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Effect of edible coating materials on shelf life of fresh cut papaya fruit under different storage conditions

Rahul Singh and Khan Chand

Abstract
The present study was designed and conducted to increase the shelf life of fresh cut papaya cubes. The papaya fruit is the richest sources of antioxidant and nutrients such as Vitamin A (carotenes), vitamin C and flavonoids, vitamins-B, folate, pantothenic acid, minerals, potassium, magnesium and fiber. As the shelf life of peeled papaya is very less, to extend the shelf life of the papaya there is a need of new technologies. Edible coating is good alternatives and used as a barrier to minimize water loss. Edible coating made from carboxy methyl cellulose (CMC) and hydroxyl propyl methyl cellulose (HPMC) was used to preserve the quality of papaya product. The independent factors selected for coating of papaya cubes were, ratio of CMC and HPMC (1:0, 1:1, 0:1) and packaging materials (Aluminium foil and Cling wrap) were taken into account. The storage study of edible coated papaya cubes was carried out for 12 days in different conditions. The effect of independent variables on the responses like vitamin C, reducing sugar and storage lifewere analyzed at an interval of 4 days. The amount of ascorbic acid was found to be 41.55 to 24.75mg/100g and range of reducing sugar was obtained to be 3.49 to 4.1%.The maximum effect on storage life on papaya cubes was when coated with CMC and packed with aluminium foil. The best results on shelf life of papaya coated with CMC obtained 12 days while the shelf life of papaya packed with aluminium foil was found 11 days.

Keywords: Fresh-cut papaya, edible coating, packaging materials and reducing sugar

1. Introduction

Papaya (*Carica papaya* L.) is one of the most important fruit crops grown in the tropical and sub-tropical regions of the world.India is the second amongst papaya producing countries and total production was 4,938.88 thousand tones during the year 2012-13.As papaya is climacteric fruit, the shelf life of papaya is very short, thus the research has focused on minimizing postharvest losses in order to enhancethe shelf life. The postharvest storage procedures for papayahelp to minimize the quality deterioration from the decomposition processes (Rohani *et al.*, 1997) [5]. Papayas offer not only the luscious taste and sunlight colour of the tropics, but are rich sources of antioxidant nutrients such as Vitamin A (carotenes), vitamin C and flavonoids, the vitamins-B, folate, pantothenic acid, minerals, potassium, magnesium and fiber. Together, these nutrients promote the health of the cardiovascular system and also provide protection against colon cancer. In addition, papaya contains the digestive enzyme known as *papain*, which is used like bromelain enzyme to treat sports injuries, other causes of trauma, and allergies. Consumers are increasingly aware of the importance of healthy eating habits, but have less time available for food preparation (Olivas and Barbosa-Canovas, 2005) [3]. Therefore, the economic importance of the fresh-cut fruit industry is becoming progressively more significant. But fruits are living tissues that undergo enzymatic browning, texture decay, microbial contamination and undesirable volatile production, highly reducing their shelf life, if they are in any way wounded.

Several cellulose derivatives such as methyl cellulose (MC), carboxymethyl cellulose (CMC), hydroxypropyl cellulose (HPC), and hydroxypropylmethyl cellulose (HPMC) are widely produced commercially (Malmiri *et al.*, 2011). Edible coating, act as a barrier to gases, is expected to generate a sort of modified atmosphere in each coated fruit piece. (Lee *et al.*, 2003) [1] and along with relative humidity and optimum refrigeration temperature, contributes to achieve a reasonable increase in shelf of fresh cut products. Therefore, the purpose of the present work is to evaluate the effect of Hydroxypropyl methyl cellulose (HPMC) and Carboxy methyl cellulose (CMC) based edible coating to improve shelf life of fresh cut papaya fruit under refrigerated and ambient conditions.

2. Methodology
The exploration was arranged to give different treatments of edible coating and packaging material to papaya cubes and storing it at ambient and refrigeration conditions to analyze the effects of coating and packaging material on quality aspects of papaya. Freshly harvested papaya of variety Pant Papaya-1.The edible food additives such as hydroxypropylmethyl cellulose (HPMC), carboxyl methyl cellulose (CMC) and glycerol were used and an Aloevera gel as antioxidant and Aluminium foil and Cling wrap as packaging materialswere used for storing fresh-cut papaya fruit.

2.1 Edible coating solution
The edible coating solution was prepared by adding ingredients such as hydroxypropyl methyl cellulose (1.2 g) and carboxy methyl cellulose (1.2 g) into 50 ml distilled water and mix it thoroughly to get uniform solution by using magnetic stirrer, then the solution was heated at temperature 70 °C in hot water bath for 25-30 minutes to provide functionality to edible film. The heated solution was cooled down in cold water bath for 30 minutes. As per preliminary trial, the amount of glycerol (6ml/100ml) and aloevera gel (10ml/100ml) were added into the edible solution as plasticizer and antioxidant, again mixed the ingredient added thoroughly using magnetic stirrer for 5 minutes. Then prepared content was again reheated to form a complex matrix at 45 °C for 10 minand then cooled again to room temperature. Now, the peeled papaya was cut into cubes of size 2 cmmanually, and thencubes were dipped in edible coating solution and packed in packaging materials, keptfor storage study at ambient and refrigerated conditions. The each response was statistically analyzed by M.S. Excel (2010). Full Factorial design has been used for experimental design. Anova was used to study the effect of independent variables on the response. (A×B+1) was adapted for analysis

2.2 Physico - Chemical Analysis
2.2.1 Vitamin-C
Ascorbic acid content was estimated by using 2,6-dichlorophenol indophenol (DCPIP) visual titration method, which involves reduction of 2,6- dichlorophenol indophenol (standard dye), deep blue in alkaline solution, to a pink end point in ascorbic acid. For eliminating sulphur dioxide (SO_2), which reduces the dye and thus interferes with ascorbic acid estimation, 1 ml of formaldehyde and 0.1 ml of HCl were added to 10 ml of filtrate and the same was allowed to stand for 10 minutes for further titration (Ranganna 2009) [4]. Ascorbic acid, in terms of mg/100g pulp, was calculated using following formula:

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up} \times 100}{\text{Aliquot of extract taken for estimation} \times \text{Wt./Vol. of sample taken for estimation}}$$

2.2.2Reducing sugar
The prepared clarified sample was titrated with freshly prepared and pre- standardized fehling's reagent using methylene blue as an indicator. The reducing sugar content was calculated by using following formula:

$$\text{Reducing sugars (\%)} = \frac{\text{mg of invert sugar} \times \text{dilution} \times 100}{\text{Titre} \times \text{weight or volume of} \times 100 \text{ sample taken}}$$

3. Results and Discussion
3.1 Effect of coating materials on ascorbic acid
i) Ambient condition
At ambient conditions the effect of coating ingredients on ascorbic acid was obtained significant ($p<0.05$) because it had higher F_{cal} (204.317) than its F_{tab} (3.554) value. The Fig.1 shows the relationship between ascorbic acid of papaya cubes and storage (days) at room temperature which depicts that the ascorbic acid of the sample was decreasing from 41.55 to 16.73 mg/100g with the increase in storage time from 0 to 8 days. The lowest ascorbic acid at ambient condition was due to the lower value of HPMC (16.73) followed by HPMC+CMC and CMC. But control sample was deteriorated on 4 th days due to environment conditions

ii) Refrigerated Condition
At refrigerated conditions the effect of coating ingredients on ascorbic acid was obtained highly significant ($P<0.05$) because it had higher F_{cal} (285.73) than its F_{tab} (3.554) value.Fig.3 shows the relationship between ascorbic acid of papaya cubes and storage (days)at refrigerated condition (7 ^{0}C) which depicts increasing the level of HPMC, HPMC+CMC and CMC. The ascorbic acid was found from 41.55 to 22.88 mg/100g upto 12th day of storage of sample. Highest effect of HPMC indicated that increase the shelf life of prefered product. Samples stored under refrigeration condition for 12 days. But control sample was deteriorated on 8th of storage.

3.2 Effect of packaging materials on ascorbic acid
i) Ambient condition
The effect of packaging material on ascorbic acid was highly significant ($P<0.05$) because it had higher F_{cal} (582.972) than its F_{tab} (3.554) value. The Fig.2 shows that in case of unpacked materials, the ascorbic acid was found 24.96 mg/100g for 4 days of storage than the food material was spoiled while the ascorbic acid decreases from 41.55 to 18.11 mg/100g with cling wrap upto 8th day of storage but the material was safe after 5 days of storage in cling wrap. In case of aluminuim foil packaging, the ascorbic acid was slight higher than cling wrap upto 8th day of storage. But the control sample was deteriorated on the 4th of storage.

ii) Refrigerated Condition
After the analyzed data, the effect of packaging material on ascorbic acid was significant ($P<0.05$) because it had higher F_{cal} (689.83) as compared with its F_{tab} (3.554) value. The Fig.4 depicts that in case of unpacked materials, The ascorbic acid was found 26.29 mg/100g for 8th day of storage than the food material was spoiled while the ascorbic acid decrease from 41.55 to 22.57 mg/100g with cling wrap upto 12th day of storage but the material was safe after 10 days of storage in cling wrap. In case of aluminum foil packaging, the ascorbic acid was slight higher than cling wrap upto 12day of storage. Samples stored under refrigerated condition for 12 days. But the unpacked samples were deteriorated at 8th day of storage.

3.3 Effect of ambient and refrigerated condition on ascorbic acid
The Fig.5 reveals that in ambient condition the ascorbic acid decreases from 41.55 to 20.85 mg/100g upto 8 day of storage while in refrigeration condition the ascorbic acid decreases from 41.55 to 24.75 mg/100g upto 12 day of storage.

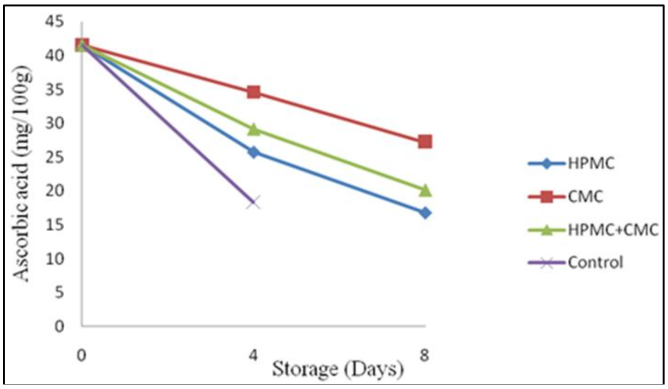

Fig 1: Effect of coating material on ascorbic acid content of papaya cubes during storage at room temperature

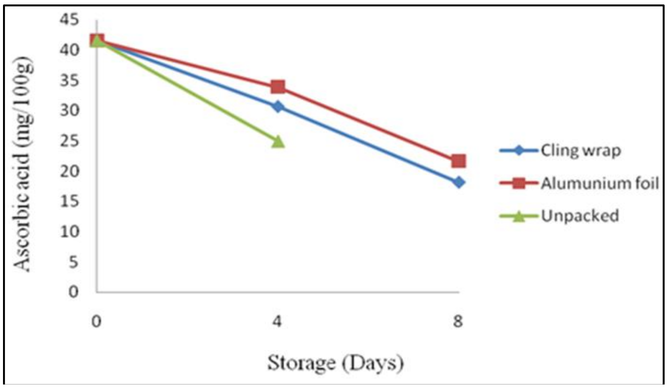

Fig 2: Effect of packaging material on ascorbic acid content of papaya cubes during storage at room temperature

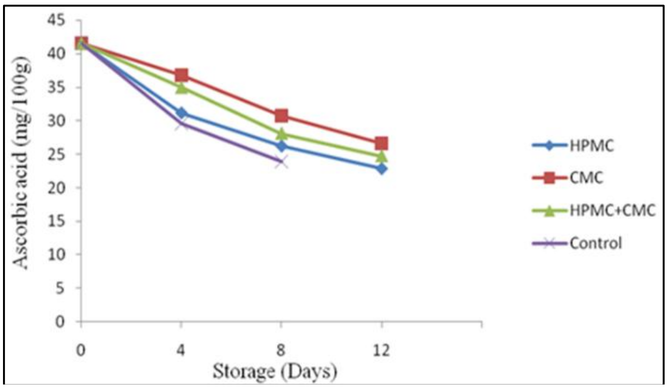

Fig 3: Effect of coating material on ascorbic acid content of papaya cubes during storage at refrigerated temperature

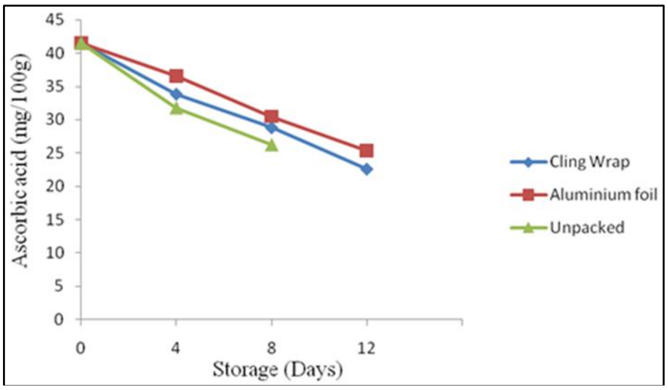

Fig 4: Effect of packaging material on ascorbic acid content of papaya cubes during storage at refrigerated temperature

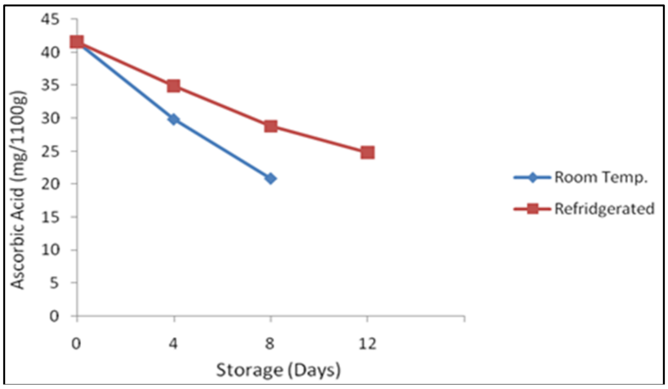

Fig 5: Effect of storage temperature on ascorbic acid content of papaya cubes

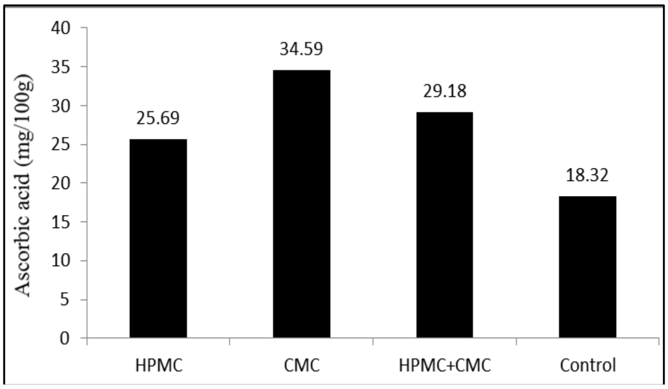

Fig 6: Variation in ascorbic acid with coating material on 4th day storage at room temperature

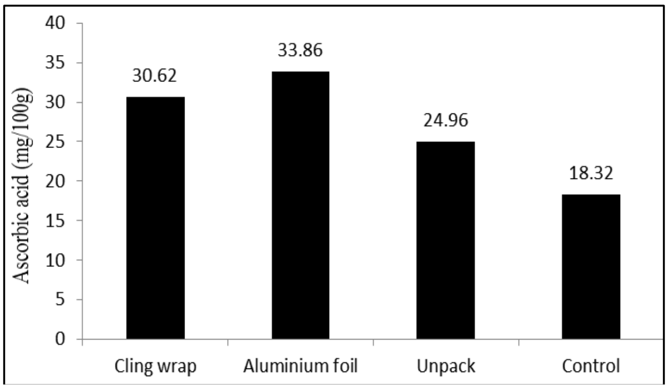

Fig 7: Variation in ascorbic acid with packaging material on 4th day storage at refrigeration temperature

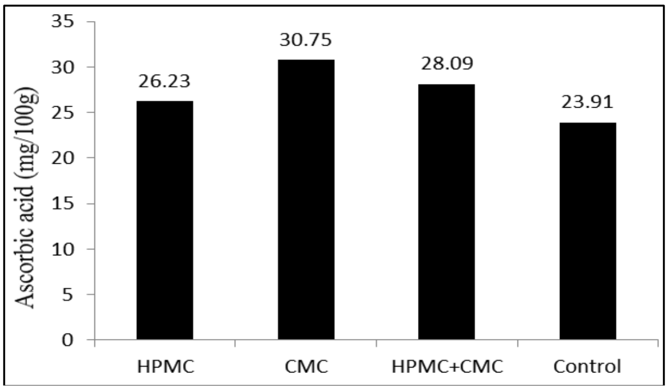

Fig 8: Variation in ascorbic acid with coating material on 8th day storage at refrigeration temperature

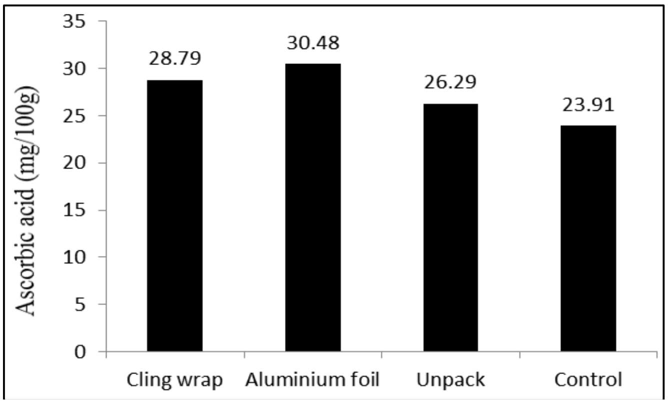

Fig 9: Variation in ascorbic acid with packaging material on 8th day storage at refrigeration temperature

3.4 Effect of coating materials on reducing sugar

i) Ambient condition

At ambient conditions the effect of coating ingredients on reducing sugar was significant ($P<0.05$) because it had higher F_{cal} (94.861) than its F_{tab} (3.554) value. The Fig 10 depicts the effect of coating material on reducing sugar of papaya cubes during storage at room temperature which shows that the reducing sugar of the sample was increasing from 3.49 to 4.14% due to increase in number of days (0 to 8) is due storage period, temperature, coating and packaging material. The highest reducing sugar at ambient condition was due to the higher value of CMC followed by HPMC+CMC and HPMC.But the control sample was deteriorated at the 4th day of storage.

ii) Refrigerated Condition

At refrigerated conditions the effect of coating ingredients on reducing sugar was significant ($p<0.05$) because it had higher F_{cal} (29.95) than its F_{tab} (3.554) value. The Fig.12 depicts the effect of coating material on reducing sugar of papaya cubes during storage at refrigerated condition (7 ^{0}C) where the reducing sugar increased with increasing the level of CMC, HPMC+CMC and HPMC. The reducing sugar was found from 3.49 to 4.19% upto 12th day of storage of sample. Highest effect of CMC indicated that increase the shelf life of prefered product. Samples stored under refrigeration condition for 12 days. But the control sample was deterioratedat the 8th of storage.

3.5 Effect of packaging materials on reducing sugar

i) Ambient condition

After analysis of data, the effect of packaging material on reducing sugar was significant ($P<0.05$) because it had higher F_{cal} (96.251) than its F_{tab} (3.554) value.Fig.11 depicts that in case of unpacked materials, the reducing sugar was found 3.82% for 4 days of storage than the food material was spoiled while the reducing sugar increase from 3.49 to 4.06% with alunimum foil upto 8th day of storage but the material was safe after 5 days of storage in aluminum foil. In case of cling wrap packaging, the reducing sugar was slightly less than aluminum foil upto 8th day of storage.

ii) Refrigerated condition

After analysis of data, the effect of packaging material on reducing sugar was significant ($P<0.05$) because it had higher F_{cal} (8.181) than its F_{tab} (3.554) value. Fig.13 depicts that in case of unpacked materials, the reducing sugar was found 3.975% for 8th day of storage than the food material was spoiled while the reducing sugar increased from 3.49 to 4.08% with aluminum foil upto 12th day of storage but the material was safe upto 10 days of storage in aluminum foil. In case of cling wrap packaging, the reducing sugar was slightly less than cling wrap upto 12th day of storage. Samples stored under refrigerated condition for 12 days.

3.6 Effect of ambient and refrigerated condition on reducing sugar

The Fig.14 that in case of ambient condition the reducing sugar increased from 3.49 to 4.04% upto 8th day of storage while in refrigeration condition the reducing sugar increases from 3.49 to 4.1% upto 12th day of storage.

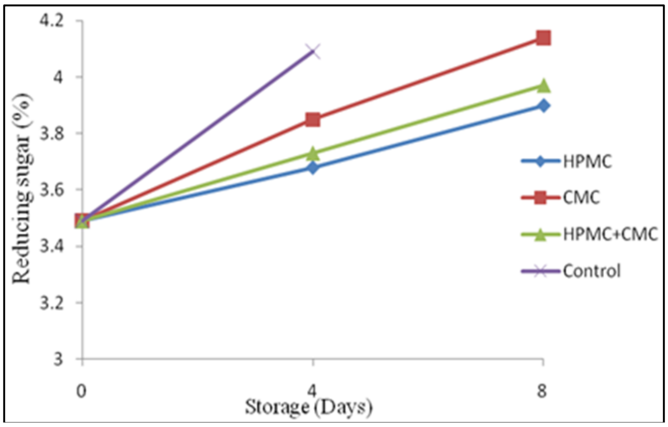

Fig 10: Effect of coating material on reducing sugar content of papaya cubes during storage at room temperature

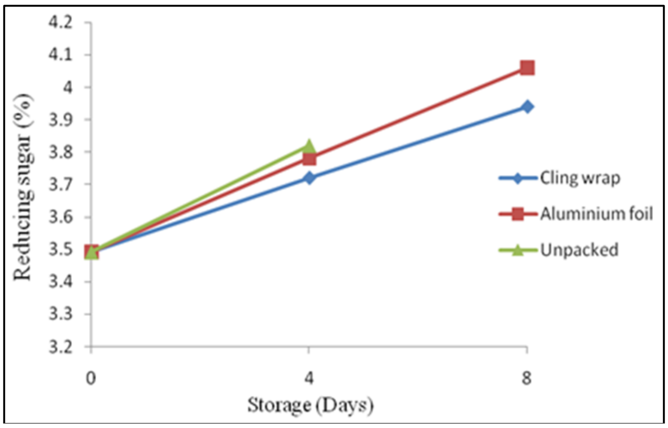

Fig 11: Effect of packaging material on reducing sugar content of papaya cubes during storage at room temperature

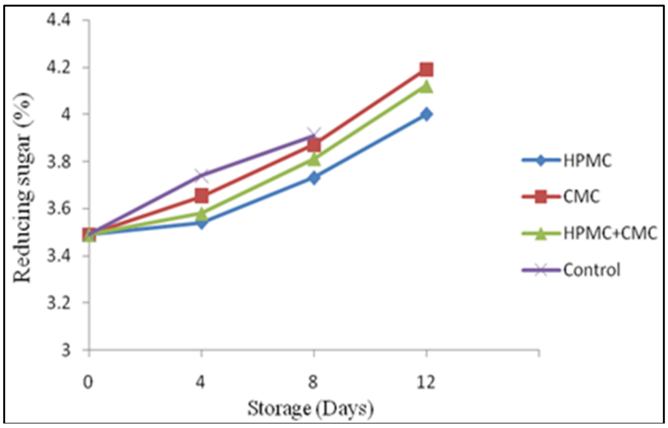

Fig 12: Effect of coating material on reducing sugar content of papaya cubes during storage at refrigerated temperature

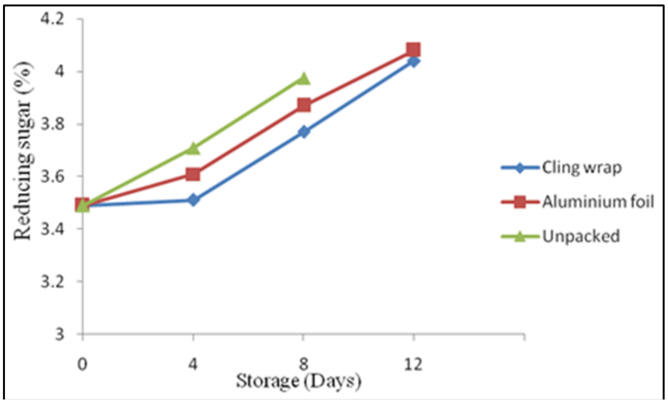

Fig 13: Effect of coating material on reducing sugar content of papaya cubes during storage at refrigerated temperature

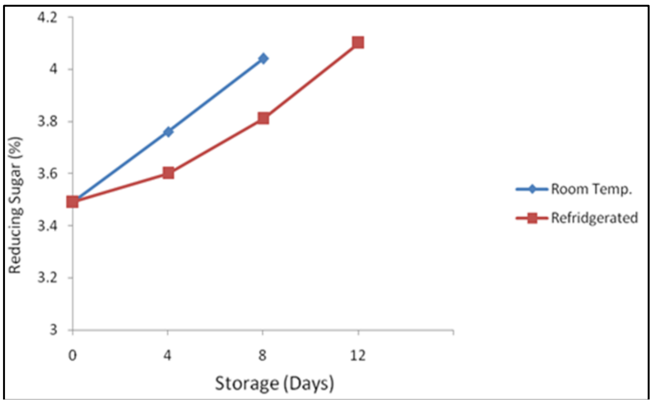

Fig 14: Effect of storage temperature on reducing sugar content of papaya cubes

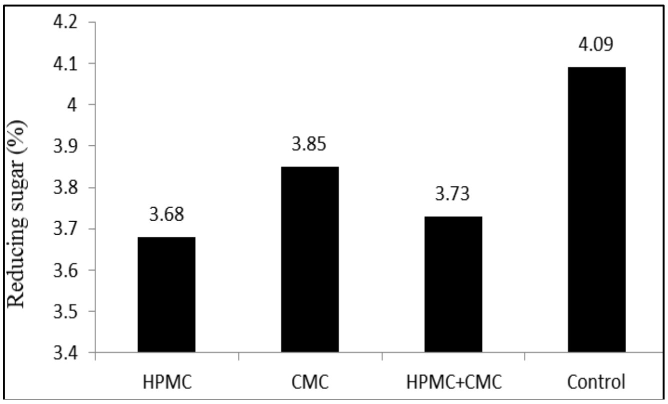

Fig 15: Variation in reducing sugar with coating material on 4th day storage at room temperature

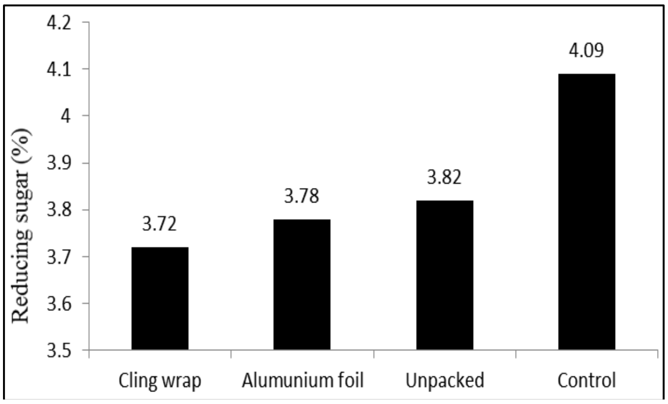

Fig 16: Variation in reducing sugar with packaging material on 4th day storage at refrigeration temperature

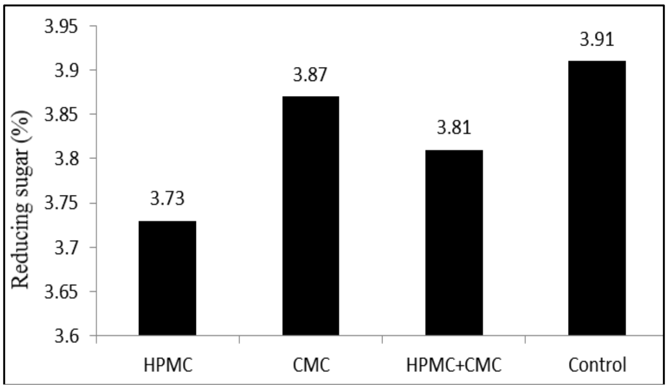

Fig 17: Variation in reducing sugar with coating material on 8th day storage at room temperature

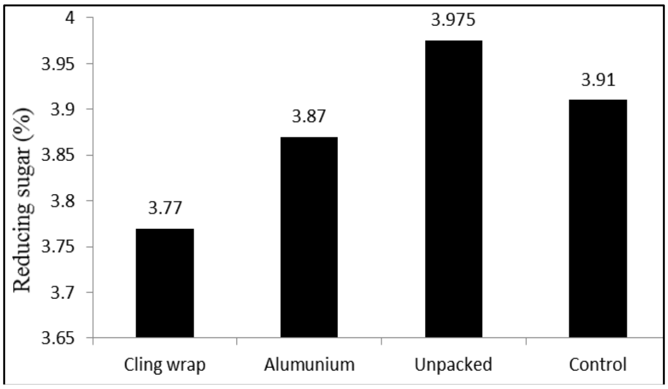

Fig 18: Variation in reducing sugar with packaging material on 8th day storage at refrigeration temperature

4. Conclusion

After the experimental results and data analysis conclusions were drawn as papaya cubes stored under refrigerated condition recorded higher ascorbic acid values compared to those stored at room temperature. Maximum ascorbic acid was found when it was coated with CMC and packed with aluminum foil. Ascorbic acid decreased with increase in days of storage. While papaya cubes stored at refrigerated temperature recorded higher reducing sugar content values compared to those stored under room condition. Maximum reducing sugar was found when it was coated with CMC and packed with aluminum foil. Reducing sugar increased with increase in days of storage.

5. References

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