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Preliminary Evaluation of Phytochemical and Proximate Composition of *Isoberlinia doka* Craib & Stapf

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Abstract *Isoberlinia doka* Craib & Stapf is an evergreen perennial hardwood tree with glabrous shining foliage. The plant is predominant in northern Nigerian guinea savanna vegetation. The present study performed both qualitative and quantitative phytochemical and proximate analyses of *I. doka* leaf, stem bark and root bark on dry matter bases. The plant samples were dried, ground into a powder and extracted using cold maceration technique. The standard laboratory procedures were then used for the analyses. The level of significance was measured using the least significant difference (LSD) post hoc test and the data were presented as the mean of three duplicates. High concentrations of alkaloids at 39.00%, saponins at 5.96%, phenols at 5.86%, steroids at 5.20% and terpenes at 4.30% were detected in the leaf. In addition, alkaloids, anthraquinone glycosides, flavonoids and steroids were only present in the leaf. Cardiac glycosides and tannins were not detected in all the plant parts investigated. Moreover, considerable levels of nutrients were found in the plant parts. The ash contents were relatively high. The percentages of crude fibre and carbohydrate of the leaf at 38.50 and 38.00 respectively were also high. The findings demonstrated that *I. doka* leaf extracts possess both considerable high pharmacological and nutritional properties; making the leaf the most important part of the plant, ethnobotanically. Hence, the use of the leaf as a vegetable as well as a base for novel drug formulation is suggested.

Keywords Fabaceae, Phytocompounds, Phytonutrients, Alkaloids, Saponins, Ash

1. Introduction

Isoberlinia doka Craib & Stapf is a tall evergreen, deciduous hard wood tree that rapidly colonises abandoned lands. This plant is bushy, shrubby and a serious weed in arable crops during its early stages of growth. It is a savanna tree that grows up to 18.29m high with a glabrous shining foliage [1]. In addition, the tree is gregarious in habit, with white flowers. It is a member of the family, Fabaceae, of the order, Fabales. Fabaceae are large, widely distributed, and among the most economically important families of flowering plants. *Isoberlinia doka* is indigenous to African tropical savannas and Guinean forest-savanna mosaic dry forests [2]. Two species of *Isoberlinia*, namely, *I. doka* and *I. tomentosa* (Harms) Craib & Stapf are dominant in the northern Nigerian guinea savanna [3,4,5]. They are also present in the southern rain forest part of the country [1], where they are usually shrubby due to constant clearing and cultivation of the farm lands.

The tree is primarily used for commercial timber. It is

the host plant for wild larvae (*Anaphe moloneyi* Druce) that produces African (Anaphe) silk [6]. The silk is utilised in the Hausa and Yoruba ethnic groups of Nigeria, for yarn manufacturing [7]. The yarns are in turn, used in the embroidery of Hausa gowns. In addition, African silk is used in conjunction with cotton for the production of the 'Sanyan' cloths in the Yoruba localities.

Moreover, plants have been used for thousands of years for medicinal purposes [8]. Medicinal plants can be used in either fresh, dried or powdered forms, and in the form of extracts, infusions, decoctions, tinctures or essential oils [9,10]. Moreover, the purpose of any of the herbal methods of preparation adopted is to extract the biologically important phytochemicals that are inherent in plants. Medicinal plants are used for primary healthcare purposes, especially in developing countries. Plant-based drugs are modestly efficacious and reasonably safe for treating disease conditions [11]. There are several species of medicinal plants in Nigeria; however, a greater percentage has not yet been fully tapped. There is a lack of literature available on the medicinal and nutritional uses of the *I. doka* parts in the southern Nigerian traditional cultures; hence, this study was aimed at investigating the active principles present in this plant species' parts. The objective of this work, therefore, was to assess the phytochemical and proximate composition of the leaf, stem and root barks of *I. doka.*

2. Materials and Methods

2.1. Sources of Materials

The leaves, stem bark and root bark of *I. doka* were collected in June from a farm at Nsukka, Enugu State, Nigeria. The voucher specimen was authenticated and deposited in the Herbarium, Department of Botany, Nnamdi Azikiwe University, Awka, Nigeria.

2.2. Preparation of Plant Samples

The plant specimens were dried at ambient temperature for 5 days and ground into a powder with the use of an electric blender (Moulinex, China).

2.3. Extraction of Plant Materials

Cold maceration technique of Atata *et al.* [12] was used for the extraction, with some modifications. One hundred grams (100g) of each ground plant sample were poured in a container; 1000ml of 80% aqueous ethanol was poured in and allowed to stand for three days with occasional shaking. The plant residues were filtered with a two-folded muslin cloth and through Whatman's filter paper [no. 41; Mettler-Toledo Instruments (Shanghai) Ltd.] for more purity. The extract was then concentrated using a rotary evaporator (Rotavapor R-300) at 40 ℃ for 2 hr. The semi-solid extracts yielded, were then stored in corked containers and kept in the refrigerator at 4 ℃ prior to the analyses.

2.4. Qualitative Analysis of Phytochemical Constituents

The standard laboratory procedures for qualitative phytochemical determination of alkaloids, anthraquinone glycosides, cardiac glycosides, flavonoids, phenols, saponins, steroids, tannins and terpenes were conducted [13]. The negative sign '-' was used to denote the absence of phytochemicals.

2.4.1. Test for Tannins (Ferric Chloride Test)

A measured 2ml 5% ferric chloride ($FeCl_3$) solution was poured into 2ml of the plant extracts. A dark blue colouration indicated the presence of tannins.

2.4.2. Test for Flavonoids

Four milligrammes (4ml) of the plant extract were measured, and 2ml of 50% methanol was added. The solution was warmed in a GFL water bath (1083; GFL) to 37 ℃ and a pinch of metal magnesium powder was added. Five drops of concentrated hydrochloric acid were added subsequently. Red colouration confirmed the presence of flavonoids.

2.4.3. Test for Phenols

Five milligrammes (5ml) of the plant extract was poured into a test tube and three drops of diluted $FeCl_3$ solution were added. Phenols are present when a red colouration is formed.

2.4.4. Test for Alkaloids

A measured 5ml of the plant extract was poured into a test tube and the filtrate was carefully tested with Mayer's reagent (potassium mercuric). The formation of a yellow-coloured precipitate pointed out that alkaloids are present.

2.4.5. Cardiac Glycosides (Keller-Killani Test)

Two drops of glacial acetic acid were added into 5ml of the plant extract. Moreover, there was addition of two drops of 10% $FeCl_3$ and concentrated tetraoxosulphate (vi) acid (H_2SO_4). Presence of cardiac glycosides was confirmed, when a reddish-brown colour appeared at the junction of the two liquid layers.

2.4.6. Anthraquinone Glycosides (Borntrager's Test)

Diluted sulphuric acid was poured into 5ml of the plant extract, brought to boil and then filtered. Subsequently, the filtrate was allowed to cool and an equal volume of chloroform was added. Separation of the organic layer followed and then ammonia was added. The ammonia layer turned pink and signified the presence of anthraquinone glycosides.

2.4.7. Test for Saponins

Exactly 5ml of the plant extract was measured into a test

tube; 2ml of distilled water was poured in and shaken energetically. The persistent froth volume or bubbles produced, demonstrated the presence of saponins.

2.4.8. Test for Steroids and Terpenes (Liebermann-Burchard Reaction)

A measured 2ml of acetic anhydride and three drops of concentrated sulphuric acid were poured into 5ml extract of the samples in a test tube. Presence of steroids was confirmed, when a blue-green ring appeared between the layers, whereas the appearance of a pink-purple ring, showed the presence of terpenes.

2.5. Quantitative Determinations

2.5.1. Determination of Alkaloids

The alkaline precipitation gravimetric method of Harborne [13] was applied for alkaloid determination. Exactly 0.5g of each sample was scattered in 50ml 10% acetic acid solution in ethanol. The mixture was shaken and allowed to stand for 4h, then filtered. Evaporation of the filtrate to 1/4 of its original volume was carried out. Concentrated ammonium hydroxide (NH_4OH) was then added in drops, in order to precipitate the alkaloids. Filtration of the precipitate was done with weighed filter paper, and then washed with a 1% NH_4OH solution. The precipitate in filter paper was dried in the oven (Labtron Equipment Ltd.) at 60 ℃ for 30 min and then re-weighed. The weight of the alkaloids was determined by the weight difference and presented as a percentage of the sample weight. The calculation was shown as follows:

$$\text{Percentage alkaloids} = \frac{W_2 - W_1 \times 100}{W}$$

Where, W is the weight of the sample while W_1 is the weight of the empty filter paper.

2.5.2. Flavonoid Determination

The determination of flavonoids was performed using the gravimetric method described by Harborne [13]. A total of 50ml water and 2ml HCl solution were added into 5g of the powdered sample in a conical flask. The solution was boiled for 30 min, allowed to cool to 25 ℃ and subsequently filtered through Whatman's filter paper [no. 42; Mettler-Toledo Instruments (Shanghai) Ltd.]. A measured 10ml ethyl acetate extract with the presence of flavonoids was regained, whereas the aqueous layer was thrown away. The second (ethyl-acetate layer) was filtered with a pre-weighed Whatman's filter paper; the residue was then placed in an oven (Labtron Equipment Ltd.) to dry at 60 ℃. The residue was weighed after being cooled in a dessicator (Bioevopeak Co., Ltd.). The level of flavonoids was calculated with the following formula:

$$\text{Percentage flavonoids} = \frac{W_2 - W_1 \times 100}{\text{Weight of sample}}$$

Where, W_1 is the weight of the empty filter paper and W_2 is the weight of the paper + flavonoids.

2.5.3. Determination of Phenols

The determination of the phenol percentage in the sample was conducted with the methods of Harborne [14]. Exactly 2g of each sample was used and the absorbance of the extracts was measured using a spectrophotometer (Bioevopeak Co., Ltd.) at 505nm wavelength.

2.5.4. Determination of Terpenoids

Terpenoid determination was conducted with the method outlined by Ferguson [15]. Exactly 10g of the sample granules were measured and immersed in alcohol for 24 h. After filtering the sample, the filtrate was extracted with petroleum ether and this ether extract was then recorded as the measure of the total terpenoids.

2.5.5. Determination of Saponins

Saponin determination was conducted using the method of Obadoni and Ochuko [16]. A measured 20g of each sample was placed into a conical flask and 100 cm^3 of 20% aqueous ethanol was added. Heating of the samples was done with continuous stirring, over a hot GFL water bath (1083; GFL) for 4 h at ~55 ℃. Filtration of the mixture was also done and the residue was re-extracted with 200ml 20% ethanol. The combined extracts were boiled in a GFL water bath (1083; GFL) at ~90 ℃ in order to reduce the quantity to 40ml. The concentrate was poured into a 250ml separatory funnel and 20ml diethyl ether was added and energetically shaken. The aqueous layer was regained whereas the ether layer was poured away.

The purification process was done repeatedly; 60ml n-butanol was added and the combined n-butanol extracts were washed with 10ml 5% aqueous sodium chloride twice. The remaining solution was boiled in a GFL water bath (1083; GFL) for 30 min and then cooled in ice for 15 min. The saponin content was then calculated after the samples were dried in an oven (Labtron Equipment Ltd.) to a constant weight. The level of saponins was analysed by the difference and evaluated as a percentage of the original sample. The formula is as follows:

$$\text{Percentage saponins} = \frac{W_1 - W_2 \times 100}{\text{Weight of sample}}$$

Where, W_1 is the weight of the evaporating dish and W_2 is the weight of the dish + sample.

2.5.6. Determination of Anthraquinone Glycosides

This analysis adopted the extraction method of Sakulpanich and Gritsanapan [17] as modified by Khoomsab and Khoomsam [18]. The absorbance of the samples was read at 515nm in an UV-Vis spectrophotometer (Jenway 7305), and recorded accordingly.

2.5.7. Determination of Steroids

Steroids were determined using the method of Okeke

and Elekwa [19]. In 100ml freshly distilled water, 5g of the sample was dispersed and homogenised in a laboratory blender (8010 G, MRC). The homogenates were filtered and the filtrate was eluted with a normal ammonium hydroxide solution (pH 9). Subsequently, 2 ml of the eluents were placed in test tubes and mixed with 2ml chloroform. An amount of 3ml ice-cold acetic anhydride was then poured into the mixture in the flask and two drops of concentrated sulfuric acid (H_2SO_4) were added carefully and the preparation and treatment of standard sterol solution were conducted. The absorbance of the standard and prepared samples was measured with a spectrophotometer (Bioevopeak Co., Ltd.) at 420nm.

2.6. Proximate Determination

The gravimetric and furnace incineration gravimetric methods respectively were used to evaluate the moisture and ash values of the samples as outlined by James [20]. In addition, the Weende, solvent extraction and Kjeldahl methods were used to determine the crude fibre, fat and crude protein contents respectively [20], while the carbohydrate content was calculated using the difference method, as the nitrogen free extractive (NFE) [19].

2.6.1. Moisture Content Determination

Thorough washing of the dishes was carried out, and subsequently dried in the oven (Labtron Equipment Ltd.). They were later placed inside a dessicator (Bioevopeak Co., Ltd.) for cooling and were then weighed. The weight of the samples was obtained by placing them in a weighed dish. The samples were subsequently dried in the oven (Labtron Equipment Ltd.) at 70 ℃ for 2 h and further at 105 ℃ for 4 h. They were cooled in the dessicator (Bioevopeak Co., Ltd.). Then the dry weight of the sample and the dish was obtained. The moisture level was then computed with the following formula:

$$\text{Percentage moisture} = \frac{W_2 - W_3 \times 100}{W_2 - W_1}$$

Where, W_1 is the initial weight of the empty crucible, W_2 is the weight of the crucible + the sample before drying and W_3 is the final weight of the crucible + the sample after drying.

2.6.2. Determination of Ash Content

A measured 5g of the sample was poured in a muffle furnace at 550 ℃ and burnt to ashes. It was later cooled in a dessiccator (Bioevopeak Co., Ltd.) and weighed, when it was completely burnt to ashes. The weight of the ash procured was calculated by the difference and recorded as the percentage of the weight of the sample analysed.

$$\text{Percentage ash} = \frac{\text{Weight of ash x 100}}{\text{Weight of original sample}}$$

$$= \frac{W_1 - W_2 \times 100}{W_2 - W_1}$$

Where, W_1 is the weight of the empty crucible, W_2 is the weight of the crucible + the sample before drying and W_3 is the weight of the crucible + ash.

2.6.3. Content Determination of Crude Protein

Exactly 2g of sample was poured into a 250ml beaker. Addition of 75ml hot water was done and subsequently boiled. The mixture was stirred energetically and 25ml 6% copper sulphate solution were added. Further boiling and vigorous stirring of the mixture were done and 25ml 1.25% sodium hydroxide solution were added. The mixture was vigorously stirred again, taken away from the flame and allowed to settle. It was later filtered on Whatman's filter paper [no. 4 Mettler-Toledo Instruments (Shanghai) Ltd.]. Cleaning off the precipitate from the sides of the beaker was carried out and the sulphate was washed off paper 6 times with very hot water. The paper was allowed to drain properly, and then taken to a Kjeldahl flask (Labtron Equipment Ltd.) containing ∼10g anhydrous sodium hydroxide and a trace of selenium. Subsequently, the addition of exactly 30ml H_2SO_4 was done, the nitrogen content was estimated and thus, the crude protein content of the sample was calculated as shown below:

Percentage crude protein = % N x F, where F is the conversion factor of 6.25;

$$\text{Percentage nitrogen} = \frac{V_S - V_B \text{ x Nacid x } 0.028 \text{ x} 100}{W}$$

Where, V_S is the required acid volume for titrating sample in millilitres, V_B is the acid volume needed to titrate the blank in millilitres, Nacid is the normality of the acid (0.1N) and W is the weight of the sample in grams. Hence, percentage crude protein = % nitrogen x 6.25.

2.6.4. Determination of Fat Content

This method is based on the guiding belief that non-polar components of the samples are easily extracted into organic solvents. Exactly 3g of each sample were placed into marked fat-free thimbles weighed, plugged with glass wool and poured into Soxhlet extractors (Labtron Equipment Ltd.) containing 160ml petroleum ether with a boiling point of 75 ℃. In addition, weighed clean dry receiver flasks were fitted to the extractors. The assembly of the extraction units was then done and the circulation of cold water was allowed, while the temperature of the water bath was maintained at 60 ℃. The extraction was conducted for 8 h, after which the removal of the thimbles containing the samples was done and placed in an oven (Labtron Equipment Ltd.), at 70 ℃ for 3 h and dried to a constant weight. The level of fat was determined as stated below:

$$\text{Percentage fat} = \frac{\text{Weight of fat x 100}}{\text{Weight of sample}}$$

2.6.5. Determination of Crude Fibre Content

The water was refluxed with 200ml of a solution comprising 1.25 g of H_2SO_4 per 100ml of solution and boiled for 30 min. Two folds of cheese cloth were used to

filter the solution on a fluted funnel. The residue was thoroughly washed with boiling water and then placed in a beaker and boiled for 30 min with 200ml of a solution containing 1.25 g of carbonate-free Sodium hydroxide (NaOH) per 100ml. The final residue was filtered through a thin but closed pad of washed and ignited asbestos in a Gooch crucible (Bioevopeak Co., Ltd.). It was then weighed after drying in an electric oven (Labtron Equipment Ltd.). It was finally burnt, cooled and weighed again. The loss in weight after the incineration x100, therefore, was the percentage of crude fibre.

2.6.6. Carbohydrate Content Determination

The carbohydrate level was estimated using the difference method as calculated as follows: Percentage carbohydrate = 100 - (% moisture + % ash + % crude fibre + % crude protein + % fat).

2.7. Statistical Analysis

The data collected were all subjected to analysis of variance (one-way ANOVA) at the 0.05% level of significance using Sigma Plot Version 12 Software (Cranes Software International Ltd.). The level of significance was measured using the least significant difference (LSD) post hoc test and the values were presented as the mean of three replicates.

3. Results

The qualitative and quantitative phytochemical analyses of *I. doka* revealed that alkaloids at 39.00%, anthraquinone glycosides at 3.63%, flavonoids at 1.20%, steroids at 5.20% and terpenes at 4.30% were present in the leaf, whereas they were absent in the stem bark and root bark. Moreover, phenols and saponins were present in the leaf, stem and root bark while cardiac glycosides and tannins were absent in all the plant parts examined (Table 1).

Table 1. Mean percentage quantitative phytochemical composition of *Isoberlinia doka* leaf, stem bark and root bark

Composition	Leaf	Stem bark	Root bark
Alkaloids	39.00[a]	-	-
Anthraquinone glycosides	3.63	-	-
Cardiac glycosides	-	-	-
Flavonoids	1.20	-	-
Phenols	5.86[a]	5.60[a]	4.06[a]
Saponins	5.96	5.20	0.49
Tannins	-	-	-
Steroids	5.20	-	-
Terpenes	4.30	-	-

Values are expressed as the mean of three replicates. [a]Mean with the higher value and highly significant.

In the proximate evaluation, high percentages of ash at 47.20, 46.90 and 55.60 were found in the leaves, stem bark and root bark respectively. The highest values of crude fibre at 38.50% and carbohydrate at 38.00% were present in the leaves, while low concentrations of crude protein were detected in the leaves, stem bark and root bark at 0.73%, 0.73% and 0.40% respectively. Fat was found in the leaves at 2.30% and stem bark at 2.05%, whereas it was absent in the root bark. The moisture contents of the plant parts were considerably high. The percentages of 2.30, 8.60 and 6.20 were found in the leaves, stem bark and root bark respectively (Table 2).

Table 2. Mean percentage proximate composition of *Isoberlinia doka* leaf, stem bark and root bark

Composition	Leaf	Stem bark	Root bark
Moisture content	2.30	8.60	6.20
Ash	47.20[a]	46.90[a]	55.60[a]
Crude fibre	38.50[a]	1.89	2.30
Crude protein	0.73	0.73	0.40
Fat	2.30	2.05	0.00
Carbohydrate	38.00[a]	25.00[a]	25.05

Data are expressed as the mean of three duplicates. [a]Mean with the higher value and highly significant.

4. Discussion

The results of the present study disclosed that *I. doka* contained various concentrations of phytochemicals that were mostly dominant in the leaf. The synthesis and accumulation of the phytochemicals in the plant leaf may be due to the genetic makeup of the plant and/or the specific function(s) of this plant part. The level of alkaloids detected in the leaf was high, probably as a result of its absence in the stem bark and root bark. This indicated that all the alkaloids synthesised by this plant were presumably accumulated in the leaf. This may be attributed to the need for the plant to protect its leaves against pathogen infestation and herbivory. Alkaloids also possess a number of biological activities. Numerous of the ~20,000 known alkaloids have been used as pharmaceuticals, stimulants, narcotics and poisons [21]. Among the phytochemicals investigated, only phenols and saponins were detected in the leaf, stem bark and root bark; and in considerable high levels. In addition, they were the only phytocompounds detected in the stem bark and root bark of this plant. Moreover, this study disagrees with the findings of a previous study, where flavonoids, alkaloids, tannins and glycosides were present in an aqueous stem bark extract of *I. doka* [22]. They also stated that the extract at a dose of 200-600mg/kg body improved male Wistar rats' sexuality. This pharmacological activity is probably due to the

saponin content of this *I. doka* part. Protection of rats' erectile function by gross saponins of *Tribulus terrestris* L. had also been reported [23]. Saponins are bitter-tasting anti-nutrient plant-derived organic chemicals that produce lather when stirred in water [24]. Secondary metabolites play a vital role in the prevention of several chronic diseases, as a result of their antioxidant, anti-inflammatory and anti-carcinogenic qualities [25]. Steroids and terpenes were present in the leaf, while they were absent in the stem bark and root bark. In a previous study, sterols and triterpenes were also absent in the leaf, stem and root of *Cola acuminata* (P. Beauv.) Schott and *Cola nitida* (Vent) Schott and Endl. (Sterculiaceae) [26]. Sterols and triterpenes are presumably synthesised and accumulated in the aerial parts of tree species. Triterpenes are precursors to all steroids. In addition, terpenes usually serve as active ingredients in pesticides in agriculture, as a result of their defensive role in plants [27]. Furthermore, cardiac glycosides and tannins were absent in all the plant parts. In a previous study, cardiac glycosides were also absent in the leaf, stem and root of *Anthocleista djalonensis* Planch. and *A. Vogelii* A. Chev. (Longaniaceae) [28]. These findings suggest that cardiac glycosides may not be synthesised by the tree species of plants. Flavonoids at 1.20% were the least phytochemical found in the leaf of this plant. Based on the chemical structure, degree of oxidation and unsaturation of the linking chain (C3), flavonoides can be grouped as anthocyanidins, chalcones, flavanones, flavan-3-ols, flavanonols, flavonols, flavones and isoflavonoids [29]. Additionally, the bioavailability of flavonoids is relatively low as a result of their limited absorption and quick elimination, generally. This research also did not conform to the report of an earlier work, where the cardiac glucosides, flavonoids, triterpenes and steroids were found in ethanol extract of *I. doka* stem bark [30]. Moreover, the absence of anthraquinone was reported in both studies.

Traditionally, the *I. doka* stem bark is used for treatment of cough in Nigeria [31]. This medicinal application of this *I. doka* part is probably due to the synergistic antimicrobial activity of phenols and saponins that were present in that part. Moreover, the decoction of *I. doka* leaf is used to treat diabetes in Benin [32] while in Chad, the bark and root are used in treatment of intestinal worms and heart disease respectively [33,34]. The antidiabetic effect of the *I. doka* leaf decoction could be a result of the alkaloid composition. Alkaloids extracted from *Adiantum capillus*-veneris L. (Pteridaceae) possessed an antihyperglycemic effect [35]. Presumably, the traditional use of *I. doka* root in the treatment of heart disease in Chad might be a result of the saponin presence. Saponins isolated from *Panax notoginseng* (Burkill) F.H. Chen (Araliaceae) ameliorated a coronary artery disease (CAD) [36].

The proximate investigation revealed appreciable levels of nutrients in the leaf, stem bark and root bark of this plant. Crude protein was present in all the plant parts, and the absence of tannins in these parts indicates that *I. doka* protein would be free for absorption in the gut. The high values of ash in all the plant parts indicated that the percentage of minerals that are present in these parts was high. Minerals assist in the proper functioning of the heart, brain, muscles and bones. They also aid in the suitable utilisation of other nutrients. The highest amounts of crude fibre and carbohydrate were found in the leaf, while considerable levels were present in the stem bark and root bark. Carbohydrates supply the body with energy and regulate blood. Fibre aids in digestion, prevents obesity, reduces the risk of cancer and cardiovascular diseases. The nutrients found in these plant parts may play a crucial role in the maintenance of optimal health; therefore, the leaf may be used as a potherb.

In conclusion, the present study showed that the leaf of *I. doka* is an excellent source of alkaloids. In addition, considerable levels of phenols and saponins were also present in the leaf, as well as in the stem bark. High levels of minerals were also found in the three parts of the plant investigated. The presence of these vital phytochemicals and nutrients suggests that *I. doka* leaf and stem bark extracts may prove to be beneficial for human health. Hence, their pharmaceutical application as well as the culinary usefulness of the leaf is recommended. Moreover, before a final conclusion is drawn, further research is required in order to determine the different classes of each phytochemical that was present and their pharmacological potentials.

Competing Interests

The authors declare that there were no competing interests.

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