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Nutritional and Anti-nutritional Compositions of the Leaves and Stem Bark of *Ficus glumosa*

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Authors' contributions

This work was carried out in collaboration among all authors. Author AFA designed the study, performed the statistical analysis and wrote the protocol. Author AIA wrote the first draft of the manuscript while author IO wrote the second draft of the manuscript. Authors AFA and IO managed the literature searches.All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aim: To evaluate the proximate, mineral, anti-nutritional and amino acid compositions of *Ficus glumosa* leaves and stem bark.
Place and Duration of Study: The proximate, mineral and anti-nutritional compositions were determined in the Chemistry Laboratory of Ekiti State University, Ado – Ekiti while the amino acid was determined at the Analytical Laboratory of Multi-Environmental Management Consultant, Lagos, Nigeria. The research was carried out between November 2020 and September 2021.
Methodology: All investigations were carried out using well established analytical procedures. Amino acid analysis was carried out through ion exchange chromatography (IEC) using the Technicon Sequential Multisample (TSM) Amino Acid Analyser.
Results: The results revealed that the leaves and the stem bark of *Ficus glumosa* had moisture contents of 9.78 and 9.67% respectively. Crude protein of 18.8% was recorded for the leaves while 7.73% was recorded for the stem bark. The leaves were observed to contain higher mineral contents than the stem bark. Na/K ratios were 0.048 (leaves) and 0.09 (stem bark). Out of the four anti-nutrients evaluated for the leaves and stem bark, tannins recorded the highest values of 5.42 and 12.5 (mgTAE/g) respectively. Amino acid compositions showed that the leaves and the stem

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bark contained a total of 95.2 and 83.4 g/100g cp amino acids respectively. Highest concentrated amino acid was Glu with 12.8g/100g cp and 16.2g/100g cp for both leaves and stem bark. Essential amino acid (with His) was 44.9g/100g cp (47.2%) for the leaves and 37.2g/100g cp (44.6%) for the stem bark.

Conclusion: The leaves and stem bark of *Ficus glumosa* contained appreciable amount of crude protein, important mineral elements and essential amino acids which could contribute to alleviating the problem of protein malnutrition in developing countries.

Keywords: Amino acids; mineral elements; anti-nutritional factors; Ficus glumosa.

1. INTRODUCTION

"Ficus glumosa Delile (*F. glumosa*) is a specie tree which belongs to the family *Moraceae*. It is commonly known as African rock fig or mountain rock fig. It is a fast-growing tree in arid areas and can even grow much faster in areas where a higher rainfall is experienced. *F. glumosa* is a small to medium sized tree that typically grows 5 to 10 m tall, although, it may become a large tree reaching 24 m and 2 cm in girth" [1,2]. The branches are widely spread, thick and hairy, the leaves are thick with silky white oblong hairs. The bark is pale to grey to yellowish grey and has a smooth to slightly rough texture.

F. glumosa is an important medicinal plant. In Senegal and Côte d'Ivoire the root and fruit are used in preparations to cure female sterility [3,4]. "Decoction of the bark is used in mouthwash against toothache. In East Africa, pounded bark soaked in water is drunk against stomach disorders [3] and also used to treat ulcers or mouth sores until they are healed" [5]. The plant parts of F*. glumosa* which include stem, leaves and bark are used as diabetic medications in African countries [6-7].

F. glumosa is cultivated for its edible fruits. The young leaves are consumed as vegetables in local delicacies [8-9], the bark is a source of tannin [3].

In Southwestern part of Nigeria, the pounded bark (brick red colour) moulded with hands into round shape, sundried and pulverized is used as the major ingredient in preparation of medicinal soup, however, other medicinal plant ingredients such as turmeric, ginger, etc. may also be added. To conquer the increasing problem of malnutrition in developing countries of the world, there is a need to search for and evaluate the nutritional value of edible neglected plants such as *F. glumosa* which have been used in time past to overcome famine by the aged people. Some researchers have worked on the medicinal properties of the leaves extract of *F. glumosa* [6,10-11], but currently, there is paucity of information on the nutritional and anti-nutritional compositions of the leaves and stem bark. The present study is designed to provide useful information on the nutritional qualities and the level of some anti-nutritional factors in the leaves and stem bark of *F glumosa.*

2. METHODOLOGY

2.1 Collection of Samples

F. glumosa leaves and bark were collected from a farm in Ado-Ekiti, Ekiti State, Nigeria. The plant leaves and stem bark were duly authenticated at the Herbarium in Plant Science Department, Ekiti State University, Ado Ekiti, Nigeria by Mr Felix Omotayo.

2.2 Sample Preparation

The leaves and stem bark of the plant were rinsed with distilled water. The stem bark was cut into smaller pieces for easy drying. The leaves and the stem bark were air dried at room temperature (30^oC) separately. The dried plant parts were ground using electric blender and the powdery sample was packed into a polythene bag prior to further analysis.

2.3 Proximate Analysis

The moisture, ash, fat, protein and crude fibre contents were determined using the methods of Association of Official Analytical Chemists [12] as described below:

For the moisture content determination, clean and dry crucible was weighed, and the weight was recorded (W_1). Three grammes (3 g) of the sample was weighed into the crucible (W_2). The crucible with the sample was dried in the oven at 105^oC for three hours. The crucible was transferred to the desiccator to cool and the

weight was noted. The process was continued until a constant weight (W_3) was obtained. The percentage loss in weight during drying was taken to be the percentage moisture content (Equation 1).

$$\% \text{ Moisture} = \frac{Weight\ loss}{Weight\ of\ sample} \times 100 \qquad (1)$$

The ash content was determined by weighing 1 g of each sample into a clean, dried and previously weighed crucibles with lid (W_1). After removing the lid, sample was ignited over a low flame to char the organic matter. The crucible was then placed in a muffle furnace at 550 ^{o}C (lid removed). The ashing continued until a light grey or white ash obtained. Crucible was then transferred directly into a desiccator, cooled and weighed immediately (W_2). The percentage ash content was obtained using Equation 2.

$$\% \text{ Ash} = \frac{W_1 - W_2}{Weight\ of\ sample} \times 100 \qquad (2)$$

For the determination of fat content, the Soxhlet extraction method was used. 2 g of sample was weighed into a filter paper. The filter paper with sample was folded neatly. Sample was thereafter placed inside a pre-dried thimble. Thimble with sample was inserted into the Soxhlet flask. A clean and dried boiling flask was weighed (W_1) and diethyl ether was poured into it. The boiling flask containing diethyl ether, Soxhlet flask with sample and condenser were assembled. Extraction was carried out under reflux for six hours. After extraction, the thimble was removed from the extraction barrel and dried. The solvent was distilled off and the boiling flask containing the fat was dried in the oven at a low temperature. The weight of the flask plus oil was recorded (W_2). Fat extracted from given quantity of sample was the calculated as the percentage fat content (Equation 3).

$$\% \text{ Fat} = \frac{(Weight\ of\ flask + fat) - (Weight\ of\ flask)}{\text{sample weight}} \times 100 = \frac{W_2 - W_1}{Sample\ Weight} \times 100 \qquad (3)$$

The total nitrogen amount in the sample was determined following the micro Kjeldahl method. Digestion of the sample (2 g) was done in a Kjeldahl flask by boiling 20 mL of concentrated H_2SO_4 and a Kjeldahl digestion tablet until a clear mixture was obtained. The digest was filtered into 250 mL volumetric flask, made up to mark with distilled water and set up for distillation. Ammonia was steam-distilled from the digest to which 50 mL of 45% NaOH solution has been added. The distillate (150 mL) was collected into a conical flask containing 100 mL 0.1 N HCl and methyl orange was used as an indicator. The ammonia reacted with the acid in the receiving flask and percentage nitrogen (N) was estimated by back titration against 2 M NaOH. Nitrogen calculated using the following equation.

$$\% \text{ Nitrogen} = \frac{(A - B)X\ 1.4007}{Weight\ of\ sample} \times 100 \qquad (4)$$

Where:

A = volume (mL) of standard HCl x normality of standard HCl
B = volume (mL) of standard NaOH x normality of standard NaOH

Percentage crude protein was obtained by multiplying the nitrogen value by a factor of 6.25%

Crude protein = Nitrogen in sample × 6.25.

To determine the crude fibre, 2.5 g of each sample was extracted with diethyl ether in a Soxhlet apparatus. The extracted sample was air dried and transferred to a dry 1 L conical flask containing 1.25% sulphuric acid and was connected to a water cooled reflux condenser and boiled for exactly 30 minutes. The mixture was allowed to cool. It was then filtered through a clean white linen and washed with boiling water until the washings were no longer acid to litmus. The residue was further boiled with 1.25% sodium hydroxide solution. The flask was immediately connected to the reflux condenser and boiled for exactly 30 minutes. The mixture of the flask was filtered through the filtering cloth. Then the residue was thoroughly washed with boiling water and transferred to a Gooch crucible prepared with a thin compact layer of ignited asbestos. The residue was first thoroughly washed with hot water and then with about 15 mL of ethyl alcohol. The Gooch crucible and contents were dried at 105±2°C in an air oven until constant weight was achieved. The dried crucible and its contents were cooled and weighed. The contents of the Gooch crucible were incinerated in a muffle furnace until all carbonaceous matter was burnt. The ash obtained was cooled in a desiccator and weighed.

The crude fibre was calculated as:

$$\text{Crude Fibre\% by weight} = \frac{W_1 - W_2}{W} \times 100 \quad (5)$$

Where,

W_1 = weight in gramme of Gooch crucible and contents before ashing
W_2 = weight in gramme of Gooch crucible containing asbestos and ash
W = weight in gramme of the dried material taken for the test

Carbohydrate was determined by difference: {100 - (ash + moisture + crude protein + crude fibre + crude fat contents)}.

Gross energy value (kcal/100g) of the samples were obtained by multiplying crude protein content by 4, carbohydrate content by 4 and crude fat value by 9.

2.4 Determination of Anti-nutrients

Saponin content was determined with slight modification to the method described in literature [13]. Five grams of the sample was put into 20% acetic acid in ethanol and allowed to stand in water bath at 500°C for 24 hours. This was filtered, and the extract was concentrated using a water bath to one-quarter of the original volume. Concentrated NH_4OH was added drop-wise to the extract until the precipitation was complete. The whole solution was allowed to settle, and the precipitate was collected by filtration and weighed. The saponin content was calculated in mg/g of sample analysed.

Saponin content = (Weight of residue in mg) /Weight of sample analysed (g)

The determination of tannins, alkaloids and cyanides was carried out as described in the literature [13].

2.5 Determination of Mineral Composition

Elemental analyses with the exception of sodium, potassium and phosphorus were carried out by Atomic Absorption Spectrometry (Bulk Scientific East Norwalk, CT, USA). Sodium and potassium were determined using flame photometer (Corning, UK Model 405). KCl and NaCl were used to prepare the standards while phosphorus was determined by vanadomolybdate colorimetric method [14].

2.6 Sample Preparation for Amino Acid Analysis

About 2.0 g of sample was weighed into the extraction thimble and the fat extracted with chloroform/methanol (2:1 v/v) mixture using a Soxhlet apparatus [12]. The extraction lasted for 5-6 hours. About 30 mg of the defatted sample was weighed into glass ampoules. Seven millilitres of 6 M HCl was added and oxygen expelled by passing nitrogen gas into the sample. The glass ampoules were sealed with a Bunsen flame and put into an oven at 105 ±5°C for 22 h. The ampoule was allowed to cool; the content was filtered to remove the humins. The filtrate was then evaporated to dryness at 40°C under vacuum in a rotary evaporator. The residue was dissolved with 5 ml acetate buffer (pH 2.0) and stored in a plastic specimen bottle and kept in the deep freezer.

2.7 Amino Acid Analysis

Amino acid analysis was by ion exchange chromatography (IEC) using the Technicon Sequential Multisample (TSM) Amino Acid Analyser (Technicon Instruments Corporation, New York). Details of the procedure was given by [15]. The amino acid values reported were the averages of two determinations. Norleucine was the internal standard.

2.8 Determination of Quality Parameters

2.8.1 Determination of amino acid scores

Determination of the amino acid scores was first based on the formula given by FAO/WHO [16]:

Amino acid score = amount of amino acid per test protein (mg/g) / amount of amino acid per protein in reference pattern (mg/g).

Secondly, amino acid score was determined based on the whole hen's egg score [17]. Amino acid score was also calculated based on the composition of the amino acids obtained in the sample compared with the suggested pattern of requirements for pre-school children (2-5 years) [18]

2.8.2 Determination of the essential amino acid index

The essential amino acid index (EAAI) was determined as described in the literature [19].

2.8.3 Determination of the predicted protein efficiency ratio

The predicted protein efficiency ratio (P-PER) was determined using the equation

P-PER = –0.468 + 0.454 (Leu) – 0.105 (Tyr). (6)

2.8.4 Other determinations

The total amino acid (TAA), total essential amino acid (TEAA), total non-essential amino acid (TNEAA), total acidic amino acid (TAAA), total basic amino acid (TBAA), total neutral amino acid (TNAA), total sulphur amino acid (TSAA) and total aromatic amino acid (TArAA) and their percentage values, percentage cystine in TSAA (% Cys/TSAA), Leu/Ile ratios were calculated. The isoelectric point (pI) was calculated using the equation of the form [20]:

$$IP_m = \sum_{i=1}^{n} IP_i X_i$$

Where IP_m is the isoelectric point of the mixture of amino acids, IP_i is the isoelectric point of the i^{th} amino acid in the mixture and X_i is the mass or mole fraction of the i^{th} amino acid in the mixture.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of *Ficus glumosa* Leaves and Stem Bark

The results of the proximate compositions of *Ficus glumosa* leaves (FGL) and *Ficus glumosa* stem bark (FGB) are presented in the Table 1. The moisture content of FGL was similar to that of FGB (9.84% and 9.67%). The values for both were lower than values documented for *Ficus capensis* leaves and barks (25.80% and 10.00%) by [21] which implies that FGL and FGB would be less susceptible to microbial spoilage because of the low moisture content when compared with *Ficus capensis* leaves and bark. The moderate amount of crude protein found in FGL (18.8%) was higher than the value in FGB (7.73%). Our result is in agreement with the report of [22] on the higher protein values of *Alchornea cordifolia* leaves and the low value in the bark. However, FGL had comparable protein value with *Waltheria indica* leaves (18.68%; [23] and *Magnifera indica* leaves (18.59; [24]). The protein value of FGL showed that it would be a good source of protein when compared with the bark. The crude fat level of FGL and FGB were 6.14% and 0.79% respectively. Our result in the present study corroborates the general observation that leafy vegetables are low in lipids. For example, the following fat content values have been reported: 2.18 - 4.15% for selected green vegetables [25], 0.04% and 0.01% for *Ocimum tenuiflorum L*. leaves and stem [26].

The amount of ash in FGL and FGB (7.18% and 10.3%) were lesser than the values reported for *Ficus capensis* leaves and bark (11.00% and 10.95%) [21]. Ash contains inorganic materials of the plant which includes oxides and salts containing anions and cation [27].

The recorded crude fibre value of FGL was lower compared with FGB (5.19% and 8.15%). However, the crude fibre contents of our samples were higher than the values reported for *Ocimum tenuiflorum L*. leaves and stems (0.56% and 0.87%) by [26]. The result obtained showed that the samples (FGL and FGB) are good sources of crude fibre which is highly essential for the body. Fibre may guard against metabolic conditions, such as hypercholesterolemia and diabetes mellitus because it adds bulk to food and prevents the intake of excess starchy food [28].

Table 1. Proximate composition of *Ficus glumosa* leaves and stem bark (%) and calculated gross energy values (kcal/100g)

Parameters	FGL	FGB
Moisture	9.78±0.14	9.67±0.0
Crude Protein	18.8±0.3	7.73±0.11
Crude Fat	6.14±0.08	0.79±0.01
Ash	7.18±0.03	10.3±0.0
Crude Fibre	5.19±0.04	8.15±0.04
Carbohydrate	52.9±0.1	63.4±0.2
Gross Energy	342	292

FGL= Ficus glumosa leaves, FGB= Ficus glumosa stem bark

As revealed in the proximate composition values, carbohydrate was the observed major nutrient in both samples with FGL having 52.9% and FGB 63.4%. The carbohydrate contents of both samples fell within the range of values reported for selected vegetable plants (49.61-64.09%) [29]. The result obtained showed that the samples are good sources of energy, with FGL having gross energy value of 342kcal/100g being a better source than FGB.

3.2 Mineral Composition of *Ficus glumosa* Leaves and Stem Bark

Table 2 presents the mineral composition of the leaves and stem bark of *Ficus glumosa*. The table shows that FGL and FGB had reasonable amounts of both trace and macro elements. The general order of abundance of the selected mineral elements in the samples were potassium > calcium> phosphorous > magnesium > sodium > iron > zinc > manganese > copper. The concentrations of the first seven most abundant mineral elements in the leaves were 844, 429, 219, 112, 40.5, 17.1 and 4.32 mg/100 g while the corresponding values in the stem bark were: 388, 288, 52.0, 44.3, 37.5, 5.55 and 4.65 mg/100 g. It is interesting to note that the composition of each mineral was higher in leaves than that of the stem bark (except for zinc). This agrees with the findings of some authors, such as [30] and [31]. This observation might be due to the fact that the leaves form the platform for photosynthetic activities and of course, the leaves were plucked in the daytime when photosynthetic and metabolic activities of the plant were at their highest level. Minerals serve as essential components of many enzymes, vitamins, hormones, and respiratory pigments, or as co-factors in metabolism, catalysts, and enzyme activator [32]. For example, zinc as a trace element is known to play a key role in human; it is important for the physiological functions of living tissues and regulates many biochemical processes [33]. Potassium and sodium are known to play key roles in controlling the osmotic and acid base balance of the body fluid [34]. They are also involved in the transportation of some non-electrolytes [35]. The concentration of Na and K in the leaves of *F. glumosa* were 40.5 and 844 mg/100 g; while the concentration of the duo in the stem bark were 37.5 and 388 mg/100g respectively.

"It has been opined that excessive dietary intake of sodium (Na) along with insufficient potassium (K) intake are related to risk of developing cardiometabolic disorders" [36]. The sodium/potassium (Na/K) ratio for FGL was 0.048 while the corresponding value for its stem bark was 0.09. These values were within the Na/K ratio of < 1.0 identified as the best balance of Na and K intakes for preventing cardiovascular diseases (CVD) and CVD- mortality related diseases [36].

"Calcium and phosphorus are of great concern in the formation of strong bones and teeth, growth, normal nerve and muscle action, blood clotting, heart function and cell metabolism" [34]. "Calcium to phosphorus ratio (Ca:P) is important for bone growth and development during infancy because bone mass accumulation in infancy is essential for the prevention of poor childhood growth and adult osteoporosis" [37]. "The value of Ca:P reported for FGL was 1.95 while the corresponding value of 5.54 was recoded for FGB. Food is considered good if the Ca/P ratio is above one, and poor if the ratio is less than 0.5" [34].

Table 2. Mineral composition of *F. glumosa* leaves and stem bark (mg/100 g)

Minerals	FGL	FGB
Sodium (Na)	40.5±0.0	37.5±0.1
Potassium (K)	844±0	388±1
Manganese (Mn)	3.86±0.04	1.52±0.01
Magnesium (Mg)	112±0	44.3±0.1
Phosphorus (P)	219±1	52.0±0
Iron (Fe)	17.1±0.0	5.55±0.03
Calcium (Ca)	429±0	288±0
Zinc (Zn)	4.32±0.01	4.65±0.03
Copper (Cu)	2.17±0.02	0.545±0.004
Lead (Pb)	ND	ND
Na/K	0.048±00	0.09±00
Ca/P	1.95±0.00	5.54±00

FGL= Ficus glumosa leaves, FGB= Ficus glumosa stem bark

3.3 Anti-nutrient Composition of *Ficus glumosa* Leaves and Stem Bark

"One major factor limiting the wider food utilization of many tropical plants is the universal occurrence in them of a diverse range of natural compounds called anti-nutrients which are capable of precipitating/eliciting harmful effects in man and animals" [38]. Anti-nutrients are so called because they have the capability to reduce nutrient bioavailability [39]. The anti-nutrients determined in *Ficus glumosa* leaves and stem bark are presented in Table 3. The values of 0.103 and 0.064 mg/g saponins were recorded for FGL and FGB respectively. Saponins are commonly considered as non-volatile, surface-active secondary metabolites, which are broadly dispersed in nature but found principally in plants [39]. It has been reported that animal metabolism and health could be affected by saponins in different ways which include: bloating in ruminants, reduced nutrient absorption, decreased liver cholesterol and overall growth rate, and reduced intestinal absorption of many nutrients through binding of saponins to the small intestine cells [40]. Saponins are also considered as factors that reduce absorption of vitamins [39]. The value of 5.42 and 12.5 mg/TAE/g tannins were recorded for FGL and FGB respectively. Tannins are phenolic compounds which are formed in plant leaves, fruits and barks [41]. Tannins are known to affect protein digestibility and lead to reduction of essential amino acids by forming reversible and irreversible tannin-protein complexes between the hydroxyl group of tannins and the carbonyl group of proteins [42]. As such, tannins cause inactivation of many digestive enzymes and decrease protein digestibility when ingested by animals [43].

Alkaloids were not detected in the leaves, however a low content of 0.421mg/g was observed in the stem bark. Alkaloids were not detected in a study reported for *Magnifera Indica* leaves by [44].

The cyanide level in leaves and stem bark of *F. glumosa* was found to be 2.85 and 6.58 mg/kg respectively. The concentration of the cyanide in *F. glumosa* is within the permissible level of 200 mg/kg fresh weight of vegetables or forages [45].

3.4 Amino Acid Composition of *Ficus glumosa* Leaves and Stem Bark

Table 4 reveals the result of the amino acids (AA) present in FGL and FGB. The total amino acid (TAA) in FGL (92.5g/100g cp) was higher than in FGB (84.3g/100g cp), this could be related to the higher content of protein in the leaves than in the bark. All the eighteen amino acids found in the leaves were present in the bark but at different concentrations. Most of the amino acids (AA) in the leaves have higher concentration when compared with the bark except glutamic and aspartic acid (Glu and Asp), tyrosine (Try) and tryptophan (Trp). The concentration of leucine (Leu) and arginine (Arg) in both samples were almost the same. The most concentrated amino acids (AA) in the leaves and stem bark of F. glumosa were Glu and Asp with 12.8 and 9.37 g/100g cp; 16.2 and 10 g/100g cp respectively. Glu is a non-essential amino acid, a component of folic acid and a precursor to glutathione, a powerful antioxidant [46]. Asp is a metabolite in the urea cycle and participates in gluconeogenesis. Trp was found to be the least concentrated AA in FGL (0.879 g/100g cp), while methionine (Met) was the least in the bark (0.82 g/100g cp). Trp is one of the biochemically active amino acids which plays a significant role in the protein and enzyme syntheses, cognition and neurohormonal regulation [47]. Met serves as a precursor for all sulphur containing amino acids and derivatives [48].

3.5 Quality Parameters of the Amino Acid Profiles of *Ficus glumosa* Leaves and Stem Bark

Table 5 shows the total essential, non-essential, acidic, neutral, aromatic and sulphur amino acid contents and their percentage compositions in FGL and FGB. Also, the calculated isoelectric point (pI), predicted protein efficiency ratio (P-PER) Leu/Ile and essential amino acid index (EAAI) of the samples are also presented in Table 5.

Table 3. Antinutrient composition of *Ficus glumosa* leaves and stem bark

Anti-nutrient	FGL	FGB
Saponins (mg/g)	0.103±0.0	0.064±0.006
Tannins (mgTAE/g)	5.42±0.08	12.5±0.1
Alkaloids (mg/g)	ND	0.421±0.008
Cyanide (mg/kg)	2.85±0.21	6.58±0.24

FGL= Ficus glumosa leaves, FGB= Ficus glumosa stem bark

Table 4. Amino acid concentration of *Ficus glumosa* leaves and stem bark (g/100g cp)

Amino acid Profile	FGL	FGB
Glycine (Gly)	6.38±0.14	3.47±0.04
Alanine (Ala)	6.66±0.05	3.12±0.10
Serine (Ser)	4.48±0.01	2.60±0.03
Proline (Pro)	6.31±0.13	4.40±0.05
Valine (Val)*	7.05±0.13	3.16±0.03
Threonine (Thr)*	4.88±0.19	3.09±0.06
Isoleucine (IIe)*	3.59±0.24	2.99±0.03
Leucine (Leu)*	6.03±0.14	6.09±0.05
Aspartic acid (Asp)	9.37±0.41	10.2±0.1
Lysine (Lys)*	6.47±0.02	5.09±0.05
Methionine (Met)*	1.59±0.08	0.818±0.01
Glutamic acid (Glu)	12.8±0.18	16.2±0.1
Phenyalanine (Phe)*	5.23±0.21	4.85±0.08
Histidine (His)*	2.85±0.28	2.90±0.04
Arginine (Arg)*	6.32±0.12	6.99±0.14
Tyrosine (Tyr)	1.94±0.03	4.43±0.02
Tryptophan (Trp)*	0.879±0.001	1.24±0.04
Cystine (Cys)	2.37±0.0	1.79±0.06
TAA	95.2	83.4

FGL= Ficus glumosa leaves, FGB= Ficus glumosa stem bark

Table 5. Quality parameters of the amino acid profiles of *Ficus glumosa* leaves and stem bark

Parameter	FGL	FGB
Total Amino Acid (TAA)	95.2	83.4
Percent total amino acid (%TAA)	100	100
Total non-essential amino acid (TNEAA)	50.3	46.2
Percent total non-essential amino acid (% TNEAA)	52.8	55.4
Total essential amino acid (TEAA) with Histidine	44.9	37.2
Percent total essential amino acid (% TEAA) with Histidine	47.2	44.6
Total essential amino acid (TEAA) without Histidine	42.0	34.3
Percent total essential amino acid (% TEAA) without Histidine	44.1	41.1
Total neutral amino acid (TNAA)	57.4	42.1
Percent total neutral amino acid (% TNAA)	60.3	50.5
Total acidic amino acid (TAAA)	22.2	26.4
Percent total acidic amino acid (% TAAA)	23.3	31.7
Total basic amino acid (TBAA)	15.6	15.0
Percent total basic amino acid (% TBAA)	16.4	18.0
Total sulphur amino acid (TSAA)	3.96	2.61
Percent total sulphur amino acid (% TSAA)	4.16	3.13
Percent cystine in TSAA	59.8	68.6
Total aromatic amino acid (TArAA)	8.05	10.5
Percent total aromatic amino acid (% TArAA)	8.46	12.6
Leu/Ile	1.68	2.04
Calculated isoelectric point (pI)	5.59	4.75
Predicted protein efficiency ratio (P-PER)	2.04	1.81
Essential amino acid index (EAAI)	1.26	1.07

FGL= Ficus glumosa leaves, FGB= Ficus glumosa stem bark

The total non-essential amino acid (TNEAA) of FGL (50.3 g/100g cp) and FGB (55.4 g/100g cp) were higher than those recorded for the leaves of *S. aethiopicum, A. hybridus* and *T. occidentalis* with 40.75, 37.21 and 38.71 g/100g respectively [49]. The total essential amino acid (TEAA) with or without histidine in FGL (44.9 and 42.0 g/100g cp) were higher than the observed values in FGB (37.2 and 34.3 g/100g cp). The percent TEAA of 47.2 for FGL and 44.6 for FGB were above the

39% considered adequate for ideal protein food for infants, 26% for children and 11% for adults [16]. The leaves and stem bark of *Ficus glumosa* could serve as a good source of protein to supplement food with low protein values. Total neutral amino acid (TNAA) in both samples were higher than total acidic amino acid (TAAA) and total basic amino acid (TBAA) which implies that FGL and FGB were made up of neutral acids.

The total sulphur amino acid (TSAA) contents of FGL (3.96 g/100g cp) and FGB (2.61 g/100g cp) could only satisfy 68.3 and 45.0% of the 5.8 g/100g cp recommended for infants [18]. The observed percent cystine in TSAA for FGL and FGB were 59.8 and 68.6 respectively. The findings of the current study were consistent with the report of some researchers [50-53] that many vegetable proteins contain substantially more Cys than Met. The total aromatic amino acid (TArAA) of FGL (8.05 g/100g cp) and FGB (10.5g/100g cp) were within the range suggested for infant protein (6.8- 11.8 g/100 g cp) [18]. The Leu/Ile values ranged between 1.68 and 2.04 in both samples. These values were less than the most ideal Leu/Ile value which is 2.36 [54].

Results from this study revealed that the calculated pI value of FGB (4.75) was lower than FGL (5.59). Since the%TAAA (31.7) of FGB was higher than 23.3 recorded for FGL, it is expected that the minimum solubility pH (pI value) of FGB would be lower than FGB. It can therefore be inferred that there is a correlation between pI and TAAA. The pI calculation from amino acids usually assists in the quick production of certain isolate of organic product without evaluating the protein solubility to get to the pI [55].

The P-PER values of FGL and FGB (2.04 and 1.81) were better than 1.56, 1.67 and 1.68 P-PER values of the root, seed and leaf of Moringa oleifera as reported by [56].

The current study found that EAAI of FGL (1.26) was more than the value obtained for FGB (1.07). The EAAI of FGL was similar to that of deffated soy flour [19]. According to [19], the EAAI method can be useful as a rapid tool to evaluate food formulation for protein quality.

The essential amino acid (EAA) scores of the samples based on FAO/WHO [16] scoring pattern are presented in Table 6. Considering the scores of the two samples, the results showed that FGL will supply more essential amino acids than FGB. Val had the highest score in FGL (1.41), while Phe+Tyr had the highest score in FGB (1.55). In FGL, Leu had the minimum score with 0.861, making it the limiting amino acid in the leaves of F. glumosa, while Val had the lowest score (0.632) in FGB making it the limiting amino acid in the bark.

Table 7 shows the amino acid scores of *Ficus glumosa* leaves and stem bark based on whole hen's egg profile. For the FGL scores, 9 among all the 18 amino acids had scores greater than 1 while the remaining 9 had scores less than 1. Moreover, in FGB, 6 amino acids had scores greater than 1. The results showed that FGL would be a better source of protein when compared with FGB. The limiting amino acid in FGL were Tyr and Trp with 0.485 and 0.488 respectively. However, the limiting amino acid in FGB was methionine (0.256) followed by serine (0.329).

Table 6. Essential amino acid score of *Ficus glumosa* leaves and stem bark based on FAO/WHO [16] standard

Amino acid	Suggested level (mg/g)	Sample score (FGL)	Sample score (FGB)
Ile	40	0.898	0.748
Leu	70	0.861	0.870
Lys	55	1.18	0.925
Met +Cys	35	1.13	0.746
Phe+ Tyr	60	1.20	1.55
Thr	40	1.22	0.773
Trp	10	0.879	1.24
Val	50	1.41	0.632

FGL= Ficus glumosa leaves, FGB= Ficus glumosa stem bark

Table 7. Amino acid score of *Ficus glumosa* leaves and stem bark based on whole hen's egg scoring pattern [17]

S/No	Amino acid	Whole hen's egg (g/100g)	Sample Score (FGL)	Sample score (FGB)
1	Val	7.50	0.94	0.421
2	Thr	5.10	0.957	0.606
3	Ile	5.60	0.641	0.534
4	Leu	8.30	0.727	0.734
5	Lys	6.20	1.04	0.821
6	Met	3.20	0.497	0.256
7	Cys	1.80	1.32	0.994
8	Phe	5.10	1.03	0.951
9	Tyr	4.00	0.485	1.108
10	Trp	1.80	0.488	0.689
11	Gly	3.00	2.13	1.16
12	Ala	5.40	1.23	0.578
13	Ser	7.90	0.567	0.329
14	Pro	3.80	1.66	1.16
15	Asp	10.7	0.876	0.953
16	Glu	12.0	1.07	1.35
17	His	2.40	1.19	1.21
18	Arg	6.10	1.04	1.15

FGL= Ficus glumosa leaves, FGB= Ficus glumosa stem bark

Table 8. Essential amino acid scores of *Ficus glumosa* leaves and stem bark based on requirements of pre-school children (2-5 years) scoring pattern [18]

S/No	Amino acid	Preschool (g/100g)	Sample Score (FGL)	Sample Score (FGB)
1	Val	3.50	2.01	0.903
2	Thr	3.40	1.44	0.909
3	Ile	2.80	1.28	1.07
4	Leu	6.60	0.914	0.923
5	Lys	5.80	1.12	0.878
6	Met + Cys	2.50	1.58	1.04
7	Phe +Tyr	6.30	1.14	1.47
8	Trp	1.10	0.799	1.13
9	His	1.90	1.50	1.53

FGL= Ficus glumosa leaves, FGB= Ficus glumosa stem bark

The amino acid scores of the samples in relation to pre-school children requirements are depicted in Table 8. In FGL, all the EAA except Leu and Trp would be able to provide more than the required EAA for the pre-school child as shown by their EAA score. However, for FGB, His, Phe+Tyr, Trp, Ile, and Met+Cys with scores greater than 1 would give more than the needed EAA. Trp is the limiting amino acid in FGL and would supply 79.9% which can be corrected by 1.25, while Lys the limiting amino acid would supply 87.8% and can be corrected by 1.14.

4. CONCLUSION

This study revealed the proximate composition, mineral elements, anti-nutritional factors and the amino acid contents of *F. glumosa* leaves and stem bark. Both leaves and stem bark of *F. glumosa* were rich in protein and important mineral elements needed for human and animal growth. The leaves of the plant contained higher mineral elements than the stem bark. Both stem bark and leaves could be a good source of reducing high blood pressure, because of the low Na/K ratio. They also contain some level of essential amino acids needed for normal functioning of man and animals. The anti-nutritional factors observed in these plant parts can be reduced through food processing.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely

no reason for conflict of interest because the products used for this study is a naturally occurring plant and hence cannot bring about any litigation. Also, the research was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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