PLANT SCIENCE TODAY
Vol x(x): xx–xx
https://doi.org/10.14719/pst.7971

eISSN 2348-1900

RESEARCH ARTICLE

Nutritional value, antioxidant activity and color properties of white-fleshed sweet potatoes in Vietnam

Nguyen Chi Dung[1], Tran Ngoc Giau[1], Hong Van Hao[1], Vo Quang Minh[2], Ngo Van Tai[3] & Nguyen Minh Thuy[1*]

[1]Institute of Food and Biotechnology, Can Tho University, Can Tho 900000, Vietnam
[2]College of Environment and Natural Resources, Can Tho University, Can Tho 900000, Vietnam
[3]School of Food Industry, King Mongkut's Institute of Technology Ladkrabang, Bangkok, 10520, Thailand

*Correspondence email - nmthuy@ctu.edu.vn

Received: 27 February 2025; Accepted: 23 July 2025; Available online: Version 1.0: 16 October 2025

Cite this article: Nguyen CD, Tran NG, Hong VH, Vo QM, Ngo VT, Nguyen MT. Nutritional value, antioxidant activity and color properties of white-fleshed sweet potatoes in Vietnam. Plant Science Today (Early Access). https:/doi.org/10.14719/pst.7971

Abstract

Sweet potatoes have been considered an essential food source in the human diet for centuries. The study provides comprehensive knowledge on the physico-chemical properties and antioxidant potential of white-fleshed sweet potato (WFSP), to raise consumer awareness of its positive health effects and encourage its greater use. The study also explores whether the food is acidic or alkaline to enhance its health benefits, through Potential Renal Acid Load (PRAL) score. Phenolic acid components were identified and quantified by Ultra-Performance Liquid Chromatography (UPLC), while the functional groups of these compounds were determined by Fourier transform infrared (FTIR) spectroscopy. The results showed that WFSP contains high levels of minerals, including potassium 79.56 mg/100 g, phosphorus 18.69 mg/100 g, magnesium 9.58 mg/100 g and calcium 7.68 mg/100 g. Resistant starch is also present in WFSP at a relative amount of 1.12 %. The total polyphenol content and total flavonoid content were found to be 1.58 mg GAE/g and 0.69 mg QE/g, respectively and it was a source of antioxidant potential (with IC_{50} DPPH and IC_{50} $ABTS^{+}$ determined as 3.31 mg/mL and 0.38 mg/mL, respectively). WFSP was identified as an alkaline food with a negative value (-0.63). Low-PRAL/alkali-ash diets have been linked to a variety of health benefits, including an improved potassium-to-sodium ratio, less muscle wasting and higher intracellular magnesium concentrations. FTIR analysis showed that the phenolic components in WFSP contained 17 functional groups. UPLC analysis identified the main phenolic acids in WFSP as caffeic acid, coumaric acid and trans-ferulic acid, which are antioxidant compounds that can protect cells from damage.

Keywords: antioxidant activity; color properties; FTIR analysis; quality; white-fleshed sweet potatoes

Introduction

Sweet potatoes (*Ipomoea batatas* L.) are members of the Convolvulaceae family and are widely cultivated in Binh Tan, Vinh Long, Vietnam. The local planting area is reported to be about 991.8 ha, with a yield of about 29.5 t/ha (1) recorded for this resource. With the characteristics of being easy to grow, with soft stems crawling on the ground or climbing, Binh Tan sweet potatoes are grown by local people twice a year. The early crop is usually sown from November to December and harvested around February to March of the following year. The late crop is sown from April to May and harvested around July to August. Binh Tan sweet potato is a longing in the memories of the people of Vinh Long province and until today, it has become a famous specialty throughout the country.

Sweet potato flesh is predominantly purple, orange, yellow, white, cream and red; this variation is attributable to various nutritional components and bioactive chemicals. WFSP added to enteral formula can also help diabetic individuals improve their nutritional status and glycemic management. Phenolic compounds in WFSP exhibit antioxidant properties, which may prevent and manage chronic diseases, including cancer, leukemia and gastrointestinal disorders (2). Furthermore, the phenolic chemicals that give WFSP its distinctive color have been demonstrated to scavenge free radicals and offer a variety of health advantages. Sweet potatoes also have resistant starch, which is categorized as dietary fiber. This starch is not digested or absorbed until bacteria ferment it in the intestines, producing short chain fatty acids (3).

Furthermore, all foods have either an acidic or alkaline effect on the body. However, knowing whether the diet is more acidic or alkaline is critical for maintaining a daily balance, as hidden acidosis has been related to chronic disease and poor health. The PRAL is a unique technique that practitioners and patients can use to assess potential dietary acid loads and, if necessary, incorporate more alkalizing foods and supplements. This activity is a practical guide to the diet's potential acid/alkaline balance. Alkalizing diets have been advocated to promote health by raising intracellular magnesium concentrations, decreasing muscle atrophy and improving the potassium-sodium ratio (4). In contrast to alkalinizing diets, diets with a high acid load (positive PRAL) may damage human health, especially in older people.

In addition, infrared spectroscopy can identify all types of materials. FTIR spectroscopy investigates the interactions between matter and electromagnetic radiation, which emerge in the form of a spectrum. Each molecule has a spectrum fingerprint, which makes it unique and distinguishes it from other molecules (5). FTIR-based procedures are quick, dependable, simple to use and do not require any sample preparation. FTIR spectra are effectively utilized across various industries, including food, pharmaceuticals, cosmetics and chemicals, due to the infrared absorption characteristics of functional groups in covalently bound compounds. The functional groups of an analyte absorb specific wavelengths (cm^{-1}) of infrared light. Another advantage of this technology is that it is relatively easy to apply, reduces analysis time, is highly reproducible, easy to operate, less expensive, provides good qualitative and quantitative information about the components at the cellular level (6). Recent studies have concentrated on discovering polyphenolic chemicals found in fruits and vegetables, which function as natural antioxidants and have been proven to benefit consumer health.

The HPLC-DAD examination of five orange and purple fleshed genotypes revealed that orange fleshed sweet potatoes have greater levels of phenolics, carotenoids, amino acids and beneficial amines (7). Thus, despite many sweet potatoes being grown in Binh Tan district, Vinh Long province, the lesson of "good harvest, low price" is not novel and has been repeated countless times. The story of asking the community to "rescue sweet potatoes" is widespread in areas where the price of sweet potatoes has fallen too low. Farmers in Binh Tan district, Vinh Long, could not sell potatoes to the market when it was time to harvest because they were routinely stacked in the fields for extended periods, resulting in decreased tuber quality and easy damage.

Furthermore, customers are unaware of the considerable nutritional benefits of sweet potatoes, so their options are limited. While orange and purple fleshed sweet potato variants have garnered significant study interest from the scientific community, WFSP have gotten less attention, despite their potential for nutritional advantages and other key applications. Moreover, thorough reports on the physical and chemical properties, antioxidant properties, functional properties and WFSP cultivated in this region are limited. As a result, showcasing all of WFSP's quality characteristics would enhance consumer awareness of its positive health effects and encourage higher use. This activity also provides new research opportunities for scientists to process various products, increase raw material and processed product exports and improve the item's economic value domestically and internationally. The study's goal is to offer a complete understanding of the nutritional qualities, bioactive compounds, antioxidant activities and color properties of WFSP cultivated in Binh Tan, Vinh Long, Vietnam. The efficient utilization of locally available WFSP with inherent nutritional properties would create opportunities for heightened production and consumption, augmenting farmers' revenue and elevating their quality of life within the community.

Materials and Methods

Harvesting of WFSP

WFSP is gathered by hand. Actual commercial cultivars are harvested about 90 to 120 days after planting. Currently, the stems and leaves of the sweet potato plants gradually turn yellow and fall off. All tubers damaged by insects or fungi must be removed. Tubers damaged by mechanical damage are not kept in the storage pile but removed for other purposes. Sweet potato tubers can maintain good quality for a certain period if stored under good conditions. Due to the significant variation in postharvest WFSP parameters, such as tuber size, weight, firmness and colour differences, a large number of samples (n = 50) were collected to quantitatively analyse physical properties, taking into account natural heterogeneity and ensuring more reliable data for the design of postharvest handling systems. This large dataset also allowed for the identification of variations related to different growing areas in the region. Nutritional composition of WFSP and antioxidant properties were analysed on only 3 randomly selected white sweet potato samples. The samples were similar in size, colour and weight. Each sample was analysed in triplicate.

Chemicals reagents

Chemicals used for research include: Gallic acid (Cat. No. G7384, Merck), Folin-Ciocalteu reagent (Cat. No. F9252, Merck), quercetin (Cat. No. Q4951, Merck), aluminum chloride anhydrous (Cat. No. 101142, Merck), sodium carbonate (Cat. No. 106391, Merck), DPPH (Cat. No. D9132, Merck), ABTS (Cat. No. A1888, Merck), potassium persulfate (Cat. No. 379824, Merck), L-ascorbic acid (Cat. No. A7506, Merck), methanol (Cat. No. 106009, Merck), ethanol (Cat. No. 100983, Merck), iodine solution (Cat. No. I2909, Merck), sodium hydroxide (Cat. No. 258105, Merck), sulfuric acid (H_2SO_4, Cat. No. 102445, Merck), petroleum ether (Cat. No. 320404, Merck). Mineral standard solutions for calcium (Cat. No. 11980), magnesium (Cat. No. 105815), potassium (Cat. No. 105847) and phosphorus (Cat. No. 104698) are chemicals of Merck (Germany). Total starch assay kit (Megazyme, Cat. No. K-RSTAR, Ireland).

Analysis of physical properties

The dimensions (cm) of the WFSP were assessed using a digital caliper. The sweet potato tubers' mass weight (g) was measured using a digital balance. The hue of the tuber flesh was evaluated with a colorimeter (Color Flex, USA). The hardness of the samples was evaluated using a Texture analyzer (Brookfield CT3, Middleboro, MA 02346, USA) with a 1500 g load cell.

Nutritional composition, bioactive compounds and antioxidant activity analysis

Proximate composition analyses were assessed using the AOAC (8). Amylose content was determined using the Avaro, Pan (9) method, with absorbance quantified by a UV/Vis spectrophotometer (Shimadzu, Kyoto, Japan). Amylopectin content was determined by subtracting the amylose content from 100 %.

The resistant starch (RS) content was assessed following the methodology outlined by McCleary, McNally (10). The concentration of vitamin C was evaluated using the spectrophotometric method (11). The mineral content of WFSP was assessed through atomic absorption spectroscopy as described by the AOAC method (12). The Total polyphenol content (TPC) was measured in mg GAE/g using the Folin-Ciocalteu assay (13). While following the method of Chang, Yang (14), Total flavonoid content (TFC) was assessed by recording the absorbance reaction of sample extract with $AlCl_3$ solution and expressed as milligrams of quercetin equivalents per gram (mgQE/g).

The scavenging activity of 1,1-diphenyl 2-picrylhydrazyl (DPPH) free radical was used to determine antioxidant activity [DPPH (%)] (15). The ABTS (%) was assessed through the scavenging activity of the 2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) ABTS + free radical (16), along with the determination of IC_{50}, which represents the concentration of antioxidant required to scavenge 50 % of free radicals.

Calculation of PRAL value

The PRAL score quantifies a particular food's acid or base production in the human body post-consumption. The value of PRAL would be based on the content of phosphorus, protein, potassium, calcium and magnesium.

Phenolic acid identification

Preparation of WFSP powder

Following harvest, WFSP tubers were sorted, washed and drained. Thuy, Giau described the methods of preparation, drying and powdering (17). WFSP powder was maintained in dark bags at 25 ± 2 °C before being used for pigment analysis.

Phenolic acid extraction

2 g of WFSP powder are accurately measured and placed in a 15 mL test tube. 6 mL of 2.6 M NaOH, containing 53 % methanol in water, was added and the mixture was agitated thoroughly. The sample underwent sonication in an ultrasonic bath (Power Sonic 410, Hwashin Technology Co., Korea) for 15 min to facilitate extraction. The tube was subsequently placed in an incubator, agitated and the reaction maintained at 200 rpm for 20 hrs at 25 ° C to facilitate the degradation of plant cell components containing phenolic acids. 2 mL of the clear supernatant were meticulously collected and transferred to a 15 mL tube. 0.5 mL of HCl solution (35 %) was added and cooled for 30 min. Subsequently, the pH of the sample was adjusted to a range of 1 to 2. The solution underwent filtration using a 13 mm PTFE (0.2 µm) to facilitate UPLC analysis.

Ultra-Performance Liquid Chromatography (UPLC) analysis conditions

A UPLC system (Ultimate 3000, Dionex, Idstein, Germany) was utilized, featuring an XTerra MS C18 column (pore size: 125 Å, particle size: 5 µm, dimensions: 3.9 mm x 150 mm; Waters, Japan), with the temperature set at 30 °C. A solvent 0.1 % formic acid water (Sigma aldrich chemie.) and B solvent 0.1 % formic acid methanol (SAMCHUN, Korea) were used as mobile phases. A volume of 1000 µL was injected. The detection utilized an Ultimate 3000 Photodiode array detector (Dionex, Idstein, Germany).

Fourier transform infrared spectroscopy (FTIR) technology

FTIR is based on the sample's absorption and transmission of infrared radiation. The scanning process produces a spectrum that generates a molecular fingerprint of the sample. This fingerprint represents the absorption peaks produced by different sample components, providing direct information about the amount of material in the sample. The absorption spectra were acquired at a resolution of 2 cm^{-1} in the 4000 - 400 cm^{-1} wave number range (30 scans per spectrum) using IR spectroscopy (Shimazu Iraffinity-1S, Japan) (18).

Data analysis

Excel software (2019) was used to calculate the mean value from the collected data and standard deviation (STD).

Results and Discussion

Physical properties of WFSP

When marketing or industrially processing them, sweet potato tubers' size, weight and shape are key factors. Most harvested WFSP have uniform, plump tubers, white tuber peel and creamy white tuber flesh. Table 1 displays the results of WFSP's physical characteristics analysis. At harvest, the length, width and weight of WFSP tubers were measured to be 13.17 cm long, 5.90 cm wide and 183.70 g, respectively. The width, size and weight of sweet potato cultivars in Martinique (France) was analyzed (19). The WFSP variety "CAM/11/006" had length, width and weight of 19.45 cm, 7.10 cm and 479.20 g, respectively. Most of these values were higher than those measured in WFSP grown in Vietnam. The length, width and weight of 21 Caribbean sweet potato cultivars varied between 17.2 - 29.3 cm, 11.1 - 22.3 cm and 0.9 - 3.1 kg, respectively (20).

It has been shown that the size and weight of sweet potato cultivars are often different and uneven. It is mainly due to the conditions of the cultivation, soil and sweet potato cultivars. The harvest stage is the final stage and the morphological characteristics of sweet potatoes reach their maximum value because the sweet potato tubers have fully developed. Sweet potatoes become more sensitive to pests as they expand in size and they may crack. Sweet potatoes are picked before they reach their maximum commercial weight and width, allowing them to be sold following the requirements set by traders.

The hardness value of WFSP in this investigation was 101.92 N (Table 1), which is remarkably comparable to the measured hardness value of three WFSP variants (21), which ranged from 90.19 to 106.01 N. The texture of sweet potatoes is heavily influenced by environmental temperature, variety and growing period (4).

Sweet potato color is a significant sensory characteristic that can affect consumer acceptance. The measured L*, a* and b* values of WFSP were 82.65, -1.57 and 18.95, respectively, presented in Table 1. L* values ranged from 75.4 to 77.8, a* values from -1.7 to 2.0 and b* values from 17.8 to 22.9 for three WFSP types were found in early works (20). The "Ssetyabule" variety had L*, a* and b* values of 69.66, 1.14 and 11.75, respectively was also reported (22). The L* value is insufficient to distinguish raw materials by color since it only represents the degree of brightness and does not clearly reveal the link between polyphenol concentration and antioxidant activity. The phenolic content and antioxidant activity (FRAP, DPPH) were positively linked with b* (yellow, + or blue, -). The b* value measured from WFSP showed high value (18.95 > 0), the higher this value, the higher the antioxidant activity.

Table 1. Physical properties of WFSP

Parameters		Value
Size [cm]	Length	13.17 ± 0.41
	Width	5.90 ± 1.09
Weight [g]		183.70 ± 57.82
Hardness [N]		101.92 ± 7.92
Color	L*	82.65 ± 1.53
	a*	-1.57 ± 0.49
	b*	18.95 ± 1.58

Values are provided as mean ± SD.

Nutritional composition of WFSP

The moisture level of WFSP in this study was approximately 68.89 % (Table 2). The protein content of WFSP examined was 1.36 % (corresponding to 4.37 g/100 g dry weight (DW)) (Table 2), which is greater than the protein content of WFSP cultivars Rutambira 4-160 (0.80 % FW) and Mugande (0.81 % FW) in Rwanda (24). The protein levels in several WFSP cultivars ranged from 4.1 to 5.8 g/100 g DW (25). Sweet potatoes are often regarded as low-protein crops, with levels ranging from 1 % to more than 10 % (26). Sweet potatoes have a relatively modest protein level. Still, the quality of the protein is high since it includes several necessary amino acids, including leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine (27). All these amino acids are required for the human body to function correctly.

The tubers of sweet potatoes are generally low in fat content. The fat content of WFSP was 0.21 % (approximately 0.69 g/100 g DW) (Table 2), which aligns with the fat levels reported for various WFSP cultivars (20), ranging from 0.5 to 1.1 g/100 g DW. Nonetheless, this value is less than that documented (25), which varied from 1.3 to 1.7 g/100 g DW. The findings suggest that WFSP is a low-fat food suitable for incorporating into a low-fat diet or pairing with healthy fats to yield health benefits.

The results given in Table 2 revealed the ash content of the WFSP was 0.74 % (» 2.38 g/100 g DW), which is quite similar to the ash content of WFSP of 2.3 - 3.4 g/100 g DW that was previously published (25). On the other hand, this value is higher than the ash content of WFSP varieties grown in China (1.68 g/100 g DW) and Rwanda (0.40 - 0.42 % FW) (24, 28). Sweet potato ash contains several minerals and trace elements. Trace elements have been shown to provide various health and fitness benefits, individually and combined.

Carbohydrates serve as the primary energy source for the body. WFSP serves as a staple food crop due to its elevated glucose content. The carbohydrate content of WFSP cultivated in Vinh Long province, Vietnam, was assessed and determined to be 26.73 % FW (85.92 g/100 g DW) (Table 2), which aligns closely with the carbohydrate content of WFSP documented (25), ranging from 85.3 to 87.3 g/100 g DW. However, these values exceed the carbohydrate content of the WFSP Blesbok cultivar (76.72 % DW) produced in South Africa (29). Carbohydrates, which can be converted into simple sugars (glucose, fructose and galactose) are crucial in providing energy for the body's metabolic functions.

The fiber content of WFSP cultivated in Vietnam was found to be 1.58 % (» 5.08 g/100 g DW) (Table 2), close to previous study of 5.47 % DW (29). This number exceeds that published by early works (24, 30), which were 0.11 - 0.12 % DW and 2.52 % DW, respectively. Dietary fiber reduces oxidative stress and protects against cardiovascular disease, colon cancer and obesity. Dietary fiber is also shown to reduce cholesterol absorption in the stomach, slow digestion and convert starches into simple sugars, an important element of diabetes control.

RS is an essential functional dietary component, as it contributes to the delayed release and absorption of glucose in the bloodstream due to its slower digestion in the lower gastrointestinal tract. This intervention reduces the risk of diabetes, obesity and associated health conditions. The RS content of WFSP cultivated in Vietnam was 1.12 % FW (approximately 3.60 g/100 g DW) (Table 2). The RS content of WFSP ranged from 2.5 to 3.7 g/100 g DW (25). The RS content of 86 sweet potato accessions ranged between 0.254 and 9.12 g/100 g DW (31). Sweet potatoes' total starch and RS content varies based on genotype, pre-and post-harvest processes and geographic location, among other factors. Differences in amylose/amylopectin ratios can also account for variations in sweet potato RS concentration (4).

WFSP cultivars cultivated in Vietnam included 24.20 % amylose and 75.80 % amylopectin (Table 2). The amylose content of WFSP cultivated in Malaysia ranged between 23.76 - 24.96 % (32). Amylose is more challenging to digest; therefore, glucose enters the system more slowly than amylopectin. Amylose elevates the blood glucose level more gradually than regular sugars and is a nutritious food option for people with diabetes. The concentration of amylose and the amylose to amylopectin ratio significantly affect the textural properties of sweet potato products, especially hardness.

Sweet potato tubers contain a significant amount of vitamin C (24). The analyzed WFSP exhibited a vitamin C content of 8.97 ± 0.26 mg/100 g FW (approximately 28.16 g/100 g DW) (Table 2). This value surpasses the vitamin C content found in the WFSP variety "CAM/11/006" (4.10 mg/100 g FW) and the three WFSP varieties (6.6 – 13.1 g/100 g DW) documented (19, 20). In contrast, the reported vitamin C content of the WFSP "White Triumph" variety from South-Eastern Polish is lower than that found which was 24.20 mg/100 g of fresh weight (33). When comparing this to vegetables cultivated in Martinique (France), sweet potato, with a vitamin C content of 12.5 mg/100 g, ranked sixth after pigeon pea (569.2 mg/100 g), cucumber (73.2 mg/100 g), St. Marteen yam (22.0 mg/100 g), sweet cassava (21.3 mg/100 g) and malanga (19.3 mg/100 g) (34).

Minerals are necessary for regulating heart rate, blood coagulation, nerve responses and reactions and, most critically, fluid balance (34). Adequate mineral consumption is essential for

Table 2. Proximate compositions and antioxidant properties of WFSP

Parameters	Value	Parameters	Value
Moisture content [%]	68.89 ± 0.10	Amylose [%]	24.20 ± 0.07
Protein [%]	1.36 ± 0.07	Amylopectin [%]	75.80 ± 0.07
Fat [%]	0.21 ± 0.06	Vitamin C [mg/100 g]	8.97 ± 0.26
Ash [%]	0.74 ± 0.03	Calcium [mg/100 g]	7.68 ± 0.13
Carbohydrate [%]	26.73 ± 0.19	Magnesium [mg/100 g)]	9.58 ± 0.08
Fiber [%]	1.58 ± 0.19	Potassium [mg/100 g]	79.56 ± 0.27
RS [%]	1.12 ± 0.10	Phosphorus [mg/100 g]	18.69 ± 0.14
Antioxidant properties			
TPC [mgGAE/g FW]	1.58 ± 0.05	IC_{50} DPPH [mg/mL]	3.31 ± 0.22
TFC [mgQE/g FW]	0.69 ± 0.04	IC_{50} $ABTS^{\cdot+}$ [mg/mL]	0.38 ± 0.02

Values are expressed as mean ± SD.

human health. The calcium content of WFSP was 7.68 ± 0.13 mg/100 g FW (24.50 mg/100 g DW) (see Table 2). Meanwhile, the documented calcium content of 86 sweet potato accessions varies from 63.8 to 633 mg/100 g DW (31). Calcium is essential for human health as it facilitates coagulation of blood, contraction of muscles, neurological function, the formation and repair of bones and teeth and various enzymatic metabolic processes.

The magnesium content of the WFSP variety grown in Vietnam was 9.58 ± 0.08 mg/100 g FW (» 30.79 mg/100 g DW) (Table 2). It was higher than the magnesium content of the two WFSP varieties, "Gbagolo" and "Avoungokan vôvô" grown in Benin, which were 21.30 and 23.37 mg/100 g DW, respectively (35). However, this value was lower than the magnesium concentration of the WFSP varieties "Koganesengan" (27 mg/100 g FW) and "White Triumph" (160 mg/100 g DW), as reported (36, 33). Magnesium is essential for circulatory conditions such as ischemic heart disease and bone calcium metabolism.

The potassium content of WFSP examined was 79.56 ± 0.27 mg/100 g FW (» 313.60 mg/100 g DW) (Table 2). It is comparable to the potassium content (308.67 – 310.67 mg/100 g DW) of WFSP published (35) but lower than the value (19), 121.45 mg/100 g FW. Potassium is essential for standard neuronal transmission and protein synthesis. Adequate dietary potassium enhances cardiovascular and skeletal health while reducing the risk of stroke and cardiovascular heart disease. It governs cardiac rhythm, neuronal signaling and physiological fluid balance. A high intake of potassium enhances iron usage in the body.

WFSP cultivated in Vietnam had a phosphorus concentration of 18.69 ± 0.14 mg/100 g FW (60.08 mg/100 g DW) (Table 2), lower than the previously reported amount (270 mg/100 g DW) (33). Nonetheless, it is greater than the value reported (35), where the phosphorus contents of WFSP ranged from 44 to 45.33 mg/100 g DW. Phosphorus is a mineral strongly tied to calcium equilibrium; hence, it plays a role in bone and tooth production. Most metabolic activities require phosphorus, including kidney function, cell proliferation and heart muscle contraction. Symptoms of phosphorus shortage include bone discomfort, difficulty breathing, weariness, anxiety, numbness, skin sensitivity and weight fluctuations. In terms of mineral content, WFSP has proved that this is a nutritious diet with the following mineral composition, ranked from high to low: potassium > phosphorus > magnesium > calcium. As a result, sweet potatoes can be regarded a good nutrient supplement in human diets.

Antioxidant properties of WFSP

The analysis revealed that WFSP grown in Vietnam had a TPC concentration of 1.58 mg GAE/g FW (» 5.08 mg GAE/g DW) (Table 2), which was relatively higher than the TPC in raw white flesh sweet potato (0.53 mg GAE/g DW) (37). However, it was remarkably similar to the TPC value (1.52 mg GAE/g FW) discovered in the study (17). The highest value (9.6 mg GAE/g DW) for sweet potato varieties in China (28). Variations in TPC may be ascribed to genetic factors that influence the production of secondary metabolites, including phenolic compounds. Moreover, the extraction and analysis processes can influence the available content of TPC. Phenolic compounds are thought to be efficient antioxidants because they scavenge reactive radicals, chelate iron and prevent lipid peroxidation (38).

Both phenolic and flavonoid molecules may have antioxidant properties. They can reduce excessive free radicals in oxidative stress, which causes many degenerative disorders. Flavonoids are a category of phenolic compounds that display significant biological effects and promising antioxidant activity because of their capacity to effectively scavenge reactive oxygen species (39, 40). The test results indicated that the TFC in WFSP was 0.69 mg QE/g fresh weight (approximately 2.22 mg QE/g DW) (Table 2). This value is comparatively high when juxtaposed with the TFC of white sweet potato reported at 1.5 mg QE/g DW (22), yet lower than the findings of early works (25), which ranged from 5.8 to 12.2 mg QE/g DW. The intensity of color serves as a reliable indicator of flavonoid content.

ABTS and DPPH radicals are the two most commonly utilized chromogen chemicals for measuring antioxidant activity in biological materials (41). The IC_{50} for DPPH in WFSP was 3.31 ± 0.22 mg/mL (Table 2), which is similar to the range of IC_{50} values (0.49 – 5.23 mg/mL) using the same approach on several sweet potato genotypes (42). However, this value is lower than cream-fleshed sweet potatoes with an IC_{50} of 6.05 to 6.8 mg/mL for DPPH (43). Lower IC_{50} values signify enhanced free radical inhibition, as effective free radical inhibitors demonstrate activity at minimal concentrations.

The IC_{50} value of ABTS in WFSP is 0.38 ± 0.02 mg/mL (Table 2), which is lower than that reported for cream-fleshed sweet potato cultivars who reported IC_{50} values ranging from 6.12 to 6.67 mg/mL (43). The IC_{50} value was employed to evaluate the ABTS radical scavenging capacity, where a lower value signifies a higher radical eliminating capacity. The phenolic acid and flavonoid compounds exhibited a dependence on dosage activity in scavenging ABTS radicals. Furthermore, the observed differences in antioxidant properties between the various types can be attributed to diverse antioxidant components.

Estimation of PRAL score

To better comprehend the acid/alkaline character of foods, a formula was created to quantify the acidifying effect of foods when consumed based on their alkalizing mineral and acid-forming protein content. This formula makes it possible to determine whether a diet is too acidic, alkaline, or balanced. The kidneys process most of this acid, so meals are referred to as having a PRAL. The PRAL score for WFSP was determined by analyzing various nutritional components. Table 3 indicates that WFSP has a minus PRAL of -0.63, positioning it as a primary buffering agent in the diet due to its potassium content. This potassium aids in maintaining the balance of acids and bases by facilitating electrolyte elimination through the exchange with hydrogen ions in the distal nephron (44). Diets characterized by negative PRAL scores (PRAL <0) generate a greater quantity of alkali precursors, resulting in increased alkalinity of bodily fluids. Individuals with chronic renal disease should select foods with reduced PRAL scores to mitigate metabolic acidosis (45). Low PRAL scores can predict and reduce urine acidity in a short time frame. People with a high acid load (PRAL positive) diet have

Table 3. Potential renal acid load (PRAL) score of WFSP

Nutritional compositions (per 100 g of edible portion)					PRAL score
Protein [g]	Phosphor [mg]	Potassium [mg]	Magnesium [mg]	Calcium [mg]	
1.36	18.69	79.56	9.58	7.68	- 0.63

reported decreased muscular reserves or faster muscle loss.

Alkaline foods nourish the body and help renew and rebuild damaged cells by neutralizing the acidity in the blood. A diet heavy in acidic foods causes the body's cells to break down early, causing significant damage. As a result, identifying meals with an alkalizing effect on the body can assist in maintaining optimal blood pH levels and preserving the body's health, energy and vitality. The most nutritious natural foods are alkaline, such as green leaves, almonds, numerous vegetables, good oils and fats and salmon. The human body can heal from chronic ailments if the blood pH remains normal or slightly alkaline. Based on the evidence, it is evident that WFSP, a low PRAL score (negative value as estimated), can be demonstrated to be a nutritious meal for humans.

Determining the functional groups of WFSP powder

FTIR is an effective method for the detection of chemical bonding. The annotated spectrum indicates that the absorbed light wavelength is characteristic of chemical bonding. Analyzing infrared absorption spectra facilitates the identification of chemical bonds within the molecule.

The FTIR investigation revealed 17 spectral peaks in WFSP cultivated in Vietnam, ranging from 3280.92 cm^{-1} to 418.55 cm^{-1} (Fig. 1 and Table 4). The glucose unit's -OH and $-CH_2$ stretching vibrations are responsible for the absorption peaks at 3426.7 cm^{-1} and 2927.7 cm^{-1}, respectively (46). FTIR spectra show 3000 - 2800 cm^{-1} peaks for C-H, O-H and $-CH_3$. These peaks are primarily caused by starches, carbon compounds, free amino acids, carboxylic acids and phenols (47). The peak 1647.21 cm^{-1} in the band at 1700 - 1600 cm^{-1} is caused by the extension of the carbonyl stretching bands C=0 and C=C and this region has been recognized as a phenolic compound. The vibration at 1541.12 - 1242.16 cm^{-1} was compared to flavonols and phenols. The vibrations at 1147.65 - 1076.28 cm^{-1} are caused by the C-OH group and sections C-C and C-O in carbohydrate structures and C-O in phenols (48).

Identifying phenolic acids in WFSP

Sweet potatoes possess a significant concentration of flavonoids and phenolic acids as chlorogenic acids and a group of esters derived from particular cinnamic and quinic acids (49). Fig. 2 depicts the chromatograms of phenolic acid standards and phenolic acids isolated from WFSP cultivated in Vietnam. Fig. 2a shows the UPLC profiles of the phenolic acid standards, which indicated the retention time (RT) of gallic acid monohydrate (2.667 min), caffeic acid (9.7 min), coumaric acid (14.683 min), trans-ferulic acid (16.9 min) and sinapic acid (18.033 min).

The absorption peak of each phenolic acid in the WFSP was determined by comparing its RT to that of the internal standard. This approach identified three different phenolic acids: caffeic acid, coumaric acid and trans-ferulic acid (Fig. 2b and Table 5), with molar quantities of 0.004 mg/g, 0.007 mg/g and 0.006 mg/g, respectively. Peak no. 4 exhibits an identical RT of 9.7 min to that of the standard sample of caffeic acid. Peak no. 5 shows a RT of 14.65 min, closely matching the standard sample of coumaric acid at 14.683 min. Additionally, peak no. 6 corresponds to a RT of 16.883 min for trans-ferulic acid, as determined by UPLC. The gallic acid, catechin, chlorogenic acid, caffeic acid, caffeic derivative, ellagic acid, epicatechin, rutin, iso-quercitrin, quercitrin, quercetin and kaempferol found in WFSP (30). The eight phenolic acids were found in sweet potatoes, including 4-hydroxy benzoic acid, vanillic acid, protocatechuic acid, gallic acid, chlorogenic acid, caffeic acid, *ρ*-coumaric acid and salicylic acid (50).

Sweet potato phenolic compounds are predominantly made up of chlorogenic acids, which are known as ester compounds. They are produced via the condensation of quinic acid with trans-cinnamic acids, like coffee acid, p-coumaric acid and ferulic acid (51). The specific phenolic acids found in newly harvested sweet potato root tissues included chlorogenic acid, caffeic acid, 4,5-caffeoylquinic acid, 3,5-caffeoylquinic acid and 3,4-caffeoylquinic acid (52).

As previously stated, the major phenolic components in WFSP cultivated in Vietnam were caffeic acid, coumaric acid and trans-ferulic acid. Caffeic acid occurs naturally in several derivatives, including caffeic acid phenethyl ester, a bioactive polyphenol. It has significant biological and pharmacological benefits, including antioxidant, anticancer and anti-inflammatory activities. A naturally occurring metabolite called p-coumaric acid can be found in many edible plants. It is a phytochemical that has numerous health benefits. Its antioxidant, oxidative stress-reducing and anti-inflammatory properties have been pronounced (53). In addition, trans-ferulic acid is a potentially important chemical with anti-inflammatory, anti-aging, anti-angiogenic, anticancer, antibacterial and antioxidant capabilities (54). As a result of its potential health benefits, the inclusion of WFSP in meals should be encouraged and expanded.

Conclusion

This study thoroughly investigated the quality of WFSP manufactured in Binh Tan, Vinh Long, Vietnam. The physical

Table 4. Peaks of functional groups found in WFSP powder

No.	Peak [cm^{-1}]	Intensity	Functional groups	No.	Peak [cm^{-1}]	Intensity	Functional groups
1	418.55	50.54	Core-benzene	10	1076.28	64.44	C-OH, C–C, C–O
2	482.20	54.87	Core-benzene	11	1147.65	74.58	C-OH, C–C, C–O
3	526.57	54.17	Core-benzene	12	1242.16	85.26	C=C, C-H
4	572.86	56.36	Core-benzene	13	1338.60	81.97	C=C, C-H
5	705.95	69.27	C-O	14	1541.12	87.40	C=C, C-H
6	761.88	72.84	C-O	15	1647.21	83.69	C=O, C=C
7	860.25	75.56	C-O	16	2926.01	86.33	C–H, O–H, $-CH_3$
8	925.83	69.32	C-O	17	3280.92	78.51	O-H, $-CH_2$
9	993.34	46.12	C-O				

Table 5. The molar concentration of five phenolic acid from WFSP extract

Phenolic acid	Gallic acid monohydrate	Caffeic acid	Coumaric acid	Sinapic acid	Trans-ferulic acid	Total
Molar concentration [mg/g]	N/D	0.004	0.007	N/D	0.006	0.017
Ratio [%]	-	23.53	41.18	-	35.29	100

N/D: Not Detected

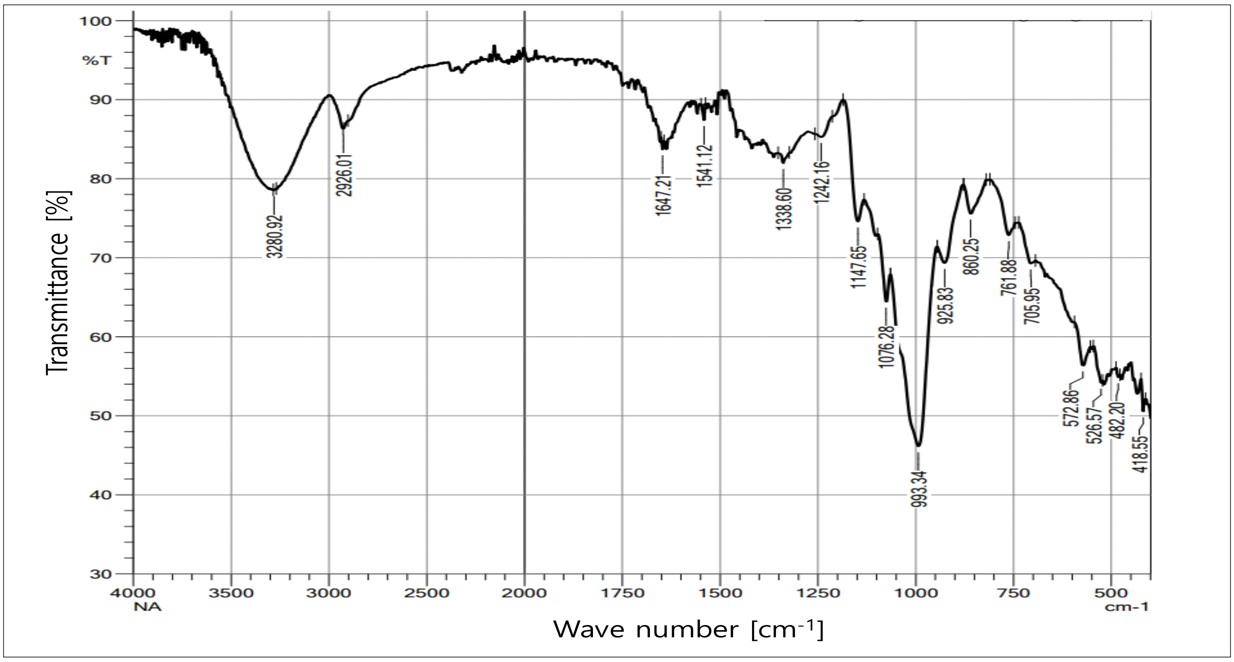

Fig. 1. FTIR analysis of WFSP powder.

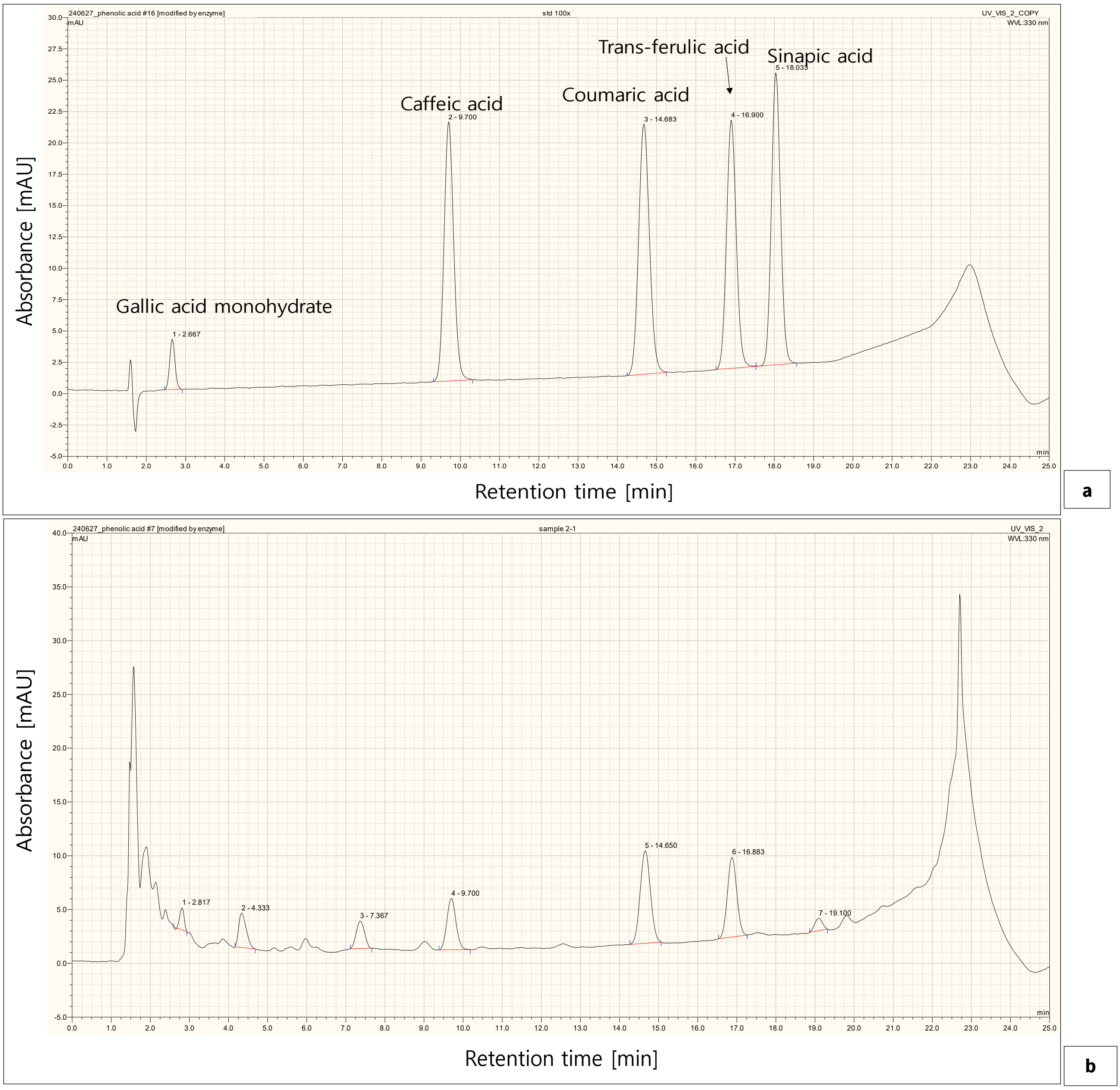

Fig. 2. Chromatograms of standard phenolic acids (a) and UPLC analysis of phenolic acid extracted from WFSP (b) using gradient elution at 330 nm.

parameters (size, weight, firmness, color), proximate analysis, bioactive compounds, antioxidant activity and PRAL score have all been determined. The size and weight of WFSP cultivars cultivated in Vietnam are frequently inconsistent and unequal. Most of them are smaller in size and weight than white sweet potato cultivars from other sources and WFSP is grown all over the world. However, WFSPs are an excellent source of nutrients, in addition to its high carbohydrate content (26.73 %), WFSP also contains protein (1.36 %), vitamin C (8.97 mg %), dietary fiber (1.58 %), high minerals content (calcium, magnesium, potassium and phosphorus) and other natural antioxidants (TPC, TFC) related to their high antioxidant capacity.

With a complete nutritional profile, WFSP is an ingredient with outstanding nutritional properties and high antioxidant potential. This helps provide useful information for selecting diverse foods that contain WFSP in their formulation, meeting the need for good foods in the human food system. The estimated PRAL score was negative (-0.63), suggesting that WFSP functions as an alkaline food upon digestion, potentially offering various health advantages. FTIR studies identified 17 functional groups in WFSP powder. UPLC analysis confirmed that the main phenolic acids in WFSP extract are caffeic acid, coumaric acid and trans-ferulic acid. These essential antioxidants can protect cells from damage and prevent adverse effects on human health. The research findings will be expanded upon to maximize the economic worth of the current local resource and establish a long-term product chain. In terms of practical applications, WFSP offers great promise in the production of functional foods. Future research will also focus on isolating particular antioxidant components from this potato type and conducting bioassays to better assess WFSP's health advantages. Breeding procedures can also be implemented immediately to improve the intrinsic functional qualities of WFSP.

Authors' contributions

NCD, TNG, HVH and NMT carried out the studies, participated in data collection and drafted the manuscript. NCD, VQM and NMT participated in the design of the study and performed the statistical analysis. NCD, TNG, HVH, VQM, NVT and NMT participated in the alignment. NMT conceived of the study and participated in its design and coordination. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

References

1. General Statistic Office. Statistical Yearbook of 2022. Ha Noi (Vietnam): Statistical Publishing House; 2022. 1268 p.
2. Franková H, Musilová J, Árvay J, Šnirc M, Jančo I, Lidiková J, et al. Changes in antioxidant properties and phenolics in sweet potatoes (*Ipomoea batatas* L.) due to heat treatments. Molecules. 2022;27(6):1884. https://doi.org/10.3390/molecules27061884
3. Chen Z, Liang N, Zhang H, Li H, Guo J, Zhang Y, et al. Resistant starch and the gut microbiome: Exploring beneficial interactions and dietary impacts. Food Chem X. 2024;21:101118. https://doi.org/10.1016/j.fochx.2024.101118
4. Dung NC, Giau TN, Van Hao H, Minh VQ, Thuy NM. Quality attributes, antioxidant activity and color profile of orange-fleshed sweet potato grown in Vietnam. Food Chem. 2024;24:102060. https://doi.org/10.1016/j.fochx.2024.102060
5. Fadlelmoula A, Pinho D, Carvalho VH, Catarino SO, Minas G. Fourier transform infrared spectroscopy to analyse human blood over the last 20 years: A review towards lab-on-a-chip devices. Micromachines. 2022;13(2):187. https://doi.org/10.3390/mi13020187
6. Fahelelbom KM, Saleh A, Al-Tabakha MMA, Ashames AA. Recent applications of quantitative analytical FTIR spectroscopy in pharmaceutical, biomedical and clinical fields: A brief review. Rev Anal Chem. 2022;41(1):21-33. https://doi.org/10.1515/revac-2022-0030
7. Basílio LSP, Nunes A, Minatel IO, Diamante MS, Di Lázaro CB, Silva ACAFe, et al. The phytochemical profile and antioxidant activity of thermally processed colorful sweet potatoes. Horticulturae. 2024;10(1):18. https://doi.org/10.3390/horticulturae10010018
8. AOAC. Official methods of analysis of the Association of Official Analytical Chemists. 16th ed. Washington (DC): Association of Official Analytical Chemists; 2005.
9. Avaro MRA, Pan Z, Yoshida T, Wada Y. Two alternative methods to predict amylose content of rice grain by using tristimulus CIE lab values and developing a specific color board of starch-iodine complex solution. Plant Prod Sci. 2011;14(2):164-8. https://doi.org/10.1626/pps.14.164
10. McCleary BV, McNally M, Rossiter P. Measurement of resistant starch by enzymatic digestion in starch and selected plant materials: Collaborative study. J AOAC Int. 2002;85(5):1103-11. https://doi.org/10.1093/jaoac/85.5.1103
11. Alam MK, Sams S, Rana ZH, Akhtaruzzaman M, Islam SN. Minerals, vitamin C and effect of thermal processing on carotenoids composition in nine varieties orange-fleshed sweet potato (*Ipomoea batatas* L.). J Food Compos Anal. 2020;92:103582. https://doi.org/10.1016/j.jfca.2020.103582
12. AOAC. Official methods of analysis of Association of Official Analytical Chemists. Washington (DC): AOAC International; 2010.
13. Philpott M, Gould KS, Lim C, Ferguson LR. In situ and in vitro antioxidant activity of sweetpotato anthocyanins. J Agric Food Chem. 2004;52(6):1511-3. https://doi.org/10.1021/jf034593j
14. Chang C-C, Yang M-H, Wen H-M, Chern J-C. Estimation of total flavonoid content in propolis by two complementary colorimetric methods. J Food Drug Anal. 2002;10(3):3. https://doi.org/10.38212/2224-6614.2748
15. Brand-Williams W, Cuvelier ME, Berset C. Use of a free radical method to evaluate antioxidant activity. LWT. 1995;28(1):25-30. https://doi.org/10.1016/S0023-6438(95)80008-5
16. Awika JM, Dykes L, Gu L, Rooney LW, Prior RL. Processing of sorghum (*Sorghum bicolor*) and sorghum products alters procyanidin oligomer and polymer distribution and content. J Agric Food Chem. 2003;51(18):5516-21. https://doi.org/10.1021/jf0343128
17. Thuy NM, Giau TN, Hao HV, Dung NC, Tai NV, Minh VQ. Effects of steaming and drying on quality and antioxidant activity of white-fleshed sweet potato powder (*Ipomoea batatas*). Rev Mex Ing Quim. 2024;23:1-16. https://doi.org/10.24275/rmiq/Alim24184
18. Cao X, Zhong L, Peng X, Sun S, Li S, Liu S, et al. Comparative study of the pyrolysis of lignocellulose and its major components: Characterization and overall distribution of their biochars and volatiles. Bioresour Technol. 2014;155:21-7. https://doi.org/10.1016/j.biortech.2013.12.006
19. Ellong EN, Billard C, Adenet S. Comparison of physicochemical, organoleptic and nutritional abilities of eight sweet potato (*Ipomoea batatas*) varieties. Food Nutr Sci. 2014;5(2):196-311.

https://doi.org/10.4236/fns.2014.52025

20. Aina AJ, Falade KO, Akingbala JO, Titus P. Physicochemical properties of twenty-one Caribbean sweet potato cultivars. Int J Food Sci Technol. 2009;44(9):1696-704. https://doi.org/10.1111/j.1365-2621.2009.01941.x

21. Sajeev MS, Sreekumar J, Vimala B, Moorthy SN, Jyothi AN. Textural and gelatinization characteristics of white, cream and orange fleshed sweet potato tubers (*Ipomoea batatas* L.). Int J Food Prop. 2012;15(4):912-31. https://doi.org/10.1080/10942912.2010.509895

22. Amagloh FC, Kaaya AN, Yada B, Chelangat DM, Katungisa A, Amagloh FK, et al. Bioactive compounds and antioxidant activities in peeled and unpeeled sweetpotato roots of different varieties and clones in Uganda. Future Foods. 2022;6:100183. https://doi.org/10.1016/j.fufo.2022.100183

23. Kuś PM, Congiu F, Teper D, Sroka Z, Jerković I, Tuberoso CIG. Antioxidant activity, color characteristics, total phenol content and general HPLC fingerprints of six Polish unifloral honey types. LWT. 2014;55(1):124-30. https://doi.org/10.1016/j.lwt.2013.09.016

24. Rose IM, Vasanthakaalam H. Comparison of the nutrient composition of four sweet potato varieties cultivated in Rwanda. Am J Food Nutr. 2011;1(1):34-8. https://doi.org/10.5251/ajfn.2011.1.1.34.38

25. Escobar-Puentes AA, Palomo I, Rodríguez L, Fuentes E, Villegas-Ochoa MA, González-Aguilar GA, et al. Sweet potato (*Ipomoea batatas* L.) phenotypes: From agroindustry to health effects. Foods. 2022;11(7):1058. https://doi.org/10.3390/foods11071058

26. Bovell-Benjamin AC. Sweet potato: A review of its past, present and future role in human nutrition. Adv Food Nutr Res. 2007;52:1-59. https://doi.org/10.1016/S1043-4526(06)52001-7

27. Mu T-H, Tan S-S, Xue Y-L. The amino acid composition, solubility and emulsifying properties of sweet potato protein. Food Chem. 2009;112(4):1002-5. https://doi.org/10.1016/j.foodchem.2008.07.012

28. Ji H, Zhang H, Li H, Li Y. Analysis on the nutrition composition and antioxidant activity of different types of sweet potato cultivars. Food Nutr Sci. 2015;6(1):7. https://doi.org/10.4236/fns.2015.61017

29. Ayeleso TB, Ayeni PO, Ayeleso AO, Ramachela K, Mukwevho E. Nutritional and chemical constituents of different cultivars of sweet potato (*Ipomoea batatas* L.) grown in South Africa. Trop J Nat Prod Res. 2024;8(2):6100-7. https://doi.org/10.26538/tjnpr/v8i2.7

30. Salawu SO, Udi E, Akindahunsi AA, Boligon AA, Athayde ML. Antioxidant potential, phenolic profile and nutrient composition of flesh and peels from Nigerian white and purple skinned sweet potato (*Ipomoea batatas* L.). Asian J Plant Sci Res. 2015;5(5):14-23.

31. Zhao S, Zhong L, Li X, Qin L, Zhou Y, Lei X, et al. Comparative analysis of nutrients, phytochemicals and minerals in colored sweet potato (*Ipomoea batatas* L.) roots. Foods. 2024;13(22):3636. https://doi.org/10.3390/foods13223636

32. Utomo JS, Ginting E. Chemical and physical characteristics of twenty one sweet potato genotypes collected from Malaysia. Buletin Palawija. 2022;20(2):71-83.

33. Krochmal-Marczak B, Sawicka B, Supski J, Cebulak T, Paradowska K, Pigonia S. Nutrition value of the sweet potato (*Ipomoea batatas* (L.) Lam) cultivated in south-eastern Polish conditions. Int J Agric Agr Res. 2014;4(4):169-78.

34. Ellong EN, Billard C, Adenet S, Rochefort K. Polyphenols, carotenoids, vitamin C content in tropical fruits and vegetables and impact of processing methods. Food Nutr Sci. 2015;6(3):299-313. https://doi.org/10.4236/fns.2015.63030

35. Sanoussi A, Adjatin A, Dansi A, Adebowale A, Sanni L, Sanni A. Mineral composition of ten elite sweet potato (*Ipomoea batatas* [L.] Lam) landraces of Benin. Int J Curr Microbiol Appl Sci. 2016;5(1):103-15. https://doi.org/10.20546/ijcmas.2016.501.009

36. Ishida H, Suzuno H, Sugiyama N, Innami S, Tadokoro T, Maekawa A. Nutritive evaluation on chemical components of leaves, stalks and stems of sweet potatoes (*Ipomoea batatas* Poir). Food Chem. 2000;68(3):359-67. https://doi.org/10.1016/S0308-8146(99)00206-X

37. Franková H, Šnirc M, Jančo I, Čeryová N, Ňorbová M, Lidiková J, et al. Total polyphenols and antioxidant activity in sweet potatoes (*Ipomoea batatas* L.) after heat treatment. J Microbiol Biotechnol Food Sci. 2022:e5356. https://doi.org/10.55251/jmbfs.5356

38. Ge X, Jing L, Zhao K, Su C, Zhang B, Zhang Q, et al. The phenolic compounds profile, quantitative analysis and antioxidant activity of four naked barley grains with different color. Food Chem. 2021;335:127655. https://doi.org/10.1016/j.foodchem.2020.127655

39. Muflihah YM, Gollavelli G, Ling Y-C. Correlation study of antioxidant activity with phenolic and flavonoid compounds in 12 Indonesian indigenous herbs. Antioxidants. 2021;10(10):1530. https://doi.org/10.3390/antiox10101530

40. Asem N, Adilah AGN, Hussaini AHN, Omar EA. Correlation between total phenolic and flavonoid contents with antioxidant activity of Malaysian stingless bee propolis extract. J Apic Res. 2020;59(4):437-42. https://doi.org/10.1080/00218839.2019.1684050

41. Arnao MB. Some methodological problems in the determination of antioxidant activity using chromogen radicals: A practical case. Trends Food Sci Technol. 2000;11(11):419-21. https://doi.org/10.1016/S0924-2244(01)00027-9

42. Huang Y-C, Chang Y-H, Shao Y-Y. Effects of genotype and treatment on the antioxidant activity of sweet potato in Taiwan. Food Chem. 2006;98(3):529-38. https://doi.org/10.1016/j.foodchem.2005.05.083

43. Phahlane CJ, Laurie SM, Shoko T, Manhivi VE, Sivakumar D. Comparison of caffeoylquinic acids and functional properties of domestic sweet potato (*Ipomoea batatas* (L.) Lam.) storage roots with established overseas varieties. Foods. 2022;11(9):1329. https://doi.org/10.3390/foods11091329

44. Osuna-Padilla IA, Leal-Escobar G, Garza-García CA, Rodríguez-Castellanos FE. Dietary acid load: Mechanisms and evidence of its health repercussions. Nefrología (Engl Ed). 2019;39(4):343-54. https://doi.org/10.1016/j.nefroe.2019.08.001

45. Sravani M, Collins S, Iyengar A. Assessment of dietary acid load in children with chronic kidney disease: An observational study. Indian J Nephrol. 2024;34:50-5. https://doi.org/10.4103/ijn.ijn_29_23

46. Zhang Y-R, Wang X-L, Zhao G-M, Wang Y-Z. Preparation and properties of oxidized starch with high degree of oxidation. Carbohydr Polym. 2012;87(4):2554-62. https://doi.org/10.1016/j.carbpol.2011.11.036

47. Mattinen M-L, Filpponen I, Järvinen R, Li B, Kallio H, Lehtinen P, et al. Structure of the polyphenolic component of suberin isolated from potato (*Solanum tuberosum* var. Nikola). J Agric Food Chem. 2009;57(20):9747-53. https://doi.org/10.1021/jf9020834

48. Rashid MT, Ma H, Jatoi MA, Hashim MM, Wali A, Safdar B. Influence of ultrasonic pretreatment with hot air drying on nutritional quality and structural related changes in dried sweet potatoes. Int J Food Eng. 2019;15(8). https://doi.org/10.1515/ijfe-2018-0409

49. Ishiguro K, Yahara S, Yoshimoto M. Changes in polyphenolic content and radical-scavenging activity of sweetpotato (*Ipomoea batatas* L.) during storage at optimal and low temperatures. J Agric Food Chem. 2007;55(26):10773-8. https://doi.org/10.1021/jf072256v

50. Kim MY, Lee BW, Lee H-U, Lee YY, Kim MH, Lee JY, et al. Phenolic compounds and antioxidant activity in sweet potato after heat treatment. J Sci Food Agric. 2019;99(15):6833-40. https://doi.org/10.1002/jsfa.9968

51. Kurata R, Sun H-N, Oki T, Okuno S, Ishiguro K, Sugawara T. Sweet potato polyphenols. In: Mu T-H, Singh J, editors. Sweet potato. Academic Press; 2019. p. 177-222. https://doi.org/10.1016/B978-0-12-813637-9.00007-7

52. Padda MS, Picha DH. Phenolic composition and antioxidant capacity of different heat-processed forms of sweetpotato cv. Beauregard. Int J Food Sci Technol. 2008;43(8):1404-9. https://

doi.org/10.1111/j.1365-2621.2007.01663.x

53. Boo YC. p-Coumaric acid as an active ingredient in cosmetics: A review focusing on its antimelanogenic effects. Antioxidants. 2019;8 (8):275. https://doi.org/10.3390/antiox8080275

54. Rezaeiroshan A, Saeedi M, Morteza-Semnani K, Akbari J, Gahsemi M, Nokhodchi A. Development of trans-ferulic acid niosome: An optimization and an *in-vivo* study. J Drug Deliv Sci Technol. 2020;59:101854. https://doi.org/10.1016/j.jddst.2020.101854

Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://horizonepublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc
See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

Publisher information: Plant Science Today is published by HORIZON e-Publishing Group with support from Empirion Publishers Private Limited, Thiruvananthapuram, India.