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by Fasih Bintang Ilhami

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The Characterization of Salt Level in Mango Fruit Through Principle of Refraction Index

[1,2]Fasih Bintang Ilhami, [1]Mohammad Budiyanto
[1]Department of Natural Science, Faculty of Mathematics and Natural Science, Universitas Negeri Surabaya, Surabaya 60231, Indonesia.
[2]Graduate Institute of Applied Science and Technology, National Taiwan University of Science and Technology, Taipei 10607, Taiwan.
Email Correspondence: fasihilhami@unesa.ac.id

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Abstract
The characterization of salt level in fruits with simple techniques still has several challenges to determine. Herein, we successfully present a simple breakthrough to resolve of purity or concentration of a substance by the principle of refraction index with a refractometer. The resulting experiments by mango fruit extracts showed refractive index is produced in NaCl solution at a concentration of 0.1 M; 0.2M; 0.5M; 1 M; 2 M by 1004; 1009; 1016.3; 1017.3; 1058, respectively. More importantly, the highest refractive index produced in mango fruit extract is owned by Manalagi mango with a refractive index of 1047.3, followed by Arum Manis mango with 1041, Banjarnegara mango with 1030, Gadung mango with 1023.3, and Raw mango with 1015,3. Thus, the higher the concentration of the solution would the greater the refractive index produced due to refractive index is inversely proportional to the speed of light in the solution. Therefore, this is a simple technique that can be used to determine salt level in fruits and allow to select healthy fruit for intake by our body.

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INTRODUCTION

Salt is a white crystalline solid that is a collection of compounds consisting mostly of sodium chloride (NaCl) about > 80% and other compounds such as magnesium chloride, magnesium sulfate, and calcium chloride (Zhang et al., 2022). Consumption of salt is generally used as consumption as a food flavor and color enhancer, preservative, texture-forming agent, and as drying agent (Krupp, Shi, Egert, Wudy, & Remer, 2015). People are typically recommended to take low-sodium salt level since the sodium concentration may contribute to high blood pressure. The body retains fluids as a result of increased salt consumption, which raises blood volume (Ellison & Welling, 2021). Hypertension arises from the heart having to beat harder to push the higher amount of blood through the smaller chambers (Yusmita, 2017). In the other hand, a body that lacks salt level will experience complications and impaired muscle function in the body such as muscle weakness, spasms, to cramps caused by an imbalance of salt intake and out of cells so that the muscle contraction process does not run normally and smoothly (Astutik, 2017). Basically, salt circulating in the community as consumption salt must have a minimum NaCl level of 94% for iodized consumption salt.

However, the NaCl level in table salt is far below the standard (<94%) which has the potential to form imbalance circulating in our body.

Based on nutritional recommendations from Health Canada, our bodies only need 115 milligrams of sodium per day for a healthy life (Salman, Herbiati, & Yasmin, 2019). For instance, 1 teaspoon of salt contains with 2,000 mg of sodium. Meanwhile, based on UK RNI (United Kingdom Reference Nutrient Intakes) the minimum limit is 575 mg and the maximum are 1,600 mg, respectively. This measure can indeed vary, depending on the climate of the country we live in. The world health agency recommends limiting sodium consumption to 2,400 mg or about 1 teaspoon of salt per day WHO (World Health Organization). The possibility of a lack of salt for those of us who live in Indonesia is very small owing to most of the food in our country is high in sodium content.

Multiple sources contributed to the intake of NaCl in the body of equilibrium, particularly fruits. Fruits have several advantages for the body are as antibodies and provide the essential nutrients needed by our body. By consuming fruit, our body will increase the need for vitamins, fiber, and other minerals needed by the human body. Fruit such as mango can also be an antioxidant that can maintain our immunity (Suryana, 2018; Yadav et al., 2016). Commonly, some of nutritional content found in fruits: (1) Fiber, which plays an important role in maintaining the function of the digestive tract. (2) Vitamin C, which is important for protecting body tissues from damage caused by free radicals (Brookie, Best, & Conner, 2018). (3) Vitamin A, which is important for healthy eyes, skin and the immune system. (4) Folate, which plays an important role in the formation of blood and genetic material. (5) Potassium, which can help maintain blood pressure and nervous system function (Karatas, 2022). Hence, daily fruit consumption is a healthy diet and can encourage a healthy lifestyle.

The development simple technique to calculate the active molecules in fruits such as salt level can be used refractive index due to possibly directly measure the concentration of a solution. The index of refraction is the speed of light in liquid compared to air (Ochoa, Fiorillo, & Ochoa, 2014; Reis, Lampreia, Santos, Moita, & Douhéret, 2010). The angle of refraction also known as the angle of refraction can be calculated using the law of refraction when light travels through the border between two media (Smith, Pendry, & Wiltshire, 2004). The amount of refraction that occurs will depend on the difference in the index of refraction between the two media and the angle of incidence (Bhaduri, Yessenov, & Abouraddy, 2020; Víg, Tóth, & Seres, 2023). If the index of refraction of the first medium is higher than the index of refraction of the second medium, light will be refracted toward the normal line. In addition, refraction of light with salt solution and fruit extract is done by first determining the refractive indices of the two media. The refractive index of a medium can be measured using a tool called a refractometer (Li, 1995). To extend the concept of the refraction index to know the physical parameters of a medium such as concentration. Herein, we successfully demonstrated a simple technique and low-cost compared to previous studies through the refraction index to determine salt levels in different kinds of mango fruits extracts.

METHODS

Materials. The instruments that used in this research is refractometer and pipette. Moreover, the materials used consist of NaCl solutions (0.1, 0.2, 0.5, 1, and 2), extracts mango fruits extracts (Manalagi mango, Raw mango, Banjarnegara mango, Arumanis mango, and Gadung mango), and aquabidest

Method. The method used in this study is the observation method. This research was conducted in the laboratory Department of Natural Science, Faculty of Mathematics and Natural Science, Universitas Negeri Surabaya. The observation method have been prepared by refractometer as

illustrated in **Figure 1**. The last results of our experiment obtained **g**raphic representation linear regression of different type mango fruits.

Figure 1. Research design using a refractometer. (Udos et al., 2020)

Characterization of salt level in mango fruits by refractometer. Firstly, calibrated the refractometer until it shows 0. Then, dropped of solution content with mango fruit extract on the refractometer glass and covered the refractometer glass with a cover slip and make sure that the solution has been covered evenly. Observed the refractive index of the solution.

RESULTS AND DISCUSSION

Refractive index is one of several important optical properties of the medium (Hassanien & Sharma, 2020). The refractive index of a liquid is essential for determining its nature and purity, concentration of a solution, and ratio of components in two liquids or the concentration extracted in a solvent by refractometer. Based on **Table 1**, NaCl solution with 0.1 M has the lowest refractive index with an average of 1004. Moreover, NaCl solution with 2 M has the highest refractive index with an average of 1058, indicating that increasing of concentration of solution is followed by increasing the refractive index and is in line with studies from (Aly & Esmail, 1993; Flood & Puagsa, 2000). On the other hand, as the concentration in the solution increases followed increase of NaCl molecules. Then, solution will be more concentrated due to the molecules are arranged more densely. In other words, the speed of light in the solution will decrease as a consequence of the slowed movement of light. Since the refractive index is inversely proportional to the speed of light in the solution, the refractive index of the solution will increase as the speed of light in the solution decreases (Didik, Safarwadi, & Muslimah, 2021). Thus, these results prompted us to explore the concept of the refraction index in fruits.

Table 1. Effect of NaCl Solution Concentration on Refractive Index.

NaCl solution (M)	Refractive index (n)			Averages
	1	*2*	*3*	
0.1	1004	1004	1004	1004
0.2	1009	1009	1009	1009
0.5	1016	1016	1017	1016.3
1	1017	1017	1018	1017.3
2	1058	1058	1058	1058

Next, we determine the salt level in different kinds of mango fruits by refractometers. As shown in Table 2, Manalagi mango with a refractive index of 1047.3, followed by Arum

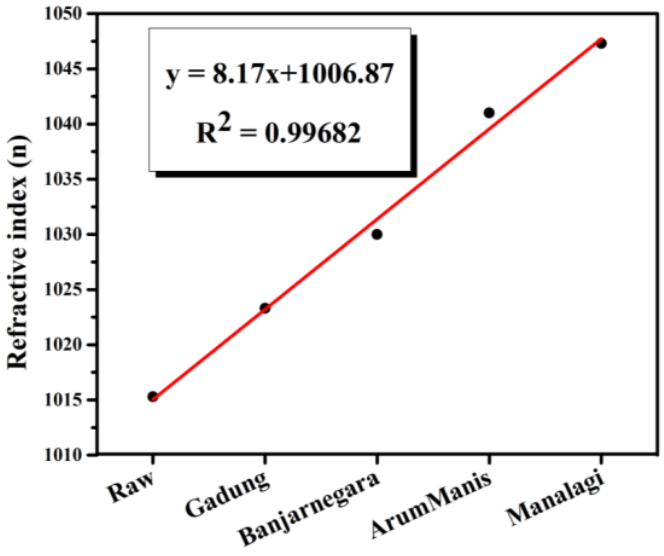
Manis mango with 1041, Banjarnegara mango with 1030, Gadung mango with 1023.3, and Raw mango with 1015,3. These results indicate that Manalagi mango has highest salt level and Raw mango has the lowest salt level. Overall, these observations related to (Zain, 2015) and (Masing, F. A. & Tokan, M. K., 2021) that the higher the salt level is the higher the refractive index value leading to refractometer shown a larger scale.

Table 1. Effect of Mango Fruits Extracts on Refractive Index.

Mango fruit extracts	Refractive index (n)			Averages
	1	*2*	*3*	
Manalagi mango	1047	1048	1048	1047.3
Raw mango	1016	1016	1014	1015.3
Banjarnegara mango	1030	1030	1030	1030
Arum Manis mango	1041	1041	1041	1041
Gadung mango	1023	1023	1024	1023.3

Furthermore, we determine of correlation between concentration of salt level and reflective index. According to the previous results above, the concentration of the salt level solution is directly proportional to the index of refraction which has the greater the concentration of the solution, the value of the refractive index will also be greater, and vice versa. This results in line with (Hidayanto, Rofiq, & Sugito, 2010) that the value of the refractive index is directly proportional to the concentration of solution. Basically, the human body needs sodium intake from salt, but less salt consumption also has other effects leading to make sodium in cells become low. Thus, the function of sodium in cells to retain water can be compromised. In contrast, when consuming excess salt will increase the amount of sodium in the cells and can disrupt fluid balance. Moreover, when fluid enters the cells can reduce the diameter of the arteries, finally the heart needs to pump blood more forcefully (Budiyanto, Suhariningsih, & Yasin, 2017; Patel & Joseph, 2020). Therefore, understanding of salt level is really needed by the body and consume foods that contain salt properly for the body (no more and no less).

Figure 1. Graphic representation linear regression Mango Fruits Extracts on Refractive Index



CONCLUSION

In conclusion, we successfully demonstrated simple technique through the refraction index to determine salt levels in different kinds of mango fruits extracts. A refractometer is to utilize the principle of refraction light, where the value of the level or concentration of the material (substance) being measured is very dependent on the index of refraction. The higher the concentration of the solution, the greater the value of the refractive index so that the refractometer will show a larger scale. Thus, fruit with a refractive index whose characteristics are not too large and not too small is a fruit that is safe for consumption by the body.

SUGGESTION

Based on the results of this study, the advice given by the author is to collect the observation with refractive index using different methods.

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