Asian Journal of Biochemistry, Genetics and Molecular Biology

Volume 16, Issue 7, Page 118-126, 2024; Article no.AJBGMB.119539
ISSN: 2582-3698

Spectral Characterization of *Canarium ovatum* Engl. (Pili) Pulp Extract from Allen, Northern Samar, Philippines

Harley Nico L. Jazmin [a], Flyndon Mark S. Dagalea [a,b*] and Karina Milagros Cui-Lim [a,b]

[a] Department of Chemistry, College of Science, University of Eastern Philippines, Catarman, Northern Samar, 6400, Philippines.
[b] University Research Office, University of Eastern Philippines, Catarman, Northern Samar, 6400, Philippines.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ajbgmb/2024/v16i7396

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/119539

Original Research Article

Received: 09/05/2024
Accepted: 11/07/2024
Published: 13/07/2024

ABSTRACT

Canarium ovatum (Pili) Pulp was widely cultivated in the town of Allen, Northern Samar, Philippines. In Allen, Northern Samar produces 60 to 100 kilograms per year every tree. The pili can used in various aspects like oil and soap production, fuel, sweet candies and bread stuffing, and used in traditional medicines for its nutritional benefits. Thus, this study focuses on characterizing the Pili

**Corresponding author: E-mail: flyndondagalea@gmail.com;*

Cite as: *Jazmin, Harley Nico L., Flyndon Mark S. Dagalea, and Karina Milagros Cui-Lim. 2024. "Spectral Characterization of Canarium Ovatum Engl. (Pili) Pulp Extract from Allen, Northern Samar, Philippines". Asian Journal of Biochemistry, Genetics and Molecular Biology 16 (7):118-26. https://doi.org/10.9734/ajbgmb/2024/v16i7396.*

extract using Ultraviolet visible (UV-vis) spectrophotometer. Physical properties were determined in terms of boiling point, color, density, odor, pH, and solubility. Likewise, the nutritional content was determined in terms of ash content, carbohydrates, crude fats, crude protein, and moisture content. Lastly, to characterize the Pili pulp, a UV-vis spectrophotometer was used to determine and quantify the nutraceutical content of the plant sample. Results showed that, *Pili* pulp has a lower boiling point than water, an orange color, with unpleasant odor, density less than water, slightly acidic, and exhibited a polar nature. Subsequently, proximate analysis revealed that ash content has a high mineral concentration and, also, carbohydrates can contribute for energy source. The presence of crude fats indicates essential fatty acids necessary for maintaining cellular structure. On the other hand, crude protein offers health diet as well as low moisture content of plant sample implies a longer shelf-life and reduced microbial growth. Correspondingly, spectra analysis of UV-vis indicates among phytochemical screening tested for positive results and promoting possible applications in developing natural remedies. Therefore, the findings provide evidence as therapeutic advantages for characterization and evaluation which produce health and economic benefits for individuals, businesses, farmers and government agencies.

Keywords: Canarium ovatum; nutraceutical content; physical properties; proximate analysis; UV-vis spectrophotometer.

1. INTRODUCTION

The Philippine Department of Agriculture identified Pili as a crop worthy of more research and development [1]. Bicol region is the country's top Pili producer having almost 1,800 hectares or 90 percent of the nut's total production area in the Philippines [2].

Canarium ovatum Engl., also called as pili nut or java almond, is recognized as a potential export commodity in the Philippines. Meanwhile, pili or "Tree of Hope"; a premium crop, "The Majestic Tree," as Filipino call it, the pili fruit consists of pulp, shell, and seed. The seed was covered with a papery seed coat and testa. In Allen, Northern Samar produces 60 to 100 kilograms per year every tree [3]. Accordingly, the pili nuts have traditionally been a major source of fat and protein in the diet [4].

Pili is versatile as being used for a variety of products, starting with the trunk and pili's wood which is used for building constructions, furniture, and general carpentry work. The pulp can be processed as meals or feds of pigs and cows as well as possible extract oil, lamp-oil and soap productions. Likewise, pili shell makes as fuel found to be a substitute for roasting and become as bags, accessories, and home decor. On the other hand, the pili nut has been transformed into many products including pili tarts, pili candies, pili ice cream, pili peanut butter, and chocolate bars with *pili nuts*. In Department of Agriculture revealed that pili has major exports to the European Union (EU) included the United States of America, United Kingdom, United Arab Emirates, and Canada enables them to gain more income from higher-value commodities of pili [5].

Humans use an extensive variety of plant derivative as food, drug, and nutritional analysis (Sen et al., 2014). Plants possessed basic nutrients like ash content, carbohydrates, protein, fat, and moisture content along with phytochemical of the plant which are imperative medicinally and these are accountable for growing and change of living being. It is estimated 80 percent of the world's population rely herbal medicines for their livelihood [6].

The mineral compositions of both the pulp and kernel of seven pili nut was determined including macro and micro minerals as well as potential toxic metals. The pulp also contains higher levels of tannic acid [7]. Phytochemicals produced by plants, which protect plant cells from environmental hazards such as pollution, UV exposure and pathogenic attack The antioxidant activity, anticancer activity, and antibacterial activity are likely responsible in pulp for health benefits [8] Cajuday et al., 2017)

However, Northern Samar desire to achieve real progress in the province to the development of pili industry as means as of helping improve the lives of the people, especially small farmers, and entrepreneurs. But the people do not have sufficient knowledge regarding the uses of pili in different sectors in the province. Thus, this study could serve as bases for contributing knowledge about the pili pulp which could pave the way for creating functional foods and dietary

supplements that offer potential health advantages. This could meet the increasing consumer interest in natural and nutrient-rich products on the market.

2. METHODOLOGY

The Pili pulp was collected in Barangay Cabacungan, Allen, Northern Samar. Pretreatment methods, extraction of samples, physical properties determination, nutritional content, and nutraceutical content were conducted at the Bio-Physical Sciences Complex at the Chemistry Laboratory Room in College of Science while the UV-Vis test was done at the Technology Innovation Center both situated at the University of Eastern Philippines, University Town, Catarman, Northern Samar.

2.1 Preparation and Extraction of the Sample

Maturities of pili was determined by the change of exocarp color from green to dark purple or black [9]. The collected pili fruit were washed with distilled water and boiled it for 10 minutes at 70°C. The fruit were peeled and separate from the pulp. The pulp was dried in an oven for 80 °C for 3 hours. Then, it was finely pulverized using an electric blender. The powdered fruit pulp underwent a maceration process in a solvent (1:6 w/v ratio), ethanol as the solvent. Subsequently, the macerated mixture was filtered using filtration process to eliminate the residue which the remaining extract was subjected to simple distillation within a temperature range 50°C-60°C and then incubated for 1-hour aiding in the evaporation of any residual alcohol content.

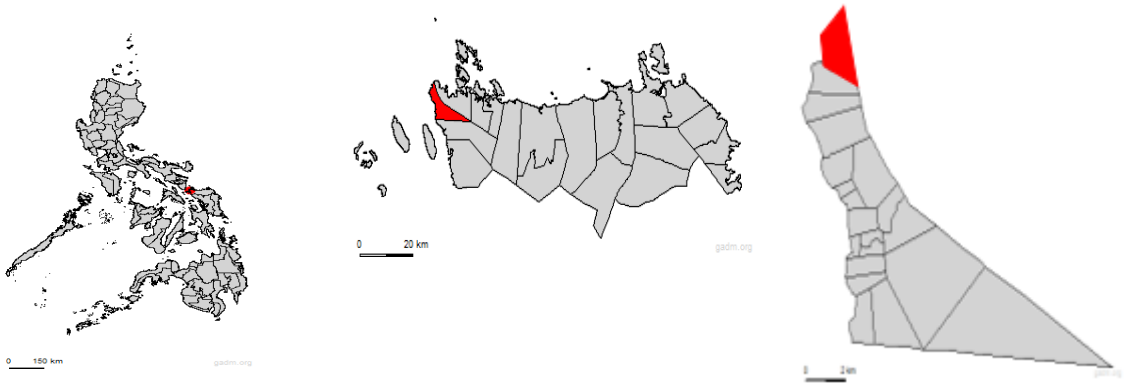

Fig. 1. Map of barangay cabacungan, Allen Northern Samar

Fig. 2. *Canarium ovatum* Engl. (Pili) Pulp

2.2 Determination of Physical Properties of *Canarium ovatum* Engl. (Pili) Pulp Extract

The methods from Dagalea et al. [10] and Valenteros [11] were employed with modification. The pili pulp extract underwent physical properties in terms of, boiling point, color, density, odor, pH, and solubility.

2.2.1 Boiling point

The extract was poured into each of the test tubes. The test tube was submerged in an oil bath and the temperature was recorded when the sample extract started to boil. It was done in three trials.

2.2.2 Color and odor

The *pili* pulp extract determined by five evaluators using their sense of sight and smell.

2.2.3 Density

Five (5) mL of pili pulp extract was weighed on the digital balance. First an empty graduated cylinder was weighed in an analytical balance, after it was weighed, the digital balance was tares then five mL of extract was transferred into the empty test tube.

The formula for density is:

$$Density = \frac{Mass\ of\ the\ Canarium\ ovatum\ Pulp}{Volume\ of\ the\ Canarium\ ovatum\ \text{Engl.}\ Pulp\ Extract}$$

2.2.4 pH

The pH of the sample was determined using pH meter. This was performed in three trials.

2.2.5 Solubility

Three (3) solvents were used, namely; water, ethanol and benzene. Then, each test tubes were added with each solvent. The test tubes were observed to determine the solubility of the samples. The results were recorded as miscible or immiscible. Three trials were done for solubility determination.

2.3 Determination of Nutritional Content of *Canarium ovatum* Engl. (Pili) Pulp

Valera et al., [12] method was employed for determination of nutritional content pili pulp powder the following procedures/analyses were used.

2.3.1 Ash content

To determine the ash content of pili pulp, three crucibles were marked, with five grams of pili pulp, heated in the oven for three to four hours at 80°C. Before putting into the desiccator for 30 minutes, the crucibles were weighed and recorded. The sample was burned using the portable gas stove until it completely turned into ash. It was followed by cooling the sample into the desiccator for 30 minutes and was weighed.

The formula for ash content is:

$$(\%) = \frac{W3 - W1}{W2 - W1} \times 100$$

2.3.2 Carbohydrates

Calculation of carbohydrates for Pili Pulp was determined by adding the total percentage of ash content, crude fat, moisture content and protein. The calculated result was subtracted to 100 using the following formula below.

(%) = 100-(Ash %+Crude Fat+Moisture %+Protein %)

2.3.3 Crude fats

Canarium ovatum Engl. (Pili) Pulp powdered was sent to the Precisione International Research and Diagnostic Laboratory, Inc located at Sta. Rosa 1 Marilao, Bulacan, Philippines. For determination of crude fats in the sample. The test was done through soxhlet extraction which the soluble material was extracted from the dried sample with hexane. After evaporating the solvent and drying of the extract, crude fat was determined by weight.

2.3.4 Crude protein

Canarium ovatum Engl. (Pili) Pulp powdered was sent to the Precisione International Research and Diagnostic Laboratory, Inc located at Sta. Rosa 1 Marilao, Bulacan, Philippines. For determination of crude protein in the sample, the test was done through the process of dumas method which was faster than kjeldahl method.

2.3.5 Moisture content

Ten grams (10) of ground sample was placed in the preheated, cooled and weighed crucibles in the drying oven for 12 hours at 105°C. The crucibles were cooled in desiccator for 30

minutes and were weighed. Three trials were made.

The formula for moisture content is:

$$\% = \frac{(B - C) \times 100}{\mathrm{A}}$$

2.4 Determination of Nutraceutical Content of *Canarium ovatum* Engl. (Pili) Pulp Extract

The methods from Dianito et al. [13] Lim et al. [14] and Valenteros [11] were employed with modification. The pili pulp extract underwent nutraceutical content in terms of, alkaloid, flavonoids, saponin and tannin.

2.4.1 Alkaloids

The picric acid test was used in determining the presence of alkaloid. Pili pulp extract was put into 3 test tubes by adding drops of solution. Formation of orange color was indicated the presence of alkaloids.

2.4.2 Flavonoids

Concentrated H_2SO_4 was added to pili pulp extract in test tubes. A formation of red-orange color indicates the presence of flavonoids.

2.4.3 Saponin

For froth test, the extract of pili pulp was diluted with 10 mL of distilled water then 5 mL of the diluted extract was transferred into the test tube then shaken vigorously for about 15 seconds. The positive result was indicated in the "honeycomb" given that the height is greater than 2 cm from the surface of the liquid and persists after 10 minutes.

2.4.4 Tanninz

Lead acetate test was used to confirm the presence of tannins. Drops of 1% lead acetate was added to sample extract in test tubes. A white or yellow precipitate indicates the presence of tannins [15].

2.5 Determination of Functional Group Present using Fourier-Transform Infrared Spectroscopy

The characterization was carried using the FTIR. Pili pulp extract was placed into the FTIR machine and analyzed for their functional groups.

2.6 Characterization of *Canarium ovatum* Engl. (Pili) Pulp Extract using Ultraviolet-Visible Spectrophotometer

The Model No. BSDBU-201-B of Biolab Double Beam UV Visible Spectrophotometer. The secondary metabolites found positive in phytochemical screening was underwent Ultraviolet Visible Spectrophotometer (UV-Vis) for confirmatory tests. Beer Lambert's Law was used to determine the concentration of the sample which was directly proportional to the absorbance of the light. The Beer-Lambert law is expressed as: A= εLc, where A, is the absorbance, ε is molar absorption coefficient $M^{-1}cm$, l is the optical path length, and c is the molar concentration M. In determining the concentration of solution is expressed the formula as:

$$\mathrm{c} = \frac{A}{(\varepsilon)(\mathrm{l})}$$

3. RESULTS AND DISCUSSION

As shown in Table 1. The sample plant extracted had an average boiling point of 79.6°C, it had lower boiling point than water which meant that the sample was more volatile than water. Boiling points of sample were important to be determined as most product develop for their application on different processes like heating [16].

Additionally, it shows the color of the *Canarium ovatum* Engl. (Pili) Pulp extract was orange color based on the majority of five evaluators. However, the density of sample was 0.86 g/ml which was less dense than water. As revealed by the five evaluators stated that *Canarium ovatum* Engl. (Pili) Pulp extract has an orange color and unpleasant odor.

In terms of pH level of pili pulp extract was slightly acidic with its pH 4.98. Just like foods, low-pH and more acidic food makes it harder for microorganisms to survive or grow in it. Additionally, it serves as a preservation as well as a safety consumption for food. Moreover, all tests were miscible to both polar, water and ethanol, and non-polar, benzene, solvents. Solubility is one of the important parameters to achieve desired concentration of drug in systemic circulation for achieving required pharmacological response [17].

Table 1. Summary of physical properties of Pili pulp extract

Parameters for physical properties	*Canarium ovatum* Engl. (Pili) Pulp Extract
Boiling Point	79.6°C
Color	Orange
Density	0.86 g/ml
Odor	Unpleasant
pH	4.98
Solubility (in water and ethanol)	Polar

Table 2. Summary of nutritional contents of Pili Pulp

Nutritional Contents	Total Average
Ash Content	48.44%
Carbohydrates	14.58%
Crude Fats	30.20%
Crude Protein	3.15%
Moisture Content	3.63%

Table 3. Summary of nutraceutical content of Pili pulp extract

Phytochemical Test	Observation	Results
Alkaloid Test	Formation of orange color	Positive
Flavonoid Test	Formation of red-orange color	Positive
Saponin Test	Formation of honeycomb	Positive
Tannin Test	A white precipitate formed after adding drops of lead acetate	Positive

Based on the results as shown on the Table 2, ash content of pili pulp has a total average of 48.44%. The ash content is a measure of the amount of specific inorganic components present within a food, such as calcium, sodium and potassium [18]. On the other hand, *Canarium ovatum* Engl. (Pili) Pulp had an average of 14.58% carbohydrates indicating the energy required for carry on body processes such as breathing, maintaining body temperature, and contraction and relaxation of the heart and muscles [19]. The crude fat of *Canarium ovatum* Engl. (Pili) Pulp it had an average of 30.20%, this implicates that pili pulp has the sufficient of crude fat need for nutrient since it helps to transport and absorption of fat-soluble vitamins such vitamins A, D, E and K in addition to providing energy [20].

Additionally, Pili contained a crude protein 3.15% this indicates enough source of protein. Protein is an essential component of a healthy diet and is a focus of research programs seeking to optimize health at all stages of life [21]. Moisture content was at 3.63% which indicated enough moisture that a food should have. Moisture content in food can have a significant impact on factors such as the product's taste, texture, appearance, shape, and weight [22].

Table 3 shows that the nutraceutical content of pili pulp was determined through different types of tests for phytochemical screening. The formation of orange color from picric acid test indicated that there was alkaloid content on the sample. In addition, the formation of red-orange color from conc. H_2SO_4 test indicated the presence of flavonoids. Flavonoids has an anti-inflammatory and anti-cancer property which is used for treatment for chronic diseases and ailments [23].

A positive result for saponin was detected on pili pulp extract using froth test (honeycomb formation) in which the level of extract was greater than 2 cm from the surface of the water and persisted after 10 minutes. One function of saponin is that it can be potential antioxidant and many foods which are rich in saponins are suggested as a dietary supplement for people who has diabetes and other disorders [24]. Lead acetate test was used to determine the presence of tannin in pili pulp extract. A white precipitate was formed after a drop of 1% lead acetate solution. Tannins exert several

pharmacological effects, including antioxidant and free radical scavenging activity as well as antimicrobial, anti-cancer, and cardio-protective properties. They also seem to exert beneficial effects on metabolic disorders and prevent the onset of several oxidative stress-related diseases [25].

Fig. 2 shows the absorbance and wavelength of pili pulp. As shown in the line graph for the Pili Pulp extract, its highest wavelength 450nm, 378nm, 356nm, 331nm, 268nm, and 222nm, with absorption spectra of 0.697, 1.283,0.983, 1.228, 1.639, and 1.963 respectively. In concentrations using Beer-Lambert's Law revealed the 6.53 M,1.01 M, and 8.47 M for alkaloid, 5.16 M, and 5.28 M for flavonoids, 6.40 M, 8.29 M, and 8.96 M for saponin and 1.29 M, 1.49 M, and 1.61 M for saponin.

The UV-Vis profile of the extract was chosen from alkaloid typically show absorption peaks around 240–450 nm due to their aromatic ring structures [26]. Flavonoids exhibit absorption peaks in the visible region 210-280 nm, due to their flavone and flavanol structure (Subaya, et al). As explained by medicinal plants and traditional medicine in africa, it shows that the extract has some similar alkaloid, flavonoids, and glycosides compounds reported [27].

The spectrum exhibited range of 260-450 nm, suggesting the presence of saponin content in the pili pulp extract [28]. In comparison, UV spectrum of the *Chlorophytum borivillianum* was taken in the wavelength range of 200-800 nm. However, after analysis for UV-Vis the sample was exhibited range of 260-450 which similar to *Canarium ovatum* (Pili) Pulp [29-31].

Tannin was determined various wavelengths ranges from 240-400 nm from plant sample [32,33]. As specified by Phytochemical Screening, Extraction, and Determination of the Bioactivities of the Extract-Enriched Polyphenols and Saponin from *Musa balbisiana* Fruit showed the result of 365-376 nm range which indicated the presence of tannins and flavonoids similar to the wavelength from pili pulp [34,35].

4. CONCLUSION

The findings of the study revealed that the pili pulp was analyzed for its identification of good physical properties with proximate composition were rich in ash content, carbohydrates, fats, moisture content and protein, and it is believed that these plants could be used for the nutritional purposes of human being to their good nutritional qualities and adequate protection against diseases. It also presence of alkanes, anhydrides, ketone, and alkenes functional group. Additionally, it can recognize the presence of bioactive compounds and preventing diseases.

This study explores the commercial applications of pili and its bioassay agent. This could involve collaboration with industry and should be made to promote sustainable harvesting practices to ensure the long-term availability of Pili industry. The result of this work offers many possibilities for therapeutic applications which produce economic benefits for individuals, farmers, businesses or entrepreneurs and different sectors of government to be beneficial for the growth of well-being. Not only contribute to economic development of Northern Samar but also promote the conservation and preservations of these natural resources for future generations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of manuscripts.

ACKNOWLEDGEMENT

The authors would like to acknowledge the support from the University of Eastern Philippines in Catarman, Northern Samar, Philippines, the funding agency, through the Special Order No. 42c, series of 2021.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Gallegos R, et al. Some physical and mechanical properties of Pili *Canarium ovatum* Engl. Cv. Katutubo Nut as a function of nut moisture content. Philipp Agric Scientist. 2013;96(1):66-74.
2. Aning J, et al. Bicol's pili nuts hit EU markets again; 2023.
3. Meniano S. DA Eyes Dev't Plan for Northern Samar's Pili Nut; 2018.
4. Petruzzello M, Singh S, et al. Pili Nut; 2021.
5. DA-AFID. Philippines regains EU market access for pili nuts export; 2023.
6. Ekor M. The growing use of herbal medicines: Issue relating to adverse reactions and challenges in monitoring safety. Front Pharmacol. 2013;4:177.
7. Millena CG, et al. Philippine Pili (*Canarium ovatum*, Engl.) varieties as source of essential minerals and trace elements in human nutrition. Journal of Food Composition of Analysis. 2018;69:53-61.
8. Dumandan NG, Kagaon AC, Acda RD, et al. Extraction, profiling, and characterization of Phytosterols and triterpenoids from Pili (*Canarium ovatum* Engl.) Pulp Oil Exhibiting Antioxidant and Antibacterial Properties, Biochemistry Research Internation; 2022.
9. Millena CG, Baloloy K, Doma N, Herman P. Effects of maturity on physicochemical and fatty acid profile of Philippine Pili (*Canarium ovatum* Engl.). Philippine Journal of Science. 2023;152(1):159-171. ISSN 0031-7683
10. Dagalea, Flyndon Mark S, Abel Alejandro U, Flores Jr, Franklin E Cortez, Karina Milagros C. Lim. Secondary metabolite screening of extracted Oil from Nypa Fruticans Wurmb. (Nipa Palm). Asian Plant Research Journal. 2022;9(3):17-24. Available:https://doi.org/10.9734/aprj/2022/v9i330208
11. Valenteros R. Nutraceutical Potential of *Clitoria Ternatea* L. (Blue Ternate) Flower; 2023.
12. Valera SA, Lim KMRC, Tonog M, Delorino RA. Nutritional content of Dioscorea hispida Dennist (Korot) found in Lavezares, Northern Samar. J. Bio. Innov. 2019;8(2):236-245. ISSN 2277-8330
13. Dianito, Nathaniel A, Flyndon Mark S, Dagalea, Manuela Cecille G Vicencio, Karina Milagros C Lim. Physicochemical properties and antibacterial activity of biosynthesized silver nanoparticles from Melothria Pendula Linn. (Pipinong-Gubat) Leaf Extract. Asian Journal of Chemical Sciences. 2022;12(1):1-11. Available:https://doi.org/10.9734/ajocs/2022/v12i119134
14. Lim, Karina Milagros R Cui, Judy Ann H Brensis, Flyndon Mark S Dagalea, Marlon John M Bangco, Maria Rosabel Castillo, Hannah G Pulga, Mark Gil M. Cruz, Jaymar L. Erivera, Feraldine M. Chiquito, Tom Jericho L. Abobo, Mary Jane Madario, Cherry I Ultra. Extraction of ethanol from Nypa Fruticans (Nipa) Palm Fruit. Asian Journal of Physical and Chemical Sciences. 2020;8(4):41-45. Available:https://doi.org/10.9734/ajopacs/2020/v8i430125
15. Shaikh JM, Patil M. Qualitative tests for preliminary phytochemical screening: An overview. International Journal of Chemical Studies. 2020;8(2):603–608. Available:https://doi.org/10.22271/chemi.2020.v8.i2i.8834
16. Ren GR, Ke G, Huang R, Pu Q, Zhao J, Zheng Q, Yang M. Study of the volatilization rules of volatile oil and the sustained-release effect of volatile oil solidified by porous starch. Scientific Reports. 2022;12(1). Available:https://doi.org/10.1038/s41598-022- 11692-w
17. Savjani KT, et al. Drug solubility: Importance and enhancement techniques. ISRN Pharmaceutical. 2012; 1-10.
18. Afify A, et al. Survey on the moisture and ash contents in agricultural commodities in Al-Rass Governorate, Saudi Arabia. ASSIUT Journal of Agricultural Sciences. 2017;48(6):55-62.
19. Herman J. Carbohydrates in Diet; 2021.
20. Sarmila KC. Determination of Crude Fat Analysis in Food samples; 2023.
21. Lantz A, et al. Protein: A nutrient in focus. Applied Physiology, Nutrition, and Metabolism. 2015;40(8):755-761.
22. Moore S. Why is Moisture Content Analysis of Food Important?; 2020.
23. Watson K. What are flavonoids? Everything you need to know. Healthline; 2019. Available:https://www.healthline.com/health/what-are-flavonoids- everything-you-need-to-know
24. Sharma K, et al. Saponins: A concise review on food related aspects,

applications and health implications. Food Chemistry Advances. 2023;2:100191.
25. Smeriglio A, Barreca D, Bellocco E, Trombetta D. Proanthocyanidins and hydrolysable tannins: Occurrence, dietary intake and pharmacological effects. British Journal of Pharmacology. 2017;174(11): 1244–1262.
26. Fachriyah E, et al. Isolation, identification, and Xanthine oxidase inhibition activity of alkaloid compound from *Peperomia pellucida*. IOP Conference Series Materials Science and Engineering. 2017;349(1): 012017.
27. Karpagasundari C, et al. Analysis of bioactive compounds in Physalis minima leaves using GC MS, HPLC, UV-VIS and FTIR techniques. Journal of Pharmacognosy and Phytochemistry. 2014;3(4):196-201
28. Sharma P, et al. Antimicrobial and antifungal properties of leaves to root extracts and Saponin fractions of *Chlorophytum borivilianum*. Current Bioactive Compounds. 2020;16:1-00.
29. Kamal M, et al. Antimicrobial and antifungal properties of leaves to root extracts and Saponin fractions of *Chlorophytum borivilianum*. Current Bioactive Compounds. 2020;16:1-00.
30. Bongao H, et al. Micro/nanocellulose from waste Pili (*Canarium ovatum)* pulp as a potential anti-aging ingredient for cosmetic formulation. Materials Today: Proceedings. 2018;22(2020):275-280
31. Madhu. Difference between Polar and Nonpolar Solvents; 2020.
32. Sari Y. Tannin determination in young coconut coir (*Cocos nucifera L.)* by FTIR and UV-Vis spectroscopy. Jurnal Matematika Dan Ilmu Pengetahuan Alam LLDikti Wilayah 1 (JUMPA). 2023;3(1):08–13.
Available:https://doi.org/10.54076/jumpa.v3i1.271
33. Samanta SK, Sen T. Medicinal plants, human health and biodiversity: A broad review. Biotechnological Applications of Biodiversity, Springer, Berlin, Heidelberg. 2014;59-100.
34. Hoang T, et al. Phytochemical screening, extraction, and determination of the bioactivities of the extract-enriched polyphenols and Saponin from *Musa balbisiana* Fruit; 2023.
35. Subayu N, et al. Analysis of the content of secondary metabolites using Uv-vis and Ftir Spectrophotometry from the Methanol extract of *Rhizophora mucronata* Leaves. Eco. Env. and Cons. 2021;S76-S78.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/119539