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Design and Development of Low Cost Portable Ozone based Fruits and Vegetable Washer-Cum-Purifier

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ABSTRACT

Keeping in view the sudden outbreak of COVID-19 pandemic, an urgent need was felt to bring home safe items such as fruits and vegetables. To address the imperative demand a low cost portable ozone based fruits and vegetable washer-cum-purifier was designed and developed to sanitize these perishable food items. The developed portable device is very cost effective, easy to manufacture and also very effective in washing and cleaning of fruits and vegetable at domestic level.

Keywords: Safety and quality, fruits and vegetables, ozone, ozone generator.

1. INTRODUCTION

During the Covid-19 pandemic as people bring home fruits, vegetable, mutton and fish (Times of India, 22 May 2020).There is often a dilemma on how to handle the items that we get from the market. Whether to wash them or consume them immediately or leave them for a while and then use. The fear of contracting corona virus from the same also looms large. Most people are also worried whether keeping them in the refrigerator would spread contamination to other food items. And due to this some people have been washing their fruits and veggies in detergent. This can really be very dangerous for health. There is no significant evidence to prove that corona virus can spread through fruits and vegetables. However to maintain utmost hygiene, they can be cleaned thoroughly with natural ingredients prepared in your kitchen(Times of India, 13 May 2020).

To ensure food safety, a suitable gadget with standard protocol is urgently required to ensure complete safety of commodities at home. Keeping in view the present grim situation of Covid-19, a portable device based on Ozone technology was developed to clean and wash fruits and vegetable. The portable system is anexcellent ozonator which removes pesticides, bacteria, viruses and harmful chemical from the surface of fruits and vegetable, sea foods and meat making them hygiene.

2. DESIGN AND DEVELOPMENT

2.1. Principle

The system works on principle of silent “corona discharge method” (Fig. 1). Ituses electric discharge to produce ozone by splitting the normal oxygen molecules in the air into single atoms. These atoms recombine with air (i.e O_2)to form ozone (O_3).The device was made with a unit cost of Rs.3500 and it is successfully demonstrated for use (Fig. 2).

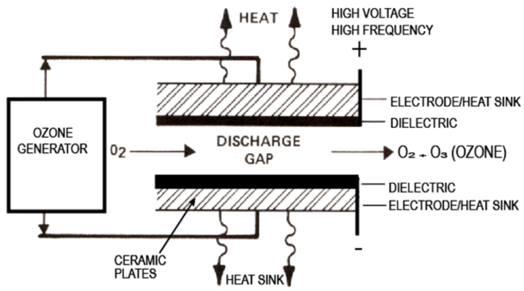

Fig. 1-Ozone production from corona discharge method used in development of portable ozone based fruits and vegetable washer-cum-purifier

Table 1- Component details of Low Cost Portable Ozone based fruits and vegetable washer-cum-purifier

S No	Name	Number	Dimension	Description
1	Outer box	01	PVC material Standard 24x28x10 cm	Outer body box of plastic PVC material.
2	Perforated wall	01	Standard	Perforated rectangular wall for air-in
3	Ozone generator	01	Voltage: 220V, 50W, Dim.: 10X5 cm Ozone output: 100-200 mg/h	Ozone generator works on the principle of corona discharge methods.
4	Air pump with pipe	01	Standard	For receiving ozone air to tank
5	Timer switch	01	85x85x50 cm, 10 Amp, 0-60 min	Time of operation
6	ON-OFF switch	01	Standard	On-off the equipment
7	Perforated stone	01	2.5X1 cm Standard	For air bubble distribution in fruit and vegetable bucket
8	Air Fan	01	Voltage: 220V, 50W Air Vol: 2-3 m^3/min	For air regulation
9	Power cable	01	Voltage: 220V, 50W	For power supply
10	Operation time	-	-	1-2 kg item: 15 min. 3 -10kg: 30 min.

2.2. Features and usage of portable ozone based fruits and vegetable washer-cum-purifier

1. This Ozone based device comprises of PVC box, air blower, ozone generator, ozone air distribution system, timer and on-off switch.The operation of developed device is very simple and user friendly.

2. Take a container and put the fruits and vegetables in it.

3. Fill the container till water level is above fruits and vegetable to be cleaned. Dip the silicon tube with air stone into the container.

4. Set the time of operation (15 -30 min based on commodity) and switch on the power supply.

5. The device will automatically stop after expiry of set time. Remove the stone and throw the treated water.

6. Finally clean and rinse the fruits and vegetables with fresh running water.

7. The cleaned fruits/vegetables are now ready to use for consumption. We can also store the item for later use.

8. The device is compact in design, requiring a small space of 28 cm length, 24 cm width and 10 cm height and weight only 1.8 Kg.

9. Its ozone output is 100-200 mg/h and its output air pressure is 0.2 kg/cm^2.

10. The device operates on a 220 V-240 AC single phase power supply.

Fig. 2-Portable ozone fruits and vegetable washer-cum-purifier

Fruits and vegetable cleanliness have become more important now in the wake of the COVID-19 pandemic. To ensure fruits and vegetable safety and quality, some are resorting to unusual practices like washing them in soaps and detergents, which is not at all safe and quite dangerous as there are various chemicals in them. Most people do try to rub off the detergent, but a little residue might get stuck to these perishable goods that have thin porous skin. Ingesting such residue can result in gastrointestinal distress and far more serious long term implications(Times of India, 13 May 2020).The Ozone technology based Portable Fruits and Vegetable Washer-Cum-Purifier (Ozo-C) is the need of the hour. The components detailed and ozone application and time schedule for various fruits and vegetable is detailed in Table 1 and 2 below:

Table 2-Ozone application and time schedule chart

Commodity	Time of application	Benefits of ozone treatment
Fruits		
Apple, grapes, strawberry, guava	15 min	Oxidizes harmful bacteria, viruses
Water melon, muskmelon, banana, orange, mango	30 min	and pesticide from fruits
Vegetables		
Taro, Lotus root, ginger and bean sprouts	15 min	Reduces harmful chemicals, odor,
Onion cucumber, tomato, cabbage, radish, carrot lettuce, peas, leek and green vegetable.	30 min	bacteria, viruses from vegetable
Seafood and Meat		
Crab, squid, rohu/katla/other fish, prawns, and meat	30 min	Eliminate pathogens, smell and germs from Seafood and Meat

3. MATERIALS AND METHODS

3.1. Ozone quantitative analysis

In this recent time, the rapid growth of technology and the utilizing of ozone broadly support the researchers to develop methods to synthesize ozone. In the industrial process, ozone is used as disinfectant before the packaging process, disinfectant in bottled water industry and food preservative. The quantitative analysis method of ozone generally consist of two ways, namely, volumetric and spectrophotometry. The applicable instrument-based method that can be used are spectrophotometric. Spectrophotometric method for the determination of ozone concentration can be performed by using a colored reagent which the wavelength absorption under ultraviolet and visible light (Rana, 2009). The colored reagent used in this study was methyl orange. Methyl orange was chosen as the reagent because it is one of the most common dye used as an indicator solution for titration in the laboratory and it fades when oxidized.

3.2. Preparation of Reagents for the Determination of Ozone Concentration

Reagents used for spectrophotometric method is methyl orange solution with concentration 5, 10 and 15 mg/L using distilled water as a solvent.

3.3. Determination of Ozone Concentration by Spectrophotometric Method

Determination of ozone concentration was done by ozonation of 5 mL methyl orange solution 5 mg/L. After ozonation, solution was diluted with distilled water until the pH is equal to the initial pH. The absorbance of methyl orange solution was then measured using a UV-Vis spectrophotometer at maximum absorption wavelength of 460 nm. Ozone concentration is determined based on the assumption that the number of moles of methyl orange oxidized is directly proportional to the number of moles of ozone to oxidize. This procedure is performed also for methyl orange solution with a concentration of 10 mg/L and 15 mg/L, as well as to the amount of methyl orange solution 10, 15 and 20 mL. Ozonation procedure was held three times.

3.4. Microbiological Examination

3.4.1. Sample collection

Tap water was collected and used in this experiment to examine its total plate count.

The plate count method relies on bacteria growing a colony on a nutrient medium so that the colony becomes visible to the naked eye and the number of colonies on a plate can be counted. Typical media include plate count agar for a general count was used and plates are incubated at 37 °C for 24 hours. At the end of the incubation period the colonies are counted manually and does not require a microscope as the colonies are typically a few millimetres across.

3.4.2. Preparation of ozonated water

The ozonized water was freshly prepared using the in-house developed ozone gas generator system. Ozone gas produced from this ozonizer was introduced into 100 ml of tap water with varying time interval (2,5 & 7 min) to check antimicrobial effect of ozone gas at varying time duration.The ozonized water was used within 20 minutes after its preparation by inoculating 100 ml of this treated water on plate count agar. Untreated water was also inoculated on plate which was treated as control.These plates were then kept for incubation at 37 °C for 24 hours.

4. RESULTS

4.1. Effect of methyl orange concentration and volume on the measured ozone concentration by spectrophotometric method

Fig.3 shows that the measured ozone concentration would increase with the increasing methyl orange concentration and volume. This is due to the increasing methyl orange concentration and volume which will increase the collision number and contact time between ozone and methyl orange molecule. Resulting, the measured ozone concentration would also increase. Reaction between ozone and methyl orange molecule was cleavage of azo bond in methyl orange molecule whether directly by ozone molecule or indirectly by hydroxyl radical. Hydroxyl radical was generated from reaction between ozone and H_2O (Okafor,2011). After cleavage of the azo bond, ozone will also degrades the azo bond breaking products into other products, or final product as CO_2 and H_2O.

The cleavage of azo bond in the molecule of methyl orange can be observed by decreasing of the methyl orange color after ozonation, which means reduction in the concentration of methyl orange. The destruction of methyl orange solution may involve formation of intermediate compounds, namely 4-aminoazobenzene and sulfonic acid phydroxibenzene derivatives (Tjahjanto*et al.*, 2012).

The average of ozone concentrations measured by the spectrophotometric method were shown in Table 3. The effect of methyl orange volume on the measured ozone concentration were shown in Fig.3.

Table 3-The average of measured ozone concentration (ml/kl) by spectrophotometric method with variation of methyl orange volume and concentration

Average of Ozone Concentration (mL/kL)				
	JM Volume			
Methyl orange Concentration (mg/l)	**50 ml**	**100 ml**	**150 ml**	**200 ml**
5	0.0017	0.0026	0.0028	0.0048
10	0.0005	0.0039	0.0077	0.0064
15	0.0097	0.0095	0.01	0.0104

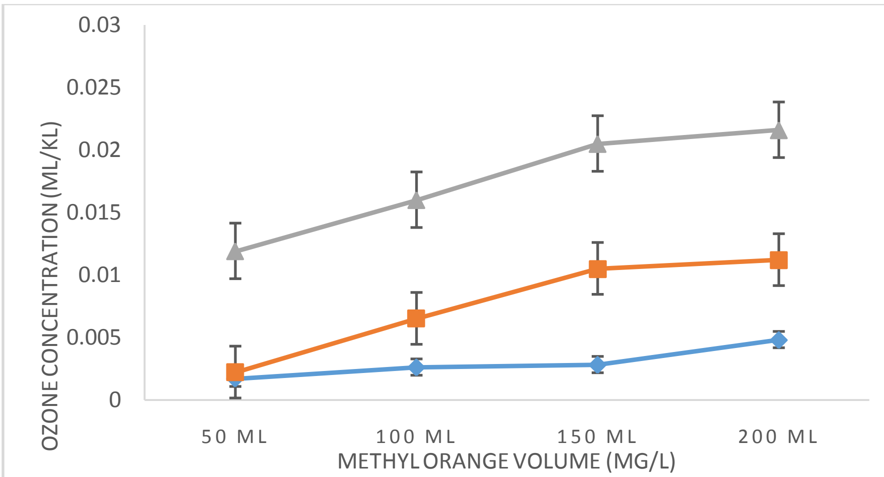

Fig.3-Graphic of methyl orange volume variation versus the measured ozone concentration.

4.2. Effect of ozonation on microbial population in tap water

The total plate count on plates showed difference. The untreated tap water samples showed smear on plate and there were 3 colonies in case of 2 mins treated tap water and 1 colonies observed for 5& 7 mins treated tap water respectively (Fig. 4).

Fig. 4-Effect of ozonation on microbial population in tap water treated with ozone fruits and vegetable washer-cum-purifier

5. CONCLUSION

The developed device produces ozone air which is very useful in cleaning fruits and vegetable to remove bacteria, viruses and harmful chemicals. Microbiologically, the ozonized water is pure and safe as effect of ozonation on microbial population in tap water is significantly different. The developed device is very useful during current pandemic as people has fear to bring home eatables specially fruits and vegetable from local market. This compact device may find a place in every kitchen, hotels, small scale fruit vegetable processors and vendors where it can play a vital role in reducing the risk of infection especially during this pandemic period.

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