# NUTRITIONAL PROPERTIES AND POTENTIAL VALUES OF *CORDIA SEBESTENA* SEED AND SEED OIL

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**Abstract**

The impetus for development of underutilized, lesser known seed and seed oils for domestic and industrial applications is derived from the overdependence on the well known ones and the resultant high cost of such. This study was therefore conducted to evaluate the nutritional properties of *Cordia sebestena* seed and seed oil for their potential applications. Proximate analysis, mineral components and anti-nutritional factors were investigated in the seed while the seed oil was characterized and investigated for its fatty acid profile using various methods reported in literatures. The results show that the seed could be a good source of oil (40.3 ± 0.8%) and protein (11.5 ± 0.6%). It could also supply some macronutrients like Mg, Ca and Na along with Zn which is an essential micronutrient. The anti-nutrient contents, phytate, tannins and oxalate were high and can be drawbacks to the applications of the seed in food. These may be removed by domestic processing. The properties of the seed oil show that it may be useful in alkyd resin synthesis, biodiesel and soap production. The fatty acid profile shows that the seed oil has predominantly oleic acid ($C_{18:1}$) being 71.1% of the total fatty acid in the oil which is good for human consumption. *Cordia sebestena* seed and seed oil demonstrate potentially valuable applications, there is however need to further study the amino acid profile of the seed and the effects of domestic processing on the anti-nutrient components.

**Keywords:** *Cordia sebestena*; proximate analysis; anti-nutrient; mineral components; fatty acids

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# CORDIA SEBESTENA TOHUMUNUN VE TOHUM YAĞININ BESİNSEL ÖZELLİKLERİ VE POTANSİYEL DEĞERİ


**Özet**

Az kullanılan hammaddelerin geliştirilmesinin ivme kazanması ile iyi bilinen tohum ve tohum yağlarına olan aşırı bağımlılıktan ve bunun sonucundaki yüksek maliyetten dolayı geleneksel ve endüstriyel uygulamalar için az bilinen tohum ve tohum yağları türetilmiştir. Bu nedenle *Cordia sebestena* tohum ve tohum yağının kullanım potansiyeli bakımından besinsel özelliklerinin değerlendirilmesine yönelik bu çalışma yapılmıştır. Tohum yağında literatürde rapor edilen çeşitli analizler kullanılarak yağ asidi profili incelenmiş ve karakterize edilmişken, tohumda ise genel bileşim, mineral bileşenler ve anti-besinsel faktörler araştırılmıştır. Sonuçlar tohumun iyi bir yağ (%40.3 ± 0.8) ve protein (%11.5 ± 0.6) kaynağı olabileceğini göstermektedir. Tohum aynı zamanda Mg, Ca ve Na benzeri bazı makro-elementler ile esansiyel bir mikro-element olan Zn kaynağı olabilir. Anti-besinlerden fitat, tanen ve oksalat içeriği yüksektir ve gıdalarda tohumun kullanımı sakıncalı olabilir. Bu maddeler belki geleneksel gıda işleme yöntemleri ile giderilebilir. Tohum yağının özellikleri onun alkid reçine sentezinde, biyodizel ve sabun üretiminde kullanışlı olabileceğini göstermektedir. Yağ asidi profili toplam yağın %71.1 oranında insan tüketimi için iyi bir yağ asidi olan oleik asiti ($C_{18:1}$) ağırlıklı olarak bulundurduğunu göstermektedir. *Cordia sebestena* tohumu ve tohum yağının önemli kullanım alanları olabileceği görülmüştür, ancak tohum yağının aminoasit profili ve anti-besinler üzerine geleneksel işlemlerin etkileri konularında daha fazla çalışmaya ihtiyaç vardır.


**Anahtar kelimeler:** *Cordia sebestena*; genel bileşim; anti-besin; mineral bileşenler; yağ asitleri

## INTRODUCTION

There are increasing demands for foods; improved and larger volume of agricultural products and new food products' research in many developing countries of the world. The demands require investigation into the full potential of several species of local agricultural plants that abound or may be grown in such countries that are not currently being utilized or under-utilized. The purpose is to mitigate against problems of development and growth associated with high population growth rates, limited and rapidly diminishing land for food and forage productions among others. Thus, the development of underutilized, lesser known seeds and seed oils for domestic and industrial applications is very imperative (1).

One of the plants with seed and its seed oil that has not been fully investigated nor explored for its domestic and industrial application potentials is *Cordia sebestena. Cordia sebestena* is a species of flowering plant in the Boraginaceae family (2). Archaeological study indicates that the plant is native to the islands, American tropics, from southern Florida through the Bahamas southwards throughout Central America (3). The plant is therefore a tropical plant. The plant was recently introduced into Nigerian flora and holds potential for applications and commercial cultivation. Previous study had reported the application of *C. sebestena* in Hawaii (2). The dark green leaves are used for dyeing; the dark orange flower used to make a Hawaiian flower necklace/ garland (Lei) and the wood calved into different articles such as food vessels, canoes among others. The embryology of *C. sebestena* has been documented in literature (4). The plant can grow to a height of 25 feet and grows well in tropical or subtropical region. There is however paucity of information on the nutritional properties, the potential industrial applications, and even the phytochemical constituents of the plant.

Thus, this study is undertaken to fill this gap. The motivation for investigating the nutritional properties and the potential applications of under-utilized seeds and their seed-oils is also derived from the high cost implication of the competitive applications of the well known and industrially explored seeds and seed oils. The competing demands for human foods, animal feed formulation and industrial applications of well known seeds and seed oil had placed heavy financial burden that can be lightened through the development of other seed for applications through research. This study is therefore aimed at investigating the proximate nutritional values of *Cordia sebestena* seed and seed oil; mineral content of the seed; fatty acid profile of the oil and to propose possible applications for the seed and its oil based on the observed properties.

## MATERIALS AND METHODS

The seeds of *Cordia sebestena*, obtained from Redemption Camp, Mowe, Nigeria, were thoroughly sun dried, screened to remove undesirable materials such as stones and other impurities. The seeds were ground into powder, kept in air-tight polythene containers and stored in a refrigerator (4 °C) prior the laboratory analysis. All reagents used were analytical grade reagents.

**Proximate Analysis of *C. sebestena* Seed**

Moisture content of the sample was determined by placing 2 g of the powdered sample in oven and dried at 105 °C till constant weight. Another portion of the sample (2 g) was subjected to ashing in a muffle furnace at 550 °C by until no presence of black particles according to Association of Official Analytical Chemists (5).

The fat content from the powdered sample was obtained by weighing 5 g of the sample and extracting it in continuous extractor (soxhlet) with n-hexane until a clear n-hexane solution is noticed in the extractor. Determination of crude fibre was carried out with 2 g of the dry powdered sample extracted with n-hexane. The extracted sample was air dried, then treated under standardized condition with boiling dilute $H_2SO_4$, boiling dilute NaOH, water, dilute HCl, alcohol and diethyl ether. The treated sample was then heated with dull-red heat to determine the crude fibre (6).

The crude protein component of the seed sample was analyzed by using method described by Kjeldahl (7) while carbohydrate content was estimated by the difference of the sum of all the proximate composition from 100%.

**Mineral Content Determination in Seed**

The mineral compositions of the sample were determined by dry ashing the powder sample in a muffle furnace at 550 °C (1, 6). The dry ash was then dissolved in 10% HCl and the resulted solution was used to determine some beneficial minerals content of the sample (Na, Ca, Mg, K, Zn) and the presence of a toxic metal (Pb) using Flame Atomic Absorption Spectrophotometer (Shimadzu AA-7000).

**Determination of Anti-nutrient Components**

Anti-nutrient components (phytate, tannins and oxalate) were also investigated in the seed. The determination of phytate contents in the seed sample was carried out by using the method of Young and Graves (8). Tannin was investigated with the method described by Markkar and Goodchild (9). Oxalate was analysed by treating the powdered seed sample with 0.75 M, $H_2S0_4$ stirred and filtered using Whatman No 1 filter paper. The filtrate was then titrated hot (80 - 90 °C) against standard potassium permanganate to a persistent faint pink color (10).

**Characterization of the Seed Oil**

The specific gravity of the seed oil was determined with specific gravity bottle while the refractive index was measured with the aid of Abbe refractometer (Optic Ivymen System) at 313 K (6, 7). The saponification value was obtained by adding alcoholic KOH solution to the sample in excess, heated by reflux on a boiling water bath. The excess KOH was titrated with 0.5M HCl using phenolphthalein as indicator to assess the quantity of KOH used up in saponification (5). The peroxide value was evaluated in the dark by dissolving the samples in a mixture of acetic acid and diethyl ether, boiled and poured into a titration flask containing 5% KI. The contents were titrated with 0.02 M sodium thiosulphate using starch indicator (11). Iodine value was estimated by method described by Joslyn (11). Acid value and free fatty acid were determined by dissolving the samples in a percentage (v/v) of alcohol and then titrated with 0.1 M KOH using phenolphthalein indicator (5).

**Fatty acid profile of the Seed Oil**

The extracted oil was analyzed for fatty acid profile by a modification of a method specified by Akintayo (1) using an Agilent 7890 A series gas chromatography interfaced with mass spectrometer (GC-MS) with a HP-5MS column (30 m x 0.32 m i.d., 0.25µm film thickness). The injector and detector temperature was maintained at 240 °C and 250 °C respectively. The temperature programming used for the analysis was 160 °C for 2 min and finally increased to 240 °C at 4 °C/min. Nitrogen was used as the carrier gas at a flow rate of 1.5 mL/min. The area percentages were recorded with a standard Chemstation Data System.

### STATISTIC ANALYSIS

All the experiments were carried out in triplicates and the mean ± standard deviation are reported.

## RESULTS AND DISCUSSION

### Proximate Composition of C. sebestena Seed

The results of the proximate analysis of the seed of *Cordia sebestena* are presented in table 1. Low moisture content and high dry matter contents are desirable for preservation and long shelf life of the seed. The obtained results for these two parameters in this seed are within reasonable limits and are comparable with others seeds that have been documented in literature to have potential uses (12, 13). The ash content which measures the gross inorganic components in the seed was relatively low which indicate that seed has more organic components (99.5%) than the inorganic ones. The ash content is relatively lower that other seeds reported in literature (13 - 16). Of much interest is the percentage composition of the fat and oil which is 40.3 ± 0.8%. The fat and oil is the most prominent proximate component of the seed. This implies that the seed will be a rich source of fat and oil which could be investigated for both domestic and industrial exploration. The crude protein content is within the range of legume plants that are often used as sources of plant protein (12 - 16). The marginally high crude fibre content of the seed enhances its value in colon digestion if applied in food and feed formulation. The percentage carbohydrate content is next to fat and oil in value which indicate that the seed could be a source of carbohydrate. Generally, the proximate analysis of the seed revealed that it has natural balance of nutritional components. There is however the need to investigate the details of the specific amino acid contents, lipid profile and the different classes of carbohydrate present in the seed to ascertain it fully nutritional potentials.

Table 1: Proximate analysis of *Cordia sebestena* seed

| Proximate Contents | Concentrations (%) |
|---|---|
| Moisture | 8.0 ± 0.3 |
| Total dry matter | 92.0 ± 1.1 |
| Ash | 0.5 ± 0.04 |
| Total organics | 99.5 ± 0.9 |
| Fat and Oil | 40.3 ± 0.8 |
| Crude Protein | 11.5 ± 0.6 |
| Crude fibre | 7.3 ± 0.4 |
| Carbohydrate | 32.8 ± 1.2 |

### Mineral Contents of the Seed

The results of the mineral contents of the seed are presented in table 2. The seed is a good source of Na, Ca and Mg, which are micronutrients needed for proper biochemical functions in humans compared to other seeds reported in literature (12, 15, 17). The comparative higher concentration of Ca relative to Na in the seed is somewhat positive. Calcium is needed in living tissues for structures such as bones and teeth formation; muscular contractions; activities of central nervous system among others. Sodium is also essential but its high concentration is undesirable because it is implicated as a causal agent for hypertension. Strangely, K was below detection limit in the seed sample which implies that *C. sebestena* may not be a good source of K supply. This nutritional information may however be site specific than being generic for this plant. Other metals that were detected in the plant may also be site related except further studies on the plant in others site are considered to confirm otherwise. Zinc which is an essential micronutrient was also substantially present in the seed sample (177.2 ± 3.5 mg/kg) making the seed a good source of Zn supply. A drawback to the seed's domestic application is the presence of Pb in concentration as high as 6.5 ± 0.8 mg/kg. Lead (Pb) is non-essential for any biochemical function in the body rather it is toxic (18). This concentration observed for Pb may be site specific relating to the extent of pollution of the area where the sample was collected being near to vehicular activities. Previous works have correlated vehicular activities with Pb pollution (18, 19). It may also be an indicator of the affinity of the plant for this metal and its extraction from the environment which is a condition suitable for phytoremediation applications of plants.

Table 2: Mineral content of *Cordia sebestena* seed

| Metals | Concentrations (mg/kg) |
|---|---|
| Ca | 1725.6 ± 8.7 |
| Na | 1071.1 ± 10.5 |
| Mg | 872.7 ± 5.7 |
| K | BDL |
| Zn | 177.2 ± 3.5 |
| Pb | 6.5 ± 0.8 |

BDL- below detection limit

### Anti-nutrient Contents of the Seed

The concentrations of antinutrients in the seed of *C. sebestena* are presented in table 3. The nutritional values of seeds and vegetables through the contributions of minerals, proteins and vitamins in human are repressed by the presence of anti-nutrients due to reduced bioavailability of these nutrition components by their interactions with anti-nutrients (15). Typical among these antinutrients are oxalic acid, phytic acid, tannins and hydrocyanic acid. A daily uptake of 450mg of oxalic acid has been documented to interfere with metabolism and an estimated oxalate toxicity level range from 2 - 5 g/100 g (15). The concentration obtained from this seed for oxalate is slightly below the toxicity level. The concentration is higher than values obtained for other seeds such as *Pterygota macrocarpa* (17), *Arachis hypogaea* L. (20) but lower than the value obtained in the seed of Telfairia occidentalis Hook f. (15). The documented negative effect of oxalate includes the reduction of bioavailability of metals such as Ca and Zn. Phytic acid on the hand is inostol hexose phosphate which is considered a major anti-nutritional factors that is found in all cereals and several legumes (21). Phytic acid acts as a strong chelating agent for dietary mineral metals such as Fe, Ca, Zn and also inhibits several proteolytic enzymes and amylases (21). It decreases Fe absorption in human by 5 fold at a concentration above 4 mg/100 g (15, 21). The concentration found in the seed of *C. sebestena* (2.84 ± 0.38 g/100 g) was much higher than some other seeds that have been documented in literature. However, phytate of concentration as high as 5.36g/100g has been found in seasame seeds which is among the highest in nature (21). The third class of anti-nutritional factor found in the seed of *C. sebestena* is tannins with a concentration of 4.70 ± 0.15 g/100 g. Tannins have negative effects on protein digestibility and on mineral nutrition (22). Most tannins in seeds are found in the seed coat. The concentration obtained in this study is relatively higher than other seeds documented in literature. The high contents of anti-nutrients in the seed of *C. sebestena* may be addressed by domestic processing such as soaking, cooking, autoclaving etc as documented in other studies (23, 24).

Table 3: Anti-Nutrient composition of *Cordia sebestena* seed

| Anti-Nutrients | Concentrations (g/100g) |
|---|---|
| Phytate | 2.84 ± 0.38 |
| Tannins | 4.70 ± 0.15 |
| Oxalate | 1.73 ± 0.09 |

### Seed Oil Characterization and Fatty Acid profile

The results of the characterization of the seed oil of *C. sebestena* are presented in table 4. The specific gravity and the refractive index of the seed are comparable with other well known and underutilized seed oils in literature. The degree of unsaturation of the oil is relatively high at 124.45 ± 3.65 g iodine/100g which can classify the oil as semi drying with suitable application in biodiesel production, soap production and alkyd resin synthesis (25). The high iodine value is responsible for the seed oil being a liquid at room temperature. The observed saponification value (SV) for this seed (199.85 ± 2.95 mg KOH/g) is similar to that of *Picralima nitida* and *Jatropha curcas* (25, 26). The seed oil's mean molecular weight is calculated using the expression reported in (25) which is 56/SV x 100. The result is 280.21 g. The saponification value and the mean molecular weight also support the potential application of the seed oil in biodiesel and soap productions. The unsaponfiable matter identified in this study is similar to the one obtained for *Parkia biglobbossa* seed oil. There is need for further study to identify the exact compounds that make the unsaponifiable matter of the seed oil of *C. sebestena*. The observed free fatty acid, acid value and peroxide values are comparable with other seed oil in the semi drying classification and simply indicate that refining processes will enhance the value of the oil for different applications.

Table 4: Characterization of *Cordia sebestena* seed oil

| Parameters | Values |
|---|---|
| Specific gravity | 0.893 ± 0.01 |
| Refractive index | 1.4200 ± 0.005 |
| Saponification value (mg KOH/g) | 199.85 ± 2.95 |
| Mean Molecular Weight (g) | 280.21 |
| Iodine value (g iodine/100g) | 124.45 ± 3.65 |
| Peroxide value (mg KOH/g) | 8.53 ± 0.88 |
| Unsaponifiable matter (%) | 2.11 ± 0.81 |
| Acid value (%) | 3.08 ± 0.11 |
| Free fatty acid (%) | 1.52 ± 0.07 |
| State at room temperature | Liquid |

Finally the fatty acid profile of the seed oil of *C. sebestena* is presented in table 5. The total degree of unsaturated fatty acid is 72.2% which is comparable with that of *Picralima nitida* (26) and *Jatropha curcas* (25). The saturated fatty acid found in *C. sebestena* is palmitic acid ($C_{16}$) which account for 27.8% of the fatty acids. The predominant fatty acid is oleic acid ($C_{18:1}$) which is 71.1% of the total fatty acid in the oil. *C. sebestena* can be classified therefore as one of the seed oils in oleic acid group. Oleic acid is a good fatty acid because of the unsaturation against heart vascular diseases (25).

Table 5: Fatty acid profile of *Cordia sebestena* seed

| Fatty acid | Concentrations (%) |
|---|---|
| Palmitic acid (C16) | 27.8 ± 0.8 |
| Oleic acid (C18:1) | 71.1 ± 0.6 |
| Linoleic acid (C18:2) | 1.1 ± 0.1 |
| Saturated | 27.8 |
| Unsaturated | 72.2 |

## CONCLUSION

The proximate analysis, mineral contents, anti-nutrient components, seed oil characterization and fatty acid profile of *C. sebestena* was carried out in this study and the report of finds has shown that the seed and the seed oil have potential domestic and industrial applications. The seed could be a good source of oil and protein. The mineral content of the seed indicate its ability to supply some macronutrients line Mg, Ca and Na along with Zn which is an essential micronutrient. The anti-nutrient which may be a drawback to the domestic application of the seed can be removed by domestic processing. The seed oil may be useful in alkyd resin synthesis, biodiesel and soap production based on the properties observed and the fatty acid profile shows that the seed oil has predominantly oleic acid which is good for human consumption. There is however need for further studies on the amino acid profile of the seed and the effect of domestic processing such as cooking, soaking etc on the anti-nutrient components.

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