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Nutritional Potential of *Maranthes polyandra* (Benth.) Prance Fruit Kernels: A Comprehensive Analysis of Macronutrient, Mineral, and Phytochemical Profiles in Burkina Faso

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Authors' contributions

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

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ABSTRACT

Humans have been using plants in traditional medicine and for food security for millions of years. Today, several plants are being studied for their nutritional and medicinal value. The aim of this study was to determine the macronutrient composition, the characteristics of the oil and the mineral and phytochemical amino acid profiles of the fruit kernels of *Maranthes polyandra* (Benth.) Prance collected in the Cascades region of Burkina Faso. Macronutrient composition, oil characteristics and phytochemical profile were determined using standard methods. Amino acid and mineral profiles were determined by liquid chromatography coupled to a tandem mass spectrometer (LC-MS/MS) and inductively coupled plasma atomic emission spectrometry (ICP-AES) respectively. The results of the analyses revealed average levels of protein (14.5 ± 0.2 g/100g), lipids (55.5 ± 0.5 g/100g) and carbohydrates (25.2 g/100g). The average saponification, iodine, acid and peroxide values of the oils were 190.92 mg KOH/g oil, 148.11 g iodine/100 g oil, 0.24 mg KOH/g oil and 25.33 mEq of O_2/kg oil. Essential amino acids (Threonine, Histidine, Isoleucine and Leucine) and non-essential amino acids (Alanine, Glycine, Arginine and Glutamic acid) were reported at varying levels. Almonds also contained ten types of minerals (B, Ca, Fe, K, Mg, Na, P, Si, Sr and Zn), total fiber (11.10%), phytate (12.46 g/kg) and polyphenols (0.13%). Almonds contained simple sugars (mg/kg) such as D-mannopyranose (41.80), Ribose (149.27), L-Rhamnose monohydrate (70.86), Glucuronic acid (161.41), Trigalacturonic acid (19.44), α-D-glucose (608.82), α-D-galactose (253.05), Aldehydo- D-xylose (22.23), Aldehydo-L-arabinose (49.72), Fucopyranose (510.58). Fructose was not detected. This study revealed that the fruit kernels of *M. polyandra* are highly rich in nutrients and can be used in food fortification to combat malnutrition in Burkina Faso.

Keywords: Maranthes polyandra (Benth.) Prance; carbohydrates; amino acids; minerals; phytochemistry; Burkina Faso.

1. INTRODUCTION

Trees and shrubs play a vital role in various areas of life throughout the world. They are used for food, medicinal purposes and in agriculture as a soil fertilizer [1]. Sub-Saharan Africa is therefore a major reservoir of edible woody species, contributing to food security and diversifying people's livelihoods [2]. However, given the strong pressure that humans exert on the flora, the edible fruit potential is declining considerably in natural areas except classified forests, protected forests, parks and reserves [3]. In Burkina Faso, the Hauts-Bassins region is par excellence the country's fruit-growing basin, providing non-timber forest products and especially edible fruit that help to improve the socio-economic life of local populations [3]. Nowadays, there is renewed interest in exploiting the biological importance of edible plants [4]. However, several species are little exploited, particularly in the agri-food and medicinal sectors. These include *Maranthes polyandra (Benth.)* Prance, which belongs to the genus *Maranthes*. This genus comprises twelve species, including ten in tropical Africa, one in tropical Asia and another in tropical America [5]. *M. polyandra* (Benth.) Prance is a plant with a high exploitation potential for its various organs such as fruits, seeds, leaves, trunk and roots. For example, the fruits of *M. polyandra* (Benth.) Prance are used for human and animal consumption. The seeds are used to produce oil. The roots are used to treat certain diseases such as syphilis, ulcers, mental illnesses and kwashiorkor [6,7,8]. Bark and leaf extracts are used to treat infections, fractures, childhood abdominal pain, metabolic disorders and fever [4]. Given their phytochemical composition, these extracts have anti-cancer and anti- inflammatory properties [9]. Wood is also used in construction, to make fence posts and for charcoal production [3]. Nevertheless, while the beneficial properties of *M. polyandra* (Benth.) Prance are known thanks to ethnobotanical investigations, data concerning the macronutrient and micronutrient composition of *M. polyandra* (Benth.) Prance fruit kernels from Burkina Faso remain scarce. The aim of this study was therefore to determine the macronutrient composition, oil characteristics and amino acid, mineral and phytochemical profiles of *M. polyandra* (Benth.) Prance fruit kernels collected in the Cascades region of Burkina Faso.

2. MATERIALS AND METHODS

2.1 Collection Site and Sampling

Mature *M. polyandra* fruits were collected in the Cascades region (see Fig. 1) in southern Burkina

Faso during October 2022. This region was chosen because of the strong presence of the species. Five localities - Mondon, Toumousséni, Wolonkoto, Djanga and Bérégadougou - were randomly selected for fruit collection. Approximately 10 kg of fruit were collected from 20 randomly selected plants per village. After harvesting, the samples were sorted, washed with water and then dried in the shade at 28-30°C for 3 weeks. After drying, 1 kg of seeds per village was taken and pooled to obtain a mixture representative of the region. Finally, the seeds obtained were shelled and the kernels were ground using a Moulinex-type grinder for biochemical analysis. Fig. 2 shows the almonds of *M. polyandra.*

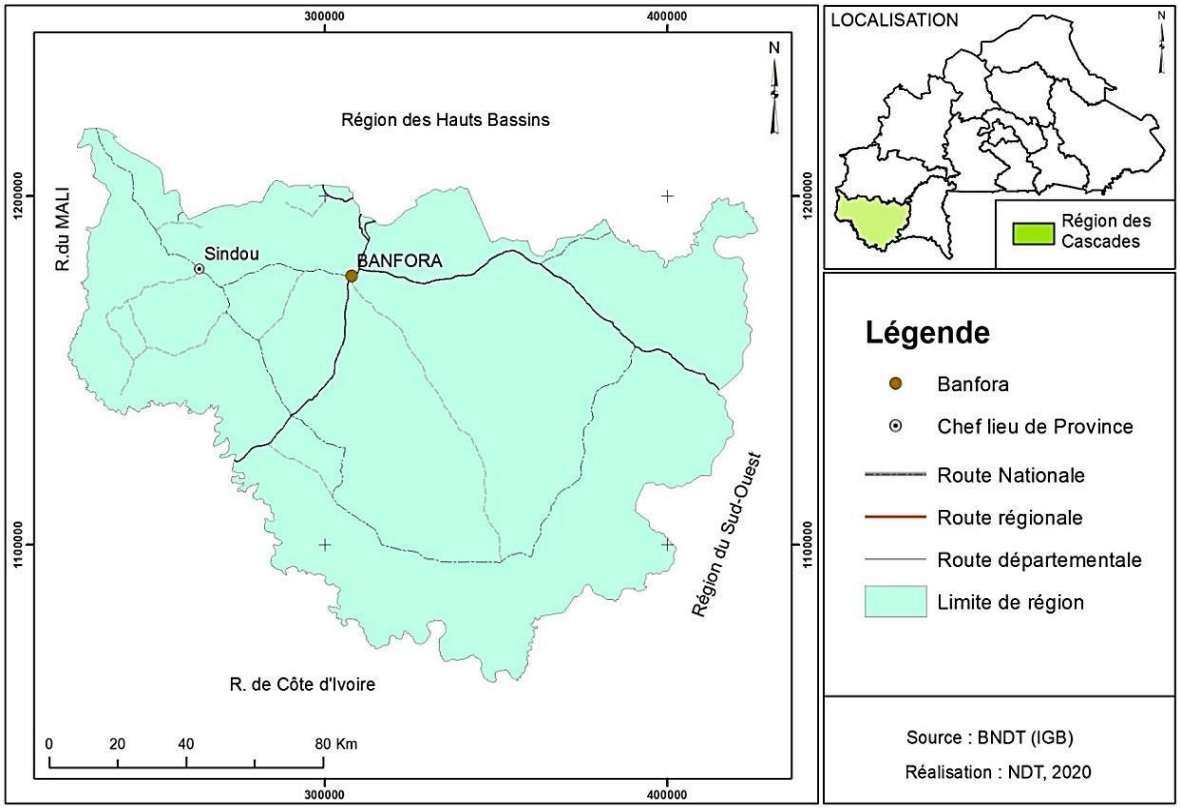

Fig. 1. Map of the Cascades region

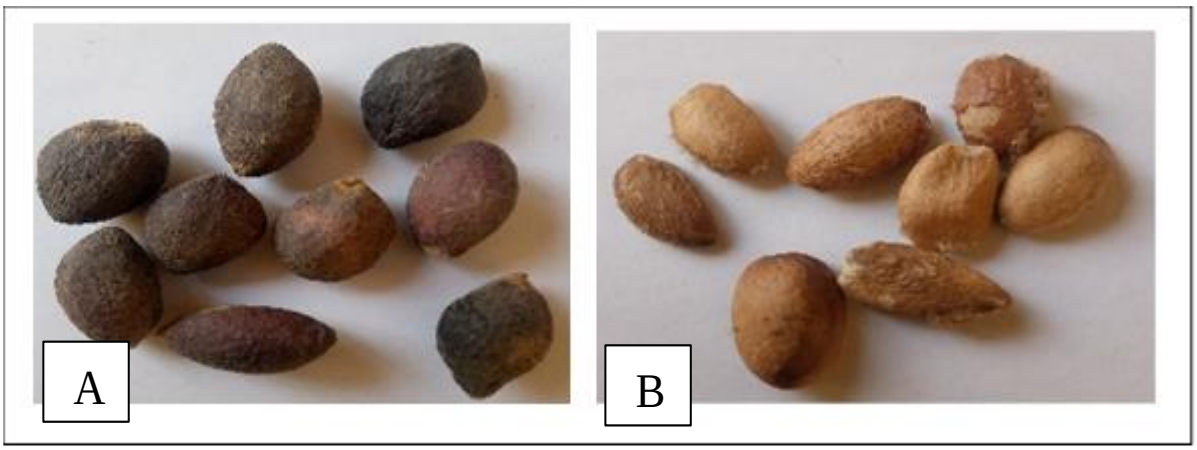

Fig. 2. Dried fruits (A) and almonds (B) of *M. polyandra*

2.2 Analysis of Proximal Kernel Composition

The water content was estimated using AOAC method 925.10 [10]. A test sample of 2 g of seed flour was placed in a tared basket. The assembly was placed in an oven at 105°C for 3 hours and then placed in a desiccator for 30 minutes to cool. The water content was obtained by differential weighing.

The crude ash content was determined according to AOAC method 923.03 [10]. This consists of incinerating the sample in a muffle furnace at a temperature of 550°C. A test sample of 3-5 g of dried seed flour is placed in a clean, dry porcelain crucible which has been weighed beforehand. The sample is then incinerated in an oven at 550°C for 4 hours. At the end of the incineration process, the crucible is removed, cooled in a desiccator for 30 minutes and the difference in mass is used to calculate the ash value.

The total protein content of the almond samples was determined according to KJELDAHL AOAC 979.09 [2]. This consists of mineralizing organic nitrogen into ammonium, which is then measured by acidimetry. A test sample of 0.2 g of dried seed meal from each sample, a digestion tablet (kjeltabs ck: 3.5 g of potassium sulphate K2SO4, 4 g of copper sulphate CuSO4, 5H2O), 10 ml of concentrated sulphuric acid and a few drops of hydrogen peroxide are added to a Kjeldahl flask. Mineralization was started for 4 hours at 400°C. After mineralization, the nitrogen is titrated and the protein content is calculated using a conversion factor.

The total fat content of dried seed flours was determined using the AOAC 960.39 Soxhlet method. [10]. The Soxhlet method is a gravimetric method for semi-continuous extraction of fats until exhaustion. A test sample of 5 g of dry matter was placed in the Soxhlet apparatus and extracted with 250 ml of petroleum ether. The extraction was carried out for 6 hours. The extraction solvent was separated from the fat by evaporation under reduced pressure using a rotavapor (BÜCHI; Germany).

The total carbohydrate content was determined using the differential method proposed by Barminas, [11]. Total carbohydrate content = 100 - (%lipids + %proteins + %ash). The theoretical energy value is calculated using the formula:

$$E = (P\times4) + (G\times4) + (L\times9)$$

Where: E is the total energy value in kilocalories (kcal), P is the quantity of protein in grams (g), G is the amount of carbohydrate in grams (g), L is the amount of fat in grams (g).

2.3 Determination of Physico-chemical Parameters of Oils

The saponification value was determined using the AOCS Cd 3-25 METHOD [12]. The oils were first hot saponified with an excess of alcoholic potash solution. The excess potash was then titrated. The difference is used to obtain the saponification index. The iodine value was calculated on the basis of the fatty acid composition of the oil found in our previous study, using the AOCS Cd 1c-85 method [12]. The peroxide value was determined by titration of the iodine released by the reaction of hydroperoxides in the presence of iodide ions according to the AOCS Cd 8-53 method [12]. 5 g of oil was dissolved in a 30 ml acetic acid/chloroform mixture (3/2, v/v). Using a propette, 0.5 ml of saturated KI was added and the mixture was left to stand for one minute. Then 30 m of distilled water was added and the iodine liberated was determined by a solution of sodium thiosulphate (0.1N) in the presence of starch. The acid number was determined by titration of the free fatty acids present in the oil using the AOCS Ca 3a-63 method [12]. The oxidative stability of the oils was determined using the automated Rancimat method. 3 g of oil were weighed into a reaction tube and introduced into the Rancimat 743 (Metrohm, Switzerland). Induced oxidation was carried out at 120°C with a purified air flow rate of 20 l/h. The time taken for total oxidation of the oil was then measured.

2.4 Determination of Amino Acid Composition

Amino acid composition was determined by liquid chromatography coupled to a tandem mass spectrometer (LC-MS/MS) [13] with slight modifications as described in our previous work [14]. The samples were first digested under heat (110˚C), with a 1‰ hydrochloric acid solution of phenol/water in (V/V) proportions. Then the operation was followed by filtration on a 0.22 µm pore membrane. The amino acid composition was then determined using a Shimadzu 8050 LC-MS/MS instrument. The column was an Endeavor-sil C18 type measuring 100*2.1mm 1.8um and the flow rate was 0.2 ml/min. The

column temperature was 40˚C and the collection time was 15 min. The mobile phase was 0.1% formic acid and acetonitrile as shown in the table. Mass conditions for electrospray ionization were as follows: interface temperature: 300˚C, desolvation temperature: 526˚C, DL temperature: 250˚C, atomising gas flow rates: 3.00 L/min, heating air flow rate: 10.00 L/min, heating block temperature: 400˚C, drying air flow rate: 10.00 L/min. Quantification was performed using combined MRM and SIM methods for direct quantitative determination of amino acids in various samples on LC/MS/MS.

2.5 Determination of Mineral Composition

Mineral composition was determined by inductively coupled plasma atomic emission spectrometry (ICP-AES) according to Selmi et al, [15] with slight modifications as described in our external work [14]. The samples were previously digested with a mixed solution of nitric acid and perchloric acid on an electric hot plate. Minerals were analyzed by gas-liquid chromatography (GLC) using the PerkinElmer (PE) AVIO200 model. Parameters were adjusted as follows: Instrumental analysis conditions: argon; Plasma gas flow rate: 12 L/min; Auxiliary gas flow rate: 0.2 L/min; Atomizing gas flow rate: 0.6 L/min; Power output: 1300 W; Pump flow rate: 1.5 mL/min; Carrier gas (greater than 99.996% argon: 0.6 - 0.8 MPa); Purge gas (greater than 99.999% argon or nitrogen: 0.3 - 0.8 MPa); Air compressor (0.6 - 0.8 Pa); Cooling water circulator (20˚C).

2.6 Determination of Reducing Sugars

2.6.1 Determination of Fructose

For the determination of fructose, approximately 0.5 g of the sample was mixed with 3 ml of trifluoroacetic acid (4 mol/L), sealed and subjected to acid digestion in an oven at 105°C for 4 hr. After cooling, the sample was again placed in the oven at 105°C, followed by the addition of a further 3 ml of methanol and subsequent drying. Next, 5 ml of water was added and the mixture was ultrasonicated for 30 min before being homogenized by vortexing. The prepared sample was filtered through a 0.22 µm filter. Analysis was carried out using a Shimadzu LC- 16 ELSD, with a chromatographic column (Shodex Asahipak NH2P -50 4E, 4.6 × 250 mm, 5 µm), at a flow rate of 1 ml/min and a column temperature of 35°C. The mobile phase consisted of water and acetonitrile in a ratio of 22:78, with a collection time of 15 min.

2.6.2 Determination of Other Simple Sugars

A sample weighing approximately 0.5 g is placed in an ampoule containing 4 ml of trifluoroacetic acid (4 mol/L), which is then sealed and subjected to acid digestion at 110°C for 4 h. After digestion, the ampoule was removed, cooled and the contents dried at 105°C. Next, 3 ml of methanol was added, followed by another drying step. The residue was then dissolved in 3 ml ammonia and filtered through a 0.22 µm membrane for derivatization. For the derivatization process, 0.1 ml of the sample is combined with 0.1 ml of a 0.5 mol/L PMP-methanol solution and heated to 70°C for 30 min. The mixture was then dried under nitrogen vapor, reconstituted with 1 ml of methanol and oven dried again. Next, 1.0 ml of water was added to dissolve the sample and the excess derivatized agent was extracted with chloroform until the chloroform layer became colorless. The supernatant was passed through a 0.22 µm filter before analysis. The instrument is a Shimadzu LC-2030PLUS, with a Diamonsil-plus C18 column (4.6 × 250 mm, 5 µm). Chromatographic conditions included a collection time of 75 min, a wavelength of 245 nm, a flow rate of 1 ml/min, a column temperature of 35°C and a mobile phase consisting of disodium hydrogen phosphate (20 mmol/L, pH 6.8) and acetonitrile in a ratio of 84:16.

2.7 Determination of Phytates

For the determination of phytates, the method adapted from (Marolt and Kolar 2021) was used. Approximately 2g of sample was added to a 50ml centrifuge tube, followed by 20ml of hydrochloric acid solution. The mixture was ultrasonically extracted at room temperature for 2 h and then centrifuged at 5,000 rpm for 15 min. 10 ml of the supernatant was accurately removed into a 50 ml distillation flask, evaporated by rotary evaporation at 50°C and the residue dissolved in 10 ml of water. Next, 5 ml of the extract was pipetted through a pre-activated solid phase extraction column, washed sequentially with 5 ml sodium dihydrogen phosphate solution and 5 ml water, removing all effluent. The column was then eluted with 5 ml of sodium dihydrogen phosphate solution. The eluent was collected and diluted to 10 ml with sodium dihydrogen phosphate solution, then passed over a 0.22 µm membrane filter prior to analysis. The instrument parameters were as follows: Agilent HPLC-1260; chromatographic column: reversed-phase C18 column (5 µm, 250 mm × 4.6 mm); mobile phase:

25 mmol/L monosodium phosphate with 5% methanol solution; flow rate: 0.5 mL/min; column temperature: 30°C; detection wavelength: 245 nm.

2.8 Determination of Total Fiber

Crude fiber was determined using the method adapted from (Van Soest et al., 1991). The sample was first digested with acid. A quantity of 2.2 g of the sample was weighed into a conical flask and 200 ml of 1.25% sulphuric acid was added. The mixture was heated to boiling and held for 30 minutes. After this, the conical flask was removed and the mixture was filtered through a gauze, washed with boiling water until the wash solution was no longer acidic. After this, 200 ml of potassium hydroxide solution (1.25%) was used to wash the residue off the gauze in the original conical flask. This mixture was heated and lightly boiled for a further 30 minutes. The conical flask was then removed and the solution filtered through a glass sand core funnel (previously dried and weighed) and washed with hot water until the filtrate was no longer alkaline. Finally, the sand-core funnel was dried in an oven at 105°C until a constant weight was obtained.

2.9 Determination of Total Polyphenols

The total phenolic content was determined according to (Kamtekar et al., 2014). An amount of 2.2 g of the sample was weighed into a conical flask. Then, an aqueous methanol solution (60%) was added for ultrasonic extraction. After cooling, the volume was adjusted to 100 ml and the mixture filtered for later use. Gallic acid (1,000 µg/ml) was used as a standard solution. Standards were prepared by pipetting 1 ml, 2 ml, 3 ml, 4 ml and 5 ml of the standard solution of gallic acid into 100 ml volumetric flasks, then adjusting the volume of each flask to 100 ml with distilled water and shaking well. To determine the polyphenol content, 1 ml of each of the previously prepared gallic acid solution and extract were pipetted into 10 ml colorimetric tubes. Next, 5 ml of 10% forintol solution was added to each tube and the mixture was shaken well and left to stand for 3 to 8 minutes. After this, 4 ml of 7.5% sodium carbonate solution was added and the mixture was again shaken well. The solution was then placed at room temperature for 60 min. Finally, a 10 mm cuvette was used to determine absorbance at 765 nm using a UV spectrophotometer (model: UV6100).

3. RESULTS AND DISCUSSION

Proximal composition and physicochemical parameters: The proximal composition of *M polyandra* kernels is given in Table 1. The water content of the kernels is low (2.1%). This content is similar to that found by Odetoye et al., [16] which is 2.7%. Water content is a very important factor in food preservation; the higher it is, the greater the activation of water and the greater the development of numerous degradation reactions (enzymatic hydrolysis, lipid oxidation and microorganism proliferation) in the seed. As a result, this low content favors the good conservation of almonds of this species. The lipid content of *M polyandre* kernels is 55.5%. This is much higher than the lipid content of cotton [17] sesame [18] soya, sunflower and rapeseed [19] with a crude oil content of between 20 and 50%. The lipid content of the fines is similar to that found by Bazongo et al., [20] on the species. The protein content of the almond kernels is 14.1%. This is low compared with several local oilseed species such as *Lophira lanceolata* (29.89%) Lohlum, [21] *Balanites aegyptiaca* (28.3%) [14] *Azadirachta indica* (32.4%) [22]. The crude ash and carbohydrate contents are 3.3% and 25.2% respectively. The ash content is lower than that found by Odetoye et al., [16]. This could be explained by differences in climatic and soil factors in the areas studied. The energy value of almonds is 670.4 (kcal/100g). This value is relatively high and could be explained by the high lipid content of almonds.

The acid and peroxide values were 0.24 mg of KOH/g of oil and 25.33 mEq of 02/kg of oil respectively. These two indices give an idea of the suitability of the extracted oil for preservation. Free fatty acids are the products of hydrolysis (enzymatic or spontaneous) of triglycerides, while the hydro-peroxide content measured indicates the quantity of oxygen present in the oil, likely to degrade it. The low free fatty acid content therefore indicates that the oil's triglycerides are in a good state of preservation, while the high peroxide value could be explained by the oil's high content of polyunsaturated fatty acids, which favor the attachment of oxygen to double bonds. It is therefore essential that after extraction, the oil is kept away from oxygen and many other factors that can promote oxidation. The saponification value reflects the surface-active properties of the oil, which is an important factor in soap manufacture. The saponification value of *M polyandra* oil is 190.92 (mg KOH/g

oil). This is similar to that of olive oil (185-196 mg KOH/g), soybean oil (193 mg KOH/g) and cottonseed oil (193-195 mg KOH/g) [23]. However, it is lower than that of palm kernel oil and coconut oil, which are considered to be surface-active oils in soap manufacture, with indices above 200 mg KOH/g. The iodine value is a measure of the degree of unsaturation of oils. It is strongly influenced by the polyunsaturated fatty acid content and the degree of oxidation of the oils. Oxidation causes oxygen to be attached to the double bonds, leading to their rupture or polymerization. This affects the nutritional quality of the oils. Oils with a high iodine value are used in lipochemistry because of the possibility of functionalization (generation of epoxides, polymerization, etc.) [24], but also, in food because of the possible presence of polyunsaturated GA. The iodine index is 148.11 (g of iodine/100 g of oil). This value is high and reflects the high level of unsaturation in the oil. This could explain the high value of the peroxide value and the low value of the oxidative stability index of the oil (1.27 h) at 120^{O} C. The melting point of the oil was 29.9°C. *M polyandra* oil is therefore semi-liquid at room temperature. This could be explained by the non-negligible presence of stearic acid and palmitic acid in the oil, as shown by the results of one of our studies on the species [20].

Table 1. Proximal composition of kernels and physicochemical parameters of *M. polyandra* oil

Parameters	Values
Humidity (g/100g)	1.9 ± 0.2
Proteins (g/100g)	14.5 ± 0.2
Lipids (g/100g)	55.5 ± 0.5
Carbohydrates (g/100g)	25.2
Ash (g/100g)	3.3 ± 0.1
Energy value (kcal/100g)	670.43
Saponification number (mg KOH/g oil)	190.92
Iodine content (g of iodine/100 g of oil)	148.11
Acid value (mg of KOH/g of oil)	0.24
Peroxide value (mEq of O_2/kg of oil)	25.33
Melting point (°C)	29.9
Oil stability (h) 120°C	1.27

Table 2. Amino acid composition of *M. polyandra* kernels

Amino acids	Value (mg/kg)
Essential amino acids	
Threonine	3710.14
Lysine	4027.85
Histidine	2196.77
Valine acid	7326.36
Methionine + cystine	232137.38
Isoleucine	6450.72
Leucine	6220.56
Phenylalanine + tyrosine	5436.88
Non-essential amino acids	
Alanine	4864.26
Glycine	4085.38
Serine	4291.17
Arginine	17314.27
Glutamic acid	30450.77
Proline	4387.51
Aspartic acid	12711.46
AAE	267506.66
AANE	78104.82

**Essential amino acid requirements for adults over 18 and children aged 1-2 (Millward, 2012) TAAE: total essential amino acids; TAANE: total non-essential amino acids*

Table 3. Mineral composition of *M. polyandra* kernels

Minerals	Values (mg/kg)
B	40.33
Ca	2968.75
Fe	34.23
K	6250.00
Mg	3477.47
Na	123.55
P	2903.34
If	4.58
Sr	7.16
Zn	18.35

Table 4. Reducing sugar composition of *M. polyandra* kernels

Simple sugars	Values (mg/kg)
D-mannopyranose	41.80
Ribose	149.27
L-rhamnose monohydrate	70.86
Glucuronic acid	161.41
Trigalacturonic acid	19.44
α-D-glucose	608.82
α-D-galactose	253.05
Aldehydo-D-xylose	22.23
Aldehydo-L-arabinose	49.72
Fucopyranose	510.58
Fructose	Not detected

Table 5. Composition of total fiber, phytates and polyphenols of *M. polyandra* kernels

Components	Value
Total fiber (g/100g)	11.10
Phytate (g/kg)	12.46
Polyphenols (%)	0.13

Amino acid composition: The amino acid composition of *M polyandra* kernels is given in Table 2. The total amino acid content is 345611.48 mg/kg, of which 267506.66 are essential amino acids, corresponding to 77.4% of the total amino acids in the seed. *M polyandra* kernels contain all the essential amino acids except tryptophan. A total of 17 of the 20 amino acids found in humans have been identified. Cysteine, glutamine (30450.77 mg/kg), arginine (17314.27 mg/kg) and aspartic acid (12711.46 mg/kg) are the main fatty acids in almonds from the species studied. Almonds are exceptionally rich in sulphureous amino acids (methionine + cystine) and could therefore make up for the lack of these acids in foods containing little of them. The species' almonds are therefore a good source of amino acids for human and animal consumption.

Mineral composition: The mineral composition of *M. polyandra* kernels is shown in Table 3. A total of 10 minerals were reported in *M. polyandra* kernels. These mineral contents varied from one mineral to another, making it possible to group them into three categories, high content minerals, medium content minerals and low content minerals. The high-grade minerals were calcium (Ca), potassium (K), magnesium (Mg) and phosphorus (P) with an average content of 2968.75 mg/kg, 6250.00 mg/kg, 3477.47 mg/kg and 2903.34 mg/kg respectively. Elements with a medium content include boron (B), iron (Fe) and sodium (Na), with mean values of 40.33 mg/kg, 34.23 mg/kg and 123.55 mg respectively. For low content elements, we have Silicon (Si), Strontium (Sr) and Zinc (Zn) with mean values of 4.58 mg/kg, 7.16 mg/kg and 18.35 mg/kg respectively. Maria and Hannah [25] reported similar levels of Ca (2210.09 mg/kg to 3664.42 mg/kg) and Mg (1712.54 mg/kg to 2118.05 mg/kg) in cashew kernels. The Fe and Zn contents were lower than those reported by Maria and Hannah [25], including 60.04 mg/kg to 79.22 mg/kg for Iron

and 36.74 mg/kg to 77.95 mg/kg for Zinc. Similarly, they were lower than those reported by Rico et al. [26] for iron (57 mg/kg) and Zinc (53 mg/kg). According to the literature, these minerals have several roles (Maria and Hannah, [25], Gutiérrez-Paz et al., [26]). Calcium plays a role in numerous biological functions such as muscle contraction, blood coagulation, hormone release, enzyme activation, mineralization and skeletal structure. Potassium contributes to the normal functioning of the nervous system and the maintenance of normal blood pressure. As for zinc, magnesium and phosphate, they are necessary for the formation of structures (bones and teeth) and the normal functioning of nerves, muscles, many of the body's enzymes and DNA synthesis. Magnesium is also linked to calcium metabolism and potassium metabolism. Iron, boron, sodium, silicon and strontium play major roles in hemoglobin formation, mineral metabolism (calcium, copper and magnesium) and improved absorption (amino acids, glucose, triglycerides and oestrogen), regulates blood pressure, strengthens the immune system and increases bone formation in bone tissue cultures, as well as osteoblastic precursor replication and collagen synthesis in bone cell cultures. Boron is also involved in sugar transport, RNA metabolism and parietal cell synthesis.

Composition in reducing sugars: The composition of reducing sugars in kernels from *M polyandra* is shown in Table 4. A total of 10 simple oses with varying levels were detected in *M polyandra* kernels. These simple oses were D-mannopyranose (41.80 mg/kg), ribose (149.27 mg/kg), L-rhamnose monohydrate (70.86 mg/kg), glucuronic acid (161.41 mg/kg), trigalacturonic acid (19,44 mg/kg), α-D- glucose (608.82 mg/kg), α-D-galactose (253.05 mg/kg), aldehydo-D-xylose (22.23 mg/kg), aldehydo-L-arabinose (49.72 mg/kg) and fucopyranose (510.58 mg/kg). α-D-glucose, α-D- galactose and fucopyranose were the single oses with the highest levels, unlike D- mannopyranose, L-rhamnose monohydrate, trigalacturonic acid, aldehydo-D-xylose and aldehydo-L-arabinose. However, fructose was not detected in this study. This finding differs from that reported by Gutiérrez-Paz et al. [27] in cashew kernels. The latter reported the presence of fructose at levels ranging from 4.40 mg/kg to 4.90 mg/kg. The presence of this diversity of simple bones reveals the highly nutritious nature of *M polyandra* kernels [28,29]. Their *in-vivo* digestion within the organism could probably result in the bioavailability of biologically active compounds with beneficial effects on consumer health [26,27].

Composition in total fiber, phytates and polyphenols: The total fiber, phytate and polyphenol composition of *M polyandra* kernels is shown in Table 4. The total fiber, phytate and polyphenol contents were 11.10 g/100 g, 12.46 g/kg and 0.13 % respectively. The total fiber content of *M polyandra* kernels was higher than that reported by Rico et al. [26] with 3.6 g/100 g, Maria and Hannah [25] with 2.53 g/100g to 5.76 g/100g and Gutiérrez-Paz et al. [27] with 0.9 g/100 g in cashew kernels. The phytate content was also higher than those reported by Maria and Hannah [25], ranging from 5.02 g/kg to 9.93 g/kg in cashew kernels. Awol [30] reported the presence of phenolic compounds in Bamboo Shoots Grown in Ethiopia. The presence of total fiber, phytates and polyphenols testifies to the richness of *M polyandra* kernels in nutritional and bioactive compounds.

4. CONCLUSION

This study determined the proximal composition, physicochemical parameters and highlighted the reducing sugar, amino acid and mineral profiles of *M polyandra* kernels from Burkina Faso. Eight essential amino acids were found in the kernels. Given the richness of these kernels in nutrients, minerals and bioactive compounds, they could be used in the fortification of food supplements to combat protein-energy malnutrition in Burkina Faso.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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