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Analysis of Primary Metabolite Content in Shallot Bulbs from Bantul and Sragen Basic Steps for Plant Breeding

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ABSTRACT

Shallots (Allium cepa L. var. aggregatum) are strategic horticultural commodities rich in primary metabolite compounds that are important for nutritional value and quality of harvest. This study aims to analyze and compare the primary metabolite content in shallot bulbs from Bantul (Special Region of Yogyakarta) and Sragen (Central Java) using the proximate test method. The parameters tested include water content (thermogravimetric method), ash/minerals (dry method), fat (Soxhlet method), protein (Kjeldahl method), and carbohydrates (by different). Analysis was carried out on fresh samples from both areas representing the main production centers. The results showed differences in the composition of primary metabolites between the two samples. This difference indicates the influence of environmental factors and cultivation techniques on the nutritional profile of shallot bulbs. These findings are expected to serve as a basis for selecting cultivation sites based on nutritional quality, developing processed products that match the nutritional characteristics of the raw materials and are expected to serve as a basic step in plant breeding.

Keywords: Shallot, Proximate, Bantul, Sragen, Primary Metabolites

1. INTRODUCTION

Shallot (*Allium cepa* L. var. *aggregatum*) is one of the most important horticultural commodities in Indonesia that has a high economic value and plays a major role in household consumption needs and the food industry. Apart from being the main kitchen spice, shallots are also known to contain various bioactive compounds that are beneficial for health, such as flavonoids, saponins, and sulfur compounds. However, what is often overlooked is the primary metabolite content in shallot bulbs, which includes essential compounds such as carbohydrates, proteins, and fats. The chemical content of shallots, such as sulphur and various primary metabolites, greatly influences their quality, flavor, and health effects (Muzhahir et al., 2023). These primary metabolites play an important role in basic plant metabolism and are a reflection of the nutritional quality of a food.

Primary metabolites are the direct products of basic plant metabolic activities. These compounds not only determine the flavor and texture of shallots, but are also directly related to the storage quality, shelf life, and nutritional value of the final product. Low moisture content in shallot bulbs contributes to better storability and reduces the risk of damage due to microorganism

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activity (Mutia, 2019). Analysis of primary metabolite content is also useful to support the development of superior varieties and increase the added value of local horticultural products through a nutrition-based approach. To meet the needs and desires of the community, efforts are needed to continue to increase production and improve the quality of plant properties (Koryati et al., 2022).

Indonesia has many shallot production centers, including Bantul district (DIY) and Sragen district (Central Java). Both are known as shallot producing areas with different agroclimatic characteristics. Agroclimatic factors such as temperature, humidity, and rainfall also affect the composition of primary metabolites in horticultural crops (Nurcahyo et al., 2024). Differences in geographical location, soil type, cultivation patterns, and fertilization methods can affect the content of nutrients in plants, including the composition of primary metabolites in their bulbs. The fertilizer dosage treatment had a significant effect on the wet weight of the shoot and the wet weight of the onion bulbs (Purba et al., 2024). Therefore, it is important to conduct a scientific study that compares the primary metabolite content of these two regions to determine the potential quality of shallots more specifically.

Although there have been many studies on the phytochemical content and secondary active compounds in shallots, specific studies comparing primary metabolites based on the origin of production areas are still very limited. Most studies emphasize agronomic aspects, such as productivity and disease resistance, without exploring in depth the chemical qualities present in the bulbs. In fact, analysis of primary metabolite content can provide more in depth information about the influence of the growing environment on plant yield. Variations in shallot bulb morphology between regions are closely related to adaptation to specific environmental conditions (Affandy, 2022).

This study aims to analyze and compare the content of primary metabolites in shallot bulbs from two different regions, Bantul and Sragen. By using appropriate laboratory analysis methods, it is expected to obtain quantitative data on the concentration of primary metabolite compounds from each sample. The results of this study are expected to provide an overview of the potential nutritional quality of shallots based on their region of origin, as well as a basis for decision making for farmers, food industry players, and local governments in the development of competitive horticultural commodities.

The practical benefits of this study also include the possibility of identifying regions of origin with better tuber quality to be developed as production centers based on quality, not just

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quantity. In addition, an understanding of the variation in primary metabolite content between regions can provide input for precision agriculture management and improved cultivation techniques according to local soil and climate characteristics. With this research, it is expected to fill the data gap in the field of food chemistry and agronomy related to the content of primary metabolites in local horticultural plants. This research is also the first step towards a science-based approach in managing shallot commodities in a more sustainable and quality-based manner. Analysis of nutrient content through proximate tests provides a strong basis for assessing the quality of local food ingredients (Rahma et al., 2024).

2. RESEARCH METHOD

This comparative analysis research was conducted at Food Chemistry and Biochemistry Laboratory, University of Sebelas Maret Faculty of Agriculture. The stage method carried out is a qualitative method with qualitative descriptive analysis as follows. Sampling Shallots were taken from two different places. The area taken is Sragen area with Bantul area, the selection of the two places is obtained from seeing the geographical differences that exist. Bantul Regency has an average height of 58 MASL (meters above sea level) while Sragen Regency is in the plains with an average height of 109 MASL. Samples were taken from several farmers in the region. Proximate Test The parameters tested included moisture content (thermogravimetric method), ash/minerals (dry method), fat (Soxhlet method), protein (Kjeldahl method), and carbohydrates (by difference).

3. RESULTS AND DISCUSSION

In this study, the team analyzed two samples of shallot bulbs from different regions, namely Sragen and Bantul. The differences in physical characteristics between the two samples can be observed directly in Figure 1, which shows a comparative photo of the shape and size of the bulbs. This variation in shape and size is important to note because it can affect the content of primary metabolites in the bulbs. In general, larger tubers could potentially have a higher accumulation of carbohydrates and water, while smaller sizes may relate to the concentration of other compounds such as protein or fat in different ratios. Therefore, visible morphological differences are the initial basis for assessing the chemical content of nutrients, which will be further discussed in the next section.

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(a) (b)

Figure 1. Shallot Bulb Samples Sragen (a) and Bantul (b)

In Figure 1, sample (a) from Sragen appears to have a rounder tuber shape with a relatively small size. In contrast, sample (b) from Bantul shows an oblong shape with a larger size. These morphological differences are thought to be related to the agro-climatic conditions of the respective regions of origin, such as soil type, light intensity, and cultivation techniques applied by farmers in each region. The productivity level of a cropping system is determined primarily by the interaction of plant genetic potential, environmental factors, and management options (Asril et al., 2023). The content of primary metabolites such as water, carbohydrates, proteins, and fats is strongly influenced by agroclimatic conditions and plant cultivation techniques (Nihayati, 2016). Some initial hypotheses that can be seen are such as the larger size of shallots allows it to have more tissue. The impact of longer growth causes a higher potential for metabolite accumulation in shallots.

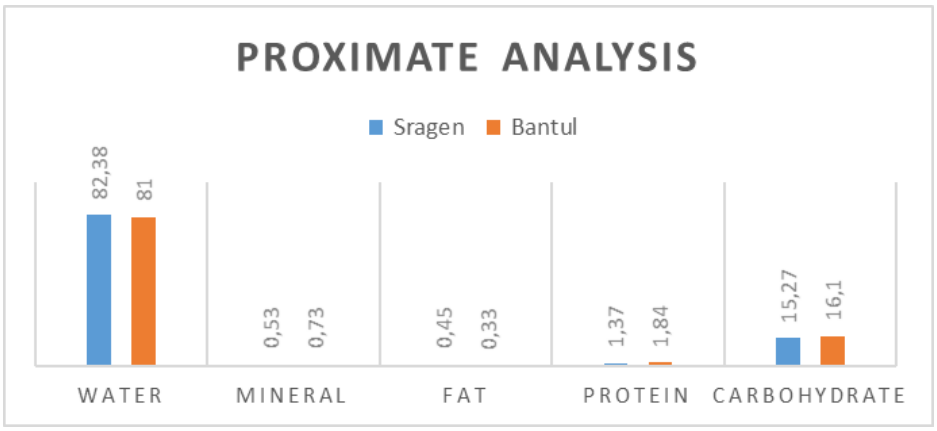

Figure 2. Proximate Analysis Diagram

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Based on the results of proximate analysis in graph 1, sragen shallots have a water content of 82.38%. This data is higher than the results of water proximate in the Bantul shallot sample. Although Bantul bulbs have a larger size, the water content is actually lower. This shows that Bantul bulbs have a denser tissue structure, so the volume of water is relatively less per unit mass. The lower water content in Bantul shallots is an advantage, as bulbs with low water content tend to have better storability and less risk of damage during storage.

Ash (mineral) content, which reflects the mineral content, showed a relatively balanced value between the two samples, with a slight advantage for Bantul onions. This indicates that the soil conditions in Bantul contribute positively to the accumulation of mineral elements in the bulbs. Mineral content in shallots generally reflects soil fertility conditions in the area of origin, especially microelements such as potassium and calcium which are important in cell structure and storage resistance (Ningsih, 2019). The ash content analyzed in this study provides a rough estimate of the total minerals in the bulbs (Agustono et al., 2017).

Overall, sragen shallots are superior in water and fat content, while Bantul shallots have high yields in mineral, protein and carbohydrate data. Different bulb shapes may reflect differences in metabolic activity (Lestari et al., 2019). Elongated bulbs may have more meristematic tissue that is actively dividing, so their potential to produce secondary metabolites is higher. The composition of water and fat in sragen shallots can be utilized as dishes that may require a soft texture and slightly mild flavor. The composition of bantul shallots such as minerals, protein and carbohydrates which are higher can be utilized as a potential source of nutrients. The fat content in shallots from Sragen was recorded to be higher than that of Bantul. Although fat content in shallots is generally low, this difference could be related to the environmental conditions of Sragen which are more favorable for the accumulation of energy reserves in the form of fat, or differences in cultivation techniques applied.

One of the important findings in this study is that shallots from Bantul have higher protein levels than Sragen, with a difference of 0.47%. This higher protein content indicates that the bulbs from Bantul have better potential nutritional value, especially in providing essential amino acids. Differences in protein levels in shallots between production areas are caused by genetic factors of varieties and nitrogen management in cultivation (Qotrunanda dan Barunawati, 2022). This protein advantage can also affect the taste, considering that protein compounds can play a role in the formation of umami flavor and distinctive aroma when onions are cooked. The carbohydrate content of Bantul shallots is also higher than that of Sragen. With lower water content, the

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carbohydrate content becomes more concentrated, making the bulbs from Bantul more suitable for dry processed products such as fried onions. The high carbohydrate content also supports the stronger natural sweetness characteristic of Bantul shallots. The high carbohydrate content in shallots plays an important role in the formation of natural sweetness and browning during processing (Khamidah & Murni, 2017).

Based on the results of the analysis of primary metabolites that have been carried out, shallots with a larger size have a higher content. Larger shallots (Darma et al., 2015) may have different proportions of tissues (e.g., epidermis, cortex, and phloem tissues). These different tissues may have different capacities to synthesize and store metabolites. In addition, the environmental conditions of onion growth also significantly affect the content of primary metabolites. Onions grown under different environmental conditions (e.g., light levels, temperature, nutrient availability) will have different responses in terms of secondary metabolite production. Onions grown under stressful conditions may produce more secondary metabolites as a defense mechanism.

Overall, shallots from Bantul showed a superior nutritional profile with higher protein and carbohydrate content, as well as lower moisture content that supports better storability. This makes Bantul a production area with great potential for raw materials for onion processing industries, such as fried onions and flavor extracts. Meanwhile, Sragen shallots, which have a higher moisture content, tend to be suitable for fresh consumption that prioritizes crunchy texture.

These findings provide an update to previous studies that generally only focused on the quantitative aspects of shallot production, such as yield per hectare and response to fertilizer or irrigation (Widodo et al., 2020; Hasibuan & Herlina, 2019). Meanwhile, shallots from Sragen, which have a higher water content, are more suitable for fresh consumption because of their crispier texture, thus targeting the household consumption market that prioritizes the fresh and spicy sensation typical of local shallots. Thus, the results of this study provide a more comprehensive picture of the quality of primary metabolites of shallots as an indicator of added value, which has so far received less attention in previous agronomic studies that emphasize quantitative productivity (Nuraini et al., 2022).

4. CONCLUSIONS

This study shows that there are significant differences in the content of primary metabolites in shallot bulbs from Bantul and Sragen. Bantul shallots have lower water content, and higher

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protein and carbohydrate content compared to Sragen shallots. The difference in protein content reaches 0.47%, making Bantul shallots superior in terms of nutritional value. Mineral content in both samples is relatively balanced, while fat content is slightly higher in the Sragen sample With a better nutritional profile and lower moisture content, Bantul shallots are considered more suitable for long-term storage and as raw material for processed industries such as fried shallots. Meanwhile, Sragen shallots are more suitable for fresh consumption which prioritizes high moisture content and crunchy texture. The results of this study can serve as a basis for developing shallot cultivation based on nutritional quality and selecting production areas according to market needs.

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