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# Application of Ozone Technology as an Effort to Increase the Economic Value of Vegetable Commodities

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**Abstract**

Vegetables are classified as food ingredients that are easily wilted and easily damaged so that vegetables that have been harvested must be marketed and consumed immediately. At room temperature, the freshness of leaf vegetables can only last for 12 hours. For this reason, proper postharvest handling is needed to maintain quality and extend the shelf life of these commodities, including ozone technology (ozonization). Ozone is able to shed pesticide and bacterial contamination as well as heavy metals attached to the surface of fruit or vegetables, making it safe for consumption for health. Vegetable cultivation by productive communities as micro-entrepreneurs has developed quite a lot. The problem that still occurs is the lack of efforts to extend the shelf life of vegetables that can increase consumer preferences for spinach. The "Mutiara Organik" Farmer Group in Sumberejo Village, Ngablak District, Magelang Regency made these efforts by cultivating vegetables and applying ozonation. The program begins with the introduction of packaging technology and continues with the presentation of permits from the Ministry of Health for ozonized organic vegetables. This program provides farmers with a set of production tools and packaging. The analysis also shows that ozone treatment provides higher efficiency, because it can reduce weight loss compared to Japanese spinach without ozone treatment. In addition, ozone treatment has the potential to increase vegetable productivity and quality.

**Keywords:** ozonization; shelf life; vegetables

## INTRODUCTION

Vegetables are a source of vitamins, minerals, and fiber that the human body needs. However, public awareness to consume fresh vegetables is still lacking. The value of vegetable consumption in Indonesia is still below the standards of the Food and Agriculture Organization (FAO). The standard of vegetable consumption based on FAO is 73 kg per capita per year, while the level of vegetable

consumption in Indonesia is only 40 kg per capita per year (Wahyuni et al., 2014).

Vegetables are a source of nutrients that are very beneficial for the body because they contain nutritional components that are very important for the body's metabolic processes, as regulatory substances, as antibodies, and are also useful for reducing the risk of chronic disease. Vegetables are foods that must be consumed every day. Not only for adults, consuming vegetables is very important for children, especially at the preschool age of 3-6 years because at that age is a golden period of growth and development for children. The Food and Agriculture Organization (FAO) recommends that people around the world eat vegetables regularly. In Indonesia, vegetables are food ingredients that are very easy to obtain, even each region has a characteristic vegetable for the area (Indira, 2015).

Vegetables have a high rate of deterioration such as wilting, yellowing of leaves, and decay. Damage to vegetables occurs because vegetables are living organs which, even though they have been harvested, still carry out physiological processes such as respiration and transpiration. Vegetable quality is generally seen based on freshness, cleanliness, and leaf color. Consumers want vegetables that visually look good, have a good taste, are rich in nutrients, and are safe for health. However, in general, after harvesting, vegetables will continue to experience a decrease in quality along with the length of storage due to respiration which can remodel the components in vegetables. For this reason, it is necessary to have proper post-harvest handling to maintain the quality of vegetables, including ozonation.

Ozone has two main functions, namely as an oxidizing agent and a disinfectant or a combination of the two functions. Ozone as an excellent oxidizing agent, in water treatment, ozone is very effective for removing color, taste and odor caused by organic and inorganic materials. which can be oxidized, such as iron, manganese and sulfide ions. In addition, ozone with its oxidizing ability can be used as a strong oxidizing agent to degrade phenol (Haifan, 2017). The reactive nature of ozone is due to the oxidizing ability of radicals that can decompose ozone in water so that it will produce active intermediate compounds such as hydroxyl radicals and superoxide. Ozone is now widely applied in vegetable storage because it can control pathogenic microorganisms that cause damage to vegetables. Ozone can also inhibit the growth of the mycelia area and prevent the sporulation of pathogens to different crops. In addition, it can remove various metal substances and residues caused by the use of pesticides. Ozone is a strong disinfectant, several research results show that only ozone concentrations of less than 0.5 mg/liter are capable of killing microorganisms, and even sterilizing water. The ozone concentration commonly used for water disinfection is 0.5–0.4 mg/liter. Ozone concentration of 0.02 mg/liter can be toxic to *E. coli* and *Streptococcus faecalis* (Asgar et al., 2011). Based on a previous study, soaking the ozone solution for 15 minutes and storage at -6°C was able to maintain drip loss,

water activity, pH, TBARS, TVB-N, and sensory properties of chicken meat (Prabawa et al., 2021).

Ozonization technology is able to shed pesticide and bacterial contamination as well as heavy metals attached to fruit or vegetables, making it safe for consumption. The mechanism of ozone ($O_3$) in killing microbes is that ozone gas enters the cell wall, resulting in changes in permeability and causes lysis of microbial cells. Water containing ozone gas can be used to wash fruits and vegetables until they are sterile without losing color, aroma, and not decomposing organic compounds in foodstuffs, so as to extend the shelf life of freshness. Preservation of fresh vegetables through ozonation technology does not change the nutritional content, because ozone gas will be lost through evaporation. If ozone gas is exposed to sunlight, it will decompose into oxygen. The application of ozonation technology on tomatoes has been shown to extend the shelf life of tomatoes by up to three weeks (Asgar et al., 2011).

$O_3$ can be turned into oxygen by autolysis reaction so it is not harmful to vegetables and fruits. Therefore, $O_3$ is suitable for removing pesticide residues from vegetables and fruit while eliminating microbes (Tamaki & Ikeura, 2012). When the ozone is combined with water for washing agricultural products, it will result in a more significant reduction in pesticide residue levels. Ozone gas is flowed into the water and then the water is used to wash agricultural products. The ability of this zoned water can degrade some pesticides (Siahaan & Widayanti, 2020). Increasing the contact time between vegetables containing pesticide residues and zonalized water will increase the decrease in levels of pesticide residues in these vegetables. Water containing ozone 3 mg/l can be used for washing tomatoes and soaking for 20 minutes, it is also effective in reducing mankozeb residue by 60% (Cengiz & Certel, 2014).

Packaging of horticultural products serves to maintain product quality, but also as a promotional medium for packaged products (Rosalina et al., 2012). The benefits of packaging for horticultural products are that it can maintain freshness; and safety product (Iflah et al., 2012). One of the packaging techniques that can be done for vegetables is to use plastic wrap. In a study conducted by Ifmalinda (2017), it showed that packaging using plastic wrap could further suppress the respiration rate of tomatoes by limiting the oxygen that would enter the tomatoes. Plastic wrap packaging also prevents large amounts of tomato weight loss, maintains the texture and firmness of tomatoes, and extends shelf life.

Storing vegetables so that they last longer is certainly a household need. Because to save time, cost, and energy, housewives no longer shop regularly with a frequency every day. This causes when they buy vegetables sometimes they store it and don't process it right away. Cooling at refrigeration temperature is the simplest and often used way to preserve and extend vegetable storage time (Wowor et al., 2014). Based on previous studies, spinach can be processed into ice (Mulya et al., 2019), cookies (Yudhistira et al., 2019), marshmallow (Yudhistira et al., 2018),

the addition of spinach is effective in increasing the nutritional content of the product. Moreover, efforts are needed to improve the quality of spinach from post-harvest to food processing. The purpose of this community service activity is to provide training so that farmers group residents can pack ozonized vegetables in marketable packaging and provide counseling on obtaining permits from the Ministry of Health for ozonized vegetable products.

## METHOD

The methods applied in service activities are as follows: (1) the introduction of packaging technology is carried out. This activity is delivered in the form of counseling and training; and (2) the introduction of management is carried out by procuring a permit from the Ministry of Health for ozonized organic vegetables. After the activity is completed, monitoring is carried out as far as possible even though it is not regularly scheduled. Consultations from the farmer groups will still be facilitated as long as the farmer groups want.

In this activity, the "Mutiara Organik" Farmers Group actively participates as producers and marketers of organic vegetables. The "Mutiara Organik" Farmers Group serves to provide organic vegetables as the main raw material. Furthermore, with the guidance of the UNS P2M Team, the "Organic Pearls" Farmer's Group carried out production and marketing activities of organic vegetables resulting from ozonation. Henceforth, after 1 year of coaching and 1 year of mentoring, it is hoped that organic vegetables can become an independent and qualified producer of organic vegetables resulting from ozonation.

## RESULTS AND DISCUSSION

### Stages of Activity Implementation

The service activity for the "Mutiara Organik" Farmer Group in Sumberejo Village, Ngablak District, Magelang Regency was carried out still in the condition of the Covid-19 pandemic. Therefore, the activity was carried out with a limitation on the number of participants and strictly implementing health protocols. This was conveyed before the implementation of the activity at the time of coordination between the Service Team from UNS and the "Mutiara Organik" Farmer Group, as well as during the implementation of the activity.

The service activity was carried out by providing material exposure on packaging techniques for organic vegetable products resulting from ozonation and counseling on the management of SPP-IRT (Household Industry Food Production Certificate). The previous packaging activities have used plastic wrapping but are still done manually. Therefore, to increase efficiency and effectiveness in packaging, a wrapping packaging machine was introduced. Residents were very enthusiastic about participating in the packaging technique training by carrying out packaging practices using a wrapping packaging machine for Japanese spinach commodities. In addition to the Japanese spinach commodity,

residents also practice packing broccoli. The several packaging practices, residents are skilled enough in packaging using a wrapping packaging machine, as shown by the packaging results obtained, and even being creative in packaging potatoes.

Residents really hope that the cooperation between UNS and the Farmers Group can be continued and improved, including research related to the treatment of ozonation concentrations and counseling as well as research related to the processing of ozonized vegetables into processed food ingredients. For this reason, it is necessary to start taking care of a production permit so that SPP-IRT can be obtained. Post-program guidance is carried out to monitor and find out the results of packaging training with wrapping machines and counseling about SPP-IRT management. The people of the "Mutiara Organik" Farmers Group have become skilled at packaging using a wrapping machine. The obstacle that is still being faced is the availability of plastic wrapping. Therefore, in the post-program development activities, plastic wrapping materials have been submitted. The management of the SPP-IRT is still facing problems because the Magelang District Health Office has not served the management directly. SPP-IRT will continue to be pursued if the Covid-19 pandemic conditions are conducive so that direct management can be made possible.

The evaluation of the packaging training was generally acceptable and carried out by all participants. This is because the packaging technology uses a simple machine. The evaluation was carried out by the UNS team with observation and qualitative methods. Each participant had the opportunity to use the tool using several different vegetables. Each product of each participant is collected and compared for joint evaluation.

**Process Efficiency Measurement**

The efficiency of the ozonation application was carried out by evaluating the weight loss on the Japanese spinach commodity. This parameter is used to determine the weight loss of vegetables, so this can affect farmers' income because some vegetable commodities are sold by weight. The data regarding weight loss is shown in Figure 1. Data related to weight loss is closely related to the economic value of vegetables, because in general, vegetables produced and sold by farmers use units of weight. Moreover, weight is a key parameter because it is related to the economic aspect. Treatments that can reduce weight loss are expected to provide higher economic value.

Based on Figure 1, it can be seen that ozone treatment can reduce weight loss compared to Japanese spinach without ozone treatment. Thus, ozone treatment provides higher efficiency. Weight loss during post-harvest very important because when there is a weight loss of 5% has resulted in changes in physiological quality vegetables, so the shrinkage results in the formation of wrinkles on the outer skin of vegetables (Purnomo et al., 2017).

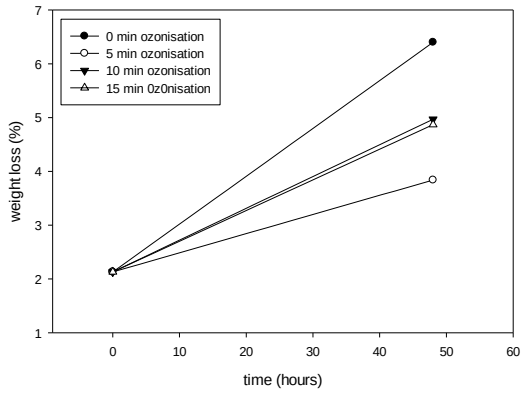


Figure 1. Japanese spinach weight loss with ozone treatment during storage

Ozone treatment and freezing temperature were effective in reducing drip loss but increasing cooking loss, decreasing color attributes, reducing aw values, maintaining pH values, maintaining the rate of increase in TBARS and TVB-N maintaining consumer preferences. The most effective treatment for chicken meat is soaking for 15 minutes and storage at a temperature of -6°C able to maintain drip loss, aw, pH, TBARS, TVB-N, and sensory properties of chicken meat (Prabawa et al., 2021).

### 3. Aspects of Economic Analysis

Economic analysis of vegetable production resulting from ozonation is needed, among others, to see the extent to which a production activity can provide added value for producers. The presented economic analysis is calculated based on one of the vegetable products produced (broccoli) and tool depreciation. Table 1 is an economic analysis of partners, so it can be calculated by applying ozone treatment to capital requirements or costs for production.

Table 1. Economic analysis of ozonized vegetable production

| No. | Item | Cost (Rp) |
|---|---|---|
| 1. | Broccoli | 187500 |
| 2. | Plastic wrapping materials | 20000 |
| 3. | Storage | 90000 |
| 4. | Depreciatian | 19000 |
| 5. | Labor | 25000 |
| 6. | Electric power | 2500 |
| 7. | Marketing transport | 100000 |
| **Total Cost** | | **444500** |

This program provides technical guidance related to efforts to maximize the use of ozone to extend the shelf life of vegetables. It can be seen in Figure 1, ozone treatment can reduce weight loss. Where, the data was not previously available. This information can be used by farmers to calculate production yields. In addition, in this program we also provide facilities for farmers to be able to register their products with the Ministry of Health, considering that products with ozone treatment are still rare in Indonesia, so it is hoped that these products will become legal according to Indonesian regulations and these products can still be sold.

From the above packages, approximately 100 packages are produced; price per package Rp7,500. 00; net 250 grams; total price Rp750,000.00. Profits Rp750,000.00-Rp 444,500.00 = Rp306,000.00. This profit will be in accordance with calculations if it is supported by packaging that attracts consumers and marketing that runs smoothly. In this program, we have not been able to evaluate the increase in the economic value of all the activities carried out. However, in this program we provide simulations related to the achievement targets and estimated costs to run the sale of

packaged vegetables with the help of ozone technology. We will do an evaluation after the farmers carry out this program continuously.

The occurrence of food insecurity conditions can be caused by many factors, but at least can be caused by, among others: (a) lack of economic access for individuals/ households to obtain sufficient food; (b) there is no physical access for individual households to obtain sufficient food; (c) insufficient food for a productive individual/ household life; and (d) food is not fulfilled sufficiently in quantity, quality, variety, safety and affordability of prices. In addition, food insecurity can be affected by people's purchasing power which is determined by their income level. Low levels of public income and reduced purchasing power of food will worsen people's consumption of energy and protein. Spinach can be a source of fulfilling community nutrition, so the nutritional status of the community can be improved and can prevent health risks (Amanto et al., 2021).

## CONCLUSION

Farmers groups can pack ozonized vegetables in marketable packaging because of the availability of ozonized vegetable packaging equipment in the form of wrapping packaging machines. This service activity needs to be followed up by applying it to various other marketable commodities, so that it can become a database for the ozonation process for various commodities. In addition, it is necessary to strive for research and service activities related to the treatment of ozonated concentrations and processing of ozonized vegetable commodities into processed food materials so that the business diversification of the Organic Mutiara Farmer Group becomes more diverse and can increase the competitiveness and welfare of the people.

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