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Chemical Content Study of Salak Sidimpuan (*Salacca sumatrana* Becc.) Fruit Based on Altitude

Rasmita Adelina, Erwin Syah dan Asrul Sipahutar

Agrotechnology Master's Program, Agriculture Faculty, Graha Nusantara University, Padangsidimpuan City, North Sumatra, 22715, Indonesia

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Corresponding Author:
Rasmiya Adelina, Agrotechnology Master's Program, Graha Nusantara University, Padangsidimpuan city, North Sumatra, 22715, Indonesia.
Email: rasmita301271@gmail.com

Abstract

Salak can grow well in the lowlands at an altitude of 200 m above sea level to an altitude of 700 meters above sea level with a wet climate type. The desired environment has a pH of 5-7 and rainfall of 1500-3000 mm per year for four to six months. This study aimed to determine the differences in soluble sugar vitamin C and total titratable acid of Sidimpuan salak fruit (Salacca sumatrana Becc) based on the three altitude classifications. This research has been carried out in West Angkola District in three locations with an altitude of 500-650m above sea level, Padangsidimpuan Hutaimbaru in 3 garden locations with an altitude of 400-500 m above sea level, and South Angkola there are 3 with an altitude of 200-300 m above sea level, starting in August to September 2021. Based on the results of this study, it is concluded that the difference in altitude of the place does not significantly affect the dissolved sugar content and vitamin C of Sidimpuan salak fruit. However, the altitude of the place has a significant effect on the total titratable acid of salak fruit, namely 1.4011% in West Angkola and 0.9822% Padangsidimpuan Hutaimbaru sub-district and South Angkola 1.2644%.

Keywords: elevation, fruit chemistry, low lands, salak sidimpuan, vitamin c

1. Introduction

Indonesia is an agricultural country that has various types of fruit. One of them is the salak fruit. Salak, native to Indonesia, was recognized and described in 1825 under the name (*Salacca edulis*). In Indonesia, salak farming has been known since the Dutch colonial era. Salak plants have many varieties, some of which have superior properties in terms of taste and appearance of the fruit. Until now, there are many well-known salak fruit production centers (Mandiri, 2010). Salak is a fruit that is well known on the island of Sumatra and even on Java. Sidimpuan salak, with its sweet, sticky, sour, and legit taste, is different from salak pondoh, Bali, and other salaks (Adelina *et al.*, 2021).

The area of South Tapanuli Regency is 4,352.86 km2, consisting of three sub-districts as centers of salak plants. West Angkola District 194.60 km2 consists of 80 villages with an altitude of 200 m above sea level to 1925 m above sea level (the peak of Mount Lubuk Raya), East Angkola District 192.60 km2 consists of 30 villages with an altitude of 250 m above sea level to 1800 m above sea level and South Angkola District 123.45 km2 consists of 34 villages with an altitude of 400 m above sea level to 700 m above sea level. Salak production in Padangidimpuan West Angkola District, with a land area of 17,666 Ha, produces 397,485 tons/year, while South Angkola District, with a land area of 466 Ha, produces 10,485 tons/year (BPS Tapanuli Selatan, 2015).

Sidimpuan salak planting centers in South Angkola District are in low to medium altitude locations, Sidimpuan salak planting centers in Padangsidimpuan Hutaimbaru District are in medium/medium altitude areas, and Sidimpuan salak planting centers in West Angkola District are in medium to high altitude areas. The difference in altitude at each location of Sidimpuan salak planting centers is expected to affect the soluble sugar content, vitamin C content, and total titratable acid of Sidimpuan salak. Sumantra et al. (2011) mentioned that the altitude of the place from sea level affects the flowering of plants. Fruiting plants grown in the lowlands flower earlier than those in the highlands. The study results showed that the thickness of fruit flesh, salak sugar content, vitamin C, and sugar/acid ratio of sugar salak originating from new development areas at lowlands to highlands 21.23%, 18.36%, 16.35%, and 51. 41% of the total population is located in the Sibetan area of Bali.

Adelina *et al.* (2018) comparison of Sidimpuan salak production in the highlands (1,231 kg per tree) is significantly different from Sidimpuan salak production in the lowlands (0,991 kg/tree). The comparison of the soluble sugar content of Sidimpuan salak in the highlands (10.550˚brix) is significantly different from the soluble sugar content of Sidimpuan salak in the lowlands (9.100˚brix).

2. Materials and Methods

This research has been carried out in West Angkola District in three locations with an altitude of 500-650m above sea level, Padangsidimpuan Hutaimbaru in 3 garden locations with an altitude of 400-500 m above sea level, and South Angkola there are 3 with an altitude of 200-300 m above sea level, starting in August 2021 until September 2021. The tools used in this study are an Altimeter, Refractometer (Atago model 201), dropper, markers, Petri dishes and scales, and titration tools (Laboratory Balitbu Tropika Solok, West Sumatra). The materials used are labels, plastic bags, and Padang Sidimpuan salak fruit.

This research is a survey research, with a purposive sampling method. The determination of the location of this study based on the height of the place consisting of:

West Angkola sub-district (highland) consists of three locations, namely: Simatorkis Village: 650m above sea level, Sitinjak Village: 600m above sea level, Huta Tunggal Village: 500m above sea level. Padangsidimpuan Hutaimbaru sub-district (medium plains) consists of 3 locations, namely in Palopat Maria Village: 436m above sea level, Tinjoman: 450m above sea level and Siharang-karang: 500m above sea level.

South Angkola Sub-district (lowland) consists of 3 locations, namely in Simarpinggan Village: 200m above sea level, Sinyior, 250m above sea level, Baringin 230m above sea level. At each altitude there are three salak gardens so that the total location of salak gardens in this study there are 9 locations of salak gardens, In each salak garden there are 10 sample plants and three salak fruits are taken per plant. So, the total sample in this study was 270 salak fruits. The data obtained from the results of this study by the observation parameters will be analyzed with One Way Anova using the SPSS application ; if there is a significant difference, it will be further tested with Duncan at the 5% level.

Measuring the altitude of the place in West Angkola District 3 garden locations, Padangsidimpuan Hutaimbaru 3 garden locations and South Angkola District 3 garden locations using an Altimeter (height measuring device) and determining the criteria for Sidimpuan salak sample plants, namely salak plants that was produced and are suitable for collection. Salak fruit collection is done by picking salak fruit from bunches and placed on plastic that has been labeled. The sampling criteria in this study are healthy salak trees that are already in production, and the salak fruit taken for the sample is ripe and suitable for harvesting

3. Results and Discussion

This research was conducted from August to September 2021 located in the districts of Angkola Barat, Padangsidimpuan Hutaimbaru, and Angkola Selatan with altitudes of 500-650, 350-450, and 200-300m above sea level. Average levels of soluble sugar, vitamin C, and total titratable acid of salak sidimpuan fruit in the highlands (West Angkola District), medium (Padangsidimpuan Hutaimbaru District), and lowlands (South Angkola District).

Table 1. Average soluble sugar content, vitamin C and TAT of salak sidimpuan (*Salacca sumatrana* Becc) fruit based on three altitude classifications.

	Dissolved Sugar Level	Vitamin C	TAT	Ratio
Angkola Barat (Highlands)	17.4767 a	49.8778 a	1.4011 a	18.3600 a
Hutaimbaru (Medium plains)	16.6933 a	49.9089 a	0.9822 b	18.7556 a
Angkola Selatan (Lowlands)	17.1267 a	44.6878 a	1.2644 ab	13.2256 a

Notes: Numbers followed by the same lowercase letter in the same column are not significantly different according to DMRT at the 5% level (a=5%).

a. Dissolved Sugar Level (Brix)

Based on the table above, observing the dissolved sugar content of Sidimpuan salak fruit (*Salacca sumatrana* Becc) based on three altitude classifications shows no significant difference between West Angkola, Hutaimbaru, and South Angkola however, based on the average there is a tendency of dissolved sugar content in West Angkola higher than Hutaimbaru and South Angkola. This is because the temperature in the highlands is lower than in the lowlands, so the sugar content of Sidimpuan salak is higher than in the lowlands. Low temperatures also slow down the physiological activities that occur in plants and will also slow down the activity of microorganisms that help the process of nutrient absorption for plants. Humidity levels are also related to the high and low temperatures that will affect the metabolic processes that occur in plants and can affect the respiration process, with higher air humidity directly proportional to the level of water content that is getting higher. Air temperature is closely related to the rate of evaporation from plant tissue into the air. The higher the air temperature, the higher the transpiration rate. If the temperature is outside the tolerance limit, the metabolic activities of plants will be disrupted or even stopped. Rainfall in the highlands (437.8 mm/month) is 77.8 mm higher than rainfall in the lowlands, this affects the sucrose content of salak fruit (Cahyani *et al*., 2013).

Respiration activity affects changes in fruit flavor and texture, if there is an increase in respiration rate, the breakdown of carbohydrate polymers is accelerated. When fruits become ripe, the sugar content increases, but the acid content decreases. As a result, the sugar and acid content will undergo drastic changes. Rachmawati (2010). The temperature in the highlands is lower than in the highlands, thus affecting the sugar content of Sidimpuan salak. Rubiyo and Sunarsono (2013) stated that low temperatures increase irespiration activities not occurring sharply where respiration activities involve the breakdown of carbohydrate polymers, especially the change of starch into sugar, so that the sugar content in the fruit does not increase rapidly and at the same time increase the sucrose content. Adelina *et al.* (2018) comparison of Sidimpuan salak production in the highlands (1,231 kg per tree) is significantly different from Sidimpuan salak production in the lowlands (0,991 kg per tree). The comparison of the soluble sugar content of Sidimpuan salak in the highlands (10.550˚brix) is significantly different from the soluble sugar content of Sidimpuan salak in the lowlands (9.100˚brix).

The breakdown of carbohydrate polymers during ripening is often expressed in the conversion from starch to sugar. The increase in sugar results in a sweet fruit flavor. The breakdown of carbohydrate polymers, especially pectic and hemicellulose compounds, weakens the cell wall and decreases the cohesiveness of intercellular bonds. Protopectin is the original form of pectin substances. Protopectin is gradually broken down or dismembered into simpler compounds that can dissolve in water during ripening and aging. The rate of pectin degradation directly causes fruit softening. Respiration is the oxidative disassembly of more complex materials, such as starch, sugars, and organic acids, into simpler molecules, such as carbon dioxide and water, together with the production of energy and other molecules that the cell can use for synthesis reactions (Taiz and Zeiger, 2002). That can be clearly demonstrated by increasing the water content in grains to over 15%, which results in a sudden increase in metabolic activity (Porter and Smenov, 2005).

b. Vitamin C Content

Vitamin C is a type of water-soluble vitamin. This vitamin is also known by the chemical name of its main form, ascorbic acid. Vitamin C belongs to the class of antioxidant vitamins that can counteract various extracellular free radicals. Some of its characteristics include being easily oxidized by heat, light, and metals. Fruits, such as salak, oranges and apples are the main sources of this vitamin. Based on Table 1. Vitamin C of salak sidimpuan fruit (*Salacca sumatrana* Becc) based on three classifications of altitude shows that there is no real effect between the highlands (Angkola Barat), medium plains (Hutaimbaru) and lowlands (Angkola Selatan) but based on the average there is a trend that vitamin C is higher in Hutaimbaru compared to Angkola barat and then followed by Angkola selatan. The increasing trend between Hutaimbaru and South Angkola shows the relationship between altitude and vitamin C content, so it can be argued that vitamin C content will increase along with the increase in altitude.

The environment where the plant grows affects the difference in vitamin C content. According to Karamoy (2009), this is related to plant metabolic processes or biochemical processes and the synthesis of secondary metabolite compounds, especially vitamins. In the end, this will characterize the morphology and content of active compounds in a plant that affects plant growth. The greater the altitude of a cultivation site, the higher the environmental stress. The intensity of sunlight is getting less and with a shorter duration of irradiation, causing the temperature to decrease, while the humidity is getting higher. The production of plant secondary metabolites is strongly influenced by these temperature, light and humidity stress conditions. In conditions of higher environmental stress, the content of secondary metabolites of a plant actually increases. Vitamin C is a plant secondary metabolite so it will also increase. At lower altitude conditions, the intensity of sunlight and temperature is higher and vitamin C in plants is more easily oxidized to dehydroascorbic acid, so this results in low vitamin C content at low altitude places.

According to Koneri (2010), differences in climate including humidity, temperature and rainfall as well as plant distribution patterns are also caused by differences in altitude where plants grow. Some physiological processes in plants depend on light and are influenced by environmental factors (Yuliasari *et al*., 2016). Plants require an optimum temperature in order to utilize these conditions for growth. Light is a source of energy for plants, plant growth will be inhibited by the presence of temperatures that are too high due to excessive light and even temperature conditions that are too high can cause death in plants, the opposite condition is that temperatures that are too low also inhibit plant growth (Milla, 2009). The content of nitrates, carotenoids and vitamin C in green mustard (*Brassica chinensis* L) is influenced by the altitude of the cultivation site with the tendency that the higher the cultivation site, the higher the content of nitrates, carotenoids and vitamin C (Winoto *et a*l., 2021).

c. Total Titratable Acid (TAT)

Total titratable acid is the amount of acid contained in a material. The basic principle of measuring total titrated acid is neutralizing acid in the material by a base (NaOH 0.1 N) through a titration liquid. From the initial analysis, the total acid value of salak fruit was 6.34%. The total value of titrated acid is all types of organic compounds or acids that contain acid

Based on Table 1. The total titrated acid of salak sidimpuan (Salacca sumatrana Becc) fruit based on three classifications of altitude of the place shows that the difference in altitude of the place significantly affects the total titrated acid of salak fruit which is 1.4011% in West Angkola sub-district and 0.9822% in Padangsidimpuan Hutaimbaru sub-district but does not significantly affect the total titrated acid in South Angkola sub-district. This happens because the soluble sugar content in South Angkola is higher than the sugar content in Hutaimbaru, so it affects the total titratable acid because the higher the soluble sugar content, the lower the total acid; this is in line with the statement of Jubaidah (2010). The total sugar content of salak is inversely proportional to the total acid content of salak vinegar. The higher the total sugar, the lower the total acid, and vice versa, the lower the total sugar, the higher the total acid of salak vinegar.

In this study, there is a link between respiration activities affecting the taste and texture of the fruit, if there is an increase in the respiration rate, the breakdown of carbohydrate polymers is faster. When fruits become ripe, the sugar content increases, but the acid content decreases. As a result, the sugar and acid content will change drastically. According to Hartanto (2002), during ripening usually, acids will decrease because they become a substrate for respiration or are converted to sugar; acids can be considered a source of reserve energy in fruit, so it is expected to decrease during the more significant metabolic activity that occurs during ripening except for bananas and pineapples, at the fully ripe stage the acid content remains high.

4. Conclusions

Based on the results of this study, it can be concluded that the difference in the altitude of the place does not significantly affect the dissolved sugar content and vitamin C of Sidimpuan salak fruit however, the altitude of the place has a natural effect on the total titratable acid of salak fruit, namely 1.4011% in Angkola Barat and 0.9822% in Padang sidimpuan Hutaimbaru sub-district and Angkola Selatan 1.2644%.

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