The Effect of Ozone to The Characteristic of Peeled Onion during Storage at Low Temperature

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Abstract. The physical, chemical, microbiological and organoleptic characteristics of peeled onion have decreased during storage. The alternative technology to maintain the characteristics of peeled onion was ozonation technology. The aim of this research was to determine the characteristic of peeled shallot ?? (shallot or onion, should be consistent) which treated with or without ozone and its characteristics during storage at 5±2°C. The ozonation used bubbling method with ozonizer TIP-01. The research method used was regression and correlation analysis. This experiment consisted of 4 treatments, without ozonation which was not packaged and packed with clingwrap plastic and 0,8 ppm ozonation result which was not packaged and packed with clingwrap plastic (should improve the English and rewrite again). The analysis was carried out for 15 days with intervals of time every 3 days. The results showed that the peeled red onion with ozone concentration of 0,8 ppm and packed in plastic clingwrap changed its physical characteristics, chemical, microbiological and organoleptic slower than the peeled onion without ozonation and packed with plastic clingwrap. The peeled Onion with ozonation of 0,8 ppm and packed with clingwrap plastic lost its weight by 4,51%. The color was bright brownish red (L*: 52,52, a*: 12,65, b*: -3,2), VRS levels decreased by 10,29 μgr/g and the total number of microorganisms decreased by 1,17 log CFU/g. The overall color, aroma, and appearance were not favored by panelists with consecutive values of 2,80; 2,87; 3,0 respectively.

The peeled Onion without ozonation that was not packed with clingwrap plastic experienced weight loss by 12.30%. The color was bright red brown (L*: 60, a*: 8,34, b*: -065). VRS levels decreased by 7,78 μg/g and the total number of microorganisms increased by 9,38 log CFU / g. The overall Color, aroma, appearance was not favored by panelists with consecutive values of 1,73; 1,87; 1,73 consecutively.

1. Introduction

One of the cultivated horticultural commodities in Indonesian is onion (Allium ascalonicum L.). The Onion is one of the vegetable commodities that have a significance value for the community, both seen from the high economic value and the nutritional content. The onion production in Indonesia continues to increase, the production of shallots or onion in 2016 reaches up to 1225 million tons. In 2017 it reaches 1,256 million tons and it always increases every year, so it is predicted that the year 2018 will reach 1,287 million tons and in 2019, it will reach 1,318 million tons. This condition is occured because the onion is often used by the community for raw ingredients to manufacture spices.

Along with the increasing of activities leads to various demands in the processing and supplying of foodstuffs including practical spices. One effort to fulfill the consumer's demand, especially for the consumption of onion as a spice is by providing in the peeled form. Peeled onion is one of the alternative options that can be done to speed up and facilitate the processing. However, the process of stripping on shallots causes the onion is easy to damage during storage, so that it give an effect to the physical characteristics and other characteristics that will cause a decrease in quality.
Cooling at refrigerator temperatures is the simplest method to preserve and prolong the shelf life of onions. [1] conducted a study on low temperature storage that can be used for vegetable products is 7 °C. [2] conducted research on storage of onion at 5 °C resulting in the best characteristics of onion. However, the cooling method can only inactivate microorganisms so that a cooling combination with a handling effort that can reduce total microorganisms to maintain peeled onion quality in order to provide safe and quality products to the consumers.

One of the efforts of handling fresh food that is currently being used, namely ozonation. Ozone (O₃) is one type of sanitizer that is widely used and safer than chlorine because ozone leaves no residue so it does not pollute the environment.

Based on the description, it is necessary to study the effectiveness of ozonation of shallot onion which is stored using low temperature (5±2 °C) to reduce the rate of onion quality reduction.

2. Materials and research methods

The materials used are roots of Menteng cultivar onion that has 70-80 days old harvested from the farmers of Ciparay, Bandung Regency. The onion was cut for the neck, roots, outer skin, and cleaned of dirt that stick without washing with water. The peeled onion is divided into 2 parts each 250 grams. 1 part of peeled onion was ozonated in aquades with the temperature 10 °C (1: 8 w/v) with bubbling ozone gas method with flow rate 2.5 L/min for 6 minutes to get the concentration 0.8 ppm. The concentration is maintained for 5 minutes. 1 part peeled onion was soaked in aquades at the temperature 10 °C for 5 minutes without ozone treatment. This ozonation technology performed using TIP-01 Ozonizer l (specification of equipment such as the country origin and other details). The sample was packed in styrofoam with size 15x10 cm² covered by clingwrap plastic, and then stored for 15 days at the temperature of 5±2 °C.

The method used was descriptive experimental method continued by regression analysis and correlation. This result was presented in graph, where the independent variable (x) was the length of storage peeled onion of given treatments, while dependent variable (y) was the main results observation of form shrinkage weights, colors (L*, a* and b*), VRS levels, total microorganisms and organoleptic (color, aroma, and overall appearance). The treatment was done by ozonating the peeled onion until reached the desired concentration, the concentrations used was as the following:

- A= Peeled Onion Without Ozonation and packed with Clingwrap plastic (BMTOK)
- B= Peeled Onion without ozonation Not Packed with Clingwrap plastic (BMTOT)
- C= Onion peeled with the concentration of ozonation 0.8 ppm packed Clingwrap plastic (BMOK)
- D= Onion peeled with the concentration of ozonation 0.8 ppm not packed Clingwrap plastic (BMOT)

The best treatment was determinized by the lowest slope (coefficient regression), where it shows that on this concentration the decline of quality decreases slowly, so it could maintain the characteristics physical, chemical, microbiology and organoleptic peeled onion.

2.1. Shrink weight testing

The sample weight was measured used analytical balance (merk, specification and country origin) by noted the weight of the packaging then weigh the onion peeled on the storage in the day of 0, 3, 6, 9, 12, and 15. The each weight of the sample obtained with this below formula:

\[ W_{onion\ peeleed} = W_{overall} - W_{styrofoam} \] (1.1)

The shrink weight was calculated at the end of the observation (day 15). Shrink weight could be calculated as follow:
Shrink weight = \( \frac{W_{\text{initial}} - W_{\text{final}}}{W_{\text{initial}}} \times 100\% \)  \hspace{1cm} (1.2)

Information:
W1 = Initial weight of sample (it is not matched with the above equation)
W2 = The final weight of the sample

2.2. Analysis color \( L^*a^*b^* \) testing
The color of peeled onion analyzed by measuring CIE \( L^*a^*b^* \) with CR-400 chromameter (detail of specification). The values of \( L^* \), \( a^* \) and \( b^* \) refer to white/dark, reddish/greenish, and bluish/yellowish from each sample respectively. The maximum values for \( L^* \) is 100 which indicated white/light color and the minimum value of \( L^* \) is 0 for black/dark. While for values \( a^* \) and \( b^* \) were not has a value limit, positive \( a^* \) indicated red and negative \( b^* \) show green, meanwhile positive \( b^* \) showed yellow and negative \( b^* \) showed blue color.

2.3. VRS content
The 20 grams Onion was weighed and then ground by using the grinder in cold sample condition then added with 30 ml of aquades. Subsequently, the onion mixture and aquades were put into VRS flask and Erlenmeyer flask previously filled with 25 ml of KMnO\(_4\) 0.02 N solution. Then the distillation was run until the volume of fluid in the Erlenmeyer flask reaching 150 ml, and then 25 ml KMnO\(_4\) and 5 ml of \( \text{H}_2\text{SO}_4 \) 6N and 3 ml of KI 20% were added into the flask, and Titration was done with a titrant of \( \text{Na}_2\text{S}_2\text{O}_3 \) 0.02 N until the color turns to light yellow. Next to the Erlenmeyer flask was added 3 drops of amylum indicator and the titration was continued until the color becomes white. The blank experiments were done with distilled water instead of samples. VRS content was calculated:
\[
\text{VRS content (µ g/µ)} = \frac{(B - C) \times N \text{Na}_2\text{S}_2\text{O}_3 \times 1000}{W_{\text{sample}}} \hspace{1cm} (2.1)
\]

Description :
B = V \text{Na}_2\text{S}_2\text{O}_3 \hspace{0.1cm} \text{0.02 N Solution for titration blank}
C = V \text{Na}_2\text{S}_2\text{O}_3 \hspace{0.1cm} \text{0.02 N Solution for titration sample}
N = Normality solution of \text{Na}_2\text{S}_2\text{O}_3 \hspace{0.1cm} \text{0.02 N}

2.4. Microbiological content
Samples for microbiological testing were made by dilution method up to \( 10^{-7} \), then taking 1 mL of the 3 highest dilutions and poured in a subsequent petri dish for total microorganism testing in poured PCA (Plate Count Agar) medium. The total colony is calculated by calculating the BAM (Bacteriological Analytical Manual) method. The formula for calculating the total of micro colonies by BAM method :
\[
N = \frac{\Sigma c}{[(1 \times n1)+(0,1 \times n2)] \times (d)} \hspace{1cm} (2.2)
\]

Information:
N = a number of product colonies, expressed in colonies per mL or colony per g
\( \Sigma C = a \) number of colonies on all calculated bowls
n1 = a number of saucers on the first dilution calculated
n2 = a number of saucers on the second calculated calculation
d = the first calculated compensation

2.5. Organoleptic Testing
This sensory testing of peeled onion red with and without ozonation was carried out by hedonic test using 15 panelists. The quality parameters tested include color, aroma, and overall appearance. Samples were tested by assessing the onion quality based on the panelist preferences on onion characteristics.
3. Results and discussion

3.1. Physical Characteristics

3.1.1. Shrink Weight

The result analysis in trial this show that their relationship between storage periods to shrinkage weight of peeled onion (please should be peeled onion). The Images of the relationship curve was shown in Figure 1. The percentage of weight loss onion peeled results which packed in plastic clingwrap was small decline in VRS compared with the treatment of onion peeled using ozonation and without ozonation results that were not packed with plastic clingwrap. The weight of onion peeled result of ozonation 0.8 ppm which is packed with clingwrap plastic is thought to be due to the ozone molecule oxidizing the respiratory enzymes (phosphorylase, amylase, transglucosylase, and maltase) to the material. Ozone gets in contact with the cell wall and oxidizes the cell wall which further causes lysis. This results in respiratory enzymes (phosphorylase, amylase, transglucosylase, and maltase) contained in cells, especially on the membranes and nuclei of the cells in the cytoplasm, will be partially inactive, and the respiratory process involving ozone will be inhibited. The inhibited respiratory process inhibits the process of water loss due to evaporation and loss of carbon during respiration resulting in shrinkage of small weight loss compared to the treatment without ozonation [3]. [4] states that this type of packaging also affects the weight loss because it affects the amount of environmental air entering into the material or the amount of air released from the material. The type of packaging relates to the permeability so that appropriate packaging is required to regulate the air coming in and out so that the weight loss can be suppressed.

![Figure 1. Curve Relationship between Storage Duration and Percentage of Weight Red Onion Shoots Results Ozonation and Without Ozonation](image-url)

Color. Known that the red color on onion originated from pigment anthocyanin. Result analysis show that there were relationship between storage periods with the value of L* (brightness), a* (red), and b* (yellow) on onion peeled. The change value L* (brightness) of onion peeled for storage could see on Picture 2. The onion peeled using ozonation and without ozonation results which are packed in plastic clingwrap has a slight increase in color (L*) compared with the treatment of the onion peeled result using ozonation and without ozonation ozonation results that were not packed with plastic clingwrap. The increase in brightness on the peeled onion treatment is suspected that the anthocyanin pigment in onion decreases as it is degraded during the storage. Ozone is a powerful oxidizing agent that could remove the organic dyes (discoloration), so the color of the ozonated material will be maintained compared with the material without ozonation [5].
Giving ozone gas to potato tubers can slow the course of respiration. The absence of ozone bubbling in the onion without ozonation causes respiration to run faster than the ozone treated onion bubbling onion. This results causes a rapid changes in brightness due to the anthocyanin degradation also in the treatment without ozonation, so the onion color is getting pale and resulting an increase in the brightness intensity value (L*).

![Graph showing the relationship between storage duration and L* brightness for red onion peel ozonation and without ozonation.](image)

**Figure 2.** Curve Relationship between Storage Duration and L* (Brightness) Red Onion Peel Ozonation and Without Ozonation

The decline of brightness was undesirable for the stored peeled onion because signifies a decline quality from rottenness materials, so if seen from the coefficients regression value of each treatment, the onion result using ozonation and without ozonation results which are packed in plastic clingwrap show a good brightness compared with ozonation result and without ozonation which is not packed with clingwrap plastic.

![Graph showing the relationship between storage duration and a* brightness for onion peeled ozonation results and without ozonation.](image)

**Figure 3.** Curve Relationship between Storage Duration with Value a* Onion Peeled Ozonation Results and Without Ozonation
Different with value a* (red), which indicates that onion peeled without ozonation and result ozonation experience decline a* value (Figure 3). When viewed from the value of the regression coefficient, the ozonation result of the onion and onion results without ozonation that is not packed with clingwrap plastic has a small (a*) color reduction compared to the treatment of shallot peeled ozonation results and without ozonation packed with clingwrap plastic. Color a* (red) onion peeled ozonation results 0.8 ppm allegedly due to ozone oxidizing mitochondria in the cell. This results in respiratory enzymes (phosphorylase, amylase, transglucosylase, and maltase) contained in the cell, especially the mitochondria in the cell organelle, will be partially inactive, and the respiratory process involving ozone will be inhibited. The inhibited respiratory process inhibits the process of mitochondrial damage resulting in a lack of energy supply for cell metabolism, resulting in cell death which affects a decrease in a* (red) color [6].

The same result showed by the value of b* (yellow), the decrease of color b* (yellow) during storage is caused by the degradation of anthocyanin pigment and also the occurrence of decay so that the red color of the outer shell is partially pale. Anthocyanin degradation can occur during the process of extraction, food processing, and storage. The factor that cause anthocyanin degradation are light, oxygen, and enzymes. The anthocyanin pigment is very sensitive to these factors so that in this observation the peeled onion is tarnished and finally yellowing. In this study, the condition of onion storage peeled generally can still be exposed to light even if stored in the refrigerator. In addition, packaging treatment with styrofoam and clingwrap still allows the exchange of oxygen into the material because it has permeability capability. During storage, the reactions to the oxygen, light, and enzymes make the peeled onions change color.
The permeability of 800 cm$^3$/cm$^2$/mm/s/cmHg. This high permeability of water vapor allows the respiration of vegetables and fruits in the package to remain smooth, so that the quality is maintained [7].

The change of VRS content of onion during storage is affected by enzyme activity. The enzyme that plays a role in this flavor change is the peptidase enzyme. The flavor change of red onion resulted from the activity of peptidase enzyme and flavor precursor of the onion L-glutamin peptidase [8]. This is supported also by [9], the higher activity of VRS-forming enzyme then the VRS level on the tuber will increase, otherwise if enzyme activity decreases then the VRS level will also decrease. Onion flavor may be affected by several factors such as the state during growth including plant life, soil sulfur content and soil water content, conditions during storage and further processing after harvest.

Figure 5. Curve Relationship between Storage Long Time and VRS Value Red Onion Peel Ozonation and Without Ozonation

3.3. Characteristics of Microbiology
Analysis Microbiology. For storage, the onions peeled is very susceptible to damage, one of them was by growth microorganisms. Ozonation is one of the handling postharvest method that have already used for reduce amount microorganisms on onion peeled. Total number of microorganisms onion peeled for storage could seen on Figure 6.

The peeled Onion with ozonation and packed with clingwrap plastic and not packed with clingwrap plastic showed lower total number of microorganisms at the beginning of storage up to the 6th day of storage and subsequently increasing until the 15th day of storage. When compared with peeled shallot or onion without ozonation, on the day of storage of the 6th, the onion resulted from ozonation which is packed with clingwrap plastic and not packed with clingwrap plastic can reduce the total number of microorganisms as much as 1.17 log CFU/g and 2.08 log CFU/g. Onion peeled without ozonation increase in total microorganisms on day 9 because of the ozone effect for sterilization has been lost because ozone leaves no residue in the samples given the immersion treatment in the water of
the ozone [11]. Although ozone is capable of reducing total organisms, the total microorganisms will rise again during storage. This is because the longer the storage time the damage from the material will increase so that trigger the growth of microorganisms and other damages. The use of low temperature and the type of packaging can inhibit the growth of microorganisms during storage. Packaging clingwrap has transparent, high tensile strength, not easily torn, resistant to acids and bases except oxidizing acids, resistant to oil, alcohol and petroleum solvents so as to inhibit the growth of microorganisms.

![Graph](image-url)

**Figure 6.** Curve Total Amount of Red Onion Microorganisms Peel Ozonation and Without Ozonation

### 3.4. Organoleptic Characteristics

**Color.** Based on observations presented in Figure 7, the peeled onion ozonation results which are packed in plastic clingwrap has a small decline compared to the onion peeled using ozonation and without ozonation results were not packed with plastic clingwrap during 15 day storage. The decrease preference for color values correspond to color values a * (red) as shown in Figure 3. The decline in the value of the color, a * (red) during storage at each treatment possibilities for onion is still experiencing metabolism during storage, in which the respiration activity is still happen. Respiration generates heat which causes the increase of heat, so the process of decline such as water loss, withered, and growth of microorganisms will increase [12].
Figure 7. Curve Level Curve on Red Onion Color Result of Ozonation and Without Ozonation

Aroma. Based on observations presented in Figure 8, onion peeled ozonation results are packed in plastic clingwrap small decline compared to treatment color red onions peeled and without ozonation results were not packed with plastic clingwrap during 15 day storage. The decrease in the preferred value to the scent corresponds to the VRS value as shown in Figure 5. The decrease in VRS levels can be caused by increasing damage as the length of storage such as the sprout bulbs. [8] argues that the sulfur precursor of flavor can be used for metabolic activity and shoot growth so that the number decreases and causes a decrease in flavor production. The typical aroma of onion will undergo changes during storage depending on the amount of allicin compounds. The aroma will increase as allinase enzyme activity increases and decreases with decreasing allinase enzyme activity [2].

Figure 8. Curve level curve on onion scent result of ozonation and without ozonation

Overall Appearance. Based on observations presented in Figure 9, the peeled onion ozonation results are packed in plastic clingwrap has a small decline compared to treatment color red onions peeled and without ozonation results were not packed with plastic during storage clingwrap in 15 day. The decrease in the preferred value to the overall appearance corresponds to the a* (red) and VRS color values as shown in FIGS. 3 and 5. Clingwrap has transparent, high tensile strength, is not easily torn,
resistant to acids and bases except oxidizing acids, resistant to oil, alcohol and petroleum solvents, this packaging has a thickness of 0.01 inches. Styrofoam has the properties to prevent leakage and maintain the form of food when held, maintaining the freshness and integrity of packaged and lightweight materials [13]. Ozone treatment can inhibit the occurrence of damage if used in the right concentration, but if used with excessive concentration can damage the structure of the network. Ozone with the right concentration is able to inhibit the occurrence of damage to vegetables, both in terms of color, texture, aroma, but ozone with very high concentration can cause damage to tissue on vegetable surface due to oxidation reaction. The use of clingwrap has a function to maintain the freshness of vegetables and vegetables. Packaging of fresh vegetables will be better if combined with minimal processing.

![Graph](image_url)

**Figure 9.** Curve of readability level on overall appearance of peeled onion by ozonation and without ozonation

### 4. Conclusion
During the storage for 15 days at 5±2 °C, the peeled onion of 0.8 ppm ozonation which is packed with clingwrap plastic showed less changes in physical, chemical, microbiological, and organoleptic characteristics than that of the peeled onion without ozonation packed with plastic clingwrap. peeled Onion with ozonation and packed with clingwrap plastic had shrink weight of 4.51%. The color is bright brown (L*: 52.52, a*: 12.65, b*: -3.2), the VRS level decreases by 10.29 μgrek/g and total number of microorganism noodles decreased by 1.17 log CFU/g. The overall color, aroma, and appearance are not favored by panelists with consecutive values of 2.80; 2.87; 3.0. The peeled Onion without ozonation that is not packed with clingwrap plastic experience weight loss of 12.30%. The color is bright red brown (L*: 60. a*: 8.34, b*: -065). VRS levels decreased by 7.78 μgr / g and the total number of microorganisms increased by 9.38 log CFU / g. Color, aroma, overall appearance is not favored by panelists with consecutive values of 1.73; 1.87; 1.73.

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