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Saraca asoca (Roxb.) de Wilde, a sacred tree: Its nutritional value, elemental composition and anti-nutritional content

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Abstract

The sacred *Saraca asoca* (Roxb.) de Wilde tree holds significant medicinal value and is utilized in ayurvedic preparations to treat various health conditions. This research investigated the nutritional, elemental and anti-nutritional properties of *S. asoca* leaves and flowers. The nutritional qualities of the tree parts were examined using the muffle furnace and micro-Kjeldahl techniques. Titration techniques were used to assess the anti-nutritional content of plants, whereas EDX (Energy dispersive X-ray) was used to determine the mineral content. Phytochemical analysis revealed the presence of tannins, phenols and flavonoids, along with antioxidant properties that could neutralize free radicals generated by metabolic processes in the body. Nutritional analysis indicated that the floral parts of *S. asoca* had higher moisture, carbohydrate and crude fat content than the leaves. Conversely, the leaves had elevated ash levels, crude fiber and protein. Leaf samples showed higher concentrations of minerals like calcium, phosphorus, sodium, iodine, iron and manganese compared to the floral samples. In contrast, flower samples exhibited higher potassium, copper, silicon and zinc levels. These findings highlight the rich nutritional profile, abundant phytochemicals and essential minerals in both tree parts, with low anti-nutrient content. This information could be instrumental in developing phytopharmaceuticals and nutritious food products. Additionally, utilizing these tree parts could offer a cost-effective way to enhance nutrient intake and address nutritional deficiencies in humans and animals.

Keywords

antinutritional factors; elemental composition; nutritional; *Saraca asoca*

Introduction

As the population grows alarmingly, it is necessary to utilize available resources wisely to meet the daily necessities. Based on FAO statistics, this population growth is predicted to result in a 60 % rise in the world's food demand by 2050 (1). This increase in food demand poses significant challenges to global food security and sustainability, making it crucial to explore alternative food sources. Researchers emphasized the significance of continuous commitment to achieving sustainable development goals for the general well-being of vulnerable communities, stressing the relevance of focused efforts to address hunger, malnutrition and related concerns by assessing SDG index reports (2). A few existing sustainable practices include food and feed sources from microalgae (3), vegan food production from

filamentous fungi (4) and nano farming in agriculture. However, these practices require developing feasible and robust processes that allow the development of different products. On this ground, it is essential to revisit plants with medicinal values to be a better diet option that serves the dual purpose of meeting daily needs and giving disease-resistance power. In addition to the role of plant extracts in providing resistance against infectious diseases, they have also been proven to have labor induction efficiency during pregnancy (5), treating dermatological disorders (6) and diabetes treatment.

Saraca asoca, also known as sita ashoka or ashoka, is a member of the Fabaceae family and is used in the Indian Ayurvedic traditional system of medicine to treat various ailments (7). *Saraca asoca* has a long history of treating gynecological diseases and other illnesses, garnering tremendous respect from the community (8). Reports showed that *S. asoca* was one of the plants that are tolerant to air pollution, based on their air pollution tolerance index (APTI) (9). Also, it has been reported that *S. asoca* flower extracts showed maximum antibacterial activity against gram-negative bacteria (10). Additionally, the floral samples after GC-MS analysis revealed the presence of different essential oils (11) and it was reported that the methanolic bark extract of *S. asoca* could attenuate benzene-induced acute myeloid leukemia in mice (12). *S. asoca* plant parts have been used in various formulations of commercial products under various names to treat human diseases (13). Consumption of these helps protect the immune system and aid it in fighting against microbial diseases and cancer treatments (14). However, *S. asoca* contains alkaloids, phytate, saponin and oxalate, anti-nutritional components, which have been claimed to inhibit the body's ability to use certain nutrients. Plants have developed anti-nutrients for their defense as well as other biological purposes (15). When ingested in moderation, these chemical compounds (antinutrients) in plants benefit human and animal health but are dangerous when consumed in large quantities. It has been shown that antinutrients reduce insulin and blood sugar responses to dietary cholesterol and carbohydrate meals (16).

The present study aims to explore the nutritional and medicinal potential of *S. asoca* within the context of addressing the increasing demand for alternative food sources and healthcare solutions due to population growth. Drawing from its traditional use in Indian Ayurvedic medicine, particularly in treating gynecological diseases, the study investigates various plant parts with antioxidant and antibacterial properties, including leaves and flowers. Furthermore, the study intends to assess the potential anti-nutritional components within *S. asoca* and their impact on nutrient absorption. It aims to provide insights into its safe and effective utilization as a dietary supplement and medicinal resource. As a result, the study seeks to enhance comprehension of how *S. asoca* can bolster nutritional well-being and immunity, thereby tackling the intertwined issues of food security and sustainable healthcare.

Materials and Methods

Collection of samples

The leaves and flowers of *Saraca asoca*, were collected in March 2023 from a garden and identified by Dr. V. Rama Rao, research officer, Central Ayurvedic Research Institute, Bangalore, Karnataka (No. RRCBI- 11468). The plant samples were allowed to air-dry at room temperature for 7-10 days after being pre-washed with tap water and then cleaned with distilled water. It was ultimately kept for oven drying at 40 °C to eliminate any remaining moisture. For later usage, the dried portion of the leaves and flowers was ground into a powder using a mixer grinder and kept in an airtight container (Fig. 1).

Fig. 1. *Saraca asoca* plant.

Extract preparation

The dried sample weighed about 0.2 g and was put into test tubes with 5 mL of solvent, methanol. Whatman No. 1 paper filtered the extract solution after 48 h, enabling the solvent to drain entirely. It took 10 days for the solvent to evaporate completely. Extracts were re-suspended in extracting solvent to achieve a stock solution of 10 mg/mL and were further diluted based on the experimental setup (Fig. 2).

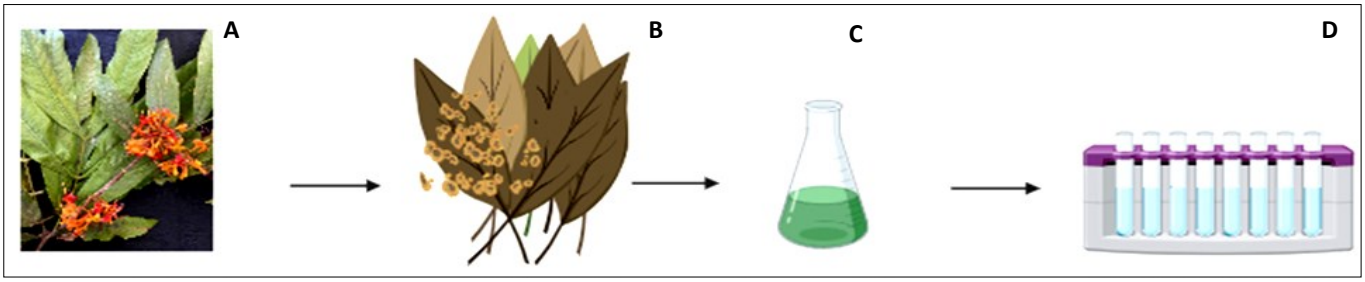

Fig. 2. Pictorial representation of sample and extract preparation of the *S. asoca* leaf and *S. asoca* flower. (**A**) *S. asoca* leaf and flower, (**B**) Dried plant parts, (**C**) Preparation of plant extracts and (**D**) Extracts for phytochemical tests and antioxidant assays.

Quantitative determination of phytochemicals

Total phenol content

Each sample extract (0.5 mL) was combined with 2.5 mL of a folin-ciocalteu reagent diluted ten times and 2 mL of 7.5 % sodium carbonate in test tubes. Using a UV spectrophotometer, the absorbance at 760 nm of the above mixture was measured after 30 min of dark incubation against the reagent blank. Using varying doses of 50-400 µg/mL of gallic acid as a standard, the total phenol content of the extract was quantified in terms of gallic acid equivalent (mg GAE /g) extract (17).

Flavonoid estimation

The total flavonoids in the plant sample provided by were estimated using the aluminium chloride method with certain modifications (18). Separate mixtures of 1.5 mL methanol, 0.1 mL 10 % aluminium chloride, 0.1 mL 1 M potassium acetate and 2.8 mL distilled water were added to each solvent extract (0.5 mL of 1:10 g mL^{-1}). After 30 min of incubation at room temperature, the absorbance of the reaction mixture was measured at 418 nm. The extract's total flavonoid content was quantified using quercetin equivalent (mg QE /g) extract, with quercetin serving as the standard at varying doses (20 µg/mL–100 µg/mL).

Tannin estimation

According to the modified protocol (19), the tannins were detected using the folin-ciocalteu method. 7.5 mL of distilled water, 0.1 mL of extracts, 0.5 mL of folin ciocalteu phenol reagent, 1 mL of 35 % sodium carbonate solution, and 10 mL of distilled water were added to the test tubes. The mixture was given a thorough shake before being allowed to sit at room temperature for half an hour. A UV spectrometer assessed absorbance at 700 nm against a blank. As a reference, tannic acid was utilized at concentrations between 20 and 100 µg/mL. The extracts' tannin content was expressed as milligrams of tannic acid equivalents per g.

In vitro antioxidant assay

Phosphomolybdate assay

The phosphomolybdate method (20) was employed to evaluate the overall antioxidant potential of solvent extracts, albeit with some modification. After adding 300 µL of the plant extract and 3 mL of the phosphomolybdate reagent to a test tube, covering it with aluminium foil, the tube was incubated in a water bath at 95 °C for 90 min. The absorbance of the sample was determined at 695 nm. Methanol was used as blank and L-ascorbic acid as standard. The antioxidant capacity was quantified as µg of ascorbic acid equivalents (AAE) per milliliter (mL) at concentrations between 20 and 100 µg/mL.

DPPH (2, 2-diphenyl-1-picrylhydrazyl) oxidant quenching potential

The modified DPPH (2, 2-diphenyl-1-picrylhydrazyl) test was used to measure the antioxidant activity of the plant samples (21). After adding and properly mixing 3.94 mg of DPPH dissolved in 100 mL of methanol, the mixture was incubated in the dark for 30 min or 0.1 mM DPPH solution. Using methanol as a blank, a UV-VIS spectrophotometer (Shimadzu, UV-1900) was used to measure the absorbance at 517 nm. The following formula was used to determine the % of antioxidant activity:

$$\text{Radical scavenging activity (\%)} = \frac{A_{control} - A_{sample}}{A_{control}} \times 100$$

…...(Eqn 1.)

Where A denotes the absorbance values

Mineral composition of *S. asoca*

EDX (Energy dispersive X-ray) was used to determine the mineral composition of *S. asoca* leaf and flower samples. It relies on the interaction of X-ray excitation and the sample (22) (Fig. 3).

Proximal analysis

Moisture content estimation

After being weighed (W_1), an empty weighing jar was chilled and dried in an oven set to 105 °C for an hour. A sample weighing 2 g (W_2) was dried at 105 °C in an oven until a consistent weight was achieved. After cooling in a desiccator, this was weighed (W_3) (23). It was determined that the moisture % was:

$$\text{\% Moisture content} = \left(\frac{W2 - W3}{W2 - W1}\right) \times 100$$

…...(Eqn 2.)

Total ash content analysis

The sample was collected in a silica crucible and heated to 600 °C in a muffle furnace for 6 h. The ash was transferred from the crucible to a desiccator and weighed once it had reached room temperature (24). The following formula was used to calculate ashes:

$$\text{Ash percent} = \left(\frac{\text{Weight of Ash}}{\text{Weight of Sample}}\right) \times 100$$

…...(Eqn 3.)

Crude fat estimation

The crude fat content was determined by extracting a 5 g ground sample for 24 h using diethyl ether (25). A known-weight beaker (W1) was utilized to filter the extract. After adding diethyl ether to 100 mL and shaking for 6 more hours, the filtrate was collected into W1. After being concentrated in a steam bath until dry, the ether was baked at 40 to 60 °C. After that, the beaker was weighed again (W2). Using the following formula, the fat content was estimated:

$$\text{\% crude fat} = \left(\frac{W2 - W1}{\text{Original weight of sample}}\right) \times 100$$

…...(Eqn 4.)

Crude protein estimation

Using the Kjeldahl method, crude protein was calculated (26). The 2 g of powdered material was heated to a precise mixture in a Kjeldahl flask using 20 mL of concentrated H_2SO_4 and a digestion tablet (catalyst). The digest was distilled following sifting and re-adding material to a 250 mL volumetric flask. After adding 50 mL of a 45 % sodium

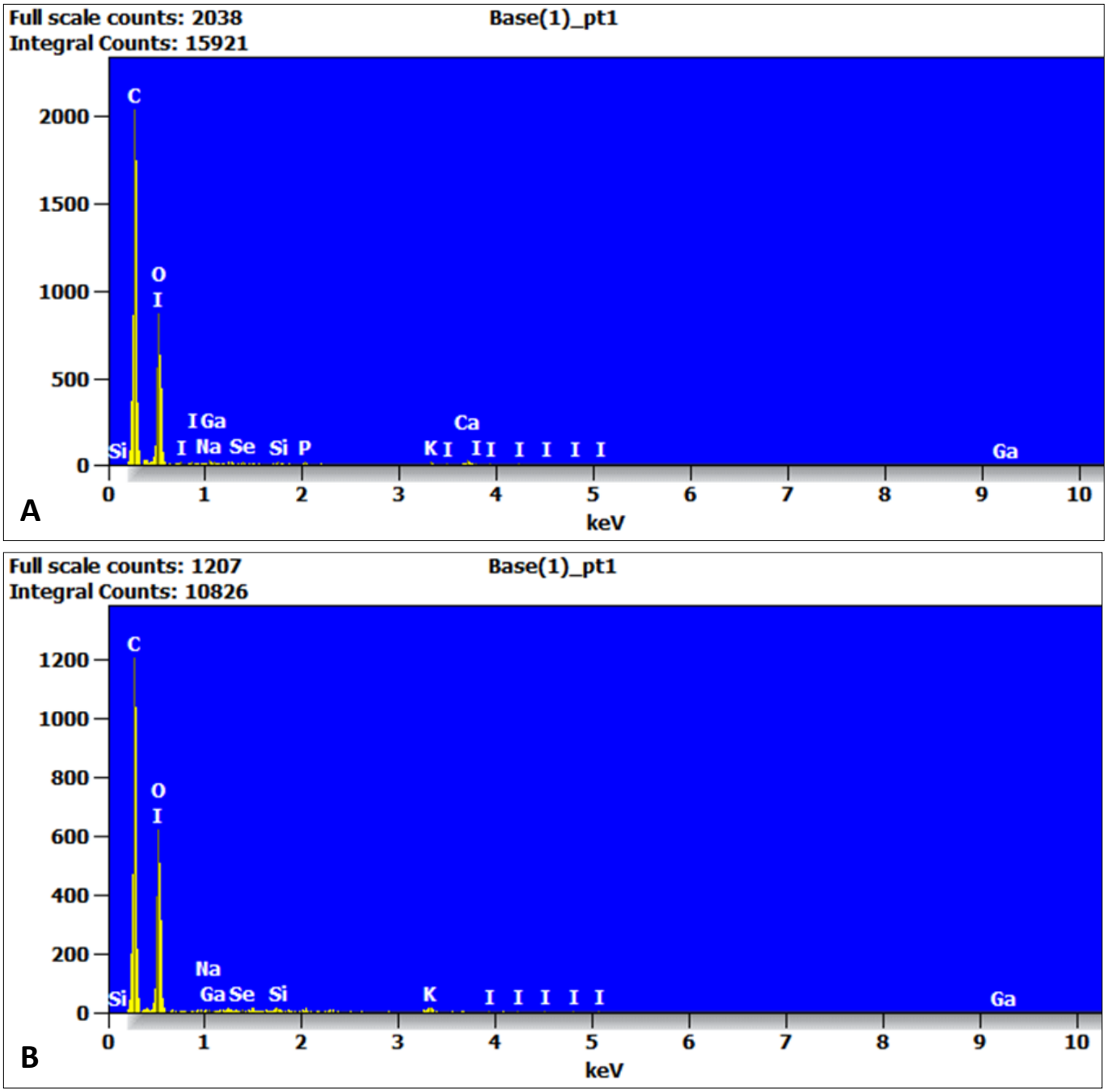

Fig. 3. (**A**). EDX analysis showing the elemental composition of *S. asoca* leaf, (**B**). EDX analysis showing the elemental composition of *S. asoca* flower.

hydroxide solution to the 500 mL round-bottom flask containing the aliquot, the liquid was distilled.150 mL of the distillate was added to a flask containing 100 mL of 0.1 N HCl. This was titrated against 2.0 mol/L NaOH using methyl orange as an indicator. At the end, the color changes to yellow.

Crude protein percentage = Nitrogen × 6.25

……..(Eqn. 5)

Carbohydrate estimation

The % of carbohydrates was determined by deducting the total dry matter (100) from the total protein, moisture content, crude fiber, ash and crude fat (27). The result was the following:

% carbohydrate = 100 -(moisture content + total ash + 5 crude fat + crude fiber + crude protein)

Determination of crude fiber

The crude fiber content of *S. asoca* was calculated using the methodology outlined by (28). After heating 1 g. of the powdered sample for 30 min, filtering it under pressure and rinsing the residue in boiling water, 100 mL of 1.25 % H_2SO_4 was added. A 100 mL solution of 1.25 % NaOH was added to treat this residue further and boil it. After that, the finished residue was weighed, dried at 100 °C and refrigerated in a desiccator (W1). After cooling for 5 h. in a desiccator, the final residue was reheated to 550 °C in a muffle furnace and weighed again (W2). The formula that follows was used to get the % of crude fiber:

$$\% \text{ Crude fiber} = \left(\frac{W2 - W1}{\text{Original weight of sample}}\right) \times 100$$

……..(Eqn. 6)

Energy value

The values obtained for crude protein, crude fat and crude carbohydrate were multiplied by 4, 9 and 4 respectively and the results were added up to establish the energy value.

$$\text{Energy value (kcal}-100\text{ g)} = (\text{carbohydrate} \times 4) + (\text{crude fat} \times 9) + (\text{crude protein} \times 4)$$

……...(Eqn. 7)

Determination of anti-nutrient content

Determination of saponin

A modified version of the approach was employed (29). After soaking 1 g of the sample in 20 mL of 20 % ethanol, it was mixed correctly and heated for 4 h at 55 °C in a water bath. The substance was filtered with 20 mL of 20 % ethanol and vigorous shaking (without heating) and then extracted again. Following filtering, the filtrate was mixed with the original filtrate. After being heated to 90 °C in a water bath, the filtrate was lowered to a quarter of its initial volume. Diethyl ether (20 mL) was added after transferring the filtrate to a separating funnel. Before reattaching the items to the tripod stand, they were thoroughly shaken. The liquid was separated into an aqueous bottom portion and an ether-like top portion with fatty chemicals. The bottom portion was preserved. After adding the n-butanol, the funnel was violently shaken, and the aqueous layer was poured back into it. After the weighted beakers were cleaned and pre-weighed, the butanol layer was collected and evaporated until completely dry. Later, to attain a consistent weight, the residue was dried in an oven.

$$\%\ \text{Saponin} = \frac{\text{weight of the residue final sample}}{\text{weight of the original sample}} \times 100$$

…..……(Eqn. 8)

Determination of phytate

The methodology for determining the phytate content was slightly modified (30). A flask containing 1 g of ground sample was filled with 50 mL of 2 % HCl, allowed to soak for 3 h and then filtered. Another 250 mL conical flask was filled with 25 mL of filtrate and an indicator (thiocyanate solution) was added. Amounts of distilled water added: 53.5 mL to achieve typical acidity. The mixture was next titrated against a reference solution of iron (III) chloride (0.00195 g/mL) and this process was repeated until the mixture retained a brownish-yellow color for 5 min. Phytate was computed in this way:

$$\text{Phytate (\%)} = \text{titer value} \times 0.00195 \times 1.19 \times 100$$

.....…...(Eqn. 9)

Estimation of oxalate content

To determine the amount of oxalate in the sample, the approach was revised (31) was used. A conical flask containing 1 g of the ground sample was filled with 75 mL of 3 M sulfuric acid and vigorously agitated with a magnetic stirrer for an hour. After the solution was filtered, 25 mL of the filtrate was saved, heated to 85 °C and maintained above 70 °C for the duration of the experiment. The heated aliquot of the filtrate was titrated against 0.05 M/L of $KMnO_4$ until the reaction reached its endpoint, which is a pale pink color that lasts for 15 sec. 1 mL of 0.05 M was used to calculate the oxalate content.

Alkaloid estimation

The alkaloid content has been determined by slightly altering the Harborne technique (32). A 100 mL beaker was filled with 2 g of the sample and 20 mL of 10 % acetic acid in ethanol and the mixture was capped and let to stand for 4 h. After filtering, the extract was concentrated to a quarter of its original volume in a water bath. The extract was gradually mixed with concentrated ammonium hydroxide until the precipitation formed. After settling the mixture, the residue was gathered, cleaned with diluted ammonium hydroxide and filtered. The alkaloid, which was weighed and dried, is the residual.

$$\%\ \text{alkaloid} = \frac{\text{weight of precipitate}}{\text{weight of the original sample}} \times 100$$

…….(Eqn. 10)

Statistical analysis

The significant difference ($p<0.05$) was determined by one-way ANOVA operating DMRT in IBM SPSS statistics 21. All the values were expressed as mean ± SD (n=3).

Results

Phytochemical analysis

Phytochemical analysis was performed for *S. asoca* leaf and flower methanolic extracts. The values are depicted in Table 1. Comparing the total phenol content of the leaf and the flower, the values were 143.48 ± 15.98 and 91.86 ± 2.88 mg GAE /g respectively, showing less total phenol in the leaf. Higher values were found for the flavonoid and tannin content in *S. asoca* leaf samples, following a similar pattern. The leaf had a flavonoid concentration of 519.16 ± 14.0 mg QE/g, whereas the flower flavonoid value was 12 mg QE/g. The amount of tannin in the flower was 12.65 ± 3.69 mg TA/g, whereas the tannin content in the leaf was reported to be 28.71 ± 0.70 mg TA/g.

Table 1. Determination of bioactive contents (mg/g) in *S. asoca.*

Quantitative parameters	Leaf	Flower
Total phenol	143.8 ± 15.98[a]	91.86 ± 2.88[b]
Flavonoid	519.16 ± 14.0[a]	430.0 ± 26.27[b]
Tannin	28.71 ± 0.70[a]	12.65 ± 3.69[b]

Values are in mean ± standard deviation, the same letters indicate no significant difference at a 5 % probability level.

In vitro antioxidant activities

Antioxidant activities of the leaf and flower were determined. Phosphomolybdate assay results for leaf and floral methanolic extract were 43.66 ± 6.47 and 13.11 ± 0.90 (µg/mL) respectively. Using DPPH to measure radical scavenging

activity, the antioxidant potential of the leaf sample was 90.35 ± 0.24 % and the flower sample was 96.52 ± 0.16 %.

Proximate analysis

The moisture content was 8.08 % and 10.44 % for the *S. asoca* leaf and flower respectively. The ash content was 10.0 % in the *S. asoca* flower and 17.0 % in the *S. asoca* leaf. The crude protein was 6.81 % in the flower and 8.43 % in the leaf, whereas the *S. asoca* flower had a higher % of total carbohydrate, 7.59 %, than the leaf and was found to be 9.69 %. Crude fat in the *S. asoca* flower was 40.63 % higher than the *S. asoca* leaf at 23.23 %, whereas the crude fiber % was higher in the leaf sample at 35.3 % than in the flower sample. The energy value was 273.15 kcal for the leaf sample and 431.67 kcal for the flower (Fig. 4).

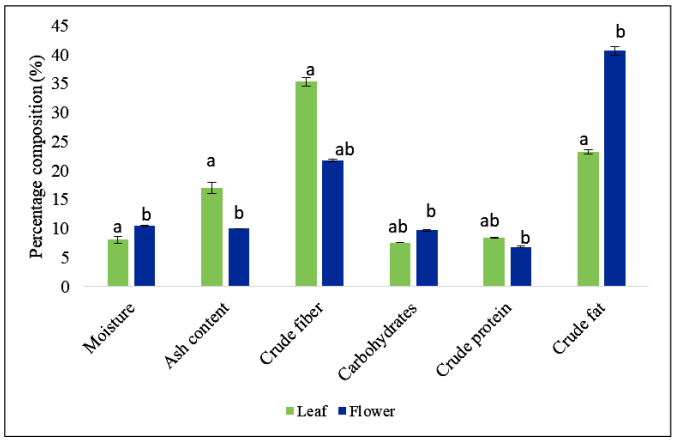

Fig. 4. Proximate composition of *Saraca asoca* leaf and flower. Histogram bar with the same letters indicates no significant difference at a 5 % probability level.

Mineral elemental analysis and antinutrient content: The EDX spectrum describes elemental analysis of the *S. asoca* plant parts. The spectra show peaks for various elements in both samples, as shown in Fig. 3 (Table. 2). The samples had carbon contents ranging from 39360 ± 6.07 to 37240 ± 9.2 mg. Compared to the *S. asoca* flower, the carbon value in the leaves was greater. The oxygen content of the leaf and flower sample varied from 53850 ± 15.6 to 58160 ± 12.02. The sodium (Na) content in the leaf was 140 ± 2.02 mg to negligible in the *S. asoca* flower. Silicon content was higher in the flower (970 ± 5.02) than in the leaf samples (200 ± 3.1). Phosphorus (P) and calcium (Ca) content was negligible in the flower, whereas the leaf had an appreciable amount of phosphorus (400 ± 2.01) mg and calcium (3410 ± 2.37). The potassium (K) content in the flower was found to be higher (3630 ± 7.30) and leaf (1240 ± 2.05). The presence of iodine (I) was detected in the leaf (1410 ± 2) and not in the floral sample. Micronutrients such as zinc (Zn), iron (Fe), manganese (Mn), and copper (Cu) were also found in the *S. asoca* samples. The samples had zinc (Zn) contents ranging from 1.18 ± 0.04 to 1.59 ± 0.07 mg. The iron range (Fe) was 4.76 ± 0.41–17.06 ± 1.8 mg; the leaf had a more excellent Fe content than the *S. asoca* flower. The values of the leaves and flowers of *S. asoca* differed significantly. The manganese (Mn) in the samples varied from 0.69 ± 0.02 to 1.458 ± 0.01 mg. The plant parts had different copper (Cu) amounts, ranging from 0.783 ± 0.01 to 1.005 ± 0 mg. The Cu concentration in *S. asoca* leaves was higher and differed from that of the flowers.

Table 2. Content of minerals in leaves and flower of *S. asoca* (mg/100 g).

Minerals	*S. asoka* leaf (Mean ± SD)	*S. asoka* flower (Mean ± SD)
C	39360 ± 6.07	37240 ± 9.2
O	53850 ± 15.6	58160 ± 12.02
Na	140 ± 2.02	-
Si	200 ± 3.1	970 ± 5.02
P	400 ± 2.01	-
K	1240 ± 2.05	3630 ± 7.30
Ca	3410 ± 2.37	-
I	1410 ± 2	-
Zn	1.18 ± 0.04	1.59 ± 0.07
Fe	17.06 ± 1.8	4.76 ± 0.41
Mn	1.458 ± 0.01	0.69 ± 0.02
Cu	0.783 ± 0.01	1.005 ± 0

mean ± SD of 3 replicates.

The samples comprised alkaloids ranging from 0.07 ± 0.02 to 0.66 ± 0.28 %. The oxalate content of *S. asoca* varied from 3.22 ± 0.25 to 3.813 ± 0.83 %; the leaf had the highest value, which was not significantly different from the flower. The sample's phytate contents varied, ranging from 0.37 ± 0.01 to 1.09 ± 0.02 %; the leaf had a comparatively more significant % of phytate. The amount of saponin varied from 0.56 ± 0.15 to 1.3 ± 0.65 %, with the highest rate found in leaves (Fig. 5).

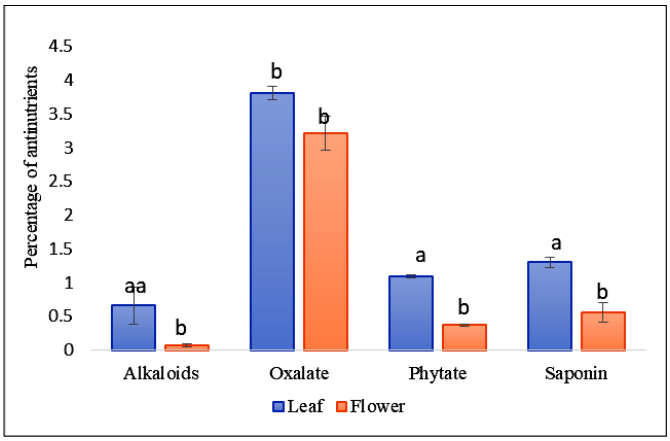

Fig. 5. Antinutrient contents of *S. asoca*. Histogram bar with the same letters indicates no significant difference at a 5 % probability level.

Discussion

The proximate mineral composition and contained antinutrients varied during the investigation of *S. asoca* leaf and flower. According to the research (33), phenols are the secondary metabolites in the plant defense systems. The antioxidant ability of phenols is connected to their structure (aromatic ring with -OH or -OCH_3 substituents), which is ideal for trapping free radicals. The phytochemical analysis of this study agrees with the reports (34) having phenolics and flavonoid content in the leaf methanolic extract. Flavonoids, in addition to their direct reactive oxygen species (ROS) scavenging properties, aid in activating several antioxidant enzyme functions and producing numerous antioxidant and phase II detoxifying enzymes (35). This

indicates the role of *S. asoca* as a potent antioxidant-rich plant. Further, this was supported by the *in vitro* antioxidant assays. The antioxidant potentiality detection assay using DPPH revealed that the flower methanol extract exhibited more significant activity than the leaf radical scavenging activity. The radical scavenging activity of the methanolic leaf extract was 94.4 ± 1.2 %. This study suggests that *S. asoca* flowers are a natural source of antioxidants that may help prevent oxidative stress. Studies by (36) showed that moisture content directly relates to the shelf life of food items. Concerning its low moisture content, *S. asoca* leaves may be more easily stored and less contaminated by microbes than *S. asoca* flowers. The ash content in food items is a mineral nutritional index (37). Dietary fiber has a role in maintaining good health by providing resistance against diseases and improving gut microbiota (38). This study showed the highest dietary fiber in the leaf, followed by the flower. Intake of dietary fat from plant-based sources could prevent the chronic ailments associated with animal-based fat (39). In this regard, the high dietary fat content of *S. asoca* leaf and flower can be an excellent alternative source of animal-based nutritional fat. Crude protein and carbohydrates were also significantly different among the parts, which can contribute to the growth and development of animals. Crude proteins were higher in the leaf than in the flower samples. Low carbohydrate content in *S. asoca* plant parts could improve obesity and overweight in patients with metabolic disorders (40). Alkaloids produced by common crops and weedy wild flora can harm the ecosystem in the same way as industrial chemicals can, especially in stagnant bodies of water (41). The concentration of alkaloids in the plant parts was moderate, easing concerns about antinutrient activities (42). Oxalates were reported to reduce Ca absorption and encourage kidney stone formation. They were also found to interact with the minerals, rendering them available for absorption (43). Both *S. asoca* leaf and flower exhibited much fewer total oxalates than spinach, a leafy vegetable with the most excellent oxalate level (658 mg/100 g). Phytate is the phosphorus and minerals storage form in plants, inhibiting trace elements' intestinal absorption. However, it has been reported that phytate has antioxidant properties and helps in osteogenesis (44). This study showed the presence of phytate in a lower range, which could not be harmful; at the same time, its lower concentration had a protective role. Saponins are chemical molecules that create insoluble complexes with minerals, rendering them unavailable for absorption at large doses. According to previous reports, exposure to higher concentrations of saponin can be toxic to humans, slugs (45), worms and fishes. In this context, the saponin content of both leaf and flower samples of *S. asoca* has negligible saponin, making it a promising candidate for human and animal diets (46). Antinutrients are substances that plants make as a defensive strategy that might impair their ability to digest food when consumed by other animals (47). However, the levels of anti-nutrients (phytate, oxalate, saponin and alkaloids) revealed in this study were below the safe threshold. They might not be harmful when ingested, particularly if heated beforehand. Pre-treatment processes such as roasting, soaking, fermentation, sprouting, milling and bran removal can reduce the antinutrient content of plant-based foods (48). Mineral nutrients are essential for the body and can be macro and micronutrients (49). Calcium (Ca) is good for strong teeth and bones; lack of calcium results in a breakdown of bones and neurological illness (50). Additionally, it is essential for the contraction of muscles. The *S. asoca* leaf sample used in this study had more calcium than the daily allotment suggested, although calcium in the flower was negligible. Oxygen content was found to be the highest element present in both *S. asoca* leaf and flower. Oxygen in its active form affects the defense mechanism and directly relates to the antimicrobial effect (51). The amount of carbon in *S. asoca* leaves and flowers is relatively high, as carbon is a significant component of biochemical molecules (52). Reports show that ROS generation is increased in plants low in potassium under various environmental stressors, such as low temperature, salinity and drought conditions (53). Potassium content in both plant parts ranged from 1240 mg/100 g to 3630 mg/100 g; that shows the capability of the plant of this study to control the production of reactive oxygen species. Sodium is essential for maintaining the body's osmotic pressure, membrane potential and nerve impulse transmission (54). Na levels in leaves were higher in this study than in flowers. Researchers have shown that silicon (Si) is an essential mineral element that minimizes the toxicity of heavy metals (55). In this study, the *S. asoca* flower has a significantly higher silicon content, 970 ± 5.02 mg/100 g, than the leaf, 200 ± 3.1 mg/100 g, indicating its potential in toxicity studies. Studies showed that iodine (I) enhanced plant development and growth, encouraging biomass creation and early flowering (56). *S.asoca* leaf showed iodine's presence, indicating its importance in plant growth. The body uses manganese for many functions, such as the metabolism of amino acids, glucose and cholesterol. It is a crucial component in the production of blood, blood clotting and inflammation control (57). Copper (Cu) is essential for healthy bone, connective tissue, brain and heart development and maintenance (58). Cu levels in both plant parts were more significant than the RDA of 0.7 for children. Iron (Fe) is a mineral element required for immune cell function and defense (59). Appreciable amounts of Fe were found in the plant's parts of *S. asoca*. Healthy growth of bones, muscles and teeth depends on phosphorus (60). Adults and children's respective RDAs for phosphorus are 1000 and 200 mg. It was found that 400 mg/100 g was the phosphorus content found in the plant leaves, indicating that the leaf could be used in the diet to meet the RDA daily allowance. Zinc levels in the leaf and floral parts were 1.18 and 1.59 mg/100 g. Zn is an important nutrient for synthesizing protein and collagen, promoting healthy skin (61).

Conclusion

Although its plant parts have been utilized widely in traditional and commercial pharmaceutical formulations, little was known about its mineral composition, which is investigated in this work. Plant parts such as leaves and flowers

of *S. asoca* are good sources of nutrients required for the body. Phytochemical analysis and antioxidant assay revealed the presence of phenolic compounds that can relieve the toxic reactive oxygen species produced in the body and relatively low antinutrients, making them a suitable candidate for consumption and inclusion in our daily diet. Boiling leaves in water could even lessen the bioaccumulation of antinutrients when taken daily. Additionally, the high demand for medicinal plants in developing nations might pose a significant threat to the widespread availability of those plants due to factors including overpopulation, deforestation and urbanization. As a result, conservation efforts are crucial and require a multifaceted approach encompassing habitat protection, reforestation, research, community engagement, policy advocacy, education, collaboration and *ex-situ* conservation. First and foremost, it is crucial to identify and safeguard the natural habitats where *S. asoca* thrives by establishing protected areas like national parks or reserves. Concurrently, tree planting initiatives can be implemented to restore degraded habitats and bolster the species population, involving community participation and native tree nurseries to ensure genetic diversity. Research and monitoring efforts should be intensified to gain insights into the species' ecology, biology and conservation needs, helping to identify threats and guide effective conservation measures. Engaging local communities through awareness campaigns can foster sustainable use and management practices, mitigating risks such as illegal logging and overharvesting. Advocacy for protective legislation, regulations and policies is essential, as well as collaborating with governmental bodies, NGOs and stakeholders to create a supportive legal framework. Educational initiatives targeting the public and schools can enhance conservation awareness and promote active involvement in conservation activities. Lastly, fostering collaboration and partnerships among conservation organizations, research institutions and communities can synergize efforts, pool resources and implement effective conservation strategies. Additionally, establishing botanical gardens, arboreta or seed banks can serve as vital *ex-situ* conservation measures, safeguarding *S. asoca* against extinction and providing a reservoir for potential reintroduction efforts. By integrating these comprehensive conservation approaches, we can strive to ensure the survival and ecological balance of endangered tree species like *S. asoca* for future generations.

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Authors' contributions

MS did quantitative studies on the plant and analyzed the results. MP has guided and edited the work. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

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