

Evaluation of the Nutritional and Phytochemical Composition of the Underutilized Vegetable 'Awa'

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ABSTRACT

Background: Awa (*Piper methysticum*), also known as kava, is an edible, medicinal, and underutilized green leafy vegetable that belongs to the Piperaceae family. While its roots are more commonly used in traditional medicine in Pacific regions, the leaves are less explored for their nutritional potential.

Objective: The objective of the study was to evaluate the nutrient and phytochemical composition of Awa leaves.

Methods: Using standard methods, the leafy part of the vegetable was analyzed for proximate composition, minerals, vitamins, and phytochemical composition.

Results: The result showed that the leafy vegetable contained 9.62% moisture, 10.27% ash, 1.07% fat, 8.67% crude fibre, 14.94% crude protein, and 55.43% carbohydrate. For minerals, the vegetable contained 5.84 mg/g iron, 3.64 mg/g zinc, 0.79 mg/g copper, 0.47 mg/g manganese, 128.93 mg/100g sodium, 88.85 mg/100g phosphorus, 284.83 mg/100g potassium, 173.19 mg/100g magnesium, and 24.49 mg/100g calcium. In terms of vitamins, it contained 47.91 mg/100g vitamin A, 29.00 mg/100g vitamin C, 4.66 mg/100g vitamin E, 1.64 mg/100g vitamin B1, 0.89 mg/100g vitamin B2, 2.83 mg/100g vitamin B3, and 4.66 mg/100g vitamin B9. The leafy vegetable contained 1.40 mg/100g tannins, 0.97 mg/100g, saponins, 2.57 mg/100g flavonoids, 2.86 mg/100g alkaloids, 0.75 mg/100g Oxalate, 1.60 mg/100g phytate, and 2.51 mg/100g hydrogen cyanide.

Conclusion: In conclusion, using *Piper methysticum* leaves as a condiment in food could enhance nutritional value and health benefits due to their appreciable nutrients and bioactive constituents.

Keywords: Awa leaves, Proximate composition, Mineral composition, Vitamin composition, Bioactive compounds

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INTRODUCTION

Vegetables are generally succulent parts of plants grown in gardens and consumed as part of the dish with starchy staples in most parts of Africa (1). Underutilized green vegetable species are crops whose potential contribution to the national economy has not been adequately explored due to the decreased attention to their cultivation, consumption, and utilization. The most common vegetables are the edible ones, which are usually grown in home or commercial gardens and are mainly prepared into soups and sauces to be

eaten with common starchy staples (2). Unpopular vegetables with high nutritional potential are not optimally utilized for therapeutic purposes over a wide range of illnesses. It is a well-known fact that vegetables are rich sources of nutrients and phytochemicals (3), and despite the vast diversity available within the African flora for utilization, several species can still be termed as under-utilized, which means they are not widely adapted as either food or a source of therapy.

Awa (*Piper methysticum*), also known as kava, is a green leafy vegetable that belongs to the *Piperaceae* family (1). *Piper methysticum* Forst. is an edible and medicinal shrubby plant that has a history of more than 2000 years. *Awa* is used for religious occasions, medicinal purposes, and social gatherings (4). *Awa* is particularly important for the indigenous people of the Pacific Rim and the Hawaiian Islands (5). In the daily life of the South Pacific Island people, the water infusion of kava root was used as a traditional beverage since ancient times for its sedative and calming effects, such as soothing the nerves, inducing relaxation and sleep, counteracting fatigue, and weight reduction (6). In Nigeria, *Awa* leaves are consumed in small communities, where they are believed to support blood volume and general well-being, yet there is little scientific data on their nutritional and phytochemical properties. Green leafy vegetables generally play a vital role in the diets of many populations, providing affordable sources of proteins, vitamins, minerals, and phytochemicals that help prevent micronutrient deficiencies and promote health. *Awa* plays an important role in human diets, as it supports the normal functioning of the different body systems through the nutrients it provides when added to the diet. It provides body cells with vitamins, minerals, fiber, essential oils, and phytonutrients. Phytochemicals are the primary source of antioxidants in the human diet and play an important role in combating the damaging effects of oxidative stress and other adverse cell responses that can lead to a wide variety of chronic and degenerative illnesses (7). These phytochemicals have been shown to promote health and provide protection against a growing list of diseases, including various cancers, cardiovascular diseases, and neurodegenerative diseases (8). *Awa* was found to be rich in essential nutrients and bioactive compounds, yet remained underexploited due to limited awareness and scientific documentation. Given the prevalence of malnutrition and micronutrient deficiencies, especially in low-resource settings, promoting such nutrient-dense indigenous vegetables offered a sustainable solution. The study aimed to evaluate the nutritional and phytochemical composition of the underutilized vegetable 'Awa' to highlight its potential as a valuable dietary resource.

MATERIALS AND METHODS

Source of raw material

The *Awa* vegetable was bought in Kenyatta market, Uwani, Enugu, Enugu State, Nigeria. The vegetable was taken to the food processing laboratory of Human Nutrition and Dietetics, Michael Okpara University of Agriculture, Umudike for analysis.

Sample preparation

The *Awa* leaves were cleaned to remove unwanted materials and plucked from the stems. The plucked leaves were washed with potable water and freeze-dried at 0 °C for 48 h. The leaves were milled, packaged in air-tight polyethylene bags, and stored in a cool, dry environment for further analysis. See Figure 1.

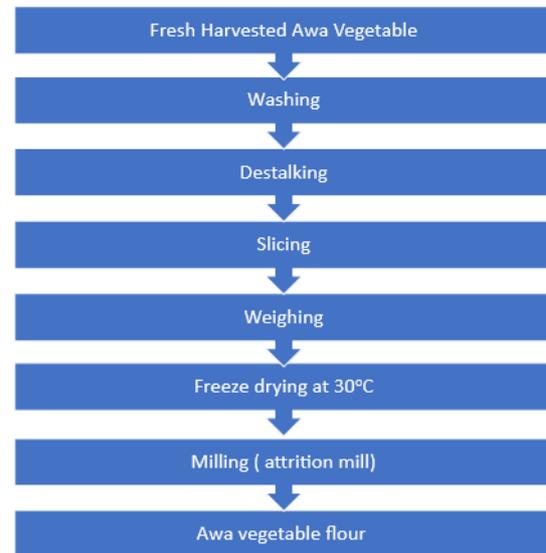


Figure 1: Flow chart of preparation of Awa flour

Determination of proximate composition

The proximate composition, including moisture, ash, fat, crude fibre, and crude protein, was determined according to the method described by AOAC (9).

Determination of minerals

The mineral composition, including iron, zinc, copper, and manganese, was determined according to the method described by Onwuka (10).

Determination of vitamins

The vitamin composition, including vitamin A, vitamin C, vitamin E, vitamin B₁, vitamin B₂, vitamin B₃, and vitamin B₉, was determined according to the method described by Onwuka (10).

Determination of phytochemical composition

The phytochemical composition, including tannins, saponins, flavonoids, alkaloids, oxalate, phytate, and hydrogen, was determined according to the method described by Onwuka (10).

RESULTS

Proximate composition of the Awa vegetable

The result of the proximate composition of the Awa leaves is presented in Table 1. The result showed that Awa vegetable contained 9.62% moisture, 10.27% ash, 1.07% crude fat, 8.67% crude fibre, 14.94% crude protein, and 55.43% carbohydrate.

Mineral composition of Awa leaves

The result of the mineral content of the Awa leaves is presented in Table 2. The result showed that the mineral content varied significantly ($p < 0.05$). The iron content was 5.84 mg/100g, the zinc content was 3.64 mg/100g, the copper content was 0.79 mg/100g, the manganese content was 0.47 mg/100g, the sodium content was 128.93 mg/100g, the phosphorus content was 88.85 mg/100g, the potassium content was 284.83 mg/100g, the magnesium content was

173.19 mg/100g, and the calcium content was 24.49 mg/100g.

Vitamin composition of Awa leaves

The vitamin composition of the Awa leaves is presented in Table 3. The result showed that the leaves contain 47.91 mg/100g Vitamin A, 29.00 mg/100g Vitamin C, 4.66 mg/100g Vitamin E, 1.64 mg/100g Vitamin B₁, 0.89 mg/100g Vitamin B₂, 2.83 mg/100g Vitamin B₃, and 4.66 mg/100g Vitamin B₉.

Phytochemical composition of Awa

The result of the phytochemical composition of the Awa leaves is presented in Table 4. The flavonoid content of the leaves was found to be 2.57 mg/g, the tannin content was 1.40 mg/g, the saponin content was 0.97 mg/g, the alkaloid content was 2.86 mg/g, the oxalate content was found to be 0.75 mg/g, the phytate content was 1.60 mg/g, and the hydrogen cyanide content was 2.51 mg/g.

Table 1: Proximate composition of Awa

Nutrient	Value (%)
Moisture	9.62 ± 0.09
Ash	10.27 ± 0.03
Fat	1.07 ± 0.03
Crude fibre	8.67 ± 0.21
Crude protein	14.94 ± 0.31
Carbohydrate	55.43 ± 0.28

Values are means ± standard deviation of duplicate determination

Table 2: Mineral composition of Awa (mg/100g)

Mineral	Value
Iron	5.84 ± 0.07
Zinc	3.64 ± 0.05
Copper	0.79 ± 0.01
Manganese	0.47 ± 0.02
Sodium	128.93 ± 0.45
Phosphorus	88.85 ± 1.08
Potassium	284.83 ± 0.95
Magnesium	173.19 ± 1.22
Calcium	24.49 ± 0.14

Values are means ± standard deviation of duplicate determination.

Table 3: Vitamin composition of Awa (mg/100g)

Vitamin	Value
Vitamin A	47.91 ± 0.35
Vitamin C	29.00 ± 0.70
Vitamin E	4.66 ± 0.08
Vitamin B ₁	1.64 ± 0.01
Vitamin B ₂	0.89 ± 0.04
Vitamin B ₃	2.83 ± 0.04
Vitamin B ₉	4.66 ± 0.04

Values are means ± standard deviation of duplicate determination.

Table 4: Phytochemical composition of Awa (mg/g)

Phytochemical	Value
Flavonoid	2.57 ± 0.08
Tannin	1.40 ± 0.02
Saponins	0.97 ± 0.08
Alkaloids	2.86 ± 0.04
Oxalate	0.75 ± 0.01
Phytate	1.60 ± 0.02
Hydrogen cyanide	2.51 ± 0.08

Values are means ± standard deviation of duplicate determination.

DISCUSSION

The moisture content of *Awa* obtained in this study was higher than 2.60% in *Combretum racemosum* leaves as reported by Akintimehin *et al.* (11), and lower than the range of values of 38.9 to 50.65% for green leafy vegetables as reported by Paulina *et al.* (3). The variation in the results could be attributed to varietal differences and method of sample preparation (freeze drying). High moisture content induces a greater activity of water-soluble enzymes and co-enzymes involved in metabolic activities of these leafy vegetables (12). High moisture content could activate enzymes that break down medicinally active compounds, increasing the susceptibility of food substances to microbial activity and promoting spoilage (13).

The ash content which is a measure of mineral matter, was found to be lower than the value of 30.05% for *Piper Methysticum* leaves as reported by Uzomba *et al.* (1). The value of the ash content of *Awa* leaves in this study was found to be higher than 4.82% found in *C. racemosum* leaves (11), 7.33% for *C. halicacabum* (14), *P. grandis* was reported to have 5.04% (15). This indicates that the studied leaves have high mineral content compared to the previous findings of some other leafy vegetables (15, 17). Ash contains essential minerals, especially mineral components necessary for blood and tissue development. They are necessary for blood coagulation, healing of wounds, and stopping bleeding. High ash content

also affects the mineral content, which the body needs for the normal process of metabolism.

Crude fat determines the free fatty lipids of a product. This property can be used as the basis of determining processing temperatures as well as auto-oxidation, which can lead to rancidity (development of off-flavors in foods). The result for fat content obtained in this study was lower when compared with the value of 3.35% for *Piper methysticum* leaves as reported by Uzomba *et al.* (1). Nisha *et al.* (16) reported that green leafy vegetables have almost a similar amount of fat content, which ranges between 2.18% for *M. pentaphylla* and 4.75% for *C. halicacabum*. This is in agreement with the general observation that leafy vegetables contain low fat and play a significant role in managing obesity.

Crude fibre measures the cellulose, hemicellulose, and lignin contents of food. High fibre content in the diet has been reported to result in increased removal of carcinogens, potential mutagens, steroids, xenobiotics, and bile acids by adsorption or binding to dietary fibre components and consequently rapidly excreted, hence these wastes will have health-promoting benefits (18). The value of the crude fibre found in this study was higher than 1.67% found in *Solanum nigrum*, lower than 18.82% found in *Cucurbita pepo*, and 12.89% *Crassocephalum crepidioides*, as reported by Paulina *et al.* (3) for green leaf vegetables.

Protein is an essential component of the diet needed for the survival of humans; its basic function in nutrition is to supply an adequate amount of required amino acids. Protein deficiency causes growth retardation, muscle wasting, abnormal swelling of the belly, and collection of fluids in the body (1). The value of the protein content obtained in this study was lower than 19.99% reported in *Cucurbita pepo*, 17.50% for *Solanum nigrum*, and 17.03% for *Crassocephalum crepidioides* of other green leaf vegetables reported by Paulina *et al.* (3).

The carbohydrates are the primary source of energy for the body. It spares fats and proteins in the body. The value of Carbohydrate content obtained in this was high when compared with 18.80% *Solanum nigrum*, 10.08% *Cucurbita pepo*, and 8.23% *Crassocephalum crepidioides* as reported by Paulina *et al.* (3).

The iron content obtained in this study was very low when compared to the iron content of 58.375 mg/100g for *Piper Methysticum* leaves as reported by Uzomba *et al.* (1) but were within the range of 2.31 to 5.80 mg/100g for green leafy vegetables as reported by Paulina *et al.* (3). Iron has been reported as an essential trace metal and plays numerous biochemical roles in the body, including oxygen binding in hemoglobin and acting as an important catalytic centre in many enzymes (19). Iron is also required for the growth of tissues and organs and for the expanding red blood cell mass; thus, the use of *Piper methysticum* in the diet can furnish the diet with sufficient iron to meet the daily requirement for the nutrient.

The value of the zinc content was very low when compared to 10.025mg/100g of *Piper Methysticum* leaves as reported by Uzomba *et al.* (1). The value was higher than the range of values of 0.10 to 2.2 mg/100g for green leafy vegetables as reported by Paulina *et al.* (3) of other green leafy vegetables. Zinc (Zn) has an important biological role in enzyme systems. It plays an important role in biological structure, e.g., in β -cells of the pancreas, where it appears to stabilize insulin structure (20).

The value of the copper content of the Awa leaves was similar to the value of 0.82 mg/100g for pumpkin leaves as reported by Uzomba *et al.* (1). The result was higher when compared with 0.003 mg/100g for *Solanum nigrum*, 0.1 mg/100g for *Cucurbita pepo*, and 0.01 mg/100g for *Crassocephalum crepidioides* as reported by Paulina *et al.* (3).

The manganese content of the Awa leaves was higher than 0.22 mg/100g for *Cucurbita pepo*, and lower compared with 6.23 mg/100g for

Solanum nigrum and 3.12 mg/100g for *Crassocephalum crepidioides* as reported by Paulina *et al.* (3). It has been reported that magnesium is an activator of many enzyme systems and maintains the electrical potentials in nerves (21).

The sodium content of the Awa leaves was very high when compared with 0.103 mg/100g for pumpkin leaves as reported by Uzomba *et al.* (1). The value was higher than 2.81 mg/100g for *Solanum nigrum*, 0.09 mg/100g for *Cucurbita pepo* and 7.10 mg/100g for *Crassocephalum crepidioides* as reported by Paulina *et al.* (3). Higher sodium intakes have been known to have stronger effects on blood pressure and risk of subsequent cardiovascular diseases (22).

The phosphorus content of the Awa leaves was very high compared with 54.1 mg/100g for pumpkin leaves as reported by Uzomba (1). The obtained value was higher than 60.02 mg/100g for *Solanum nigrum* and 50.02 mg/100g for *Crassocephalum crepidioides*, lower than 90.04 mg/100g for *Cucurbita pepo* as reported by Paulina *et al.* (2021). Phosphorus and calcium are interrelated because hormones, such as parathyroid hormone (PTH), regulate the metabolism of both minerals. In addition, phosphorus and calcium make up hydroxyapatite, the main structural component in bones and tooth enamel (23).

The potassium content of the Awa leaves was very high when compared with 2.755 mg/100g for pumpkin leaves as reported by Uzomba *et al.* (1). The value was also higher than 52.42 mg/100g for *Solanum nigrum*, 49.05 mg/100g for *Cucurbita pepo* and 76.21 mg/100g for *Crassocephalum crepidioides* as reported by Paulina *et al.* (3). Higher potassium intakes have been shown to have strong effects on blood pressure and risk of subsequent cardiovascular diseases (22). Salts of potassium are known to regulate the acid-base balance of the body (24). Potassium occurs in abundance more than other mineral elements, which suggests that the flour can be a good source of dietary potassium. Based on an earlier study, high dietary potassium in humans plays a protective role against hypertension, stroke, cardiac dysfunctions, renal damage, kidney stones, and osteoporosis (25).

The value of the magnesium content was higher than 65.04 mg/100g for *Solanum nigrum*, 33.42 mg/100g for *Cucurbita pepo* and 16.21 mg/100g for *Crassocephalum crepidioides* as reported by Paulina *et al.* (3). Magnesium is important in the regulation of blood pressure, improvement of serum lipid profile, prevention of stroke and skeletal growth and development (26).

The calcium content was very high when compared with 1.455 mg/100g for pumpkin leaves as reported by Uzomba *et al.* (1). The result was also higher than 22.58 mg/100g for *Solanum nigrum* but lower than 133.54 mg/100g for *Cucurbita pepo* and 89.03 mg/100g for *Crassocephalum crepidioides* as reported by Paulina *et al.* (3). The salts of calcium regulate the acid-base balance of the body (24).

The Vitamin A content of the Awa leaves was comparably higher than the Vitamin A content range of 2.77 to 5.07 mg/100g for some selected lesser-known vegetables, as reported by Agiang *et al.* (27), but lower than 197.5 mg/100g for *G. latifolium* as reported by Bob *et al.* (28). Vitamin A is a lipid-soluble antioxidant that is necessary for the production and resynthesis of Rhodopsin. High levels of Vitamin A intake have been correlated with lower risk of lung cancer, coronary heart disease, stroke, and age-related eye disease (29).

The Vitamin C content of the Awa leaves was higher than the value range of 3.47 to 4.39 mg/100g for pumpkin accessions as reported by Blessing *et al.* (30) but lower than the value range of 45.83 to 68.50 mg/100g for some selected lesser-known vegetables as reported by Agiang *et al.* (27). The variations in the result could be due to varietal differences and processing methods. Vitamin C helps prevent scurvy in infants.

The Vitamin E content of the Awa leaves was within the range of 2.06 to 6.23mg/100g for some selected lesser-known vegetables, as reported by White (5). The value obtained in this study was higher when compared with 0.67-0.9 mg/100g for *V. amygdalina* leaf as reported by Bob *et al.* (28). Vitamin E (α -tocopherol) appears to be the most important lipid-soluble antioxidant protecting membranes from lipid peroxidation by acting as a chain-breaking antioxidant. It also limits the oxidation of LDL cholesterol and may help prevent or delay the development of atherosclerosis and/or coronary heart disease (CHD) (31). This probably explains why high vitamin E intake is associated with lower rates of heart disease.

The value of vitamin B₁ (thiamin) obtained in this study was higher than 0.9 mg/100g for some leafy vegetables, as reported by Edelman and Colt (32). The consumption of processed Awa leaves has a higher propensity to play a principal role in so many metabolic reactions that occur in the human body, especially in the metabolism of carbohydrates and proteins required for energy generation, and functioning of the heart, nervous system, and muscles (33).

The Vitamin B₂ (riboflavin) content of Awa leaves was slightly lower than the value range of 0.9 to 1.8 for some green leafy vegetables as reported by Edelman and Colt (32). The Vitamin B₃ (niacin) content of Awa leaves was found to be 2.83 mg/100g. B vitamins are known for their significant role in energy metabolism and several body functions. Vitamin B₂ helps the body cells use fat, protein, and carbohydrates.

Vitamin B₉ is an essential element for the formation of new blood cells, amino acids, and DNA synthesis (34). The need for folic acid increases dramatically during pregnancy as new cells and DNA are forming. Vitamin B₉ is found in many foods, especially leafy vegetables.

The flavonoid content of the Awa leaves was lower than the value range of 0.04 to 25.93 mg/g for some under-utilized traditional green leafy vegetables as reported by Paulina *et al.* (3). Flavonoids are potent water-soluble antioxidants that prevent oxidative cell damage, suggesting anti-inflammatory properties. The presence of flavonoids in the Awa leaves suggests that it has biological functions such as protection against allergies, free radicals, platelet aggregation, microbes, ulcers, hepatoxins, and has strong activity and protection against the different levels of carcinogenesis (35).

The value of tannins obtained in this study was within the value range of 0.71 to 38.38 for some under-utilized traditional green leafy vegetables, as reported by Paulina *et al.* (3). The recommended limit for tannins is 200–500 mg/100 g (34). The value obtained in this present study was lower than the lethal dose level of 30mg/kg (3mg/100g) reported by Rathod and Valvi (37).

The result of saponin content contradicts the report of Uzomba (1), who reported that saponins were not present in *Piper methysticum*. The value obtained in this study was lower compared to 3.92 to 14.69 mg/100g for some under-utilized traditional green leafy vegetables, as reported by Paulina *et al.* (3). The variations in the results could be due to the differences in processing methods, location, and time of harvest of the vegetable. Saponin is an anti-nutrient factor that interferes with the metabolism of key nutrients and negatively influences their bioavailability.

The value of alkaloid obtained in this study was within the range of values of 1.75 to 6.99 mg/g for some under-utilized traditional green leafy vegetables, as reported by Paulina *et al.* (3). Alkaloids are known to have anti-inflammatory, antifungal, anti-hypertensive, and antimicrobial effects at low levels. This attribute is useful in their medicinal and therapeutic roles against a large

number of illnesses (38). However, alkaloids are anti-nutrient factors that interfere with the metabolism of key nutrients and negatively influence their bioavailability.

The oxalate content of the Awa leaves was lower than the value range of 3.279 to 8.882 mg/g for fluted pumpkin leaves grown in different NPK solutions as reported by Agogbua *et al.* (39) and the oxalate value of 12.00 mg/g for air dried pumpkin leaf as reported by Fadupin *et al.* (40). Oxalic acids are known to precipitate or form insoluble complexes with calcium, magnesium, zinc and iron thus interfering with their bioavailability.

The phytate content of the Awa leaves was found to be lower than 3.445 – 15.837mg/g reported by Agogbua *et al.* (39) for fluted pumpkin leaves grown in different NPK solutions. The concentrations of antinutrients in different foodstuffs affect their nutritive values. However, the low quantity of phytate in the samples can enhance the bioavailability of minerals such as iron, magnesium, and calcium (41). The hydrogen cyanide of the Awa leaves was found to be lower than the value range of 4.42 to 10.63 mg g for hydrogen cyanide of some under-utilized traditional green leafy vegetables, as reported by Paulina *et al.* (3).

CONCLUSION

This study assessed the nutritional and phytochemical composition of Awa, an underutilized vegetable, and found it to be rich in essential nutrients and bioactive compounds. These constituents support immune function, prevent chronic diseases, and promote overall well-being. The nutritional profile of Awa positions it as a valuable food source capable of addressing malnutrition and improving dietary diversity, particularly in communities with limited access to varied and nutritious foods. The presence of phytochemicals such as flavonoids and phenolic compounds suggests potential therapeutic uses in pharmaceutical and functional food development. Overall, the findings underscore the health-promoting and nutritional potential of Awa, advocating for its inclusion in diets to enhance public health and support sustainable food systems. The study recommends further scientific exploration and promotion of its cultivation and consumption to unlock its full benefits and encourage its integration into nutrition policies and food-based interventions.

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