

An Evaluation of the Phytochemical and Nutrient Composition of the Seeds and Stem Bark of *Detarium senegalense* Gmelin

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Abstract

The chemical constituents of the seeds and stem bark of *Detarium senegalense* Gmelin used as soup thickener and in herbal medicine in south Eastern Nigeria were studied. Phytochemical studies revealed the presence of alkaloids (0.37% - 0.72%), flavonoids (2.28% - 5.68%), tannins (0.47% - 0.79%), phenols (0.35% - 0.67%) and saponins (1.85% - 4.60%). The mineral constituents were Ca (1.44% - 1.80%), Mg (0.32% - 0.40%), K (0.50% - 0.85%), Na (0.53% - 0.40%), P (1.00% - 0.54%), Fe (7.11% - 6.97%), Mn (0.45% - 0.70%), and Zn (5.40% - 6.15%). The plant samples were found to be rich in vitamins comprising riboflavin (0.62mg/100g - 0.60mg/100g), thiamin (0.14mg/100g - 0.27mg/100g), niacin (2.06mg/100g - 8.11mg/100g) and ascorbic acid (83.6mg/100 - 24.2mg/100g). The proximate composition revealed the presence of protein (20.5% - 9.60%), crude fibre (10.5% - 17.8%), fats/oil (55.6% - 3.56%), ash (5.00% - 5.50%), carbohydrates (8.40% - 63.54%) and food energy (616.0g/cal - 324.6g/cal.).

Keywords: Chemical composition, leguminosae, saponins, tannins, flavonoids.

1. Introduction

Since creation, man has used plant as source of food and drug. They are always valued in the treatment of diseases. one of these plants is a leguminous African genus, *Detarium Senegalense* Gmelin. The seeds are processed into flour and used traditionally in Nigeria as a flavouring agent and as a soup thickener. It has been reported that the seeds of *D.Senegalense* contains a large amount of water - soluble, non - starch polysaccharide, zyloglucan which suggests that this plant has considerable potential in food, drugs and chemical industries (Wang et al,1997). The stem bark of this plant is used in herbal medicine in Nigeria in the treatment of venereal diseases, urogenital infections, wounds, haemorrhoids, diarrhea, pneumonia, malaria and rheumatism (Burkill, (1995). The bark is also used to alleviate pains such as headache, backpain, sore throat and painful menstruation (Keay et al,1989). It is also macerated in palmwine for bronchitis, pneumonia and for leprosy treatment (Burkill, (1995). The Igbo tribe of Nigeria macerate it in palmwine for preservation of palmwine. The Zyloglucan isolated from the seed of *D. Senegalese* was found to have considerable promise in the treatment of diabetes, hyperlipidaemia and cancer (Wang et al,1997) and (Rayment et al,2000). *D. Senegalese* Gmelin grows in the drier regions of west and central Africa, from Senegal to sudan, Nigeria and on to Zaire. It is a large tree, up to 36m high with a large very leafy crown. The bark is grayish and fairly smooth but covered with fine cracks. The heart wood is dark reddish brown, hard and fine grained. The flowers are creamy white and the leaves bright green. It produces its fruits from November to March. The fruit are 4 - 6 cm diameter, fibrous, sweet and one seeded (Keay et al,1989). Despite the fact that the tree exudes gum, it is also used for its timber in production of furniture and cabinet works, plywood cones and fences, boat ribs, canoes and tool handles. The wood is strong durable and resistant to termites and borers. In Nigeria, two varieties are recognized locally though there is no morphological distinction, one with edible fruit, the other with toxic fruit. The poisonous form serves the Igbo tribe of Nigeria as a ritual plant.

In spite of the various uses of *D. senegalense* in food and as drug, their various phyto constituents have not been fully documented. Thus, this study was undertaken to evaluate the chemical constituents of the seeds and barks of *D. senegalense* and to consequently assess their potential usefulness as food supplements and pharmaceutical raw material for drug production.

2. Materials and Method

2.1. Plant Materials : The seeds and stem barks of *Detarium senegalense* were collected from forests in Lokpaukwu in Umunneochi L. G. A, Abia state, Nigeria. Authentication of plant materials was done by Dr A. Nmeregini of Taxonomy section, Forestry Department, Micheal Okpara University of Agriculture, Umudike, Nigeria.

2.2. Sample Preparation : The seeds were soaked overnight. The loosened testa were then peeled off and dried in air. The stem barks were also air dried, the dry samples were pounded and finally milled with Thomas Willey milling machine and then stored in air tight bottles for analysis.

2.3. Chemical Analysis: Alkaloids and phenols were determined according to the method described by Okwu and Omodamiro (2005). Saponin was determined using the method of Obadoni and Ochuko (2001)). while flavonoid was determined by the method of Baham and Kocipai (1974).

The macro elements, calcium, sodium, potassium, phosphorus, magnesium and the micro elements, iron, manganese and zinc were determined according to the method of Shahidi *et al.* (1999). The vitamin-B complexes (thiamin, riboflavin and niacin) were determined according to (Baraket *et al.*,(1993)). Total nitrogen (N) content was determined by the use of a micro Kjeldahl MD 55 (Singapore) apparatus. The protein content was calculated as N x 6.25. Crude fiber, Fats/oil and ash content were determined according to Pearson,(1976). Total Carbohydrates were estimated as the remainder after accounting for ash, crude fiber, Protein and fats/oil according to Muller and Tobin (1980). The gross food energy was estimated according to the method of Osborn and Voogt (1978) by using the equation.

$$FE = (\% CP \times 4) + (\% CHO \times 4) + (\% Fat \times 9).$$

Where FE = Food energy (in g / cal)

CP = Crude Protein

CHO = Carbohydrates.

2.4 Statistical analysis: All measurements were replicated three times and standard students t – test at P < 0.05 was applied to assess the difference between the means as describe by Steel and Torrie (1980).

3.0. Results and Discussions

Table 3.1 Phytochemical composition of Seeds and Stem Barks of *Detarium senegalense* expressed as percentages (%)

Constituents	Seed	Stem bark
Alkaloids	0.37 ± 0.02	0.72 ± 0.02
Flavonoids	2.28 ± 0.04	5.68 ± 0.02
Tannins	0.47 ± 0.01	0.79 ± 0.08
Phenols	0.35 ± 0.22	0.67 ± 0.05
Saponins	1.85 ± 0.11	4.60 ± 0.01

Data are means of triplicate determinations ± standard error

Table 3.2 Mineral Composition of the Seeds and Stem Barks of *D. senegalense* expressed in percentages (%)

Elements	Seed	Stem bark
Magnesium	0.32 ± 0.03	0.40 ± 0.02
Calcium	1.44 ± 0.05	1.80 ± 0.02
Potassium	0.50 ± 0.06	0.85 ± 0.05
Sodium	0.53 ± 0.05	0.40 ± 0.01
Phosphorus	1.00 ± 0.02	0.54 ± 0.02
Iron	7.11 ± 0.01	6.97 ± 0.02
Manganese	0.45 ± 0.02	0.70 ± 0.05
Zinc	5.40 ± 0.10	6.15 ± 0.03

Data are means of triplicate determinations ± standard error

Table 3.3 Vitamin Composition of the Seeds and Barks of *D. senegalense* (mg/100g).

Constituents	Seed	Stem bark
Riboflavin	0.62 ± 0.04	0.67 ± 0.02
Thiamin	0.14 ± 0.05	0.27 ± 0.02
Niacin	2.60 ± 0.03	8.11 ± 0.10
Ascorbic acid	83.6 ± 0.05	24.2 ± 0.01

Data are means of triplicate determinations ± standard error

Table 3.4 Proximate composition and energy content of the seeds and stem barks of *Detarium senegalense*

Constituents	Seed	Stem bark
Crude Protein N x 6.25%	20.5 ± 0.05	9.60 ± 0.01
Crude Fiber%	10.5 ± 0.01	17.8 ± 0.05
Fats/oil %	55.6 ± 0.03	3.56 ± 0.02
Ash%	5.00 ± 0.04	5.50 ± 0.05
Carbohydrates%	8.40 ± 0.10	63.54 ± 0.01
Food energy g/calories	616.0 ± 0.01	324.6 ± 0.03

Data are means of triplicate determinations ± standard error

Both the seeds and the barks were found to contain alkaloids. The stem bark contained 0.72 % and the seeds contained 0.37 % of alkaloid. Plants that contain alkaloids are best known for their potent pharmacological properties. Pure isolated plant alkaloids and their synthetic derivatives are known for their analgesic, antispasmodic and antibacteriacidal effects (Okwu,(2005). This may be the reason the stem bark of *D. senegalense* is used in herbal medicine to treat malaria, stomach ache, rheumatism, headache, sore throat and painful menstruation. In recent years, attention has been focused on alkaloids with anti-tumourous effect (Frantisek, (1998).

The flavonoid content was found to be higher in the barks (5.68 %) than in the seeds (2.28 %). Flavonoids are known to possess antioxidant property, protect against allergies, inflammation, microbes, ulcer, viruses and tumor (Salah *et al.*(1995); Okwu and Okwu (2004). This may account for the use of the stem bark of *D. senegalense* to stop the inflammation of broken limbs, and cure infections. They are also known to prevent oxidative cell damage, have strong anti-cancer activity and inhibit all stages of carcinogenesis (Okwu,(2005);Okwu (2004). This supported the use of *D. senegalense* seed by the natives for the treatment of diseases such as diabetes, hyperlipidaemia and cancer (Wang et al,1997)).

Tannin is another important phytochemical contained in the seeds and the stem barks of *Detarium senegalense* . The stem bark contains 0.79 % of tannin while the seed contains 0.47 % of tannins. Tannins are organic substances of diverse composition with pronounced astringent properties that promote the healing of wounds and inflamed mucous membranes (Frantisek, (1998), Okwu, (2004).Externally, the stem barks of *Detarium senegalense* are used for treating haemorrhoids, wounds and burns, as mouthwash, and for treating inflammation. Internally, it is used in the treatment of diarrhea and cholera (2).

The stem barks contain more phenol (0.67 %) than the seeds (0.35 %). Plants that contain phenols could be used as anti-inflammatory, immune enhancers and hormone modulators (Okwu, (2004).

Both the stem barks and seeds of *D. senegalense* were found to contain high quantity of saponin. The stem barks contain 4.60 % of saponin and the seeds contain 1.85 % of saponin. Plants that contain saponin are known to produce foams in aqueous solution, and this may be the reason the ash from the burnt bark is used in soap making. Saponins are known to make the bronchial secretion more liquid, reduce the congestion of the bronchi and ease coughing. This also may be the reason the plant is used in herbal medicine for the treatment of tuberculosis. *D. senegalense* plant is thus a very useful plant in treatment of bronchial catarrh, bronchitis and bronchial pneumonia (George, and Pamplona-Roger,(2002). The high saponin content of both the seeds and barks of *D. senegalense* justifies the use of the extracts from this plant to stop bleeding and in treating wounds.

Both the seeds and barks contain some amount of calcium . The seeds contain 1.44 % of calcium and the stem barks contain 1.80 % of calcium. Phosphorus was found to be higher in seeds (1.00 %) than the bark (0.54 %). Calcium and Phosphorus are needed for bone and teeth formation. Phosphorus is also required for nearly every metabolic process in the body .It is good for kidney function (Salem,(2000). The amount of Magnesium in the seeds was found to be 0.32 % and in the barks 0.40 % . Magnesium helps to reduce cholesterol according to Salem,(2000). Sodium and potassium which are needed in the blood fluid and in nerves were also found in both the seeds and stem barks of this plant. The seeds contain 0.53 % of sodium and 0.50 % of potassium and the stem barks contain 0.40 % of sodium and 0.85 % of potassium. Manganese content was found to be 0.45 % and 0.70 % in the seeds and stem barks respectively. Manganese controls the nerves in one's body. The seeds and stem barks also contain a good quantity of iron. Iron content in the seeds was 7.11% and in the barks 6.97 %.

Iron is part of the haemoglobin molecule involved in Oxygen transport to and within the cells (Michael, (1997). The amount of zinc in the seeds was found to be 5.40 % and in the barks 6.15 %. Zinc is an essential nutrient. Low zinc status in children has been associated with retarded growth, poor appetite and impaired sense of taste (Michael,(1997).

The seeds and stem barks of *D. senegalense* are rich sources of Vitamin C (ascorbic acid) .The seeds contained higher amount of vitamin C (83.6 mg /100g) than the stem bark (24.2 mg /100g). Vitamin C is an anti-scurvy vitamin. It facilitates the transformation of cholesterol into bile acid in the liver. The presence of vitamin C hastens the healing of wounds. It enhances the absorption of iron and thus has a role in reducing iron deficiency and anemia (Norman and Joseph,(1997).

Other vitamins such as niacin, riboflavin and thiamin were also found in the plant. The seeds contain 2.60 mg/100g of niacin, 0.62 mg/100g of riboflavin and 0.14 mg/100g of thiamin. The stem barks contain 8.11 mg/100g of niacin, 0.67 mg/100g of riboflavin and 0.27 mg/100g of thiamin. Niacin is active in preventing the diseases pellagra which is characterized by skin and mucous membrane disorders as well as depression and confusion.

The results of the proximate composition showed that both the barks and the seeds contain basic food nutrients such as protein, fats, carbohydrates and fiber. The seeds contained higher amount of crude protein (20.50 %) than the bark (9.60 %). Crude fiber content was found to be 10.5 % in the seeds and 17.8 % in the stem barks. Fiber is very important for vibrant health. The important role of fiber is to clean out or sweep the digestive system, flushing the residue as efficiently and quickly as possible ((Salem,(2000). The seeds and stem barks of *D. senegalense* contain 55.6 % and 3.56 % of fats/oil respectively. The higher inclusion of lipids in these plants is an indication of their potential as a source of vegetable oil (Okwu, (2004). The ash content of the stem bark (5.50 %) was higher than the ash content of the seed (5.00 %). The stem barks contain higher amount of carbohydrates (63.54 %) than the seeds which contained (8.40 %) of carbohydrates. This plant was found to be rich in calories, the seeds have the highest food energy 616 g cal⁻¹ and the bark has 324.6 g cal⁻¹.

The amount of proteins and vitamins contained in *D. senegalense* seeds are high compared to other traditional soup thickeners such as *Brachystegia eurycoma* and *Mucuna flagellipes* as reported by (Okwu and Okoro,(2007).

4.0 Conclusion

The results of this investigation have shown that the seeds and stem bark of *D. senegalense* plant contain phytochemicals, minerals and vitamins. As rich sources of phytochemicals, they can function as antioxidants, anti-inflammatory and anti-carcinogenic agents. The seeds contain high protein and ascorbic acid and thus can be incorporated into infant formulae and weaning foods especially in countries where the rate of infant mortalities are high as a result of mal-nutrition, kwashiorkor and scurvy. The seeds can be used as food supplements. The nutritional and health benefits of the seeds and stem bark of *D. senegalense* have proved the plant to be a potential source of useful drugs and quality food.

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