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ORIGINAL ARTICLE

The Efficacy of Ultraviolet (UV) Radiation to Protract the Shelf Life of *P. florida*

Akihiro Nohara Olea
Université des Sciences et des Technologies de Hanoi (USTH), Hanoi, VN
*Correspondance email: aki_ole@hotmail.com

ABSTRACT
Farm produce if not consume soon could readily manifest changes in its characteristics which may appear unacceptable for human consumption. Various techniques and methods have been developed that would prolong the shelf life of fruits and vegetables, but to date, none has been done specifically for mushroom. The present undertaking attempted to utilize an innovative technology – UV radiation as a method of extending the shelf life of mushroom. About 8 to 10 freshly harvested mushrooms were used for each treatment per replicate. Half of the samples were treated with UV radiation and the other half served as the control. The time of UV exposure was set at 20, 30 and 60 minutes, respectively. After UV treatment, the samples were placed in a Styrofoam, enclosed in a plastic bag and placed inside an ordinary refrigerator. The number of days was counted until sign of wilting was manifested. Likewise, the daily changes in weight were monitored. Significance was evaluated by 2-tailed Student's t-test between mean. The result showed a significant difference between the samples exposed to UV radiation and the control, except those exposed to UV for 30 minutes. The mushroom exposed for 20 minutes, lasted for an average of 10 days, while the control lasted for about 5.2 days. The samples exposed to UV for 60 minutes, showed a shelf life of 8.2 days, the control lasted for about 5 days. The results of proximate analysis before and after UV exposure showed no significant difference. From the result of the present study, it could be inferred that ultraviolet (UV) radiation is an effective method in prolonging the shelf life of mushroom.
Key words: *mushroom, UV radiation, shelf life, Pleurotus florida, food irradiation*

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INTRODUCTION

Mushroom is highly perishable commodity. After harvest it may readily manifest changes in its characteristics which may appear unacceptable for human consumption. Among the observable changes that may be manifested are wilting, loss of moisture, the loss of texture, aroma, and flavor. The difficulty of maintaining the freshness and/or prolonging the shelf life of mushroom have been a perpetual problem among the growers and have caused devastating losses of harvest produce.

Attempts have been made to develop a technique or method that will extend the shelf life of different varieties of fruits and vegetables [1, 2, 3, 4, 5], but to date, few or none at all has been done specifically for mushroom.

In recent times, a new food technology – irradiation is emerging as a potential method for food preservation. This method is also being used to extend the shelf life of raw and processed food. It was reported that irradiation when used alone can cause the development of undesirable sensory and chemical changes in some food items [6]. However, these changes can be prevented if irradiation is used in combination with other methods, such as heating, cryogenic temperature or vacuum packaging.

In literature, it was reported that irradiation of mulberry leaves with UV reduced the feeding responses of *Bombyx mori* silkworm larvae [7]. An organic extract analysis of UV-irradiated leaves showed to have induced the production of moracins C and N which act as feeding deterrents. Furthermore, it was reported, that UV-B radiation induced a rapid increase in intracellular carotenoids and a marked decline in chlorophyll A among *Tetraselmis sp*. [8, 9].

In view of the limited and diverse information on UV irradiation, consumer acceptance of this innovative technology is varied and opinions are diverse. It was argued that acceptance of a new food technology is not simply related to the characteristics of the process itself, but the needs, beliefs and attitudes of individual food consumers and the nature of economic, political and social environment in which food choices take place [10]. Although this innovative technology has already been recognized worldwide, industrial application of this technology is still very limited.

Henceforth, in the present undertaking, an attempt was made to utilize this novel technology in farm product. Specifically, an attempt was made to use ultraviolet (UV) radiation irradiation on mushroom in an attempt to extend its shelf life after harvest.

MATERIALS AND METHOD

A. Mushroom

In the experiment, a variety of semi-temperate mushroom, *Pleurotus florida* (angel mushroom) was used. Freshly harvested mushrooms from the mushroom farm (inside the tunnel), within the RTU university campus were obtained and sorted out. About eight to ten mushrooms of comparable sizes were used for each intervention per replicate.

B. Ultraviolet (UV) box

The UV box is made of wooden frame measuring about 65 cm x 75 cm x 55 cm in length, width and height, respectively. The compartment has three drawer type movable commodity holder made up of plastic wire and aluminum wire. A 15 watt UV lamp was attached on top of the box.

C. Commodity Intervention

The mushrooms were exposed to UV radiation at three levels: 9 inch (22.9 cm), 13 inch (33 cm) and 17 inch (43.2 cm), respectively. The UV treatment was varied at three different exposure time: 20 min, 30 min and 60 minutes. The irradiated mushrooms were placed in a Styrofoam plate, enclosed in a plastic bag and then placed inside an ordinary refrigerator. The same was done with the control (mushrooms not exposed to UV). The daily changes in weight of the mushroom (UV exposed and control) were monitored. Likewise, the physical characteristic of the mushroom was observed daily, until such time that sign of putrefaction and other characteristics were observed. At such instance, observation was terminated and the number of days it lasted was recorded.

D. Proximate and Sensory Analyses

Mushrooms exposed to UV radiation and control was submitted to SGS, Phil., Inc. (Makati, PHL) for proximate analysis.

For sensory analysis, a standard protocol was undertaken to 20 individuals who volunteered.

E. Statistical Analysis

The results of the study were evaluated using the Student's t-test between mean ± SD (p=.05).

RESULTS

I - Initial Phase

An initial experiment was conducted to determine at what distance the mushroom should be placed in reference to the UV lamp and to determine the UV exposure time that would be best appropriate and serve the purpose. The UV exposure distance between the mushroom and the UV lamp was initially set at three levels: 9 inch (22.9 cm), 13 inch (33 cm) and l7 inch (43.2 cm), respectively. However, the initial results showed that the levels were not significant. Thus, in the experiment proper, the average distance of the three levels was used. The computed average was 13 inch (33 cm). Initially, the UV exposure time was also varied and set at three different exposure time: 20 min, 30 min and 60 min, respectively. The results are presented in Fig. l. As shown, the mushrooms exposed to UV for 20 minutes posted and average of l0 days, before they manifested observable changes in the physical characteristics. In contrast, the control (mushroom not exposed to UV) lasted for an average of 5.2 days. The mushrooms exposed to UV for 30 minutes showed an average of 8 days, while the control lasted for 5.5 days. At 60 minutes UV exposure time, the samples (mushroom) recorded a shelf life of 8.2 days, while the control lasted for an average of 5 days.

II - Experimental Phase

The mushrooms were placed at a distance of 33 cm in reference to the UV lamp on top of the UV box. The UV exposure time was set at 20 minutes. Several replicates were done and the results are presented in Fig. 3. As shown, in the first replicate (R1), the mushrooms exposed to UV radiation recorded a shelf life of an average of 10 days, against the control which lasted for an average of 5 days. In replicate two (R2), the UV exposed samples posted a shelf life of 9 days, while an average of 5.1 days was recorded in the control. In replicate three (R3), the UV exposed mushroom recorded an average of 9 days, against the control which recorded a shelf life of 5 days. In the fourth and the last replicate (R4), the mushrooms exposed to UV posted a shelf life of 9.5 days, while the control samples recorded the least, which is about 4.5 days. Statistical analysis should significant difference between the mushrooms exposed to UV and the control at (p = .05). At the onset of every experiment, the weight of the samples both of the UV exposed and unexposed was determined. Thereafter, the daily changes in weight were recorded until the mushroom manifested changes in physical characteristics. In Fig. 2, the results showed that the weight of the mushroom exposed to UV and the control decreased gradually until the 10th day. However, statistical analysis showed that the decrease in weight between the UV exposed and control was not significant. The result of the proximate analysis on the mushroom before and after UV treatment showed no significant difference.

DISCUSSION

Whereas, almost in perpetuity, mushroom growers are faced with a perplexing situation such as how to maintain the freshness of the produce before it gets to the market and/or how to extend the shelf life until it gets way to the consumer, apparently no eminent solution is forthcoming. Numerous studies have been conducted relevant to post harvest problems, however, results are varied and diversified. Maybe, this diversity could be attributed to the highly diverse varieties of farm products. So that, a method best suited for one product, may not necessarily be effective to other farm harvest. Chemical treatment method [2, 4] and a number of evaporative cooler (EC) have been found effective in improving the quality and shelf life of several varieties of fruits and vegetables [1, 3, 5, 11, 12]. However, these methods may not serve the purpose for other produce, specifically for mushroom. The results of this investigation have confirmed that UV radiation is an effective method in extending the shelf life of mushrooms. Furthermore, the results of the proximate and sensory analyses showed no significant difference between the UV exposed and the control. In contrast, studies showed that UV irradiation induced sensory and chemical changes. Organic extract analysis of UV exposed mulberry leaves induced the production of phytoalexins - a food deterrent [7]. Likewise, irradiation increased the production of intracellular carotenoids among *Tetraselmis sp.* [8, 9]. Solar UV-B radiation has been found to cause damage to early developmental stages of fish, mollusks and other animals. The most severe effects are decreased reproductive capacity and impaired larval development [13]. Somehow, the previous studies seem inconsistent with the argument of Sykes [14], accordingly, the energy of radiation is very low and this means that its power of penetration is also low. Furthermore, Sykes [14] asserted that UV penetration into solids is virtually nil, while penetration is only slight in liquid, depending on their opacities. In clear water over 50% of the radiation energy is lost at a depth of less than 2 inches, and in river water it may be within 1 cm; in milk significant penetration is limited to 1 or 2 cm. In addition, because of the apparent lack of penetration only direct ultraviolet (UV) rays are effective.

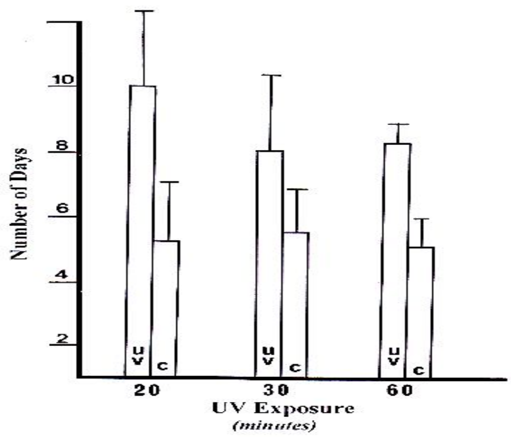

Fig. 1 The shelf life of mushroom in days after Ultraviolet (UV) treatment for 20, 30 and 60 minutes, respectively

The difference in the results of the present work and those reported earlier could be traced to the process itself. Report showed that irradiation when used in combination with other methods may inhibit undesirable sensory and chemical changes [6]. Furthermore, it was reported that irradiation in combination with vacuum packaging or modified atmosphere packaging also extends the shelf-life of processed meats [15]. Acceptance or rejection of an innovative food technology could be a complex-decision-making process. It involves an assessment of the perceived risks and benefits associated with the new technology and existing alternatives. A recurring theme in the argumentation of those opposed to food irradiation is the claim or suspicion that consumption of irradiated food and other products may entail negative chronic health effects [16]. Despite its scientific and technical label of worldwide approval, acceptance and use of food irradiation in the U.S. has become stagnant and a political and psychological issue [17].

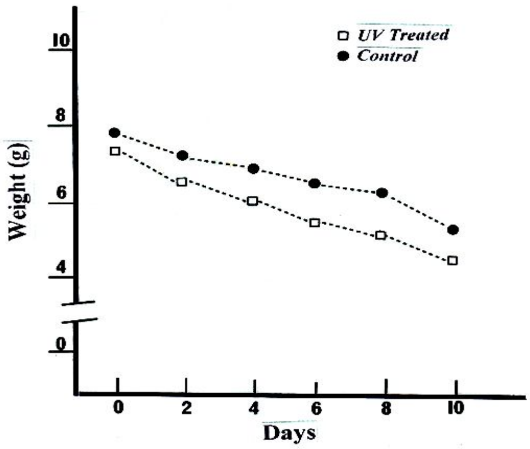

Fig. 2 The changes in weight of the UV treated (□) and control (•) *p. florida* mushroom. Mean ± SD

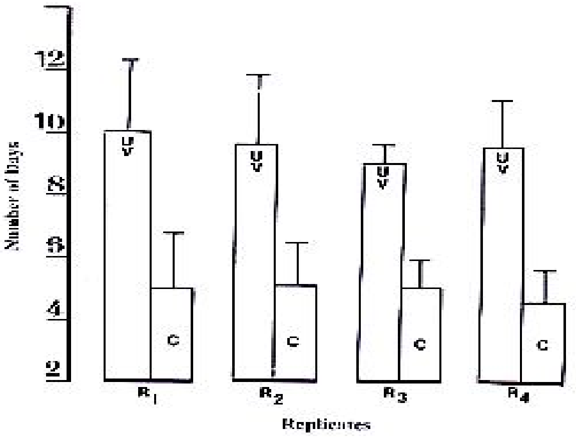

Fig. 3 The different replicates (R) reflecting the number of days before the UV treated and the control mushroom showed sign of wilting. Mean ± SD (p =.05).

Lagunassalor [18] asserted that as a physical process, food irradiation provides opportunities to improve food protection and preservation technologies. In addition, its use would solve known public-health problems, as well as minimize the environmental effects caused by chemical and energy intense processes. In part, the stagnant situation is due to the lack of an educational program, well focused to address critical public concerns properly coordinated by the government, academe and industry. Majority of consumer will respond positively to irradiate foods when the advantages of the process are explained and when safety, nutritional value, and workers and environmental concerns are addressed [19].

Finally, from the large number of evidence presented and the results of the present work, it could be inferred that UV radiation, in combination with other methods like refrigeration, is an effective method in prolonging the shelf life of mushroom. Notwithstanding, the use of UV radiation for farm products can be construed as safe and useful.

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