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Technical and Fumigation Time Effects on Shallot Storage Quality

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Abstract. Storage involves management after harvest which plays an important role in the quality control of shallots. Shallot farmers also store using the traditional methods of fumigation, e.g smoke, which is used in liquid smoke processing. This research aims to determine the effect of smoking during storage on the physical and sensory characteristics of shallots. The random nature of the block had two factors: smoking (traditional smoking, spraying, dipping methods) and smoking time (1, 2, and 3 hours respectively). The measured variables include weight loss, moisture content, damage and sensory characteristics (texture, flavour). Furthermore, tests were conducted every week for 4 weeks without fumigation according to controls. The results showed that fluid smoke decreases weight loss, moisture content, and lowers the risk of damage using the immersion process. The consistency of shallots can be preserved for up to four weeks by soaking in liquid smoke for 2 hours. There was a weight loss of 4.6%, damage of 1.17% and moisture content of 82.5%. Smokeless shallots also had a weight loss of 33%, damage of 9.17% and humidity 87.29%. Therefore, soaking shallots for 2 hours in liquid smoke helps to retain their physical and chemical properties without changing their sensory characteristics.

Keywords: liquid smoke, shallot, soaking

1. Introduction

Shallots are essential vegetable products in Indonesia used as kitchen spices daily [1], [2]. There is also a growing demand for raw shallots as functional foods to prevent a variety of degenerative diseases [3]. Shallot productivity is greatly affected by the season and increasing demand. The production increased from 2015 to 2017, with 1,446,869 tons, 1,470,155 tons and 1,503,438 tons each year.

Shallots have a high moisture content, therefore they are easily damaged [4], [5]. This damage can also occur during storage from germination. Storage is a post-harvest handling that plays an important role in quality control in order for the shallots to be accepted by the market [6], [7]. Furthermore, there are vegetable storage techniques to maintain quality during storage, such as controlled or modified atmospheric methods [8], [9] or temperature regulation [4]. However, these methods cannot be applied by farmers due to cost constraints.

Shallot farmers utilize the unregulated temperature fumigation device as a normal storage process [9]. Hot smoking occurs when the material is located relatively close to the smoke source and the temperature is set between 65°-70°C, but the effect is inconsistent [4]. This leads to weight losses of up to 30% for shallot farmers and damages to microorganisms, reducing production. Smoking is an old procedure which preserves the quality and efficiency of the shallot, as well as in other agricultural



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products [7]. Furthermore, fumigation inhibits texture changes and loss of vitamin C, microbiologically reduce production, and prevent sporous fungal growth on the stored material [7], [10]. The lack of traditional smoking presents problems when changing the flavor and concentration of smoke materials. This is because the end product is not standardized, as carcinogenic aromatic hydrocarbons can be manufactured at optimum time and temperature.

Smoking technology has been developed to retain smoke in form of liquid. The acidic portion of liquid smoke, namely formic, acetic, propionic, butyric, valeric and isocaproic acid, possesses the capacity to increase the shelf-life of food commodities with antibacterial activity [11]. The components and characteristics of liquid smoke is dependent on materials such as rice husks and coconut shells [12], [13].

Liquid smoke application can be achieved using techniques of spraying or immersion [14]. Smoking is one of the inexpensive methods of preservation for agricultural products, according to [10]. This study's novelty is the research into the effect of liquid smoke application techniques on shallots during storage. Furthermore, it is aimed at studying the influence of the smoking process on the physical and sensory characteristics of shallots during storage.

2. Experimental details

2.1. Ingredients

The main ingredients were shallot without leaves, harvested 70 days after planting, from Brebes, Central Java, and liquid smoke from coconut shells (PT. Asap Cair Multiguna Semarang, Central Java, Indonesia).

2.2. Method of fumigation and storage condition

Fumigation was performed using three methods: traditional smoking, liquid smoke solution immersion, and liquid smoke sprinkling. Smoke was administered for 1, 2 and 3 hours. Traditional smoking was performed in a 5x8 meter enclosed space with sections of bamboo. The smoked shallots were then stored in a 30°C room for analysis.

2.3. Experimental design

The research used a split plot with 2 replications of a totally random design. The factors tested included: 1) storage time as the main plot: 1, 2, 3, 4 weeks; 2) sub-plot fumigation phase (traditional smoking, liquid smoke spray and dip methods) and 3) sub plot fumigation time (0, 1, 2, 3 hours).

4. Analysis of samples

The analysis was performed on moisture content via the gravimetric method [15], weight loss with the pre and post-storage difference [16] and sensory properties (texture and aroma) with difference method [17]. Furthermore, sensory testing was conducted by ten trained panelists.

3. Results and Discussion

3.1. Moisture content

One of the parameters that affect the quality of shallots during storage is moisture content. The interaction between smoking method and storage time caused a significant difference in the moisture content of shallots. They had 89% moisture content without smoking, where moisture remained intact during storage for 4 weeks. This corresponds with [18] that shallots have an 89% moisture content. Meanwhile, smoking either reduces the moisture content of the shallots using conventional methods or with liquid smoke (Fig 1a). The shallots sprayed with liquid smoke had the lowest humidity compared to the other methods. The soaking method did not result in any significant difference in moisture content, compared to traditional smoking during storage. The water content was lower after the spraying method, as water does not bind significantly with the substance. Therefore, this smoking method is practically

the same as the shallot treatment technique, where curing reduces the moisture content outside the shallot [19].

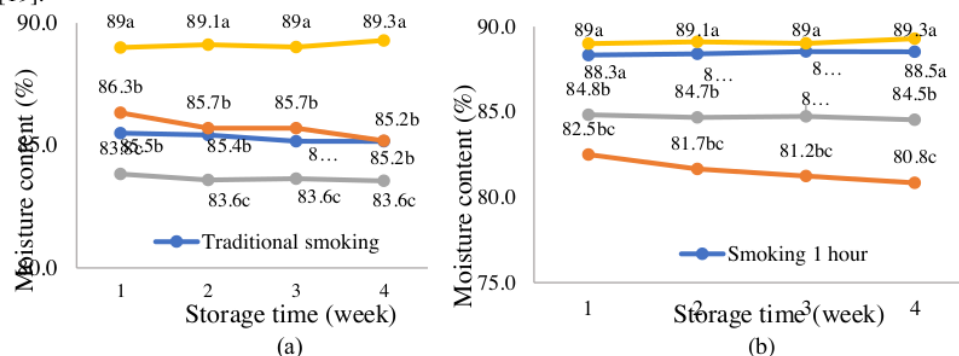


Figure 1. a) Effect of the shallot smoking method on moisture content during storage; b) Effect of the shallot smoking time on moisture content during storage

The interaction between smoking and storage time caused a significant difference in the moisture content of shallots. Smoke application for 2 hours produced the lowest moisture content and remains during storage (Fig 1b). Non-smoked or smokeless shallots had the highest moisture content during storage from the first (89%) to the fourth week (89.3%). Furthermore, smoke acts as a mask that prevents moisture from entering, as the moisture content is lower after smoking.

The moisture content of shallots during storage was largely unchanged. This differs from [4], which claimed that the water content decreased until the end of storage. This decrease may have occurred due to transpiration and respiration.

3.2. Weight loss

The loss of weight during storage represents the degree of freshness, as lower weight loss signifies a fresher product [4]. The interaction between smoking and storage time significantly affected the weight loss of shallots. Smoked shallots had a lesser weight loss than non-smoked ones. Furthermore, shallots smoked according to the conventional method had a higher weight loss compared to the use of liquid smoke. Shallot weight loss can be minimized using liquid smoke during storage compared to the conventional and non-smoking (Fig. 2a). The liquid smoke by dipping produced the lowest weight loss shallots. Due to the soaking procedure, liquid smoke was absorbed more effectively in the shallots. According to [20], the use of liquid smoke will minimize material weight loss during stocking. Furthermore, the smoke acts as a coating to prevent weight loss during storage. It also prevents shallot moisture from escaping to ensure consistency in weight during storage.

The interaction of smoking and storage time significantly influenced shallot weight loss. This weight loss was the highest obtained, without smoking or other temperature treatments. It occurred due to the evaporation of water content from the tubers, causing increased weight loss during storage. The 2-hour smoking time was the lowest compared to the 1 hour (Fig. 2b). In the meantime, weight loss increased for 3 hours due to the increase in water absorbed into the material.

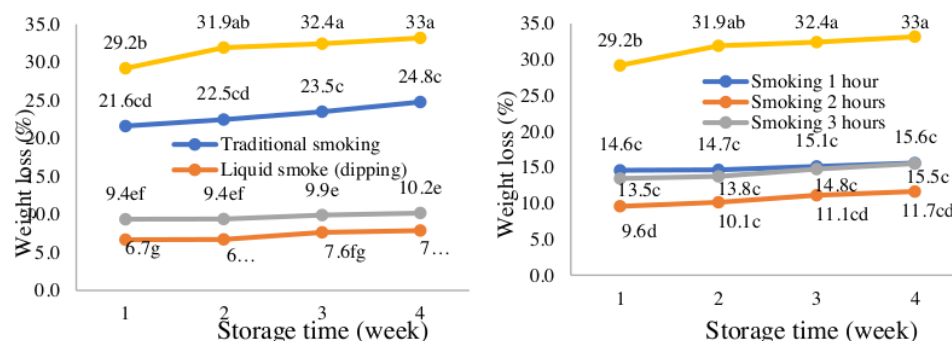


Figure 2. a) The effect of the shallot smoking method on weight loss during storage; b) The effect of smoking time on weight loss during storage

The weight loss in shallots continued to increase with an increased storage time. This is because red shallots still carry out metabolic processes including respiration. Furthermore, during respiration, an enzymatic process occurs which causes an overhaul of complex compounds to form energy with the end result in form of water and carbon dioxide released into the air. This causes the decrease in the weight of the shallots. The presence of smoking forms a coating that functions as a protection to reduce weight loss during storage.

3.3. Damage Rate

Shallots are damaged when they form mechanical arrows, red and hollow due to pesticides or diseases. The interaction between smoking and storage time had a significant effect on the level of damage to shallots. Fumigation decreased the number of shallots damaged, while the level of damage remained relatively unchanged for 4 weeks of storage (Fig. 3a). Shallots not smoked in the first week had a 9.2% damage rate which proceeded to rise to 14.02% at the fourth week. After 4 weeks of storage, non-smoked shallots had a 14.02% damage rate. This occurred due to high sprouts and root growth in tubers during the storage of shallots. Smoking can reduce the amount of shallot damage, and no separate damage was caused by the three smoking techniques during storage. In the first week, shallots administered with fluid smoke by immersion, spraying, and conventional methods had a damage rate of 1.0; 1.6% and 1.8%. Furthermore, the 4-week storage rate only marginally increased to 2.0; 2.1 and 2.4% respectively.

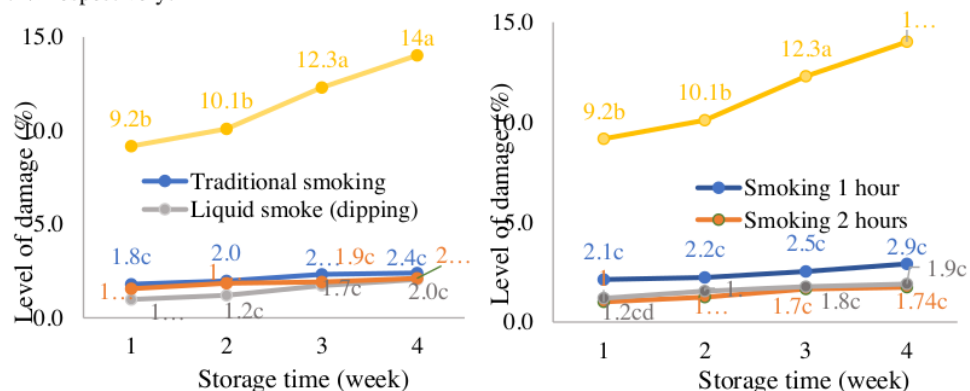


Figure 3. a) Effect of the shallot smoking method on damage rate during storage; b). Effect of shallot smoking time on damage rate during storage

Shallots do not suffer significant smoking damage compared to the non-smoked shallots. However, during storage the rate of damage to shallots without smoking increased. Until 4 weeks of storage, there was no significant increase in damage in smoked shallots (Fig 3b).

3.4. Sensory characteristics

The aroma of shallots and texture decreased during storage. This occurred due to the carbonyl group reactions in smoke with proteins and fats, the appearance, aroma and texture of smoked shallots were produced. In the characteristics of colour, texture, flavour and aroma, smoke plays an important role. In addition, phenol is the largest carbonyl in smoke which plays the most significant role.

The aromas of shallots are mainly dependent on the volatile component thiosulfinate. Pyruvic acid, which gives it a pungent scent, constitute one of the characteristic fragrances of shallots. According to [18], shallot sweetness is determined by the level of pungency and sugar content. High pungency can cover sugar levels even when they are not sweet.

The shallot texture decreased in durability until the end of storage. The texture between the smoked and non-smoked shallots was significantly different. [18] stated that the change in the texture of pectin insoluble in water (protopectin) occurred due to its transition to water-soluble. Furthermore, changing hardness during storage occurred due to changes in components of the cell walls into simpler compounds that weaken these walls and cause tissue cohesion.

4. Conclusion

The supply of liquid smoke preserves shallot quality during storage. Liquid smoke administered for two hours by the shallot soaking method prevents damage during storage. It had a weight loss of 4.6%, damage of 1.17% and moisture content of 82.5%. Although smokeless shallots had a weight loss of 33%, damage of 9.17% and humidity of 87.29%, they possessed the exact same sensory properties with and without smoking.

Acknowledgements

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