Effect of low temperature and period of storage on the quality of Garlic Seeds (*Allium sativum* L)

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Abstract. The aim the study was to analyze the effect of temperature storage of garlic seeds including weight loss, sprouting and damage during the storage period. The samples of Garlic seeds are local varieties, cv. Lumbu Hijau and cv. Lumbu Kuning were collected from the farmers in Temanggung Regency. The experiments were set at two different temperature conditions, i.e. 5°C and room temperature (29-31°C) as a control. The relative humidity (RH) of storage conditions was 50-70% for cold storage and 70-80% for storage in room temperature. The amount of sampel used was about 47-68 tubers (500 g) for cv. Lumbu Hijau and around 24-32 tubers (500 gr) for cv. Lumbu Kuning, were placed in cold storage at different temperatures and in dark. The period of storage was design for 5 months. All experiments were carried out in three replications. The results showed that the decrease in weight loss for garlic stored at storage temperatures of 5°C and room temperature were 10.48 and 7.46 % for cv. Lumbu Hijau and 15.03 and 11.38 % cv. Lumbu Kuning, respectively. The highest sprouting percentage was found for those seeds garlic cv. Lumbu Kuning at 5°C, i.e., 22.22 %. The highest percentage of damage after 5 months of storage was found in the seeds of garlic cv. Lumbu Hijau stored at room temperature were 2.30 % and cv. Lumbu Kuning at 5°C were 19.04 %.

1. Introduction
Garlic is one of the important horticultural commodities and has high economic value. The productivity of garlic in 2016 was 8.79 tons / ha with a harvest area of 2,407 ha and production of 21,150 tons [1]. Garlic is a seasonal horticultural product. On season availability is abundant while off season the availability of garlic is small. This has an impact on the import of garlic to meet national needs. The availability of garlic in Indonesia has been obtained from Chinese and Indian imports. In 1998 Indonesia experienced self-sufficiency in garlic with a total area of 28,000 ha and Indonesia's imports under 10%. However, at present almost 95% of the total national needs which reach 400,000 tons are imported from other countries.

The productivity of garlic is very much determined by the use of high-quality seed bulbs. Garlic is propagated vegetatively of bulbs. Plant propagation is the process of growing new plants from a variety of sources; seeds, cuttings, bulbs and other plant parts. Bulbs that are good for planting do not contain disease, are not deformed and are not stored for too long. A good bulbs is a tuber that has broken its dormant period and is healthy and optimal size. Dormancy is a condition of plant organs that cannot grow under conditions below optimum. Quality seeds are seeds that have been declared as high-quality seeds from superior types of plants. High quality seeds have more than 90% germination,
growth power or viability, so proper maintenance activities are needed. Improper handling will cause the viability and vigor of the seed to decline. The seeds will experience setbacks caused by humidity and temperature.

Garlic has perishable properties and it is difficult to maintain freshness in a long time. Therefore, proper handling is needed so as not to experience changes in quality at the time of storage. Storage is one of the important ways to overcome the availability of garlic. With good and correct storage, the stock will be controlled continuously with quality in accordance with market demand [2].

Garlic requires a good temperature for storage conditions so that its quality is relatively durable. Temperatures that are too high cause high shrinkage weights and cause the tubers to shrink. While high humidity provides an opportunity for the growth of fungi and molds and stimulates the growth of shoots and roots [3]. One common method is to store fresh agricultural products at low temperatures to extend shelf life and product quality. Storage of garlic seeds at low temperatures can reduce water loss in tubers, maintain respiration rate to be stable and slow the occurrence of metabolism so that it can inhibit the growth of shoots. Various damage that can occur is a decrease in water content, growth of shoots, hollowing, rot and softening (chilling Injury).

Various studies of garlic storage at low temperatures have been carried out. However, there are still not many reports regarding local varieties. It is important to know the changes that occur in storage for the long term through low temperature storage. The purpose of this study was to analyze the effect of low temperature storage on the storage of garlic seeds.

2. Material and Method

Sample of local garlic seeds i.e. cv.Lumbu Hijau and cv Lumbu Kuning were harvested from farmers orchard at Temanggung Regency, Central Java. After being harvested, the garlics were cured and dried until the water content reached approximately 60%. The experiments were set at temperature of 5°C (RH 50-70%) and room temperature (29-31°C, RH 70-80%). The weight garlic seeds samples were 500g and consisted of 47-68 bulbs for cv. Lumbu Hijau and 24-32 bulbs for cv. Lumbu Kuning. The samples were put in the cold storage at a given temperatures under the darkness condition (Figure 1). The storage period was designed for 4 months. Changes in weight loss, percentage of sprouting and damage bulbs were measured during the storage period. All experiments were carried out in three replications.

![Figure 1. Drying and storage condition of seeds garlic](image)

3. Result dan Discussion

The results of this study indicate that weight losses for storage of 5°C and room temperature after 4 months storage were 7.90 and 5.95% for cv. Lumbu Hijau and 10.87 and 9.22% for cv. Lumbu Kuning (Figure 2 and 3). Temperature storage of 5°C can maintain loss of water content of the bulb. Efforts to prevent water loss can be done by adjusting the right temperature and humidity. Because when stored the material will undergo a transpiration process where some of the water in the material tissue will evaporate [4]. In addition, changes in weight loss are influenced by the rate of respiration and respiration rate affected by temperature [5].
After 4 months storage of garlic seeds, sprouting was found at temperature of 5°C of the cv. Lumbu Kuning which was equal to 1.11% and not found in the cv. Lumbu Hijau at all storage temperatures. This shows that each variety gives different responses to the temperature treatment. Storage at various low temperatures for both varieties can be applied to maintain the seeds from sprouting. During storage, sucrose and starch are consumed in high content and parts of carbohydrates that are not consumed cause glucose accumulation from the garlic tissue thereby increasing sprouting. Bulbs stored at 10°C for 30 days storage temperature increase the percentage of sprouting [6]. Storage temperatures of 5 and 30°C can inhibit the growth of onion bulbs [3]. The effect of cold storage depends not only on temperature but also on its duration and depends on cold temperatures which can break its dormancy [6].

Packaging of garlic seed bulbs that produce plants with growth and the best results is the use of plastic nets with a shelf life of 57 days and damage of 9.6% [7]. Garlic cannot be planted immediately after harvest because garlic requires a dormancy period before continuing growth. The dormancy period varies depending on the variation and storage temperature. The optimum storage temperature for garlic buds ranges between 5 and 10°C. Cold storage combination 7°C duration for 30 days has a higher growth percentage [8].
Table 1. Sprouting bulbs of seeds garlic cv. Lumbu Hijau and cv. Lumbu Kuning during 4 months storage

| Month | Lumbu Hijau | Lumbu Kuning |
|-------|-------------|--------------|
|       | Sprouting bulb (%) | Sprouting bulbs (%) |
| 5°C   | Room Temperature | 5°C | Room Temperature |
| 1     | 0 | 0 | 0 | 0 |
| 2     | 0 | 0 | 0 | 0 |
| 3     | 0 | 0 | 0 | 0 |
| 4     | 0 | 0 | 1 | 0 |

Table 2. Damage bulbs of seeds garlic cv. Lumbu Kuning and Cv. Lumbu Hijau during 4 months storage

| Month | Lumbu Hijau | Lumbu Kuning |
|-------|-------------|--------------|
|       | Damage Bulbs | Damage Bulbs |
|       | 5°C | Room Temperature | 5°C | Room Temperature |
|       | Empty Bulb | Waxy breakdown | Pest diseases | Rot | Empty Bulb | Waxy breakdown | Pest diseases | Rot |
| 1     | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2     | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3     | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 4     | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

Based on the results of this experiment, there was also some damage to the garlic seeds. Damage that occurs as empty bulb, waxy breakdown, pest diseases and rot. Damage can occur because when storing low temperatures garlic seeds cannot carry out normal metabolic processes. Then a decrease in the fruit's ability for oxidative phosphorylation occurs which will increase further in the presence of low temperatures [4].

Figure 4. The damage of Garlic Seeds cv. Lumbu Hijau (a), cv. Lumbu Kuning (b) at 0 °C and sprouting of cv. Lumbu Kuning at 5°C

4. Conclusion
The temperature of 5°C RH 50-70% (dark conditions) resulted in the highest percentage of weight loss for seeds garlic of cv. Lumbu Hijau and cv. Lumbu Kuning. The damage of seeds garlic were found in the seeds garlic of lumbu Hijau at a temperature of 5°C and room temperature that occurs as empty bulbs, while in cv. Lumbu Kuning damage that occurs as waxy breakdown and rot at
temperature 5°C and pest diseases at room temperature. The initial sprouting was found at storage period of 4 month in 5°C cv Lumbu Kuning and did not occur in the cv. Lumbu Hijau.

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