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# The Chemical Evaluation Of Seeds Of Two Jatropha (Wild & Cultivated) For Oil And Biogas Production By Using Seed Cake.

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**ABSTRACT:** The objectives of this study are to evaluate Jatropha seeds for oil, and biogas production by using seed cake. The seeds were chemically analysed following the AOAC, 1990 method [1]. The chemical analyses of the Jatropha seeds indicated that the wild Jatropha seeds have high moisture content (5.4%), ash content (6.6%) and oil content (33.2 %) compared with cultivated one which showed 4.43% moisture content, 5.2% ash content and 24.2% oil content. The seeds of cultivated Jatropha have high protein (20.2%) and carbohydrate (10.3%) compared with wild Jatropha which showed 18.5% protein and 0.9% carbohydrate while both are similar in fiber content (35.6, 35.7 %). Based on the chemical analysis the wild Jatropha seed cake was tested for biogas and bio-fertilizer production. The chemical analysis of the seed cake showed that the seed cake has 6.3% moisture and 93.7% total solid. Out of these 54.4% is organic carbon and 39.2% protein. It has 0.9% Phosphorus, 6.3 % nitrogen and the C/N ratio was 9:1. On the hand digested slurry showed 6.65% protein and 5.3% phosphorus. It is obvious that fermentation of seed cake resulted in substantial increase of phosphorus. The seed cake was fermented to investigate the potentiality for biogas and bio-fertilizer production. One kilogram of seed cake produced 24 liters of biogas. Microbiological investigation indicated that the microorganisms involved in the fermentation process were Bacillus and Lactobacillus bacteria. The pH was acidic (5.5) at the beginning of fermentation process (zero time), it reached 8.0 after 6 hr, then dropped to 6.5 after 24 hr and became more acidic (4.5) after 72 hr.

**Keywords:** Jatropha, Seed cake, biogas

## 1. Introduction

Jatropha curcas is multipurpose drought resistant, perennial plants gaining importance for the production of biodiesel. Jatropha is a genus of over 170 species from the Euphorbiaceae family, native to the Central America but commonly found and utilized across most of the tropical and subtropical regions of the world. It has a yield per hectare of more than four times that of soybean and ten times that of corn [2]**.** It is a tropical plant that can be grown in low to high rainfall areas. Jatropha grows almost anywhere except water logged lands, even on gravelly, sandy and saline soils. It can thrive on the poorest stony soil. It can grow even in the crevices of rocks. Regarding climate, Jatropha is found in the tropics and subtropics and likes heat, although it does well even in lower temperatures and can withstand a light frost, grows under a wide range of rainfall from 250 to over 1200mm/annum [3]. One of the renewable sources gained important at the beginning of this century is Jatropha oil. The seeds are non edible, and contain 30-35% oil. Oil can be recovered through mechanical expellers and the rest (70-75%) of the seeds is seed cake. The seed cake can neither be used as animal feed nor in agricultural faming due to its toxic nature [4]. The generation of biogas from seed cakes is a best solution for its efficient utilization. The biogas produced can provide energy for heating, cooking lightening and engine operations. The digested slurry can be applied to agricultural farming. A few studies have been conducted on anaerobic digestion of Jatropha seed cake.

## 2. Materials and Methods

The study was conducted at Dept. of Agric. Biotechnology, Faculty of Agriculture, and University of Khartoum, Sudan.

### 2.1 Sampling

Jatropha seeds were collected from Western Sudan (Abasia Locality (wild cultivar) and Bara Locality (cultivated cultivar).

### 2.2 Sample characterization

The determination of moisture, crude protein, crude fat, and ash, were carried out according to the Standard Methods of Association of Official Analytical Chemists, (AOAC 1990).

### 2.3 Minerals determination

#### 2.3.1 Preparation of samples

Moisture content of plant were determined by drying samples residues to a constant weight in 70°C oven, the residues were ground and sieved to 1 mm sieve for analysis. Two grams of the sample were placed into a muffle furnace and gradually ashed to reach 550°C until a constant weight was obtained. The weight of the plant ash was defined as the ash content (% ash content = ash weight / sample weight×100). Then the elements Calcium, Magnesium, Potassium and phosphorous were determined according to methods described by **[5]** after addition of 10 ml 5N HCL (to dissolve the elements) were added to the ash materials and placed in hot sand bath for 5 minutes. The contents were filtered using Whattman No.42 and completed with distilled water into a 50 ml volumetric flask.

#### 2.3.2 Magnesium determination

Calcium and magnesium were determined together according to Chapman and Part (1961).

#### 2.3.3 Calcium determination

The concentration of Calcium was determined by titration against ethylene diamine tetra acetic acid (EDTA).

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### 2.3.4 Determination of potassium and sodium
Potassium and Sodium concentrations were determined from the extract by the flame photometer (model PFP7) and the unit was expressed in meq/L.

### 2.3.5 Determination of phosphorus
The phosphorous content was determined using spectrophotometer (PERKIN-ELMER 2380).

### 2.3.6 Organic carbon determination
Organic carbon was measured by using the modified Walkley-Black method [6].

### 2.4 Sample preparation
The seeds from wild type were milled mechanically using squeezer to obtain seed cake. The seed cake was chemically characterized according to AOAC (1990), since the important parameter of biogas production is the composition of feedstock. Seed cake was mixed with water at ratio 1kg seedcake: 4Liter of water. The mixture was incubated in a digester. No any microbial starter was used. The gases were determined by the dislacement of water from the fermentor (ml/ hour).

### 2. 5 Biochemical Tests:
Samples from the fermented material were cultured according to Harrigan **[7]**. The isolated bacteria were subjected to various biochemical tests. The isolates were identified according to Bergey's manual [8].

## 3. RESULTS

### 3.1 Chemical composition of Jatropha seeds
The seed of the wild Jatropha is heavier, has high moisture content, ash content and oil content compared to the cultivated Jatropha. Both Jatropha wild and cultivated have similar fiber contents. The cultivated Jatropha surpassed the wild one only in protein and carbohydrate contents. On the other hand no significant differences were observed between the two Jatropha with regard to minerals contents (Table1).

### 3.2 The minerals percent of Jatropha seeds
Both Jatropha seeds have similar minerals contents. The calcium and potassium contents of the seeds of both Jatropha (1.99, 1.92%) were higher than magnesium, sodium and phosphorus contents. It is clear that the sodium was the least among all minerals (Table1).

### 3.2 Chemical composition of wild Jatropha seed cake
Chemical analysis of the seed cake revealed that seed cake moisture content was 6.3% and the total solid constitutes 93.7%. The organic carbon constitutes 54.4% of the total solid while crude protein constitutes 39.2 %. The C/N ratio was 9:1(Table 2).

### 3.3 Chemical composition of seed cake and slurry.
The chemical analysis showed that the nitrogen content of the digested slurry was slightly higher than the seed cake. With regard to potassium content the seed cake has high potassium content compared with the digested slurry. The digested slurry contained very high phosphorus which was six times that of the seed cake (**Error! Reference source not found.** ).

***Table1:*** *The chemical composition of wild and cultivated Jatropha seeds.*

| Parameters | Wild | Cultivated |
|---|---|---|
| Weight of 100 seed/g | 69.7 | 58.3 |
| Moisture content (%) | 5.4 | 4.43 |
| Ash content (%) | 6.6 | 5.2 |
| Oil content (%) | 33.2 | 24.2 |
| Fiber content (%) | 35.6 | 35.7 |
| Protein content (%) | 18.5 | 20.2 |
| Carbohydrates (%) | 0.9 | 10.3 |
| Ca % | 1.99 | 1.92 |
| Mg % | 0.40 | 0.38 |
| Na% | 0.18 | 0.18 |
| K% | 1.3 | 1.23 |

***Table 2 :*** *Chemical composition of the wild Jatropha seed cake*

| Parameters | % |
|---|---|
| Crudeprotein | 39.2 |
| Ash | 8.6 |
| OrganicCarbon | 54.4 |
| Moisture content | 6.3 |
| T(TS) | 93.7 |
| N | 6.3 |
| K | 1.1 |
| P | 0.9 |

### 3.4 Biogas yield
The determination of gases was carried out by displacement of water from fermentor over 3 days. One kilogram of seed cake produced 24 Liters of biogas.

### 3.5 pH
The pH values were measured at 4 intervals during the fermentation process, at zero time, 6, 24 and 72 hr. At the beginning of fermentation process (zero time) the pH was acidic (5.5), it reached 8.0 after 6 hr, then dropped to 6.5 after 24 hr and became more acidic after 72 hr (4.5) ( fig 1). The temperature during the fermentation process fluctuated between 28-31°C.

### 3.6 Microorganisms
The microorganisms involved in the fermentation of the seed cake were investigated. The morphological and biochemical tests showed that there were two genera of the bacteria. These were Bacillus and lactobacillus.

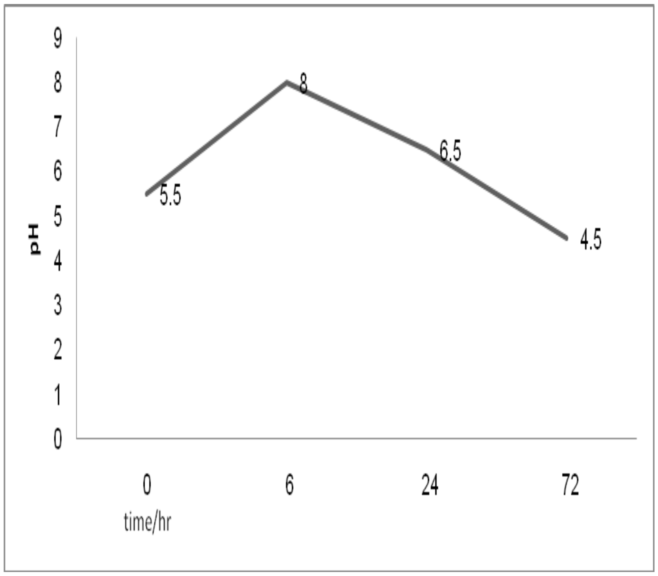


***Figure 1:*** *pH during biochemical reactions*

***Table 3:*** *Chemical composition of seed cake and digested slurry*

| parameters | Seed cake | Digested slurry |
|---|---|---|
| N % | 6.3 | 6.65 |
| P% | 0.9 | 5.3 |
| K% | 1.1 | 0.71 |

## Discussion

The practical and commercial importance of Jatropha derives largely from its high oil content. Our results confirmed this for both wild and cultivated Jatropha in the Sudan. The oil contents of the two amounted to 33 and 24% respectively. This result is consistent with the finding of Hiba [9] who examined wild Jatropha with cultivated plants from Khartoum. Nzikouet (10) found even higher oil content, (48.5%). We also found a large difference in carbohydrate content between wild and cultivated forms, 0.9 and 10% respectively. This finding agreed with results of Nicole and Christoph [11] who suggested that during oil deposition in developing seeds, the carbohydrate is converted to triacylglycerols into the embryo. The utility of the seed cake is suggested by its chemical composition. Our results with respect to the chemical composition of wild Jatropha seed cake were similar to those of [12],[13] in terms of moisture, total solids and organic carbon. However, the overall usefulness of Jatropha and of seed cake in particular is limited by its toxicity. Many researchers reported this toxicity to both plants and animals [4). This means that the seed cake can neither be used as animal feed nor in agricultural faming due to this toxicity [14]. Jatropha seed cake contains curcin, a highly toxic protein similar to ricin in castor making it unsuitable for animal feed. Its potential as a fertilizer however was shown by Sherchann [15] who stated that the application of 10 t/ha of Jatropha seed cake resulted in increasing yield of many crops. In order to utilize this seed cake the toxicity must be removed. One of the ways to achieve this is through fermentation to produce biogas with subsequent use of the digested slurry as biofertilizer as proposed by Gollakota and Jayalakshmi [4]. In our experiments, the biodigestion of seed cake by ferementaion processes led to an increase in both nitrogen and phosphorus and a decrease in potasssium. The results for phosphorus were particularly striking. The phosphorus content of seed cake increased almost by 30% compared with the phosphorus content of the seed, while after fermentation the phosphorus content increased enormously compared to the phosphorus content of both seed and seed cake.This increase in the phosphorus content after fermentation is likely to be due to the microorganisms involved in the fermentaion process. Raheman and Modal [16] also reported that the biodigetion of seed cake resulted in an increase in ntirogen content, which they attributed to decomposition of protein, while both phosphorus and potassium remained unchanged. Our findings therefore agreed with theirs as far as nitrogen is concerned and but not for phosphorus. Biogas is the immediate beneficial product of seed cake digestion. Our results showed the potenial for biogas production. The yield of biogas was increased with an increase of pH. The pH was acidic (5.5) at the start of fermentation and continued to increase till it reached 8.0 then fell. This result was consistent with the findings of Sinbuathong [12] who reported that the initial pH of slurry was acidic (5.5). The system gradually increased to final pH 8.3 and higher methane production was observed in the reactor in which final pH exceeded 8.0. Regarding the microorganisms involved in the fermentation of the seed cake the biochemical and morphological tests indicated that they belong to the bacterial genera Bacillus and Lactobacillus.

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