Curing Process Modification of Shallot Through Cutting Leaves

Dwi Amiarsi*, K S Sasmitaloka, A B Arif and S M Widayanti

1Indonesian Center for Agricultural Postharvest Research and Development, Jln. Tentara Pelajar No. 12, Bogor 16112

*Email : amiansidwi@yahoo.co.id

Abstract. Shallot (Allium cepa L. Var. ascalonicum Backer) is one of horticulture crop that serves as a spice in daily cuisine for almost all Indonesian people. One of postharvest handling of shallot after harvesting is the curing process to extend the freshness of shallot bulbs. Curing process needs a lot of energy to dry the leaves. Even though the curing process only to dry the bulbs. For this reason, we can cut the leaves through a curing process to save the energy. This study aimed to obtain the right cutting leaves to save energy needed in the curing process. The shallot bulbs are harvested in the morning. Then the shallot leaves are cut to the length of each leaf 1-10; 11-20; 21-30 cm and without cutting (as a control). The results showed that the cutting technique of shallot leaves with a leaf length of 1-10 cm to 11-20 cm from the initial leaf length could shorter until 4 days curing processing time with a weight loss of 16.22%, water content of 80.83%, the brightness value of 45.60, and the texture of 1589.00 gram/mm².

1. Introduction

Shallots are one of the leading vegetable commodities that have been intensively cultivated by farmers. Shallots are used as a seasoning for cooking and traditional medicine because they contain antiseptics and alliin compounds. The alliinase enzyme will convert alliin compounds to be pyruvic acid, ammonia and allin as anti-microbial [1]. Shallots also contain vitamin C, potassium, fiber, folic acid, calcium and iron. Central Bureau of Statistics [2] reported that shallots production increased by 5.04% per year where in 2016 the production amounted to 1.172 million tons then in 2017 to 1.23 million tons. As a seasoning for cooking and traditional medicine, Indonesian per capita consumption per year is 2.76 kg. So that if it is assumed that Indonesia's current population is 250 million, Indonesia's need for shallots is around 690,000 tons/ year. This means that the need of shallots can already be met by national shallot production. However, because of shallots products are seasonal horticultural products and prone to disease in inappropriate post-harvest handling (curing, drying, and storage process), then there is often a gap between demand and supply. So we need products with quality and quantity that are able to compete commercially and guaranteed the continuity of production.

Quality of shallot bulbs was determined by the color, moisture content, hardness, and durability of the freshness of the shallot bulbs during storage. Consumers expect the appearance of good shallot bulbs with their freshness resistance. However, shallots have relatively short freshness resistance, around 2-3 days (personal interview). This characteristic can be an obstacle in the supply of materials, both for fresh and for processing. This is because in general horticultural products are living structures that are still undergoing processes of chemical and biochemical changes caused by metabolic
activities. In order to reach further distribution places with long freshness, special treatment is needed. One of treatment is by cutting the leaves followed by storage, which is an alternative treatment to protect the shallot from decay damage and facilitate further handling [3, 4].

The curing process is the first postharvest handling process that is carried out after the shallots are harvested. Curing process aimed to reduce water content around the leaves and bulbs of shallots. Modification of the shallots storage system with aeration setting is expected to be developed to improve the shallots storage technique so as to extend the shelf life of shallots. Curing process needs a lot of energy to dry the leaves. Even though the curing process only to dry the bulbs. For this reason, we can cut the leaves through a curing process to save the energy. This study aimed to obtain the right cutting leaves to save energy needed in the curing process.

2. Materials and methods

2.1. Raw materials

The study was conducted at Postharvest Research Laboratory, Indonesian Center for Agricultural Postharvest Research and Development, Ministry of Agriculture, Bogor, West Java from March to October 2017. Shallots are harvested in early morning at the commercial level of farmers. Shallots harvested were selected fresh, healthy and as uniform as possible with the cutting leaves of 1-10 cm, 11-20 cm, 21-30 cm, and without cutting leaves.

2.2. Methods

The study was designed based on a completely randomized design with one experimental factor including cutting leaves, as many as four levels, i.e. (1) without cutting leaves (control); (2) cutting leaves 1-10 cm; (3) cutting leaves 11-20 cm; and (4) cutting leaves 21-30 cm. Then, it were storage at temperature of 27-30°C. Observations carried out every day consisting of weight loss (AOAC, 1995), moisture content (AOAC, 1995), colour (chromameter), and texture (Texture Analizer Pro CT).

2.3. Statistical analysis

The data collected during the experiment was tabulated and evenly distributed from each treatment, then analyzed using the S.A.S method version 9.13 To see the mean difference between treatments, continued the Duncan Multiple Range Test (DMRT) different test of the 5% test level.

3. Results and discussion

Shallot plant components presented in Table 1. Based on data Table 1, there are differences in components, i.e. leaves (41.74 ± 2.46%) and bulbs (58.26 ± 2.46%) of the total shallot plants. Onion bulbs contain antiseptics and alliin compounds.

| No. | Components | Percentage     |
|-----|------------|----------------|
| 1.  | Leaf       | 41.74 ± 2.46%  |
| 2.  | Bulbs      | 5.26 ± 2.46%   |

3.1. Weight loss

Weight loss is one of the indicator the decrease quality in agricultural products, especially horticultural products such as shallots. The high water content in freshly harvested shallots, which is around 82.00%, causes shallots to be treated immediately so as not to cause decay due to high respiration and transpiration activities that occur in shallots after being harvested. Cutting shallot leaves is part of post-harvest handling that can be applied to resist the decrease in water content of shallots which greatly affects the onion weight loss.

In Table 2, it can be seen that there is an increase in shallots weight loss in all treatments during storage. The increase in weight loss is indicated by the curing process of shallot leaves. Statistical
analysis of cutting leaves with a variety of different cuts showed different results. The results showed that shallots stored at room temperature (28°C) with Rh 65% had a weight loss ranging from 16.22 - 34.87%. Weight loss for 6 days of storage in control or without cutting onion leaves is 34.87%, cutting leaves with a leaf length of 21-30 cm is 33.30%, cutting leaves with a leaf length of 11-20 cm is 31.34%, and cutting leaves with a leaf length of 1-10 cm is 16.22%.

During the storage process, shallots still carry out the metabolic process. The process that is still active is respiration, when the respiration process takes place an enzymatic chemical reaction that breaks down starch, sugar, proteins, fats, organic acids and other complex compounds into simpler energy (H₂O and CO₂). The water and carbon dioxide are then released into the air in the form of steam and gas. With this release, there is a decrease in weight loss on the stored shallot bulbs [5].

Table 2. Weight loss of shallots at room temperature (28°C), Rh 65%

| Sample | Weight loss (%) | Days - |
|--------|-----------------|--------|
|        | 0   | 1   | 2   | 3   | 4   | 5   | 6   |
| RK     | 0±0a | 11.75±1.06a | 20.31±1.09a | 27.28±1.62a | 31.05±0.90a | 33.75±1.43a | 34.87±0.74a |
| RB     | 0±0a | 11.77±0.59a | 20.41±1.19a | 26.48±0.99a | 29.69±1.02ab | 31.91±1.16ab | 33.30±1.28ab |
| RC     | 0±0a | 12.37±1.85a | 20.17±3.22a | 24.50±2.27a | 27.62±2.15b  | 29.49±1.81b  | 31.34±1.86b  |
| RD     | 0±0b | 7.43±1.49b  | 10.59±2.02b  | 12.52±2.41b  | 14.14±2.32c  | 15.01±2.52c  | 16.22±2.98c  |

Remarks:
RK: control (without cutting leaves)
RB: with cutting leaves 21-30 cm
RC: with cutting leaves 11-20 cm
RD: with cutting leaves 1-10 cm

3.2. Color

Color is an important factor in assessing the quality of shallots. The color notation system is stated using the Hunter system, which is characterized by three parameters, namely L*, a*, and b*. The value of L represents brightness which has a value ranging between 0 (black) and 100 (white). The value of a* represents the color of chromatic (°Hue) which is a mixture of red and green. The value of b* states the chromatic color which is a mixture of yellow and blue. The degree of hue (°Hue) is calculated by the equation of arc tan or b/a. If °Hue ranges from 18° to 54° the color is red, and if °Hue ranges from 54° to 90° the color is reddish yellow. Statistical analysis results of the brightness color show that are not significantly different. Observations show the L*; a*; and b* values shallots each range from 41.57 to 48.42; 22.22 to 29.34; -3.58 to -9.07. Statistical analysis results showed that cutting leaves did not significantly different for colour. Sample with cutting leaves 1-10 cm on days 6 had L value of 45.60, a value of 25.33, and b value of -5.94.

The degree of Hue (°Hue) was obtained from the measurement of a* and b* values that are stored ranges from 22.22 to 29.34 including in the red category because it is between 18° and 54° [6]. While the b* value ranges from -3.58 to -9.07. It is meant that the colour of shallots approaching dark/purple (Hunter colour system notation). This is caused by the oxidation of carotene and xanthoply pigments which occur gradually due to contact with free air [7].
### Table 3a. Color (L) of shallots stored at room temperature (28°C), Rh 65%

| Sample | Days - |
|--------|--------|
|        | 0      | 1      | 2      | 3      | 4      | 5      | 6      |
| RK     | 44.05±3.40<sup>a</sup> | 44.43±4.26<sup>a</sup> | 44.91±3.54<sup>a</sup> | 41.57±1.55<sup>a</sup> | 45.45±2.31<sup>a</sup> | 44.98±3.60<sup>a</sup> | 44.7±3.84<sup>a</sup> |
| RB     | 42.50±2.56<sup>a</sup> | 43.44±1.38<sup>a</sup> | 44.04±2.87<sup>a</sup> | 43.65±0.61<sup>a</sup> | 43.52±2.38<sup>a</sup> | 42.88±2.73<sup>a</sup> | 42.87±2.26<sup>a</sup> |
| RC     | 42.10±4.69<sup>a</sup> | 44.94±1.36<sup>a</sup> | 43.53±1.28<sup>a</sup> | 41.59±2.04<sup>a</sup> | 44.64±1.64<sup>a</sup> | 43.99±1.31<sup>a</sup> | 45.59±2.19<sup>a</sup> |
| RD     | 48.42±4.57<sup>a</sup> | 46.98±3.57<sup>a</sup> | 45.90±2.86<sup>a</sup> | 43.40±1.50<sup>a</sup> | 45.61±2.49<sup>a</sup> | 45.25±2.10<sup>a</sup> | 45.60±2.03<sup>a</sup> |

Remarks:
- RK: control (without cutting leaves)
- RB: with cutting leaves 21-30 cm
- RC: with cutting leaves 11-20 cm
- RD: with cutting leaves 1-10 cm

### Table 3b. Colour (a) of shallots stored at room temperature (28°C), Rh 65%

| Sample | Days - |
|--------|--------|
|        | 0      | 1      | 2      | 3      | 4      | 5      | 6      |
| RK     | 26.81±5.14<sup>a</sup> | 26.75±6.83<sup>a</sup> | 26.84±7.20<sup>a</sup> | 23.31±5.63<sup>a</sup> | 25.60±6.57<sup>a</sup> | 25.10±6.48<sup>a</sup> | 25.12±7.19<sup>a</sup> |
| RB     | 27.13±2.08<sup>a</sup> | 22.22±1.52<sup>a</sup> | 26.08±3.55<sup>a</sup> | 25.51±2.94<sup>a</sup> | 26.35±2.08<sup>a</sup> | 25.52±2.08<sup>a</sup> | 25.82±1.00<sup>a</sup> |
| RC     | 29.34±1.43<sup>a</sup> | 28.05±1.91<sup>a</sup> | 29.50±1.95<sup>a</sup> | 26.32±4.02<sup>a</sup> | 27.79±2.97<sup>a</sup> | 27.84±3.28<sup>a</sup> | 27.07±3.30<sup>a</sup> |
| RD     | 24.14±2.94<sup>a</sup> | 24.11±2.42<sup>a</sup> | 25.59±3.03<sup>a</sup> | 27.26±2.22<sup>a</sup> | 26.05±1.96<sup>a</sup> | 26.19±2.22<sup>a</sup> | 25.33±2.22<sup>a</sup> |

Remarks:
- RK: control (without cutting leaves)
- RB: with cutting leaves 21-30 cm
- RC: with cutting leaves 11-20 cm
- RD: with cutting leaves 1-10 cm

### Table 3c. Color (b) of shallots stored at room temperature (28°C), Rh 65%

| Sample | Days - |
|--------|--------|
|        | 0      | 1      | 2      | 3      | 4      | 5      | 6      |
| RK     | -7.53±4.03<sup>a</sup> | -7.19±3.11<sup>a</sup> | -6.84±3.04<sup>a</sup> | -6.59±3.11<sup>a</sup> | -6.33±1.81<sup>a</sup> | -5.23±1.68<sup>a</sup> | -5.58±2.22<sup>a</sup> |
| RB     | -6.26±1.01<sup>a</sup> | -3.58±1.09<sup>a</sup> | -5.95±2.17<sup>a</sup> | -7.32±2.77<sup>a</sup> | -6.22±1.66<sup>a</sup> | -5.69±1.18<sup>a</sup> | -4.72±1.52<sup>a</sup> |
| RC     | -9.07±2.47<sup>a</sup> | -7.94±1.01<sup>a</sup> | -8.19±1.11<sup>a</sup> | -6.70±1.54<sup>a</sup> | -6.59±1.78<sup>a</sup> | -7.14±0.73<sup>a</sup> | -6.49±0.91<sup>a</sup> |
| RD     | -7.61±1.32<sup>a</sup> | -8.82±2.53<sup>a</sup> | -8.87±2.63<sup>a</sup> | -6.63±0.67<sup>a</sup> | -5.99±3.20<sup>a</sup> | -5.28±1.62<sup>a</sup> | -5.94±1.72<sup>a</sup> |

Remarks:
- RK: control (without cutting leaves)
- RB: with cutting leaves 21-30 cm
- RC: with cutting leaves 11-20 cm
- RD: with cutting leaves 1-10 cm

### 3.3. Moisture content

Overall the moisture content in the treatment of different cutting leaf lengths during storage tends to be constant and does not change, which is around 79.86 - 82.98%. The water content is high. This is due to the storage of 28°C temperature with a relative humidity of 65%, the process of respiration and evaporation runs fast and consequently the water content at high temperatures can be maintained. Moisture content of shallots stored at room temperature (28°C) with cutting leaves 1-10 cm on days 6 was 81.18%. This moisture content still constant and did not change during curing process.
Table 4. Moisture content of shallots stored at room temperature (28°C), Rh 65%

| Sample | Moisture content (%) | Days - | 0    | 1    | 2    | 3    | 4    | 5    | 6    |
|--------|----------------------|--------|------|------|------|------|------|------|------|
| RK     | 82.98±0.22 a          | 81.87±1.04 a | 81.11±0.45 a | 81.04±0.64 a | 79.63±0.24 a | 80.84±0.52 a | 79.14±0.17 a |
|        | 81.99±1.21           |         |      |      |      |      |      |      |      |
| RB     | 82.98±0.22 a          | 81.58±0.59 b | 81.35±1.56 a | 81.06±0.57 a | 82.38±0.12 b | 81.89±1.88 b | 80.83±0.60 b |
|        | 82.56±0.24           | 82.45±0.22 b |      |      |      |      |      |      |      |
|        | 82.06±0.08           | 81.39±0.21 b |      |      |      |      |      |      |      |
| RC     | 82.98±0.22 a          | 82.69±0.10 b | 82.56±0.24 b | 82.45±0.22 b | 81.49±0.51 a | 81.30±0.79 c | 81.18±0.22 c |
|        | 82.06±0.08           |          |      |      |      |      |      |      |      |
| RD     | 82.98±0.22 a          | 82.58±0.23 a | 82.06±0.08 a | 81.49±0.51 a | 81.30±0.79 c | 81.18±0.22 c |

Remarks:
RK: control (without cutting leaves)
RB: with cutting leaves 21-30 cm
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RD: with cutting leaves 1-10 cm

3.4. Texture

The results of statistical analysis of the texture showed that different leaf cutting treatments during storage showed differences. The texture value of shallots during storage ranged from 1210.83 to 2125.83 grams/mm². Observations on the texture during storage showed an increase and decrease in the texture value of shallots. The increase and decrease in texture values associated with evaporation of water and texture values depend on the thickness of the outer skin and the content of the composition of the cell wall in a material [8,9]. This increase in texture value also affects the weight loss due to the high texture value caused by the amount of water lost [10,11]. Texture of shallots stored at room temperature (28°C) with cutting leaves 1-10 cm on days 6 was 1522.67 g/mm². Statistical analysis showed that texture of shallots with cutting leaves 1-10 cm on days 6 did not significantly different with texture of shallots with cutting leaves 1-10 cm on days 0 (fresh shallot).

Table 5. Texture of shallots stored at room temperature (28°C), Rh 65%

| Sample | Texture (g/mm²) | Days - | 0    | 1    | 2    | 3    | 4    | 5    | 6    |
|--------|----------------|--------|------|------|------|------|------|------|------|
| RK     | 1657.17 a      | 1266.67 a | 1488.33 a | 1759.17 ab | 1559.50 ab | 1844.67 a | 1456.50 a |
|        | 1266.67 a      |         |      |      |      |      |      |      |      |
| RB     | 1657.17 a      | 1464.50 ab | 1838.67 a | 1693.83 a | 1743.50 a | 1395.50 ab | 1697.83 a |
|        | 1795.00 b      | 1827.83 a | 2125.83 ab | 1210.83 b |      | 1496.00 b | 1589.00 a |
| RC     | 1657.17 a      | 1694.50 ab | 1255.67 a | 1339.67 a | 1564.83 ab | 1684.17 ab | 1522.67 a |
|        | 1795.00 b      |          |      |      |      |      |      |      |      |

Remarks:
RK: control (without cutting leaves)
RB: with cutting leaves 21-30 cm
RC: with cutting leaves 11-20 cm
RD: with cutting leaves 1-10 cm

4. Conclusions

The results showed that the cutting technique of shallot leaves with a leaf length of 1-10 cm to 11-20 cm from the initial leaf length could shorter until 4 days curing processing time with a weight loss of 16.22%, water content of 80.83%, the brightness value of 45.60, and the texture of 1589.00 gram/mm².

5. References

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