Enhancement of shelf life of fresh cut papaya under different storage conditions using edible coating

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ABSTRACT : Investigations were carried out to increase the shelf life of fresh cut papaya cubes. It is very important a fruit for the health purpose as papaya 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 appears one of the good alternatives for this. Edible coating is used as a barrier to minimize water loss. The independent factors which 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 12days. The pH, total soluble solids (°Brix), sensory and storage life were analyzed at an interval of 4 days. The result of the study shows that the pH of the stored papaya varied from 4.31 to 6.54 whereas TSS was found in range of 12.42 to 14.3 ^{0}Brix. The maximum effect on storage life on papaya cubes was when coated with CMC and packed with aluminium foil. The shelf life of papaya coated with CMC obtained 12 days while the shelf life of papaya packed with aluminium foil was found 11 days.

Key words: Coating materials, CMC, HPMC, papaya cubes, pH, TSS

Papaya (*Carica papaya L.*) belongs to the plant family Caricaceae and is one of the most important fruit crops grown in the tropical and sub-tropical regions of the world. Being a climacteric fruit, papaya has a short postharvest life, thus, research has focused on minimizing post harvest losses in order to prolong shelf life. The postharvest storage procedures for papaya help to minimize the quality deterioration from the decomposition processes **(**Rohani, *et al*, 1997). Papaya may therefore be a healthy fruit choice for preventing such illnesses as recurrent ear infections, colds and flu and very helpful for the prevention of atherosclerosis and diabetic heart disease.

Consumers are increasingly aware of the importance of healthy eating habits, but have less time available for food preparation (Olivas and Barbosa, 2005). Therefore, the economical 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. Edible coatings can be used to help preserve fresh cut fruits, providing a selective barrier to moisture, oxygen and carbon dioxide, improving mechanical and textural properties, carrying additives, avoiding volatiles loss, etc (Lee et al, 2003). Edible films and coatings act as semi permeable barriers which may be able to keep the quality of the food. Being biodegradable they, offer alternative packaging systems which cause reduced environmental damages. Edible films and coatings can consist of three types of biological materials: polysaccharides, proteins and lipids (Lin and Zhao, 2007).

Several cellulose derivatives such as methyl cellulose (MC), carboxymethyl cellulose (CMC), hydroxypropyl cellulose (HPC), and hydroxypropyl methyl cellulose (HPMC) are widely produced commercially (Olivas and Barbosa, 2005). These edible coatings have been applied to a variety of fruits to provide moisture, oxygen and carbon dioxide barriers, and to improve adhesion of coating formulations. Glycerol is used as plasticizers in the coating formulations to improve the water vapour and oxygen barrier and mechanical properties of the coatings. Therefore, the purpose of the present study 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.

MATERIALS AND METHODS

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) procured from Horticulture Research Center, Pantnagar, Uttarakhand. The edible food additives such as hydroxypropyl methyl cellulose (Batch no:- MCR278/100216), carboxyl methyl cellulose (Batch no:- RN329), glycerol, Aloevera gel (Batch no:- HP-FY) as an antioxidant and packaging material Aluminium foil (25 micron) and Cling wrap (12 micron) were procured from M/s R.K. Scientific Laboratory, Rudrapur, Uttarakhand, India for research purpose. On the basis of results obtained in preliminary experiments, the independent variables and its levels were decided for conducting the experiment to enhance the shelf life of edible coated material.

Preparation of edible coating solution

The edible coating solution was prepared by adding ingredients such as hydroxypropyl methyl cellulose (1.2 gm) and carboxy methyl cellulose (1.2 gm) 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 mins to provide functionality to edible film. The heated solution was cooled down in cold water bath for 30 min. 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 min. Then prepared content was again reheated to form a complex matrix at 45°C for 10 min and then cooled again to room temperature. The ripened papaya was selected to form papaya cubes (2*2*2 cm in size). Then sorted and graded. There after sample was cleaned with water and peeled it with the help of knife. Then manually peeled papaya cut into cubes of size 2 cm. Then dipping the cubes in edible coating solution and finally packaged. After that stored the sample for storage study at ambient and refrigerated conditions. Table 1 shown the levels of independent and constant variables decided after the study of preliminary trials and review of literature. The each response was statistically analyzed by M.S. Excel (2010). Full Factorial design was used for experimental design. ANOVA was used to study the effect of independent variables on the response statistically.

Physico - Chemical Analysis

pH

The pH value of sample was measured directly by digital pH meter (Triode India Ltd.) with 0.01 least count of pH meter and it work between temperature ranges of 0-100˚C. The pH probe was calibrated using standard buffer solution (pH 4 and 7) prior to measurement pH of stored edible coated papaya sample at 30˚C (Green, 1971).

Total soluble solids

Wash the screen with distilled water and clean it by cotton and set it at zero by rotating the screw, two visible line appear in the refractrometer white and blue, where both lines meet take the reading (Srivastava, 1993).

Sensory analysis

The quality of stored fruit was subjected to sensory evaluation by 5 panelists using 9-point Hedonic scale. The flavour, texture, taste and overall acceptability were evaluated. Fruit samples were selected randomly and evaluated for their sensory characteristics using a semi trained sensory panel consisting of 5 judges. The judges were requested to record their degree of liking and disliking on a sensory score card using 9 point Hedonic scale ranging from 1 to 9, which represents from like extremely to dislike extremely (Ranganna, 2009).

Table 1: Levels of independent and constant parameters

Variables	Levels	Conditions
HPMC: CMC	3	1:0 , 1:1, 0:1
Packaging Materials	3	Aluminium foil, Cling wrap and Unpacked
Storage	2	Refrigerated and ambient conditions
Constant		
Glycerol		6 ml/100 ml
Aloevera gel		10 ml/100 ml
Replications	3	

RESULTS AND DISCUSSION

Storage studies of edible coated papaya samples were carried out at an interval of 15 days. Quality characteristics of stored edible coated papaya cubes were determined in terms of pH, total soluble solids (TSS, °Brix), titratable acidity (%), ascorbic acid (mg/100g pulp) and sensory. Statistical analysis of the experiments was carried out at ambient and refrigeration temperature.

Effect of coating materials on pH

Ambient condition

At ambient conditions the effect of coating ingredients on pH was highly significant (P<0.05) because it had higher F_{cal} (594.52) than its F_{tab} (3.554) value. Fig. 1 which depicts that the pH of the sample was increasing from 4.31 to 6.25 with increase in number of storage days (0 to 8). The highest pH at ambient condition was due to the highest value of HPMC followed by HPMC+CMC and CMC**.** The pH increases acidity decreases due to utilization of organic acids in respiration. Samples stored under ambient condition for 12days. After 4^{th} day of storage of fresh cut papaya, the maximum value of pH was found 5.6 of control while minimum value of pH was found 5.3 coated with CMC shown in Fig 5.

Refrigerated Condition

At refrigerated conditions the effect of coating ingredients on pH was significant (P<0.05) because it had higher F_{cal} (25.561) than its F_{tab} (3.554) value. At refrigerated condition (7°C) Fig. 3 shows the effect of coating material on pH of papaya cubes during storage the pH increased by increasing the level of HPMC, CMC and HPMC+CMC. The pH was found from 4.31 to 6.77 upto 12^{th} day of storage of sample. Highest effect of HPMC indicated that increase the shelf life of prefered product. After 8^{th} day of storage of fresh cut papaya, the maximum value of pH was found 6.5 of control while minimum value of pH was found 5.92 coated with CMC shown in Fig 7.

Effect of packaging materials on pH

Ambient condition

The effect of packaging material on pH was significant (P<0.05) because it had higher F_{cal} (49.01) than its F_{tab} (3.554) value. It was seen from Fig. 2 that in case of unpacked materials, the pH was 5.52 after 4 days of storage then the food material was spoiled while the pH increase from 4.31 to 6.15 with cling wrap upto 8^{th} day of storage but the material was safe after 5 days of storage in cling wrap. In case of aluminum foil packaging, the pH was slight less than cling wrap upto 8^{th} day of storage. After 4^{th} day of storage of fresh cut papaya, the maximum value of pH was found 5.6 of control while minimum value of pH was found 5.35 packed with aluminium foil shown in Fig 6.

Refrigerated condition

The effect of packaging material on pH was highly significant (P<0.05) because it had higher F_{cal} (445.33) than its F_{tab} (3.554) value. It was seen from Fig**.** 4 that in case of unpacked materials, the pH was found 6.32 for 8^{th} day of storage than the food material was spoiled while the pH increase from 4.31 to 6.53 with cling wrap upto 12^{th} day of storage but the material was safe after 10 days of storage in cling wrap. In case of aluminum foil packaging, the pH was slight less than cling wrap upto 12^{th} day of storage.Samples stored under refrigerated condition for 12 days. After 8^{th} day of storage of fresh cut papaya, the maximum value of pH was found 6.505of control while minimum value of pH was found 5.93 packed with aluminium foil shown in Fig 8.

Effect of coating materials on Total Soluble Solids

Ambient condition

At ambient conditions the effect of coating ingredients on TSS was highly significant (P<0.05) because it had higher F_{cal} (16.439) than its F_{tab} (3.554) value. Fig. 9 which depicts that the TSS of sample increased from 12.42 to 14.67 ^{0}Brix due to increase in number of days (0 to 8) and it is due to loss of moisture during storage. The highest TSS at ambient condition was due to the higher value of CMC (14.67) followed by HPMC+CMC and HPMC. After 4^{th} day of storage, the maximum value of TSS found 14.33 of control while minimum value of TSS found 13.44 coated with HPMC shown in Fig 10.

Refrigerated condition

At refrigerated conditions the effect of coating ingredients on TSS was highly significant (P<0.05) because it had higher F_{cal} (160.37) than its F_{tab} (3.554) value. At refrigerated condition (7 ^{0}C), Fig. 11 shows the effect of coating material on TSS of papaya cubes during storage increased the TSS by increasing the level of CMC, HPMC+CMC and HPMC. The TSS was found

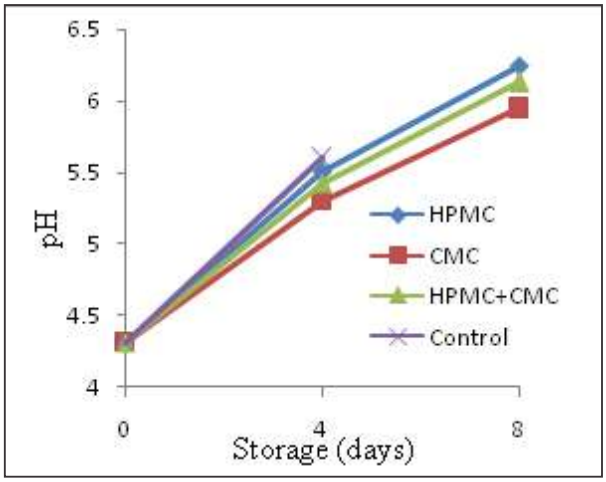

Fig. 1: Effect of coating material on pH stored at room temperature

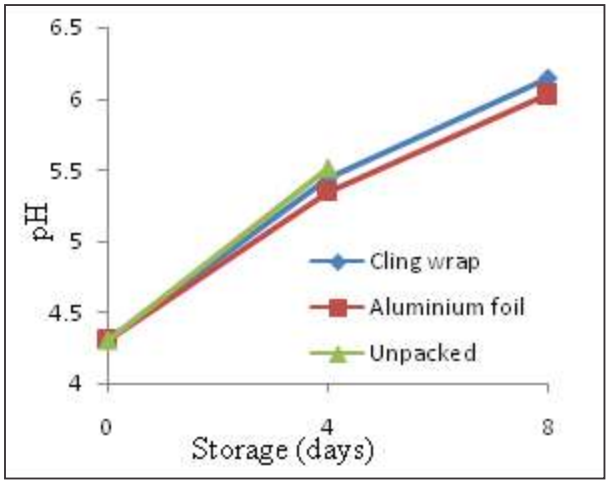

Fig 2: Effect of packaging material on pH stored at room temperature

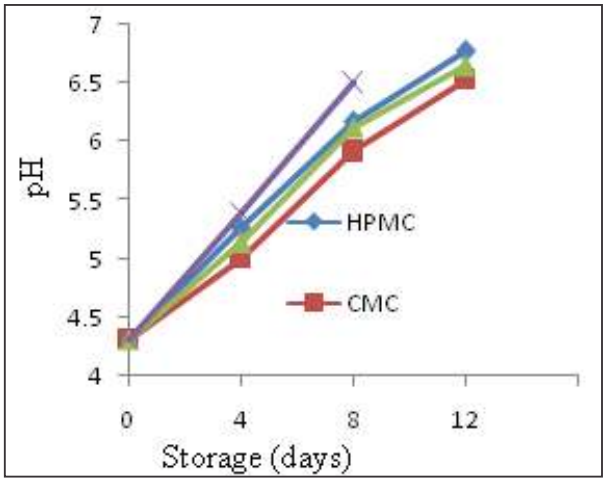

Fig. 3: Effect of coating material on pH stored at refrigerated temperature

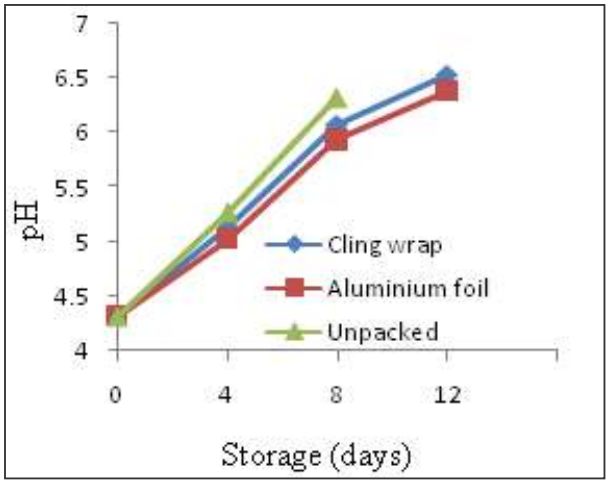

Fig. 4: Effect of packaging material on pH stored at refrigerated temperature

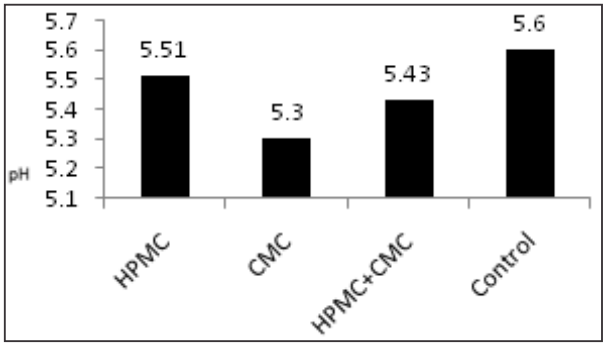

Fig. 5: Variation in pH with coating material on 4th day storage at room temperature

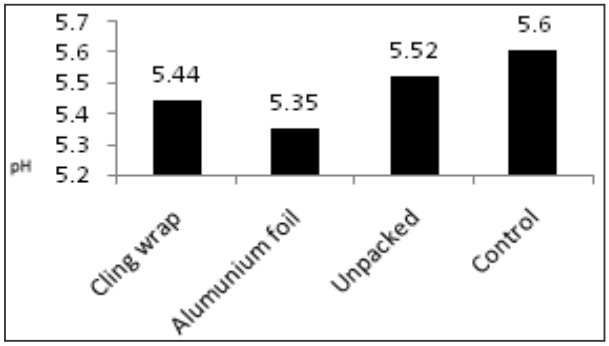

Fig. 6: Variation in pH with packaging material on 4th day storage at room temperature.

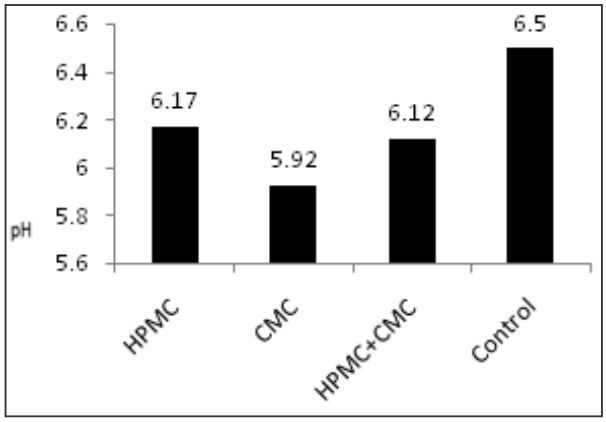

Fig. 7: Variation in pH with coating material on 8th day storage at room temperature

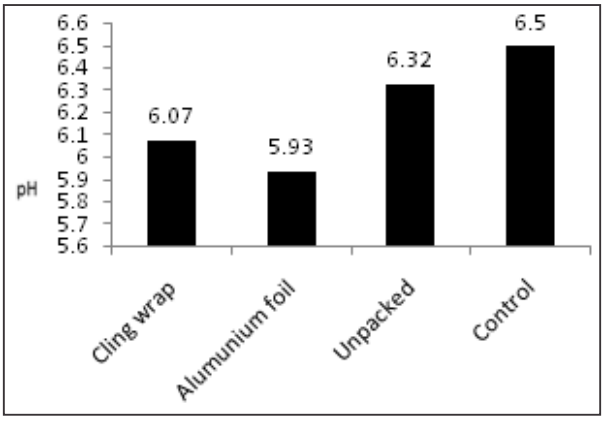

Fig. 8: Variation in pH with packaging material on 4th day storage at room temperature

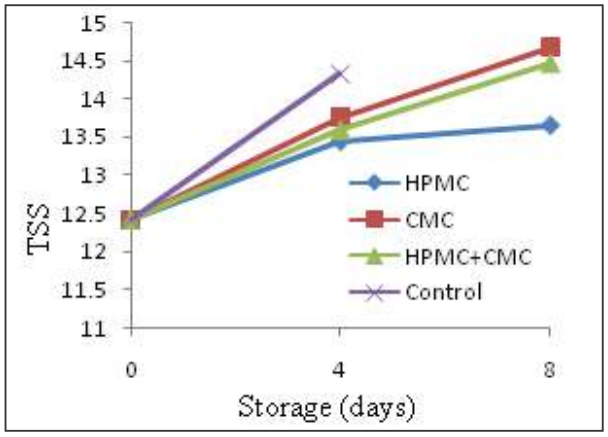

Fig. 9: Effect of coating material on total soluble solids at room temperature

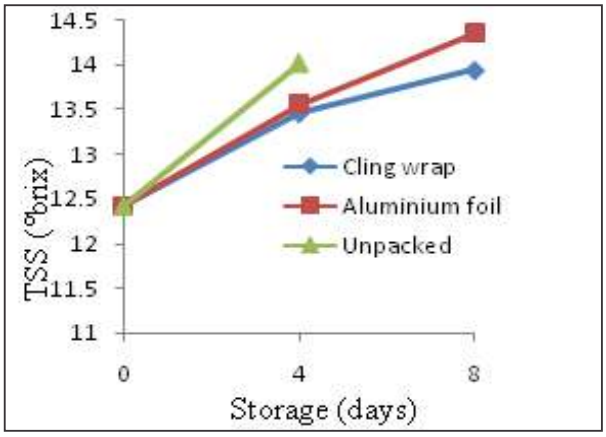

Fig. 13: Effect of packaging material on total soluble solids at room temperature

from 12.42 to 14.135 ^{0}Brix upto 12th day of storage of sample. Highest effect of CMC indicated that increase the shelf life of prefered product. After 8th day of storage, the maximum value of TSS found 13.59 coated with CMC while minimum value of TSS found 13.24 coated with HPMC shown in Fig 12.

Effect of packaging materials on total soluble solids

Ambient condition

The effect of packaging material on TSS was highly significant (P<0.05) because it had higher F_{cal} (104.94) than its F_{tab} (3.554) value. It was seen from Fig**.** 13 that in case of unpacked materials, the TSS was found 14.02 ^{0}Brix for 4 days of storage than the food material was spoiled while the TSS increased from 12.4 to 14.35 ^{0}Brix with aluminuim foil upto 8th day of storage but the material was safe after 5 days of storage in aluminuim foil. In case of cling wrap packaging, the TSS was slight less than aluminum foil upto 8th day of storage. After 4th day of storage of fresh cut papaya, the maximum value of TSS was found 14.33 of control while minimum value of pH was found 13.46 packed with cling wrap shown in Fig 14.

Refrigerated condition

The effect of packaging material on TSS was significant (P<0.05) because it had higher F_{cal} (92.064) than its F_{tab} (3.554) value. It was seen from Fig**.** 15 that in case of unpacked materials, The TSS found 14.01 ^{0}Brix for 8th day of storage than the food material spoiled while the TSS increase from 12.42 to 14.10 ^{0}Brix with aluminum foil upto 12th day of storage but the material was safe after 10 days of storage in aluminum foil. In case of cling wrap packaging, the TSS was slight less than aluiminium foil upto 12th day of storage. After 8th day of storage, the maximum value of TSS was found 14.01 of unpacked while minimum value of TSS was found 13.43

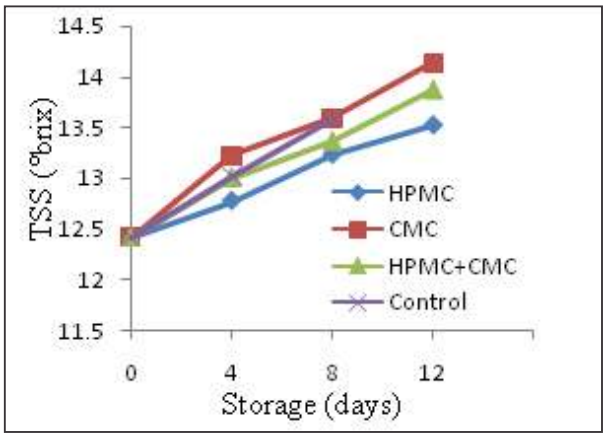

Fig. 11: Effect of coating material on total soluble solids at refrigerated temperature

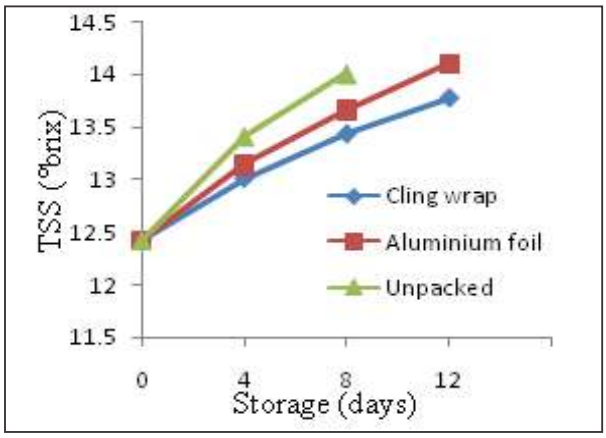

Fig. 15: Effect of packaging material on total soluble solids at refrigerated temperature

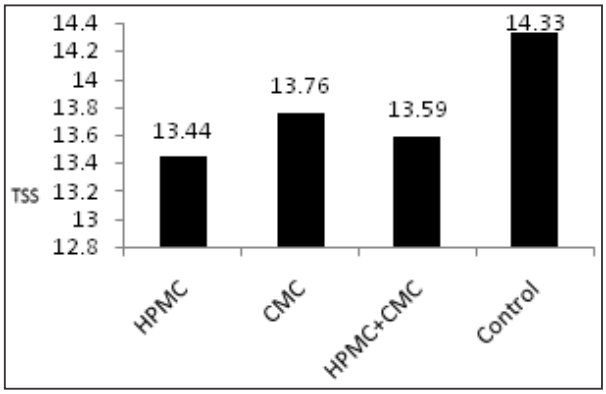

Fig. 10: Variation in TSS with coating material on 4th day storage at room temperature

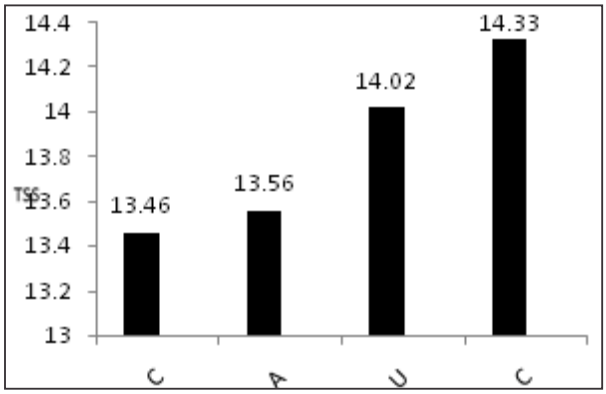

Fig. 14: Variation in TSS with packaging material on 4th day at refrigeration temperature

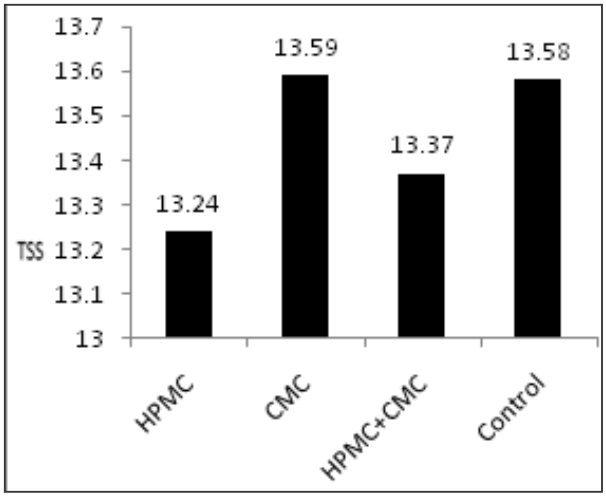

Fig. 12: Variation in TSS with coating material on 8th day storage at room temperature

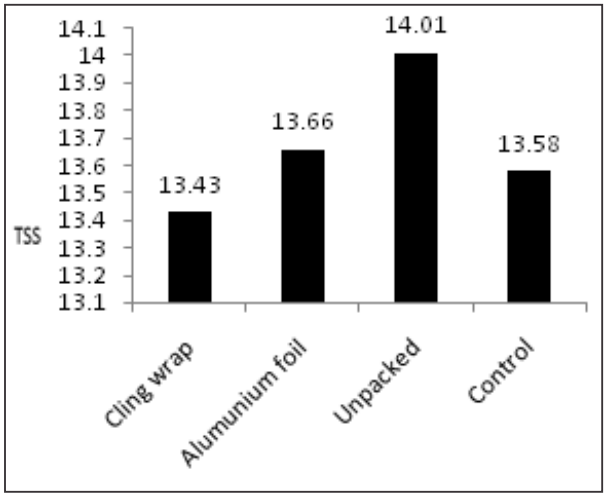

Fig. 16: Variation in TSS with packaging material on 8th day at room temperature

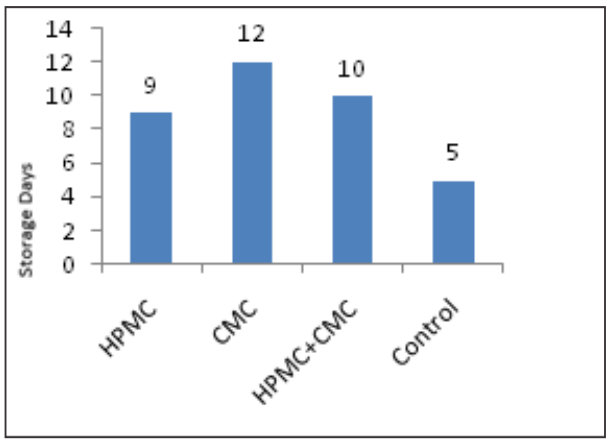

Fig. 17: Variation of storage life with coating material and control at refrigeration condition

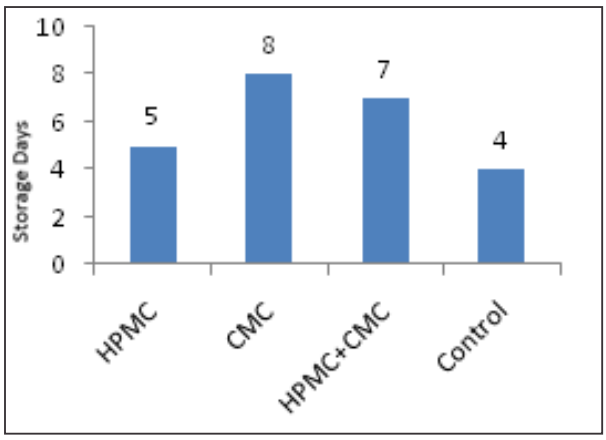

Fig. 18: Variation of storage life with coating material and control at ambient condition

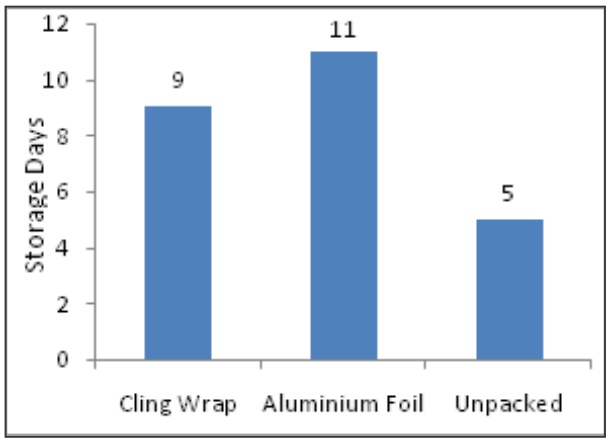

Fig. 19: Variation of storage life with packaging material and unpack at refrigeration condition

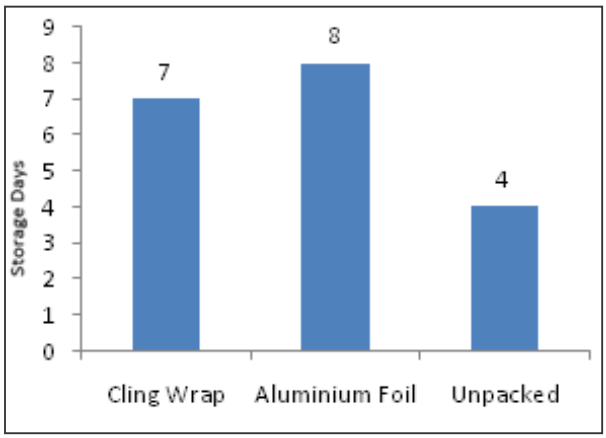

Fig. 20: Variation of storage life with packaging material and unpack at ambient condition

packed with cling wrap shown in Fig 16.

Sensory evaluation of papaya cubes

At refrigeration condition, maximum value of overall acceptability of stored edible coated papaya cubes was found 7.8 coated with CMC packed with aluminum foil upto 12th day of storage while the minimum value of overall acceptability obtained 6.2 coated with HPMC packed with cling wrap. But at ambient condition, maximum value of overall acceptability of stored edible coated papaya cubes was found 5.9 coated with CMC packed with aluminum foil upto 8th day of storage while the minimum value of overall acceptability obtained 4.6 coated with HPMC packed with cling wrap. The overall acceptability of control sample was found 4.0 and 5.6 stored at ambient and refrigerated condition respectively.

Fig 17 depicted that the variation of storage life with coating material and control at refrigeration condition, the highest effects of ingredient CMC in 12 days followed by HPMC+CMC in 10 days, HPMC in 9 days and control in 5 days. These results reveals the conditions at which coated material fit for consumption, deterioration of the material takes after these conditions. Also Fig 18 concluded storage life with coating material and control at room condition, the highest effects of ingredient CMC in 8 days followed by HPMC+CMC in 7 days, HPMC in 5 days and control in 4 days. These results reveals the conditions at which coated material fit for consumption, deterioration of the material takes after these conditions. Now the Fig 19 explained the storage life with packaging material and unpack at refrigeration condition, the highest effects of packaging materials Aluminium foil in 11 days followed by Cling wrap in 9 days and unpack in 5 day. These results reveals that conditions at which material fit for consumption, deterioration of the material takes after these conditions. It was also seen from Fig 20 that the variation of storage

life with packaging material and unpack at room condition, the highest effects of packaging materials Aluminium foil in 8 days followed by Cling wrap in 7 days and unpack in 4 day. These were the conditions at which material was fit for consumption, deterioration of the material.

CONCLUSION

Edible coating made from carboxy methyl cellulose and hydroxyl propyl methyl cellulose was investigated for their ability to preserve the quality of papaya, the storage study of papaya samples was carried out for 12 days at refrigeration condition and ambient condition. It was concluded that the pH of the stored papaya varied from 4.31 to 6.54 whereas total soluble solids was in range of 12.42 to 14.3 ^{o}Brix. Papaya cubes stored at refrigerated temperature recorded higher pH values compared to those stored under room condition**.** Maximum value of pH is found when it was coated with HPMC and packed with cling wrap. pH increased with the increase in days of storage.. The shelf life of papaya coated with CMC was found 12 days while the shelf life of papaya packed with aluminium foil was found 11 days

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