Agricultural and Biological Sciences Journal
Vol. 1, No. 3, 2015, pp. 95-99
http://www.publicscienceframework.org/journal/absj

Effect of Nopal Gel Solution on the Preservation of Banana *(Musa Paradisiaca)*

Le Pham Tan Quoc*, **Truong Hoang Duy**

Institute of Biotechnology and Food Technology, Industrial university of Ho Chi Minh City, 12 Nguyen Van Bao street, Ward 4, Go Vap district, Ho Chi Minh City, Vietnam

Abstract

Bananas are tropical plants grown widely in Vietnam. In this study, we used gel from Nopal cactus to make edible film and examined its effect on postharvest preservation of banana fruits. The examined parameters included: changes in weight loss, level of reducing sugars, respiration intensity and total acid content. The results show that Nopal gel significantly improves preservation of banana fruits.

Keywords

Banana, Edible Film, Nopal Cactus, Storage, Respiration

Received: April 1, 2015 / Accepted: April 12, 2015 / Published online: April 20, 2015

1. Introduction

Bananas are the tropical fruit trees of the family *Musa Troglodytarum*, easy to grow and harvest time is short (Chi, 1978). It was the most important fruits in Vietnam and also was fruit exports, especially China (Persley and George, 1996). Commercial annual production in Vietnam is over one million tons, not including home gardens and main production areas in Vietnam are: Dong Nai, Can Tho, Soc Trang, Tien Giang, Vinh Long, Ben Tre and Vinh Phu provinces (FAO, 2004). The banana plant consists of roots, leaves, flowers, fruit... banana leaves with broad leaves and grows symmetrically. Bananas have developed steadily during growth period (Tuyen, 2012). Currently, role of banana was quite important and was consumed with significant quantities in Vietnam. The main components of banana include water, sugar, polysaccharides, organic acids, nitrogen compounds, aromatics, colorants, the polyphenols and vitamin... Bananas are easily absorbed because the component of bananas contains two simple sugars which are fructose and glucose (Dung and Hoa, 2003). Due to its high nutritive value, banana fruit is easy to diseases caused by microorganisms. Besides, it was susceptible and chilling injury at low temperature (Cano *et al.*, 1997). Nowadays, there are a lot of methods to preserve fruits by modern methods such as modified atmosphere (MA) storage and controlled atmosphere (CA) storage (Stewart *et al.*, 2005) but applying these methods in developing countries was limited by technical level, cost price. Hence, they can use edible film to improve shelf life of fruit such as apple, strawberry (chitosan) (Hernández-Muñoz *et al.*, 2008; Shao *et al.*, 2012); banana and mango (polysaccharide) (Kittur *et al.*, 2001); kiwifruit (protein isolate) (Xu *et al.*, 2001)…but gel of Nopal catus was new interested research from Vietnamese scientists.

The Nopal cactus (*Opuntia ficus-indica*) is a plant of the Cactaceae family native to the American continent and is widely distributed in Mexico (Saenz *et al.*, 2006). It grown fast and suited the conditions of drylands and Nopal cactus were imported and planted successfully in Vietnam, especially Ninh Thuan and Binh Thuan province (Oanh, 2011). Nopal cactus has the great bioactive compounds such as phenolics, flavonols, β-carotene and ascorbic acid…was antioxidant compounds and antimicrobial activity (Medina-Torres *et al.*, 2011). Extracts from Nopal cactus was suitable to make edible

* Corresponding author
E-mail address: lephamtanquoc@yahoo.com (L. P. T. Quoc)

film to preserve the fruit.

In this study, the objective was to study the effects of concentration of Nopal solution on the changes of weight loss, reducing sugar, total acidity and respiration intensity.

2. Materials and Methods

2.1. Materials

Banana (*Musa paradisiaca*) was harvested at the time from 80-95 days after flowering in Tien Giang province (Vietnam) and not exceeds 18 hours after harvest. It has the uniform size (232.5 ± 2.5 g/fruit), diameter of fruit 4.25±0.25 cm, length of fruit 9.25± 0.25 cm, non physical damage, insect or pathogen infection.

2.2. Methods

Extraction of Nopal gel: fresh leaves was harvested from Ninh Thuan province (Vietnam). It was milled and extracted by alcohol 20^0 (v/v) during 8 hours, then filter by cloth. Received gel was added and stirred some additives such as Al_2SO_3 (0.65%, w/v), citric acid (0.47%, w/v), ascorbic acid (0.03%, w/v), carrageenan (0.02%, w/v), sodium metabisulfite (0.003%, w/v).

Figure 1. Leaves of Nopal cactus

Figure 2. Nopal gel

Fruit coating: Fruits are soaked in Nopal gel during approximately 3 minutes and dried at condition room. The fruit were stored in perforated PE bags at room temperature approximate 31±2°C and the relative humidity 82±3%.

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

$$Weight\ \ loss\ (\%) = \frac{m_2 - m_1}{m_1}.100$$

m_1: weight of fruit before storage period (g)

m_2: weight of fruit after storage period (g)

Reducing sugars: determined by glucometer (Clever check-Germany)

The glucose was determined by a Glucometers Cleverchek (Germany)

$$\%\ \text{Glucose} = x*10^{-3}*180*\frac{V}{1000*m}*100 \quad (\text{Tan } et\ al., 2013)$$

x: The concentration of glucose displays on the glucometer (mmol/L)

180: Molecular mass of glucose

m: Mass of fruit (g)

V: The dilution of solution (ml)

Total acidity content: determined by titration method (TCVN 5483: 1991). Titration acidity was performed by NaOH 0.1 N with phenolphthalein 0.1 % as an indicator and expressed in grams (g) of total acidity per 100 g of fruit.

$$X = \frac{250}{m}*V_1*C*\frac{100}{V_0}$$

X: Total acid content (g/l)

m: Mass of fruit (g)

V_1: Volume of NaOH 0.1N (ml)

V_0: Volume of analyzed sample (ml)

C = 0. 067: Converted coefficient of malic acid

Respiration intensity (RI): determined CO_2 meter (Sibata-Japan)

Banana was weighted and put into the container for determining respiration intensity. Fruits respire and created CO_2 and O_2; the fan will blow the air (CO_2, O_2) in container pass through CO_2 meter at the determined flow, time and temperature. Results will display on screen of apparatus (ppm CO_2). Respiration intensity was calculated by practiced formula below:

$$RI\ (mg_{CO2}.kg^{-1}.h^{-1}) = \frac{(C_1 - C_o)*L*60*273*44*0.1}{22.4*m*(t_o+273)}$$

C_1: CO_2 concentration of samples (ppm)

C_0: CO_2 concentration of air (ppm)

L: Air flow (ml.minute^{-1})

273: Kelvin temperature (°K)

t_0: Room temperature (25°C)

44: Mass of CO_2 molecule (g)

22.4: Volume of the air in standard condition (l)

m: Mass of fruit (g)

2.3. Data Analysis

The experiment was arranged in a completely randomized design with three replications. Data would be analyzed by Statgraphics software (Centurion XV) with confidence interval $p_{value}<0.05$

3. Results and Discussion

3.1. Weight Loss

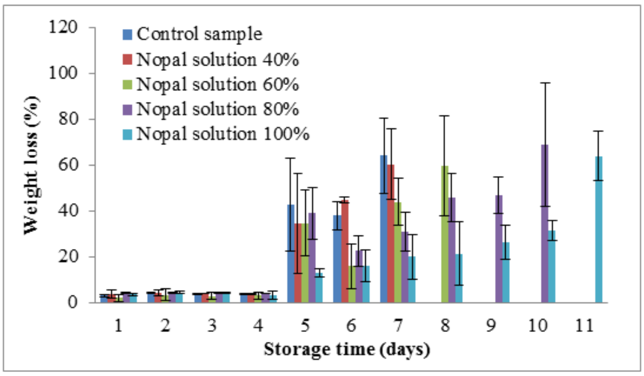

Figure 3. Weight loss of bananas during the storage time

The banana ripe during 11 days, the ratio of ripe samples has the best value at 5th-7th days (50~80%) with the soaked samples in Nopal solution. Figure 3 shows that all banana samples which reduced the weight of fruit and the weight loss increased with increasing storage time. In any storage conditions, almost fruit cannot avoid the weight loss, especially the fruit has the high moisture such as acerola, water melon, banana…but when facilitating good storage can reduce the weight loss (Dinh and Tiep, 2008). The slower speed of weight loss in coated fruit might be partially caused by a blockade of dehydration (Shahidi *et al*., 1999).

From 1 to 4 days after soaking in the Nopal gel, the weight of sample is reduced slightly. In this time, the fruit are still green, slow respiration, not black dot on the peel. Starting at 5th days, weight loss of banana increased extremely and began to appear decay. Hence, standard deviation of weight loss fluctuated sharply at the last ripe stage. At 9th days, the sample at Nopal concentration of 60% was complete decay and the shelf life of banana extended to 11th days with Nopal solution of 100% (The ripe fruit was 9% and the rest of samples were decay). Almost of samples have the preservation time from 5 to 7 days, this result was similar the study of Suseno *et al.* (2013) that also used chitosan to coating banana.

3.2. Reducing Sugar

Starch in banana has the high content; it can achieve 25% with some kind of bananas in Vietnam. The conversion of starch into sugar is a characteristic of bananas (Tam, 1997) and starch is a main component of green bananas and it changes when bananas ripe (Condernunsi and Lajolo, 1995). When bananas ripe, content of starch decreases due converted into reducing sugar which will increase steady during ripe period (Goulao and Oliveiria, 2008).

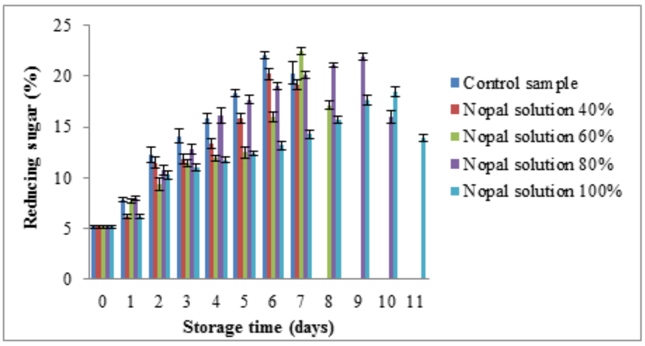

Figure 4. Reducing sugar of bananas during the storage time

Figure 4 shows the reducing sugars content that increased from first preservation day to 7th days and peaked at 6-7th days with the control samples, 40 and 60%. Reducing sugar content in the high concentration increase slowly. After that, reducing sugars content decreased slightly until the decay period. Reducing sugar in this case was higher than the research of Gol and Rao (2011), their maximum result were 9% using calcium chloride to coating banana (*Musa* spp.) after 10th days. Cause of this difference was different species because there are a lot of banana species on the world, each specie has the characteristic shape, colour and nutrition components.

3.3. Total Acidity Content

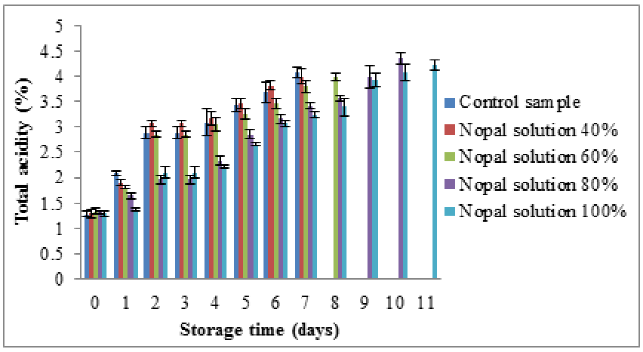

Figure 5. Total acid content of bananas during the storage time

Bananas have 14 kinds of organic acids such as oxalic acid, malic acid, citric acid… (Wyam and Palmer, 1964). 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 CO_2 and H_2O. Acid content decreased with reduction of the starch content, and increase the sweetness of the fruit (Dinh and Tiep, 2008).

During the storage time, organic acids participate the metabolism and the acid content of the samples increases steady during storage time and reached a maximum value about 4-4.5 g/l. Control samples have the total acidity content which reached a maximum level of 4.1g/l at 7th days. While the samples soaked in Nopal gel solution 100% reached a maximum level of 4.4 g/l at 11th days (Figure 5). Edible film by Nopal solution can control respiratory process of bananas, it can hinder metabolism in cells and acid concentrations peaked longer.

3.4. Intensity of Respiration of Banana

Nopal gel creates a membrane which covered bananas thus it will reduce the contaction between fruit and oxigen from surrounding enviroment and increase CO_2 content after 3 days. The ripe process will be delayed and extended storage time. Besides, ethylene also appears more and more; it make bananas that ripe quickly.

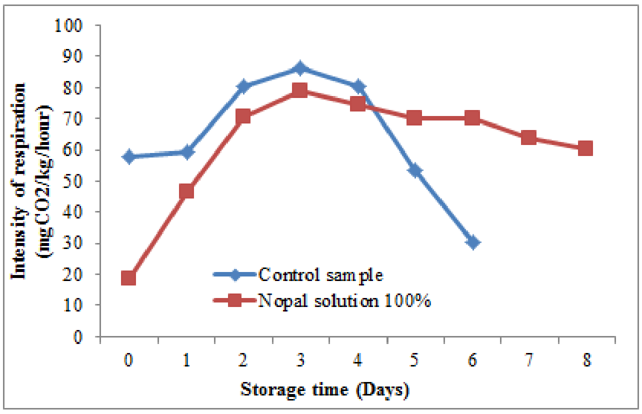

Figure 6. Respiratory activity of bananas during storage time

To extend storage time should be limited the intensity of reapiration of bananas that mean to reduce the creation of ethylene by reducing the concentration of O_2 in air storage (Stanley and Ellen, 1965). The first stage, respiration process occurs sharply and CO_2 level is high level 86.38 $mg.kg^{-1}.hour^{-1}$ with control samples and 78.81 $mg.kg^{-1}.hour^{-1}$ with coated sample at 3rd day. Then, CO_2 content decreases extremely during later stage for control samples (Figure 6). This proves that Nopal solution had the ability to control respiratory process and prolonged the storage time.

Figure 7. Control bananas after 7th days

Figure 8. Bananas soaked in Nopal solution 100% after 7th days

4. Conclusion

The Nopal gel solution used as coating for fruit, especially banana in this case. It shows the effective system in reducing the respiration process, the weight loss; increasing the storage time and keeping the colour of fruits. In addition, Nopal gel was extracted from natural materials which do not harm to health of customers, nor prescribed dosage. We recognize that it can use widely in the postharvest technology such as edible film and can be suitable some fruits.

References

[1] Cano, M.P., De Ancos, B., Matallana, C., Camara, M., Reglero, G. & Tabera, J. (1997). Difference among Spanish and latin-american banana caltivers: morphological, chemical and sensory characteristics. Food Chemistry, 59, 411-419

[2] Chi, V. V. (1978). Phan loai thuc vat bac cao. Ha Noi: NXB DH va THCN (in Vietnamese).

[3] Condernunsi, B & Lajolo, F. (1995). Starch breakdown during banana ripening: sucrode synthase and sucrose phosphate synthase. Journal of Agriculture and Chemistry, 43, 347-351.

[4] Dinh, Q & Tiep, V. N. (2008). Bao quan va che bien rau qua. NXB Khoa hoc ky thuat Ha Noi (in Vietnamese).

[5] Dung, T. H & Hoa, T. N. (2003). Bao quan va che bien rau, qua thuong dung o Viet Nam. Ha Noi: NXB Phu nu (in Vietnamese).

[6] FAO document. (2004). Fruits of Vietnam. Regional Office for Asia and the Pacific.

[7] Hernández-Muñoz, P., Almenar, E., Del Valle, V.,Velez, D & Gavara, R. (2008). Effect of chitosan coating combined with postharvest calcium treatment on strawberry (*Fragaria x ananassa*) quality during refrigerated storage. Food Chemistry, 110, 428-435.

[8] Goulao, F & Oliveiria, C. (2008). Cell wall modification during fruit ripening: when a fruit is not the fruit. Trends in Food Science and Technology, 25.

[9] Kittur, F.S., Saroja, N & Tharanathan, H.R.N. (2001). Polysaccharide-based composite coating formulations for shelf life extension of fresh banana and mango. European Food Research and Technology, 213, 306-311

[10] Medina-Torres, L., Vernon-Carter, E.J., Vernon-Carter, J.A., Rocha-Guzman, N.E., Herrera-Valencia, E.E., Calderasa, F & Jimenez-Alvarado, R. (2011). Study of the antioxidant properties of extracts obtained fromnopal cactus (*Opuntia ficus-indica*) cladodes after convective drying. Journal of the Science of Food and Agriculture, 91, 1001–1005.

[11] Oanh, T. T. (2011). Thu nghiem chiet xuat hop chat khang khuan tu cay xuong rong Nopal. Vien co dien nong nghiep va cong nghe sau thu hoach (in Vietnamese).

[12] Persley, G.J. and George, G (1996). Banana Improvement: Research Challenges and Opportunities. Library of Congress Cataloging in Publication Data.

[13] Saenz, C., Berger, H., Corrales-Garcıa, J., Galletti, L., Garcıa-de-Cortazar, V., Higuera, I., Mondragon, C., Rodrıguez-Felix, A., Sepulveda, E % Varnero, M.T. (2006). Utilizacion agroindustrial del nopal. Boletin de Servicios Agrıcolas de la FAO. No. 162.

[14] Shahidi, F., Arachchi, J.K.V & Jeon, Y.J. (1999). Food applications of chitin and chitosans. Trends in Food Science and Technology, 10, 37-51.

[15] Shao, X.F., Tu, K., Tu, S & Tu, J. (2012). A combination of heat treatment and chitosan coating delays ripening and reduces decay in ‘Gala’ apple fruit. Journal of Food Quality, 35, 83-92.

[16] Stanley, P. B & Ellen, A. B. (1965). Relationship Between Ethylene Production And Ripening In Bananas. Botanical Gazette.

[17] Stewart, O.J., Raghavan, G.S.V., Golden, K.D. & Gariepy, Y. (2005). MA storage of cavandish banana using silicone memberane and diffusion chanel systems. Postharvest Biology and Technology, 35, 309-317.

[18] Suseno, N., Savitri, E., Sapei, L & Padmawijaya, K.S. (2014). Improving shelf-life of Cavendish Banana Using Chitosan Edible Coating. Procedia Chemistry, 9, 113–120.

[19] Tam, T. M. (1997). Bao quan va che bien nong san sau thu hoach. NXB Nong nghiep Tp. Ho Chi Minh (in Vietnamese).

[20] Tan, L.V., Hien, N.T., Hang, H.T.L & Ha, Q.L. (2008). Cong nghe bao quan va che bien rau qua. NXB Khoa hoc va ky thuat (in Vietnamese).

[21] Tan, Q.L.P., Cam, L.T., Anh, V.N., Thai, D.V & Bich, D.T. (2013). Research the influence of ethephon on the ripe ambarella (*Spondias dulcis* L.). Annals Food Science and Technology, 14, 27-33.

[22] Tuyen, N. V. (2012). Ky thuat trong mit và chuoi. Ha Noi: NXB Thanh Nien (in Vietnamese).

[23] Xua, S., Chena., X & Sun, D.W. (2001). Preservation of kiwifruit coated with an edible film at ambient temperature. Journal of Food Engineering, 50, 211-216.

[24] Wyam, H & Palmer, J.K (1964). Bananas and Plantains. Handbook of tropical foods, U.S.D.A.