NUTRITIONAL AND ANTI-NUTRITIONAL COMPOSITIONS OF THE LEAVES AND STEM BARK OF *Ficus glumosa*

ABSTRACT

Aims: 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 had moisture contents of 9.78 and 9.67% respectively. The crude protein of 18.8% was recorded for the leaves while 7.73% was recorded for the bark. The leaves were observed to contain higher mineral content than the stem bark. Na/K ratios were 0.048 (leaves) and 0.09 (bark). Out of the four anti-nutrients evaluated, tannin recorded the highest values of 5.42 and 12.5 (mgTAE/g) respectively. Amino acid compositions showed that the leaves and the stem bark contained a total of 95.2 and 83.4 g/100g cp amino acids respectively.
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 [1-2]. 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 [3]. 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. The root, fruit and bark are used for menstrual cycle and in preparations to cure female sterility [4]. Decoction of the bark is used in mouthwash against toothache. Pounded bark soaked in water is drunk against stomach disorders [2] and 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. Young leaves are eaten as vegetables [8], the bark is a source of tannin [2].
In Southwestern part of Nigeria, the pounded bark (brick red colour) moulded into round shape, sundried and pulverized are used in the preparation of medicinal soup alone or with other medicinal plant ingredients such as turmeric, ginger, etc.

To conquer the increasing problem of malnutrition in developing countries of the world, there is a need to search for edible neglected plants which have been used in time past to overcome famine. 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 *Ficus 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.

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 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 [9]. 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 [10]. 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 literature [10].

2.5 Determination of mineral Contents

Elemental analyses with the exception of sodium, potassium and phosphorous 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 {11].

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 [9]. The extraction lasted for 5-6 h. 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 [12]. 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 [13]:
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 [14]. 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) [15]

2.8.2 Determination of the essential amino acid index

The essential amino acid index (EAAI) was determined as described in literature [16].

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).

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 [17]:
$IP_m = \sum_{i=1}^{n} IP_i X_i$
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 [18] which implied 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 [19] 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 %; [20] and *Magnifera indica* leaves (18.59; [21]). 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 values have been reported: 2.18 - 4.15 % fat for selected green vegetables [22], 0.04 % and 0.01 % for *Ocimum tenuiflorum L*. leaves and stem [23].

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 %) [18]. Ash contains inorganic materials of the plant which includes oxides and salts containing anions and cation [24].

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 [23]. 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 [25].

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 %) [26]. 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.

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

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 the stem bark (except for zinc). This agrees with the findings of some authors such as [27] and [28]. 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 cofactors in metabolism, catalysts, and enzyme activator [29]). For example, Zn 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 [30]. Potassium and sodium are known to play key roles in controlling the osmotic and acid base balance of the body fluid [31]. They are also involved in the transport of some non-electrolytes [32]. 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 [33]. 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[33].

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 [31]. 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 [34]. 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 [31].

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 [35]. Anti-nutrients are so called because they have the capability to reduce nutrient bioavailability [36]. 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 36]. 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 [37]. Saponins are also considered as factors that reduce absorption of vitamins [36]. 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 [38]. 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 [39]. As such, tannins cause inactivation of many digestive enzymes and decrease protein digestibility when ingested by animals [40].

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 [41].

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 [42].

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

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 relate 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 to 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 [43]. 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 [44]. Met serves as a precursor for all sulphur containing amino acids and derivatives [45]**.**

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

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.
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 [46]. 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 [13]. 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 implied that FGL and FGB were made up of neutral acids.

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 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 [15]. 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 (47-50] 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) [15]. 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 [51].
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 [52].
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 [53].
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 [54]. According to [16], the EAAI method can be useful as a rapid tool to evaluate food formulation for protein quality.

Table 6. Essential amino acid score of *Ficus glumosa* leaves and stem bark based on FAO/WHO [13] 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
The essential amino acid (EAA) scores of the samples based on FAO/WHO [13] 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 7. Amino acid score of *Ficus glumosa* leaves and stem bark based on whole hen's egg scoring pattern [14]

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

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 would be corrected by 1.14.

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 [15]

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

4. CONCLUSION

This study revealed the proximate composition, mineral elements, anti-nutritional factors and the amino acid contents of *FIcus glumosa* leaves and stem bark. Both leaves and stem bark of *Ficus glumosa* were rich in protein and important mineral elements needed for human and animal growth. They also contain some level of essential amino acids needed by man and animals. The anti-nutritional factors observed in these plant parts can be reduced through food processing.

COMPETING INTERESTS DISCLAIMER:

AUTHORS HAVE DECLARED THAT NO COMPETING INTERESTS EXIST. THE PRODUCTS USED FOR THIS RESEARCH ARE COMMONLY AND PREDOMINANTLY USE PRODUCTS IN OUR AREA OF RESEARCH AND COUNTRY. THERE IS ABSOLUTELY NO CONFLICT OF INTEREST BETWEEN THE AUTHORS AND PRODUCERS OF THE PRODUCTS BECAUSE WE DO NOT INTEND TO USE THESE PRODUCTS AS AN AVENUE FOR ANY LITIGATION BUT FOR THE ADVANCEMENT OF KNOWLEDGE. ALSO, THE RESEARCH WAS NOT FUNDED BY THE PRODUCING COMPANY RATHER IT WAS FUNDED BY PERSONAL EFFORTS OF THE AUTHORS.

REFERENCES

1. Mutungi MM, Muema FW, Kimutai F, Xu Y-B, Zhang H, Chen GL et al. Antioxidant and antiproliferative potentials of *Ficus glumosa* and its bioactive polyphenol metabolites. Pharmaceuticals. (2021); 14: 266.

2. Jansen PCM. *Ficus glumosa* Delile. In: Jansen, P.C.M. and Cardon, D. (Editors). PROTA (Plant Resources of Tropical Africa / Ressources végétales de l'Afrique tropicale), Wageningen, Netherlands; 2005.

3. Orwa C, Mutua A, Kindt R, Jamnadass R, Simons A. Agroforestree Database:a tree reference and selection guide version 4.0 2009, (http://www.worldagroforestry.org/af/treedb/)

4. Quattrocchi U. CRC world dictionary of medicinal and poisonous plants, common names, scientific names, eponyms, synonyms and etymology. CRC Press, Boca Raton, FL; 2012.

5. Burkill HM. The useful plant of west tropical Africa. 2nd ed. Kew: Royal Botanical Gardens; 1985.

6. Madubunyi II, Onoja SO, Asuzu IU. In vitro antioxidant and in vivo antidiabetic potential of the methanol extract of *Ficus glumosa* Del (Moraceae) stem bark in alloxan-induced diabetic mice. Comp Clin Pathol. 2012; 21: 389–394. https://doi.org/10.1007/s00580-010-1103-5.

7. Olaokun OO., Lyndy JM., Jacobus NE and Vinny N. Evaluation of the inhibition of carbohydrate hydrolysing enzymes, antioxidant activity and polyphenolic content of extracts of ten African Ficus species (Moraceae) used traditionally to treat diabetes. BMC Complementary and Alternative medicine. 2013; 13:94

8. Mansfeld R. Moraceae. In: Mansfeld's encyclopaedia of agricultural crops (except ornamentals). Hanelt, P., Mansfeld, R. and Buttner, R. Eds., Springer-Verlag, Berlin; 2001:355-385.
9. AOAC .Official methods of analysis. (18th ed.). Association of Official Analytical Chemists, Washington DC; 2005.

10. Ekpa E, Sani D. Phytochemical and anti-nutritional studies on some commonly consumed fruits in Lokoja, Kogi State of Nigeria. General Medicine. 2018; 2(3): 1 – 5.

11. Aletan UI, Kwazo HA. Analysis of the proximate composition, anti-nutrients and mineral content of *Maerua crassifolia* leaves. Nigerian Journal of Basic and Applied Science. 2019;27(1): 89-96. DOI: 10.4314/njbas.v27i1.12

12. Adeyeye EI. Effect of cooking and roasting on the amino acid composition of raw groundnut (Arachis hypogaea) seeds. Acta Sci. Pol., Technol. Aliment. 2010; 9(2): 201-216
13. FAO/WHO. Energy and protein requirements, Technical Report Series No 522, WHO, Geneva;1973.

14. Paul AA, Southgate DA, Russel J. First supplement to McCance and Widdowson's. The composition of foods. HMSO, London; 1976.

15. FAO/WHO/UNU (1985). Energy and protein requirements: Report of a Joint FAO/WHO/UNU Expert Consultation,WHO Technical Report Series no. 724. Geneva: WHO.

16. Nielsen SS. Introduction to the chemical analysis of foods, CBS Publishers and Distributors, New Delhi, 2002.

17 Olaofe O, Akintayo ET. Prediction of isoelectric points of legume and oilseed proteins from their amino acid compositions. The Journal of Technoscience. 2000; 4: 49-53.

18. Uzoekwe NM, Mohammed JJ. Phytochemical, proximate and mineral contents of leaves and back of *Ficus capensis*. Journal of Applied Science and Environmental Management. 2015; 19(4): 633- 637

19. Ngaha NMI, Dahlan I, Massoma LD, Mandengue SH, Yusuf AA. Comparative proximate analysis of leaves and bark of *Alchornea cordifolia* (Euphorbiaceae). Journal of Agriculture and Environmental Sciences. 2016; 5: 200-206.

20. Basiru A, Soetan KO, Olayemi FO. Comparative proximate, minerals c omposition and anti-nutritional factors of *Waltheria indica* leave, root and stem. Annals of Food Science and Technology. 2016; 17(2): 478-484.

21. Ali BA, Alfa AA, Tijani KB, Idris ET, Unoyiza US, Junaidu Y. Nutritional, health benefits and bioactive compounds of *Mangifera indica L* (mango) leaves methanolic extracts. Asian Plant Research Journal. 2020;6(2):41-51.

22. Arasaretnam S, Kiruthika A Mahendran T. Nutritional and mineral composition of selected green leafy vegetables. Ceylon Journal of Science. 2018; 47(1): 35-41.

23. Mousavi L, Rabeta MS, Murugaiyah V. Nutritional and anti-nutritional values of leaves and stems of *Ocimum tenuiflorum L*. Food Research. 2019;3(6):798-807.

24. Gopalan C, Sastri BVR, Balasubramanian SC. Nutritive value of Indian foods. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India. 2004; 2-58

25. Barry KA., Wojcicki BJ, Bauer LL., Middelbos IS, Boler BM, Swanson KS et al. Adaptation of healthy adult cats to select dietary fibers in vivo affects gas and short-chain fatty acid production from fiber fermentation in vitro. Journal of Animal Science. 2011;89: 3163-3169.

26. Mgbeje B IA, Umoh EU, Ekpe O. Comparative proximate, vitamin and mineral composition of leaves of four selected tropical vegetable plants namely: *Ocimum gratissimum*, *Piper guineense, Gongronema latifolium* and *Vernonia amygdalina*. European Journal of Nutrition and Food Safety. 2019;10(1):84-93.

27. Ogbonna PC, Idumah MC. Phytochemical and mineral content in leaves, stem and bark of *Pterocarpus santalinoides* (Nturukpa) from Afikpo, Ebonyi State, Nigeria. Journal of Applied Science Environmental Management.2018;22(8): 1147 –1150.

28. Haider SZ, Lohani H, Bhandari U, Naik G, Chauhan N. Nutritional value and volatile composition of leaf and bark of *Cinnamomum tamala* from Uttarakhand (India), Journal of Essential Oil Bearing Plants. 2018;21(3):732-740 DOI: 10.1080/0972060X.2018.1497546.

29. Alagbe JO, Shittu MD, Bamigboye SO, Oluwatobi AO. Proximate and mineral composition of *Pentadiplandra brazzeana* stem bark. Electronic Research Journal of Engineering, Computer and Applied Sciences. 2019;1: 91- 99.

30. Osasona I, Kanuhor UB. Characterization and utilization of sulphuric acid and bitter leaf extract activated carbon from rice husk for Zn(II) adsorption . Indonesian Journal of Chemistry; 2021;21(2): 318-331.

31. Ndamitso MM, Mustapha S, Etsuyankpa MB, Ajai AI, Mathew JT. Evaluation of chemical composition of *Acacia nilotica* seeds. FUW Trends in Science & Technology Journal. 2017;2(2): 927 – 931.

32. Faleye FJ, Akinwumi O A. Comparative nutritional compositions of the leaves, bark and root of *Nauclea latifolia*. Journal of Medical and Biological Science Research. 2019;2(7):127 – 130.

33.Mirmiran P, Gaeini Z, Bahadoran Z, Ghasemi A, Norouzirad R, Tohidi M et al. Urinary sodium-to-potassium ratio: a simple and useful indicator of diet quality in population-based studies. European Journal of Medical Research. 2021;26**(**3) DOI: https://doi.org/10.1186/s40001-020-00476-5

34. Loughrill E, Wray D, Christides T, Zand N. Calcium to phosphorus ratio, essential elements and vitamin D content of infant foods in the UK: Possible implications for bone health. Maternal and Child Nutrition. 2017;13(3): e12368.

35. Sha'a Clarkson GP, Artimas SP. Phytochemical analysis, proximate composition and antinutritional factors of *Corchorus oliterius* plant. International Journal of Biological and Chemical Science. 2019;13(4): 2147-2157.

36. Samtiya M, Aluko RE, Dhewa T. Plant food anti-nutritional factors and their reduction strategies: an overview. Food Production, Processing and Nutrition.2020;2**(**6): https://doi.org/10.1186/s43014-020-0020-5

37. Kregiel DB, Witonsk J, Antolak I, Proestos H, Babic C, Babic M et al. Saponin-based, biological-active surfactants from plants. In Application and characterization of surfactants. 2017; 183–205.

38.Timotheo CA, Lauer CM. Toxicity of vegetable tannin extract from *Acacia mearnsii* in *Saccharomyces cerevisiae*. International Journal of Environmental Science and Technology, 2018**;**15(3): 659–664.

39. Raes K, Knockaert D, Struijs K, Van Camp J. Role of processing on bioaccessibility of minerals: Influence of localization of minerals and anti-nutritional factors in the plant. Trends in Food Science & Technology. 2014; 37(1): 32–41.

40. Joye I. Protein digestibility of cereal products. Foods. 2019;8(6):199.

41. Aiyelaagbe OO, Osamudiamen PM. Phytochemical screening for active compounds in *Magnifera indica* leaves from Ibadan, Oyo State. Plant Sciences Research. 2009; 2(1):1-13.

42. Musa A, Ogbadoyi EO. Determination of anti-nutrients and toxic substances of selected fresh leafy vegetables obtained from Minna town, Nigeria. *Nigerian Journal of Basic and Applied* Science. 2014;22(3&4): 79-83.

43. Adeyeye EI. The comparison of the amino acids profiles of whole eggs of duck, francolin and turkey consumed in Nigeria. Global Journal of Science Frontier Research Chemistry. 2013;13(3): 10-20.

44. Bichitra NN, Singh RB, Harpal SB. Role of tryptophan in health and diseases: Systematic review of the antioxidant, anti-inflammatory and nutritional aspects of tryptophan and its metabolites. World Heart Journal, 2019; 11(2); 161-178.

45.Schnekenburger M, Diederich M. Nutritional epigenetic regulators in the field of cancer: New avenues for chemopreventive approaches. In: Epigenetic Cancer Therapy; Gray, S. G. ed., Academic Press, Boston, MA, USA, 20153;393-425

46. Aja PM, Ale BA, Ekpomo EU, Nwite I, Aja, Asouzu NC. Amino acid profiles of *Solanum aethiopicum, Amaranthus hybridus and Telfairia occidentalis*, common leafy vegetables in Nigeria. Science Progress. 2021;104(3): 1-14.

47. Adeyeye E I. The chemical composition of liquid and solid endosperm of ripe coconut. Oriental Journal of Chemistry. 2004; 20(3): 471-476.

48. Aremu MO, Olaofe O, Basu SK, Abdulazeez G, Acharya SN. Processed cranberry bean (*Phaseolus coccineus*) seed flours for African diet. Canadian Journal of Plant Science. 2010; 90: 718 – 728.

49. Olaofe O, Adeyeye EI, Ojugbo S. Comparative study of proximate, amino acids and fatty acids of *Moringa oleifera* tree. Elixir Applied Chemistry. 2013;54 (2013):12543– 1255

50. Akinsola AF, Omotayo FO. Proximate analysis, mineral contents and amino acid composition of *Antrocaryon micraster* stem bark. Journal of Agriculture and Environmental Sciences. 2019;8(2): 45-59

51. FAO/WHO (1991). Protein quality evaluation. Report of Joint FAO/WHO Expert Consultation held in Bethesda, USA, 4-8 December, 1989. Rome : FAO/WHO.

52. Adeyeye EI, Ayodele O, Orege JI. Amino acids composition of liver, heart and kidneys of *Thryonomys swingerianus* (Temminck 1827) Compared. International Letters of Natural Sciences. 2020;79:23-39.
53. Okereke CJ, Akaninwor JO.The protein quality of raw leaf, seed and root of *M. oleifera* grown in Rivers State, Nigeria. Annals of Biological Research. 2013; 4(11): 34-38.

54. Cavins JC, Kwolek DF, Inglett GE, Cowen JC. Amino acid analysis of soybean meal: interlaboratory study. Journal of Association of Official of Analytical Chemistry. 1972;55: 686 – 694.