Jurnal Akademika Kimia, 12(3): 182-185, August 2023
ISSN (online) 2477-5185 | ISSN (print) 2302-6030
http://jurnal.fkip.untad.ac.id/index.php/jak/

Determination of Citric Acid Level in Starfruit (*Averrhoa bilimbi* L.) and Starfruit Raisins

***Sri Rahayu & Siti Nuryanti**
Program Studi Pendidikan Kimia/FKIP – Universitas Tadulako, Palu – Indonesia 94119

Received 03 June 2021, Revised 30 July 2021, Accepted 09 August 2023
doi: 10.22487/j24775185.2023.v12.i3.pp182-185

Abstract

Citric acid is one of the plants in Indonesia that has many benefits in various fields, especially in the industry. This study aims to determine the levels of citric acid in starfruit (Averrhoa Bilimbi L.) and starfruit raisins in Oti Village, Sindue Tobata District, Donggala Regency. The analytical method used to determine the levels of citric acid is alkalimetric titration. The sample used in this study came from Oti Village, Sindue Tobata District, Donggala Regency. The percentage results showed that the levels of starfruit citric acid were 6.363 %, and the starfruit raisins were 4.703 %.

Keywords: Citric acid, starfruit, alkalimetric titration

Introduction

Belimbing wuluh is a fruit widely spread in Indonesia as a houseyard plant that has not been cultivated and developed its utilization. Belimbing wuluh fruit has a high acid and water content, causing the fruit to be rarely consumed as fresh fruit, and the shelf life is relatively short (Damayanti et al., 2020). Utilization and development of wealth star fruit in Indonesia have not been done optimally because the selling value of the fruit is still low and not balanced with the potential of wealth star fruit (Ferawati, 2005; Kanwar & Budhwar, 2018).

A well-grown star fruit plant can produce 100 to 300 fruits in one tree in one harvest, so it often experiences spoilage before being utilized. Therefore, it is necessary to process the product to anticipate abundant fresh production (Fitriani, 2008).

Utilization of wealth star fruit is still rarely done. The fruit is used only for cooking and sweets. Belimbing wuluh plants produce fruit throughout the year. In addition, this plant is also easy to plant and reproduce, so the fruit is abundant (Hidayati, 2007).

Belimbing wuluh is not durable after cooking and is easily damaged and rotten, so it is often wasted. It also tastes sour, so few people want to consume it as fresh fruit. So that this fruit, which has enormous benefits, is not wasted and can last longer, it will be made into dried sweets (Mayasari et al., 2020).

Citric acid is an organic acid in the form of crystals or white powder. It is easily soluble in water and ethanol, odorless, and has a sour taste. It is also found in fruit juices such as pineapple, orange, lemon, and passion fruit. This acid is used to increase the sour taste (adjust the acidity level) in various beverage processing, dairy products, jams, jellies, etc., and to prevent the blanching of various foods, such as canned fruits and fish (Margono, 2000).

Citric acid is one of the important organic acids in human life, as it is widely used in the industrial world. About 70 % of the citric acid produced is used in the food and beverage industry for various purposes, while 12 % is used in the pharmaceutical industry and 18 % for other industrial uses (Rahman, 1992; Behera et al., 2021).

Citric acid is one of the most important commercial products in the world, including Indonesia. In Indonesia, 65 % of citric acid consumption is in the food and beverage industry, 20 % is in the household detergent industry, and the rest is in the textile, pharmaceutical, cosmetic, and other industries. Citric acid is widely contained in fruits such as lime, kaffir lime, star fruit, and other fruits. Besides containing citric acid, belimbing wuluh also contains oxalic acid (Wardani & Handrianto, 2019).

Citric acid can be produced chemically or by fermentation using microorganisms. Several factors influence the treatment of conditions in the production process so that the results are optimal. Citric acid production is a by-product of oxalic acid

*Correspondence:
Sri Rahayu
e-mail: ayu.ayuyu08@gmail.com

fermentation using Penicillium glaucum. Aspergillus niger can produce citric acid in a low pH medium with high sugar content. Since then, citric acid has been produced commercially using the mold Aspergillus niger in the production of citric acid, gluconic acid, and several enzymes such as pectinase and amylase. Aspergillus niger can synthesize citric acid in the extracellular fermentation medium with a high enough concentration if it is cultured in a medium with low salt content and contains sugar as a carbon source (Broekhuijsen et al., 1993; Sawant et al., 2018).

Methods

Tools and materials

The tools used are erlenmeyer, measuring cup, beaker, flask, stirring rod, burette, stative and clamp, funnel, dropper pipette, spray bottle, knife, blender, filter cloth, and digital balance. The materials used are star fruit and star fruit raisins, distilled water, 0.1 N Sodium Hydroxide (NaOH) solution, 0.1 N CH_3COOH solution, and Phenolphthalein Indicator.

Research samples

The samples used in this study were wuluh star fruit and wuluh star fruit raisins taken from Oti Village, Sindue Tobata District, Donggala Regency.

Research methods

Sample preparation

Wuluh starfruit and wuluh starfruit raisins were cleaned and cut into small pieces, weighed as much as 50 grams, and then mashed using a blender until they resembled juice. The blended samples were filtered using a filter cloth to separate the filtrate. After the filtrate is obtained, it is entered into a 100 mL measuring flask, and then distilled water is added to the limit mark.

Preparation of 0.1 N NaOH standard solution

1 g of NaOH solids was weighed and put into a 250 mL volumetric flask. Distilled water was added to the limit mark and then homogenized.

Preparation of CH_3COOH solution

A total of 0.63 g of CH_3COOH solids were weighed and then put into a 100 mL volumetric flask. Distilled water was added to the limit mark and then homogenized.

Standardization of NaOH solution with CH_3COOH solution

Take 5 mL of 0.1 N CH_3COOH solution, then put it into Erlenmeyer. Then, three drops of Phenolphthalein Indicator were added and titrated with NaOH solution until light pink.

Determination of citric acid content alkalimetric titration

Take 5 mL of sample extract, then put it into 50 mL Erlenmeyer. After that, three drops of Phenolphthalein Indicator solution are added and titrated with 0.1 N NaOH solution. This procedure is calculated using the formula:

$$\text{Citric Acid Content (mg/gram)} = \frac{VXNXBEXFp}{Vsample\ x1000} x100\%$$

V is NaOH's volume, N is NaOH's normality, FP is the dilution factor, BE is the equivalent weight, and V sample is the sample volume (mL).

Results and Discussion

This study used wuluh star fruit and wuluh star fruit raisins taken from Oti Village, Sindue Tobata District, Donggala Regency. The samples were analyzed using the alkalimetric titration method. The results of citric acid analysis in wuluh star fruit and wuluh star fruit raisins can be seen in **Table 1** and **Table 2.**

Table 1. Results of citric acid level analysis of belimbing wuluh fruit (sample A)

Repetition	Titrant Volume (mL)	Citric Acid Content (mg / 100 g)
I	0.9	7.470
II	0.7	5.180
III	0.7	5.180
Average citric acid content (mg / 100 mg)		6.363
SD		± 0.957

Table 2. Results of citric acid level analysis of starfruit raisins (sample B)

Repetition	Titrant Volume (mL)	Citric Acid Content (mg / 100 g)
I	0.7	5.180
II	0.5	4.150
III	0.5	4.150
Average citric acid content (mg / 100 mg)		6.363
SD		± 0.957

The method used in this study is Alkalimetric titration, an analysis based on careful measurement of the base volume used or determination of the levels of acidic substances using an appropriate and standardized base solution. The tool used to measure the amount of acid or base added is a burette, while to give a clue when the acid or base is right is an indicator, which is a substance that is added until the entire reaction is complete, which is marked by a color change that indicates the end point of the titration has been reached (Bresnick, 2002; Thirumalai, 2020).

The sample of belimbing wuluh used in this study was taken from Oti Village, Sindue Tobata District, Donggala Regency. The fruit was taken randomly to manufacture wuluh starfruit raisins. Making raisins involves several procedures, starting with cleaning the fruit, soaking the fruit with whiting, cooking the fruit in a sugar solution until the water is reduced, and adding a little salt for the flavor. After cooking, the fruit is drained and dried in the sun for three days.

This research begins by preparing the tools and materials to be used. Then, NaOH and 0.1 N

CH3COOH solutions are made, the NaOH solution is standardized with the CH3COOH solution, and the star fruit and star fruit raisins sample is titrated.

Based on the data obtained from the results of research on the determination of citric acid content of star fruit and star fruit raisins by acid-base titration method, it shows that sample A has an average citric acid content of 6.363 mg / 100 g and sample B 4.703 mg / 100 g. From these data, sample A has a higher content than sample B. From these data, sample A has higher levels than sample B.

Luan et al. (2021) state that 100 g of total solids of star fruit contain 1.9 mEq or 1.9 mg of acid, and citric acid as much as 133.8 mEq, equivalent to 44.6 mg of acid. This shows that star fruit contains 1.9 % acetic acid and 44.6 % citric acid.

Based on research conducted by Muzaifa (2018) on the analysis of organic acids in belimbing wuluh and sunti acid, the dominant organic acids in belimbing wuluh are oxalic acid 825.12 %, ascorbic acid 112.68 %, citric acid 46.76 %, lactic acid 19.44 %, and malic acid 41.82 %. Generally, the organic acids in star fruit decrease after processing and storage, except for lactic acid.

Research by Windyastari et al. (2012) found that processing wealth star fruit in dried sweets decreased total acidity, reaching 1.58 %. Soaking the star fruit in a high-sugar solution will increase the total sugar in the material, thus reducing the sourness of the star fruit. This decrease also occurs because calcium ($Ca(OH)_2$) includes an alkaline solution, which is a strong base, so there is a neutralization reaction between organic acids in star fruit.

According to Agnieszka & Lenart, (2009), sugar can bind free water in the material, so some water is unavailable for microbial growth. Thus, the water activity in the material can be reduced due to the osmosis process (the release of water in food ingredients), and the entry of sugar liquid into the material slowly replaces some of the water that comes out (Giannakourou et al., 2020). In addition, the blanching process on the material can help the sugar solution to enter the material tissue.

The research conducted by Sihotang et al. (2019) stated that the most considerable acid content in organic acid tests on both types of star fruit is citric acid. The citric acid in Bogor star fruit is 3526.91 ppm (equivalent to 0.35 % citric acid content in the star fruit extract), and in Aceh star fruit, it is 3551.67 ppm (equivalent to 0.36 % citric acid content in the star fruit extract).

The difference in data from the analysis results with the analysis results obtained based on the literature. There may be differences in the varieties of star fruit used in the literature with star fruit used for research, so the chemical composition contained in several factors, among others, are differences in varieties, harvesting methods, maturity at harvest time, and storage conditions after harvest (Agustin & Putri, 2014).

Conclusions

Based on the research and data analysis, it can be concluded that the citric acid content in belimbing wuluh and kismis belimbing wuluh is 6.363 mg / 100 g and 4.703 mg / 100 g, respectively. These results show that the citric acid content of wuluh star fruit is more than that of wuluh star fruit raisins. This is because belimbing wuluh raisins experience changes in the content of chemical components during the processing process.

Acknowledgment

The author would like to thank Mrs. Siti Nuryanti for providing advice and input for this paper. To the Chemistry laboratory staff of FKIP UNTAD, thank you for assisting the author during the research.

References

Agnieszka, C., & Lenart, A. (2009). Rehydration and sorption properties of osmotically pretreated freeze-dried strawberries. *Journal of Food Engineering, 97*(2010), 267-274.

Agustin, F., & Putri, W. D. R. (2014). Pembuatan jelly drink averrhoa blimbi l. (kajian proporsi belimbing wuluh: Air dan konsentrasi karagenan). *Jurnal Pangan dan Agroindustri*. 2(3), 1-9.

Behera, B. C., Mishra, R., & Mohapatra, S. (2021). Microbial citric acid: Production, properties, application, and future perspectives. *Food Fronteirs, 2*(1), 62-76.

Bresnick, S. (2002). Intisari Kimia Umum. Jakarta: Hipokrates.

Broekhuijsen, M. P., Mattern, I. E., Contreras, R., Kinghorn, J. R., & Hondel, C. A. M. J. J. V. (1993). Secretion of heterologous proteins by aspergillus niger: Production of active human interleukin-6 in a protease-deficient mutant by KEX2-like processing of a glucoamylase-hIL6 fusion protein. *Journal of Biotechnology, 31*(1), 135-145.

Damayanti, F., Astuti, I. P., Zulkarnaen, R. N., Sunarti, S. (2020). Nutritional contents and the utilization of Indonesian native starfruits: Averrhoa dolicocarpa and a. leucopetala. *BIODIVERSITAS, 21*(4), 1303-1309.

Ferawati, Y. (2005). *Pengaruh konsentrasi $CaCl_2$ dan metode pengeringan terhadap sifat fisik, kimia dan organoleptik belimbing wuluh kering*. Unpublished undergraduate' thesis. Malang: Universitas.

Fitriani, S. (2008). Pengaruh suhu dan lama pengeringan terhadap berberapa mutu manisan belimbing wuluh kering (averrhoa bilimbi l.). *Jurnal Sagu, 7*(01), 32-37.

Giannakourou, M. C., Dermesonlouoglou, E. K., & Taoukis, P. S. (2020). Osmodehydrofreezing: An integrated process for food preservation during frozen storage. *Foods, 9*(8), 1-25.

Hidayati, I. L. (2007). *Formulasi tablet effervescent dari ekstrak daun belimbing wuluh (averrhoa bilimbi l.) sebagai anti hipertensi*. Unpublished undergraduate' thesis. Bogor: Institut Pertanian Bogor.

Kanwar, A., & Budhwar, S. (2018). Utilization of star fruit (averrhoa carambola) into value added products and their storage stability. *International Journal of Food Science and Nutrition, 3*(1), 77-80.

Luan, F., Peng, L., Lei, Z., Jia, X., Zou, J., Yang, Y., He, X., & Zeng, N. (2021). Traditional uses, phytochemical constituents and pharmacological properties of averrhoa carambola l.: A review. *Frontiers in pharmacology, 12*(August), 1-27.

Margono, S. (2000). Metodologi penelitian pendidikan. Jakarta: Rineka Cipta.

Mayasari, E., Agustia., & Rahayuni, T. (2020). Wuluh Star fruit (averrhoa bilimbi linn) and pineapple (ananas comosus l.) formulations on the quality of fruit syrup. *International Journal of Advance Tropical Food (IJATF), 2*(1), 25–32.

Muzaifa, M. (2018). Perubahan komponen kimia belimbing wuluh (averrhoa bilimbi l.) selama pembuatan asam sunti. *Jurnal Teknologi Pertanian Andalas*, *22*(1), 37-43.

Rahman, A. (1992). *Teknologi fermentasi industrial: Produksi metabolit prime*. Jakarta: ARCAN.

Sasmitaloka, K. S. (2017). Produksi asam sitrat oleh aspergillus niger pada kultivasi media cair. *Jurnal Integrasi Proses, 6*(3), 116-122.

Sawant, O., Mahale, S., Ramchandran, V., Nagaraj, G., & Bankar, A. (2018). Fungal citric acid production using waste materials: A mini-review. *Journal of Microbiology, Biotechnology, and Food Sciences, 8*(2) 821–828.

Sihotang, E. C., Indriyani., & Wulansari, D. (2019). The effect of comparison of starfruit and carrot porridge on characteristics of sheet jam. *Indonesian Food Science and Technology Journal, 2*(2), 37-45.

Thirumalai, M. (2020). Quantitative estimation of acid and base from locally available materials by using titration method. *Open Access Library Journal, 7*(June), 1-10.

Wardani, R. K., & Handrianto, P. (2019). Analisis kadar kalsium oksalat pada tepung porang setelah perlakuan perendaman dalam larutan asam (analisis dengan metode titrasi permanganometri). *Jurnal of Research and Technology, 5*(2), 144-153.

Windyastari, C., Wignyanto., & Putri, W. I. (2012). Pengembangan belimbing wuluh (averrhoa bilimbi) sebagai manisan kering dengan kajian konsentrasi perendaman air kapur ($Ca(OH)_2$) dan lama waktu pengeringan. *Jurnal Industri, 1*(3), 195-203.