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NUTRITIONAL AND PHYTOCHEMICAL COMPOSITION OF JUJUBE (*ZIZIPHUS MAURITIANA* LAM.) FRUIT HARVESTED IN CÔTE D'IVOIRE

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ABSTRACT

Ziziphus mauritiana Lam. (Rhamnaceae), commonly known as the jujube tree, is a wild fruit tree widespread across West African savannas, whose fruit is traditionally consumed and used in traditional medicine. In Côte d'Ivoire, while a few studies have addressed the leaf phytochemistry of this species, no published data, to our knowledge, describe the nutritional and phytochemical composition of its fruit. This study aimed to fill this gap by determining the proximate composition, energy value, phenolic compound content, vitamin profile and mineral content of whole dried fruit (pulp and seed) powder of Z. mauritiana harvested in the Korhogo department, Côte d'Ivoire. Analyses performed in triplicate revealed a carbohydrate-rich (82.63 ± 0.35 g/100 g) and therefore energy-dense composition (368.0 ± 0.4 kcal/100 g), with notable contents of phenolic compounds (myristicin, eugenol, gallic acid, caffeic acid and catechin) and vitamins (E, C and B3 predominating). The mineral profile was dominated by calcium (530.5 mg/100 g) and potassium (264.4 mg/100 g). One-way ANOVA followed by Duncan's multiple range test (5% threshold) allowed statistical ranking of these compounds within each biochemical family. These first-of-their-kind results for Côte d'Ivoire confirm the nutritional potential of Z. mauritiana fruit and support its promotion as a local food resource, while pointing to the need for further studies on its geographic and varietal variability.

Keywords: *Ziziphus Mauritiana*; Jujube; Nutritional Composition; Phenolic Compounds; Vitamins; Mineral Elements

1 INTRODUCTION

Ziziphus mauritiana Lam. (Rhamnaceae) is a spiny, evergreen fruit tree belonging to a pantropical genus comprising about a hundred species; it is commonly known as the jujube tree, Indian plum or "ber", depending on the region [1,2]. Native to South Asia, the species has become naturalized in more than a hundred countries across Africa, Asia, Oceania and the Americas, where it plays an important role in the agroforestry systems of arid and semi-arid zones owing to its tolerance to drought, poor soils and high temperatures [2]. In West Africa, particularly in Mali and Burkina Faso, it contributes to food security and the income of rural populations, especially during lean periods, and has been the subject of domestication and varietal improvement programmes [2–4]. Present notably in the savanna formations of northern Côte d'Ivoire [5], the species is traditionally harvested there but remains scientifically undocumented.

The fruit, rich in sugars, is consumed fresh, dried or processed, while its various organs (leaves, bark, roots, seeds) are widely used in traditional medicine against diabetes, hypertension, digestive disorders, wounds and various infections [4,6]. Antioxidant, antimicrobial, anti-inflammatory and antidiabetic properties have also been reported for several of its extracts [1,7]. The biochemical composition of the Z. mauritiana fruit has furthermore been the subject of several studies in Southern Africa, West Africa, South Asia, Southeast Asia and the Middle East, revealing notable levels of carbohydrates, vitamin C, phenolic compounds and mineral elements (particularly potassium and calcium) with substantial variability according to population, cultivar and edaphoclimatic conditions [8–13]. In West Africa, the species has also attracted growing agronomic interest, illustrated by the introduction and evaluation of improved cultivars in the Sahelian zone and by studies of floristic variability in Burkina Faso [3,4], as well as pharmacological interest in its leaf and root extracts, notably in Mali [14].

In Côte d'Ivoire, where Z. mauritiana is present in the savannas of the north and is subject to traditional food and medicinal uses, the available scientific literature remains very limited. Previous work carried out in Côte d'Ivoire is limited to the isolation of saponins and flavonoid glycosides from the leaves of the species, harvested in a forest area [15], and the antidiabetic activity of an extract in animals [16]. To our knowledge, no published data currently characterize the nutritional and phytochemical composition of the Z. mauritiana fruit consumed by populations in Côte d'Ivoire, even though this information is an essential prerequisite for any food or nutraceutical valorization strategy for the resource.

The present study therefore aims to fill this gap by determining the physicochemical and biochemical composition and the mineral profile of the dried fruit (pulp and seed) of Z. mauritiana collected in the Korhogo department.

2 MATERIALS AND METHODS

2.1 Biological material and study area

The biological material used in this study consisted of ripe *Ziziphus mauritiana* fruits collected in the Korhogo department (Côte d'Ivoire) between June and August 2025. A total of 30 kg of fruit was harvested at physiological maturity, packaged and transported to the Laboratory of Biology and Agro-resources Valorization of Peleforo GON COULIBALY University (Korhogo).

2.2 Sample preparation

Upon receipt, the fruits were carefully washed with clean water to remove impurities. Unlike the more common practice of separating the pulp from the seed, the fruits were here processed whole (pulp and seed not separated), dried at room temperature (27 ± 2 °C) to constant mass, and then ground into a fine powder using a grinder. The resulting powder was stored in a flask pre-dried in an oven at 45 °C for 24 h, according to the method described by the AOAC [17].

2.3 Proximate analyses and energy value

Moisture and dry matter contents were determined according to the AOAC method [18]; ash content according to the AOAC [18]; fat content according to the BIPEA method [19]; and total protein content according to the AOAC [20]. Reducing sugars and total sugars were determined according to the methods of Bernfeld [21] and Dubois et al. [22], respectively. Total carbohydrate content was calculated by difference, according to the method recommended by the AOAC [18]: Total carbohydrates (g/100 g) = 100 − (Moisture + Fat + Protein + Ash). The energy value of the flour was then calculated using the conversion factors of the FAO [23], at 4 kcal/g for carbohydrates and protein and 9 kcal/g for lipids: Energy (kcal/100 g) = (4 × Carbohydrates) + (4 × Protein) + (9 × Lipids).

2.4 Identification and quantification of phenolic compounds

A 2.5 g sample of *Ziziphus mauritiana* fruit powder was placed in a flask and spiked with 200 µL of each of the standard solutions (para-hydroxyphenylacetic acid in methanol at 4.64×10^{-2} mg/mL and/or syringic acid at 9.6×10^{-3} mg/mL). The solvent was then evaporated using a rotary evaporator at a temperature below 40 °C. The residue was finally taken up in 6 mL of isooctane for solid-phase extraction (SPE).

Solid-phase extraction was performed on a Supelclean LC-DIOL diol-phase cartridge (500 mg/3 mL, SUPELCO; 2,3-dihydroxypropoxypropyl polymeric bonding, 7% C), conditioned with 6 mL of methanol followed by 6 mL of isooctane. After loading the residue, the cartridge was washed first with 2 × 3 mL of isooctane, then with 4 mL of an isooctane/ethyl acetate mixture (90/10, v/v). The phenolic compounds were then eluted with 10 mL of methanol, and the entire eluate was transferred to a conical flask. After evaporation to dryness at a temperature below 40 °C, the residue (extract) was taken up in 100 µL of a methanol/water mixture (1/1, v/v) at 40 °C.

From the phenolic-compound-rich methanolic extracts thus prepared, 10 µL of each sample was analyzed by HPLC (Shimadzu system, Japan) equipped with a binary pump (LC-6A) coupled to a UV-Visible detector (SPD-6A). Phenolic compounds were separated on an ICSep ICE ORH-801 column (25 cm) at a temperature of 30 °C. The mobile phase consisted of a 50 mM NaH_2PO_4 solution at pH 2.6 (solution A), an acetonitrile/NaH_2PO_4 mixture (80/20, v/v) (solution B) and 200 mM ortho-phosphoric acid at pH 1.5 (solution C), with a 70 min run time at a flow rate of 1 mL/min. Phenolic compounds present in the Z. mauritiana methanolic extract were identified by comparing their retention times with those of standard solutions injected under the same conditions. The concentration of each phenolic compound, expressed in mg/100 g of dry matter, was estimated from the mean peak area of the standards, according to the relation:

$$CE = \frac{\text{Area E x CT}}{\text{Area T}}$$

where, CE is the concentration of the phenolic compound in the sample, Area T the mean peak area of the standard compound, Area E the peak area of the phenolic compound in the sample, and CT the concentration of the corresponding standard solution.

2.5 Determination of mineral composition

Mineral elements were determined by the colorimetric method described by Aremu and Ibrahim [24], with slight modifications. Samples were wet-mineralized using a mixture of nitric, perchloric and sulfuric acids in a 3:2:1 ratio, according to Gorsuch [25]. Sample preparation was carried out in a dust-free room to avoid any contamination, with demineralized distilled water used for all dilutions [26]. Appropriate blanks were included in each analytical run, and trace elements were quantified by atomic absorption spectrophotometry, with certified standards analyzed alongside the samples to verify measurement accuracy.

2.6 Determination of vitamin profile

Fat-soluble vitamins. Vitamin A was determined by HPLC with ultraviolet (UV) spectrophotometric detection, in accordance with AFNOR standard NF EN 12823-1 [27]. A volume of 25 mL of hexane was added to 5 g of sample, and extraction was performed by sonication for 30 min. After filtration, the filtrate was evaporated protected from light, and the residue was taken up in 10 mL of methanol and then homogenized by sonication for 10 min. The methanolic solution was filtered through a hydrophobic filter before injection. Chromatographic conditions were as follows: HPLC-grade methanol mobile phase, flow rate of 1 mL/min, UV detection at 313 nm.

Vitamins E (tocopherols) and K were determined in accordance with AFNOR standard NF EN 14663 (2006) [28]. Vitamin E was extracted by liquid-liquid extraction, the residue being taken up in methanol (100%) with alpha-tocopheryl acetate as internal standard; the analysis was performed on a C18 column (250 × 4.6 mm × 5 µm) with a methanol/water mobile phase (99/1, v/v) at a flow rate of 1.4 mL/min and detection at 292 nm. Vitamin K was purified on a C18 solid-phase cartridge, followed by liquid-liquid re-extraction under acidic conditions; the evaporated extract was taken up in 150 µL of mobile phase and injected onto a reverse-phase column (Lichrocart Superspher RP18, 125 × 2 mm, 4 µm), with fluorimetric detection after post-column reduction to hydroquinone forms on a zinc reactor (excitation 243 nm, emission 430 nm). Results are expressed in mg/100 g dry matter for vitamin E and in µg/100 g dry matter for vitamin K, the analysis being performed on the whole dried fruit powder.

Water-soluble vitamins. Vitamins B1 (thiamine), B2 (riboflavin), B3 (niacin) and B5 (pantothenic acid) were determined by HPLC with fluorimetric detection, in accordance with AFNOR standard NF EN 12823-2 (2000) [29]. Vitamins B6 (pyridoxine) and B9 (folic acid) were analyzed according to AFNOR standard NF EN 14663 (2006) [28]. Samples were extracted in a 10 mM ammonium acetate/methanol mixture (50/50, v/v) containing BHT as antioxidant, subjected to stirring and then sonication for 15 min at a temperature below 25 °C, centrifuged at 14,000 g for 12 min, and then

filtered through a 0.45 µm nylon membrane before HPLC injection. Vitamin B9 was analyzed under strict protection from light owing to its high photosensitivity.

Vitamin C was extracted according to the method of Boonkasem et al. [30]: ten grams of ground sample were suspended in 20 mL of 3% (w/v) metaphosphoric acid, magnetically stirred for 30 min protected from light, and then centrifuged at 4,000 rpm for 20 min; the supernatant was filtered through a 0.45 µm membrane before HPLC injection. Results are expressed in mg/100 g dry matter, with the exception of vitamins B9 and K, expressed in µg/100 g dry matter.

2.7 Statistical analysis

All analyses were performed in triplicate (n = 3). Results are expressed as mean ± standard deviation, and the coefficient of variation (CV, %) was calculated for each parameter. Within each table presenting compounds expressed in a common unit (phenolic compounds, vitamins, mineral elements), a one-way analysis of variance (ANOVA) was performed to test for significant differences among the mean contents of the different compounds, followed, where significant, by Duncan's multiple range test at the 5% threshold.

3 RESULTS

3.1 Proximate composition and energy value

Table 1: Proximate composition and energy value of whole dried *Ziziphus mauritiana* fruit (n = 3)

Parameter	Mean ± SD	CV (%)
Reducing sugars (mg/g)	54.10 ± 0.26	0.47
Total sugars (mg/g)	567.03 ± 2.22	0.39
Moisture (%)	8.64 ± 0.07	0.81
Fat (%)	3.13 ± 0.10	3.32
Protein (%)	2.33 ± 0.25	10.83
Ash (%)	3.27 ± 0.05	1.40
Total carbohydrates (%)	82.63 ± 0.35	0.42
Energy value (kcal/100 g)	368.00 ± 0.43	0.12

The proximate composition of the whole dried Z. mauritiana fruit powder is presented in Table 1. It is characterized by a high total carbohydrate content (82.63 ± 0.35 g/100 g), including a substantial fraction of simple sugars (56.70 ± 0.22 g/100 g total sugars). Residual moisture (8.64 ± 0.07%), fat content (3.13 ± 0.10%), protein content (2.33 ± 0.25%) and ash content (3.27 ± 0.05%) remained moderate. The calculated energy value reached 368.0 ± 0.4 kcal/100 g, with a very low coefficient of variation (0.12%), reflecting good analytical reproducibility.

3.2 Phenolic compounds

Table 2: Phenolic compound contents of *Ziziphus mauritiana* fruit flour (n = 3)

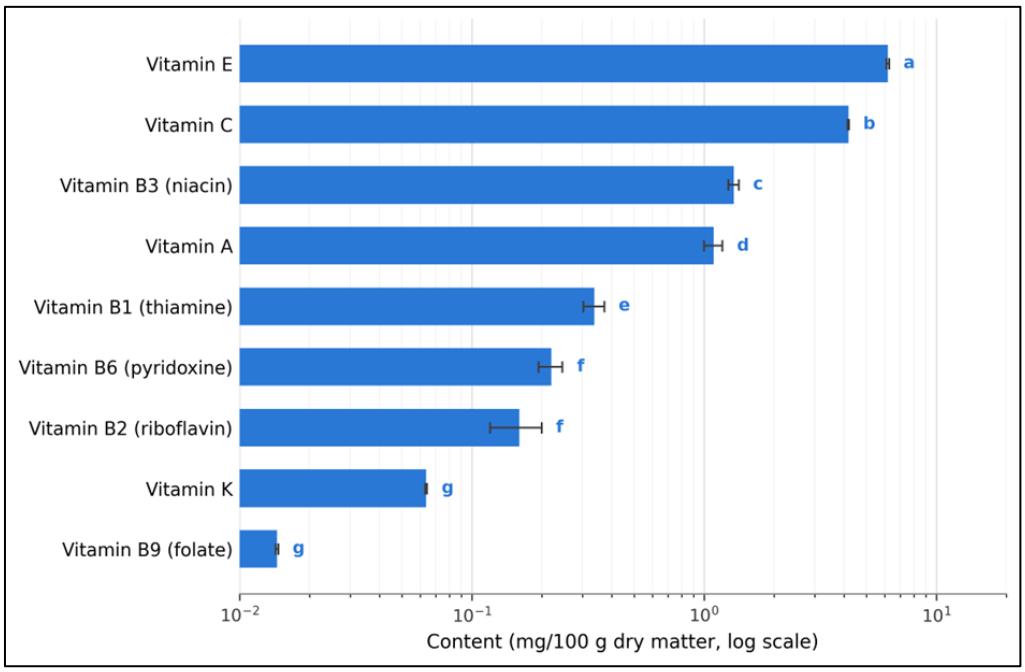
Compound	Content (mg/kg) ± SD
Myristicin	1630.63 ± 1.41a
Eugenol	287.48 ± 0.49b
Gallic acid	38.23 ± 0.39c
Caffeic acid	21.54 ± 0.62d
Catechin	11.20 ± 0.12e

Within a column, means followed by the same letter are not significantly different at the 5% threshold (Duncan's test).

Five phenolic compounds were identified and quantified in the study sample (Table 2): myristicin, by far the most abundant (1630.63 ± 1.41 mg/kg), followed by eugenol (287.48 ± 0.49 mg/kg), gallic acid (38.23 ± 0.39 mg/kg), caffeic acid (21.54 ± 0.62 mg/kg) and catechin (11.20 ± 0.12 mg/kg). One-way ANOVA revealed a highly significant difference among the mean contents of the five compounds ($F(4, 10) = 2{,}619{,}318$; $p < 0.001$). Duncan's test classified each

compound into a distinct statistical group (a to e), confirming a clear, sharply defined hierarchy among these compounds.

3.3 Vitamin profile



Different letters indicate a significant difference between vitamins (Duncan's test, 5% threshold). B5: vitamin not determined (n.d.).

Figure 1: Vitamin profile of *Ziziphus mauritiana* fruit flour

Nine of the ten vitamins investigated could be quantified (Figure 1). Vitamin E clearly dominated the profile (6.18 ± 0.09 mg/100 g), followed by vitamin C (4.18 ± 0.03 mg/100 g) and vitamin B3 or niacin (1.34 ± 0.07 mg/100 g). Vitamins B1, B6, B2, K and B9 were present in markedly lower amounts, the latter two reaching only the hundredth-of-a-mg/100 g scale (0.0636 ± 0.0007 and 0.0145 ± 0.0002 mg/100 g, respectively, i.e. 63.59 ± 0.65 and 14.51 ± 0.18 µg/100 g). After converting all contents to a common unit (mg/100 g dry matter), in accordance with the method described in Section 2.7, ANOVA confirmed highly significant differences among the mean contents ($F(8, 18) = 4720.55$; $p < 0.001$). Duncan's test clearly distinguished vitamins E, C, B3, A and B1 (groups a to e), while vitamins B6 and B2 (group f), and then vitamins K and B9 (group g), each formed a statistically indistinguishable pair, the latter two showing the lowest contents in the vitamin profile.

3.4 Mineral composition

Table 3: Mineral composition of *Ziziphus mauritiana* fruit flour (n = 3)

Element	Content (mg/kg) ± SD
Calcium (Ca)	5304.69 ± 32.04a
Potassium (K)	2643.95 ± 14.53b
Sodium (Na)	342.30 ± 2.61c
Phosphorus (P)	250.73 ± 10.75d
Magnesium (Mg)	128.46 ± 0.06e
Iron (Fe)	51.18 ± 0.25f
Manganese (Mn)	37.30 ± 0.20fg
Zinc (Zn)	17.48 ± 0.50g

Within a column, means followed by the same letter are not significantly different at the 5% threshold (Duncan's test).

Eight mineral elements were quantified from the ground fruit (Table 3). Calcium was the predominant element (5304.69 ± 32.04 mg/kg), followed by potassium (2643.95 ± 14.53 mg/kg) and sodium (342.30 ± 2.61 mg/kg). Phosphorus and magnesium were present in intermediate amounts, while iron, manganese and zinc were the least abundant trace

elements. ANOVA revealed a highly significant difference among the mean contents of the eight elements ($F(7, 16) = 64{,}790.31$; $p < 0.001$); Duncan's test distinguished six well-separated statistical groups (a to d, then f and g), with manganese occupying an intermediate position not significantly different from either iron or zinc (group fg).

4 DISCUSSION

The high total carbohydrate content (82.63%) and high energy value (368.0 kcal/100 g) measured in this study are similar to those reported for the Z. mauritiana (masau) fruit by Nyanga et al. [9] and Butt et al. [6], who reported a carbohydrate content of 79.5 to 83.2 g/100 g dry matter and an energy value of 1516 to 1575 kJ/100 g, i.e. approximately 362 to 376 kcal/100 g. This convergence, obtained on samples from different climatic zones, supports the reliability of the energy value calculated in the present study and confirms the intrinsically energy-dense character of the fruit of this species, making it a food of choice during lean periods. Butt et al. [6] also reported, for the seed alone, a lower calorific value (411.6 kJ/100 g, i.e. approximately 98 kcal/100 g) despite a high carbohydrate (63.2%) and lipid content, owing to a substantial proportion of poorly digestible crude fibre (48.1%). The energy value of the whole fruit powder obtained here, which combines the sugar-rich pulp and the fibers, lipid-rich seed, is thus consistently intermediate between these two components.

The fat content (3.13%), by contrast, is higher than that reported for the fruit pulp alone by Nyanga et al. [9] (0.8 to 1.5%), which is likely explained by the inclusion of the lipid-rich seed in the sample analyzed. This methodological choice was deliberate in the present study, as it reflects the traditional mode of consumption of the whole dried fruit. Conversely, the protein content (2.33%) is lower than that reported for the pulp alone by the same authors (7.9 to 8.7%), suggesting that the seed's protein contribution to the whole powder is more limited than its lipid contribution, or that varietal and edaphic differences are involved. These observations are also consistent with the data reported by Mohd Jailani et al. [12] on the pulp and seed of Malaysian Z. mauritiana: fat content of 0.45% (pulp) and 1.89% (seed), protein content of 6.67% (pulp) and 6.64% (seed).

Vitamin E (6.18 mg/100 g) dominates the vitamin profile, followed by vitamin C (4.18 mg/100 g). These contents remain markedly lower than the values reported in the literature for vitamin C, which nevertheless covers a very wide range: 15.0 to 43.8 mg/100 g in fresh fruit in Zimbabwe [9], 11.76 to 25.61 mg/100 g dry matter in wild fruits from northwestern India [10], 55.27 to 164.47 mg/100 g in eleven Indian jujube cultivars grown in Saudi Arabia [11], and 70 to 165 mg/100 g according to Butt et al. [6]. This substantial variability likely reflects the influence of cultivar, ripening stage and growing conditions on this parameter. This discrepancy nonetheless remains consistent with the strong thermolability and oxidizability of ascorbic acid, which is particularly sensitive to the prolonged open-air dehydration applied in the present study.

The presence of niacin (B3), thiamine (B1), riboflavin (B2) and pyridoxine (B6) in small amounts confirms that the fruit can contribute to water-soluble vitamin intake, but remains of interest primarily for its antioxidant vitamins (E and C). Vitamins K and B9 (folate), although present, are among the most minor compounds in the vitamin profile, with respective contents of 63.59 ± 0.65 and 14.51 ± 0.18 µg/100 g. This trace level is consistent with the contents usually reported for these two vitamins in fleshy fruits. The lack of consistent data for vitamin B5 highlights the need for further research. These results corroborate the work of Akanda et al. [7], who emphasize the nutritional and medicinal importance of the jujube tree for human health.

Five phenolic compounds were identified, dominated by myristicin (1630.63 mg/kg) and eugenol (287.48 mg/kg). The presence of these two molecules is particularly noteworthy. Myristicin is recognized for its antioxidant and antimicrobial properties, as well as for its anti-inflammatory potential [6]. It acts as a free-radical scavenger and contributes to protection against oxidative stress, which reinforces the fruit's interest as a functional food. Eugenol, for its part, is widely documented for its antimicrobial and analgesic effects, as well as for its applications in food preservation [7].

The phenolic profile obtained, dominated by myristicin and eugenol, differs from that reported for the Z. mauritiana fruit in Zimbabwe by Muchuweti et al. [8], who identified mainly p-hydroxybenzoic acid, caffeic acid, ferulic acid, p-coumaric acid and vanillic acid by HPLC. The common presence of caffeic acid in both studies nonetheless supports this compound as a recurrent phenolic constituent of the species, while the differences observed for the other compounds could result from genetic variation, fruit ripening stage, or the extraction and analytical method used. More broadly, Z. mauritiana is known for the diversity of its secondary metabolites (cyclopeptide alkaloids, triterpenic saponins, flavonoids) reported notably in the leaves and bark [1,7]. In addition, a phytochemical screening of the seeds of Z. jujuba, a related species, revealed the presence of alkaloids, flavonoids, saponins and triterpenes, with no detectable tannins or glycosides [31]. This observed profile would be broadly consistent with the inclusion of the seed in the whole sample analyzed here. The presence of catechin and gallic acid, two compounds with strong antioxidant potential, is furthermore consistent with the antioxidant properties reported for leaf and root extracts of the species in Mali [14],

and suggests that the whole fruit could, like the other organs of the plant, constitute a valorizable source of bioactive compounds. Thus, the combination of myristicin and eugenol confers on the fruit a nutraceutical and technological potential: on the one hand, as a natural source of antioxidants and anti-inflammatory agents, and on the other, as a food preservation agent. These results corroborate the observations of Diarra et al. [14], who had shown significant antioxidant activities of leaf and root extracts of the species in Mali.

The fruit is particularly rich in calcium (530.5 mg/100 g) and sodium (34.2 mg/100 g), contents that fall within the range of values reported by Sareen et al. [10] (Ca: 149.4–428.4; Na: 36.7–139.3 mg/100 g) and by Butt et al. [6] (Ca: 160–254 mg/100 g). The calcium richness is notable, as it positions the fruit as a complementary source in diets where dairy products are little consumed. Magnesium (12.8 mg/100 g) and iron (5.1 mg/100 g), although more modest, remain of the same order of magnitude as the contents reported by Abubakar et al. [13] for a comparable West African product based on Z. mauritiana pulp (Mg: 420; Fe: 1.8 mg/100 g), as is zinc (1.7 mg/100 g). The presence of iron and zinc, although modest, also contributes to the nutritional interest of the fruit, particularly in combating micronutrient deficiencies in West Africa [24]. These results confirm the agronomic and nutritional importance of the species in agroforestry systems [2].

Potassium (264.4 mg/100 g) and phosphorus (25.1 mg/100 g), by contrast, remain lower than those reported by Sareen et al. [10] (K: 701.8–2661.3 mg/100 g), Butt et al. [6] (K: 1865–2441; P: 87–148 mg/100 g) and Abubakar et al. [13] (K: 1156 mg/100 g, local biscuit based on Z. mauritiana pulp harvested in Nigeria). This difference could be due to the colorimetric extraction and analysis method used here compared with the atomic absorption spectrometry used in the compared studies.

These results confirm, for the first time in Côte d'Ivoire, the nutritional value of the Z. mauritiana fruit, which is energy-dense and possesses a non-negligible phytochemical, vitamin and mineral profile. They constitute a useful reference base for future food valorization work (composite flours, nutritional supplements) or for varietal and geographic comparisons (other Ivorian localities, other preparation methods).

Strengths and limitations of the study

This work provides the first data on the nutritional and phytochemical composition of the Z. mauritiana fruit in Côte d'Ivoire, filling a literature gap that had, until now, been limited to leaf phytochemistry and animal pharmacology studies. As such, it constitutes an original reference baseline for a wild edible fruit of considerable local relevance, particularly for food security during lean periods. Several limitations should nonetheless be acknowledged. First, the fruit was collected at a single site (Korhogo department) during a single harvest season, so the results cannot yet capture the geographic, seasonal and varietal variability known to strongly influence the biochemical composition of this species. Second, the analysis was deliberately performed on the whole dried fruit (pulp and seed combined), reflecting the traditional mode of consumption but limiting direct comparability with the many studies that report pulp and seed separately. Third, Fourth, vitamin B5 could not be reliably quantified, and replication was limited to analytical triplicates from a single composite batch rather than independent biological replicates. Finally, while the phytochemical and vitamin profile reported here suggests antioxidant, antimicrobial and antidiabetic potential consistent with the traditional medicinal uses of the species, no direct bioactivity assay was performed in this study, and such properties remain to be experimentally confirmed. These limitations do not diminish the value of the present findings, which remain the first of their kind for Côte d'Ivoire.

5 CONCLUSION

This study provides the first available data on the nutritional and phytochemical composition of the whole *Ziziphus mauritiana* fruit harvested in Côte d'Ivoire. The resulting powder shows a marked energy and carbohydrate richness, a phenolic profile dominated by myristicin and eugenol, and notable vitamin and mineral contents, particularly for vitamins E and C and for calcium and potassium. These results confirm the potential of this wild edible fruit as a local food and nutraceutical resource, and call for further work involving multiple samples (geographic variability, ripening stage, drying methods) as well as the evaluation of its biological activity (antioxidant, antidiabetic) in relation to its phytochemical profile.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Statement of ethical approval

This study did not involve human participants, human data, or animal experimentation. The plant material (ripe fruit of *Ziziphus mauritiana*, a non-protected, widely distributed wild fruit tree) was collected in the Korhogo department, Côte d'Ivoire, in accordance with local customary and regulatory practice for the harvesting of non-protected wild plant species, and no additional institutional ethical approval was required.

Declaration of AI Use

This manuscript was prepared through the joint contributions of all authors, particularly with respect to the study design, data collection and analysis, content development, results, interpretation, and scientific work. The authors acknowledge the use of ChatGPT to assist with grammatical proofreading, language refinement, and reference formatting. These AI-assisted tools were not used as authors and did not replace the authors' intellectual contributionsor scientific judgment.

AUTHORS' CONTRIBUTIONS

All authors contributed to the design and implementation of the study, to the analysis of the results, and to the writing of the manuscript. All authors read and approved the final manuscript.

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