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Chemical composition, physicochemical parameters and nutritional value of *Lannea velutina* A. Rich (Anacardiaceae) seed and seed oil

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A study on *Lannea velutina* seeds was carried out to establish their chemical compositions. Proximate composition, physicochemical parameters, fatty acids, tocopherols, minerals, amino acids, simple sugars, phytates, fibers and polyphenols of seed kernel and seed oils were evaluated using the pre-established methods. The oil content was 57.3%. Oleic acid (43.9%), palmitic acid (34.9%) and linoleic acid (12.7%) were the most dominant fatty acids. The induction period (Rancimat, 20 L/h, 160°C) was 46.2 h. The iodine value, saponification value, acid value and peroxide value were similar to those of olive oil. γ-Tocopherol (36.1 mg/100 g) is the major tocopherol of seed oils. The protein content of seed kernels was 19.9 ± 0.2%. Cystine acid (56.09%) followed by glutamic acid (11.15%) were the major amino acids. The minerals composition showed that K, follow by P, Ca, Mg and Na were the major minerals. The seed kernel is rich in simple sugars such as α-D-glucose (6489.87 ± 10 mg/kg). The concentration of phytate is about 29.22±0.1 g/kg, with crude fibers content at 20.40±0.07% and polyphenols content of 0.10±0.02%. The results show that *L. velutina* seed kernels and seed oils could be used in food and food products.

Key words: *Lannea velutina*, seed oils, amino acids, phytate, fatty acids, minerals, polyphenols.

INTRODUCTION

Understanding the physicochemical composition of *Lannea velutina* (A.) Rich (Anacardiaceae) seeds and oils is particularly relevant in the context of sustainability and food security in Burkina Faso, where local resources are

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Figure 1. *L. velutina* fruit and almond after shelling.

vital for addressing nutritional needs and economic development. However, studies have indicated that certain seeds may be suitable for animal feed due to their nutritional value and as raw materials for paint formulations, depending on the type and quantity of oils they contain (Meng et al., 2021).

As a result, there is a growing interest in seed oils obtained from various vegetable species, stimulating scientific research into their industrial applications, which include cooking oils, pharmaceuticals, and cosmetics. In Africa, the Anacardiaceae family is prominently represented, particularly by the genus *Lannea*, which has roughly 40 species, the majority of which are indigenous to the continent (Maroyi, 2018). Some species within this genus are prized for their timber, while others are utilized in traditional medicine (Maiga et al., 2006).

Among these, *L. velutina*, a versatile species from the African savannah, is used to prevent soil erosion and is used for various medicinal purposes to treat conditions such as chest pain, gastric ulcers, wounds, skin diseases, respiratory tract infections, inflammations, hemorrhoids, and fever.

Among this, *L. velutina* a multipurpose species from the African savannah is used to prevent soil erosion and it is used for various medicinal purposes treating conditions such as chest pain, gastric ulcers, wounds, skin diseases, respiratory tract infections, inflammation, hemorrhoids, and fever (Malú et al., 2022).

Moreover, bioactive compounds such as proanthocyanidin, catechin and epicatechin have been identified from the root bark and the leaves of *L. velutina* (Malú et al., 2024). Methanolic, aqueous and ethanolic extracts from of the leaves, roots, and barks have demonstrated antifungal, larvicidal, molluscicidal, antioxidant, and antibacterial properties (Malú et al., 2024).

Despite these hopeful findings on the various applications of *L. velutina*, there is still a significant vacuum in understanding about the composition of its seeds and seed oils. As a result, the development of its oils for industrial purposes like as biofuels and cosmetics is consistent with sustainable practices that encourage the use of indigenous plant species, thereby benefiting local economies and environmental protection. The purpose of this study is to determine the physicochemical composition of *L. velutina* seeds and seed oils, which is important for a variety of reasons. Understanding the composition of these seeds and oils can provide useful information about their nutritional value, possible usage in animal feed, and appropriateness for industrial applications such as biofuels, cosmetics, and pharmaceuticals.

MATERIALS AND METHODS

Collection site and sampling

This research was carried out in the Cascades region, a key area in southwest Burkina Faso recognized for its rich biodiversity. The region has a tropical climate with two seasons: rainy from May to October and dry from November to April. Fruits of *L. velutina* (Figure 1) were collected from five localities which are Mondon (10° 51’ 07’’ north, 4° 49’ 10’’ west), Toumousséni (10° 37’ 60’’ north and 4° 54’ 0’’ west), Wolonkoto (10° 40’ 35’’ north, 4° 58’ 20’’west), Djanga (10° 36′ 07.6″ N 004° 13′ 17.9″ W) and Bérégadougou (10° 49′ 39.3″ N 004° 43′ 38.4″ W). In this region, the average annual temperatures range from 30 to 36°C (Yaméogo and Rouamba, 2023). They are characterized by ferruginous soils, hydromorphic soils, ferralitic soils, and lithisols. Approximately 10 kg of fruits were gathered from 20 randomly selected plants in each village. After collection, the fruits were transported to the laboratory, where they were sorted to remove any damaged specimens. The ripe, uninfected fruits were then dried at room temperature (between 28 and 30°C) for three weeks.

Subsequently, 1 kg of seeds from each village was pooled to create a mixture representative of the region. Finally, the seeds were shelled, the almonds (Figure 1) were crushed and total fats were extracted by semi-continuous extraction using Soxhlet apparatus for biochemical analyses. A herbarium of the species was deposited at the national herbarium of Burkina Faso (HNBU) under number 8075 B.

Reagents and chemicals

Reagents and chemicals used were of analytical grade and were purchased from Shanghai Sinopharm Chemical Reagent Co. Ltd.

(Shanghai, China).

Determination of proximate composition of seed kernel

The proximate composition of the seed kernels was determined according to AOAC methods (AOAC, 1999). The moisture content was determined by differential weighing after drying in an oven at 105°C according to the AOAC 925.10 method. The ash content was determined by incineration of the sample in a muffle furnace at a temperature of 550°C according to the AOAC 923.03 method. The total protein content of samples was determined by mineralization of organic nitrogen into liquid ammonia followed by acidimetric titration according to the Kjeldahl method AOAC 979.09. The determination of the total fats was carried out by semi-continuous extraction of the fats using Soxhlet according to the AOAC 960.39 method. The total carbohydrate content was estimated by the differential method (Barminas, 1999).

Determination of physicochemical parameters of seed oils

The physicochemical parameters of the seed oils was determined according to AOCS method (AOCS, 1990). The saponification index was calculated using the AOCS Cd 3-25 method, which required saponifying the oils with an excess of alcoholic potassium hydroxide (KOH) and then titrating the unreacted KOH. The iodine index was estimated using the AOCS Cd 1c-85 technique and the oil's fatty acid content. The peroxide index was determined by titrating the iodine generated during the interaction of hydroperoxides with iodide ions using the AOCS Cd 8-53 method. For this analysis, 5 g of oil was dissolved in a mixture of 30 mL of acetic acid/chloroform (3/2, v/v). A micropipette was used to add 0.5 mL of saturated potassium iodide (KI), and the mixture was allowed to stand for 1 min. After that, 30 mL of distilled water was added, and the released iodine was measured using a 0.1 N sodium thiosulfate solution in the presence of starch. The acid number was measured by titrating the free fatty acids in the oil using the AOCS Ca 3a-63 technique. The oxidative stability of the oils was evaluated using the automated Rancimat method. In this procedure, 3 g of oil was placed in a reaction tube and introduced into the Rancimat 743 (Metrohm, Switzerland). The oxidation was induced at 120°C with a purified air flow rate of 20 L/h, and the time until total oxidation occurred was recorded. The percentage of triglycerides, diglycerides, monoglycerides and free fatty acids of oil were determined according to Shukla (1988).

Determination of fatty acid composition of seed oil

Tocopherols were separated and quantified by HPLC, according to AOCS method Ce 8–89 (AOCS, 1990). Oil was dissolved in n hexane and submitted directly to HPLC analysis. A Perkin Elmer Fluorescence detector Series 200 and a Rheodyne 7125 Injector (IDEX Health and Science, Oak Harbor, WA, USA) equipped with a 20 µL loop were used. Excitation wavelength was 290 nm and Emission wavelength was 330 nm. The solvent system used was water saturated hexane, hexane and propan-2-ol (49.55:49.55:0.9). The columns consisted of 2 × 150 mm 4.6 mm I.D. packed with 3 µm CN particles [27]. A mixed tocopherols standard was used, which contained α-, β-, γ-, δ-tocopherols (Sigma-Aldrich, Inc., St. Louis, MO, USA). The tocopherol contents of samples were quantified by the external standard method. The analysis was done in duplicate.

Determination of amino acid composition of seed kernels

The amino acid composition was determined by liquid chromatography coupled to a tandem mass spectrometer (LC-MS/MS) as described in our previous work (Bazongo et al., 2023). The samples were first digested hot (110˚C), with a 1‰ phenol/water hydrochloric acid solution in the proportions (V/V). Then the operation was followed by filtration on a 0.22 µm pore membrane. Then, the amino acid composition was determined using the Shimadzu 8050 LC-MS/MS instrument. The column was Endeavor-sil C18 type, size 100×2.1 mm, 1.8 µm 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 consisted of 0.1% formic acid and acetonitrile. The electrospray ionization mass conditions were as follows: interface temperature: 300˚C, desolvation temperature: 526˚C, DL temperature: 250˚C, atomization gas flow rates: 3.00 L/min, heating air flow: 10.00 L/min, heating block temperature: 400˚C, drying air flow: 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.

Determination of mineral composition of seed kernels

The mineral composition was determined by inductively coupled plasma atomic emission spectrometry (ICP-AES) according to Selmi et al. (2021) with slight modifications as described in our exterior works (Bazongo et al., 2023). The samples were previously digested with a mixed solution of nitric acid and perchloric acid on an electric hotplate. Mineral analysis was carried out by gas-liquid chromatography (GLC) with the PerkinElmer (PE) AVIO200 model. The parameters were adjusted as follows: Instrumental analysis conditions: argon; Plasma gas flow: 12 L/min; Auxiliary gas flow: 0.2 L/min; Atomization gas flow: 0.6 L/min; Output power: 1300 W; Pump flow: 1.5 mL/min; Carrier gas (more than 99.996% argon: 0.6 - 0.8 MPa); Purge gas (more than 99.999% argon or nitrogen: 0.3 - 0.8 MPa); Air compressor (0.6 - 0.8 Pa); and Cooling water circulator (20˚C).

Determination of the 11 types of simple sugars of seed kernels

Fructose

For the determination of fructose, approximately 0.5 g of the sample is mixed with 3 mL trifluoroacetic acid (4 mol/L), sealed, and subjected to acid digestion in an oven at 105°C for 4 h. After cooling, the sample is dried again at 105°C, followed by the addition of another 3 mL of methanol and subsequent drying. Next, 5 mL of water is added, and the mixture undergoes ultrasonication for 30 min before vortex mixing. The prepared sample is filtered through a 0.22 µm filter. The analysis is performed 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, utilizing a mobile phase composed of water and acetonitrile in a ratio of 22:78, with a collection time of 15 min.

Other simple sugars

A sample weighing about 0.5 g is placed in an ampoule with 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 is removed, cooled, and the contents are dried at 105°C. Subsequently, 3 mL of methanol is added, followed by another drying step. The residue is then dissolved in 3 mL of 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 at 70°C for 30 min. Afterward, the mixture is dried under a nitrogen blower,

reconstituted with 1 mL of methanol, and dried again. Then, 1.0 mL of water is added to dissolve the sample, and excess derivatizing agent is extracted with chloroform until the chloroform layer becomes colorless. The supernatant is passed through a 0.22 µm filter before analysis on a Shimadzu LC-2030PLUS instrument, using a Diamonsil-plus C18 column (4.6 × 250 mm, 5 µm). The chromatographic conditions include 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 composed of disodium hydrogen phosphate (20 mmol/L, pH 6.8) and acetonitrile in a ratio of 84:16.

Determination of phytate of seed kernels

For determination of phytate, the method adapted from Marolt and Kolar (2021) was used. About 2 g of sample were added to a 50 mL centrifuge tube, followed by 20 mL of hydrochloric acid solution. The mixture underwent ultrasonic extraction at room temperature for 2 h, then was centrifuged at 5000 r/min for 15 min. 10 mL of supernatant was accurately aspirated into a 50 mL distillation flask, evaporated using rotary evaporation at 50°C, and the residue was dissolved in 10 mL of water. Subsequently, 5 mL of the extract was pipetted through a pre-activated solid phase extraction column, washed sequentially with 5 mL of sodium dihydrogen phosphate solution and 5 mL of water, discarding 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 through a 0.22 µm filter membrane before analysis. 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 sodium dihydrogen phosphate with 5% methanol solution; flow rate: 0.5 mL/min; column temperature: 30°C; detection wavelength: 245 nm.

Determination of crude fibers of seed kernels

The determination of crude fibers was done using the adapted method of 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% sulfuric acid was added. The mixture was heated to a slight boil and maintained for 30 min. After this, the conical flask was removed, and the mixture was filtered through gauze, washing with boiling water until the wash solution was no longer acidic. After that, 200 mL of potassium hydroxide solution (1.25%) was used to wash the residue on the gauze into the original conical flask. This mixture was heated and slightly boiled for another 30 min. The conical flask was then removed, and the solution was filtered through a dried and weighed G2 glass sand core funnel, washing 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 achieved.

Determination of total phenolic content of seed kernels

Total phenolic content was determined according to Cai et al. (2023). A quantity of 2.2 g of the sample was weighed into a conical flask. Then, a aqueous methanol solution (60%) was added for ultrasonic extraction. After cooling, the volume was adjusted to 100 ml, and the mixture was filtered for further use. The gallic acid solution was prepared by pipetting 1, 2, 3, 4, and 5 mL of the gallic acid standard solution (1000 µg/mL) into separate 100 mL volumetric flasks, then adjusting the volume to the mark with water and shaking well. For the determination of polyphenol content, 1 mL of each gallic acid working solution was pipetted into a 10 mL colorimeter tube along with water. Then, 5 mL of 10% Folin-Ciocalteu reagent was added, and the mixture was shaken well and left to stand for 3 to 8 min. After that, 4 mL of 7.5% sodium carbonate solution was added and the mixture was shaken well again. The solution was then placed at room temperature for 60 min. Finally, a 10 mm cuvette was used to determine the absorbance at 765 nm using a UV spectrophotometer (model: UV6100, China). The blank consisted of the mixture of water (1 mL), Folin-Ciocalteu reagent (5 mL) and sodium carbonate solution (4 mL).

Data analysis

Data were recorded using Excel 2019 and the percentages and means of chemical elements were calculated. The GUM method was used for the assessment of total uncertainty.

RESULTS AND DISCUSSION

Proximate composition and physicochemical parameters

Table 1 presents the characteristic of *L. velutina* seeds kernels and seed oils.

The moisture contents of *L. velutina* seed kernels were 3.6 ± 0.2%. Moisture content was quite low and within the range reported for sesames (3.7 ± 0.2%), melon seed (4.12%), but lower than coconut seed (23.13%), and palm kernel seed (14.26%) (Onyeike and Acheru, 2002; Elleuch et al., 2007). Since the low moisture content would prevent food spoilage through increased microbial and enzymatic action. Ash content determination is specifically an index of the quality of feeding materials used by animal feed compounders for poultry and cattle feeding (Esuoso et al., 1998). The ash content of *L. velutina* was 3.7%. Crude proteins of seed were 19.9 ± 0.2%. This values are relatively low as compared to popular conventional sources of protein such as bean seeds (22.1%) and groundnut seeds (26.5%) (Onyeike and Acheru, 2002) and some local seeds such as *Lophira lanceolata* (29.89%) (Lohlum 2010), *Balanites aegyptiaca* (34.4%) (Nour et al., 1985), and *Azadirachta indica* (32.4%) (Djenontin et al., 2012). The crude oil contents *L. velutina* seed was 57.3 ± 0.6%. The crude oil contents of specie is higher than that of soybean, sunflower, rapeseed (Mariod and Eichner, 2004), cotton, palm kernel (Kok et al., 2011) and sesame (Elleuch et al., 2007) which crude oil content ranged between 20 and 50%. *L. velutina* have low total carbohydrate contents which is 19.1%. This contents are lower than those reported for date palm seed (72.59%) (Nehdi et al., 2010) and *B. aegyptiaca* seed (24%) (Bazongo et al., 2023).

On the other side, the characteristic of *L. velutina* seed oils is similar to those of *Lannea microcarpa* (Bazongo et al., 2014) which could be attributed to genetic factor of the two species. The saponification value of *L. velutina*

Table 1. Characteristic of *L. velutina* seeds kernels and seed oils.

Components g/100 g of dry matter	Value
Moisture (%)	3.6 ± 0.2
Lipids (g/100 g of dry matter)	57.3 ± 0.6
Proteins (g/100 g of dry matter)	19.9 ± 0.2
Carbohydrates (g/100 g of dry matter)	19.1 ± 0.3
Ash (g/100 g of dry matter)	3.7 ± 0.2
Physicochemical parameters of oil	
Saponification value (mg of KOH/g of oil)	195.57 ± 0.5
Iodine value (g of I_2/100 g of oil)	58.81 ± 0.2
Peroxide value (meq of O_2/kg of oil)	1.99 ± 0.04
Acid value (mg of KOH/g of oil)	1.11 ± 0.00
Melting point (°C)	18.5 ± 0.8
Oxidative stability index (h)	46.2 ± 0.7
Polymers (%)	-
Triglycerids (%)	92.1 ± 0.1
Diglycerides (%)	2.4 ± 0.2
Monoglycerides (%)	-
Free fatty acids (%)	5.5 ± 0.1

seed oils were 194.24 mg KOH/g. This value is similar to palm oil (196-205 mg KOH/g), olive oil (185-196 mg KOH/g), soy oil (193 mg KOH/g), cotton seed (193-195 mg KOH/g), and linseed oil (193-195 mg KOH/g) (Ayo et al., 2007). Saponification values indicate relatively molecular weight of fatty acids esterified in triglyceride structure. The high saponification value of *L. velutina* seed oil indicates high content of low molecular weight triacylglycerols. The iodine values were 58.86 g of I2/100 g of oil. This value is similar to those reported for palm oil (56.8 g of I2/100 g of oil) and moringa oil (65.9 g of I2/100 g of oil) (Abdulkarim et al., 2007) and lower than those of olive, cotton, groundnut and sunflower oils ranged from 85 to 137 g of I2/100 g of oil (Esuoso et al., 1998). The iodine value is a valuable characteristic that measures unsaturation but does not define the specific fatty acids present. The relatively low iodine value of both species' zoils was indicative of the presence of a low number of unsaturated bonds number. The peroxide and acid values of the oils were determined immediately after extraction of the oils. The peroxide value was 1.99 mEq/kg of oil, while the acid value was 1.11 mg of KOH/g of oil. These values were lower than those reported for olive oil, suggesting that the extracted oils had a lower degree of oxidation and free fatty acid content (Torres and Maestri, 2006; Longobardi et al., 2012) and *Moringa oleifera* oil (Abdulkarim et al., 2007). The low peroxide value of oil indicates that it is less liable to oxidative rancidity at room temperature. The low acid value provides a good indication of the high quality of the collected samples. These results are confirmed by the low free fatty acids (5.5%), monoglycerides (0%), digycerides (2.4%) contents and high triglycerides (92.1%) contents of oil which suggest low hydrolysis. Therefore, the oil could be stored for a long period without deterioration. *L. velutina* oil was liquid at room temperature and had melting point of 18.5°C. The oxidative stability index is a measurement of resistance of lipids to oxidation. A longer oxidative stability index duration indicates that the oil is more stable. Oxidative stability index could be used to compare various oils to predict their stability and respective shelf lives. Moreover, it might be used to evaluate the effectiveness of antioxidants. Oxidative stability index value was determined at 130°C. The oxidative stability index value of *L. velutina* was 46.2 h. These values are higher than reported for *Sclerocarya birrea* (43.0 h) (Mariod et al., 2006), olive (10 h) (Suàrez et al., 2011) and *M. oleifera* (8.7 h) (Anwar et al., 2007) determined at 120°C. This might be due to their high contents of natural antioxidants and the lower unsaturation level. Proximate composition and physicochemical parameters oil seed kernels and oil showed that *L. velutina* seeds are good sources of proteins and lipids with stable oil for diet.

Tocopherol composition

Vitamin E is an effective chain breaking antioxidant that protected polyunsatured fatty acids from free radical damage. The total and individual tocopherol of *L. velutina* seed oils are shown in Table 2. The obtained results revealed the presence of 3 tocopherols (α, γ, δ-tocopherols) in the range of 3.6 mg/100 g, 36.1 mg/100 g

Table 2. Tocopherol composition of *L. velutina* seed oils.

Tocopherols	Value (ppm)
α-tocopherol	36 ± 0.1
β-tocohherol	-
γ-tocopherol	361 ± 1.01
δ-tocopherol	46 ± 0.2
Total	443 ± 1.01

Table 3. Fatty acids composition of *L. velutina* seed oil.

Fatty acids	Value (%)
Saturated Fatty Acid (SFA)	
Heptadecanoic acid (C17:0)	0.17 ± 0.01
Lauric acid (C12:0)	0.02 ± 0.01
Myristic acid (C14:0)	0.37± 0.00
Pentadecanoic acid (17:0)	0.03 ± 0.01
Palmitic acid (C16:0)	41.26 ± 0.02
Stearic acid (C18:0)	8.59 ± 0.03
Tetracosanoic acid (C24:0)	0.04 ± 0.01
Monounsaturated Fatty Acid (MUFA)	
Cis-9-oleic acid (C18:1 ω-9)	46.58± 0.01
Cis-9-tetradocarenoic acid (C14:1 ω-5)	0.10± 0.03
Palm oleic acid (C16:1)	0.35 ± 0.00
Polyunsaturated Fatty Acid (PUFA)	
Cis-9,12-linoleic acid (C18:2 ω-6)	0.58 ± 0.00
Cis-6-9-12-γ-linolenic acid (C18:3 ω-6)	0.44 ± 0.01
Cis-9,12,15-linolenic acid (C18:3 ω-3)	0.19 ± 0.01
Cis-11,14,17-eicosanotrienoic acid(20:3 ω-9)	0.10 ± 0.00
Cis-11-arachidonic acid (C20:4 ω-6)	0.58 ± 0.02
Trans-9,12-linoleic acid (C18:2 ω-6)	0.47 ± 0.00
Eicosapentaenoic acid(EPA) (C20:5 ω-3)	0.11 ± 0.00
SFA	50.48 ± 0.02
MUFA	47.03 ± 0.03
PUFA	2.47± 0.02

and 3.6 mg/100 g. Seed oils are good sources of γ-tocopherol which is higher than peanut oil (3.6-7.8 mg/100 g) but similar to rapeseed oil (50.0 mg/100 g) and flaxseed oil (41.3 mg/100 g) [40]. Good tocopherol content may contribute to the high oxidative stability index found in this work.

Fatty acid composition

Fatty acid composition of *L. velutina* seed oils is shown in Table 3. A total of 18 fatty acids were identified in the seed oils. Oleic (46.58), palmitic (41.26%), and stearic (8.59%), were the major fatty acids accounting for 96.38% of total fatty acids (TFA). *L. velutina* seed oils can be regarded as oleic-palmitic oils, because of the abundance of oleic acid followed by palmitic acid. They may show the same properties of subclass MUFA-SFA-alphalinoleic vegetable oil such as argan, peanut, rice bran, Jatropha, and buckthorn berry seed oils (Dubois et al., 2007). Oleic acid was the major unsaturated fatty acid found. Yet, this acid has an important role in nervous cell construction. It can be changed by organism into a set of compounds close to prostaglandins which have an

Table 4. Amino acids composition of *L. velutina* seeds kernel.

Amino acids	Value (%)
Essential amino acids	
Threonine	1.26 ± 0.12
Lysine	0.72± 0.01
Histidine	0.80± 0.00
Valine	3.17± 0.01
Methionine	0.51± 0.00
Isoleucine	2.78± 0.02
Leucine	2.37± 0.11
Phenylalanine	2.15± 0.01
Tryptophan	-
Non-essential amino acids	
Alanine	1.25± 0.00
Glycine	1.36± 0.10
Serine	1.25± 0.00
Arginine	7.04 ± 0.08
Cystine	56.09 ± 0.07
Glutamic acid	11.15± 0.04
Proline	1.83± 0.00
Aspartic acid	5.03± 0.00
Tyrosine	1.24± 0.01
Total essential amino acid	13.76± 0.16
Total non-essential amino acid	86.24± 0.15

important role at the vessel level and for blood coagulation. Moreover, it can prevent against cardiovascular diseases (Nehdi, 2011). The total saturated fatty acids of *L. velutina* seed oil are 50:49% which makes them strong resistance to oxidative rancidity. The present fatty acid composition of *L. velutina* seed oil shows that it could be used in food product as frying oil.

Amino acid composition

Amino acid composition of *L. velutina* seeds kernel is shown in Table 4. A total of 17 amino acids out of the 20 amino acids in the human body have been detected. The contents of amino acids varied between 0.51% for methionine to 56.09% cystine. The essential amino acids represented 13.75% of seed kernels. The non-essential amino acids represented 86.25% of total amino acid of seed kernels. Cystine (56.09%) and arginine (7.04%) were the major amino acids. The cystine content is lower than that of *B. aegyptiaca* (about 68%) found in Bazongo et al. (2023)'s study. Valine, leucine, isoleucine, and phenylalanine are the major essential amino acid. Considering the essential amino acid needs in children and adults, *Hosta undulata* almonds could cover all daily needs with the exception of tryptophan (Millward, 2012).

Mineral composition

The mineral composition of *L. velutina* seed kernels is presented in Table 5. The total mineral content of the seeds kernel was 99.05%, which corresponds to macroelements, while the trace elements accounted for 0.95%. There are 4 major minerals which are potassium (39.70%), phosphorus (28.42%), magnesium (17.03%) and calcium (13.2%). The potassium and phosphorus was higher than those of sesame, groundnut, bean and palm kernel (Onyeike and Acheru, 2002; Elleuch et al., 2007) but lower than those of *B. aegyptiaca*. The seed's high potassium and seed content of the seeds of *L. velutina* could be advantageous in agriculture.

Simple sugars composition

The composition of simple sugars is summarized in Table 6. α-D-glucose is the most significant simple sugar, with a concentration of 6489.87 ± 10 mg/kg, followed by α-D-galactose at 2353.53 ± 5 mg/kg and aldehydo-L-arabinose at 1594.49 ± 6 mg/kg. A high composition of simple sugars such as α-D-glucose can provide quick energy benefits (Remesar and Alemany, 2020). This is particularly relevant in the case of the seed of *L. velutina*, which may serve as a valuable energy source.

Table 5. Mineral composition of *L. Velutina* seed kernels.

Minerals	Value (%)
Macroelements	
Ca	13.20± 0.02
K	39.70± 0.11
Mg	17.03± 0.01
P	28.42± 0.07
Na	0.70± 0.000
Trace elements	
B	0.23± 0.000
Fe	0.18± 0.02
Zn	0.18± 0.05
Ba	0.07± 0.01
Sr	0.28± 0.00

Table 6. Simple sugars composition of *L. velutina* seed kernel.

Simple sugars	Value (mg/kg)
D-mannopyranose	232.09±0.23
Ribose	132.45±0.16
L-Rhamnose monohydrate	511.21±1
Glucuronic acid	168.66±0.6
Glucuronic acid	87.07±0.08
α-D-glucose	6489.87±10
α-D-galactose	2353.53±5
Aldehydo-D-xylose	381.03±0.80
Aldehydo-L-arabinose	1594.49±6
Fucopyranose	141.56±0.05
Fructose	Not detected

Table 7. Phytate, total polyphénol and fibers of *L. Velutina* seed kernel.

Components	Value
Crude fibers (%)	20.40±0.07
Phytate (g/kg)	29.22±0.1
Polyphenols (%)	0.10±0.02

The seed kernel of *L. velutina* has a concentration of phytate of 29.22±0.1 g/kg, crude fibers content of 20.40±0.07% and polyphenols contain of 0.10±0.02% (Table 7). Thus, it has been shown that L-arabinose is a monosaccharide that has many biomedical and health effects by having an inhibitory effect on intestinal sucrose (Hu et al., 2018). So its high amount could be beneficial for blood glucose management and weight control. Also, according to some authors, diets rich in galactose have more pronounced effects on metabolic factors and intestinal permeability (Omar et al., 2021).

The high concentration of phytate indicates that this seed may have antinutritional properties, as phytate can bind to minerals such as calcium, iron and zinc, reducing their bioavailability (Castro-Alba et al., 2019). However, phytate is also recognized for its potential beneficial effects as an antioxidant and anticancer agent (Pires et al., 2023). The crude fiber content is high which is beneficial for digestive health. Dietary fiber is essential for regulating intestinal transit, preventing constipation and maintaining a healthy gut microbiota (Guan et al., 2021). In addition, it can contribute to satiety and weight management (Clark and Slavin, 2013). The work indicates the presence of polyphenols, known for their antioxidant properties, but this level is relatively low in the seeds of *L. velutina*.

Conclusion

L. velutina seeds have a low moisture content, which favors their preservation. Although their protein content is

lower than that of conventional sources such as beans and peanuts, they are distinguished by a high oil content, comparable to that of other vegetable oils. The significant presence of crude fiber is beneficial for digestive health and weight management, while phytate, although it can reduce the bioavailability of minerals, also has antioxidant properties. Polyphenol levels are relatively low, but they may contribute to the overall antioxidant activity of the seeds, to which antioxidant tests could confirm it. Overall *L. velutina* could be valued as a nutrient source in human and animal diets, while requiring special attention regarding its antinutritional properties.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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