Sciences of Phytochemistry

SciPhy Volume 2, Issue 2, Page 40-47, 2023
e-ISSN 2830-7259
p-ISSN 2830-7046
DOI 10.58920/sciphy02020040

ETFLIN

Research Article

Nutritional analysis of *Colocasia esculenta* l. tubers aqueous extract and comparative analysis with existing literature

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Received: 11 Aug 2023
Revised: 25 Aug 2023
Accepted: 29 Aug 2023
Published: 30 Sept 2023

Editor
James H. Zothantluanga
Reviewers
Both the reviewers choose to remain anonymous. The reviewer's data and their review history is saved in our database.

Keywords: Nutritious; aqueous extract; *Colocasia esculenta*; Tuber

Abstract: Taro (*C. esculenta L.*) is a plant in the Araceae family that is farmed as a tuber. This plant is one of the non-animal sources of nutrients, minerals, and trace elements and has had numerous biological activities. Taro plants offer antidiabetic, antibacterial, antifungal, antioxidant, and antihepatotoxic properties. To have better nutritional content and wider and longer-lasting applications in culinary products, the taro tuber requires going through a process that increases its use value, one of which is extraction. The research aim of this work was to use several analytical methods to determine the nutrition components in the aqueous extract of *C. esculenta L.* Some of the nutrients found in the aqueous extract of *C. esculenta L.* consist of total protein 10.9%, total carbohydrate 75.5%, amylose 8.20%, amylopectin 43.6%, starch 51.8%, omega 6 0.2%, and fat-soluble vitamins A, D, and E at 0.5 IU/100gr, 24.8 g/100gr, and 0.01 mg/100 gr. Water-soluble vitamins B1, B2, B6, and C were present in amounts of 4.55, 1.96, 0.17, and 0.70 mg/kg, respectively. *C. esculenta L.* aqueous extract also included minerals such as the trace elements sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), and zinc (Zn) in the amounts of 35.2, 4638, 137, 129, 47.9, and 13.8 (mg/100gram), respectively. The aqueous extract of *C. esculenta L.* tubers includes a variety of nutrients and offers the potential to be consumed as a functional food.

1. Introduction

One of the plants from the Araceae family that is cultivated in the form of tubers is taro (*Colocasia esculenta L.*). This plant is a food in subtropical and tropical areas that has the potential as a functional food. Functional food is food that contains active components that can provide health benefits, beyond the benefits provided by the nutrients contained in it. Taro is cheap and easy to cultivate but not widely used. The chemical composition of taro tubers depends on the variety, climate, soil fertility, and harvest age. Taro (*C. esculenta*) is a plant in the Araceae family farmed as a tuber. This plant is a subtropical and tropical food with the potential to be a functional food. The term functional food is food that has active substances that can provide benefits for health in addition to the nutrients it contains. Taro is inexpensive and simple to grow, although it is not commonly used. Taro tuber chemical composition varies according to varietal, climate, soil quality, and harvest age. Taro contains 11.2 g of protein, 0.4 g of fat, 34.2 g of carbohydrates, 26 g of calcium, 54 mg

How to cite: Yantih N, Mulatsari E, Sumiyati Y, Sari IP, Qisthiara C, Prastica A, Devira R J, Millati A A, Masyrufah D. Nutritional analysis of *Colocasia esculenta* L. tubers aqueous extract and comparative analysis with existing literature. Sciences of Phytochemistry. 2023; 2(2):40-47.

of phosphorus, 1.4 mg of iron, 0.1 mg of vitamin B1, vitamin C 2 mg, water 63.1 g, ash 1 gr per 100 g of material weight (1,2). Other studies have discovered that Taro tubers have a high potential as an inexpensive source of carbs, protein, total fat, vitamins, electrolytes like sodium and potassium, and minerals like calcium, copper, magnesium, iron, and zinc (3).

Figure 1 Taro tubers (3)

The utilization of taro tubers so far has only been used as processed food that is fried and boiled, even though the mineral content in taro is quite high which can be used to improve people's nutrition. For the taro tuber to have higher nutritional content and wider and longer-lasting applications in food products, it is necessary to have a process that can increase its use value, one of which is by extraction. Several studies related to the taro extraction process have been carried out, the extracted taro part was leafed with ethanol and hydrophilic solvents. The main content in taro leaves is calcium oxalate, fiber, minerals, carbohydrates, and vitamins A, B, and C. Phytochemically, taro leaves contain secondary metabolites apigenin, anthocyanins, luteolin, and flavones (4). Several studies related to the aqueous extraction process have been carried out by Adedapo AA et all, 2019 that reported aqueous tuber extract of *Pueraria tuberose* (Willd.), and Bagus 2016 reported Aqueous Extract of Purple Sweet Potato Tubers (5,6).

Based on this, further study on *C. esculenta* tuber extract to determine its nutritional content must be carried out as a source of information for tuber processing as an ingredient that is functional in food.

2. Experimental Section

2.1 Materials

C. esculenta, tubers that are planted on Subang, Aqua demineralization, and freshly prepared chemical compounds.

2.2 Methods

Extraction Process

The initial *C. esculenta* tubers are dried in the oven at a temperature of around 35 to 45 degrees. Coarsely ground using a 60 mesh milling machine. The process of extracting the extraction method with a water solvent at a temperature of approximately 40-50◦C. The results of the liquid extract are filtered and then concentrated and evaporated at a temperature of 45-50◦C. Concentration results in the oven at 35-45◦C. Then finely ground with a grinding machine, then sifted using 80-100 mesh.

Water Content Determination

The analysis was carried out along with the methods authorized by the national standardizing agency by SNI 01-2354.2-2006[7].

Ash Content Determination

The analysis was carried out by procedures authorized by the national standardization agency by SNI 01-2354.1-2006[8].

Total Protein Determination

The procedure, Kjeldahl methodology, was adopted according to AOAC International protocol 981.109 (9). For 2 hours, 1 g of raw material was hydrolyzed with 15 mL of concentrated sulfuric acid (H_2SO_4) involving two copper catalyst tablets at 420 °C. H_2O was added to the hydrolysates after cooling previous to neutralization and titration. The total nitrogen content of the raw materials was multiplied by both the standard conversion factor of 6.25 (10).

Carbohydrate, Amylose, and Amylopectin Determination

The analyzed carbohydrate solution is transferred to a flask containing a specified amount of boiling copper sulfate solution and methylene blue indicator using a burette. The copper sulfate in the flask reacts with the reducing sugars of the carbohydrate solution. The addition of the reducing sugar will cause the indicator to turn from blue to white after all the copper sulfate in the solution has reacted. The amount of sugar solution required to achieve a goal has been calculated.

This method of determining amylose content started with the preparation of the substance that was extracting starch from the sample by immersing the sample, then smoothing and filtering. The filtrate was then allowed to stand until sludge formed, and the sludge was washed with distilled water to yield a white precipitate that was starch, after which the amylose and amylopectin were separated by heating at 50 °C for 30 minutes. Because of the existence of components that are easily soluble in hot water (amylose) and constituents that are insoluble in hot water (amylopectin), heating white precipitates (starch) to separate amylose and amylopectin may happen. The heated starch was then mixed with 50 L of iodine solution and trichloroacetic acid. Blue is going to show in the solution. Amylose content is then estimated using the spectrophotometer at 625 nm to measure the color blue intensity of the solution. The amylose content can be calculated using the amylose standard curve equation. The starch that has separated between amylose and amylopectin is dried to a consistent weight in an oven at 70 °C. The weight of starch is constantly weighing. Amylopectin content can be measured by reducing amylose content (11,12).

Trace Elements Determination

AOAC 985.35 described the procedure for analyzing trace elements within *C. esculenta* aqueous extract. Add $LaCl_3$ solution to each standard and sample the final dilution to make 0.1% w/v La for Ca and Mg destruction only. To create 0.5% w/v Cs (0.04M) for the elimination of Na and K, add CsCl solution to each standard and sample final dilution. The calibration curve preparation for each mineral is to be identified using the wavelength and flame indicated in the AOAC 985.35 procedure (13). Prepare a calibration solution for the instrument that covers a linear range of the calibration curve. Analyze samples in the same way. Take the concentration of each mineral from its calibration curve and determine the concentration in the sample, taking sample size and dilutions into consideration.

Vitamins Determination

In the isocratic separation by HPLC with a UV detector, vitamin determination utilizing a reversed-phase column was used. UV detection for vitamin A was observed at 325 nm, 265 nm for vitamin D, 290 nm for vitamin E, and 254 nm for vitamin B. Vitamin A and E levels were determined using an internal standard and the precipitation reagent. External standardization was employed for vitamins D, E, and B (14).

Total Fat and Fatty Acids

Soxhlet extraction was used for total fat analysis. The solvent was removed and recycled after extraction. Total fat was determined by adding the fat removed with the Soxtherm apparatus. Gas Chromatography was used to determine fatty acid levels.

3. Result

The nutritional content of the aqueous extract of *C. esculenta* tubers are grown from Tasikmalaya Planted Place as shown in Table 1.

Table 1 Nutrition of Aqueous Extract of *C. esculenta* Tubers from Tasikmalaya Planted Place

Nutrition Parameter	Unit	Results
Water Content	%	6.43
Ash Content	%	6.47
Total Protein (N x 6,25)	%	10.9
Total Fat	%	0.68
Karbohidrat	%	75.5
Amylose	%	8.20
Amylopectin	%	43.6
Amylum	%	51.8
Sodium (Na)	mg/100 gram	35.2
Pottasium (K)	mg/100 gram	4638
Calsium (Ca)	mg/100 gram	137
Magnesium (Mg)	mg/100 gram	129
Iron (Fe)	mg/kg	47.9
Zink (Zn)	mg/kg	13.8
Omega 3	%	0
Omega 6	%	0.20
Vitamin A	IU/100 gram	<0.50
Vitamin B1	mg/kg	4.55
Vitamin B2	mg/kg	1.96
Vitamin B6	mg/kg	0.17
Vitamin C	mg/kg	<0.70
Vitamin E	mg/100 gram	<0.01
Vitamin D	µg/100 gram	24.8

The total protein of the aqueous extract of *C. esculenta* tubers is about 10.9%, this value is higher than that of fresh Colocasia, Colocasia powder, Colocasia noodles, and Colocasia cookies which is 7.79 ± 0.03; 10.32 ± 0.06; 3.23 ± 0.14; 0.69 ± 0.03 % respectively. Even so, this level is still lower than the leaf extract of *C. esculenta* 29.41 ± 0.16%.

The fat content in the aqueous extract of *C. esculenta* tubers of 0.68% is almost the same as the fat content of *C. esculenta* tuber without the extraction process of 0.65 ± 0.02%16 and lower than the fat content in the leaves which reaches 10.17 ± 0.02 (17). The fatty acid such as Omega 6 content reaches 0.2% and does not contain omega 3 fatty acids.

The mineral content in the aqueous extract of *C. esculenta* tubers includes sodium, potassium, calcium, magnesium, iron, and zinc of 35.2, 4638, 137, 129, 47.9, and 13.8 respectively. Potassium is the highest content among other mineral content.

The aqueous extract of *C. esculenta* tubers consists of a high concentration of vitamins, both water-soluble and fat-soluble. The fat-soluble vitamins A, D, and E had amounts of 0.5 IU/100gr, 24.8 g/100gr, and 0.01 mg/100gr, respectively. Water-soluble vitamins B1, B2, B6, and C have amounts of 4.55, 1.96, 0.17, and 0.70 mg/kg, respectively.

Table 2. Comparison of Nutrition in Aqueous Extract of *C. esculenta* Tubers with Existing *C. esculenta L* Literature Data

Specification	Unit	*C. esculenta* tuber Aqueous Extract	*C. esculenta* tuber non extraction	*C. esculenta* leaf extract	*C. esculenta* Powder	*C. esculenta* Noodles	*C. esculenta* Cookies
Water content	%	6.43					
Ash content	%	6.47	2.44±0.16 [16]	10.0 ± 0.01[17]	2.78±0.07[20]	1.39±0.13[16]	0,24±0,02[16]
Total Protein (N x 6,25)	%	10.9	7.79±0.03 [16]	29.41 ± 0.16[17]	10.32 ± 0.06[20]	3,23 ± 0,14[16]	0,69 ± 0,03[16]
Total Fat	%	0.68	0.65± 0.02 [16]	10.17 ± 0.02[17]	1.03 ± 0.03[20]	0,19 ± 0,3[16]	0,13 ± 0,01[16]
Total Carbohydrate	%	75.5	86.11 ± 0,02 [16]	22.38 ± 0.10[17]		59,92 ± 0,21[16]	36,69 ± 0,20[16]
Amylose	%	8.20					
Amylopectin	%	43.6					
Amylum	%	51.8	27[18]		53.07 ± 2.41[20]		
Sodium (Na)	mg/100 gram	35.2	25.6[18]	77.07 ± 0.04[17]			
Pottasium (K)	mg/100 gram	4638	372.4[18]				
Calcium (Ca)	mg/100 gram	137	55.00 ±1.64[16]	412.07 ± 0.09[17]	64.84 ± 0.44[18]	32,41 ± 0,35[16]	13,90 ± 0,11[16]
Magnesium (Mg)	mg/100 gram	129	543.9[18]				
Iron (Fe)	mg/kg	47.9	2.95 ± 0.19[16]	43.31 ± 0.13[17]	4.06 ± 0.13[18]	2,84 ± 0,21[16]	3,47 ± 0,11[16]
Zinc (Zn)	mg/kg	13.8	16.7 ±0.06[16]		1.84 ± 0.06[18]	1,29 ± 0,04[16]	0,87 ± 0,01[16]
Omega 3	%	0					
Omega 6	%	0.20					
Vitamin A	IU/100 gram	<0.50	10[19]				
Vitamin B1	mg/kg	4.55	0.5[19]				
Vitamin B2	mg/kg	1.96	0.4[20]				
Vitamin B6	mg/kg	0.17					
Vitamin B3	mg/100g		0.92[20]				
Vitamin C	mg/kg	<0.70	20[19]				
Vitamin E	mg/100 gram	<0.01					
Vitamin D	µg/100 gram	24.8					

4. Discussion

C. esculenta tuber extracted with water solvent is expected to be a potential food source that has high nutritional value and is efficacious for overcoming stunting. Processing in extract form is expected to increase the shelf life by reducing the water content which can stimulate bacterial growth. The results of the water content test for *C. esculenta* water extract showed 6.43%, this value met the requirements specified in the

Indonesian herbal pharmacopeia which required the water content in the extract not to be more than 10% (15). The ash content of the water extract of *C. esculenta* is 6.47%, this value is much higher than the content of *C. esculenta* which is not extracted (fresh tubers) (16), as well as tubers made in the form of powder without extraction[17], Colocasia which is formulated in the form of noodles and cookies. However, this ash content is lower than the leaf extract of *C. esculenta* (10.0 ± 0.01) (17).

Total carbohydrates in the aqueous extract of *C. esculenta* tubers reached 75.5%, lower than fresh *C. esculenta* tubers. This could be due to the extraction process which dissolves carbohydrates and is wasted with the solvent. The carbohydrate content in *C. esculenta* tubers is far greater than the carbohydrate content in the leaves which only reaches 22.38±0.1017. The amylose content in the water extract of *C. esculenta L* reaches 8.2%, amylose is a polysaccharide that has many benefits. Amylose is a substance found in foods that can be used to function as an emulsion stabilizer, water binder, thickener, and gel-forming agent. To generate complex molecules, the hydrophobic molecules of the helical amylose chain can bind hydrophilic molecules such as aromatic compounds and lipids. However, after crystallizing, it could lose stability, specifically the ease with which water can be released during processing and storage, a condition known as syneresis. Amylose gel adhesiveness diminishes with increasing amylose concentration, but gel integrity increases. The viscosity changes when other compounds, such as amylopectin, bind to amylose, although adding xanthan gum, alginate, carrageenan, or low molecular weight sugars could increase stability against syneresis. Amylose's ability to bind water has the potential to improve food quality. Apart from amylose, the polysaccharide detected in *C. esculenta* water extract was amylopectin (43.6%). Amylopectin is a polysaccharide that consists of hundreds of glucose units separated by two types of bonds: linear and branched, making amylopectin a complex branched polymer.

The aqueous extract of *C. esculenta* tubers has a variety of nutritional content that is needed by the human body, namely carbohydrates, proteins, fats, vitamins, and minerals. Carbohydrates are needed by the body for as much as 45-65% of the calorie needed per day. Protein is needed for 16 percent of the average person's body weight. Protein is used primarily for growth, health, and body maintenance. Fat is needed by the body as much as 20-30% of the calorie needed per day. Vitamins and Minerals help support the body. They're essential for many body functions, including building strong bones and teeth, regulating your metabolism, and staying properly hydrated. Some of the most common minerals are calcium, iron, and zinc.

5. Conclusion

C. esculenta tubers aqueous extract included minerals such as the trace elements sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), and zinc (Zn) in the amounts of 35.2, 4638, 137, 129, 47.9, and 13.8 (mg/100gram), respectively. The aqueous extract of *C. esculenta* tubers includes a variety of nutrients and offers the potential to be consumed as a functional food.

Funding

Matching Fund Grant 2022 from the Ministry of Education and Culture and Higher Education, Republic of Indonesia.

Acknowledgment

We acknowledge the financial support from the Ministry of Education and Culture and Higher Education, Republic of Indonesia, through Matching Fund Grant 2022.

Conflict of Interest

The authors have no conflicting interest.

Authors contribution

Concept – N.Y., Y.S; Design – N.Y., E.M., Y.S.; Supervision – E.M, I.P.; Resources – N.Y., E.M.; Materials – Y.S.; Data Collection and/or Processing – C.Q., A.P.; Analysis and/or Interpretation – J.D., D.M., A.P.; Literature Search – D.M., A.P., I.P.; Writing – E.M., I.P.; Critical Reviews – N.Y., Y.S.

References

1. Faamatuainu W, Amosa F. Taro (*Colocasia Esculenta (L.) Schott Var Esculenta*) Cultivation in Trinidad. *Journal of Plant Science: Current Research*. (2022) 6(19): 1-6.
2. Oktavianingsih L., Suharyanto E., Daryono BS., Purnomo. Morphological Characters Variability of Taro (Colocasia spp.) in Kalimantan, Indonesia Based on Phenetic Analysis Approach. *Journal of Breeding and Genetics*. (2019) 51(1): 37-56.
3. Rashmi DR, Anitha B, Anjum SR, Raghu N, Gopenath TS, Chandrashekrappa GK, Kantthesh MB. An overview of taro (*Colocasia esculenta*): A review. *Academia Journal of Agricultural Research.* (2018) 6(10): 346–53.
4. Shinde SB, Gondkar, S. Pagar HJ. A Review on Study of Analgesic Activity of *C. esculenta (*Linn.) Schott in Experimental Animals. *Journal of Emerging Technologies and Innovative Research*. (2021) 8(8): 798-805.
5. Bagus KS. Aqueous Extract of Purple Sweet Potato Tubers Decrease MDA and Increase SOD2 in Kidney of Diabetic Rats. *Bali Medical Journal*. (2016) 5(3): 29-32.
6. Adedapo AA, Fagbohun OA, Dawurung C, Oyagbemi AA, Omobowale TO, Yakubu MA. The Aqueous Tuber Extract Of *Pueraria* Tuberosa (Willd.) D.C. Caused Cytotoxic Effect On HT 29 Cell Lines With Down-Regulation Of Nuclear Factor-Kappa B (NF-Kb). *Journal of Complementary and Integrative Medicine*. 2017 16(40).
7. Badan Standarisasi Nasional. Pengujian kadar air. SNI 01-2354.2-2006. Jakarta: Badan Standarisasi Nasional; 2006
8. Badan Standarisasi Nasional. Pengujian Kadar Abu. SNI 01-2354.1-2006. Jakarta: Badan Standarisasi Nasional; 2006
9. Association of Official Analytical Chemists AOAC. 1990. Officials Method of Analysis 981.10. Washington DC: Helriok Publisher
10. Kjeldahl, J. Neue Methode zur Bestimmung des Stickstoffs in organischen Körpern. Fresenius. *Journal of Analytical Chemistry*. (1883) 22: 366–82.
11. Subroto E, Jeanette G, Meiyanasari Y, Luwinsky I, Baraddiaz S. Review on the Analysis Methods of Starch, Amylose, Amylopectinin Food and Agricultural Products. *International Journal of Emerging Trends in Engineering Research*. (2020) 8(7): 3519-524.
12. Palupi N., Kusnandar., Lestari., Biological Values of Dried Corn Noodles Substituted with Heat Moisture Treated (HMT)-Corn Flour. *Jurnal Teknologi dan Industri Pangan*. (2015) 25(2): 06-16.
13. Association of Official Analytical Chemists AOAC. 1990. Officials Method of Analysis 985.35. Washington DC: Helriok Publisher
14. Sami R, Li Y, Qi B, Wang S, Zhang Q, Han F, Ma Y. Jing J., Jiang, L. HPLC Analysis of Water-Soluble Vitamins (B2, B3, B6, B12, and C) and Fat-Soluble Vitamins (E, K, D, A, and β-Carotene) of Okra (*Abelmoschus esculentus*). *Journal of Chemistry*. (2014) 2(1): 1-7
15. Departemen Kesehatan Republik Indonesia. Farmakope herbal Indonesia. Jakarta: Departemen Kesehatan Republik Indonesia; 2008
16. Alcantara RM, Hurtada WA, Dizon EI. The Nutritional Value and Phytochemical Components of Taro [*C. esculenta* (L.) Schott] Powder and its Selected Processed Foods. *Journal of Nutrition & Food Sciences*. (2013) 3(3):01-07

17. Eleojo AA, Charles UC, Nimat M. Proximate, Phytochemicals and Reducing Power of Leaf Extracts of *C. esculenta* and *Ipomoea batatas*. *International Journal of Biochemistry Research & Review*. (2019) 28(4):01-11
18. Mulugeta M., Tebeka T. Proximate and Some Minerals Analysis of *C. esculenta* (Taro) Tuber in Southern Ethiopia. *International Journal of Pharmacy & Pharmaceutical Research*. (2017) 10(2):01-12.
19. Arlin BD, Fadjar KH, Nunuk H. Identification of Nutrition, Phytochemicals and Antioxidants Taro (*Colocasia sp*). *Proceedings of the 1st Asian Conference on Humanities, Industry, and Technology for Society*. (2019)
20. Otekunrin OA, Sawicka B, Adeyonu AG, Otekunrin, OA, Rachon, L. Review Cocoyam [*C. esculenta* (L.) Schott]: Exploring the Production, Health, and Trade Potentials in Sub-Saharan Africa. *Sustainability*. (2021) 13: 4483