ASEAN Journal of Science and Engineering

JURNAL UPI

AJSE ASEAN Journal of Science and Engineering

Journal homepage: http://ejournal.upi.edu/index.php/AJSE/

The Effect of Composition Variation of Pineapple, Squeezed Orange (*Citrus sinensis*), and Tomato on The Electrical Properties of Voltaic Cells as an Electrolyte Solution

*Dina Trianadewi, Hilda Yanuar Abadi, Zia Nazaliah Ainisyifa, Adam Siswanto, Sri Anggraeni, Asep Bayu Dani Nandiyanto**

Universitas Pendidikan Indonesia, Setiabudi No.229, Isola, City of Bandung, Indonesia

Correspondence: E-mail: nandiyanto@upi.edu

ABSTRACT

This study aims to demonstrate the electrolyte solution from the fruits to be used as electrical source energy. We combined and varied the composition of the pineapple, squeezed orange, and tomato. The novelties of this research are (1) investigation of the composition of three electrolyte solutions, such as pineapple, squeezed orange, and tomato; (2) the use of these electrolytes. Experiments were done by designing the experimental apparatus and mixing fruits with different compositions. The fruits were mashed using a saw-milling apparatus. We made a series of electrical circuits to test the electrolyte solution. Data were collected every hour for 5 h. We tested the voltage, current strength, and pH. In the circuit, we used a small LED light (2 volts) for ensuring the electrical ability. The results of this study showed the presence of a voltage and current generated, turning on the LED. The more volume of the squeezed orange increased the citric acid, resulting the electrolyte solution to be more acidic (less pH). The utilization of fruits such as pineapple, squeezed orange, and tomato is effective as an electrolyte solution.

© 2022 Universitas Pendidikan Indonesia

ARTICLE INFO

Article History:
Submitted/Received 13 Des 2021
First revised 10 Jan 2022
Accepted 21 Mar 2022
First available online 30 Mar 2022
Publication date 01 Sep 2023

Keyword:
Electrolyte Solution
Voltage
Strong Current
Pineapple
Tomato
Squeeze Orange

1. INTRODUCTION

The production of pineapples, tomatoes, and squeezed oranges fruits in Indonesia has always increased in every year, for example pineapples production in 2017 was 1,795,985 tons and increased to 2,196,458 tons in 2019 (Astoko, 2021). Among fruits, lemon, lime and orange contain more citric acid. Citric acid is a weak tricarboxylic acid that is naturally concentrated in citrus fruits (Penniston *et al*., 2008).

Several previous studies that are relevant have been reported on electrolyte solutions of fruits such as used lime, lemon, grape, orange, coconut and watermelon (Osahenvemwen *et al*., 2020). Studied about electrolyte Performance of Noni (*Morinda Citrifolia L.*) fruit extracts (Akbar *et al*., 2018). Aliteh et al. studied about the Fruit Battery Method for Oil Palm Fruit Ripeness Sensor and Comparison with Computer Vision Method (Aliteh *et al*., 2020) using electrolyte solution principle. Khan and Obaid demonstrates bioelectricity from waste citrus fruit and result that lemons are most preferred for use as a source of bioelectricity including fruits (oranges, grapefruit and mix fruit) (Khan and Obaid, 2015) and Rajagukguk et al. studied about Effect of Wuluh Starfruit electrolyte filtrate addition to ionic conductivity and the electrical characteristics of hydrogel aluminium battery (Rajagukguk *et al*., 2020).

The purpose of this study was to determine the combination of electrolyte solution using fruits. There is tomato, squeezed orange, and pineapple, which have the most effective and optimal levels of electricity. In this study, we did an experimental demonstration with calculated pH, voltage, and strong current, then tested it on the LED lamp (2 volt). The main novelties in this study are (1) use a new combination of three fruits for electrolyte solutions, such as pineapple, squeezed orange, tomato and (2) use new variation in the ratio of the composition electrolyte solution.

2. METHODS

The materials used in this study were 2500 grams of pineapples, 1500 grams of tomatoes, and 1900 grams of squeezed oranges (from a local market in Kuningan, West Java). The tools used in this research include multimeter, cable, crocodile clamp, pH meter, 2 volt LED lamp, Cu and Zn electrodes, glass, filter, blender, measuring cup, scale, scissors, knife, bowl, spoon,adhesive, and cloth dry.

Figure 1 shows the method in making an electrolyte solution in which pineapple, squeezed orange (peeled), and tomato, respectively, were mashed, used a blender and squeezed the juice. With these materials, an electrolyte solution made based on the variation without mixing and mixing in the composition of the ingredients from tomato: squeezed orange: pineapple (0:1:0, 0:0:1, 1:0:0, 1:1:1, 1:2:2, 2:1:2, 2:2:1). The electrolyte solution was tested for pH using a pH meter. Then, the electrolyte solution test carried out with the work function of the voltaic cell tool used an electrode source, were Cu and Zn connected to a cable then tested it on a series electric circuit to determine the current, voltage, and turn on a small LED lamp (2 volt).

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2776-6098 e- ISSN 2776-5938

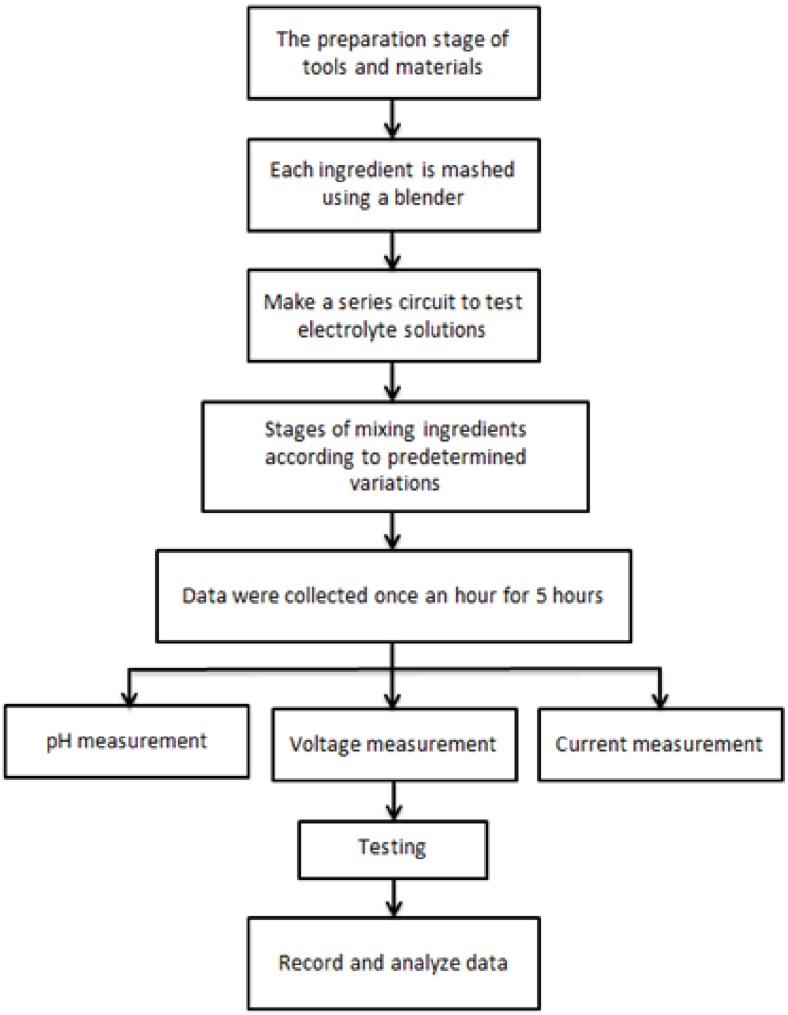

Figure 1. The experimental steps for making an electrolyte solution

3. RESULTS AND DISCUSSION

3.1. Series circuit tool design

The measuring voltage and current were carried out with a series circuit and the data were collected once an hour for five hours without adding resistance. **Figure 2** shows a series circuit design of this study (Astuti *et al*., 2020). The series circuit was chosen because it can increase the voltage value. Total voltage in a series circuit is equal to the sum of the individual voltage drops.

$$V_{Total} = V_1 + V_2 + \ldots Vn$$

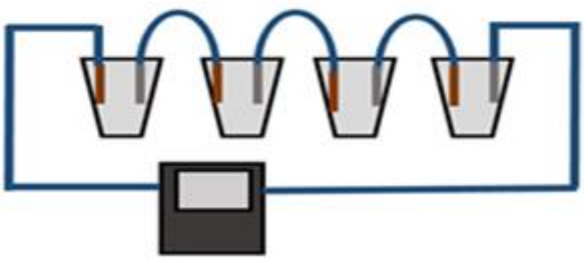

Figure 2. Series circuit design

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2776-6098 e- ISSN 2776-5938

3.2 Analysis of testing voltage and current of electrolyte solution

Figure 3 shows the pH value of the electrolyte solution. For the pH measurement result that combination of tomato, squeezed orange, and pineapple (0:1:0, 0:0:1, 1:0:0, 1:1:1, 1:2:2, 2:1:2, and 2:2:1) had a pH (2.2, 3.9, 4.5, 2.9, 2.8, 3.2, and 3.0). The largest pH value is owned by the sample with a composition ratio 1:0:0 (tomato: squeezed orange: pineapple) which has pH value 4.5. The lowest pH value is owned by the sample with a composition ratio 0:1:0 (tomato: squeezed orange: pineapple) which has pH value 2.2.

Figure 4 shows the average current of the electric current in the electrolyte solution for five hours. See from Figure 3 (b), the sample solution that has a strong electric current with 3.52 A is found in the sample with a composition ratio of 2:2:1 (tomato: squeezed orange: pineapple) which has a pH of 3.0 and can turn on a 2 volt LED lamp. Meanwhile, the sample solution that has the lowest average current with 3.31 A is found in the sample with a composition of 0:0:1 (tomato: squeezed orange: pineapple) which has a pH of 3.9 but still can turn on a 2 volt LED lamp because due to the composition of the material and the high acidity level or different pH values will affect the magnitude of the current. Where the composition ratio of materials that have a high current strength has a volume of 40 ml of squeezed orange and tomato solution. Oranges and pineapples have high levels of citric acid. Pineapple waste produced 46.4% and 45.4% of citric acid at moisture contents of 54.8% and 63.4% (Kuforiji *et al*., 2010). Citric acid which produces acidic properties in solution and makes the solution have an acidic pH or pH value below 7. Fruit solutions that have a high pH level will have a small electric current and otherwise if the fruit solution has a small pH level, it will have a large electric current. This can be interpreted that the level of acidity or pH is inversely proportional to the strong electric current (Fauzi *et al*., 2019). Corresponding to the results of research by Khan and Obaid fruit with the lower pH produces greater voltage (Khan and Obaid, 2015).

Figure 5 shows the average voltage state in the electrolyte solution for five hours. See from Figure 3 (c), the sample solution that has the optimum average voltage with 4.44 V is found in the sample with a composition ratio of 0:1:0 (tomato: squeezed orange: pineapple) which has a pH of 2.2 and can turn on a 2 volt LED lamp. That sample has a lower pH than the other. That's why the voltage of orange is high. Meanwhile, the sample solution which has the lowest average voltage with 2.36 V is in the sample with the ratio of the composition of the ingredients of 0:0:1 (tomato: squeezed orange: pineapple) which has a pH of 3.9 but still can turn on a 2 volt LED lamp. The pH value affects the voltage and the current, the smaller the pH value (acid stronger) then the voltage and the resulting current will be greater, which means that pH is inversely proportional to the voltage generated (Fauzi *et al*., 2019).

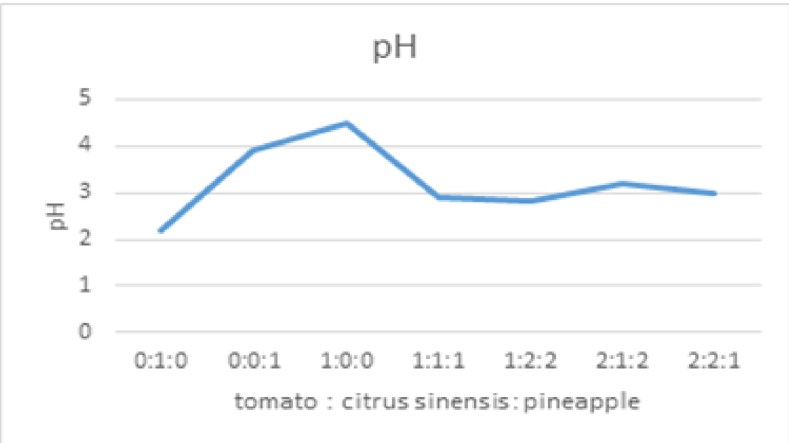

Figure 3. The pH value

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2776-6098 e- ISSN 2776-5938

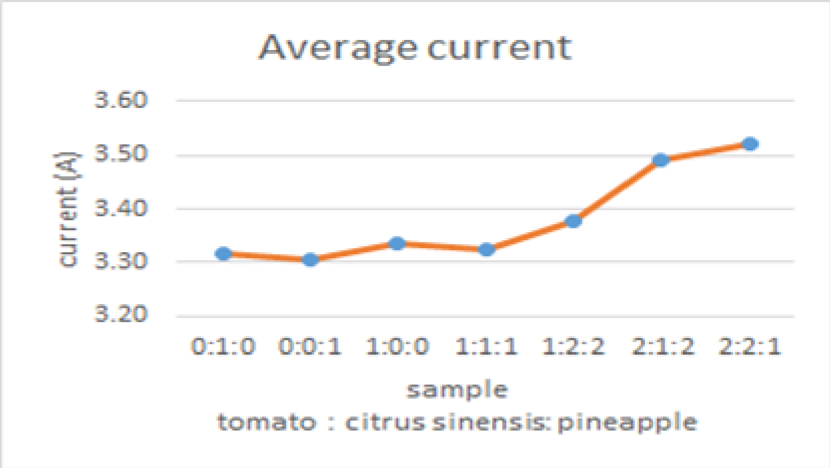

Figure 4. Average current

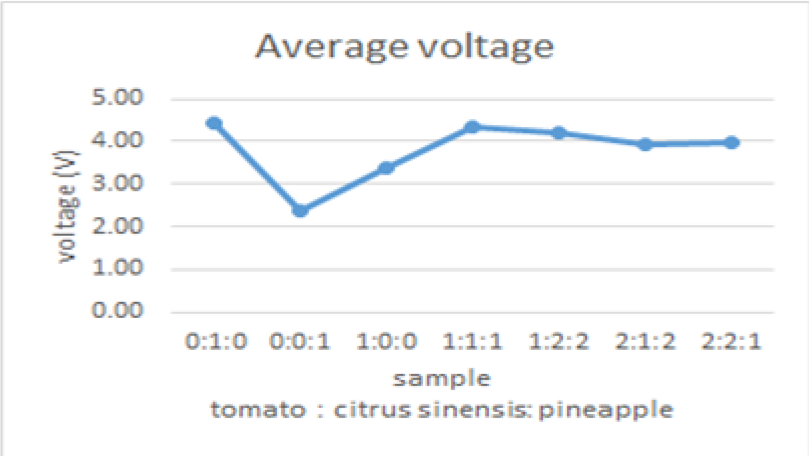

Figure 5. Average voltage

4. CONCLUSION

The effect of variations in the composition of the electrolyte solution from pineapple, tomato, and squeezed orange was investigated by testing the voltage, current strength, pH, and a small 2 Volt LED light. This study experimental use of fruits is pineapple, squeezed orange, and tomato as alternative energy for electricity with an electrolyte solution. After analyzing all electrolyte solutions, it shows that all variations in the composition of the material produce voltage, current, and can turn on a small 2 Volt LED lamp. More the volume of the orange solution increases, the more acidic the solution will be, resulting in a low pH and optimal current and voltage. It can be concluded that the electrolyte solution that has a high current strength is in a solution with a 2:2:1 material composition ratio while the optimal voltage is a 0:1:0 material composition ratio.

5. ACKNOWLEDGEMENTS

We thank our Research Advisers, Panel of Examiners, Participants of the Study, Indonesian Education University (UPI), the Researchers' Families, and above all, The God Almighty.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

6. REFERENCES

Akbar, S. A., Armelianda, D., and Muttakin, M. (2018). Electrolyte performance of noni fruit extracts (Morinda Citrifolia L.) for C–Zn batteries. *Chemical Engineering Research Articles*, *1*(2), 74-81.

Aliteh, N. A., Minakata, K., Tashiro, K., Wakiwaka, H., Kobayashi, K., Nagata, H., and Misron, N. (2020). Fruit battery method for oil palm fruit ripeness sensor and comparison with computer vision method. *Sensors, 20*(3), 637.

Astoko, E. P. (2021). Analisis Usaha Nanas Asam Gulas (Ananas Comosus Merr.) Di Koperta Langgeng Mulyo, Desa Ngancar, Kabupaten Kediri Jawa Timur. Agrilan: *Jurnal Agribisnis Kepulauan*, *9*(1), 79-87

Astuti, A. P., Hanafy, P. S., Nandiyanto, A. B. D., Anggraeni, S., and Usdiyana, D. (2020). Design alat peraga pembelajaran sel volta yang menghasilkan energi listrik menggunakan fermentasi larutan wortel sebagai larutan elektrolit. *Journal of Engineering Practice*, *2*(1), 11-15.

Fauzia, S., Ashiddiqi, M. A. H., and Khotimah, A. W. I. K. (2019, March). Fruit and vegetables as a potential source of alternative electrical energy. *In Proceeding International Conference on Science and Engineering* (Vol. 2, pp. 161-167).

Khan, A. M., and Obaid, M. (2015). Comparative bioelectricity generation from waste citrus fruit using a galvanic cell, fuel cell and microbial fuel cell. *Journal of Energy in Southern Africa*, *26*(3), 90-99.

Kuforiji, O., Kuboye, A. O., and Odunfa, S. A. (2010). Orange and pineapple wastes as potential substrates for citric acid production. *International Journal of Plant Biology, 1*(1), e4-e4.

Osahenvemwen, O. A., Okhaifoh, J. E., and Ifidon, J. O. (2020). Deployment of Fruit Juices as Battery Electrolyte. *American Journal of Sciences and Engineering Research.* E-ISSN-2348-703X, Volume 3.

Penniston, K. L., Nakada, S. Y., Holmes, R. P., and Assimos, D. G. (2008). Quantitative assessment of citric acid in lemon juice, lime juice, and commercially-available fruit juice products. *Journal of Endourology, 22*(3), 567-570.

Rajagukguk, A. H., Ginting, M. H. S., Sundari, E., and Misran, E. (2020, December). Effect of wuluh starfruit (Averrhoa Bilimbi) electrolyte filtrate addition on making hydrogel aluminum battery based on carboxymethyl cellulose. In IOP Conference Series: *Materials Science and Engineering* (Vol. 1003, No. 1, p. 012130). IOP Publishing.

DOI: http://dx.doi.org/10. 17509/xxxx.xxxx
p- ISSN 2776-6098 e- ISSN 2776-5938