

EFFECT OF XANTHAN GUM SOLUTION ON THE PRESERVATION OF ACEROLA (*MALPIGHIA GLABRA* L.)

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Received November 25, 2014

ABSTRACT. Nowadays, storing fresh fruit and vegetable by edible film was the best method. There are a lot of chemical which can coat the surface of fruit to increase the preservation time. Among the chemicals was xanthan gum which was known as an additive and applied widely in food technology but it can use currently in the post harvest technology as an edible film. Coating of acerola fruit with xanthan gum has been found to delay the ripening process. Xanthan gum in aqueous solutions of 0.4, 0.6, 0.8, 1.0, 1.2 and 1.4% (w/v) was applied as an edible coating of unripe acerola which were stored at 30°C and 70-80% RH for 6 days. Fruits were coated with 1.4% xanthan gum delayed the ripening process by slowing down the rate of respiration, in terms of percentage weight loss, soluble solids concentration (°Bx), total acidity and color of acerola fruit during storage as compared to the uncoated control and fruit treated with other xanthan gum concentration. The result suggest that using 1.4% xanthan gum as edible coating may form a protective barrier on the surface of acerola, the ripening process of acerola can be delayed and prevented oxygen penetration. It can be prolong the preservation during 6 days at 30°C without

any negative effects on quality of fruit. The appearance of acerola does not have blemishes and which is fresh, shiny and bright colored.

Key words: Acerola; Edible film; Glucose; Storage; Respiration.

INTRODUCTION

Acerola (*Malpighia glabra* L.) is a tropical fruit in the family Malpighiaceae. Acerola can be found from South Texas, through Mexico and Centre American and in subtropical areas throughout the world such as parts of Asia, India and South American. Brazil is the largest producer of acerola in the world (Mohammed, 2000); it was cultivated in the South Vietnam (Tien Giang province) with the high yield.

Acerola consumption is highly correlated with reduced risk of cancer, hypertension and also low incidence of some cardiac diseases (Filgueiras *et al.*, 2007). However, acerola has a

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short shelf life, easy damage after harvest because it has a thin skin, much water. For this reason, it can lose moisture quickly when stored at high temperatures and low relative humidity. Generally, low temperature storage is the best preservation method. However, it also causes chilling injury and contraction of the skin, also damages the physiology with some fruit. Thus, edible coating based on natural products can provide an additional protection for fresh fruit and vegetables may provide an excellent barrier against gaseous exchange and water loss which are detrimental to quality of fruit.

Now a days, there are some edible coatings for preservation fruit for instant chitosan (tomatoes) (Le-Pham-Tan *et al.*, 2014), gelatin, CMC and soy protein (sweet cherries) (Stathopoulos *et al.*, 2011), gum arabic (tomatoes) (Ali *et al.*, 2013). With xanthan gum, it was known additives and was used widely in food industry, for instance bakery product, beverages, dairy and pet food processing (Sharma, 2006). In addition, xanthan gum had the role in coating of easy peelers (Chen and Nussinovitch, 2000), improved the desirable surface color of baby carrots (Mei *et al.*, 2002); when used as an edible coating, xanthan gum can reduced respiration rate and weight loss, may form a protective barrier on the surface of fruit and reduce the supply of oxygen so extend the shelf life of prickly pear (Mohamed *et al.*, 2013). However, some research about effect of xanthan gum on the self life

of fruit has some limitation. Therefore, the aim of this study was to determine whether xanthan gum has the potential to be used as an edible coating for delaying ripening, enhanced shelf-life and maintaining quality of stored acerola.

MATERIALS AND METHOD

Materials

Acerola (*Malpighia glabra* L.) was at level 2 or 3 (yellow green and little pink) (Alves *et al.*, 1995), were harvested from Go Cong, Tien Giang province (Vietnam). It has the uniform size (4-6 g), diameter of fruit 20 ± 1.87 mm, non physical damage, insect or pathogen infection.

Xanthan gum solutions were prepared by dissolving 0.4, 0.6, 0.8, 1.0, 1.2 and 1.4 g of powder in 100 ml of distilled water with 1 g citric acid, 0.5 g glycerol and 0.25 ml oleic acid, then the solution was heated gradually to 85°C by using a magnetic stirrer, was filtrated and was cooled to room temperature.

Method

Fruit coating

A total of 30 fruits (150-160 g) were washed and dipped into xanthan gum solutions (0.4, 0.6, 0.8, 1.0, 1.2 and 1.4%, w/v) during 1 min and dried at 30°C for 2 hours. The fruit were stored in perforated polyethylene bags at room temperature approximate $30 \pm 3^\circ\text{C}$ and 70-80% RH.

Analysis method

Determination of ripen rate

The rates of ripen were measured according to Alves *et al.* (1995), the ripe fruit was at level 5 and 6 (red and dark red).

EFFECT OF XANTHAN GUM SOLUTION ON THE PRESERVATION OF ACEROLA

Weight loss

Weight loss was determined by weighting the whole acerola before and after the storage period. Weight loss was expressed according to the percentage rate (%).

Total reducing sugar (glucose)

The glucose was determined by a Glucometers Cleverchek (Germany):

$$\% \text{Glucose} = x * 10^{-3} * 180 * \frac{V}{1000 * m} * 100$$

(Le-Pham-Tan *et al.*, 2014),

where x is the concentration of glucose displays on the glucometer (mmol/L), 180 is the molecular mass of glucose, m is the mass of fruit (g) and V is the dilution of solution (ml).

Total acidity

The total acidity value was determined by (AOAC 942.15, 2007). Titration acidity was performed by NaOH 0.1 N with phenolphthalein 0.1% as an indicator and expressed in grams (g) of total acidity (malic acid) per 100 g of fruit.

Determination of respiration rate

A quantity of 300 g fruits were placed in the plastic container for 1 hour, CO₂ from fruit was pumped and reacted with sodium hydroxide (NaOH 0.1N) in another plastic container and then titrated with NaOH 0.1N excess by HCl 0.1N. The amount of CO₂ production was expressed in mg CO₂ · kg⁻¹ · h⁻¹.

Color evaluation

Color parameters were measured on coated and uncoated acerola. Color was determined using by a Chroma Minota CR-410 equipment every day, during storage time. Values were recorded as lightness (L*, ranging from 0 to 100,

corresponding to black to white, respectively), chroma (C*, representing color intensity or saturation), and hue angle (h*, representing by degrees of the angle) (Cook, 2000).

Data analysis

The experiment was arranged in a completely randomized design with three replications. Data were analyzed by Statgraphics software (Centurion XV), with confidence interval $p < 0.05$.

RESULTS AND DISCUSSION

Effects of xanthan gum concentration on the maturity and weight loss during preservation time of acerola

The ripe acerola rate increases then decreases through each day in the xanthan gum concentrations. The uncoated sample has the fastest ripe rate, reaching 94.44% after storing one day and a downward trend in the next day, due to the damage fruit. Meanwhile, the remaining sample can be further increased up to 100%, in first two days (*Fig. 1*). In addition, this result is higher than coating acerola by ethephon at the same storage time (Quoc *et al.*, 2012). Ripe fruit was preserved up to 5-6th day. This suggests that xanthan gum solution can prolong storage of acerola. This result is due to xanthan gum film surrounded surface of fruit and it limits the respiration of acerola, as well as reducing the production of ethylene.

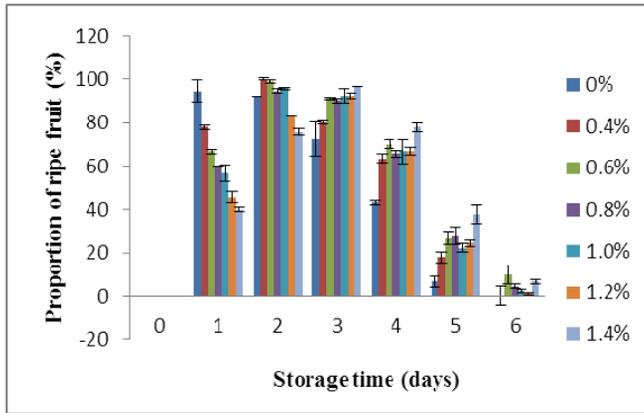


Figure 1 - Changes in the ripping stage of acerola with concentration of xanthan gum

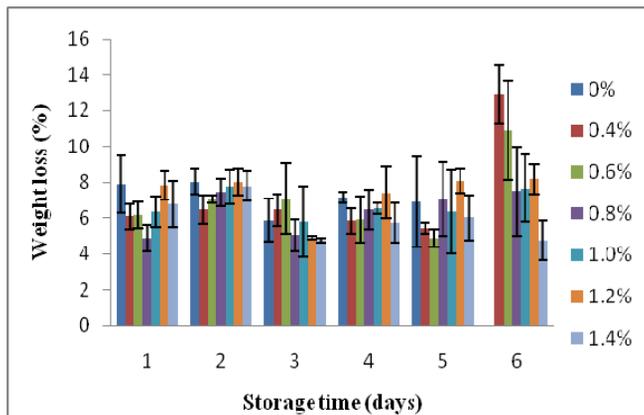


Figure 2 - Changes in the weight loss of acerola with concentration of xanthan gum

Weight loss fluctuated in the storage time due to respiration of fruit, accompanied by a large loss of water. The sample at 1.4% had the lowest weight loss (Fig. 2), this shows that samples at 1.4% has the ability to limit the weight loss in the long time. This result is similar to the study of Mohamed *et al.* (2013), using xanthan gum solution preserved prickly pear; the uncoated fruit during storage time has more weight losses than xanthan

gum coated. In addition, comparing with study of stimulated ripe acerola by ethephon (Quoc *et al.*, 2012) showed that weight loss in the finish ripe process decreases up to 16.60%, on 4th day, and uncoated sample in this research peaked at just 12.91%, on 6th day. It showed a clear difference weight loss between the preservation and stimulation of ripe acerola.

EFFECT OF XANTHAN GUM SOLUTION ON THE PRESERVATION OF ACEROLA

Effects of xanthan gum concentration on total acidity and glucose content

Total acidity of uncoated samples decreased faster than coated samples in different concentrations. The highest total acidity was in concentrations of 1.4%, during preservation time (Fig. 3). In general, acid content in all samples decreased during the storage period. This result is similar to study about acerola storage by starch (Maciel *et al.*, 2004) and sweet cherries storage by membrane (gelatin, soy protein, CMC) (Stathopoulos *et al.*, 2011)

Total acidity is the main substrate of respiration process and can be reduced to 50% during the existence of fruits (Tan *et al.*, 2008). The decrease of acid content is due to acid consumption in respiration process, while organic acids (e.g. malic acid) are decomposed into CO₂ and H₂O. Acid content decreased with

reduction of the starch content, and increase the sweetness of the fruit (Tiep *et al.*, 2008).

The coated sample of 1.4% got significant difference at $P < 0.05$ against other samples. The ripe fruit has the highest rate during storage time. Using over 1.4% xanthan gum has the quite viscid solution which can not cover surface of fruits. Hence, it is the optimum concentration for preserving the acerola.

Fig. 4 shows the glucose content tends to increase in the early stages and then decreases in time. Glucose of the uncoated sample increased and decreased rapidly, compared with the coated samples in different concentrations, glucose of the uncoated sample began to decrease on the second day. Meanwhile, another sample began to decrease on the third day. Changes in sugar content leads to changes in total soluble solids (°Brix) change as well.

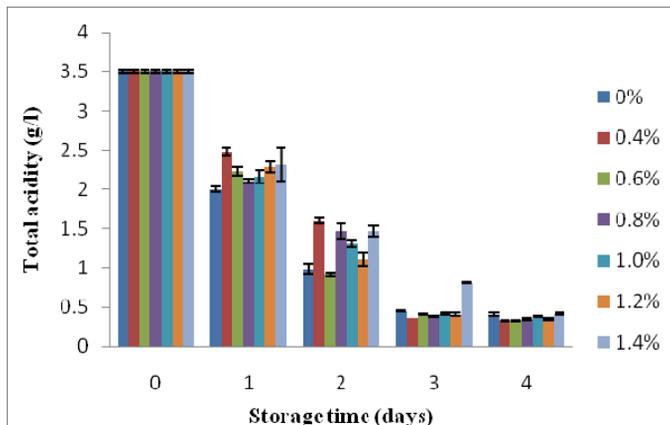


Figure 3 - Changes in the acid content of acerola with concentration of xanthan gum

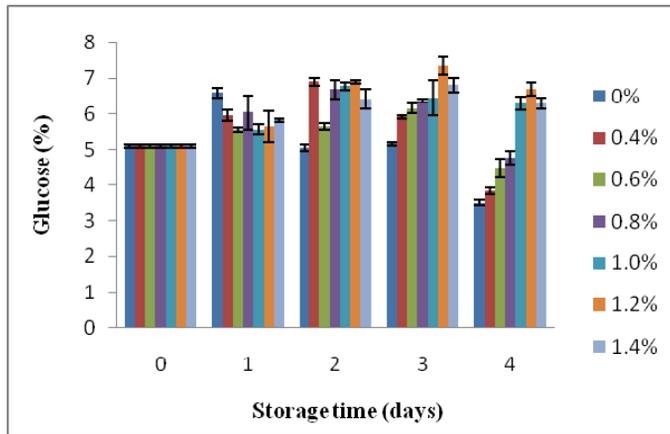


Figure 4 - Changes in the glucose content of acerola with concentration of xanthan gum

The first stage in the process of respiration takes place strongly, it used glucose but still not reduce the sugar content which increased due to the formation of glucose from cellulose, hemicellulose, starch, tannin (Tiep *et al.*, 2008). At a later stage, glucose content decreases steady and entails the reduction of soluble solids. Glucose content in acerola reached the highest value is 7.35%, in the third day. This result is lower than stimulating ripe acerola at 8.43%, after 2 days storage (Quoc *et al.*, 2012).

Effects of xanthan gum concentration on color of fruits

Fruits are evaluated for quality first by their appearance. Consumers prefer acerola with no blemishes and which are clean, fresh, shiny and

bright colored. The lightness (L^*) values decreased during storage time and less change was thereafter (Fig. 5). On the first two days, the respiration of fruit takes place strongly and color changes from yellow green, pink to red; uncoated sample was significantly different ($P < 0.05$) from coated sample and then they were similar.

The hue (h^*) value also decreases during ripening. The hue value of the uncoated sample was significantly different ($P < 0.05$) from coated sample throughout the first three days (Fig. 6), though acerola with 1.4% xanthan gum treatment continued to show less ripening. This result demonstrates xanthan gum has the ability to control the color change of the acerola in the preservation process.

EFFECT OF XANTHAN GUM SOLUTION ON THE PRESERVATION OF ACEROLA

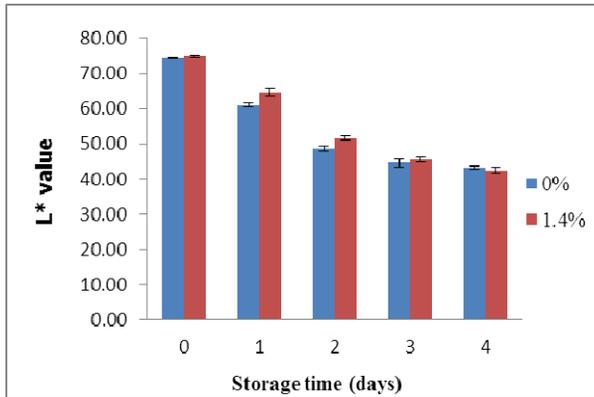


Figure 5 - Mean L^* values of acerola during storage time

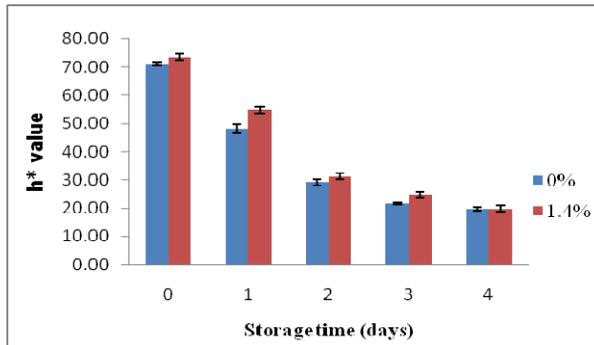


Figure 6 - Mean h^* values of acerola during storage time

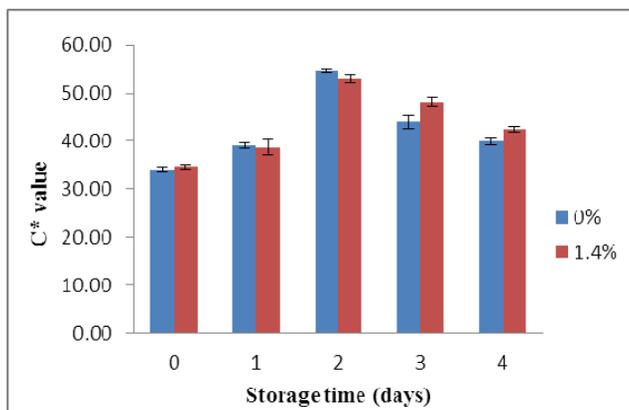


Figure 7 - Mean C^* values of acerola during storage time

Color chroma (C^* value) varied at different fruit ripening stages of the studied samples (Fig. 7). The C^* value did not differ in the first day; the lowest value was detected in the unripe fruit (approximately 34). The

highest value peaked at two day storage (C^* value=53-54.6) and then decreased slowly during storage, the C^* value of coated sample was higher than uncoated sample.

Effects of xanthan gum concentration on the respiration process of acerola

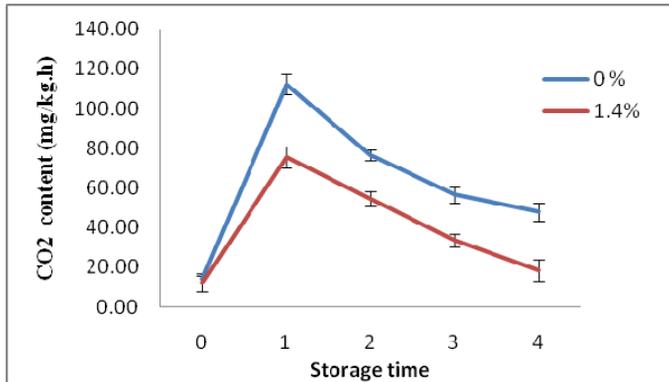


Figure 8 - Respiratory activity of acerola during storage time

The first stage, respiration process occurs sharply and CO₂ level is high level. Then, CO₂ content decreases extremely during later stage. Uncoated sample respire stronger than the coated samples, CO₂ level peaked in the first day in both samples, 112 mg.kg⁻¹.h⁻¹ for uncoated sample and 76 mg.kg⁻¹.h⁻¹ for coated sample at 1.4% xanthan gum solution (Fig. 8). This result has shown a typical climacteric pattern, this suggestion is similar to the study of Alves *et al.* (1995) that preserved acerola in polyvinyl chloride (PVC) bag at 8°C, CO₂ content obtained 80 mg.kg⁻¹.h⁻¹ and storage time can extend up to a week. This proves that xanthan gum had the ability to control

respiratory process and prolonged the storage time.

CONCLUSION

The xanthan gum solution used as coating for fruit, especially acerola that proved to be the effective system in reducing the weight loss, the respiration process, increasing the storage time and keeping the color. The appearance of acerola does not have blemishes and which is clean, fresh, shiny and bright colored. In addition, xanthan gum is known the additive though not harmful to health of consumers, nor prescribed dosage. It can use widely in the postharvest technology such as edible film and can be suitable some fruits.

EFFECT OF XANTHAN GUM SOLUTION ON THE PRESERVATION OF ACEROLA

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