ผลของการรมโอโซนต่อคุณภาพขนุนตัดแต่งพร้อมบริโภค
Ozone Fumigation Affecting Postharvest Quality of Fresh-cut Jackfruit

Meidita Lisvioni Rahmi[1] อภิรดี อุทัยรัตนกิจ[1,2] ผ่องเพ็ญ จิตอารีย์รัตน์[1,2] ณัฏฐา เลาหกุลจิตต์[3] สุกัญญา เอี่ยมลออ[4] และ อรพรรณ เสลามาศสกุล[3]

Meidita Lisvioni Rahmi[1], Apiradee Uthairatanakij[1,2], Pongphen Jitareerat[1,2], Natta Laohakunjit[1], Sukanya Aim-laor[4] and Orapun Salamassakul[3]

บทคัดย่อ

ในปัจจุบันผลไม้ตัดแต่งมีความต้องการเพิ่มขึ้นเนื่องจากผู้บริโภคให้ความใส่ใจเรื่องสุขภาพมากขึ้น อย่างไรก็ตามการปนเปื้อนของจุลินทรีย์นับเป็นข้อจำกัดที่สำคัญของอายุการวางจำหน่ายผลิตภัณฑ์ โอโซนนับเป็นวิธีหนึ่งที่ใช้ในการกำจัดจุลินทรีย์ปนเปื้อนในอุตสาหกรรม งานวิจัยนี้มีวัตถุประสงค์ศึกษาความเข้มข้นของโอโซนต่อคุณภาพในการรับประทานขนุนตัดแต่ง โดยนำเนื้อขนุนตัดแต่งพันธุ์ทองพลอยมารมด้วยแก๊สโอโซน ความเข้มข้น 0 (ชุดควบคุม), 200, 400 และ 800 มิลลิกรัมต่อลิตร เป็นเวลา 5 นาที และบรรจุ 200 กรัมในถาด polypropylene ที่ปิดผนึก เก็บรักษาที่อุณหภูมิ 4 องศาเซลเซียส ความชื้นสัมพัทธ์ 80-85% นาน 12 วัน พบว่า การรมโอโซน 800 มิลลิกรัมต่อลิตร ทำให้ขนุนตัดแต่งมีความแน่นเนื้อดีกว่าชุดควบคุม และมีกิจกรรมการต้านอนุมูลอิสระ ปริมาณสารประกอบฟีนอลทั้งหมดและประมาณสารฟลาโวนอยด์ทั้งหมดมากที่สุด อย่างไรก็ตามโอโซนไม่มีผลต่อค่าสีเนื้อขนุน ปริมาณกรดที่ไทเทรตได้ ปริมาณของแข็งที่ละลายน้ำได้ทั้งหมด และปริมาณวิตามินซี

คำสำคัญ: ขนุน ผลไม้ตัดแต่ง สารต้านอนุมูลอิสระ โอโซน

Abstract

Nowadays, the demand for fresh-cut products increases because consumers are concerned about health and convenient. However, the product shelf life is limited due to microbial contamination. Ozone has been used as an alternative sanitizing technology in the fresh produce industry. This research aimed to investigate the effect of ozone concentrations on maintaining the eating quality of fresh-cut jackfruit cv. Thong ploy Fresh-cut jackfruits were fumigated with 0 (control), 200, 400, and 800 mg·L^{-1} ozone gas for 5 min. 200 grams of samples were packed in a polypropylene (PP) tray and top-sealed with PP film. All samples were stored at 4 ℃ and 80-85% RH for 12 days. The ozone treatment at 800 mg·L^{-1} significantly maintained the fruit firmness, which was higher than the control. Moreover, antioxidant activities, total phenolic contents, and total flavonoid contents were the highest in 800 mg·L^{-1} ozone-treated samples. However, all ozone treatments did not affect pulp color (L* a*, b*, and h°), titratable acidity, total soluble solids, and vitamin C.

Keywords: antioxidant, fresh-cut, jackfruit, ozone

Introduction

Jackfruit is a popular fruit and has high commercial value. However, handling and marketing of jackfruit is very difficult due to fruit size being large and then difficult to peel (Sudheer *et al*., 2016). Optimizing minimal processing techniques for large jackfruit can increase ease of handling, and transportation

[1] คณะทรัพยากรชีวภาพและเทคโนโลยี มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี, 49 ถนนบางขุนเทียนชายทะเล25 แขวงท่าข้าม เขตบางขุนเทียน กรุงเทพมหานคร 10150

[1] School of Bioresources and Technology, King Mongkut's University of Technology Thonburi 49 Tientalay 25, Thakam, Bangkhuntien, Bangkok 10150, Thailand

[2] ศูนย์นวัตกรรมเทคโนโลยีหลังการเก็บเกี่ยว กองส่งเสริมและประสานเพื่อประโยชน์ทางวิทยาศาสตร์ วิจัยและนวัตกรรม สำนักงานปลัดกระทรวงการอุดมศึกษา วิทยาศาสตร์ วิจัยและนวัตกรรม 10400

[2] Postharvest Technology Innovation Center, Science, Research and Innovation Promotion and Utilization Division, Office of the Ministry of Higher Education, Science, Research and Innovation 10400, Thailand

[3] สถาบันพัฒนาและฝึกอบรมโรงงานต้นแบบ มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี แขวงท่าข้าม เขตบางขุนเทียน กรุงเทพมหานคร 10150
Pilot Plant Development and Training Institute, King Mongkut's University of Technology Thonburi, Thakam, Bangkhuntien, Bangkok 10150, Thailand

[4] สำนักวิชาเทคโนโลยีการเกษตร มหาวิทยาลัยเทคโนโลยีสุรนารี 111 ถ. มหาวิทยาลัย ต. สุรนารี อ. เมือง จ. นครราชสีมา 30000

[4] Institute of Agricultural Technology, Suranaree University of Technology, 111 University Avenue, Suranaree Sub-District, Muang Nakhon Ratchasima District, Nakhon Ratchasima 30000, Thailand

efficiency. However, processing activities such as washing, sorting, peeling, and cutting are highly susceptible to accelerated senescence and microbial spoilage of fresh-cut jackfruit, leading to tissue softening, flavor loss, color loss, browning, and decaying (Sudheer *et al*., 2019; Saxena *et al*., 2009). Therefore, technology is needed that can maintain the quality of fresh-cut jackfruit. Ozone technology extends food shelf life by improving safety without compromising quality or harming the environment, as ozone decomposes quickly into oxygen at room temperature (Guzel-Seydim *et al*., 2004) and is recognized as safe (GRAS) by the FDA. Additionally, ozone can induce signal molecules in plants which can stimulate secondary metabolites related to genetic and metabolic antioxidants (Sudheer *et al.,* 2016). For example, Wang *et al*. (2022) found that ozone treatment (1 mg/L) increased the shelf life and antioxidant capacity of fresh-cut kiwifruit, while Sripong *et al*. (2022) reported that ozone treatment (500 and 900 ppm) reduced bacteria and enhanced the quality, antioxidant activities, and phenolics content in fresh-cut durian. However, the effect of ozone fumigation on fresh-cut jackfruit quality and its bioactive compound has not been reported yet. Therefore, this study aims to investigate the effect of gaseous ozone concentrations on maintaining the quality of fresh-cut jackfruit during storage.

Materials and Methods

1. Preparation of fresh-cut jackfruit

Jackfruits cv. Thong ploy at 80% maturity were purchased from the farmer and transported to the physiology laboratory at King Mongkut's University of Technology Thonburi. After the fruits ripened, they were peeled in the air-conditioned room (18°C) under hygienic conditions The fresh-cut jackfruits were selected and packaged in a PP tray box with a dimension of 18 cm x 13 cm x 4.5 cm (200 g of sample).

2. Effect of ozone concentrations on postharvest quality of fresh-cut jackfruit

The prepared samples were fumigated with 0 (control or untreated sample), 200, 400, and 800 mg L^{-1} ozone gas for 5 min. All samples were kept at 4°C with 80-85% RH for 12 days and randomly taken to determine postharvest quality every three days, including firmness (N), total soluble solids (TSS-Brix), titratable acidity (% citric acid), color (*L, a*, b*,* chroma, hue angle (h°), total phenolic contents (TPC) (Singleton and Rossi, 1965), total flavonoid contents (TFC) (Shafiee *et al*., 2021), Vitamin C (Roe *et al*., 1948), and antioxidant activity using 2,2-Diphenyl-1-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) methods (Pintatum *et al.,* 2014).

Results

The effect of ozone on postharvest quality in fresh-cut jackfruit during storage is shown in Fig.1. Fruit firmness significantly decreased during storage in all treatments. At day 12, the ozone-treated sample had the higher firmness than the control (20.70 N), especially ozone at 800 mg L^{-1} (26.23 N) (Fig. 1A). TSS of fresh-cut jackfruit increased during storage in all treatments. The ozone-treated sample had higher TSS than the control, but there was no significant difference. On day 12, TSS increased to 22.25, 22.50, 23.25 and 23.75 °Brix in the control, 200, 400, and 800 mg L^{-1}, respectively (Fig. 1B). Titrable acidity (TA) tended to decrease in all treatments during storage. ozone-treated samples had higher TA than the control. On day 12, the values of *L*, a*, b*,* chroma, and *h°* were high at ozone 800 mg L^{-1}, but not significantly different between treatments (Table 1). TPC and TFC increased in all treatments during storage. Ozone-treated samples presented the highest TPC and TFC, especially 800 mg L^{-1} when compared to the control. However, vitamin C decreased in all treatments during storage. On day 12, ozone-treated samples had higher vitamin C than the control. In addition, DPPH and FRAP activities decreased during storage in all treatments with no significant differences (Table 1).

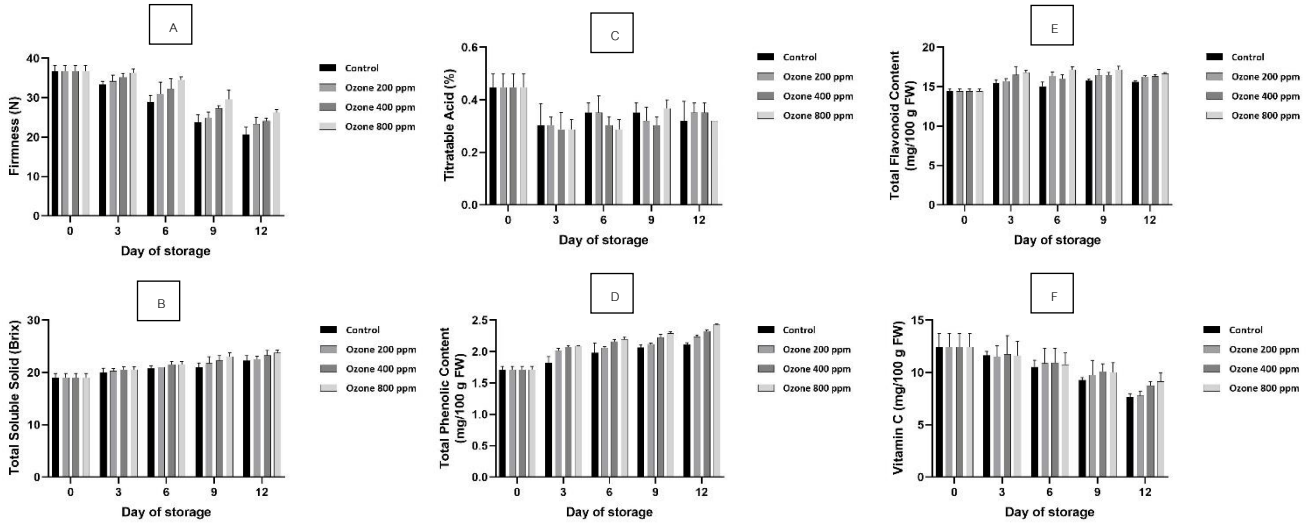

Figure 1. Effects of ozone treatments on firmness (A), total soluble solids (B), titratable acidity (C), total phenolic contents (D), total flavonoid contents (E), vitamin C (F) of fresh-cut jackfruit stored at 4°C for 12 days.

Table 1. Effects of ozone concentrations on DPPH, FRAP, and color of fresh-cut jackfruit stored at 4°C

Treatments	DPPH (%Inhibition)	FRAP (μmol/100 g)	*L**	*a**	*b**	Chroma	Hue
Control	22.72A	0.93B	70.97A	0.30A	59.02A	59.67A	81.57A
Ozone 200 mg L^{-1}	23.06A	0.96AB	70.38A	0.31A	59.51A	60.11A	81.88A
Ozone 400 mg L^{-1}	23.66A	1.01AB	72.54A	0.29A	60.97A	61.66A	81.46A
Ozone 800 mg L^{-1}	24.07A	1.04A	73.74A	0.34A	62.30A	62.93A	81.95A

Values are the means of three replications. Mean values labeled with different letters are significantly different as determined by least significant differences analysis ($P \leq 0.05$).

Discussion

Rapid deterioration and quality changes are serious problems of fresh-cut fruit. Cutting can increase oxidative stress, resulting in not only increasing microbial population, excessive softening, and tissue browning, but also significantly reducing the content of phytochemicals such as phenolic, ascorbic acids, and flavonoids (Saxena *et al.,* 2009). Therefore, the effect of ozone on maintaining the quality of fresh-cut jackfruit was investigated. The results showed that ozone treatment with high concentration could maintain the quality of fresh-cut jackfruit. Ozone at 800 mg.L^{-1} could maintain the firmness of fresh-cut jackfruit from day 0 until day 9. This result may be due to ozone inhibiting the activities of cell wall degrading enzymes, such as polygalacturonase, and pectin methylesterase (Minas *et al*., 2012). The other effect of ozone was in antioxidants, which ozone treatment enables a protective mechanism against stress antioxidants in fresh-cut jackfruit. Phenolic content, flavonoid content, ascorbic acid, and total antioxidant capacity were higher in fresh-cut jackfruit after ozone treatment. This may be due to ozone-induced oxidative stress, enhancing non-enzyme antioxidant accumulation (Sripong *et al*., 2022). The higher TPC is linked to ozone's hyper-reactivity and activation of phenylpropanoid metabolism (Wang *et a*l., 2022), therefore can activate of phenylalanine ammonia-lyase enzyme (Ong *et al*., 2012). Moreover, ozone, as an abiotic stressor, may increase flavonoid content by stimulating plant cell activities (Wang *et al.,* 2022). Furthermore, antioxidant capacity in ozone-treated increased compared to the control, this may be due to stress caused by a strong oxidizing agent as

ozone activates the antioxidant system resulting in the enhancing antioxidant status (Gonzales-Aguilar *et al*., 2010).

Conclusion

The fumigation of ozone gas at 800 $mg.L^{-1}$ maintained the quality of fresh-cut jackfruit by reducing loss of firmness, and enhancing the total phenolic contents and flavonoid contents. However, ozone concentrations did not affect the changes in color, total soluble solids, and titratable acidity when compared to the control sample.

Acknowledgments

This research was supported by KISP scholarship, KMUTT. We appreciate the Postharvest Technology Innovation Center, Science, Research and Innovation Promotion and Utilization Division, Office of the Ministry of Higher Education, Science, Research and Innovation, Bangkok for providing us with scientific facilities, and also thank Mr. Apichai Jenjob, Postharvest Physiology Laboratory members, KMUTT, for helping and supporting during this work.

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