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Evaluation of chemical and antinutritional characteristics of obeche (*Triplochition scleroxylon)* and some mulberry (*Morus alba)* leaves

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ABSTRACT

The chemical composition and antinutritional contents of some selected varieties of white mulberry leaves and obeche leaves were investigated. Three varieties of mulberry leaves (S_{36}, S_{54} and K_2) were harvested from Ondo State sericulture centre while obeche leaves were harvested from Aponmu Forest Reserve located in Ondo State, Southwestern Nigeria, for analysis. Proximate composition, minerals and antinutritional contents were determined on dry matter basis for the samples. The percentage of crude protein in all the samples were significantly high ($P \leq 0.05$) with 34.31, 21.66%, 21.55% and 21.24% in obeche, S_{36}, S_{54} and K_2 respectively. Similarly, crude fibre follow the same trend with 20.73%, 13.70, 10.81%, 13.70% and 8.74% respectively, while the percentage water content were 73.70% 79.35%, 72.16% and 76.00%, in obeche, S_{36}, S_{54} and K_2 respectively. The results further show that the samples contain zinc in the range of 34.4 - 57.5 mg/kg, sodium 1069 – 1526 mg/kg, manganese 14.83 – 24.37 mg/kg, calcium 944 – 1467 mg/kg, potassium 1684 – 2170 mg/kg, iron 129.70 – 238.00 mg/kg, and magnesium 1450 – 2196 mg/kg. Phytate is significantly higher ($P \leq 0.05$) in obeche than other treatments. Likewise, cyanide and tannin were significantly higher ($P \leq 0.05$) in S_{36} than other treatments (obeche, K_2 and S_{34}). However, these antinutrients (phytate, cyanide and tannin) were much lower than the permitted values in fruits and any other food items. The result of the chemical analysis showed that all the selected mulberry varieties and obeche leaves contained adequate level of food nutrients required for normal body functioning.

Keywords: mulberry leaves, nutritional characteristics, obeche leaves, Proximate composition.

INTRODUCTION

The mulberry tree is a perennial woody plant which belongs to the family Moraceae, Genus *Morus* and species *alba.* It is a deep-rooted perennial plant, capable of thriving under a variety of conditions ranging from temperate to tropical region. Several varieties of the tree are under cultivation in Ondo State, Nigeria, where the study was carried out. Mulberry tree is recognized as food plant for silkworm as well as an economic tree (Kasiviswanathan et al., 1988; Jaiyeola and Adeduntan, 2002). Its leaves have high protein content and is also used in cattle feed for milk production (Kasiviswanathan et al., 1988). The timber is used for furniture, tool handle and the fruits are used for making wine, while the seeds are used for making jam (Datta and Ravikumar, 1988). The mulberry can be grown as low bush, high trunk or deep-rooted tree and as such, could be utilized in afforestation of land and anti-erosion programmes (Datta and Ravikumar, 1988). Powder of *Morus alba* leaves has been used to prepare a drink by some people as a healthy diet in Japan, but its chemical composition was not known (Shimizu et al., 1992).

Trilochition (*Triplochiton scleroxylon*) (obeche) is indigenous to the humid tropical forests of Central and West Africa. It is a commercial and important timber species in its natural habitat, the timber is used as veneer and for light construction. The species have shown considerable promise as plantation species in tropical areas of Africa and Pacific (particularly in the Solomon Island). It has an excellent form, self-pruning and grows very fast. The main drawback with the species is its short-lived seed that has stimulated considerable research into vegetative propagation techniques. Juvenile leaf cuttings have been propagated successfully in conditions of high humidity in West Africa. Obeche has been used as hedges and for environmental stability. Its wood is used as fuel wood, while the sawn timber is used in building and for light construction, and the leaves are used as food.

Some plant species with edible fruits in lowland rainforest ecosystem of Southwestern Nigeria are noted to contain large quantities of protein and vitamins especially vitamins A, B, and C (Okafor 1979; Akachuku 1997). Their consumption therefore is able to augment the diet of people thereby preventing kwashiorkor and malnutrition especially in children. Some literature knowledge about the anti nutritional characteristics of these leaves should be stated. This study examined the nutrients and anti-nutrient potentials of obeche leaves and three varieties of mulberry leaves as a step towards establishing a wider and more purposeful utilization of these indigenous and exotic plant species, as well as to reduce the level of malnutrition in rural villages where these plants can be easily grown.

MATERIALS AND METHODS

Obeche leaves which were collected from different parts of the branches (i.e. top, middle and base) were obtained from Akure Forest Reserve, Aponmu, Nigeria, while the varieties of the mulberry leaves (S_{36}, S_{54} and K_2) were collected from Ondo State Ministry of Agriculture Sericulture Centre, Akure, Nigeria. The mulberry varieties were given equal silvicultural treatments, while the analysis of the samples was carried out in triplicate using standard procedures (AOAC, 1990). Each of the leaf samples of obeche and the three mulberry varieties were oven dried at 60 °C, pulverized and sieved through a 2 mm mesh screen and further dried at 60 °C to constant weight, labeled and stored in an air-tight plastic jar at 4 ^{o}C until required for analysis.

Proximate compositions of various samples were analyzed. Crude protein, crude fibre, crude fat and crude ash were determined by using the methods of Association of Official Analytical Chemist (AOAC, 1990). The samples were dissolved in 10% HCL, filtered and diluted to 100 ml before estimation of their heavy metal contents. The nitrogen free extract (carbohydrate) was estimated by subtracting the sum of weights of crude protein, crude fibre, crude fat and crude ash from the total dry matter. Phosphorus was determined by the Phosphovanado molybdate method of Ranjhan and Krisha (1980), while the other minerals were determined after wet digestion with a mixture of nitric, sulphuric and perchloric acids using an Atomic Absorption Spectrometer (AAS: Model SP 9). A corning flame photometer model 410 was used for the determination of Na and K.

Extraction and precipitation and determination of phytate were done by the method of Wheeler and Ferrel (1971), as used by Aletor (1995), Enujuigha and Ayodele (2003). Iron in the precipitate was determined by the method of Makower (1970) Tannin values were obtained by adopting the method of Markar and Goodchild (1996), while hydrogen cyanide in the samples was determined by AOAC 1990 method.

Data obtained from proximate minerals and antinutritional properties were subjected to one-way analysis of variance (ANOVA) (Steel and Torrie, 1960). Mean separation was done by Duncan Multiple Range Test (DMRT) (Duncan, 1955). A P value of < 0.05 was considered statistically significant.

RESULTS

Proximate composition of the leaf samples is presented in Table 1. The result shows that there is wide variation in the samples and there were significant differences between the chemical analysis of obeche and mulberry leaves. The crude protein ranged from 21.24% to 21.66 in mulberry leaves while obeche leaves contain 34.31%. The result further indicated that crude protein is significantly higher in obeche leaves than any leaf samples, while it is significantly lower in K_2.

The level of carbohydrate in mulberry K_2, S_{54}, S_{36} varieties and obeche were 56.42%, 49.04%, 47.27% and 30.04% respectively, with K_2 having the highest values and obeche having the least value. However, carbohydrate in obeche leaf is significantly lower than any of the mulberry leaves. S_{36} has the highest fat level of 8.02% followed by S_{54} with 6.05% while obeche and K_2 are 5.46% and 5.31% respectively. The value for S_{36} is significantly higher than all the treatment, while there were no significant differences between percentage crude fat content for obeche and k_2, which are significantly lower.

The ash content is the lowest in K_2 (8. 19%) and the highest in S_{36} (12.63%); obeche and S_{54} has 9.22% and 9.65% respectively. Percentage ash content is significantly higher in S_{25} but significantly lower in K_2.

The fibre content is lowest in K_2 (8.74%) with obeche having the highest of 20.73%. The lowest level of fibre in K_2 may be attributed to its high carbohydrate content of 56.42% while obeche that has the highest fibre resulted in the lowest carbohydrate 30.04%. Generally, the result of the proximate analysis of the samples (S_{36}, S_{54}, K_2 and obeche) shows significant differences for crude protein, ash, crude fibre and carbohydrate but there was no significant difference in crude fat of obeche and K_2.

Table 2 shows the level of anti-nutrients in various samples (S_{36}, S_{54}, K_2 and obeche), which hinder the utilizable nutrient in them. The mean values show that there was a significant difference in the phytate levels of the samples. The phytate content ranges from 451.3 mg/kg in K_3, 456.8 mg/kg in S_{54}, 488.9 mg/kg in S_{36} to 997.8 mg/kg in obeche.

The cyanide content of the leaves is 1.01 mg/kg in K_2, 1.12 mg/kg in obeche, 1.24 mg/kg in S_{54} and 2.14 mg/kg in S_{36} which is the highest value. The cyanide content for S_{36} is significantly higher than for all other treatments, while other treatments were not significantly different from each other.

Table 2 also shows the tannin levels in the samples. S_{36} has the highest tannin content of 5.32 mg/kg which is significantly higher than for other treatments followed by S_{54} (3.78 mg/kg), while K_2 (3.65 mg/kg) and obeche (3.54 mg/kg) were not significantly different from each other.

Table 3 shows the mineral contents of the leaves. There were significant differences in the zinc content between obeche and the other samples (S_{54} and K_2). Zinc content of S36 is significantly higher with 57.50 mg/kg than for other treatments, followed by obeche 48.60 mg/kg while S54 and K_2 with value of 34.40 mg/kg is significantly lower compare with other treatment.

S_{36} has the highest magnesium content of 2196 mg/kg followed by obeche with 1700 mg/kg, both K_2 and S_{54} have 1450 mg/kg.

Calcium in obeche is significantly lower than any other samples with 944.7 mg/ kg while K_2 and S_{54} ranked second with value of 1375 mg/kg and S_{36} ranked the highest with 1467 mg/kg as shown in Table 3.

Potassium level in S_{36} is significantly higher than all other treatments with 2170 mg/kg while the level in obeche, which was 1703 mg/kg, is significantly higher than those of K_2 and S_{54} with value of 1684 mg/kg each as shown in Table 3.

Table 1: Proximate composition of mulberry leaves and obeche leaves.

Samples	Moisture Content (%)	Crude Protein (%)	Crude fat (%)	Ash (%)	crude fibre (%)	Total carbohydrate
S_{36}	79.35 ± 0.69^a	21.66 ± 0.0^b	8.02 ± 0.30^a	12.63 ± 0.20^a	10.8 ± 0.80^c	47.27 ± 0.41^c
Obeche	73.70 ± 0.13^c	34.31 ± 0.0^a	5.46 ± 0.00^c	9.22 ± 0.04^c	20.73 ± 0.15^a	30.04 ± 0.17^d
S_{54}	72.16 ± 0.41^d	21.55 ± 0.0^c	6.05 ± 0.00^b	9.65 ± 0.16^b	13.70 ± 0.18^b	49.04 ± 0.23^b
K_2	76.00 ± 0.44^b	21.24 ± 0.0^d	5.31 ± 0.03^c	8.19 ± 1.70^d	8.74 ± 0.15^d	56.42 ± 0.53^a

Values in the same column followed by the same superscript are not significantly different (P >0.05).

Table 2: Anti-nutritional composition of the samples.

Samples	Phytate (mg/kg)	Cyanide (mg/kg)	Tannin (mg/kg)
S_{36}	488.90 ± 32.47^b	2.14 ± 0.20^a	5.32 ± 0.13^a
Obeche	997.80 ± 130.27^a	1.12 ± 0.20^b	3.54 ± 0.04^c
K_2	451.30 ± 0.00^b	1.01 ± 0.00^b	3.65 ± 0.01^c
S_{54}	456.80 ± 9.45^b	1.24 ± 0.20^{ab}	3.78 ± 0.00^b

Values in the same column followed by the same superscript are not significantly different (P>0.05).

The values of iron in K_2 and S_{54} were 141.57 mg/kg and 141.75 mg/kg respectively. The value in obeche is significantly lower with value of 129.7 mg/kg, while S_{36} is significantly higher than other treatments with value of 2380 mg/kg. The mineral element in Table 3 however indicated further that cobalt, copper, cadmium and lead were not detected but their absence is not a nutritional disadvantage.

DISCUSSION

The result shows that crude protein ranged from 21.24% to 21.66 in mulberry leaves while obeche leaves contain 34.31% (Table 1). This shows higher protein content compared with some major vegetable leaves such as *Solanum melongenas, Solanum nodiflorum* and *Vernonia amygdalina* (FAO, 1990). Table 1 further revealed that obeche has the highest protein content followed by S_{36}, S_{54} and K_2. The high protein values observed is in agreement with Kasiviswanathan et al. (1988) and it is an indication that both mulberry and obeche can be of food value in man, silkworm and animal. The limitation to the full utilization of obeche leaves could be due to high concentration of anti-nutritional factors mainly phytate and cyanide. This result equally indicated higher levels of crude protein compared to the commonly cultivated legumes such as cowpea; pigeon pea and lima beans as it was reported by Aletor and Adeogun (1995). Thus all species of mulberry and obeche leaves tested in this work could serve as substitute for existing plant protein and since the biomass yield of mulberry plant is very high at very short time (Adeduntan, 2003), coupled with lower cost of production, it could be highly recommended as food for man, animal and Silkworm. The level of carbohydrate in mulberry K_2, S_{54}, S_{36} varieties and obeche were 56.42%, 49.04%, 47.27% and 30.04% respectively with K_2 having the highest values and obeche having the least value. There is a corresponding relationship between the carbohydrate content of the leaves and their protein values. As protein values increase in some variety, their corresponding carbohydrate value decreases. Thus, the higher the protein, the lower their corresponding carbohydrate, a situation that is very advantageous for rural sector of the economy that is facing food crisis today.

S_{36} has the highest fat level of 8.02% followed by S_{54} with 6.05% while obeche and K_2 were having 5.46% and 5.31% respectively. These results signify that there are significant differences among the samples in fat levels and this agreed with the result obtained in the nutrient composition in mulberry leaves carried out in Asia (United Nations, 1993). The ash content was the lowest in K_2 (8. 19%) and the highest in S_{36} (12.63%); obeche and S_{54} has 9.22% and 9.65% respectively. High ash content was considered to be a good source of mineral food (Enujiugha and Agbede 2000). The fibre content is lowest in K_2 (8. 74%) with obeche having the highest of 20.73%. The lowest level of fibre in K_2 may be attributed to its high carbohydrate content of 56.42% while obeche that has the highest fibre resulted in the lowest carbohydrate 30.04%. Table 2 shows the level of anti-nutrients in various samples (S_{36}, S_{54}, K_2 and obeche), which hinder the utilizable nutrient in them. The mean values show that there are significant differences in the phytate levels of the samples. The phytate content is significantly higher than any other treatment. Enujiugha and Agbede (2000) reported that phytin-p is known to be the primary storage form of

Table 3: Mineral Elements of mulberry leaves and obeche.

Samples	Zinc (mg/kg)	Sodium (mg/kg)	Manganese (mg/kg)	Calcium (mg/kg)	Potassium (mg/kg)	Iron (mg/kg)	Magnesium (mg/kg)	Co	Cd	Pb	Cu
S_{36}	57.50 ± 0.45[a]	1526 ± 0.8[a]	24.37± 0.47[a]	1467± 1.05[a]	2170± 0.35[a]	238±0.66[d]	2196.4±1.23[a]	ND	ND	ND	ND
Obeche	48.60±0.46[b]	1069±0.31[c]	14.83±0.25[c]	944±0.47[c]	1703±0.44[b]	129.7±0.46[c]	1700± 0.55[b]	ND	ND	ND	ND
S_{54}	34.40±0.56[c]	1081±0.32[b]	18.27±0.21[b]	1375±0.7[b]	1684±0.53	141.7±0.45[b]	1450±0.36[c]	ND	ND	ND	ND
K_2	34.40±0.46[c]	1081±0.55[b]	18.23±0.25[b]	1375±0.43[b]	1684±0.29	141.5 ±0.49[b]	1450±0.35[c]	ND	ND	ND	ND

Values in the same column followed by the same superscript are not significantly different (P >0.05). ND: Not Detected.

phosphorus in mature legume seed. The high phytin content in obeche has nutritional significance as it does not only make phytin-p unavailable to humans and monogastric but it also lowers the availability of many other essential divalent minerals such as calcium as reported by Aletor (1995).

The phytate contents of these leaves varying between 45.13 mg/100 g and 997.70 mg/100g which are less than what is obtained in some fruits such as guava (327 mg/100 g), Plantain (553.08 mg/100 g), and banana (847.53 mg/100 g) whereas the lethal standard value for phytate is 2500 mg/100 g (FAO 1990).

The cyanide content of the leaves is 1.01 mg/kg in K_2, 1.12 mg/kg in obeche, 1.24 mg/kg in S_{54} and 2.14 mg/kg in S_{36} which is the highest value. This result is far below the standard permitted value for cyanide in fruits and in any other food value. The minimum standard cyanide value in leaves is 30 mg/kg (FAO 1990). These levels of cyanide may not have much effect on man and silkworm.

Table 2 also shows the tannin levels in the samples. S_{36} has the highest tannin content of 5.32 mg/kg followed by S_{54} (3.78 mg/kg), K_2 (3.65 mg/kg) and obeche (3.54 mg/kg). These values obtained were considered to be lower when compared with the standard value of 37 mg/kg (FAO, 1990). Thus these leaves are safe for consumption by man and livestock. Goldstein and Swain (1963) described Tannin as phenolic compounds with degree of hydrozylethyn with molecular size that is sufficient to form complexes with proteins thus making them unavailable. Rubino and Davidoff (1979) reported that cyanide of any part of plants often causes cyanide poisoning.

There were significant differences in the zinc content between obeche and the other samples (S_{54} and K_2) (Table 3). S_{36} has the highest zinc content with 57.50 mg/kg followed by obeche 48.60 mg/kg while both S_{54} and K_2 has 34.40 mg/kg. Zinc has been found to be an essential component of enzymes that plays critical role in protein and carbohydrate synthesis. The deficiency of zinc can cause break down in immune function of host defensive mechanism.

Calcium in obeche was significantly lower than any other samples with 944.7 mg/kg while K_2 and S_{54} ranked second with value of 1375 mg/kg and S_{36} ranked the highest with 1467 mg/kg as shown in Table 3. The values of calcium detected are in order of which is noted to be good for bone formation and osmo-regulation. Potassium level in S_{36} is significantly higher than all other treatments with 2170 mg/kg while the level in obeche, which is 1703 mg/kg, is significantly higher than those of K_2 and S_{54} with value of 1684 mg/kg each as shown in table 3, which is good for nerves and muscle functions in man.

Conclusion and recommendation

Obeche (*Triplochiton scleroxylon*) contained very high protein and crude fibre that is very essential for man, livestock and silkworm's growth. Its leaves have been eaten by some communities in Ondo State, Nigeria, but its consumption has not been widespread. It is therefore suggested that the leaves be subjected to further treatments or processing to reduce the toxic level before processing for consumption. K_2 S_{54} varieties of mulberry leaves should be encouraged by local farmers to feed their silk worms and livestock because they contain lower phytate, cyanide and tannin content, and are rich in essential minerals which are made available for utilization. This work thus supports the consumption of mulberry and obeche leaves by man since it has been reported by Datta (1992) that mulberry leaves serve as a source of delicious vegetable, which is very rich in protein.

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