeled and cut into about 5 mm thickness to facilitate rapid drying. The sliced fruits were divided into four samples, 400 g each, prior to pre-treatments.

2.2 Pre-treatments

The sliced fruit samples were subjected to three different pre-treatment methods (AAD- ascorbic acid dip; HD-honey dip; SB-steam blanching) and a control sample (unpretreated pawpaw samples). The sliced fruit samples treated with steam blanching, were placed in steamer pot in a thin-layer and put over boiling water for 2 min. To allow adequate circulation of the steam, the fruit was covered tightly. For AAD pre-treatment, this followed the standard procedure of Abano and Sam-Amoah (2011). For HD pre-treatment, honey-water solution was prepared using a part of honey to four parts. The fruits slices were dipped into the solution, left for 4 min and drained well before drying. A laboratory-size oven dryer (Galen Kamp) was used for the drying experiment. The oven was calibrated to a temperature of 65 °C before the fruits were placed into it and the fruit were weighed at 1 h interval until constant weight was obtained. The drying was carried out for a period of 6 h.

2.3 Proximate, Beta-Carotene and Vitamins Analyses

AOAC (2006) standard procedures were used in analysis of the proximate composition (moisture, fat, protein, ash, and crude fibre) of the dried fruit samples and carbohydrate content was calculated by difference. Vitamin C and β-carotene contents of the dried fruit sample was estimated by 2, 6- Dichlorophenol-indophenol visual titration (as described by AOAC (1996) in Verma et al (1996) and spectrophotometric method based on Ultraviolent (UV) inactivation.

2.3 Statistical Analysis

All data were analysed in triplicate and Analysis of variance (ANOVA) was carried out using the SPSS 20.0 software at 5% level of significance. Mean differences in the treatments were tested for significance using the Duncan Multiple Range test (DMRT).

3 Results and Discussions

3.1 Drying Curve for Pretreated Oven-dried Pawpaw Fruit

The moisture content of the pre-treated fruits was plotted against the time of drying to generate the drying curves. Fig. 1 shows the drying curves of pawpaw with the different pre-treatments. The results showed that as the time of drying increases, the moisture content of the fruit sample decreases until a constant moisture content is reached. The variation of the drying shows that moisture content of HD (70%) pre-treated pawpaw reduces faster than those pre-treated with AAD (71%) and SB (74%) after drying for 2 h. After 4 h of drying, the moisture content of SB pre-treated pawpaw reduced drastically to 11%. The trend of the drying curve is similar to moisture content drying time in the reports of Md Zaki et al. (2007) and Abano et al. (2013) in the pre-treatment of pawpaw and mango slices, respectively. Drying kinetics is affected by several drying parameters including; time, power intensity and system pressure (Md Zaki et al., 2007). In addition, as the treatment time increased, the weight loss increased, but the rate at which this occurs decreased (Kumari et al., 2013).

HD and SB pre-treated pawpaw samples reached constant moisture loss after drying for 4 h while the lowest moisture contents observed for the control sample and AAD pre-treated pawpaw were 5.00% and 4.50% respectively. This shows that, drying was quickly attained in those samples compared to HD and SB pre-treated samples. This could be attributed to sticky coat which prevents moisture loss from the HD pre-treated pawpaw samples as well as little condensed water deposit on pawpaw prior oven-drying (Abano et al., 2013; Nobosse et al., 2017). Also, steam blanching could have resulted in a type of coating of the surface by wax-like oil therefore prolonging its drying period (Tunde-Akintunde et al., 2011). These statements agreed with the observation made in this study.

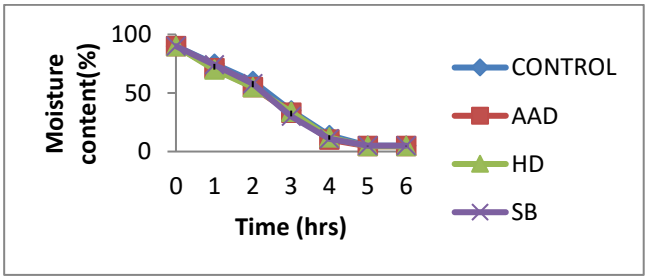


Fig. 1: Drying curve of pawpaw using different pre-treatment methods

3.2 Proximate Composition of Dried Pawpaw Fruit

The proximate qualities of the dried pawpaw samples for the different pre-treatment methods are presented in Table 1. The moisture contents of the dried pawpaw samples varied between 4.50% and 5.00% across the different pre-treatments. Pawpaw samples treated with AAD and HD had lower values of moisture contents (4.50%) compared to other samples. These values are similar to those reported by Islam et al. (2019) for osmotically pre-treated air-dried papaya, Raja et al. (2019) for pawpaw leaf powder and far lower than those obtained by Reis et al. (2018) for dried papaya. These differences may be as a result of varietal differences, drying methods, and also climatic conditions such as ambient humidity and air temperature (Silva et al., 2017; Kemp, 2007). Generally, low values of moisture contents will inhibit the growth of spoilage microorganisms and guarantee microbiological stability of dehydrated

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products. The result also established that pre-treatments have varying significant effects on the fat, protein, ash, fibre and carbohydrate contents of dried pawpaw samples.

AAD and HD had the same values of fat content (6.00%) while SB had a higher value (8.00%) compared to control sample (7.50%). The value was however different in the drying of papaya pulp in the report Okon et al. (2017). Possible reasons could be attributed to drying parameters such as temperature, drying time and physiological state of fruit. AAD and HD had the highest (3.85%) and lowest (2.02%) values of protein content respectively. This value could be considered too low for protein content. However, it is noteworthy that the protein content of unripe pawpaw is higher than that of ripe pawpaw (Nguyen et al., 2019). This therefore agreed with the findings of this study. The highest values for ash and fibre contents of the pre-treated samples were 3.00% (AAD), 9.64% (HD) compared to 2.00% and 9.01%, respectively in the control samples. Highest carbohydrate content was found in the control sample (74.35%). This shows that, pre-treatment methods increased the ash and fibre contents of the dried pre-treated pawpaw but reduced the carbohydrate contents.

Table 1. Proximate qualities of dried pawpaw

Samples	MC (%)	Fat (%)	Protein (%)	Ash (%)	Fibre (%)	Carbohydrate (%)
Control	5.00^{a}	7.50^{bc}	2.14^{a}	2.00^{a}	9.01^{a}	74.35^{b}
AAD	4.50^{a}	6.00^{a}	3.85^{b}	3.00^{ab}	9.19^{b}	73.46^{a}
HD	4.50^{a}	6.00^{a}	2.02^{a}	3.50^{b}	9.64^{b}	74.34^{b}
SB	5.00^{a}	8.00^{c}	2.77^{b}	2.50^{a}	9.61^{b}	72.12^{a}

Values followed by the same letter in the same column are not significantly different at $P < 0.05$.
AAD- Ascorbic Acid Dip; HD-Honey Dip; SB- steam Blanching; MC-Moisture Content

3.3 Effect of Pre-treatment Methods On the Vitamin C Contents Of Oven Dried Pawpaw

Vitamin C is a very important quality indicator in many food processes including drying of fruits. The effect of some pre-treatments on vitamin C retention in dried pawpaw samples was studied and the results are presented in Table 2. The results showed that dried pawpaw sample treated with honey had the highest retention of vitamin C. This may be as a result of the fact that honey contains several vitamins (Ajibola et al., 2012). This, coupled with the high nutritional profile of honey and its anti-browning effect, encouraged its use as pre-treatment in this study (Ajibola et al., 2012). Steam blanched dried pawpaw has the second highest value of vitamin C which may be due to the fact that the pawpaw samples were not blanched directly in water but with steam. This reduced the solubility of the vitamin (since vitamin C is water soluble and heat affected), thereby enhancing vitamin C retention. Deng et al. (2019) also reported that steam blanching improves the retention of water-soluble nutrients as compared with water blanching, due to its negligible leaching effect. The values of vitamin C obtained from this study are significantly higher than those reported by Reis et al. (2018) for dried papaya, Islam et al. (2019) for osmotically pre-treated hot-air dried papaya, Nguyen et al. (2019) for blanched papaya and Bolarinwa and Ajetunmobi (2020) for osmotically pre-treated African star apple. However, higher retention of vitamin C was recorded by Leiton-ram et al. (2020) for dried guava. The differences in these values may be due to many reasons such as the pre-treatment methods employed, the drying methods or other drying parameters such as temperature, air speed circulation in the oven.

Table 2. Vitamin C contents of dried pawpaw samples

Samples	Vitamin C (mg/100g)
Control	77.02^{a}
AAD	98.90^{a}
HD	116.05^{c}
SB	109.02^{b}

Values followed by the same letter in the same column are not significantly different at $P < 0.05$.
AAD- Ascorbic Acid Dip; HD-Honey Dip; SB- steam Blanching

3.4 Effect of Pre-treatment Methods on Beta-Carotene Contents of Oven Dried Pawpaw

Carotenoids are a group of orange, yellow and orange-red fat-soluble pigments that are widely distributed in nature. There are lots of them present, especially in fruits and vegetables but β-carotene is the most predominant and active of them all. It is a precursor of vitamin A and a major carotenoids found in pawpaw fruit (Pritwani and Mathur, 2017; Vasanthakaalam et al., 2018). In this study, the influence of three pre-treatment methods on its retention in dried pawpaw samples was observed and the results are presented in Table 3.

The results indicated that dried pawpaw sample treated with ascorbic acid solution retained β-carotene the most compared to other samples. This is because honey itself as a low marked level of ascorbic acid (Nwaichi et al., 2015). More so, β-carotene is not generally available from plants unless synthesized from β-carotene containing plants such as broccoli and carrots. (Lester, 2006). However, the other pre-treatments also give a good retention of β-carotene without significant difference between the values. These results were nearly similar to those reported by Reis et al. (2018) for dried pawpaw. Lower values but similar trend of β-carotene retention were recorded in the drying of osmotically pre-treated African star apple (Bolarinwa and Ajetunmobi, 2020) and in dried guava pulp (Leiton-ram et al., 2020).

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Table 3. β-Carotene contents of dried pawpaw samples

Samples	β-carotene (mg/100g)
Control	12.31[a]
AAD	12.68[a]
HD	12.65[a]
SB	12.30[a]

Values followed by the same letter in the same column are not significantly different at $P < 0.05$.
AAD- Ascorbic Acid Dip; HD-Honey Dip; SB- steam Blanching

4 CONCLUSION

The pre-treatment methods (AAD, HD, SB) increased the ash, fibre, and fat contents of the dried pre-treated pawpaw but reduced the carbohydrate content. Protein content of HD pre-treated sample was lower compared to AAD and control sample. Dried pre-treated pawpaw sample with HD and AAD had better retention of vitamin C and β -carotene, respectively. The vitamin C and β-carotene contents increased in the order of AAD<SB<HD and SB<HD<AAD, respectively. The results from this study indicate that HD and AAD could be employed as pre-treatment methods in drying for nutrients retention in dried pawpaw. Further studies can be carried out by varying the concentration of the pre-treatments and observing its effects on the quality and the rate of moisture removal from the fruit as well as investigating the storage stability of the dried fruit.

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