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Evaluating the Nutritional Potential of *Acacia Sieberiana* Seeds (Dc) Growing In North West of Nigeria

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Abstract

Concerted efforts in search of alternative sources of protein has grown due to dearth of animal protein in developing countries, as food shortage and poverty become more endemic, people increasingly depend on plants rather than animals for proteins in their diets. This work focuses on untapped indigenous wild savannah tree, *Acacia sieberiana* (seeds) for its nutritional and economical values. The seeds were collected and processed for proximate compositions, phytochemicals and elemental analysis. The high percentage of crude protein content of 49.7% and absence of toxic elements such as Cadmium (Cd), Arsenic (Ar), and very low percentage of Lead (Pb) 0.001ml/g has proven that the *Acacia sieberiana* seeds are very safe and could serve as an alternative source of protein. The result of the quantitative minerals determination shows the presence of Manganese (3.93mg/g), Calcium (2.02mg/g), and Iron (0.11mg/g). The germination trials of the seeds were also carried out, and the result shows that, soaking, heating the seeds at 60^0C and even the non treated seeds as well as those planted and mulched gave promising results of the plant's seeds germination. The statistical package for social science (SPSS) software was used to analysed the significant differences between the treatments at critical value ($p \geq 0.05$).

Keywords: *Acacia sieberiana*, Elemental analysis, Germination trial, Proximate compositions, Phytochemicals screening.

1. Introduction

Throughout history man has used some 3,000 plant species for food, at least 150 of them have been commercially cultivated to some extent. But over the centuries the tendency has been to concentrate on fewer and fewer crop and a large percentage are underutilized (NAS, 1984) In developing countries, wild plants are exploited as sources of food and other life supporting commodities and thus provide an adequate level of nutrition to the human beings (Aberoumand and Deokule, 2010). These wild plants serve as an indispensable constituent of human diet supplying the body with minerals, vitamins and certain hormone precursors, in addition to protein and energy (Akubugwo *et al*., 2007).

*Acacia sieberiana (*English name: White thorn, Hausa: Fara kaya, Yoruba: Aluki sie). A member of the Family Fabaceae – Mimosoideae, is a tree that grows up to 15 m high with light-coloured bark and often with a flat crown. The leaves, 10-15 cm long have straight white thorns at their base. The branches and often the leaves are covered with yellow hairs. The flower heads are cream-coloured and spherical. The seeds are contained in straight pods, 8-12 cm long and 2-3 cm broad. The tips of young shoots are intensively browsed particularly toward the end of the dry season. *A. sieberiana* grows in the savannah and woodland. It occurs with various botanical characteristics in the entire Sahel and other semi-arid regions in Africa (Orwa *et al.*, 2009). The tree possessed some ethnobotanical history; decoction of the root is taken as remedy for stomach-ache. The bark, leaves and gums are used to treat tapeworm, bilharzia, haemorrhage, orchitis, colds, diarrhoea, gonorrhoea, kidney problems, syphilis, ophthalmia, rheumatism and disorders of the circulatory system. It is also used as an astringent. The pods serve as an emollient, and the roots for stomach-ache, acne, tapeworms, urethral problems, oedema and dropsy (Orwa *et al.*, 2009).

This work was aimed at evaluating the seeds of *A. sieberiana* (DC) which is untapped nutritionally and economically; the proximate composition, phytochemicals, elemental analysis and germination trials were carried out. The work could contribute to educate the indigenous people about the nutritional values of this seeds, and the seeds can also be incorporated among edible and commercial seed plants, which will positively improve the indigenous economy. The research is also being the first attempt to consider the nutritional and economical value of *A. sieberiana* (DC) seeds.

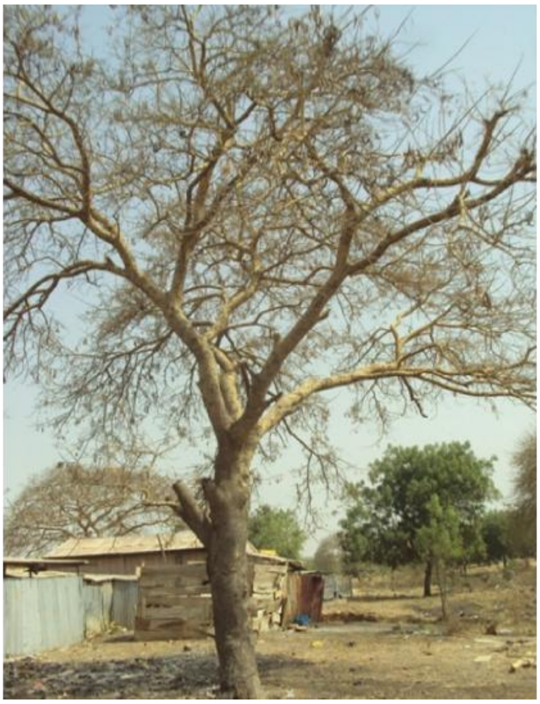

Figure 1. *Acacia sieberiana* tree

Figure 2. *Acacia sieberiana* pod and seeds.

Source: BUK, 2013.

2. Materials and Methods

2.1 Sample Collection

The *A. sieberiana* seeds were collected from uncultivated land in Bayero University new campus Kano state, Nigeria. It is located in North-West Nigeria, lies between latitude 13^0N and 11^0N and longitude 8^0W and 10^0E, in the east. The vegetation is the semiarid savannah, the area contained the wild tree plants with nutritional, ethnomedicinal and economical values, such as *Acacia nilotica*, *Parkia biglobosa*, *Khaya senegalensis*, *Prosopis africanum*, *Azadirachta indica*, *Vitalleria paradoxa*, *Vitex doniana*, *Tamarindus indica* and *Ficus exasperate* just to mention but a few (Ibrahim *et al*., 2012).

2.2 Seed Authentication

The pods containing the seeds were collected between December- January, and brought to the botanical garden of Biological Science Department, University of Abuja, which was identified by Mr. O. Segun and Verified by Professor O. Olorode (Botanist/Taxonomist) before taken to the laboratory for processing.

2.3 Seed Processing

The pods were crushed using mortar and pestle and blown to obtain the seeds .Using laboratory hot plate (Hot Hc 1200, UK, BIBBY) the seeds were boiled for 5hours at 100^0C and dehulled, after cooling. The dehulled seeds were oven dried at 60 ℃ for twenty-four (24) h, using (Memmert oven Schutzari 40050-1p 20 Germany) to a constant weight, then cooled and ground to powder (flour), using Mortar and Pestle and stored at 4^0C prior to use.

2.4 Proximate Analysi

Standard methods of the Association of Official Analytical Chemists (AOAC, 1990) were used to determine the moisture, crude protein, crude lipid, ash content and crude fibre contents of the sample.

Moisture content was determined by weighing 2g of the flour (W_1) into preweighed crucible (W_o) and placed into a hot drying oven at 105^oC for 3h. The crucible was removed, cooled in desicator and weighed. The process of drying, cooling and weighing were repeated until a constant weight (W_2) was obtained. The weight loss due to moisture was obtained by the equation:

$$\text{Moisture (\%)} = {W1 - W2}/{W1 - Wo} \times 100$$

Where:

W_o= Weight of the empty crucible (g), W_1= weight of the powder sample + empty crucible (g) W_2= weight of dried sample + empty crucible (g).

Crude protein (% total nitrogen x 6.25) was determined by the Kjeldahl method, using 2g of the seeds flour;

Crude lipid was obtained by exhaustively extracting 5g of the sample in a Soxhlet apparatus using petroleum ether (boiling point range 40-60 ℃) as the extractant.

Ash content was determined by the incineration of 10g sample and placed in a muffle furnace maintained at 550 ℃ for 5h.

Crude fibre was obtained by digesting 2g of sample with H_2SO_4 and NaOH and incinerating the residue in a muffle furnace maintained at 550 ℃ for 5h.

Carbohydrate value was obtained by (percentage of ash + percentage of Fat + percentage of Protein + percentage of crude fibre.

Each analysis was carried out in triplicate.

2.5 Phytochemical Screening of A. Sieberiana Seed Flour

Sixteen (16) preliminary qualitative phytochemicals screening were conducted, in accordance

with the standard procedure (Harborne, 1974**;** 1992; Debela, 2002; Sofowora, 1993). Test for alkaloids, steroids, tannins, saponins, glycoside, cardenolides, terpenoid, reducing sugar, flavonoids, cardiac glycosides, balsams, resins, volatile oils, phlobatannins, phenols, and triterpenoids tests are all conducted, on both aqueous and methanolic flour extract.

2.6 Sample Digestion For Elemental Analysis

About 2g of the sample was digested with (Aqua regia) 3ml of HCL to 1ml OF HNO_3 until a clear solution was observed; the suspension was then filtered into a 100m volumetric flask and made it up to the mark (100ml) using deionized water. Atomic absorption spectrophotometer (Younglin AAS 8010 Model, Korea) was used for the determination.

2.7 Germination Trials

One hundred seeds were subjected to various treatments for breaking the dormancy of *A. sieberiana* for its propagation, treatments such as soaking the seeds in concentrated $H_2SO_{4,}$ and 50% $H_2SO_{4,}$ Concentrated (nitric acid) HNO_3 and 50% HNO_3 for 1hrs each, Boiling the seeds at 100^{o}C, heating the seeds at 60^{0}C, using (water bath), socking the seeds in cold water for 24hrs, mechanical treated and untreated seeds were all planted in polyethene bag containing soil for four weeks germination trials. Mulching the seeds was also attempted.

3. Results and Discussions

The proximate composition results in table 1 shows that Moisture content of *A. sieberiana* seeds flour was 6.2±0.00% which is low compared to that of *Parkia biglobosa* 11.21%, reported by Elemo *et al*., (2011). The low moisture content will afford a long shelf life for *A. sieberiana* seeds flour. The crude lipid is high 30.6±0.02% compared with that of *Parkia biglobosa* 15.48%, Elemo *et al*., (2011) pigeon pea 1.7% and soybeans 23.5% (Paul and Southgate, 1985). This is an indication that *A. sieberiana* seeds can be grouped as part of plants oil-rich legume seeds. The most interesting value is that of crude protein 49.7±0.03 which is considered very high compared to protein rich foods such as soyabeans 36.00% (Edema *et al*.,

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2005), pigeon pea 21.0% (Abdelrahman et *al*., 2010), *prosopis africanum* 23.6±1.5 (Aremu *et al.*, 2006) and *Parkia biglobosa* 27.9% (Elemo *et al*., 2011).

Table 1. Proximate constituents of *A. sieberiana* seed flour in percentages (%)

S/No.	Constituents (%)	Seeds flour
1	Moisture content	6.2±0.00
2	Ash Content	5.8±0.04
3	Crude lipids	30.6±0.02
4	Crude fibre	4.9±0.29
5	Carbohydrate	8.2±0.32
6	Crude protein	49.7±0.03

Values are mean ±standard deviation of triplicate.

Phytochemicals screening of aqueous and ethanolic extract of the seeds flour in table 2, revealed the present of alkaloids, which generally exert pharmacological activity particularly in mammals such as humans, many of our most commonly used drugs are alkaloids from natural sources (Robert and Wink 1998). Alkaloids have many pharmacological activities including antihypertensive effect, antiarrhythmic effect, antimalarial activity and cancer action these are few functions of alkaloids illustrated by Cordell (1983).Tannins are also present which serve as natural defense against microbial infection. Tannins have also been reported to exert other physiological effects, such as to accelerate blood clotting, reduce blood pressure, decrease the serum lipid level, produce liver necrosis and modulate immunoresponses (Bele *et al.*, 2012). The seed flour also contains terpenoids, terpenes have biological activities and are also used for the treatment of human diseases. The worldwide sales of terpenes–based pharmaceuticals in 2002 were approximately US $12billion. Among these pharmaceutical, the anticancer drug taxol, and the antimalarial drug artimesinin are two of the most renowned terpenoids based drugs (Lixin and Arnold, 2005). Saponins are also present, a secondary plant metabolite well known for antimicrobial properties. Flavonoids are polyphenols known for antioxidants activity improve blood circulation and relieve tissues damaged by pathogens. Flavonoids play a role in pigmentation and also have anti-inflammatory properties. The seeds flour also contains volatile oil which is a component of plant that offers the strong aroma to attract foraging wildlife, and this oil often provides concentrated medicinal benefits as well. Some components of volatile oil are strongly antiseptic and normally possess anti-inflammatory properties as well. Aromatherapy involves the use of volatile (essential) oil to alter moods and perception as well as to detoxify the body (Kirk, 2009). Cardiac glycoside is also present which is the natural diuretics that directly strengthen the heart by increasing the contraction rate, cardiac glycosides also improve circulation, lower blood pressure and relieve the urinary tract.

Table 2. Phytochemicals screening of aqueous and ethanolic *A. sieberiana* seeds flour.

S/No.	Test	Results
1	Alkaloids	+

2	Steroids	-
3	Tannins	+
4	Saponins	+
5	Glycosides	+
6	Cardenolides	-
7	Terpenoides	+
8	Reducing sugar	-
9	Flavonoids	+
10	Cardiac glycosides	+
11	Balsams	-
12	Resins	-
13	Volatile Oil	+
14	Phlobatannins	-
15	Phenols	-
16	Triterpenoids	-

KEY:- (+) Indicate present. (-) Indicate absent

From the table 3 below the concentrations of the essential elements appeared to be low but within safety limit (W. H. O., 1996). These elements support human biochemical processes by serving structural and functional roles as electrolytes (Nelson and Cox, 2008). The values of Calcium (2.02±0.5), Magnesium (3.93±0.03), Cupper (0.19±0.01), and Manganese (0.02±0.00) are considerable, as they play important roles in metabolic activities, manganese (Mn) used extensively in chemotherapy and others are known to help in bone and teeth development (Khan, 1996; Ogugbuaja *et. al.*, 1997). The result of the minerals content of *A. sieberiana* was also comparable with minerals analysis on *Pakia biglobosa* seed (Elemo *et al*., 2011), and *Prosopis africanum* seed (Aremu, *et al.*, 2006).

The result shows that Cadmium (Cd), and Arsenic (Ar) are not detected and the infinitesimal value of Lead (Pb) 0.001±0.00, indicated that the seed flour contains little or no heavy metals, as heavy metals have been implicated in cancer, liver and kidney problems (Ogugbuaja *et. al.*, 1997). Minerals help maintain acid-base balance, to keep the body pH neutral (Akpanyung, 2005). Minerals help regulate body processes, such as in enzyme systems. They also function in nerve impulse transmission and muscle contraction.

Table 3. Elemental analysis of *A. sieberiana* processed seeds flour.

S/No.	Test Elements	Conc. in Mg/g
1	Fe	0.11±0.01
2	Mg	3.93±0.03

3	Ni	0.045 ±0.00
4	Ca	2.02 ±0.5
5	Cu	0.19 ±0.01
6	Zn	0.15 ±0.01
7	Cd	Nil
8	Pb	0.001 ±0.00
9	Mn	0.02 ±0.00
10	Cr	0.02 ±0.01
11	Ar	Nil

Values are mean ± standard deviation of triplicate.

The result of germination trials of *A. sieberiana* seeds after subjecting each group of 10 seeds to different treatments in Figure 3, shows that out of 100 seeds treated, a total of 50seeds germinated in all. All the seeds (10) treated with cold soaking and mulching germinated, 9 seeds germinated from the group of untreated seeds, 8 seeds germinated from the group that was subjected to boiling at 60^0c, 7 seeds germinated from the group that was subjected to mechanical treatments, 3,2, and 1 seed(s) germinated from groups treated with 50% HNO_3 for (1hr), 50% H_2SO_4 for (1hr) and boiling at 100^0c for (1hr) respectively. Seeds treated with 100% HNO_3 for (1hr) and 100% H_2SO_4 for (1hr) produced no germination. Thus, cold soaking, mulching and natural (no-treatment) prove promising methods of propagating *A. sieberiana*. The result was in line with the world agroforestry data base (www.worldagroforestry.org/af/treedb/). The data collected from the germination trials were subjected to analysis of variance one way (ANOVA). Means with significant differences were separated by Least Significant Difference (LSD) after Post-hocTest, using SPSS software at critical value ($p \geq 0.05$).

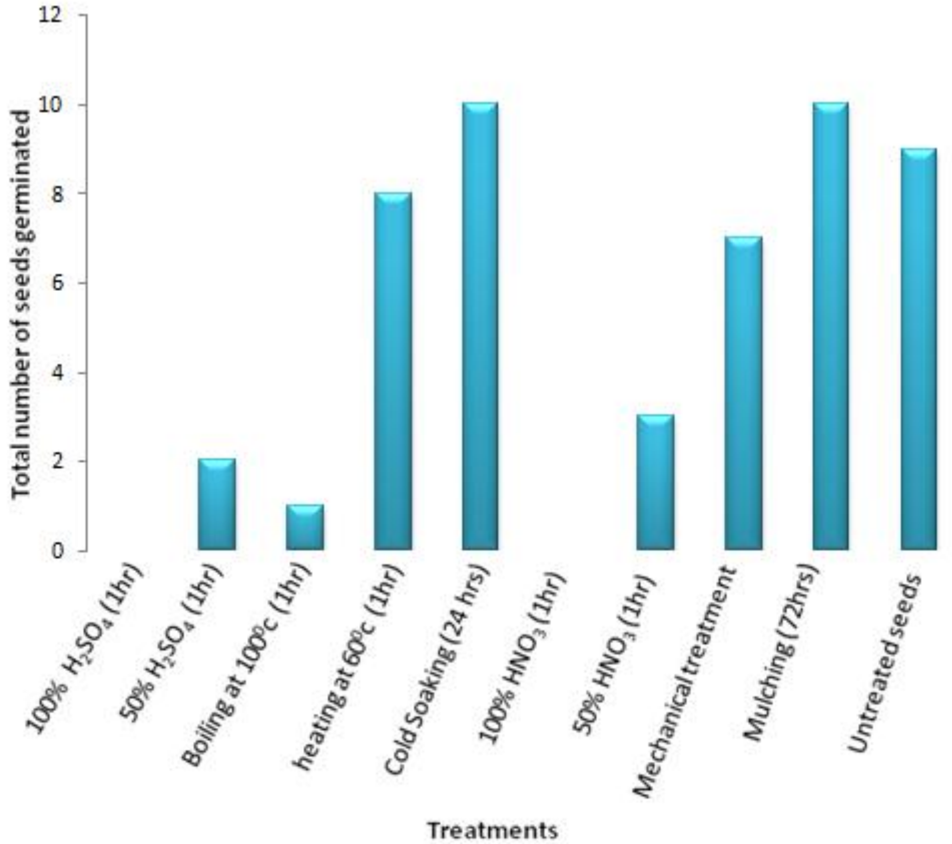

Figure 3. Germination trials of *A. sieberiana* seeds

Figure 4. *A. sieberiana* growing in screen house.

(SOURCE: SHESTCO, 2013)

4. Conclusion and Recommendations

The result of this work shows that *A. sieberiana* could be an important tree crop in Sub-Saharan region (economically and nutritionally). It has relatively an average mineral content and rich in protein content which can serve to reduce the protein shortage in the region.

Base on our findings we recommend the following:-

There is a growing concern about human destruction of vegetation, it is necessary to collect the germplasm of this untapped nutritive and economically important tree species for conservation before it becomes extinct.

The seeds should be incorporated in agricultural development programmes placing special emphasis on its nutritional value and production potential.

More work should be carried out on its nutritional value i.e. Amino acid profiles, Vitamins, and other nutritive elemental analysis.

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