ISSN: 0974-5823 Vol. 7 No. 1 January, 2022

International Journal of Mechanical Engineering

ORGANIC BIO MORINGA SUBSTITUTION OF LIME JUICE AS A PRODUCER OF SUSTAINABLE ENVIRONMENTALLY FRIENDLY ELECTRICAL ENERGY

Johannis Wilhelmus Daniel Therik[1,2], Soemarno[3], Ponco Siwindarto[4], Agus Susuilo[5]

[1]Postgraduate Environmental Science Universitas Brawijaya, Indonesia

[2]Department of Electrical Engineering, State Polytechnic of Kupang, Indonesia

[3]Department of soil and plant science, Faculty of Agriculture,

Universitas Brawijaya, Indonesia

[4]Department of Electrical Engineering, Faculty of Engineering,

Universitas Brawijaya, Indonesia

[5]Department of Animal Science, Faculty of Animal Husbandry,

Brawijaya, Indonesia

ABSTRACT

The potential and current capacity produced from organic bio moringa liquid substitution of lime juice as electrical energy. In research using the new standard cell accumulator container. The liquid used in this study comes from Moringa leaves which are processed by crushing and filtering, adding lime juice and aquades. Data collection was taken from a solution of fresh bio moringa and lime juice, respectively. The electrolyte solution of bio moringa and lime is used as an electrolyte solution. The results of the discussion in this paper show that biomoringa liquid substitution of lime juice is able to increase the acidity level of pH to 4 by adding aquades as a diluent. The relationship between current capacity and the acidity of this electrolyte solution is inversely proportional, meaning that the more acidic (the smaller the pH value) the stronger the electric current of the solution and vice versa, the greater the pH value, the smaller the value of the electric current of the solution. The electric voltage generated by the bio moringa liquid substitution of lime juice before being used shows the amount of the lowest electric current of bio moringa liquid equal to 5,44 volts and the electric current amounted to 0,03 mA before being given a charger current. The highest result in the charging of the bio moringa electrolyte charger in the cell accumulator for 2 hours 30 minutes obtained 11,64 Volts with a stored current of 2,5 Ampere in the accumulator cell. The maximum liquid temperature in the cell accumulator when filled was 29,3^{0}C and the specific gravity of the liquid was 1,27. The results of the test using a 12 Volt 270mA DC lamp load connected to a cell container containing bio moringa electrolyte lasts for a maximum of 2 hours 15 minutes. Bio Moringa electrolyte liquid is able to produce electrical energy that is environmentally friendly, non-toxic and made from organic materials, becoming a renewable and sustainable source of electrical energy.

Keywords: Bio Moringa, Lime Juice, Electrical energy, Environmentally friendly.

1. Introduction

The electrical energy crisis is caused by sources of electrical energy which generally come from fossil fuels (coal and oil) whose numbers continue to decline because these fossil fuels require a very long time to renew. Affrilla, U. D. (2020). As time goes by, the presence of mineral rocks in nature is dwindling, so scientists begin to innovate to create environmentally friendly electricity sources and use materials that are easily obtained and are included in renewable resources Fitriyaningsih et al, (2014). The effect of the acidity of citrus fruits on the current capacity namely the more acidic then the greater the solution current capacity and vice versa, the greater the pH value, the smaller the value of the current capacity. Based on research conducted by Dian et al (2013).

Electrolytes are substances that dissociate in water into charged particles called ions. Positively charged ions are called cations. Negatively charged ions are called anions. In simple terms, an electrolyte is a substance that can conduct electricity when it is melted or dissolved in water. Cekic et al. (2021).

In batteries, two materials with different electron affinities are used as electrodes; electrons flow from one electrode to another outside the battery, while inside the battery the circuit is closed by electrolyte ions. Here, the electrode reaction converts chemical energy into electrical energy. Kamil et al (2011).

Basically, an electrolyte solution is a liquid that has the potential to conduct electricity due to the presence of salts, bases, and acids that dissolved in it. Electrolyte ions have a great impact on the reaction environment of electrochemical systems and can be a major driver in determining the reaction rate and selectivity of electro-organic reactions. Blanco et al. (2020). Compared to solid-state electrolytes, until nowadays, traditional liquid state electrolytes are still the most preferred choice for battery commercialization Li-S. et al (2021). One of the main difficulties faced by the future society of the world is the development of pollution-free and environmentally acceptable sources of energy B.S. Thorat, et al (2019).
Based on this study, the researchers used fresh bio moringa liquid substitution of lime juice and aquades as a sustainable source of environmentally friendly electrical energy.

2. Literature Review

Research on anode redesign, in introducing alternative electrolytes, and in engineering high performance bifunctional oxygen catalysts have successfully extended battery reversibility. Leong, et al (2022). The use of renewable cathode materials for batteries is an area that has been widely discussed in recent years, with activated carbonaceous materials (AC), obtained from biomass, being studied intensively through classification and discussion of carbon materials according to the type of biomass. Chen et al (2014). Lithium ion batteries are the main power source for cellular energy, and one of the most promising solutions for environmentally friendly transportation such as electric vehicles.Xu, et al. (2012). Efficient production of electrolytic hydrogen to store electricity-generated renewable energy and secure the contribution of renewables to future power supplies. Zhen et al (2015). For the first time, the small organic molecule 2,2′,5,5′-tetrahydroxybiphenyl (BP4OH) was synthesized as a new organic cathode for Li-ion batteries. Yu et al. (2020). As Li-ion batteries are the first choice source of portable electrochemical energy storage, increasing their cost and performance could greatly expand their applications and enable new technologies that rely on energy storage. Nitta et al (2015). Recent developments in nanostructured organic (carbon) based electrodes with high specific surface areas are driving the search for new electrolytes. P. Han et al (2018).

Utilization of biomass energy has achieved particular interest due to the gradual depletion of conventional fossil fuel sources. Natural products from plants, either as pure compounds or as standardized extracts, have unrivaled availability in chemical diversity. S. Sasidharan et al (2011). The manufacture of organic sodium-ion batteries using environmentally friendly organic materials as electrodes, which exhibit high energy/power density and good structural design capabilities, has recently attracted great attention. Yinet et al. (2020).

Sun et al (2020) researching organic-covalent frameworks, and featuring structural diversity, framework tenability and functional versatility, have emerged as promising organic electrode materials for rechargeable batteries and have received tremendous attention in recent years.

Moringa oleifera is a commonly used plant and is rich in nutrients and antioxidants. Coppin et al (2015). *Moringa oleifera* (MO) is a tree native to northern India, Pakistan, and Nepal, where all of its components (leaves, seeds, flowers and bark) are considered medicinal. Its medicinal components have been used by traditional Ayurvedic medicine, Siddha, Egyptian, Greek, and Roman curators, among the main traditional medicines. Because of the medicinal properties of Moringa, it has also been given names such as "magic tree" and "mother's friend" Leone et al., (2015).

Moringa leaves contain essential amino acids, including amino acids that contain sulfur in higher levels than those recommended by the Food and Agriculture Organization (FAO). Ganatra et al. (2012). The content of vitamin C in the young leaves of six M. oleifera was found equal to 62,66-143,587 mg/100 g, mature leaves contained 51,226 to 150,157 mg/100 g. Ahmed et al (2016).

Electrolysis converts electrical energy into chemical energy by storing electrons in the form of stable chemical bonds that can be used as fuel or converted back into electricity when needed. Electrolysis of water to hydrogen and oxygen is a well-established technology, while fundamental advances in CO_2 electrolysis are still needed to allow short-term and seasonal energy storage in the form of liquid fuels.Yan et al (2020). Organic flow battery with energy density solid state battery has solid organic steric and electronic properties for high capacity and voltage efficiency which can be accessed to monitor charge status as a function of time, thus exhibiting moderately high duty cycle and material utilization and reasonably high voltage efficiency. Wong et al (2021).

Organic solute substances are ionic compounds and organic solutes that are not ionic compounds when dissolved in water, produce ions and electrons flow carried by ions such as acids, bases and salts. Polar covalent compounds when dissolved in water, will dissociate into ions. Zhang et al (2018). The anode and cathode are the positive and negative areas of the battery that allow electrons to flow in and out. Manzetti et al (2015). A significant advantage that bio batteries have over other batteries is their ability to recharge instantly. Meziane et al (2021).

This experimental study describes the potential of Moringa material in the form of a liquid taken from and processed fresh as an electrolyte that produces environmentally friendly electrical energy and displays results in the form of measured electric current and voltage potential using a standard cell accumulator as a container for storing bio moringa liquid. .

3. Research Method

- The research method used in this study is an experimental method using tools and materials among others: lime juice, 250 ml of fresh bio Moringa liquid, 750 ml of aquades as well as supporting tools in the measurement of analog multimeters, cables and jack, measuring cylinder, pH meter, ruler, juicer, plastic container, cell accumulator. Data collection was taken from moringa solution with lime juice substitution, each with a volume of 250 ml of bio moringa-electrolyte. Lime juice solution as an acidity-enhancing electrolyte solution. Then the solution is placed in the container provided, the acidity of the bio-electrolyte of Moringa and lime juice is measured using a pH meter.

- In measuring the current capacity of the bio-electrolyte by connecting the cable to the ammeter and to the cell accumulator as a connector at the positive and negative poles.
- Initial measurement data is the initial highest achievement rate for the bio-electrolyte capacity of Moringa before conducted the charging of current and voltage in the cell accumulator.
- The charging of electric current using an automatic charger with an interval of 1 hour 30 minutes and monitoring the charging current and voltage every 15 minutes until the cell accumulator is fully charged.
- LED lamp load capacity 12 Volt DC Watt 270mA parallel connection 2 lamps to test the capacity and ability of bio moringa electrolyte in the use as energy used.
- Charging of the electric current to the battery is basically to find out how the active ions of the bio moringa electrolyte liquid interact with the electrode material and how much charge the battery can store, which depends on the potential difference between the electrochemical reactions of the active ions that occur at the two electrodes of the cell accumulator used.

Research Implementation Stage :

A. Preparation of 250 ml of bio-moringa electrolyte which has been mixed with 750 ml of distilled water (aquades)and 250 ml of lime juice.
B. The liquid formulation used is only 180 ml of the formulation according to the storage volume capacity of the accumulator container.
C. The pH of the liquid is measured pH (Hydrogen Power) Moringa electrolyte paste with a pH meter.
D. Measure the electric current in the bio moringa electrolyte before being used in the cell accumulator
E. Weighing 180 ml of bio moringa electrolyte liquid materials and put it in the cell accumulator box container and measure the liquid level and specific gravity
F. The new accumulator cell is used as a container for Moringa bio-electrolyte fluid with a voltage capacity of 12 Volt, 2.5 Ampere / 10 Hr. Standard GS Premium brand made by PT GS Battery Indonesia.

The increased electrical potential difference (i.e., current potential) can be obtained through the flow of bio moringa electrolyte in the cell accumulator after being charged for 1 hour 30 minutes and continued with the testing on the LED light load to see the ability of the accumulator capacity to load usage.

4. Results and Discussion

Plant leaves used as bio-electrolytes were obtained from raw leaves of Moringa weighing 136 grams, cleaned and crushed using an electric blender. The addition of 750 ml of distilled water (aquades) for dilution and 250 ml of lime juice liquid extract was stirred and filtered clean to obtain liquid results. Figure 1 shows the leaves of the wet Moringa plant being refined using distilled water (aquades) and a crushing blender.

.

Figure 1. Bio Moringa Electrolyte Making Process

The liquid form is actually a thick light green color mixed with lime juice to increase the acid. After the acid-base test was carried out, the litmus paper showed a red color after being immersed in Moringa liquid which is an acidic electrolyte with a pH value below 4. The results of the formulation of this acid solution mixture which will be used as bio moringa electrolytes are inserted into the accumulator cell which forms salt and water. So that it becomes a source of electrical energy that will be charged in the cell accumulator. Figure 2. The process of mixing and filling of bio moringa electrolyte liquid.

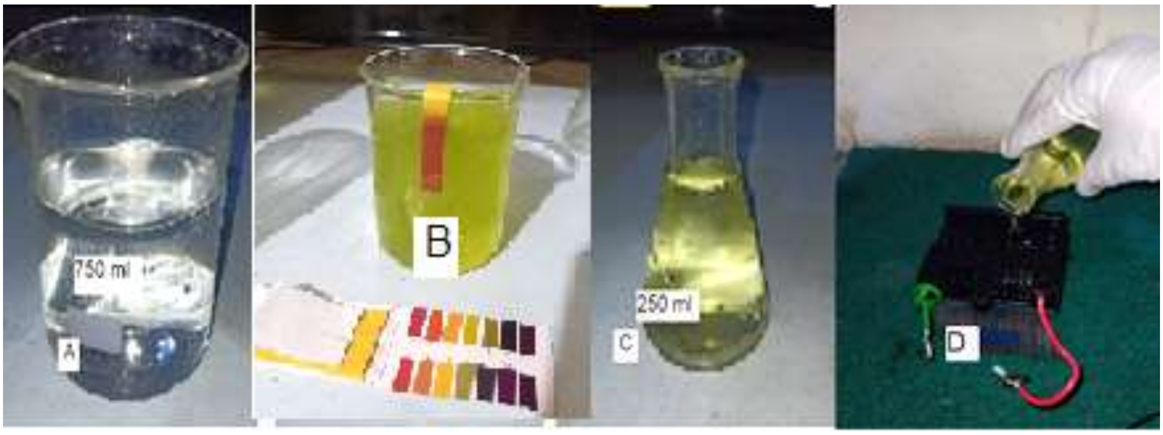

Figure 2. Bio Moringa Electrolyte Mixing Process

According to the order in figure 2 A :Aquades B : Bio Moringa electrolyte liquid mixed with lime juice. C lime juice, and D is the process of filling the cell accumulator as much as 180 milliliters from the formulation. The results of the initial measurements on the cell accumulator obtained a cell voltage of 5,44 Volts and an electric current of 0,03mA. Figure 2 shows the process of measuring the bio moriga electrolyte fluid using a volt meter in the cell accumulator container.

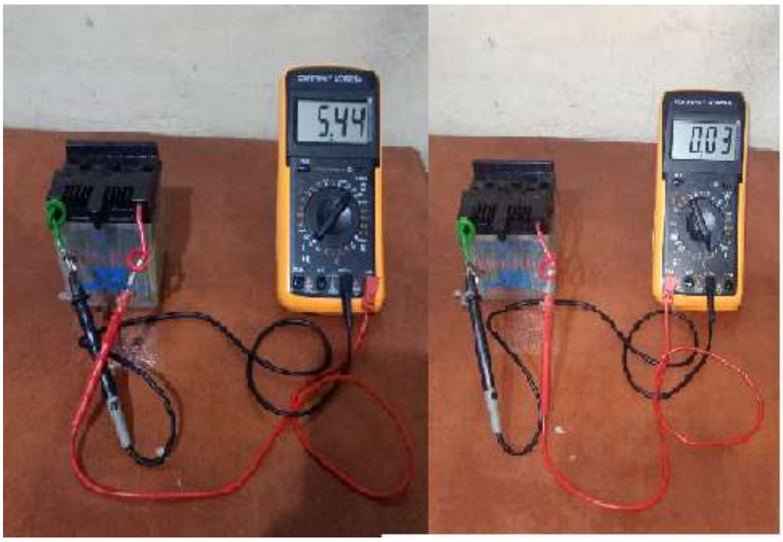

Figure 2. Electric Current Measurement of Bio Moringa electrolyte Liquid Before charger

The charging of the electric current in the accumulator cell for 2 hours 30 minutes using a constant current automatic charger with a charging current capacity of 3Amperes and a charging voltage of 12 Volts DC. The variables observed in the study included current, power voltage and the pH of the solution and the temperature of the liquid simultaneously measured every 15 minutes in the test treatment. Figure 3 shows the charging process of electric current in the bio moringa electrolyte cell accumulator.

Figure 3. Bio Moringa Electrolyte Cell Accumulator Charging Process

Charging of the bio moringa electrolyte accumulator charger is used to compensate for the loss of contents (*self discharge*), before used it is carried out with a low current from the appropriate capacity of the accumulator cell container. *Slow charging* is a more normal charging. The charging current must be 1/10 of the battery capacity. With a capacity of 2,5 Ah, the amount of slow charging current is a maximum of 2A. This charging time depends on the designed battery capacity. Charging of the electric current in the accumulator cell, the charge voltage gradually increases to 8,5 volts, 9 volts, 10,2 until 11,0 volts. With the charging electric current of 3 Ampere and a charging voltage of 13,5 Volts from an automatic charger. The results of these measurements visually obtained data that the charger used was a 12 Volt DC Charger Input voltage (V) and a charging current of 3.A. When the charging occurs, the temperature rises from the (T) charging minimum of 25.2°C to the charged maximum peak of 29.8°C. The maximum voltage on charging is obtained at 11,64 Volts with a stored current of 2,5 Ampere in the cell accumulator. The charging results of voltage and electric current can be seen at table 1.

Table 1. Charging Time for Voltage and Electric Current in Cell Accumulator

No	**Charging time/15 minutes**	**Charging voltage Volt**	**Charging current mA**	**Charging power mW**	**pH liquid**	**Specific gravity**	**Temperature °C**
1	15	7,2	0,04	0,288	4	1,25	25,2
2	30	8,2	0,06	0,492	4	1,25	25,8
3	45	9,5	0,09	0,85	4	1,25	28,3
4	60	10,2	0,11	1,12	4	1,25	28,3
5	75	10,6	0,13	1,37	4	1,25	28,4
6	90	10,5	0,15	1,57	4	1,27	28,5
7	105	10,8	0,16	1,72	4	1,27	29,5
8	120	11,1	0,18	1,99	4	1,27	29,7
9	135	11,28	0,19	2,14	4	1,27	29,9
10	150	11,44	0,24	2,74	4	1,27	28,9
11	165	11,63	0,27	3,14	4	1,27	28,8
12	180	11,64	0,27	3,14	4	1,27	29,3

Increase in the voltage on the cell according to the charging time to reach the maximum value of current storage and charger voltage. This can be seen from the increase in current and voltage every 15 minutes when charging the cell accumulator.

Testing the accumulator cell filled with bio moringa electrolyte liquid using an LED lamp with a capacity of 12 Volts 270 mA, arranged 2 LED lights in parallel to see the usage ability of the bio moringa material cell accumulator capacity. The decrease in current and voltage, liquid temperature and specific gravity in the use of the load is observed and recorded. Figure 5, shows the test of cell accumulator made from bio moringa electrolyte using a lamp.

Figure 4. Bio Moringa Cell Accumulator Electrolyte Testing on LED lamps

A. Volt meter.B. Cell Accumulator.C Cell Accumulator.D LED Lamp. E. Digital temperature device.

The results of measurements and observations in the accumulator test using the LED light load can be seen in table 2 of the usage time.

Table 2. The Usage Time of 12 Volt 270mA DC Light Load Against Accumulator Capacity Decrease

No	Downtime/15 minutes	Voltage down	Current down	Power down	pH liquid	Specific gravity	Temperature ºC
1	15	10,3	0,27	2,78	4	1,27	27,1
2	30	9,0	0,11	0,99	4	1,27	28,8
3	45	8,5	0,06	0,03	4	1,27	29,3
4	60	8,3	0,03	0,24	4	1,27	28,9
5	75	8,2	0,02	0,16	4	1,25	28,8
6	90	8,2	0,02	0,16	4	1,25	28,8
7	105	8,0	0,01	0,08	4	1,22	28,5
8	120	7,9	0,01	0,08	4	1,22	28,5
9	135	7,9	0,00	0.00	4	1,22	28,3

Bio moringa electrolytes substitution based on experimental results appear to have an effect on the increase in voltage and electric current in measuring instruments where the more acidic the liquid, the higher the current and voltage in the cell. The measurement results in Table 1 shows how the ability of the bio-electrolyte volume affects the performance of the electrochemical cell reacting from the number of 180 milliliters of acidic electrolyte capable of producing an electrical output voltage of 10,3 Volts and an electric current of 2,5 Amperes in the cell accumulator properly from the results of charging through the charger.

Similar findings indicate that the use of fresh biomoringa liquid substitution electrolyte of lime acid and aquades diluent becomes significant in experimental results. The anode is the negative terminal of the electrochemical cell where the oxidation reaction of the biomoringa electrolyte liquid takes place which is responsible for the regeneration of electrons and its properties greatly affect the overall electrochemical performance of the cell.

5. Results and Discussion

The electrical energy generated from fresh electrolyte fluid bio moringa contains natural organic acids obtained from the formulation between bio moringa liquid and lime juice and produces a pH of 3 to 4 with a specific gravity of organic liquid (Specific Gravity) 1,27 and is a weak organic acid. The electrolyte of bio moringa is a weak liquid organic acid that can dissolve or decompose into ions and then the solution becomes an electrical conductor, ions which are charged atoms. Bio moringa electrolyte liquid is proven to be able to generate electrical energy in the accumulator container cell.

This study aims to determine the amount of the electric current produced from fresh green bio moringa liquid which is added to a lime solution. By connecting the copper wire to the accumulator pole, and connecting it to a multimeter measuring instrument to measure, conduct and connect the LED lamp, then the current and voltage will flow from the battery cell to the lamp through the conductor wire and release electrical energy to the lamp in the form of light.

The degree of acidity of the bio moringa electrolyte on a scale of 4 has proven to have an important effect in generating electrical energy. Bio moringa electrolytes are liquid substances that dissociate in water to become charged particles in the form of ions. Fresh organic bio moringa electrolyte substitution of lime juice is able to literally function as a storage medium and a provider of electrical energy. The source of electricity used as a power generator is in the form of direct current. A battery is a collection of chemical cells, each of them contains two metal electrons immersed in a conducting solution called an electrolyte. Due to chemical reactions between the conductors and the electrolyte, one electrode of the anode is positively charged and the other, the cathode, becomes negatively charged. Bio moringa organic electrolyte liquid is an environmentally friendly organic liquid-chemical compound that stores energy and releases it in the form of electricity. Bio moringa electrolyte liquid is an organic solution that can conduct electric current. The solution is classified in a homogeneous mixture consisting of a solvent and a solute. The solvents commonly used are water. While the solute consists of various ionic and covalent compounds. The electrical conductivity of bio moringa is a substance dissolved in water that can be determined by a real test. An electrolyte solution contains ions that have different charges and move freely.

6. Conclusion

The part of Moringa that can be used as an alternative source of electricity is the leaves which are processed in liquid form. One of the chemical compounds from the juice of Moringa leaves namely contains ascorbic acid which is an electrolyte with a pH level of 4, that can be used as a voltaic liquid to produce an environmentally friendly electric current.

The lowest electric current capacity of bio moringa liquid equal to 5,44 volts and the electric current amounted to 0,03 mA before being given a charger current. The highest result in the charging of the bio moringa electrolyte charger in the cell accumulator for 2 hours 30 minutes obtained 11,64 Volts with a stored current of 2,5 Ampere in the accumulator cell with maximum liquid temperature in the cell accumulator when filled was 29,3^{0}C and the specific gravity of the liquid was 1,27. The results of the test using a 12 Volt 270mA DC lamp load connected to a cell container containing bio moringa electrolyte lasts for a maximum of 2 hours 15 minutes.

This research is an initial finding of the potential of organic fresh biomoringa in producing environmentally friendly renewable and liquid electrical energy.

REFERENCES

1. Affrilla, U. D. (2020). “Konversi Buah Jeruk Nipis (Citrus aurantifolia) Dan Belimbinhg Wuluh (Averrhoa bilimbi) Menjadi Energi Listrik Alternatif .Doctoral dissertation, Politeknik Negeri Sriwijaya.
2. Ahmed, K. S., Banik, R., Hossain, M. H., & Jahan, I. A.” (Vitamin C (L-ascorbic acid) Content in Different Parts of Moringa Oleifera Grown in Bangladesh. American Chemical Science Journal, 11(1), 1-6.
3. Aarushi, Naveen Nandal, Parul Agrawal. AN EXPLORATORY RESEARCH IN PRODUCT INNOVATION IN AUTOMOBILE SECTOR. JCR. 2020; 7(2): 522-529. doi:10.31838/jcr.07.02.98
4. Kumar, S. (2022). Effective hedging strategy for us treasury bond portfolio using principal component analysis. Academy of Accounting and Financial Studies Journal, Vol. 26, no.2, pp. 1-17
5. B.S. Thorat, S.M. Raut, Multil. Sci. (2019) 132–138
6. Blanco, Daniela E., et al. "Effect of Electrolyte Cations on Organic Electrosynthesis: the Case of Adiponitrile Electrochemical Production." *Journal of the Electrochemical Society* 167.15 (2020): 155526.
7. Chen, Lin, and Leon L. Shaw. "Recent Advances in Lithium sulfur Batteries." *Journal of Power Sources* 267 (2014): 770-783.
8. Chen, R., Bresser, D., Saraf, M., Gerlach, P., Balducci, A., Kunz, S. Chen, J. (2020). “A Comparative Review of Electrolytes for Organic-Material-Based Energy-Storage Devices Employing Solid Electrodes and Redox Fluids. *ChemSusChem*, *13* (9), 2205.
9. Coppin, Julia P., et al. "Variations in Polyphenols and Lipid Soluble Vitamins in Moringa Oleifera." *Processing and Impact on Active Components in Food*. Academic Press, 2015. 655-663.
10. D. Teketay. (2010). “Edible Wild Plants of Ethiopia, vol. 575, Addis Ababa: Addis Ababa University Press, Addis Ababa.
11. Ding, Yu, and Guihua Yu. (2016). "A bio-inspired, Heavy Metal Free, Dual Electrolyte Liquid Battery Towards Sustainable Energy Storage." *Angewandte Chemie* 128.15 (2016): 4850-4854.
12. Duncan, Hugues, Nuha Salem, and Yaser Abu-Lebdeh. (2013)."Electrolyte Formulations Based on Dinitrile Solvents for High Voltage Li-ion Batteries." *Journal of The Electrochemical Society* 160.6 A838.
13. Ganatra, T., Joshi, U., Bhalodia, P., Desai, T., & Tirgar, P. (2012). “A Panoramic View on Pharmacognostic, Pharmacological, Nutritional, Therapeutic and Prophylactic Values of Moringa Oleifera lam”. *Int Res J Pharm*, *3*(6), 1-7.
14. Helder, Marjolein. (2015). "Renewable Energy Is Not Enough It Needs To Be Sustainable." *World Economic Forum. September*. Vol. 2.
15. Huang, J., Dong, X., Guo, Z., & Wang, Y. (2020).”Progress of Organic Electrodes in Aqueous Electrolyte for Energy Storage and Conversion. *Angewandte Chemie*, *132*(42), 18478-18489.
16. Oduro, WO Ellis, and D. Owusu, (2008). “Nutritional Potential of Two Leafy Vegetables: Moringa oleifera and Ipomoea batatas leaf,” Scientific Research and Essays, vol. 3, no. 2,
17. JMM Engels and E. Goettsch, Konso (1991.).”Farming and Its Plant Genetic Resources, Ethiopian Plant Genetic Resources. Cambridge University Press, Cambridge.
18. Kamil Perzyna; Regina Borkowska; Jaroslaw Syzdek; Aldona Zalewska; Wladyslaw Wieczorek (2011). "Effect of Lewis Acid Type Additives On Lithium-gel Electrolyte Characteristics". Electrochimica Acta. 57 : 58–65.
19. Leong, Kee Wah, et al. "Rechargeable Zn-air Batteries: Recent Trends and Future Perspectives." *Renewable and Sustainable Energy Reviews* 154 (2022): 111771.
20. Liang, Yanliang, and Yan Yao.(2018)."Positioning Organic Electrode Materials in the Battery Landscape." *Joule* 2.9 1690-1706.
21. Lin, Y., Huang, S., Zhong, L., Wang, S., Han, D., Ren, S., & Meng, Y. (2021). “Organic Liquid Electrolytes in Li-S Batteries: Actualities and Perspectives. *Energy Storage Materials*, *34*, 128-147.
22. Ma, Manman, Michael R. Booty, and Michael Siegel. (2021)."A Model for the Electric Field Driven Deformation of a Drop or Vesicle in Strong Electrolyte Solutions." *arXiv preprint arXiv:2110.08416*
23. Manzetti, S., & Mariasiu, F. (2015). “Electric Vehicle Battery Technologies: From Present State to Future Systems. *Renewable and Sustainable Energy Reviews*, *51*, 1004-1012.
24. Meziane, S. (2021). “Materials Development for Energy Storage Applications. In *Green Technological Innovation for Sustainable Smart Societies* (pp. 363-396). Springer, Cham

25. National Research Council, Moringa. (2006). “The Lost Plant of Africa. vol. II: Vegetables, The National Academy Press, Washington, DC.
26. Nitta, N., Wu, F., Lee, J. T., & Yushin, G. (2015). Li-ion battery Materials Present and Future. *Materials Today*, *18*(5), 252-264.
27. P. Han, X.u. Gaojie, X. Han, J. Zhao, Xinhong Zhou, (2018). Advanced Energy Materials, Guanglei Cui, p. 1801243.
28. Perzyna; Regina Borkowska; Jaroslaw Syzdek; Aldona Zalewska; Wladyslaw Wieczorek (2011). "Effect of Lewis acid-type additives on lithium-gel electrolyte characteristics". Electrochimica Acta. 57 : 58–65.
29. S. Sasidharan, Y. Clen, D. Saravanan, K.M. Sundram, L. Yoga Latha, Afr. J. Tradit. (2011) .“Complement Altern. Med. 8(1), 1-10.
30. Sun, T., Xie, J., Guo, W., Li, D. S., & Zhang, Q. (2020). “Covalent Organic Frameworks: Advanced Organic Electrode Materials for Rechargeable Batteries. *Advanced Energy Materials*, *10*(19), 1904199.
31. Vergara-Jimenez, Marcela, Manal Mused Almatrafi, and Maria Luz Fernandez. (2017). "Bioactive components in Moringa Oleifera Leaves Protect Against Chronic Disease." *Antioxidants* 6.4 91.
32. Wong, C. M., & Sevov, C. S. (2021). “All-Organic Storage Solids and Redox Shuttles for Redox-Targeting Flow Batteries”. *ACS Energy Letters*, *6*(4), 1271-1279.
33. Xu, B., Qian, D., Wang, Z., & Meng, Y. S. (2012). “Recent Progress in Cathode Materials Research for Advanced Lithium ion Batteries”. *Materials Science and Engineering: R Reports*, *73*(5-6), 51-65.
34. Yan, Z., Hitt, J. L., Turner, J. A., & Mallouk, T. E. (2020). “Renewable Electricity Storage Using Electrolysis. *Proceedings of the National Academy of Sciences*, *117*(23), 12558-12563.
35. Yin, X., Sarkar, S., Shi, S., Huang, Q. A., Zhao, H., Yan, L. & Zhang, J. (2020). “Recent Progress in Advanced Organic Electrode Materials for Sodium-ion Batteries Synthesis, Mechanisms, Challenges and Perspectives. *Advanced Functional Materials*, *30*(11), 1908445.
36. Yu, Q., Yao, Z., Shi, J., Tang, W., Wang, C., Li, D., & Fan, C. (2020). “Electrochemically Manipulating the Redox State of 2, 2′, 5, 5′-Tetrahydroxybiphenyl as a New organic Li-rich Cathode for Li-ion Batteries. *Organic Electronics*, *81*, 105661.
37. Yu, Qihang, et al. (2020)."Electrochemically Manipulating the Redox State of 2, 2′, 5, 5′Ttetrahydroxybiphenyl as a New Organic Li-rich Cathode for Li-ion Batteries." *Organic Electronics* 81 105661.
38. Zhang, J., Corman, R. E., Schuh, J. K., Ewoldt, R. H., Shkrob, I. A., & Zhang, L. (2018). “Solution properties and practical limits of Concentrated Electrolytes for Nonaqueous Redox Flow Batteries. *The Journal of Physical Chemistry C*, *122*(15), 8159-8172.
39. Zhen, Xudong, and Yang Wang. (2015). "An Overview of Methanol as an Internal Combustion Engine fuel." *Renewable and Su*
40. Zula, Aemiro Tadesse, Dagem Alemayehu Ayele, and Woinshet Abera Egigayhu. (2021)."Proximate Composition, Antinutritional Content, Microbial Load, and Sensory Acceptability of Noodles Formulated from Moringa (*Moringa Oleifera*) Leaf Powder and Wheat Flour Blend." International Journal of Food Science.