Phytochemical and Nutraceutical Potentials of Beach Bean (*Canavalia rosea* SW.) DC Grown in Anyigba, Kogi State, Nigeria

Kokori Bajeh Tijani¹, Abdullahi Attah Alfa²*, Audu Momoh⁳ and Abdullahi Aminu Sezor⁴

¹Department of Pharmacology and Therapeutics, Faculty of Basic Clinical Sciences, Kogi State University, Anyigba, Nigeria.
²Department of Anatomy, Faculty of Basic Medical Sciences, Kogi State University, Anyigba, Nigeria.
³Department of Animal Production, Faculty of Agriculture, Kogi State University, Anyigba, Nigeria.
⁴Department of Chemistry, Faculty of Sciences, Kogi State University, Anyigba, Nigeria.

Authors’ contributions

This work was carried out in collaboration among all authors. Author KBT designed the study, performed the statistical analysis. Author AAA wrote the protocol and wrote the first draft of the manuscript. Authors AM and AAS managed the analyses of the study. Author AM managed the literature searches. All authors read and approved the final manuscript.

ABSTRACT

Beach Bean is a species of flowering plant of the genus Canavalia in the pea family, Fabaceae that has a pantropical distribution. This study aims to determine the phytochemical and nutraceutical activities of Beach Bean grown in Anyigba area of Kogi State, Nigeria. Beach Bean (*Canavalia rosea*) leaf and seed were dried in the powder form, then the leaves and seeds of 200 grams each were extracted in 2000 ml of aqueous. The macerated for 48 hours and filtered using filter paper and filter pump. The sample was concentrated using a rotary evaporator and freeze-dried to

*Corresponding author: E-mail: kbtbiochempharma@gmail.com, attahalfa@gmail.com;
powdered form. The filtrate obtained from each extraction was tested for alkaloids, saponins, flavonoids, phenol, fat and oils, steroids, tannins and glycosides. The proximate analysis of the samples was carried out for moisture content, ash, fat, crude protein, crude fibre after drying the samples of Beach Bean at room temperature. Vitamins A, E, B and C were determined and the mineral elements were determined by the dry ash extraction. The phytochemical components of secondary metabolites of the extracts from the obtained result, anthraquinone and tannins (leaf) were not present in the extracts. The proximate composition of nutritive value of seed and leaves has a higher value of crude protein of amounting to 50.84% while the leaves have crude protein value of 30.59%, carbohydrates percentage of the leaves was higher (40.60%) while the seed has 26.98%. The percentage of ash content which is an indicator of the quality of mineral nutrients present has a value of 8.45% in leaves and 2.53% in the seed. By implication, the leaves are richer in mineral nutrients/elements than the seeds. This research classified a large number of nutraceuticals available from various sources and their significant uses in the treatment of various diseases such as Cardiovascular, Obesity, Diabetes, Cancer, Alzheimer, Parkinson, Inflammatory, and Allergy. These are cured by herbal nutraceuticals or food herb dietary condiment for phytotherapeutic purposes.

Keywords: Nutraceutical; phytotherapeutic; anyigba; phytochemicals; proximate analysis; beach bean.

1. INTRODUCTION

African traditional plants have been researched extensively on food herbs base on the nutritional and genetic relationship to prevent diseases and promote a healthy lifestyle [1]. Currently, there is an increased global interest due to the recognition that nutraceuticals play a major role in health enhancement [2]. The term "Nutraceutical" was coined by combining the terms "Nutrition" and "Pharmaceutical" in 1989 by Dr Stephen De Felice, Chairman of the Foundation for Innovation in Medicine [1]. Nutraceutical is a marketing term developed for a nutritional supplement that is sold with the intent to treat or prevent disease and thus has no regulatory definition. Hence a nutraceutical is any substance that may be considered a food or part of a food and provides medical or health benefits, encompassing, prevention and treatment of diseases [2,3].

Nutritional food provides the body with the required amount of vitamins, fats, proteins, carbohydrates necessary for healthy survival. When functional food aids in the prevention and/or treatment of disease/disorder other than deficiency conditions like anaemia it is called a nutraceutical. Thus, functional food for one consumer can act as a nutraceutical for another [4].

![Nutraceuticals Concept](image_url)
A dietary supplement is a product that is intended to supplement the diet that bears or contains one or more ingredients like, vitamin, mineral, herb, amino acid or a concentrate, metabolite, constituent, extract, or combinations of these. Medical foods are a specific category of therapeutic agents that are intended for the nutritional management of a specific disease [5]. An example of medical foods is formulations intended to manage patients with inborn errors in amino acid metabolism. Newer medical foods are designed to manage hyperhomocysteinemia, pancreatic exocrine insufficiency, inflammatory conditions, cancer and other diseases [6]. The use of nutraceuticals, as an attempt to accomplish desirable therapeutic outcomes with reduced side effects, as compared with other therapeutic agents has met with great monetary success. Some popular nutraceuticals include glucosamine (for arthritis), lutein (for macular degeneration), ginseng (for cold), echinacea (anti-immune), folic acid, cod liver oil capsules, etc [7]. The most popular functional food and beverage products include calcium-enriched orange juice, green tea to mention a few. Majority of the nutraceuticals do possess multiple therapeutic benefits, however, in the present review, much effort has been devoted to decentralize them based on their disease-specific major indication [4]. Nutraceuticals have been claimed to have a physiological benefit or provide protection against the following diseases (and/or found to act as) [1]. Many antioxidant compounds can be found in fruits and vegetables including phenolics, carotenoids, anthocyanins, and tocopherols [8]. Approximately 20% of known plants have been used in pharmaceutical studies, impacting the healthcare system in positive ways such as treating cancer and harmful diseases [9].

Beach Bean (Canavalia rosea) tender pods, as well as ripened beans, are used occasionally as food by fishermen community and coastal dwellers [10]. Aboriginals used the green beans soaking in water to remove toxins. A root infusion is used to treat aches, pains, rheumatism and for leprosy while plant decoction is used to treat tuberculosis. The leaves help to relieve pain and promote the healing of burns. Roasted and powdered seeds substitute for coffee powder. Tender flat pods were roasted/boiled for consumption and sprouted seeds were also consumed [1]. The young pods and seeds were used as food in northern Australia and Australian aboriginals use the seeds as food and other parts of the plant for medicinal purposes. The fresh and dried flowers were used as a garnish and for flavouring. Leaf powder is smoked as a substitute for marijuana. The L-betonicine isolated from leaves of C. rosea is used to arrest bleeding [1]; Canavanine against fight flu, viruses, bacteria, fungi and Trigonelline is a remedy for cervical cancer, liver cancer and also lowers blood sugar. The preliminary phytochemical investigation of Canavalia rosea, which are responsible for the antibacterial activity of the extracts of the leaves on selected bacterial species [10]. Plants can produce a large number of diverse bioactive compounds. High concentrations of phytochemicals, which may protect against free radical damage, accumulate in fruits and vegetables [10]. Plants containing beneficial phytochemicals may supplement the needs of the human body by acting as natural antioxidants [8]. Various studies have shown that many plants are a rich source of antioxidants. For instance, vitamins A, C, E, and phenolic compounds such as flavonoids, tannins, and lignins, found in plants, all act as antioxidants [8]. The consumption of fruits and vegetables has been linked with several health benefits, a result of medicinal properties and high nutritional value [11]. Antioxidants control and reduce the oxidative damage in foods by delaying or inhibiting oxidation caused by reactive oxygen species (ROS), ultimately increasing the shelf-life and quality of these foods [8]. Beta carotene, ascorbic acid, and many phenolics play dynamic roles in delaying ageing, reducing inflammation, and preventing certain cancers [9]. Increasing the consumption of fruits and vegetables has been recommended by many agencies and health care systems throughout the world [12]. The study is to determine the phytochemical and nutraceutical activities of Beach Bean grown in Anyigba area of Kogi State, Nigeria.

1.1 Scientific Classification of Beach Bean

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plantae</th>
</tr>
</thead>
<tbody>
<tr>
<td>(unranked)</td>
<td>Angiosperms</td>
</tr>
<tr>
<td>(unranked)</td>
<td>Eudicots</td>
</tr>
<tr>
<td>(unranked)</td>
<td>Rosids</td>
</tr>
<tr>
<td>Order</td>
<td>Fabales</td>
</tr>
<tr>
<td>Family</td>
<td>Fabaceae</td>
</tr>
<tr>
<td>Genus</td>
<td>Canavalia</td>
</tr>
<tr>
<td>Species</td>
<td>C. rosea</td>
</tr>
</tbody>
</table>

**Vernacular names:**
- Ebira: Eza Ovagu
- Igala: Opadodo
- Prabhu et al., [10].
1.2 Edibility and Nutritional

Seeds are edible and serve as an important source of dietary protein in West Africa and Nigeria. Tender pods and seeds may be boiled or roasted. When mature, pods and seeds are soaked before being eaten to remove toxins [10].

1.3 Folkloric

Juice from the petioles applied to puncture wounds by thorns or other sharp objects.

The decoction of leaves used for rheumatism. The paste of leaves used for boils and sores.

In Samoa, plant potion used during labour.

Shoot decoction used to treat tuberculosis. Roots used for the treatment of ciguatera fish poisoning, aches, pains, rheumatism, and leprosy. Leaf extracts used for burns, and as styptic [12].

In Tonga, hot water infusion of leaves with other plants used to treat secondary amenorrhea and postpartum haemorrhage [4].

Used as aboriginal bush medicine in Australia: root extract rubbed on the skin to relieve various aches and pains [3].

In Australia, the beans soaked in water and pounded into cakes, used for baldness [2]. In Broome, Western Australia, root infusion applied locally for aches and pains, rheumatism, leprosy, and for treating colds [4].

1.3.1 Others

Fodder: In Africa and Southeast Asia, used as fodder because of the high protein content of leaves, flowers, fruits, and seeds in animal feed production [12].

Entheogen: Dried leaves have been used as an entheogen, a component to some ancient rituals. In ancient Ebira, the leaves and roots powder are used in the treatment of appendicitis. In South America, Africa and the Gulf Coast of Mexico, beans of C. maritima are ingested or smoked with the dried leaves for marijuana-like effects [13]. An increasing following for its use as a marijuana substitute.

1.4 Nutritional Evaluation of Tender Pods

The study evaluated the nutritional, antinutritional and protein qualities of tender pods of C. maritima. Crude protein was comparable to many edible legumes. Cooking significantly elevated carbohydrates and calorific value of tender pod, while crude fibre was significantly decreased. Minerals did not drain too much on cooking; K, Mg, Zn and Mn in fresh or cooked pods were comparable or higher than the NRC-NAS recommended pattern. While cooking decreased the essential amino acids, threonine, valine, isoleucine, phenylalanine and lysine in cooked pods. Levels were equivalent to or higher than the FAO-WHO-UNU recommended pattern. Also, pressure cooking improved nutritional qualities by lowering hemagglutinin activity [14].

1.5 Anticancer / Cytotoxic on Cancer Cell Lines MCF-7 and HT-29

The methanol extract of cooked (C. rosea) and fermented (C. cathartica) split beans showed better in vitro anticancer activities compared to the raw beans. Results suggest a potential for the extracts of cooked/fermented beans to control colon cancer by diet management [4].
1.6 Antibacterial Leaves
Evaluation of various leaf extracts of Canavalia rosea showed high activity against microorganisms B. cereus, B. megaterium, B. stearothermophilus, B. subtilis, Staphylococcus aureus, and Streptococcus faecalis. Gram-negative bacteria were not as susceptible (see constituents above) [15].

1.7 Canarosine / Antiplasmodial / Anti-Herpes Type 1 / Leaves
Study of aerial parts isolated six compounds including new guanidine alkaloids, canarosine, a flavonoid glycoside, rutin, epioinositol 6-0-methyl ether, β-sitosterol glucoside, and a 2:1 mixture of β-sitosterol and stigmasterol. Canarosine caused 95% inhibition of dopamine-1 receptor binding. The alkaloids were also active against P. falcifarum K1 strain, with moderate activity against Herpes simplex virus type 1 [9].

1.8 Central Nervous System Depressant Effects / Toxicity Study / Leaves
The study evaluated the CNS activity of an ethanolic extract of C. maritima using behavioural studies such as potentiation of phenobarbitone sleeping time, actophotometer activity test, rotarod test, forced swim test, haloperidol-induced catalepsy test in mice and rats. Acute oral toxicity study of ethanolic extract of leaves done per OECD 425 guideline showed an LD50 > 2000 mg/kg. Results showed CNS depressant effects as evidenced by a reduction in locomotor activity, significant dose-dependent myorelaxant activity, dose-dependent sedative and anxiolytic effect [2].

2. MATERIALS AND METHODS

2.1 Collection of Plant Materials
The seeds and leaves of Beach bean (Canavalia rosea) were collected from the College of Health Sciences, Kogi State University, Anyigba, Nigeria in March 2019. The plant’s identification was authenticated by Mr Ayegba Ojochele Sule at the Herbarium Unit of the Department of Biological Sciences, Kogi State University, Anyigba and voucher specimen number of KSU/BS/062 was deposited for future reference.

2.2 Processing of Plant Material
The leaves and seeds of Beach Bean were washed and air-dried over three-four weeks in Faculty of Agriculture. The dried samples were milled into fine powder by pounding manually with a clean and sterile mortar and pestle, stored in sterile containers in a cool dry place until further use.

2.3 Extraction of Plant Material
The dried powder leaves and seeds of 200 grams each were extracted in 2000 ml of aqueous. The sample was macerated for 48 hours and filtered using filter paper and filter pump. The sample was concentrated using a rotary evaporator and freeze-dried to powdered form. The dried extracts were weighed and kept in labelled sterile specimen bottles. The percentage (%) extract yield was calculated as follows [16]:

% yield = weight of extract (g) / weight of garlic cloves (200 g) x 100

2.4 Determination of Phytochemical Compounds in Beach Bean (Canavalia rosea) Parts Extracts
The phytochemical compound was carried out from leaf extract and aqueous seed extract of Canavalia rosea. The methods of Kokori et al., [17] and Abdullahi et al., [16] were applied for the determination of the presence of phytochemicals. The filtrate obtained from each extraction was tested for alkaloids, saponins, flavonoids, phenol, fat and oils, steroids, tannins and glycosides.

2.5 The Proximate Analysis
The proximate analysis of the samples was carried out according to AOAC [18] for moisture content, ash, fat, crude protein, crude fibre after drying the samples of Beach bean (Canavalia rosea) at room temperature.

2.5.1 Moisture
The seeds and leaves (5 g each) of both plants were weighed and oven-dried at a steady temperature of 70ºC. The amount of moisture in each sample was then expressed as loss in weight after cool weighing.

2.5.2 Ash content
The samples 5 g each were placed in a crucible and heated to 550ºC to eliminate organic components. The crucible and its contents were then cooled and weighed, and the ash evaluated
as a proportion of the original dry weight of samples.

2.5.3 Crude protein

This was done using the micro-Kjeldahl method. The nitrogen proportion of the protein in 5 g of each of the sample was converted into ammonium sulphate by digestion with concentrated hydrogen tetraoxosulphate (VI) acid using copper sulphate as a catalyst. The liberated ammonia was collected in boric acid double indicator solution and the nitrogen quantified through standard hydrochloric acid titration until the endpoint was reached. The amount of crude protein was then obtained by multiplying by a factor of 6.25.

2.5.4 Crude fat

Crude fat was extracted from both plant part samples using 5 g of the plant samples, petroleum ether and soxhlet extractor apparatus. The weight of the fat obtained after evaporating off the petroleum ether from the extract gave the crude fat in the samples and this was expressed as a percentage.

2.5.5 Crude fibre

The defatted samples of 5 g were used to determine the fibre contents in samples via extraction by acid digestion, filtration and base digestion. The resulting residues were eventually ignited at 550°C. Fibre content was then expressed as a percentage lost on ashing and initial weight.

2.5.6 Carbohydrate

The amount of carbohydrate in each of the samples was then estimated as the difference from 100 of the sum of crude protein, fat, ash, and fibre.

2.6 Determination of Vitamins

Vitamins A, E, B and C were determined according to methods previously described [19,20].

2.7 Determination of Mineral Elements

The mineral elements were determined by the dry ash extraction method of AOAC [20].

2.8 Statistical Analysis

Results obtained were recorded as mean ± SEM and subjected to one-way analysis of variance (ANOVA) and where significant differences exist, means were compared using Waller Duncan test using Statistical Analysis System (SAS, software version 2002) at a significant level (P<0.05).

3. RESULTS AND DISCUSSION

Table 1 shows the percentage yield of Beach Bean (Canavalia rosea). Phytochemical screening of the leaves extract of Canavalia rosea revealed the presence of tannins, phlobatannins, saponins, flavonoids, alkaloids, cardiac glycosides and phenolics (Table 2). These compounds have potentially significant application against human pathogens, including those that cause enteric infections [21]. Several authors have linked the presence of these bioactive compounds to the antimicrobial properties of Canavalia maritima plant extracts [10]. The presence of alkaloids is interesting, as significant quantities are used as antimalarials, analgesics and stimulants [22]. The presence of glycosides moieties like saponins, cardiac glycosides and Flavonoids which are known to inhibit tumour growth and serve also to protect against gastrointestinal infections are of pharmacognostic importance and give evidence to the use of the plant in ethnomedicine. Herbs that have tannins as their components in the leaf extract are astringent and are used for treating intestinal disorders such as diarrhoea and dysentery thus exhibiting antibacterial activity [23].

Tannins are widely used in traditional medicine in treating wounds and to arrest bleeding [24]. Some of these bioactive compounds which are synthesized as secondary metabolites as the plant grows also serve to protect the plant against microbial attacks and predation by animals. The increasing reliance on the use of medicinal plants by a sizeable proportion of the people in the so-called industrial world has been traced to the extraction and development of several drugs and chemotherapeutic agents’ from these plants as well as from traditionally used rural herbal remedies [21].

Table 3 shows the proximate composition of the nutritive value of Beach Bean seed and the leaves. The seed has a higher value of crude protein of amounting to 50.84% while the leaves have crude protein value of 30.59%, for the carbohydrates, the leaves are higher in it has a value of 40.60% while the seed has 26.98%. The percentage of ash content which is an indicator of the quality of mineral nutrients present has a value of 8.45% in leaves and 2.53% in the seed.
By implication, the leaves are richer in mineral nutrients/elements than the seeds. There is no much difference in the percentage of crude fibre content between beach bean seeds and leaves. The seeds have a value of 3.84% while the leaves have a value of 3.99%.

Table 4 shows the estimation of vitamins of seeds and leaves of Beach Bean (Canavalia rosea) where vitamin A, B, C, E (130, 252, 5, 6) in seed and (141, 243, 7, 8) in leaf.

Table 5 Shows mineral composition of seeds and leaves of Beach Bean (Canavalia rosea) where Na, K, Ca, Mg, Fe, Zn, P and Mn were detected but Cu and N non-detected.

3.1 Extraction of the Plant Material

The calculated percentage yield from the 200 g of Beach Bean (Canavalia rosea) used for the extraction was as given in Table 1:

Table 1. Percentage yield of beach bean (Canavalia rosea) extract of leaves and seeds

<table>
<thead>
<tr>
<th>Extract</th>
<th>% Yield (w/w)</th>
<th>Observed Colouration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>24.14</td>
<td>light green powder</td>
</tr>
<tr>
<td>seeds</td>
<td>32.0</td>
<td>light brown powder</td>
</tr>
</tbody>
</table>

3.2 Phytochemical Screening of the Extracts

The table is a summary of the phytochemical components of secondary metabolites of the extracts. From the obtained result, anthraquinone and tannins (seed) were not present in the extracts.

3.3 Proximate Analysis

The result obtained showed that the proximate composition of nutritive value of Beach bean seed is higher in protein (50.84) showed significant value P<0.05 compared with that of leaves (30.59) (See Table 3).

Table 3. Shown summary of proximate composition of beach bean (leaf and seed)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seed</td>
</tr>
<tr>
<td>%Moisture Content</td>
<td>12.24</td>
</tr>
<tr>
<td>% Ash Content</td>
<td>2.53</td>
</tr>
<tr>
<td>% Crude Fibre</td>
<td>3.84</td>
</tr>
<tr>
<td>% Fat Content</td>
<td>3.57</td>
</tr>
<tr>
<td>% Crude Protein</td>
<td>50.84</td>
</tr>
<tr>
<td>% Carbohydrate</td>
<td>26.98</td>
</tr>
</tbody>
</table>

3.4 Determination of Vitamins

Table 4 shows the determination of vitamins of seeds and leaves of Beach Bean (Canavalia rosea).

Table 4. Estimation of vitamins of seeds and leaves of Beach Bean (Canavalia rosea)

<table>
<thead>
<tr>
<th>Vitamins (mg/100 mL)</th>
<th>Beach Bean (Canavalia rosea)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seed</td>
</tr>
<tr>
<td>A</td>
<td>130</td>
</tr>
<tr>
<td>B</td>
<td>252</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>E</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 5. Mineral composition of seeds and leaves of beach bean (Canavalia rosea) (mg/100 g dry matter)

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Beach Bean (Canavalia rosea)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seed</td>
</tr>
<tr>
<td>Na</td>
<td>49</td>
</tr>
<tr>
<td>K</td>
<td>981</td>
</tr>
<tr>
<td>Ca</td>
<td>301</td>
</tr>
<tr>
<td>Mg</td>
<td>123</td>
</tr>
<tr>
<td>Fe</td>
<td>54</td>
</tr>
<tr>
<td>Zn</td>
<td>15</td>
</tr>
<tr>
<td>Cu</td>
<td>n</td>
</tr>
<tr>
<td>P</td>
<td>620</td>
</tr>
<tr>
<td>N</td>
<td>n</td>
</tr>
<tr>
<td>Mn</td>
<td>3</td>
</tr>
</tbody>
</table>

Key: n-non detected
3.5 Determination of Mineral Elements

Table 5 shows the determination of mineral elements present in both seed and leaf of Beach Bean (Na, K, Ca, Mg, Fe, Zn, P and Mn).

4. CONCLUSION AND RECOMMENDATION

The phytochemical composition and proximate analysis of the seed and leaf extracts of the Canavalia rosea indicate the presence of eight active constituents. The presence of these phytotherapeutic potentials is indicative that the plant may have an antibacterial property and it will be used for the treatment of bacterial and other microbial infections. Further investigation, purification and determination of these promising constituents can be done to assay their antimicrobial activity and food supplements as alternative medicine.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENT

Authors acknowledge the great help received from Mr. Olu Department of Biochemistry, Kogi State University, Anyigba. The authors are also grateful to authors/editors/publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES


2. Seena S, Sridhar KR. Nutritional and microbiological features of little known legumes, Canavalia cathartica Thouars, maritima C. Thouars of the southwest coast of India. Microbiology and Biotechnology, Department of Biosciences, Mangalore University, Mangalagangotri, Mangalore India. 2018;574:199.


12. Xinping Huang, Bing Mu, Wenhan Lin, Yan Qiu. Pterocarpin and Isoflavon Derivatives


