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EFFECT OF PACKAGING MATERIALS ON THE STORAGE LIFE OF JACKFRUIT (*Artocarpus heterophyllus*) LEATHER

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Abstract

An experiment was conducted to study the effect of packaging materials on the storage life of oven dried jackfruit leather. Jackfruit leather was prepared from fully ripe fruit. Freshly prepared leather scored between 2 (Like very much) and 3 (Like moderately) while organoleptically evaluated. Three types of packaging materials (poly propylene, high density poly propylene, and laminated aluminum foil) were used. The samples in all packaging did not show much change in colour compared to freshly prepared samples for a period of 30 days but showed higher rate of moisture gain. The pH value decreased with the increase of storage period. Leather kept in laminated aluminum foil (LAF) performed better than those kept in poly propylene and high density poly propylene pouch.

Keywords: Jackfruit, leather, packaging, storage, drying.

Introduction

Jackfruits is nutritious with high content of carbohydrate, vitamins, and minerals. It has pleasant flavour, high palatability and availability in abundance in its season at moderate price. The fresh fruit has limited shelf life. The post harvest loss of jackfruit ranges 20-30% (Rahman *et al.,* 1994). Therefore, it is necessary to process and preserve it to increase its availability over an extended period and to stabilize the price during glut season. Since jackfruit is consumed fresh, it can be preserved as pickles, dehydrated fruit, jam, jelly, canned jackfruit, jackfruit salads, nectar, cordial, candy, chutney, jackfruit concentrate, jackfruit papad and jackfruit beverage (Bhatia *et al.,* 1955a,b; 1956 b,c,d,e; Samaddar, 1985). Jackfruit flakes may be bottled or canned and served after mixing with honey and sugar (Samaddar, 1985; Berry and Kalra, 1988). Some research works on leather preparation and storage of jackfruit were conducted at Bangladesh Agricultural University, Mymensingh (Haque, 2010).

Drying has been used extensively to preserve fruits, such as apples, apricots, bananas, grapes, peaches, pears, and prunes (Steele, 1987). Fruit leathers are dried

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sheets of fruit pulp, which have a soft, rubbery texture and a sweet taste (ICUC, 2004) and commercially known as fruit bars, sheets or rolls, which are manufactured by dehydration of fruit purees into leathery sheets (Raab and Oehler, 1974). Fruit leather is unsurpassed as a healthy and delicious for both children and adults (Naomi, 1978). Leather is very much popular in North America though it is prepared and formed in different parts of the world. In Bangladesh, leather from mango is prepared and has been popular since the time immemorial. A wide variety of fruits, such as apples, apricots, bananas, blackcurrants, cherries, grapes, peaches, pears, pineapples, plums, raspberries, papayas, sweet potatoes, and ciku can be utilized to make leather (Chan and Cavaletto, 1978; Lodge, 1981; Che man and Raya, 1983; Collins and Hutsell, 1987; Che man *et al.,* 1992). Che man and Taufik (1995) reported the development and storage stability of jackfruit leather and Che man and Sanny (1996) reported storage stability of jackfruit leather in different packaging materials in Malaysia. Che man and Sin (1997) developed jackfruit leather from the unfertilized floral parts of jackfruit. The unfertilized floral parts of jackfruit were macerated into puree and was mixed with 15% glucose syrup, 25.5% sugar, 5% water, 500µg/g sorbic acid based on the weight of puree and stored at room temperature in polypropylene, polyvinyl chloride, and laminated aluminum foil. Nazneen (2005) studied jackfruit leather dried under sun and solar tunnel dryer and Chowdhury (2010) studied solar drying of jackfruit leather in Bangladesh Agricultural University, Mymensingh.

Packaging is the technology that ensures adequate protection and safe delivery of produce from the producer to the consumer. Packaging of fresh perishable produces is very important component of postharvest chain for storage life. Packaging plays a decisive role, since the success or failure of good marketing with premium price depends to a large extent on the packaging-the type selected, its particular features and how it is suited to its contents. Quality packaging is important at all stages of product distribution system as it ensures the products travel safety from the production line through handling, storage and transportation until it reaches the ultimate consumer in sound condition. The present study was, therefore, carried out to investigate the effect of packaging materials on storage stability of oven dried jackfruit leather.

Materials and Methods

The experiment was conducted in the laboratory of Postharvest Technology Section of the Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur. Fully ripe fruits were used to prepare leather. The fruits were washed with clean water at first. Then peeling was done carefully. After that, bulbs were collected and seeds were removed from bulbs. The bulbs were then macerated into a puree with a sharp knife blender. The total soluble solid of the puree was measured and was adjusted to 25°B by adding cane sugar. Citric acid @ 0.3% and potassium metabisulphite @ 0.1% were added. Potassium metabisulphite dissolved in water before adding directly to the puree and then mixed thoroughly. The mixture was then made a thin layer sheet (20mm) on stainless steel trays smeared with glycerol. Then placed into an oven dryer and was dried at 60°C to a final moisture content of 14%. The sheets were prepared triplicate. The dried sheet was cut into 2cm x 8cm dimensions. The colour of the leather was determined using Chromameter (Minolta, Chromameter, CR-400, Japan).

The determination of chemical constituents of jackfruit leather at different storage conditions were done as per method described by Ranganna (1979) and in AOAC (1965). Vitamin C (Ascorbic acid) was determined by titrating with 2, 6-dichlorophenol indophenol dye using phenolphthalein indicator to a pink colour end point, which persisted for at least 15 seconds. Acidity of leather was determined titrating with 0.1 N NaOH solution using 2 to 3 drops of phenolphthalein indicator and a permanent pink colour appeared. Total soluble solid (TSS) content of jackfruit pulp was estimated by using Abbe refractometer. Percent TSS was obtained from direct reading of the instrument. The pH of leather was determined using a pH meter (Fisher, Accumet Model 320 expanded scale pH meter). Chromatographic column method described in AOAC (1965) was employed for extraction and estimation of total carotene content of the pulp of jackfruit leather.

Sensory evaluation

Sensory evaluation was conducted using a taste testing panel consisting of 10 members of different ages. All the judges of the panel were conversant with the factors governing the quality of the product. The organoleptic evaluation was carried out for assessing the colour, flavour, taste, texture and overall acceptability of the jackfruit leather. A 9-point hedonic scale (1= Like extremely, 2= Like very much, 3= Like moderately, 4= Like slightly, 5= Neither like or dislike, 6= Dislike slightly, 7= Dislike moderately, 8= Dislike very much, 9= Dislike extremely) was used to evaluate the samples as described byLarmond, 1977.

Determination of yeast and mould count

In this study, Potato Dextrose Agar (PDA) was used to enumerate the yeast and mould count of jackfruit leather (Anon., 2002). Peeled and sliced potato, boiled distilled water, commercial dextrose and agar were used to prepare PDA. Then dilution blanks was prepared with phosphate buffer solution. One gram of well leather pulp was transferred into 99 ml portion sterilized buffered dilution blank and the sample was shaken and placed into sterile Petri dishes aseptically. The agar was then mixed with the dilution and allowed to solidify. After solidification of agar, the plates were inverted and incubation was done at 25°C for five days. After incubation, the plates were taken out from the incubator and colonies were counted. Finally, the colony number was multiplied by the dilution and the counts per gram of sample were recorded.

Storage study

A storage stability study of the prepared leather was carried out for a period of 60 days at room temperature and at refrigerator. The samples were wrapped in three types of packaging materials, such as i) Poly propylene pouch (PP)-0.05mm thickness, ii) High density poly propylene pouch (HDP)- 0.08mm thickness, and iii) Laminated aluminum foil (LAF)- 0.07mm thickness. The pouches were withdrawn periodically and the samples were analyzed for physico-chemical and organoleptic characteristics.

Results and Discussion

The results have been presented and discussions are made below under the following heads:

Composition of jackfruit leather

The physico-chemical characteristics of prepared jackfruit are presented in Table 1 and in Plate 1. The low moisture content (14%) of the freshly prepared leather suggests that the fruit leather can be considered as an intermediate – moistured food, which can be eaten without rehydration. Che man and Sin (1997) developed leather from unfertilized floral parts of jackfruit and found moisture (12.26 %), protein (2.85%), ash (0.87%), pH 4.8, and vitamin C (0.023 mg) ascorbic acid/100g. From the study, moisture, protein, and vitamin-C contents were found higher than those of leather developed by Che man and Sin (1997). Mukisha *et al.* (2010) prepared jackfruit leather and got 18.85%, 14.79%, and 18.5% moisture in cabinet, oven, and solar drying method, which were higher than the present finding. Hunter colour values obtained for the fruit leather were L= 57.69, a= 1.3, b= 42.26, the colour of the fruit leather was light yellow.

Sensory evaluation of fresh leather

The sensory evaluation of freshly prepared leather was carried out. The panelists were of different ages. The result of the evaluation is shown in Table 2. It is evident from the result that, on a 9 point hedonic scale, the taste attribute had the lowest score (2.44) followed by overall acceptability (2.72). All the scores of the sensory attributes lie between 2 (Like very much) and 3 (Like moderately). This result obtained from the evaluation indicates that the product had quality in all respects.

Table1. Chemical constituents of freshly prepared leather.

Moisture (%)	pH	Reducing sugar (%)	Total sugar (%)	Protein (%)	β-carotene (μg/100g)	Vit.-C (mg/100g)	T. acid (%)	Ash content (%)
14.0	4.74	19.23	38.27	7.5	40.0	8.3	1.60	1.78

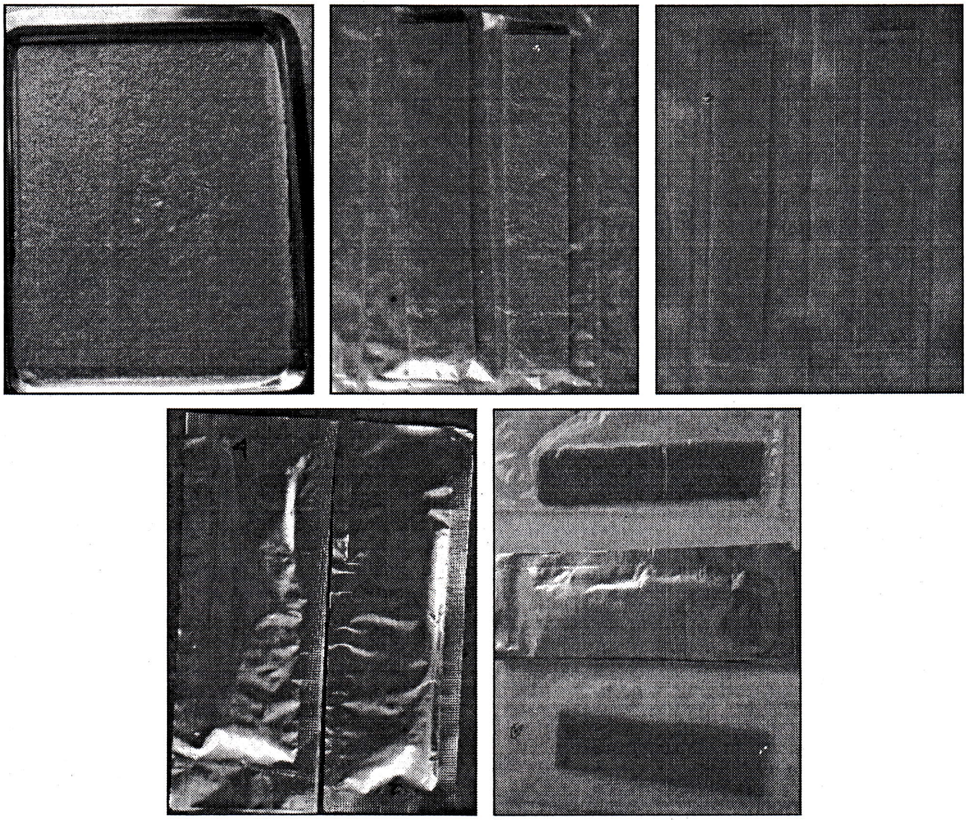

Plate 1. Pictorial view of jackfruit leather.

Table 2. Mean scores for sensory evaluation of freshly prepared fruit leather.

Sensory attribute	Score (1-9)
Colour	2.44
Aroma	2.65
Texture	2.33
Taste	2.78
Overall acceptability	2.72

Storage studies

The changes in chemical constituents of jackfruit leather during storage (60 days) at room temperature in different packaging materials like poly propylene, high density poly propylene, and laminated aluminum foil pouch are described below. All the three types of packaging have proven to be a barrier of water vapour diffusion and thus prevented growth of microorganism in the sample. The samples in all packaging did not show much change in colour and moisture compared to that of freshly prepared samples for a period of 30 days. The stability of the colour could be due to long time dry period at high temperature which destroyed the enzyme that causes enzymatic browning. Potassium metabisulphite also helped prevent enzymatic browning. After 30 days of storage, the colour of the sample kept in poly propylene pouch became pale compared to that of freshly prepared leather due to moisture absorption.

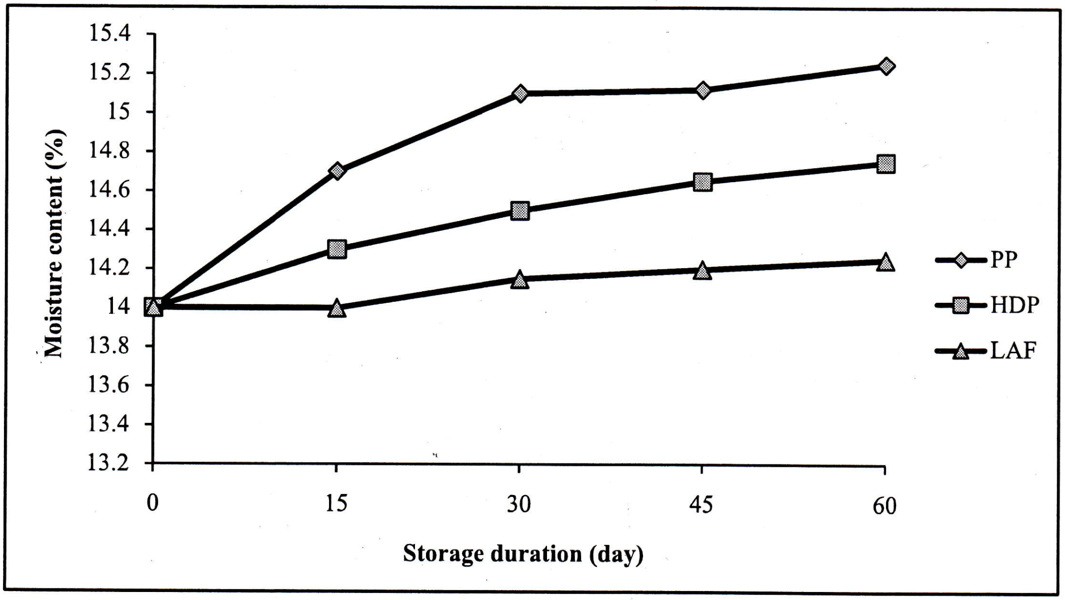

Fig. 1. Changes in moisture content of jackfruit leather during storage at room temperature.

Moisture content of all the samples was not stable for the storage period (Fig. 1). It was observed that up to 30 days of storage period, all the samples irrespective of packaging materials showed higher rate of moisture gain [for polypropylene (1.10%), HDP (0.5%), and LAF (0.15%)] and after this period, the rate of moisture gain was lower. Among the packaging materials, LAF showed minimum rate of moisture absorption during the storage period of leather. The increase of moisture content of the samples may be attributed to the water vapour transmission through packaging materials. During storage in room temperature in different packaging materials, the fluctuation of moisture content has been observed by Che man and Sanny (1996) for jackfruit leather, by Manimegalai *et al.* (2001) for jackfruit bar/leather and by Rao and Roy (1980) for mango sheet/leather.

The change in p^H value of jackfruit leather in different packaging materials during storage period is shown in Fig. 2. p^H value decreased with the increase of storage, period. After 60 days of storage, the p^H value of leather kept in LAF was the highest (4.71) followed by that in HDP (4.70) and PP (4.65). Che Man and Sanny (1996) showed the fluctuation of p^H values of jackfruit leather during three months of storage period.

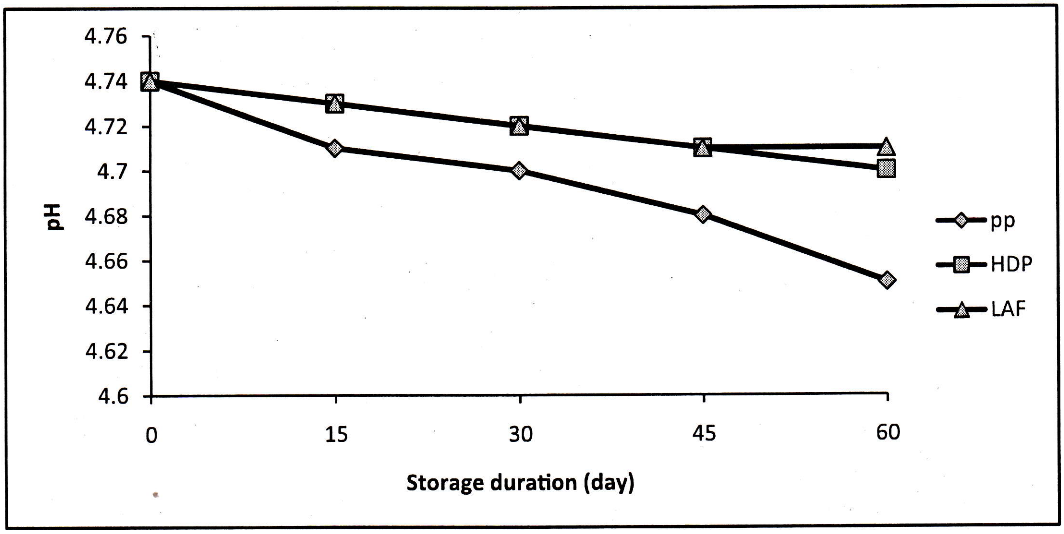

Fig. 2. Changes in p^H value of jackfruit leather for storage in room temperature.

The decreasing trend of total sugar content of jackfruit leather in different packaging during storage period was observed (Fig. 3). The decrease in total sugar content of jackfruit leather during storage might be due to an increase in reducing sugars by acid hydrolysis of total sugars and thereby inversion of total sugar. The highest decrease of total sugar was observed for jackfruit leather kept in PP (3.27%) followed by the leather kept in HDP (3.25%) and LAF (1.77%). At the end of

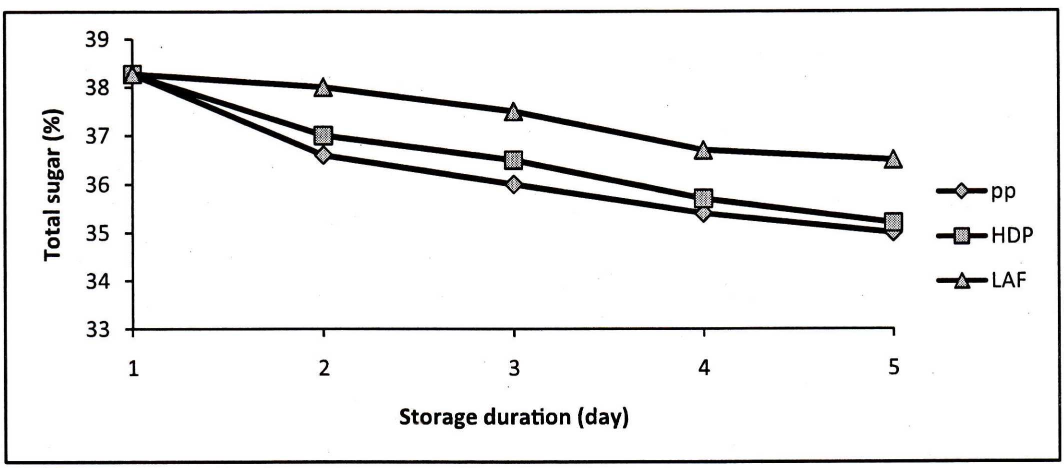

Fig. 3. Changes in total sugar content of jackfruit leather for storage in room temperature.

storage period, the total sugar content was 35.0, 35.2, and 36.5% for the leathers packaged in PP, HDP, and LAF, respectively. Similar pattern of decreasing of total sugar was reported by Doreyappa Gowda *et al.* (1995) for mango bar and by Rao and Roy (1980) for mango leather. This result also agreed with the findings of Manimegalai *et al.* (2001) for storage of jackfruit bar in room temperature.

Reducing sugar of jackfruit leather in all packaging materials increased during storage (Fig. 4). After 60 days of storage,

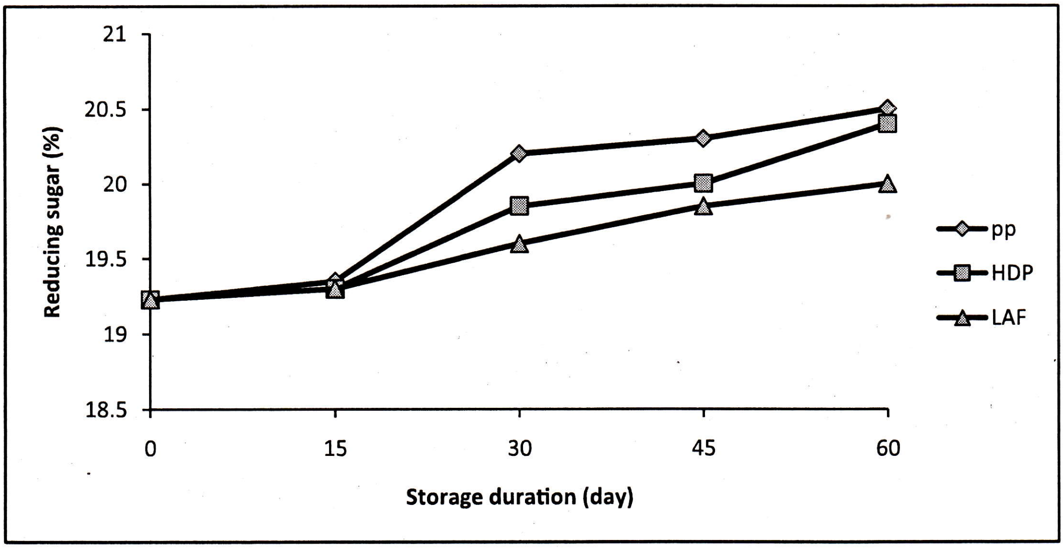

Fig. 4. Changes in reducing sugar content of jackfruit leather during storage at room temperature.

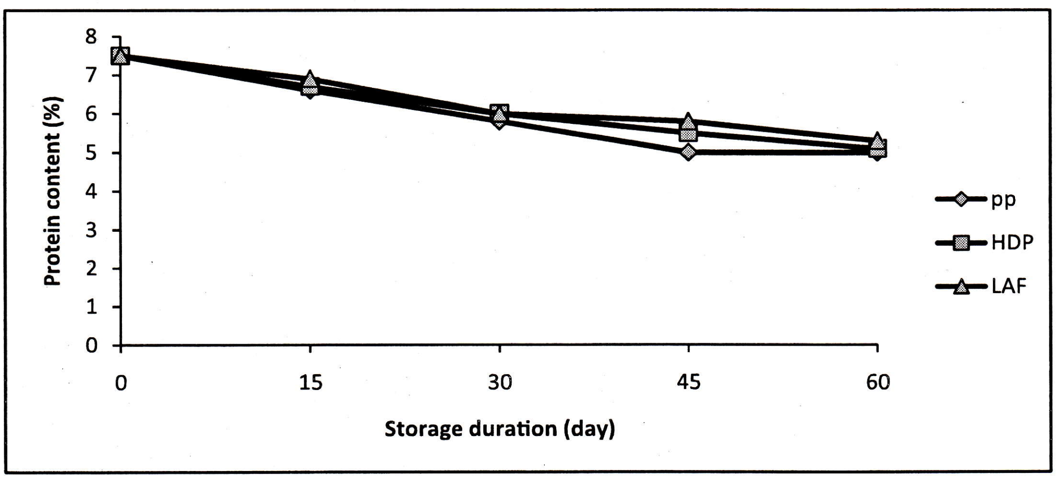

Fig. 5. Changes in protein content of jackfruit leather during storage at room temperature.

the increase of reducing sugar content in jackfruit leather packaged in PP was higher (20.50%) than in PP (20.40%) and LAF (20.0%). Similar increasing trend was observed for mango and papaya bars by Rao and Roy (1980) and Aruna *et al.* (1999), respectively.

The protein content of jackfruit leather also decreased as shown in Fig.5 during storage period irrespective of packaging materials. At the end of storage period, the protein content was found lowest (5.0%) for the sample packaged in PP followed by that in HDP (5.1%) and in LAF (5.53%), respectively.

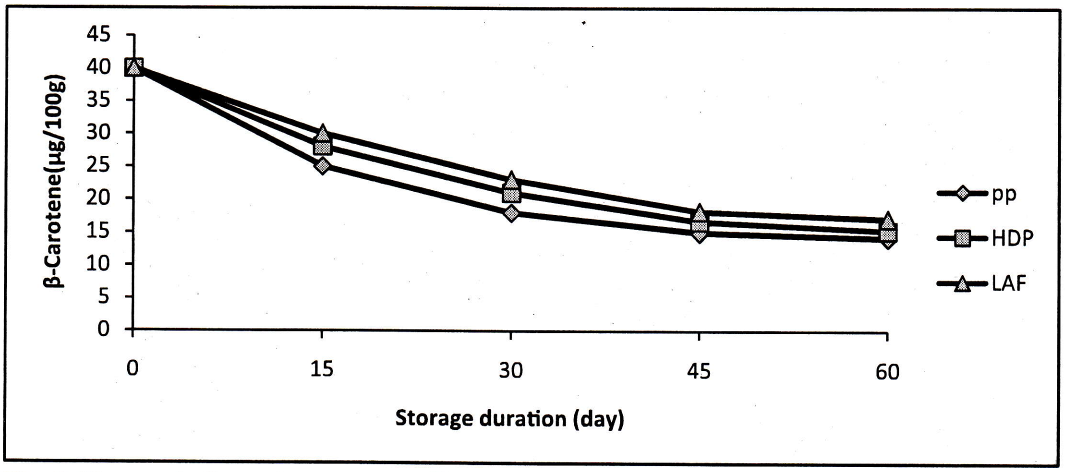

Fig. 6. Changes in β-carotene content of jackfruit leather during storage in room temperature.

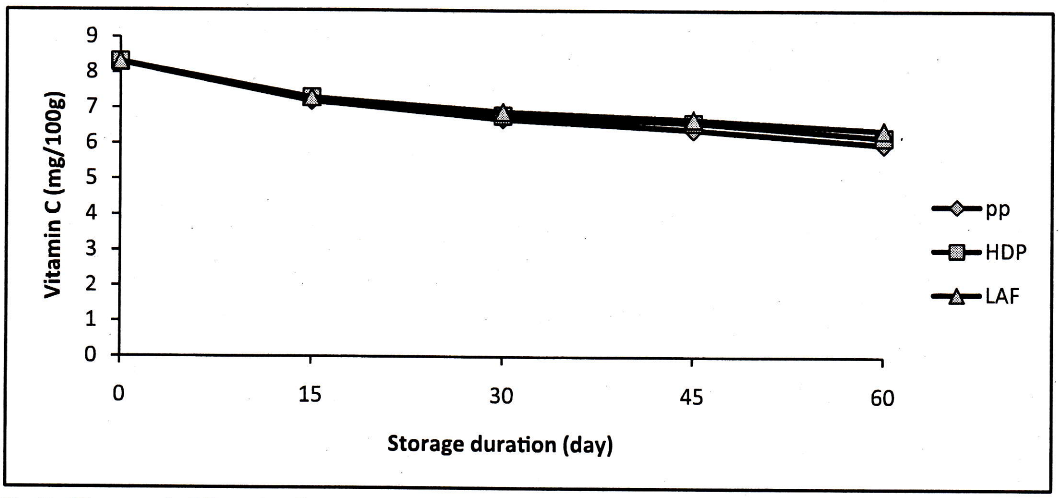

Fig.7. Changes in Vitamin C content of jackfruit leather during storage in room temperature.

During the storage period of jackfruit leather, a remarkable reduction was observed in β-carotene content of the samples as shown in Fig. 6. At the end of storage period (60 days), β-carotene losses were 25.80%, 24.7%, and 22.9% for the samples packaged in PP, HDP, and LAF, respectively. Manimegalai *et al.* (2001) showed the decreasing trend of β-carotene content in jackfruit bar during storage at room temperature. Gahilad *et al.* (1982) reported that mango leather packaged in polyethylene bags had a reduction in β-carotene content after storing for 70 days at 10±1^{0}C temperature. Among the packaging materials, LAF was better compared to PP and HDP in retaining of β-carotene content.

Vitamin-C content of leather decreased with the increase of storage duration (Fig.7). The highest amount of vitamin-C losses was observed in the sample packaged in P (2.3%) followed by that in HDP (2.1%) and in LAF (1.9%).

During the storage period, amount of total acid content of the leather in different packaging materials increased (Fig. 8). At the end of the storage, leathers packed in PP, HDP, and LAF contained 1.68, 1.64, and 1.63% acid, respectively.

In refrigerated temperature at 30 days of storage period, the sample showed higher rate in moisture loss and after that period, this change was lower (Table 3) and no significant change in P^H value was observed during storage period. The significant decrease of β-carotene was observed for the first 30 days and the next 30 days of storage period, the change was insignificant. Reducing sugar percentage was observed to be increased, which indicates that total sugar content decreased during the storage period. At first 30 days of storage, Vit-C content decreased significantly and at the next 30 days, the change was insignificant. The retention of β-carotene and Vit-C in refrigerated

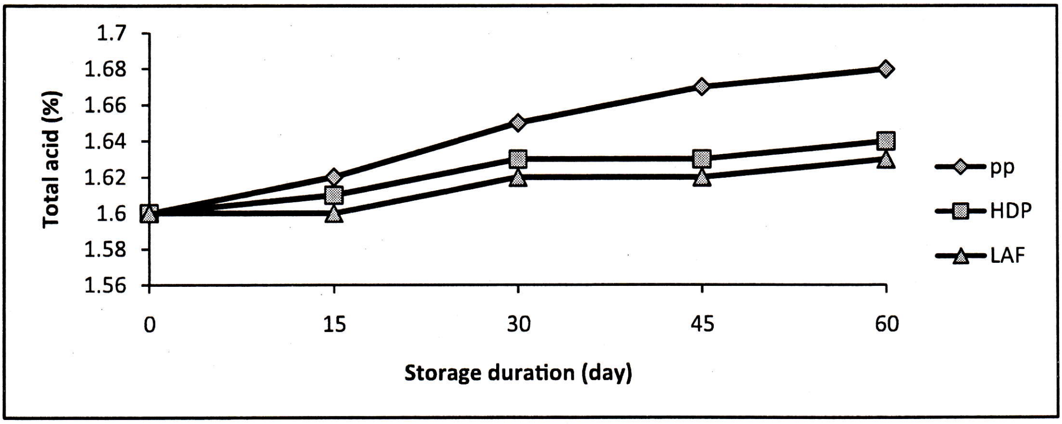

Fig. 8. Changes in total acid content of jackfruit leather during storage in Room temperature.

condition was better than those in room temperature condition which might be attributed to lower oxidation process at refrigerated condition. During storage at refrigerator, acidity increased slowly.

Table 4 shows mean scores of four attributes of jackfruit leather as determined by a sensory panel. During the first 30 days of storage, much difference was not found in case of colour, flavour, test, texture and overall acceptability. After that, highly significant differences were observed for all the sensory attributes till the end of the storage period for the samples.

All the sensory attributes of jackfruit leather irrespective of packaging materials were in

Table 3. Changes of chemical constituents in jackfruit leather during storage in refrigerated temperature (7±1°C) (on dry weight basis).

Storage period (Days)	Moisture (%)	PH	Reducing sugar (%)	Total sugar (%)	Protein (%)	β-carotene (μg/100g)	Vit-C (mg/100g)	T. acid (%)
0	14.0	4.74	19.23	38.27	7.5	40.0	8.3	1.60
30	13.95	4.74	19.35	35.50	7.15	35.1	6.9	1.61
60	13.92	4.74	19.70	34.0	6.40	33.0	6.3	1.63
LSD	0.236	0.063	0.296	2.398	0.409	2,825	0.384	0.063
Level of sign.	NS	NS	**	**	**	**	**	**

Table 4. Mean scores of quality attributes of jackfruit leather as determined by a sensory panel in case of room temperature.

Storage :ime (day)	Colour			Flavour			Taste			Texture			Overall acceptability		
	PP	HDP	LAF	PP	HDP	LAF	PP	HDP	LAF	PP	HDP	LAF	PP	HDP	LAF
0	2.44	2.44	2.44	2.65	2.65	2.65	2.78	2.78	2.78	2.33	2.33	2.33	2.72	2.72	2.72
15	2.47	2.46	2.44	3.20	2.75	2.65	3.10	3.0	2.9	3.0	2.9	2.65	3.65	3.8	3.0
30	3.5	3.20	2.70	4.70	4.25	3.85	4.5	3.8	3.1	3.9	3.5	3.0	4.9	4.40	3.25
45	5.2	5.0	4.30	5.20	5.0	4.5	5.0	4.1	3.5	5.0	4.75	4.0	5.10	4.9	4.7
60	5.3	5.10	4.6	6.0	5.6	4.9	6.0	4.9	4.0	6.0	5.5	4.5	5.7	5.0	4.8

Table 5. Mean scores for quality attributes of jackfruit leather as determined by asensory panel in case of refrigerated condition [temperature (7±1°C)].

Storage duration (Day)	Sensory Attributes				
	Colour	Flavour	Taste	Taste	Overall acceptability
0	2.44	2.65	2.78	2.33	2.72
30	2.45	2.66	2.78	2.33	2.72
60	2.46	2.67	2.78	2.33	2.72

acceptable level (Scores less than 5) during 30 days of storage period. The leather in PP and HDP were unacceptable after 30 days of storage (Score higher than 5). While leather in LAF remained in acceptable condition till the end of the storage period in the case of colour attributes. After 30 days of storage, the leather packaged in PP and HDP was tougher than similar samples packaged in LAF. Packaging the leather in LAF made it less sticky than samples packaged in PP and HDP. Scores for colour, flavour, test, texture, and overall acceptability for samples packaged in LAF were less than 5. The lowest scores for all parameters tested after 60 days of storage was for leather packaged in LAF. In refrigerator, all the sensory attributes of jackfruit leather were in acceptable condition (Scores 2.33-2.72) after 60 days of storage (Table 5).

Conclusion

Among the packaging materials, laminated aluminum foil (LAF) showed better performance in terms of qualitative and organoleptic attributes during storage of jackfruit leather. So laminated aluminum foil (LAF) packaging can be used for longer period storage of jackfruit leather.

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