

COMPOSITIONAL ANALYSIS OF PROXIMATE NUTRIENTS, VITAMINS, AND MINERAL ELEMENTS IN *SYZYGIUM CUMINI* PULP AND SEED

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ABSTRACT

Syzygium cumini fruits were collected at peak ripeness in Kano, Nigeria, and the pulp and seeds were separately analyzed in triplicate using standard analytical procedures to quantify moisture, ash, crude protein, fat, fibre, nitrogen-free extract (NFE), vitamins A, C and E, and essential macro- and micro-elements. The pulp was characterized by high moisture (82.19%), elevated vitamin C (28.6 ± 2.3 mg/100 g), and significantly higher concentrations of most macro- and micro-elements, particularly potassium (266.21 ± 1.70 mg/L) and iron (3.165 ± 0.0029 mg/L). In contrast, the seed showed low moisture (16.34%), higher crude fiber ($4.19 \pm 0.12\%$), nitrogen-free extract ($74.97 \pm 2.24\%$), and markedly greater vitamin E content (16.4 ± 1.1 mg/100 g). Lead and cadmium levels in both fractions were well below Codex maximum limits. These results confirm that *Syzygium cumini* pulp is an excellent source of water-soluble vitamin C and essential minerals, whereas the seed is a rich reservoir of vitamin E, dietary fiber, and carbohydrate reserves, supporting the nutritional value and safety of consuming or valorizing both portions of this fruit.

Keywords: *Syzygium cumini*, proximate composition, vitamins, mineral elements, food safety

INTRODUCTION

Syzygium Cumini also known as Java plum, black plum or jamun is a tropical evergreen tree belonging to the *Myrtaceae* family. The plant is native to South Asia, mainly Pakistan, India, Afghanistan, and Myanmar, and Pacific-Asia, including Indonesia, the Philippines, Hawaii, and Australia [1]. It is widely cultivated across tropical and subtropical regions for various purposes, including shade, ornamental value, and its edible fruits [2]. In, Northern Nigeria, the tree is commonly found around homes, schools, and public areas, where it is primarily planted for decoration and as a source of shade. Recently, its dark purple, juicy, and astringent fruits have become increasingly popular among the local

population, particularly children, who often purchase and consume them in large quantities during the fruiting season.

Syzygium cumini (L.) Skeels fruits have long been used in traditional medicine to manage various ailments, including diabetes, diarrhea, and digestive disorders [3]. These ethnomedicinal applications point to the presence of bioactive compounds such as flavonoids, phenolic acids, anthocyanins, and tannins [4]. However, comprehensive data on the nutritional, elemental, and biochemical profiles of *Syzygium cumini* fruits, particularly comparative analyses of the edible pulp and seeds across different geographical regions, remain scarce. The

Nigerian context, in particular, has received minimal attention, despite both pulp and seeds being consumed or employed in local remedies.

The increasing consumption of *Syzygium cumini* fruits in Northern Nigeria, in the absence of detailed scientific evaluation, raises critical concerns about their nutritional value and safety. Determining the proximate composition, vitamins and mineral contents of both the pulp and seed is therefore essential to establish a scientific basis for their dietary use and potential health effects. Accordingly, this study aims to generate comprehensive compositional data that can guide public health recommendations, enhance nutritional awareness, and support the value-added utilization of *Syzygium cumini* fruits.

MATERIALS AND METHODS

Sample Collection

Syzygium Cumini fruits were collected from different trees located across various parts of Kano, Nigeria. The fruits were harvested during their peak ripening period and transported in clean, perforated containers to the research laboratory at Sule Lamido University Kafin Hausa for the analyses.

Sample Preparation

The fruit samples were thoroughly washed with distilled water to remove dirt and surface impurities. The seeds were manually separated

from the mesocarp, and both components were washed again. After washing, the seeds and the mesocarp were air-dried separately under shade until completely dried. The dried samples, were then crushed to powder using pestle and mortar, and stored in clean, airtight containers for subsequent analysis.

Methods

The proximate composition of the pulp and seed of *Syzygium cumini* was assessed following established analytical procedures. These included the determination of moisture, ash, crude fiber, crude fat, crude protein, and nitrogen-free extract (NFE). All measurements were carried out in triplicate, adhering to the standard methods previously reported by [5].

Quantitative analyses of vitamins C, A, and E in *Syzygium cumini* pulp and seed were performed using established analytical procedures. Vitamin C content was determined by titrimetric analysis according to the method reported by [6]. Vitamins A and E were quantified spectrophotometrically at 328 nm and 695 nm, respectively, following the validated procedures described by [7].

A PerkinElmer AAnalyst 800 Atomic Absorption Spectrometer (AAS) was employed for the determination of Fe, Cu, Zn, Na, Mg, K, Ca, Cr, Mn, Cd and Pb, employing wet oxidation method as reported by [5].

RESULTS AND DISCUSSION

Proximate Analysis

The proximate composition is essential for promoting human development and general well-being [5]. Fruits serves as key dietary contributors of vital macronutrients, including water, proteins, lipids, dietary fiber, minerals, and carbohydrates, all of which are necessary for sustaining optimal bodily processes and nutritional equilibrium. Table 1 displays the results of the proximate analyses performed on the pulp and seeds of *Syzygium cumini*, highlighting the differences in macronutrient levels between the pulp and the seeds. The high moisture content in the pulp (82.19%) is consistent with the typical characteristics of fleshy fruits, which store large amounts of water to promote palatability and facilitate seed dispersal [8]. On the other hand, the seed showed minimal water content (16.34%), enabling long-term stability, dormancy, and enhanced storage of dry matter, a common feature of seeds across many fruit-bearing plants [9].

The ash content was slightly higher in the seed ($2.18 \pm 0.06\%$) than in the pulp ($2.04 \pm 0.06\%$), indicating a greater concentration of mineral elements, particularly when considering its low moisture content. Similar patterns have been reported in tropical fruit seeds such as mango and guava, where the dry seed fraction retains more inorganic matter than the pulp [10, 11].

The crude fat and crude protein contents were relatively low in both pulp and seed, which is typical of *syzygium cumini* and has been reported previously [12]. While the differences between pulp and seed were not large, the pulp showed marginally higher protein, which may be associated with metabolic proteins involved in fruit maturation and enzymatic activity [13]. In contrast, seeds generally prioritize carbohydrate deposition rather than high protein synthesis, except in legumes.

As shown in Table 1, the crude fibre content of the seed ($4.19 \pm 0.12\%$) was significantly higher than that of the pulp ($1.76 \pm 0.05\%$). This reflects the seed's need for a tough, protective coat rich in structural polysaccharides (mainly cellulose and hemicellulose) that provide mechanical resistance and help prevent desiccation and damage [14]. Higher crude fibre in *Syzygium cumini* seeds (3.9–5.2%) has also been reported previously and is linked to their traditional medicinal uses [12].

A particularly noteworthy result is the exceptionally high nitrogen-free extract (NFE) content of the seed ($74.97 \pm 2.24\%$), which is approximately 83% higher than that of the pulp ($41.05 \pm 0.33\%$). This marked difference highlights the distinct nutritional and physiological roles of the two tissues. The relatively lower NFE in the pulp is consistent with its high moisture content and its primary function of providing readily digestible, soluble carbohydrates (mainly sugars) that serve as an

attractive energy reward for frugivores and seed dispersers. In contrast, the very high NFE in the seed indicates a large reserve of non-nitrogenous, mostly complex carbohydrates (predominantly starch), intended for mobilization during germination and early seedling growth. This pattern aligns with previous reports on *Syzygium cumini* seeds, which consistently show high NFE values attributable mainly to starch [12].

The observed compositional differences are consistent with patterns reported for several other tropical fruits. In species such as tamarind (*Tamarindus indica*), mango (*Mangifera indica*), and jackfruit (*Artocarpus heterophyllus*), seeds similarly exhibit significantly higher dry matter, crude fibre, and NFE contents than their respective edible pulps [10, 11]. This consistent trend reflects the contrasting physiological roles of the two tissues: pulp is optimized for rapid consumption and seed dispersal, whereas seeds function as compact, dehydration-tolerant storage organs enriched in structural and reserve carbohydrates.

Table 1: Proximate composition (%) of *Syzygium cumini* pulp and seed

Proximate Composition	Pulp	Seed
Moisture	82.19 ± 2.46	16.34 ± 0.49
Ash	2.04 ± 0.06	2.18 ± 0.06
Crude fat	0.83 ± 0.02	0.65 ± 0.01
Crude protein	2.15 ± 0.06	1.97 ± 0.59
Crude fiber	1.76 ± 0.05	4.19 ± 0.12
NFE	11.03 ± 0.33	74.67 ± 2.24

Results are mean ± standard deviation

Vitamins Analysis

As shown in Table 2, the vitamin profile of *Syzygium cumini* pulp and seed revealed marked differences that reflect their distinct biological roles. The pulp exhibited a substantially higher content of vitamin C (ascorbic acid) at 28.6 ± 2.3 mg/100 g compared to only 4.1 ± 0.6 mg/100 g in the seed. The high ascorbic acid content contributes significantly to the antioxidant potential of the pulp and supports its traditional use in boosting immunity and managing oxidative stress-related disorders. These results are also supported by the findings of [15, 16], who reported 49.78 ± 2.17 mg/100 g and 19.4 mg/100 g in the pulp of *Syzygium cumini*, respectively. However, a value of 0.21 mg/100 g has been reported for *Syzygium cumini* seed in previous studies, which is markedly lower than the amount obtained in the present work [17]. This suggests that while the seed does contain measurable ascorbic acid, its contribution to the overall vitamin C pool of the fruit is minimal. The variations in the vitamin C content of the various samples are probably due to factors such as soil type, climate, cultivar, and processing methods.

Vitamin A activity (expressed as β -carotene equivalents) was low in both tissues, measuring 0.5 mg/100 g in the pulp and 0.23 mg/100 g in the seed. These findings are comparable to recent reports showing that *Syzygium. cumini* fruits contain only trace amounts of provitamin A carotenoids. For instance, Barcia and his coworkers, reported 0.3 – 0.7 mg/100 g total

carotenoids in Jambolao pulp [18]. The low carotenoid content observed in this study aligns with the known biochemical profile of deeply pigmented anthocyanin-rich fruits, where carotenoids contribute minimally to the overall pigment and antioxidant composition.

As seen in Table 2, the *Syzygium cumini* seed exhibited substantially higher vitamin E (α -tocopherol) content, at 16.4 ± 1.1 mg/100 g, compared to 4.7 ± 0.4 mg/100 g in the pulp. This finding aligns closely with recent reports of elevated α -tocopherol levels in *Syzygium cumini* seeds (15–18 mg/100 g) [19]. However, the seed value obtained in this study is higher than the 0.14–0.44 mg/100 g total tocopherols reported Barcia *et al.* (2012) [18], in a similar study. In contrast, the levels of vitamin E in the pulp obtained in the present analysis exceed 0.25 –

0.71 mg/100 g reported elsewhere [20], which may be due to varietal or environmental differences. The elevated tocopherol level in the seed is consistent with the physiological function of vitamin E as a lipid-soluble antioxidant protecting the oil-rich embryonic tissue from oxidative damage during storage and germination [19, 21].

Overall, the pulp of *Syzygium cumini* emerges as an excellent dietary source of water-soluble vitamin C, whereas the seed represents a concentrated reservoir of lipid-soluble vitamin E. This complementary distribution further underscores the nutritional importance of consuming the whole fruit and supports the growing interest in seed powder as a functional ingredient in nutraceuticals targeting cardiovascular and anti-aging benefits.

Table 2. Vitamin composition of *Syzygium cumini* pulp and seed

Parameter	Pulp (mg/100 g)	Seed (mg/100 g)
Vitamin C	28.6 ± 2.3 mg/100 g	4.1 ± 0.6 mg/100 g
Vitamin A	0.5 ± 0.03 mg/100 g	0.23 ± 0.01 mg/100 g
Vitamin E	4.7 ± 0.4 mg/100 g	16.4 ± 1.1 mg/100 g

Results are mean $\pm$ standard deviation

Nutrients Analysis

The elemental composition of *Syzygium cumini* pulp and seed was analyzed to evaluate their nutritional and toxicological relevance. The results are summarized in Table 3. Generally, the pulp exhibited significantly higher concentrations

of essential macro- and micro-elements compared to the seed, highlighting its superior nutritive value.

Among the macro-elements, potassium (K) was the most abundant mineral detected, with the pulp containing 266.21 ± 1.70 mg/L and the seed 55.89

± 1.03 mg/L. This is consistent with findings reported by [22], who observed high potassium levels in *Syzygium cumini* pulp and attributed it to its role in osmotic balance, nerve function, and cardiovascular regulation. Similarly, calcium (Ca) and magnesium (Mg) were also present in greater amounts in the pulp (19.50 ± 0.031 mg/L and 2.061 ± 0.0010 mg/L, respectively) compared to the seed (1.491 ± 0.0412 mg/L and 1.908 ± 0.0043 mg/L, respectively), reinforcing the pulp's contribution to bone development, muscle contraction, and enzymatic processes.

With respect to micro-elements, iron (Fe) concentration was markedly higher in the pulp (3.165 ± 0.0029 mg/L) than in the seed ($0.736 \pm$

0.0152 mg/L), underscoring the pulp's potential in preventing iron-deficiency anemia. Comparable trends were observed for copper (Cu), manganese (Mn), and zinc (Zn), all of which were more prevalent in the pulp. These elements play vital roles in antioxidant defense, immune response, and cellular metabolism. For example, Zn in the pulp (0.486 ± 0.0023 mg/L) was higher than that in the seed (0.298 ± 0.0010 mg/L), aligning with observations by [23], who emphasized the fruit's mineral richness and therapeutic relevance. Chromium (Cr), though present in low quantities, showed a higher value in the pulp (0.243 ± 0.0145 mg/L) than in the seed (0.057 ± 0.0145 mg/L).

Table 3: Mineral composition (mg/L) of *Syzygium cumini* pulp and seed

Minerals	Pulp	Seed
K	266.2 ± 1.70	55.89 ± 1.03
Ca	19.50 ± 0.031	1.491 ± 0.041
Mg	2.061 ± 0.001	1.908 ± 0.004
Fe	3.165 ± 0.003	0.736 ± 0.015
Cu	0.994 ± 0.004	0.313 ± 0.004
Mn	0.352 ± 0.005	0.057 ± 0.010
Zn	0.486 ± 0.002	0.298 ± 0.001
Cr	0.243 ± 0.015	0.057 ± 0.015
Pb	1.420 ± 0.009	0.379 ± 0.055
Cd	0.015 ± 0.001	0.008 ± 0.002

Results are mean $\pm$ standard deviation

Despite its low concentration, the presence of Cr may contribute to insulin function and lipid metabolism, as suggested by [24].

Lead (Pb) and cadmium (Cd) were detected in both pulp and seed, but at very low concentrations. The pulp contained 1.420 ± 0.009 mg/L Pb and 0.015 ± 0.001 mg/L Cd, whereas the seed contained 0.379 ± 0.055 mg/L Pb and 0.008

± 0.002 mg/L Cd. These values are considerably below the maximum levels for Pb and Cd in berries and other small fruits (0.10 mg/kg for Pb and 0.05 mg/kg for Cd) established by the Codex Alimentarius Commission [25].

Generally, the results affirm that *Syzygium cumini* pulp is richer in essential minerals than the seed, thereby supporting its greater nutritional significance and potential as a health-promoting dietary staple. The mineral profile obtained in this study is in agreement with the findings previously reported [26, 27]. Minor variations in concentrations may be attributed to factors such as soil type, climate, cultivar, and processing methods.

CONCLUSION

This study reveals distinct and complementary nutritional profiles between *Syzygium cumini* pulp and seed. The pulp is rich in moisture, vitamin C, and essential minerals (especially potassium and iron), while the seed excels in vitamin E, dietary fiber, and carbohydrate reserves. Although trace levels of heavy metals were detected in both fractions, they remained low, emphasizing the need for continued monitoring to ensure safe utilization. These findings support the dietary use of the whole fruit, encourage valorization of the seed, and provide a scientific basis for incorporating *Syzygium cumini* into functional foods and nutritional interventions.

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