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Comparative assessment of sulfur treatment and ozone treatment on sterilization of cinnamon quills

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ABSTRACT

Ceylon cinnamon is a highly valued bark spice used as culinary and medicinal spice. Sensory properties may loss during the storage due to environment factors and microbial contamination specially by fungus. Sulfur fumigation as sterilization methods is commonly used method which has issues for human health. Ozone can be used as an alternative because it has not a residual effect and environmentally friendly. The study was carried out to find the effectiveness of sulfur treatment and different dosage of ozone treatments on sterilization of cinnamon quills. Completely Randomized Design was used for 5 treatments with three replicates. Ozone treatment was done with 2 ppm concentration using ozone generator (PRO 450 P) for 15min, 30min, 60 min and sulfur treatment with 0.3% of sulfur powder on weight basis and control without any treatment were used. Representative initial sample was tested before applying the treatment. Microbial count, color and texture were tested. Microbial count was done by narrow strip of flexible material with a pressure sensitive adhesive to pick up fruiting structures of fungal colonies. Color and texture were tested by giving scores using hedonic scale. Statistical Analysis was done by one way ANOVA & Kruskal Wallis test. Mean comparison was done with Duncan Multiple Range Test. Microbial contamination was significantly controlled by increasing exposure time of ozone gas as application for 60 min duration showed better performance. The color is remained as initial level in all treatment. But an additional golden-brown color had been developed by sulfur treatment. Initial texture is properly maintained in 60 min ozone treatment and sulfur. Oil content and quality were not changed due to ozone treatment. Therefore 2 ppm ozone treatment for 60 min duration can be used as good alternative for sulfur treatment.

***Keywords*:** Cinnamon, microbial contamination, ozone treatment, sterilization, sulfur fumigation

INTRODUCTION

Cinnamon is a bark spice belongs to genus Cinnamomum that comprise of many of spices mainly distributed in tropical countries. But only few species are cultivated commercially as a spice. Cinnamon is a tropical evergreen plant which having two main varieties, *Cinnamomum zeylanicum* (also known as Ceylon cinnamon or true cinnamon) and *Cinnamomum cassia* (also known as Chinese cinnamon or cassia cinnamon). Forty seven representative cinnamon accessions were studied from Matara District in Sri Lanka (Azad *et al.,* 2016). Ceylon cinnamon is indigenous to Sri Lanka. It is a highly valued spice used as culinary and medicinal spice. Tan brown in color, Thin and paper-like textured bark that forms multiple layers when rolled up, fragile and easily broken, soft and sweet aromatic, Safe for the human health as less coumarin content (0.0004%), delicate and sweet. Mostly used in USA and Canada (Ranasinghe *et al*., 2013).

Few steps can be identified during preparation of cinnamon quills such as harvesting, peeling, extraction of bark, rolling, piping and grading. Different sterilization methods that belong to different categories can be found in controlling and preventing microbial contamination of cinnamon quills. As physical methods, steam at 100-200°C, high pressure, CO2 under pressure, infrared radiation, ionizing radiation, microwaves etc. are done. Methyl bromide, formaldehyde, ethyl alcohol, ethylene oxide, sulfur fumigation etc are used as chemical methods which are very useful to sterilize the cinnamon quills (Brodowska and Œmigielski, 2014). There are many constraints in chemical methods such as change the chemical composition and reduce the essential oil content in the cinnamon quills, change in characteristic color and texture. Health issues are occurred with some

chemicals. Sulfur is most commonly used in the cinnamon industry as Sulfur dioxide for preventing microbial contamination. Sulfur dioxide is a gas and is not convenient to handle in most food applications (Gould and Russell, 2003).

Ozone is an alternative sterilization method for radiation and steam. It has a high oxidizing power and antimicrobial property. Ozone is an effective alternator for commonly used chlorine. Ozone is a broad spectrum antimicrobial agent that inactive bacteria, fungi, viruses and protozoa at low concentration within short exposure duration. It is currently used in food industry as an environmental friendly sanitizer. It reduces the microbial content efficiently without changing the chemical composition of cinnamon and low impact on environment. This study was focused to find out the potential of ozone sterilization on cinnamon quills. The antimicrobial ability of ozone treatment and sulfur treatment was comparatively assessed and to identify the suitable ozone dosage for preventing microbial contamination of cinnamon quills.

MATERIALS AND METHODS

The study was carried out at Laboratory of Department of Agricultural Engineering, Faculty of Agriculture, University of Ruhuna, Sri Lanka from August 2018 to December 2018. Randomly selected 7 kg of cinnamon quills in C4 grade from Ratna Cinnamon Exporters (Pvt)Ltd, Kamburupitiya, Sri Lanka were used for the experiment.

Experimental Design was Completely Randomized Design (CRD) with 5 treatments and three replicates as T1-Cinnamon quills under 15min ozone treatment, T2-Cinnamon quills under 30min ozone treatment, T3-Cinnamon quills under 60 min ozone treatment, T4-Cinnamon quills under sulfur treatment and T5-Cinnamon quills without any treatment (Control). Each treatment contains 400g of quills with 27 cm of length with 14% moisture content.

Ozone treatment

For ozone treatment, cardboard boxes (29*22*21) cm^3 laminated by 150 gauge polythene were used and a rack inside the boxes using iron cables were prepared for keeping quills (figure 1).

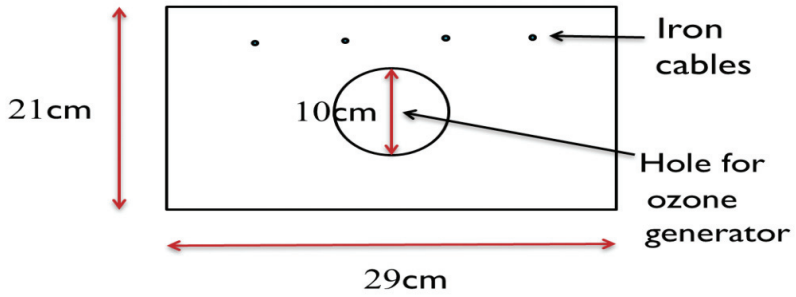

Fig. 1: Front view of the cardboard box

Fig. 2: Ozone generator

Samples were laid on rack as two layers for a better exposure to the ozone. Ozone treatment was facilitated by ozone generator (PRO 450 P) provided by Bobbin group (pvt) Ltd (Figure 2). Ozone gas was introduced with the concentration of 2 ppm into the hole in each box during different time interval such as 15 min, 30 min and 60 min. After completing application, all boxes were sealed immediatly. Those were kept in dry and clean place under the room temperature (Figure 3).

Fig. 3: Cinnamon storage structure for ozone treatment

Sulfur treatment

For sulfur treatment, iron rack was used. Cinnamon quills were laid on the rack and covered with black polythene. The 5g of sulfur powder was burnt below the rack by using Bunsen burner according to the application rate of 0.3% on weight basis of quills. After completing the burning, structure was covered properly for 24 hrs (Figure 4).

Fig. 4: Cinnamon storing iron rack for sulfur treatment

Cinnamon quills were kept normal dry & clean place under room temperature as control without giving any treatment (Figure 5).

Fig. 5: Cinnamon quills under the control treatment

Representative initial sample were tested before applying the treatment. All samples were tested for microbial count, color, texture, oil content and cinnamaldehyde content. Tape mounting method using sello-tape was used for counting microbial fungal mycelium using microscope with saffrine drop. Color was visually observed using hedonic scale ranging very bad (1) to very good (5). Texture was tested by breaking the quills using same hedonic scale.

Modified Clevenger Method was used for oil extraction (Wong *et al.*, 2014). Oil quality was determined by GC-MS (Gas Chromatography-Mass Spectrometry) (Paranagama *et al*, 2001). Four

weeks after different treatment application, same parameters are tested.

Data on microbial count and cinnamaldehyde content were statisticaly analysed using one way ANOVA. Color & texture were analyzed using Kruskal Wallis test. Means were compared with Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Comparison of mean microbial count before and 4 weeks after experiment were given in table 1.

Above table shows the mean microbial count in four weeks after treatment application. There is no significant different in between sulphur treatment and 1 hr ozone treatment. As microbial count was increasing in 15 min ozone treatment it is not effective. Ozone treatment for 1 hr duration is controlled the microbial contamination.

Table 1: Mean microbial count before and 4 weeks after treatment

Treatment	Mean of Initial Microbial Count	Mean of Final Microbial count
15 min ozone treatment	8.33	11.33 a
30 min ozone treatment	7.66	6 b
1 hr ozone treatment	8.33	2 c
sulfur treatment	7.66	2.33 c
control	8.33	17.67 d

The content and quality parameters distilled oil from cinnamon quills under different treatment was given in the table 2. The ozone treatment was not affected for the oil content of the cinnamon quills compared to sulfur treatment and control.

There is no any significant effect on ozone treated sample when considering the quality parameters. The ozone treatment is an appropriate technique for enhancing the keeping quality of cinnamon quills as the cinnamaldehyde is the main constituents of bark. As ozone is a non thermal food preservation technology it helps to enhance the quality of product with maintaining the desirable cinnamaldehyde content which is distinctive constituent in cinnamon quills (Guzel-Seydim *et al*., 2004).

Table 2: **Oil Content and quality of cinnamon quills after 4 weeks**

Treatment	Oil Content (%)	Cinnamaldehyde (%)	Eugenol (%)	Cinnamyle acetate (%)
15 min Ozone	1.14	55.39	8.6	11.46
30 min Ozone	1.2	57.56	9.52	16.3
60 min Ozone	1.55	63.08	6.46	12.19
Sulfur treatment	1.27	57.31	6.73	14.45
Control	1.16	55.64	7.18	15.02

The colour of the cinnamon quills before and after different treatments was given in the figure 6. Four weeks after applying the treatments, color is remained as its intial level (good-4) of among all the ozone treated cinnamon quills. But some additional color was developed in sulfur treated cinnamon quills as sulfur deposit on quills to develop some yellow brownish colour. Results reveal that the color of the cinnamon quills was not affected due to ozone.

Zhao and Cranston (1995) showed that ozonation successfully reduced the microbial loads and did not cause significant oxidation of the volatile oil in whole black peppercorns.

Initial texture retained same level in 1 hr ozone treatment and sulfur treatment after 4 weeks but texture was deteriorated in all other treatment (Figure 7).

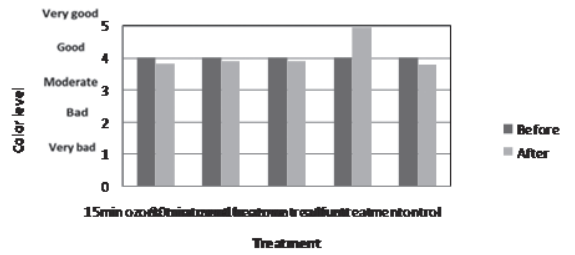

Fig. 6. Color of cinnamon quills before and after treatment application

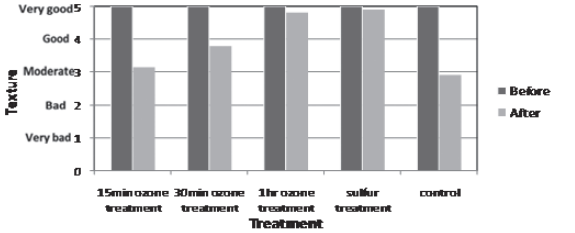

Fig. 7: Texture of cinnamon quills before and after treatment application

CONCLUSION

Microbial contamination was significantly controlled by increasing exposure time of ozone gas. Ozone application with the concentration of 2 ppm for 1 hr duration showed the better performance. There is no difference in-between 1 hr duration of ozone application and sulfur treatment which is currently practices at commercial level in Sri Lanka. Oil content and cinnamaldehyde content of oil is not affected due to ozone applications as most of cinnamon quills are used for extracting essential oil in the industry. Finally, ozone treatment with the concentration of 2 ppm for 1 hr duration is a good alternative for sulfur treatment without any deterioration of cinnamon quills. The operational cost of ozone generator was estimated as SLRs. 0.50 for 1 hr duration.

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