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Physicochemical, antioxidative and sensory properties of pre-treated sliced pear cultivar during frozen storage

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Abstract

Pear is a typical fruit of temperate zones with high nutritive values and organoleptic properties, but when this fresh fruit being harvested, it will undergo chemical changes which can cause spoilage and product deterioration. Freezing could be as a preservative method to maintain quality attributes (colour, texture) of fresh produce that change over time. The purpose of this study is to determine ascorbic acid content and antioxidant activity of frozen fruit treated with osmotic solution. Pears were pre-treated with blanching, osmotic and both blanching and osmotic solution prior to freezing. Two varieties of pear fruit which are Asian pear and Packham pear were analyzed for physicochemical (colour and texture), antioxidative properties (ascorbic acid content, antioxidant activity and total phenolic content) and sensory acceptability. The pears were subjected to different pre-treatments prior to freezing such as blanching and osmotic solution during storage. The results showed that colour attributes of frozen pears were significantly affected by treatment which in contrast to texture properties of frozen pears during storage. Ascorbic acid content of frozen Packham pear was recorded the highest (6.38 ± 0.96 mg/100 g) after treated in osmotic solution compared to frozen Asian pear, the highest (4.62 ± 1.15 mg/100 g) was found in blanching treatment prior to storage, both tested after day 1 of storage. When treated in blanching treatment, the antioxidant activity of frozen Packham pear using DPPH assay exhibited (84.61 ± 0.69 %) contains high scavenging activity on day 1, while for Asian pear (67.63 ± 2.37 %) in blanching treatment on day 3. Using seven-point hedonic scale, sensory acceptability shows that frozen Asian pear treated in osmotic solution was highly rated among consumers with overall acceptance of 5.80 ± 0.85. Thus, combination of pre-treatment which were osmotic and blanching and freezing helps to retain the quality of frozen pears during period of storage.

1. INTRODUCTION

Pears are a member of Rosaceae (Rose) family and are often called as pome fruits which is a fruit with characteristic compartmented core. Asian pears are called as “apple pears” because of their apple-like texture, while Packham pears are a cross between two English pears, with firm, sweet, juicy flesh. Pears also are an excellent source of dietary fibre (1.8 mg / 100 g) and a reliable source of vitamin C (7.6 mg / 100 g) (Reiland & Salvin, 2015). Fruits also are acknowledged as a good and major source of antioxidants in human diet (Gebczynski *et al*., 2017). Improvement of different techniques for preservation of food is very crucial as increasing demand for more natural and healthy products. Fresh produce's short shelf life is frequently accompanied with enzymatic reactions that could result in financial loss. Deterioration of fresh produce will lead to economic loss. Economy loss often occur resulting from spoilage of fresh produce during harvesting, transportation, and storage. Besides, inappropriate processing method results in fast deterioration in fresh produce. During processing of food, nutrient value of food always altered and will be reduced thus will lead to fast deterioration. Thus, pre-treatment of the fruits and freezing process will be one of the methods to prolong the shelf life of the products. Frozen fruits also have gained popular owing to high quality and easily prepared (Suzanne, 2014). Freezing could be as a preservative method to maintain quality attributes (color, texture) of fresh produce that change over time. Influence of pre-treatments on the quality attributes of frozen products will help to develop commercialized frozen fruit products. Plus, frozen products need to be stored below -18°C to decrease the rate of deteriorative reactions during storage time (Tsironi & Taoukis, 2017).

The aim of this study is to improve the fresh produce shelf life by using freezing as preservation

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method. Freezing preservation helps to retain the quality of products over long period of storage. Freezing also consist of combination effect of low temperature at which no growth of microorganism, reduction of chemical reaction caused by enzyme and delay the cellular metabolic reactions. Therefore, this frozen fruit may become commercialized in the market. However, commercial application of frozen pear to be exported is limited. The market for the frozen fruit is low compared with canned fruits. Besides, there are fewer studies on the impact of process condition on quality attributes of the final fruit product especially on pear.

The objectives of this study are to determine physicochemical properties of frozen fruit treated with osmotic solution. Pears are pre-treated with blanching, osmotic and both blanching and osmotic solution prior to freezing. Next is to determine antioxidative properties of frozen fruit treated with osmotic solution and to determine sensory acceptability of frozen fruit treated with osmotic solution. The study able to identify the effect of different pre-treatments before freezing with the nutritional composition of frozen fruit during storage at -21°C, where the quality attributes of the final frozen product were evaluated based on texture analysis and color properties during storage. Then, in regards of prior to consumption, the ascorbic acid content, antioxidant activity and sensory acceptability of the frozen pear were conducted.

2. MATERIALS AND METHODS

2.1. Samples preparation and treatments

Two varieties of fresh pear fruits, which are fresh pear fruits (500 g) were purchased from hypermarket in Tanah Merah, Kelantan. The fruits were washed and cut into 16 slices with the volume of 16 cm^3 (1cm x 4cm x 4cm) before subjected to any treatments. As for control, the sample was sliced and not subjected to any treatment. The second sample was treated with blanching only. The pear slices were steam blanched at 95°C for 3 minutes. The third sample was immersed in osmotic solution prepared with commercial sucrose and distilled water and set at 45° Brix for 2 hours (Yadav & Singh, 2014). The forth sample was subjected to both blanching and immersing in osmotic solution. After that, with 3 replicates, all samples were kept in plastic bags and sealed. The samples were stored at -21°C for 24 hours and thawed for 30 minutes prior to analysis.

2.2. Determination of colour properties

Color properties of frozen pear during storage were determined by using a chroma-meter (Chroma Meter CR 400, Konica Minolta, Japan) at day 1, day 2 and day 3. The colour properties were expressed in L^*, a^*, b^* values where L^* indicates (whiteness or brightness/darkness), a^* (redness/greenness) and b^* (yellowness/blueness), and the colour was measured in 3 consecutive days (Alhamdan *et al*., 2018).

2.3. Determination of textural properties

The textural properties (TPA) of the frozen pears were determined using texture profile analyser (Brookfiled CT3 Texture Analyzer). TPA of frozen pear was carried out by compressing them with TA4/1000 (cylinder) probe. The studies were conducted at test speed 1.0 mm/s, load cell 5 000 g, and trigger load 5 g. The textural parameters measured were hardness, cohesiveness and chewiness (Trinh & Glasgow, 2012), and was measured in 3 consecutive days.

2.4. Determination of ascorbic acid content

Vitamin C content was determined by dye-titration method. Metaphosphoric acid (HPO3) (3% ,w/v) was prepared by dissolving the sticks of HPO3 in distilled water. Ascorbic acid standard was prepared by dissolving 1 mg/ml L- ascorbic acid in HPO3 solution. Dye solution was prepared by dissolving 50 mg of sodium salt 2.6-dichloroindophenol in 150 ml of hot distilled water containing 42 mg sodium bicarbonate. The dye solution was then cooled, filtered and diluted with distilled water. The standardization of dye was carried out by pipetted out 5 ml of the standard ascorbic acid solution into 100 ml conical flask and 5 ml of the 3% HPO3 solution was added. The ascorbic acid solution was titrated against dye solution until it turns into pink color.

The sample was prepared by blending 20 g of fruit samples with 100 ml of HPO_3 (3% w/v). The sample was then, filtered through Whatman No. 1 filter paper, was pipetted out (5 ml) into conical flask and titrated against dye solution. Ascorbic acid content was then tested on day 1 and day 3. In this oxidation-reduction reaction, ascorbic acid in the extract was oxidized to DHAA and the indophenol dye reduced to a colorless compound. End point of the titration was detected when excess of the unreduced dye gives a rose-pink color in acid solution (Tee, Young, Ho, & Mizura, 1988).

2.5. Determination of scavenging activity

The antioxidant activity was determined by the DPPH assay, as described by Franco *et al*. (2007). One millimolar of DPPH solution was prepared by dissolving 0.004 g of powdered DPPH in 100 ml ethanol. The bottle was swirled until the mixture was homogenous. Sample was dissolved in ethanol to prepare 200 µg/mL extract. Then, each extract concentration (2 mL) was added with 2 ml of DPPH ethanolic solution and test tubes were shaken vigorously. The bleaching of DPPH was measured using spectrophotometer at 517 nm, after 30 min of reaction, at 25°C (Salta *et al*., 2010). The formula of DPPH scavenging effect (%)/% is represented by Inhibition = (A0-A1)/A0 × 100, where A0 = The absorbance of control and A1=The absorbance of sample.

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2.6. Sensory evaluation

Pear slices samples were placed in a plastic and labelled from A to H. Consumer acceptance was measured as degree of liking. Consumers were asked to rate the samples on color, hardness, chewiness, sweetness, and overall acceptance for each sample. The degree of liking has seven-point hedonic scale (1 = extremely dislike; 2 = dislike very much; 3= dislike moderately; 4; neither like nor dislike; 5 = like moderately; 6 = like very much; 7 = extremely like) (Eriksson et al., 2000). The sensory involved 30 people from age 22 to 27 years old.

3. RESULT AND DISCUSSION

3.1. Total phenolic contents (TPC)

The color properties of pre-treated frozen pears during storage are presented in Figure 1. Positive a* values indicate the red color in the samples, whereas negative *a** intensify the green color in the samples. High value of *a ** indicates the sample was subjected to browning. Therefore, control samples were subjected to browning faster than pears which undergo pre-treatment. When undergo pre-treatments such as blanching, immerse in osmotic solution and both blanching and osmotic solution, the pears could be preserved longer than without pre-treated pears as no treatment shows rapidly increasing of *a ** values throughout the days as shown in Figure 1. Both pre-treatments which is blanching, and osmotic solution give better result compared to other treatment as the browning of the samples could be delayed during frozen storage.

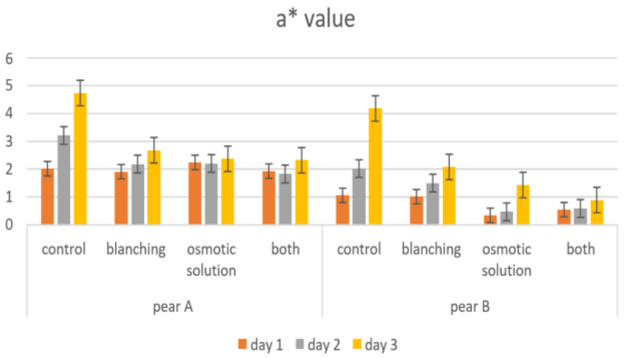

Figure 1: *a** value for frozen pears during storage.

Table 1: Total phenolic contents of *H. polyrhizus* and *H. undatus*.

Dragon Fruit	Total Phenolic Content (mg Gallic Acid Equivalent /100g FW)
H. polyrhizus	20.50 ± 0.02
H. undatus	11.47 ± 0.01

*Values are mean ± standard deviations.

The hardness of the samples was presented in Figure 2. Hardness often associated with the tensile strength of the sample. The result shows that the highest hardness value was found in control Asian pear at 5071 g while the lowest value (5018 g) was found in blanching treatment. For Packham pear, highest hardness value, 5057 was found in blanching and osmotic treatment while lowest value, 5014 in control as well as blanching and osmotic solution treatment. Overall, throughout the days, hardness of the samples is decreasing. The control of the samples shows rapidly decreasing from day 1 to day 3. Samples with blanching treatment decrease from day 1 to day 2 but increase on day 3. Pre-treatments in osmotic solution show slowly decreasing of hardness, which is 5052, 5038, 5027 for day 1, day 2 and day 3, respectively for Asian pear and for Packham pear 5034, 5027.5 and 5017.5 for day 1, day 2 and day 3, respectively. The hardness of the samples will be reduced upon introduced to freezing due to sublimation of the frozen water led to very soft product. Plus, textural properties of the fruits were influenced by freezing and freezing method (Alhamdan *et al*., 2015). The freezing process will cause the rupture of cell membranes, thus increasing the surface area for further enzymatic and chemical reactions. The increased surface area in frozen fruits also results in greater volume, which may lead to a reduction in the amount of fruit necessary to achieve a daily serving of fruit.

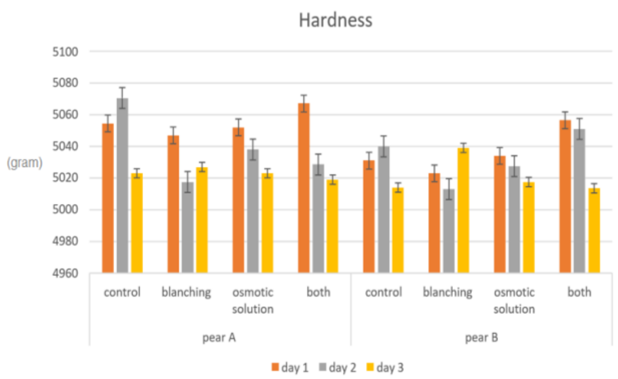

Figure 2: Hardness value of frozen pears with different treatment during storage.

Ascorbic acid content of pre-treated frozen pears during storage are shown in Table 1 and 2. Ascorbic acid content was found in the range of 1.20 to 6.38 mg ascorbic acid/ 100g frozen sample /100 g in the tested frozen pears. Asian pear treated with blanching has highest ascorbic content at 4.62 mg/100 g while lowest ascorbic content 1.20 mg/100 g was found in control sample. Highest ascorbic acid content (6.38 mg/100 g) was found in treated Packham pear in osmotic solution on day 1 while lowest ascorbic acid content, 1.81 mg/100 g was record in blanching treatment on day 3. This show that the current finding on ascorbic acid content of both frozen pears which in range of 1.2 to 6.38 mg/100 g were in line with the previous study (Bulut, 2015). However, some factors such as genotype difference, harvesting methods, pre-treatments and maturity of pears would affect the ascorbic acid content of the fruits.

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Table 1: Ascorbic acid content of frozen Asian pear sample (mg/100) with different treatment during storage. (n=3)

Sample	Treatment	Day 1 Mean ± SD	Day 3 Mean ± SD
Asian pear	Control	2.72 ± 0.85	1.20 ± 0.00^{b}
	Blanching	4.62 ± 1.15	2.38 ± 0.24^{ab}
	Osmotic solution	3.69 ± 1.20	2.48 ± 1.91^{ab}
	Blanching & osmotic	3.34 ± 1.11	3.27 ± 1.23^{a}

$^{a-c}$ Different superscript letter in the same column indicate significant differences among samples (P < 0.05)

Table 2: Ascorbic acid content of frozen Packham pear sample (mg/100) with different treatment during storage. (n=3)

Sample	Treatment	Day 1 Mean ± SD	Day 3 Mean ± SD
Packham pear	Control	5.79 ± 1.75	2.17 ± 0.95^{b}
	Blanching	5.48 ± 1.82	1.81 ± 0.48^{b}
	Osmotic solution	6.38 ± 0.96	5.03 ± 1.01^{a}
	Blanching & osmotic	5.29 ± 0.96	5.22 ± 0.75^{a}

$^{a-c}$ Different superscript letter in the same column indicate significant differences among samples (P < 0.05)

All pre-treatments subjected prior to freezing show decreasing of ascorbic acid content during storage from day 1 to day 3 for both pears. Blanching cause loss of ascorbic acid content from 4.62 mg/100 g on day 1 to 2.52 mg/100 g on day 3 for Asian pear. Ascorbic acid is a heat sensitive substance as reported by many researchers (Suna *et al*., 2014; Emese & Nagymate, 2008; Bello & Fowoyo, 2014). As stated by Tosun & Yücecan (2008), this loss may be due to leaching and thermal degradation of ascorbic acid to L-dehydro-ascorbic acid and further oxidation might occur. This statement also was supported by Bulut (2015), stating that ascorbic acid content of blanched green bean was reduced about 30%. During frozen storage, blanching significantly protects ascorbic acid in vegetables plus steam blanching provide better protection of ascorbic acid (Bulut, 2015).

Double pre-treatment which is blanching and osmotic on both Asian pear and Packham pear show not much changes of ascorbic acid loss on day 1 and day 3. This may be due to total ascorbic acid level was fully retained during blanching and osmotic solution prior to freezing. At the end of the storage ascorbic acid content of double pre-treatment were higher that control samples. Favell (1998) also found that in quick-frozen products, level of ascorbic was equal or much better than fresh product. Only treatment on day 3 was found significantly difference at $p<0.05$ for both frozen pears whereas effects of treatments on day 1 was not significantly difference.

The antioxidant activity of pears was determined by using DPPH radical scavenging assay. DPPH Scavenging activity (%) of frozen Asian pear treated with different treatment during storage at concentration of 200 µl/ml was shown on the Table 3 and 4. Different treatment subjected in Asian pear has significance difference at $p<0.05$ throughout the storage. The highest antioxidant activity was found in pear treated with osmotic solution with the reading of 50.77%, whereas the lowest value 26.41% was observed in control sample. Control sample show decreasing trend during storage, but other treatment shows increasing value of % of inhibition during storage. The decrease in antioxidant activity might be due to decreasing of phenolic content during storage. The increasing trend of percentage of inhibition might be due to the fruit itself which is not suitable for the treatment conducted or it might increase on day 3 but will decreased after further storage. This trend also observed in apples (Yadav & Singh, 2014) where free radical scavenging activity increase during storage due to the synthesis of phenolic compounds.

Table 3: DPPH Scavenging Activity (%) of frozen Asian pear with different treatment during storage at concentration of 200 µl/ml. (n=3)

Sample	Treatment	Day 1 Mean ± SD	Day 3 Mean ± SD
Asian pear	Control	49.17 ± 0.95^{b}	26.41 ± 0.00^{d}
	Blanching	42.69 ± 0.19^{c}	55.61 ± 1.86^{c}
	Osmotic solution	50.77 ± 0.19^{a}	67.63 ± 2.37^{a}
	Blanching & osmotic	36.03 ± 0.62^{d}	60.87 ± 0.58^{b}

$^{a-c}$ Different superscript letter in the same column indicate significant differences among samples (P < 0.05)

Table 4: DPPH Scavenging Activity (%) of frozen Asian pear with different treatment during storage at concentration of 200 µl/ml. (n=3)

Sample	Treatment	Day 1 Mean ± SD	Day 3 Mean ± SD
Packham pear	Control	39.81 ± 1.17^{c}	29.52 ± 1.22^{a}
	Blanching	84.61 ± 0.69^{a}	22.49 ± 0.18^{b}
	Osmotic solution	44.36 ± 0.48^{b}	21.79 ± 0.09^{b}
	Blanching & osmotic	18.85 ± 1.17^{d}	17.50 ± 0.24^{c}

$^{a-c}$ Different superscript letter in the same column indicate significant differences among samples (P < 0.05)

In addition, Packham pear also has significance difference among treatment performed on the sample during storage as $p<0.05$. The highest percentage (%) of inhibition for Packham pear B (84.61%) was found in blanching treatment on day 1 and for day 3 (29.52%) in control sample. The lowest reading was obtained when Packham pear treated in both blanching and osmotic solution with the reading of 18.85% on day 1 while 17.50% on day 3 in the same treatment. Therefore, the highest scavenging activity was found in pear treated with

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blanching while the lowest value was found in blanching and osmotic treatment with regard of the day. DPPH scavenging activity (%) of frozen Packham pear show decreasing trend during storage from day 1 to day 3. This was supported by previous study by stated that owing to period of storage, free radical scavenging activity decrease on average of 42% in first 60 day in storage and remain constant during remaining storage (Silva *et al*.,2010).

Based on previous studies conducted by Zhang et al., (2006), found that capacities of pear extracts were similar among cultivars ranging from 79.3% to 92.0%. When comparing pear cultivars with other fruits, pear has low antioxidant activity (9.97-14.07%) (Ozturk *et al*., 2009). These different findings on percentage of inhibition might be due to the different cultivars of pear used, processing method, harvesting and storage.

Sensory evaluation of frozen Asian pear in term of is color, hardness, chewiness, sweetness, and overall acceptance was shown in Table 5. For color attributes of frozen Asian pear, osmotic solution has highest score among treatment with 5.07 value and the lowest value with the score of 3.97 was in blanching and osmotic treatment. For hardness attributes, the osmotic treatment rated highest again with the mean value of 5.20 ± 1.06, and the lowest is blanching treatment at 3.97±1.13. Panellist mostly rated like moderately the hardness of osmotic treatment over with others pre-treatment. Chewiness attributes also has osmotic solution with the highest mean (5.43±0.87) followed by control, both blanching and osmotic treatment and blanching treatment at 5.07±1.02, 5.00±0.87 and 4.13±1.11 respectively. For sweetness, highest mean value (5.97±0.81) recorded in osmotic treatment while the lowest mean (3.20±1.34) recorded in blanching treatment. For overall acceptance, highest mean is 5.80±0.85 in osmotic treatment and the lowest (3.83±1.09) in blanching treatment. According to hedonic scale, osmotic treatment was moderately like by most of the panels and blanching was dislike moderately. Thus, most panellist rate pear treated in osmotic solution higher than other treatment.

4. CONCLUSION

In a conclusion, results showed that ascorbic acid content, antioxidant activity and total phenolic content significantly decreased during frozen storage which was rapidly occur in untreated sample compared to pre-treated samples. Additionally, frozen pears tend to be brighter when treated in osmotic solution, less red when treated in blanching and osmotic solution and less yellow in blanching treatment. Besides, there are no significant effects observed in textural properties in term of hardness, cohesiveness and chewiness attributes among pre-treated pears and untreated pears. However, hardness attributes of frozen pears when treated with osmotic solution showed better result than blanching and control samples. Finally, antioxidant capacity was closely related with phenolic compounds as well as ascorbic acid in frozen, stored pears. Vitamin C levels will be higher in products undergo pre-treatment and stored at the lower temperature. Osmotic treatments and freezing storage are the best combination for preserving frozen pears which get the highest scores among consumers. Overall, the frozen pears that had been pre-treated with osmotic solution and blanching tend to retain their quality and can be preserved for a longer time. Freezing preservation helps to retain the quality of products over long period of storage. Therefore, this frozen fruit may become commercialized in the market.

Table 5: Sensory acceptability of frozen Asian pear with different treatment (n=30)

Treatment	Color Mean ± SD	Hardness Mean ± SD	
Control	4.63 ± 1.16^{ab}	4.63 ± 1.03^{b}	
Blanching	4.10 ± 1.40^{b}	3.97 ± 1.13^{c}	
Osmotic solution	5.07 ± 1.29^{a}	5.20 ± 1.06^{a}	
Blanching & osmotic	3.97 ± 1.43^{b}	4.73 ± 0.87^{ab}	
Treatment	**Chewiness Mean ± SD**	**Sweetness Mean ± SD**	**Overall Mean ± SD**
Control	5.07 ± 1.02^{a}	4.17 ± 1.42^{c}	4.90 ± 0.15^{b}
Blanching	4.13 ± 1.11^{b}	3.20 ± 1.35^{d}	3.83 ± 1.09^{c}
Osmotic solution	5.43 ± 0.82^{a}	5.97 ± 0.81^{a}	5.80 ± 0.85^{a}
Blanching & osmotic	5.00 ± 0.87^{a}	5.00 ± 1.53^{b}	4.60 ± 1.28^{b}

$^{a\text{-}c}$ Different superscript letter in the same column indicate significant differences among samples (P < 0.05)

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