STUDY ON PROLONGATION OF WATERMELON FRESH-CUT SHELF-LIFE BY OZONE TREATMENT

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ABSTRACT: *This paper focuses on the application of ozone treatment in watermelon fresh-cut processing. Our experimental results showed that ozone blowing into the package containing watermelon fresh-cut improved significantly the hygienic quality of the final product. With the ozone concentration in the blowing flux 4.2mg/dm^3 (30^{o}C, 1atm), the suitable time for watermelon fresh-cut treatment was 3 minutes. Some packaging materials were then tested for prolonging the fresh-cut shelf-life and polyethylene was selected. From the microbiological point of view, the shelf-life of watermelon fresh-cut stored at 4^{o}C was 7 days.*

Keywords: *fresh-cut, ozone treatment, polyethylene, shelf-life, watermelo.*

1. INTRODUCTION

Nowadays, minimal processing for “fresh produce” has been rapidly developed on the world. In fruit and vegetable industry, minimally processed fruits are products that maintain their attributes and quality similar to those of fresh products [6].

In tropical countries, fruit fresh-cut has been a highly consumed product. In this paper, ozone was used in watermelon fresh-cut processing as an antimicrobial agent. Firstly, the time of ozone blowing into the package containing watermelon fresh-cut was examined. Then some packaging materials were tested for prolonging the fresh-cut shelf-life.

2. MATERIALS AND METHODS

Materials:

Watermelon: a variety of Citrullus lanatus - supplied by a farm in Long An – was used in this study.

Ozone: ozone flux was produced by an ozone generator. This equipment was supplied by Yili Machinery Co., Ltd. (China).

Polystyrene (PS) and polyethylene (PE) were originated from a Taiwan company, polyvinyl chloride (PVC) – from a Japanese company.

Technological schema of watermelon fresh-cut processing:

Watermelon → Selecting → Washing by water → Peeling → Cutting → Putting on polystyrene trays → Preliminary wrapping by polyethylene or polyvinyl chloride → Ozone blowing into the package containing the fresh-cut → Complete wrapping by polyethylene or polyvinyl chloride → Storing at 4^{o}C → Watermelon fresh-cut for consumption.

Analytical methods:

Total sugar was quantified by spectrophotometric method using phenol reagent [1].

Colour was determined by Minolta Chroma Meter (Japan) with CIE colour systems. Three parameters were used: L* for lightness, a* for redness and b* for yellowness. For comparing the colour intensity difference between two samples, a method proposed by McGuire (1992) was used [4].

Aerobic bacteria, yeasts and molds were quantified by plate count agar methods [1]

Sensory quality was analyzed by triangular method [5]

Statistical treatment

All the experiments were realized in triplicate. The obtained results were subjected to analysis of variance (ANOVA), $p<0.05$ using Statgraphics plus, version 3.2.

3. RESULTS AND DISCUSSION

3.1. Influence of blowing time of ozone flux on the watermelon fresh- cut quality

In this experiment, ozone flux was directly blown into the package containing watermelon fresh-cut. The ozone concentration in the blowing flux was 4.2mg/dm^3 (30^{o}C, 1atm). Four samples T1, T2, T3 and C1 were examined. The blowing time of samples T1, T2 and T3 was 1, 2 and 3 minutes, respectively. C1 was the control sample – without ozone treatment. All samples were then stored at 4^{o}C for 6 days. The microbiological characteristics of the watermelon fresh-cut are presented in Figure 1 and 2.

It can be noted that ozone blowing into the package containing watermelon fresh-cut decreased the number of microbial cells in the product. The longer the treatment time, the lower the number of bacteria, yeasts and molds in the product. In addition, during the storage, the growth of bacteria, yeasts and molds in samples T1, T2 and T3 was slower than that in control sample C1. It can be explained that ozone has a bactericidal effect [2]. The same results were also observed in the study of pineapple fresh-cut treatment by ozone [3].

According to Vietnam standards, the number of bacteria in fruit fresh-cut should be equivalent or lower than 10^{4}cfu/g. Our results showed that when the ozone blowing time was 3 minutes, the number of bacteria did not exceed 104cfu/g after 6 day - storage.

The evolution of vitamin C content and pH value in the fresh-cut during the storage is visualized in Figure 3 and 4, respectively. At the beginning of the storage, the vitamin C content in the samples treated by ozone was a little lower in comparison with that in the control sample (Figure 3). It was due to the oxidation reaction of vitamin C. However, ozone treatment did not influence on pH value of the fresh-cut (Figure 4). During the storage, the vitamin C content and pH value in samples T1, T2 and T3 decreased less than those in control sample C1 (Figure 3 and 4). It can be explained that lower microbial growth in the samples treated by ozone slowed down the decrease in vitamin C content and pH value in the watermelon fresh-cut. The longer the time of ozone treatment, the less the decrease in vitamin C content and pH value.

Colour of the product treated by ozone after 0 day – storage and 6 day - storage is showed in Figure 5 and 6, respectively. It can be noted that ozone treatment reduced slightly the redness (a* value) in the watermelon fresh-cut (Figure 5). According to Perkins – Veazie et al., lycopene was the principle pigment in watermelon. During the treatment by ozone, lycopene could partially be oxidized [7]. However, the analysis of variance showed that colour change in the fresh-cut during 6 day – storage was insignificant.

It can be concluded that the suitable time for watermelon fresh-cut treatment was 3 minutes. In this case, after 6 day – storage at 4^{o}C, the number of bacteria in the product did not exceed the present regulation.

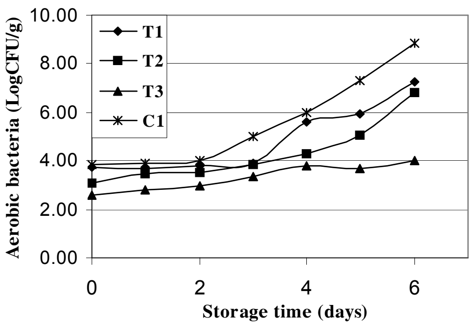

Figure 1. Bacterial growth in the watermelon fresh-cut during the storage at 4°C. Treatment time of T1, T2 and T3 samples was 1, 2 and 3 minutes, respectively. C1 was the control sample.

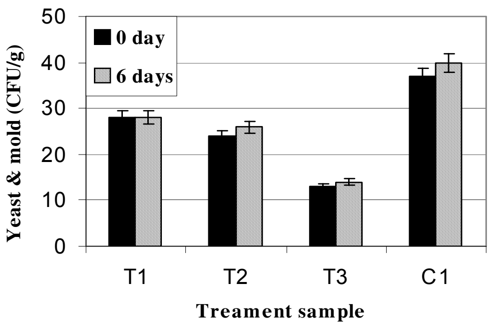

Figure 2. Yeast and mold quantification in the watermelon fresh-cut after 0 day - storage and 6 day - storage at 4°C. Treatment time of T1, T2 and T3 samples was 1, 2 and 3 minutes, respectively. C1 was the control sample.

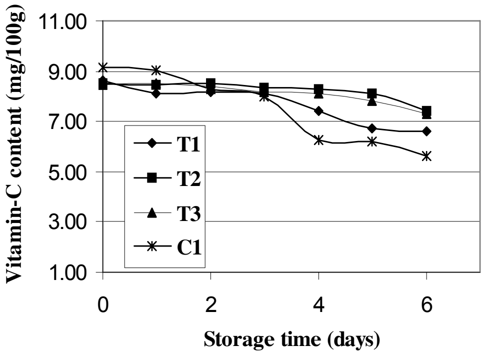

Figure 3. Evolution of vitamin C content in the watermelon fresh-cut during the storage at 4°C. Treatment time of T1, T2 and T3 samples was 1, 2 and 3 minutes, respectively. C1 was the control sample.

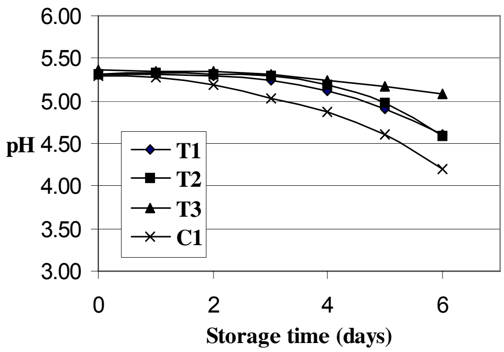

Figure 4. Evolution of pH in the watermelon fresh-cut during the storage at 4°C. Treatment time of T1, T2 and T3 samples was 1, 2 and 3 minutes, respectively. C1 was the control sample.

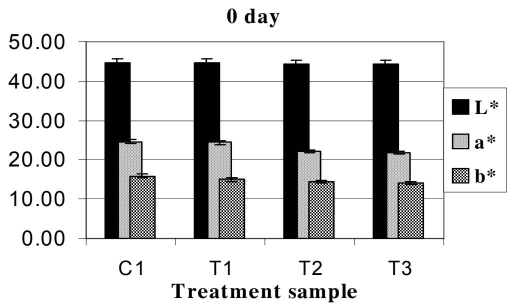

Figure 5. L* (lightness), a* (redness) and b* (yellowness) values of watermelon fresh-cut after ozone treatment. Treatment time of T1, T2 and T3 samples was 1, 2 and 3 minutes, respectively. C1 was the control sample.

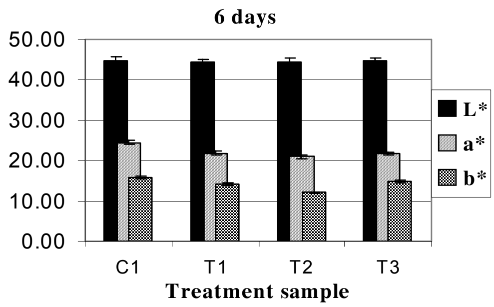

Figure 6. L* (lightness), a* (redness) and b* (yellowness) values of watermelon fresh-cut after 6 day - storage at 4°C. Treatment time of T1, T2 and T3 samples was 1, 2 and 3 minutes, respectively. C1 was the control sample.

3.2. Influence of packaging materials on the watermelon fresh cut quality

In this experiment, the package containing watermelon fresh-cut was blown by ozone flux during 3 minutes. The ozone concentration in the blowing flux was 4.2mg/dm^3 (30^{o}C, 1atm). Some popular polymer materials were used for the fresh-cut wrapping: polyethylene (PE) and polyvinyl chloride (PVC). C2 was the control sample – without packaging. All samples were then stored at 4oC. The results are presented in Figure 5, 6, 7 and 8.

The microbial growth in watermelon fresh-cut in the packaging samples was significantly lower than that in control sample C2 (Figure 7 and 8). It was due to lower oxygen content in the packaging samples for microbial multiplication. In addition, microbial re-infection from the environment into the packaging samples was limited. From the microbiological point of view, packaging fruit fresh-cut was always better than non-packaging fruit fresh-cut. After 7 day – storage, the sample wrapped by polyethylene had the lowest number of bacteria, yeasts and molds and these values did not exceed the present regulations (10^{4}cfu/g).

Weight loss was observed during the storage of watermelon fresh-cut (Figure 9). It was due to water evaporation. The highest weight loss was observed in control sample C2 (without packaging). The sample wrapped by polyethylene had the lowest weight loss.

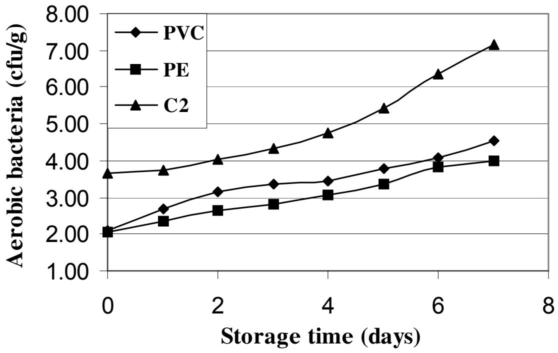

Figure 7. Influence of packaging material on bacterial growth in the watermelon fresh-cut. C2 was the control sample.

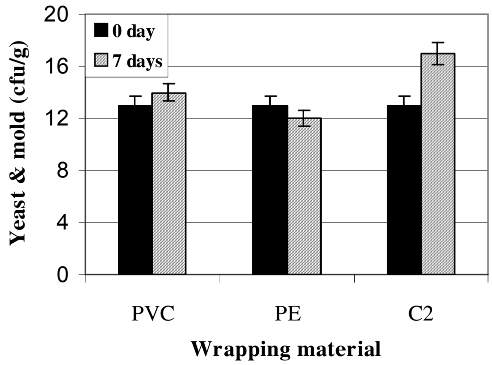

Figure 8. Influence of packaging material on yeast and mold growth in the watermelon fresh-cut. C2 was the control sample.

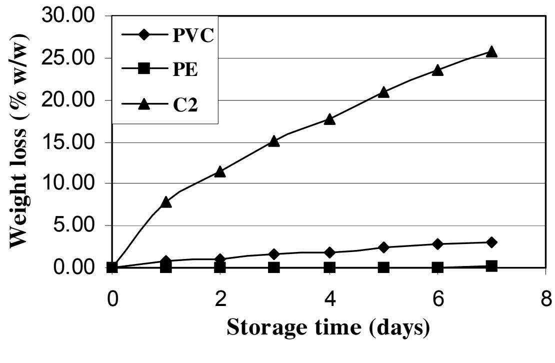

Figure 9. Evolution of weight loss of the watermelon fresh-cut wrapped by different materials. C2 was the control sample.

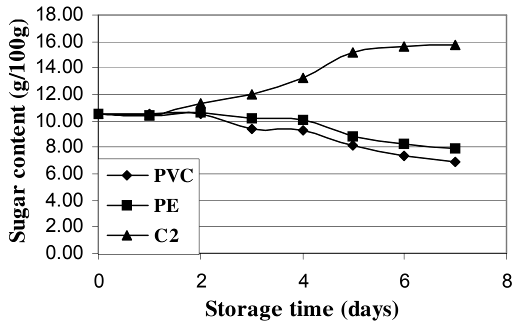

Figure 10. Evolution of total sugar content in the watermelon fresh-cut wrapped by different materials. C2 was the control sample.

Figure 10 showed the change in total sugar content (expressed by g/100g product) during the storage. After 7 days, the sugar content in control sample C2 increased highly due to water evaporation. On the contrary, the sugar content in the packaging samples reduced slightly. Perhaps, micro-organisms utilized partially sugars in the watermelon fresh-cut for their growth. The analysis of variance showed that after 7 day – storage, the difference in sugar content in the two packaging samples was insignificant. So it can be concluded polyethylene was the suitable packaging material in watermelon fresh-cut processing.

3.3. Sensory evaluation

During the storage of watermelon fresh-cut at 4^oC, samples were taken everyday for sensory evaluation. Our evaluation focused on odour and taste of the fresh-cut. The obtained results showed that the sensory properties of the 3 day – storage sample and the 0 day – storage sample (control sample) was similar ($P<0.05$). However, after 4 day – storage, people could perceive the difference in sensory properties of the watermelon fresh-cut in comparison with the control sample.

4. CONCLUSION

Ozone blowing into the package containing watermelon fresh-cut was a suitable treatment method for prolonging the product shelf-life. In comparison with the traditional method based on washing fresh-cut in ozone solution, our method was more simple and easy realizing. After 3 day – storage at 4^oC, the sensory quality of the watermelon fresh-cut treated by ozone was similar to that of the fresh sample (without storage). However, from the microbiological point of view, the shelf-life of watermelon fresh-cut stored at 4^oC was 7 days.

NGHIÊN CỨU KÉO DÀI THỜI GIAN BẢO QUẢN DƯA HẤU TƯƠI CẮT MIẾNG BẰNG PHƯƠNG PHÁP XỬ BÝ OZONE

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TÓM TẮT: *Trong nghiên cứu này, chúng tôi sử dụng phương pháp xử lý bằng ozone để sản xuất dưa hấu tươi cắt miếng. Kết quả thực nghiệm cho thấy việc thổi dòng khí ozone vào bao bì chứa dưa hấu cắt miếng đã cải thiện đáng kể chất lượng vệ sinh của sản phẩm. Với nồng độ ozone trong dòng khí thổi là 4.2mg/dm3 (30^oC, 1atm), thời gian thổi khí thích hợp để xử lý dưa hấu tươi cắt miếng là 3 phút. Tiếp theo, chúng tôi thử sử dụng một số loại vật liệu bao bì khác nhau để bao gói sản phẩm nhằm mục đích kéo dài thời gian bảo quản. Bao bì polyethylene cho kết quả tốt nhất. Sau 7 ngày bảo quản ở 4^oC, sản phẩm dưa hấu tươi cắt miếng vẫn đạt các chỉ tiêu về vi sinh vật.*

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