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Postharvest Quality and Shelflife of Bitter Gourd (*Momordica Charantia*) at Varying Ultraviolet-C Illumination

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Abstract

Bitter gourd is highly perishable and is susceptible to senescence showing early signs of weight loss, yellowing, and softening. A study was conducted to determine the optimum exposure period to ultraviolet-C on the postharvest quality and shelflife of bitter gourd, investigate the chemical characteristics of bitter gourd as influenced by UV-C illumination, and evaluate the effects of UV-C illumination on the postharvest quality and shelflife of bitter gourd. An experiment was laid out in a Completely Randomized Design (CRD) with five samples per treatment and replicated three times. The treatments were designated as follows: T0 – Control, T1 – 30 mins. UV-C + Ambient, T2 – 60 mins. UV-C + Ambient, T3 – Without UV-C + 20°C, T4 – 30 mins. UV-C + 20°C and T5 – 60 mins. Results revealed that UV-C illumination at varying periods and storage conditions significantly affected the chemical characteristics, postharvest quality, and shelf life of bitter gourd. Fruits subjected to UV-C for 30 minutes and stored at 20°C significantly reduced weight loss, prolonged visual quality and shelf life, and delayed color changes or yellowing after 8 days of storage. Furthermore, oxidation-reduction potential (mV), pH, and chemical characteristics such as TSS and Vitamin C were significantly affected by different UV-C exposure and storage conditions of bitter gourd. UV-C-treated fruits stored at 20°C obtained the highest initial and final oxidation-reduction potential, pH level, and Vitamin C content. Further, the latter treatment had the highest initial and final oxidation-reduction potential, pH level, and Vitamin C content. Fruits subjected to UV-C for 30 minutes and stored at 20°C significantly prolonged the shelf life and maintained the quality of bitter gourd.

Keywords: Bitter gourd, ultraviolet-C, shelflife, chemical characteristics

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INTRODUCTION

Bitter gourd, scientifically known as (*Momordica charantia* L.) belongs to the Cucurbitaceae family and is widely grown for its edible fruits. In various regions of the world, it is called as bitter melon, balsam pear, karela, african cucumber, and bitter cucumber (Devi et al., 2019). Due to its hypoglycemic function, bitter gourd is a well-known vegetable for treating a variety of diseases, particularly diabetes. It has immense medicinal properties due to the presence of beneficial phytochemicals, which are known to have antibiotic, antimutagenic, antioxidant, antiviral, antidiabetic, and immunity-enhancing properties (Grover and Yadav, 2004).

A compound known as momordicin and charantin in the bitter gourd is used to treat diabetes by reducing blood sugar levels (Lotlikar et al., 1966). In addition to some minerals such as iron, zinc, phosphorus, sodium, and magnesium, it also provides a significant amount of vitamin C, which constitutes about 55% of the fruit's total vitamin content (Devi et al., 2019). However, high moisture content, large surface area to volume ratio, thin cuticle, and corrugated fruit surface of bitter gourd reduces its shelf life to 4 days under ambient conditions (Preetha et al., 2015). Bitter gourd fruit is perishable and is highly susceptible to senescence showing early signs of yellowing, softening, and red pigmentation in the arils if stored under ambient conditions (Zong et al., 1995). Hence, low-temperature storage could be a potential means of prolonging the shelf life of bitter gourd (Mohammed and Wickham, 1993). A number of studies were performed so far to extend the shelf life of bitter gourds, including the postharvest treatment of 1- MCP @ 5 L L 1 (Han et al., 2015), edible coating with carnauba wax (1.0%) (Bhattacharjee and Dhua, 2017), and improved atmospheric packaging (Preetha et al., 2015). Recently, green technologies are receiving more attention due to their chemical-free composition and lack of negative effects on human health and the environment. One such alternative for shelflife extension could be UV-C illumination. Studies have demonstrated that ultraviolet light significantly improved the quality of various postharvest fruits and vegetables, such as three-leaf vegetables (Liao et al., 2016), broccoli (Formica-Oliveira, Díaz-López, Artés, and Artés-Hernández 2017), apricot (Taze and Unluturk, 2018) and pineapple (Sari, Setha and Naradisorn, 2016). Additionally, it has been found to inhibit senescence, enhance various phytochemical components (phenols and antioxidants), promote the accumulation of secondary metabolites, and activate various defense-related compounds, all of which result in pathogen resistance and ultimately lengthen the food's shelf life (Martinez-Sanchez et al., 2019). Hence, a study was conducted to determine the effect of varying UV-C illumination on the postharvest quality, chemical characteristics, and shelf life of bitter gourd.

MATERIAL and METHOD

Fruit Samples and Sample Preparation

Bitter gourds were procured from a commercial vegetable farm at Barili, Cebu. The fruits were harvested at the mature green stage and carried out carefully to minimize mechanical injuries. Fruits were placed in a plastic crate and transported to the Center for Studies in Biotechnology – Cebu Technological University Barili Campus. Uniform and healthy fruits were randomly distributed on each treatment.

UV-C Treatment

Sample fruits were precooled to ambient condition after harvesting. The UV-C treatment was carried out in a sealed container that measured 40 cm (W) x 65 cm (L) x 60 cm (H) and was fitted with a germicidal tube (UV 20 W; 61.5 cm length; 28 mm diameter/T8, Philips, Poland) that emitted radiation at a wavelength of 253.4 nm. To maintain uniform light dispersion inside the chamber, aluminum foil was used as the interior covering and black paper as the exterior. The UV chamber was turned on for 15 minutes prior to usage to stabilize the UV-C dose. Uniform size of bitter gourd fruit was selected and kept at 25 cm distance from the light source. Following a review of earlier studies (Imaizumi et al., 2018; Pinheiro et al., 2015) in which cucumber, persimmon, and tomato were exposed to various UV-C doses to investigate its role in shelflife extension and phytonutrient retention, two different exposure times (30 minutes and 60 minutes) were chosen.

To guarantee that the fruit received the full amount of UV-C exposure, fruits were arranged in a single layer at a constant spacing (15 cm) and rotated at a 180° angle halfway through the treatment. Fruits were kept in ambient and low-temperature storage at 20°C after UV-C lighting.

Experimental Design

A study was laid out in a simple Completely Randomized Design (CRD) with 5 samples per treatment replicated 3 times. The treatments were designated as follows: T0 – Control; T1 – 30 mins. UV-C + Ambient, T2 –60 mins. UV-C + Ambient, T3 – Without UV-C + 20°C, T4 – 30 mins. UV-C + 20°C and T5 – 60 mins. UV-C + 20°C. All data were subjected to Analysis of variance (ANOVA) and treatment means comparison by the Least Significant Difference (LSD) was performed using STAR (Statistical Tool for Agricultural Research) program.

Physical and Chemical Characteristics

Evaluation of physical characteristics of bitter gourd was done every other day, including weight loss, visual quality rating, yellowing index, and shelflife. In addition, initial and final chemical characteristics were obtained, including pH, total soluble solids, titratable acidity, vitamin C, and oxidation-reduction potential.

RESULTS and DISCUSSION

Physiological Weight Loss

As shown in Table 1, physiological weight loss increases as the storage period increases, regardless of different UV-C exposure and storage conditions. Results revealed a significant effect on the weight loss of bitter as influenced by different UV-C treatment and storage conditions from day 2 to day 6. Fruits treated with UV-C for 30 minutes and stored at 20°C exhibited the least weight loss among treatments after 8 days of storage. A similar study conducted by Prajapati et al. (2021) found that UV-C treatment stored at 10°C can significantly reduce weight loss in bitter gourd. On the other hand, bitter gourd fruits stored at ambient conditions regardless of UV-C treatment obtained the highest rate of physiological weight loss after 4 days of storage. Comparable effects can be observed on fruits treated for 60 minutes UV-C and stored at 20°C. The respiration and transpiration of water from the product are attributed to the physiological weight loss of the samples (Wills et al., 1989).

Visual Quality Rating

Visual quality rating of bitter gourd fruits subjected to varying UV-C illumination and storage conditions is presented in Table 2. After 4 days of storage, bitter gourd fruits stored at ambient conditions regardless of UV-C treatment had significantly reduced visual quality ratings at 3.40, 3.80, and 3.67, respectively. Visual quality rating of 3 described as poor, defects serious and limit marketability. In contrast, after six days of storage, UV-C treated fruits for 30 minutes stored at 20°C prolonged the visual quality rating to 5.40. Comparable effects were observed on fruits stored at 20°C regardless of UV-C treatment. However, it was evident that the visual quality rating of bitter gourd fruits consistently decreased to 3 after 8 days of storage.

Table 1. Cumulative weight loss (%) of bitter gourd *(Momordica charantia* L.*)* as influenced by different UV-C doses and storage conditions.

Treatments	Cumulative Weight Loss			
	Day 2	Day4	Day 6	Day 8
T0 – Control	11.9ab	27.34a	–	–
T1 – 30 mins. UV-C + Ambient	12.12a	19.78b	–	–
T2 –60 mins. UV-C + Ambient	11.91ab	20.67ab	–	–
T3 – Without UV-C + 20°C	10.30bc	18.97b	32.84	–
T4 – 30 mins. UV-C + 20°C	9.28c	18.64b	31.57	37.61
T5 – 60 mins. UV-C + 20°C	11.61ab	19.62b	31.86	–
% CV	5.68	12.41	4.43	–

Means within the same column followed by a common letter and/ or without letter designation are not significantly different from each other at 5 % level of significance

Table 2. Visual quality rating of bitter gourd *(Momordica charantia* L.*)* as influenced by different UV-C doses and storage conditions.

Treatments	Visual Quality Rating				
	Day 0	Day 2	Day 4	Day 6	Day 8
T0 – Control	9.00	5.93b	3.40b	–	–
T1 – 30 mins. UV-C + Ambient	9.00	5.93b	3.80b	–	–
T2 –60 mins. UV-C + Ambient	9.00	5.80b	3.67b	–	–
T3 – Without UV-C + 20°C	9.00	7.00a	6.47a	4.33b	–
T4 – 30 mins. UV-C + 20°C	9.00	7.00a	6.87a	5.40a	3.67
T5 – 60 mins. UV-C + 20°C	9.00	7.00a	6.33a	4.47b	–
% CV		3.27	4.90	9.34	

Means within the same column followed by a common letter and/ or without letter designation are not significantly different from each other at 5 % level of significance

Yellowing

Bitter gourd fruits gradually changed color from green to yellow during storage (Table 3). Results indicated that fruits subjected to UV-C for 30 minutes stored at 20˚C delayed color changes after 8 days of storage. Comparable effects were observed in fruits stored at 20°C regardless of UV-C treatment. In contrast, untreated fruits stored at ambient conditions, regardless of UV-C treatment, significantly increased color changes.

Shelflife

A significant difference was observed in the shelflife of bitter gourd fruits as influenced by different UV-C illumination and storage condition (Figure 1). Fruits subjected to UV-C for 30 minutes stored at 20˚C significantly prolonged the shelf life for 8 days. In addition, fruits stored at 20°C regardless of UV-C treatment extended shelflife for 6 days. Bautista (1990) mentioned that produce stored in low temperature or cold storage with higher relative humidity is generally required to reduce the rate of the deteriorative process such as respiration and transpiration, which improves the visual quality appearance, thereby prolonging the shelflife of the produce.

On the other hand, fruits stored at ambient condition regardless of UV-C treatment shortened postharvest life for 4 days. Preetha et al., (2015) indicate that bitter gourd has a shelf life of just four days under ambient conditions due to its high moisture content, large surface area to volume ratio, thin cuticle, and corrugated fruit surface. According to Zong et al. (1995), if stored under tropical ambient conditions, bitter gourd fruit is highly susceptible to senescence and will exhibit early signs of yellowing, softening, and red pigmentation in the arils. As a result, low-temperature storage may be an alternative method of extending bitter gourd's shelf life (Mohammed and Wickham, 1993).

Figure 1. Visual quality rating of bitter gourd *(Momordica charantia* L.*)* as influenced by different UV-C doses and storage conditions. (A) Day 0; (B) Day 4; T0 – Control; T1 – 30 mins. UV-C + Ambient; T2 –60 mins. UV-C + Ambient; T3 – Without UV-C + 20°C; T4 – 30 mins. UV-C + 20°C; T5 – 60 mins. UV-C + 20°C.

Table 3. Yellowing index of bitter gourd *(Momordica charantia* L.*)* as influenced by different UV-C doses and storage conditions.

Treatments	Yellowing Index				
	Day 0	Day 2	Day 4	Day 6	Day 8
T0 – Control	1.00	2.47b	3.53	–	–
T1 – 30 mins. UV-C + Ambient	1.00	2.60b	3.60	–	–
T2 –60 mins. UV-C + Ambient	1.00	2.60b	3.60	–	–
T3 – Without UV-C + 20°C	1.00	2.00a	3.27	3.70	–
T4 – 30 mins. UV-C + 20°C	1.00	2.00a	2.93	3.30	4.50
T5 – 60 mins. UV-C + 20°C	1.00	2.00a	3.33	3.83	–
% CV		5.48	8.14	8.74	

Means within the same column followed by a common letter and/ or without letter designation are not significantly different from each other at 5 % level of significance

Chemical characteristics (TSS, TA and Vitamin C)

Chemical characteristics (TSS, TA and Vitamin C) of bitter as influenced by different UV-C exposure and storage conditions is presented in Table 4. Significant differences in initial and final total soluble solids were observed on bitter gourd fruits as influenced by UV-C exposure and storage conditions. Untreated fruits stored at 20°C obtained the highest level of total soluble solids, which were comparable to other treatments. Meanwhile, fruits treated with UV-C for 60 minutes and stored at ambient conditions attained the lowest total soluble solids.

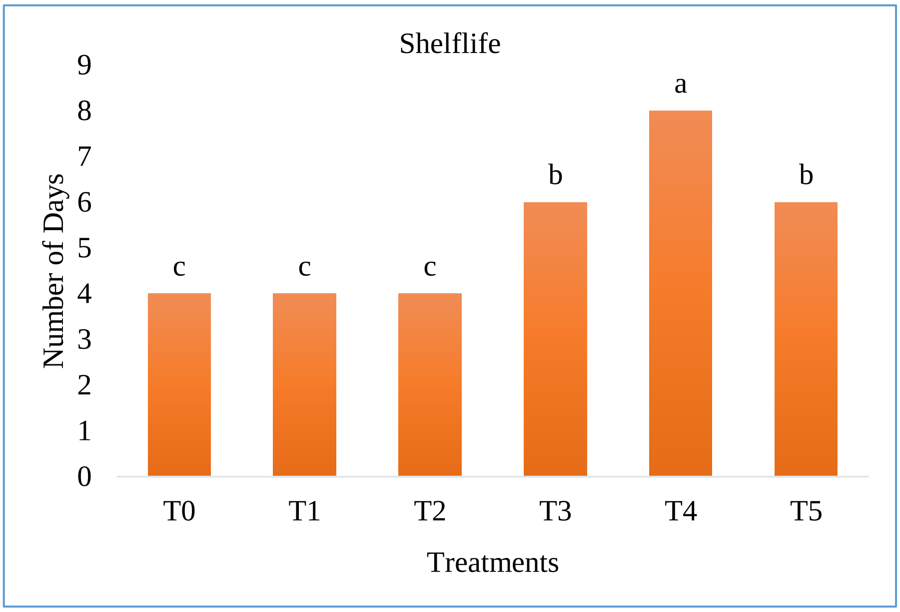

Figure 2. Shelflife of bitter gourd *(Momordica charantia* L.*)* as influenced by different UV-C doses and storage conditions.

Table 4. Chemical characteristics (TSS, TA and Vitamin C) of bitter gourd *(Momordica charantia* L.*)* as influenced by different UV-C periods and storage conditions.

Treatments	TSS		TA		Vitamin C	
	Initial	Final	Initial	Final	Initial	Final
T0 – Control	3.55ab	1.23bc	0.15	0.97	10.14	0.85b
T1 – 30 mins. UV-C + Ambient	3.47ab	1.50abc	0.15	0.85	9.49	0.85b
T2 – 60 mins. UV-C + Ambient	3.20b	1.17c	0.13	0.65	8.95	0.91b
T3 – Without UV-C + 20°C	3.80a	1.97a	0.14	0.81	9.19	1.06b
T4 – 30 mins. UV-C + 20°C	3.43ab	1.33bc	0.12	0.81	10.14	1.86a
T5 – 60 mins. UV-C + 20°C	3.33ab	1.73ab	0.13	0.80	9.82	1.10b
% CV	5.24	12.47	19.05	16.91	5.14	8.53

Means within the same column followed by a common letter and/ or without letter designation are not significantly different from each other at 5 % level of significance

Oxidation Reduction Potential (mV) and Power of Hydrogen (pH)

The oxidation-reduction potential (mV) and pH of bitter gourd, as influenced by different UV-C exposure and storage conditions, are shown in Table 5. Results indicated that UV-C treatment and storage conditions significantly affect bitter gourd's initial and final oxidation-reduction potential. UV-C-treated fruits stored at 20°C obtained the highest initial and final oxidation-reduction potential. Comparable effects can be observed on untreated fruits stored at 20°C. On the other hand, fruits either treated or untreated with UV-C stored at ambient conditions obtained the lowest initial and final oxidation-reduction potential.

Table 5. Oxidation Reduction Potential (mV) and pH of bitter gourd *(Momordica charantia* L.*)* as influenced by different UV-C exposure and storage conditions.

Treatments	Oxidation Reduction Potential (mV)		pH	
	Initial	Final	Initial	Final
T0 – Control	282.00b	204.33cd	6.56	5.50a
T1 – 30 mins. UV-C + Ambient	283.33b	195.33d	6.60	5.05b
T2 –60 mins. UV-C + Ambient	286.67b	215.67c	6.19	5.06b
T3 – Without UV-C + 20°C	302.00a	267.00b	5.96	4.94b
T4 – 30 mins. UV-C + 20°C	301.00a	275.33ab	6.56	5.58a
T5 – 60 mins. UV-C + 20°C	306.67a	283.00a	5.95	4.87b
% CV	1.63	2.26	5.01	3.04

Means within the same column followed by a common letter and/ or without letter designation are not significantly different from each other at 5 % level of significance

No significant difference was observed in initial pH as influenced by UV-C treatment and storage conditions. However, a numerical difference can be observed. The final pH level of bitter gourd was significantly affected by UV-C treatment and storage conditions. Fruits treated with UV-C for 30 minutes and stored at 20°C recorded the highest pH level, which was comparable with untreated fruits stored at ambient conditions. On the other hand, fruits treated with UV-C for 60 minutes and stored at 20°C obtained the lowest pH level, which was comparable to other treatments.

CONCLUSION

UV-C illumination at varying periods and storage conditions significantly affected the chemical characteristics, postharvest quality, and shelf life of bitter gourd. Fruits subjected to UV-C for 30 minutes and stored at 20°C significantly reduced weight loss, prolonged visual quality, and shelflife, and delayed color changes or yellowing after 8 days of storage. Further, the latter treatment obtained the highest initial and final oxidation-reduction potential, highest pH level, and Vitamin C content. Fruits subjected to UV-C for 30 minutes and stored at 20°C were found to be the best in maintaining quality and prolonging the shelf life of the produce.

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REFERENCES

Acabal A., Calibo C.L., Loreto MATP & Jansalin J.G.F. 2015. *Unpublished Laboratory Manual in Chem 31a: Biochemistry*, Visayas State University: Philippines, pp. 48-49.

Acedo A.L. Jr. 1999. Postharvest physiology of perishable crops. *Unpublished Laboratory Manual in Horticulture 111*. Department of Horticulture, College of Agriculture, Visayas State University, Visca, Baybay, Leyte, Philippines.

Bhattacharjee D. & Dhua R.S. 2017. Impact of edible coatings on the postharvest behaviour of bitter gourd (*Momordica charantia* L.) fruit. *International Journal of Current Microbiology and Applied Sciences*, 6(3), 336–347.

Devi S., Mahato D.K., Singh S. & Singh S.P. 2019. Optimization of process variables for retention of functional properties of bitter melon (*Momordica charantia* L.) and its shelf - life extension. *Current Agriculture Research Journal*, 7(1), 74–89.

Formica-Oliveira A. C., Díaz-López V., Artés F. & Artés-Hernández F. 2017. Use of postharvest uv-b and uv-c radiation treatments to revalorize broccoli byproducts and edible florets. *Innovative Food Science & Emerging Technologies*, 43.

Grover J.K. & Yadav S.P. 2004. Pharmacological actions and potential uses of *Momordica charantia:* a review. *J. Ethnopharmacol.,* 93: 123-132.

Han C., Zuo J., Wang Q., Xu L., Wang Z., Dong H. & Gao L. 2015. Effects of 1-MCP on postharvest physiology and quality of bitter melon (*Momordica charantia* L.). *Scientia Horticulturae*, 182, 86–91.

Liao C., Liu X., Gao A., Zhao A., Hu J. & Li B. 2016. Maintaining postharvest qualities of three leaf vegetables to enhance their shelf lives by multiple ultraviolet-c treatment. *Lebensmittel-Wissenschaft und -Technologie- Food Science and Technology*, 73, 1–5.

Lotlikar M.M. & RajaramaRao M.R. 1966. Pharmacology of hypoglycemic principle isolated from the fruit of *Momordica charantia* Linn. *Indian J Pharm.*, 28: 129- 132.

Martínez-Sánchez P., Lozano-Pastor F., Artés-Hernández F. & Artés E. 2019. Aguayo Preharvest UV-C treatment improves the quality of spinach primary production and postharvest storage. *Postharvest Biology and Technology,* 155: pp. 130-139, 10.1016/j.postharvbio.2019.05.021

Mohammed M. & Wickham L.D. 1993. Extension of bitter gourd (*Momordica charantia* L.) storage life through the use of reduced temperature and polyethylene wraps. *Journal of Food Quality*, 16, 371–382.

Preetha P., Varadharaju N. & Vennila P. 2015. Enhancing the shelf life of fresh-cut bitter gourd using modified atmospheric packaging. *African Journal of Agricultural Research*, 10(17), 1943–1951.

Salas F.M., Salas R.A., Pole V.N. & Quevedo M.A. 2015. Shelf life and free radical scavenging activity of tomato (*Lycopersicum esculentum* Mill.) fruits coated with safe phytochemicals. *Journal of Food and Nutrition Sciences,* 3: 1-2 pp.94-99. Doi: 10.11648/j.jfns.s.2015030102.28

Zong R.J., Morris L. & Cantwell M. 1995. Postharvest physiology and quality of bitter melon (*Momordica charantia* L.). *Postharvest Biology and Technology*, 6(1-2), 65–72.