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Relevance of Industrial Wastes from *Jatropha curcas* L. Seed in Agricultural Biotechnology

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***Abstract*—** *This paper investigated the usefulness of seed cake and husk as industrial wastesgenerated from Jatrophacurcas in biotechnology. Seeds were dehulled, milled and processed for biodiesel production at department of Chemical and Biological Engineering, University at Buffalo, New York, USA.Proximate analysis of the wastes generated (seed husk and cake) was carried out the National Research Institute for Chemical Technology (NARICT) Zaria, Kaduna State, Nigeria. All concentrations were determined using the Microwave Plasma Atomic Emission Spectrophotometer Agilent 4200 (MP-AES) model. Statistical analysis was done on the Minitab software 16.The cake contained 35% moisture, 17% ash, 40% lipid, 70% protein and 78% carbohydrate.However, fibre content in husk (27%) was higher than in cake (16%). The husk also contained fairly high amount of carbohydrate (47.8%).Phosphorus was high in both husk and cake (17.1% and 22.3% respectively). The cake contained higher quantities of micronutrients than the husk with significant differences (t=2.243, p=0.05). The seed cake and husks are rich organic sources of manure as they contain basic nutrients needed by plants to grow. The high amount of protein and carbohydrate makes them perfect candidates as animal feeds when detoxified. From all indicators except in fibre and potassium contents, the seed cake is better than the seed husk. The combined strength and properties of both seed husk and cake should be exploited in Agricultural biotechnology. The two wastes are relevant in both crop and animal production when used as organic manure and animal feeds respectively.*

***Keywords*— Agricultural biotechnology, Animal feeds, Industrial waste, Jatrophacurcas, Organic manure.**

I. INTRODUCTION

Jatrophacurcas L. (family Euphorbiaceae) has recently gained global attention as potential source of biodiesel production(Akogwu, 2011; Nanda *et al*., 2015). The quest for biofuel as environmentally friendly and renewable energy source is in line with UN goal on climate and the need to ensure safer biosphere that is free from pollutants generated from fossil fuel combustion(Aguoru*et al*., 2015). Many advanced countries are now cultivating useful plants in large scale for oil and biodiesel production. *Jatrophacurcas*is particularly of interest today because of its availability, adaptability, ease of cultivation, non-interference with food production and non-edibility (Ouattara*et al*., 2018). For this reason, heaps of wastes are generated from the seeds after industrial processing, especially the cake and husks. Burning the wastes would add more to the global CO_2 level resulting in enhanced greenhouse effect and climate change(Rathore *et al*., 2016). Degradation of the recalcitrant husk may take long time thus polluting the environment. Biotechnological conversion of biowastes into useful products is now a welcome development.The aim of this research was to establish the relevance of wastes generated from *Jatrophacurcas* seed during biodiesel production. The report focused on the proximate analysis and nutritional composition of the seed cake and husks and their potential applications.

II. MATERIALS AND METHODS

For the purpose oil and biodiesel production, seeds of *Jatrophacurcas* were collected from 9 Local Government Areas in Benue State. Seeds were dehulled, milled and processed at department of Chemical and Biological Engineering, University at Buffalo, New York, USA.

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Proximate analysis of the wastes generated including seed husk and cake was carried out the National Research Institute for Chemical Technology (NARICT) Zaria, Kaduna State, Nigeria. Nutritive components, macro and micro-elements were investigated following standard protocols (Adinurani *et al*., 2015; Sanchez-Arreola *et al*., 2015). All concentrations were determined in part per million (ppm) using the Microwave Plasma Atomic Emission Spectrophotometer Agilent 4200 (MP-AES) model. Statistical analysis was done on the Minitab software 16.

III. RESULTS AND DISCUSSION

Table 1presents seven nutritional composition in the industrial waste investigated in *Jatropha*seed. The cake contained 35% moisture, 17% ash, 40% lipid, 70% protein and 78% carbohydrate. These components are relatively of higher values in cake than husk. However, fibre content in husk (27%) was higher than in cake (16%). The husk also contained fairly high amount of carbohydrate (47.8%). Box plot (Figure 1) revealed significant differences in the nutritional values of the two wastes from *Jatropha* seeds (t=4.092, P=0.002).Figure 2 shows the macronutrients investigated. Phosphorus was high in both husk and cake (17.1% and 22.3% respectively). The potassium content of husk (21.2%) doubled that of cake (11%) but the latter contained more sodium (20.4%). Among the five micro-elements studied (Table 2), the iron content recorded the highest values (3.12ppm in husk, 6.66ppm in cake). Other elements >1ppm were zinc (1.98ppm in cake) and lead (1.62ppm in cake). The cake contained higher quantities of micronutrients than the husk with significant differences (t=2.243, p=0.05). Arsenic was present in equal proportion (0.36ppm). With the exception of copper present in minute quantity in seed husk (0.059 ppm), other micronutrients were present in high quantity which appeared to confer toxicity to the seed.

Table 1: Comparative Nutritional Compositions of*Jatrophacurcas*Seed Husk and Cake
Jatropha seed cake and husk(t=4.092, P=0.002)

	Moisture (%)	**Ash (%)**	**Lipid (%)**	**Fiber (%)**	**Protein (%)**	**Carbohydrate (%)**
Husk	11.8	6	3.2	27	5	47.8
Cake	35	17	40	16	70	78

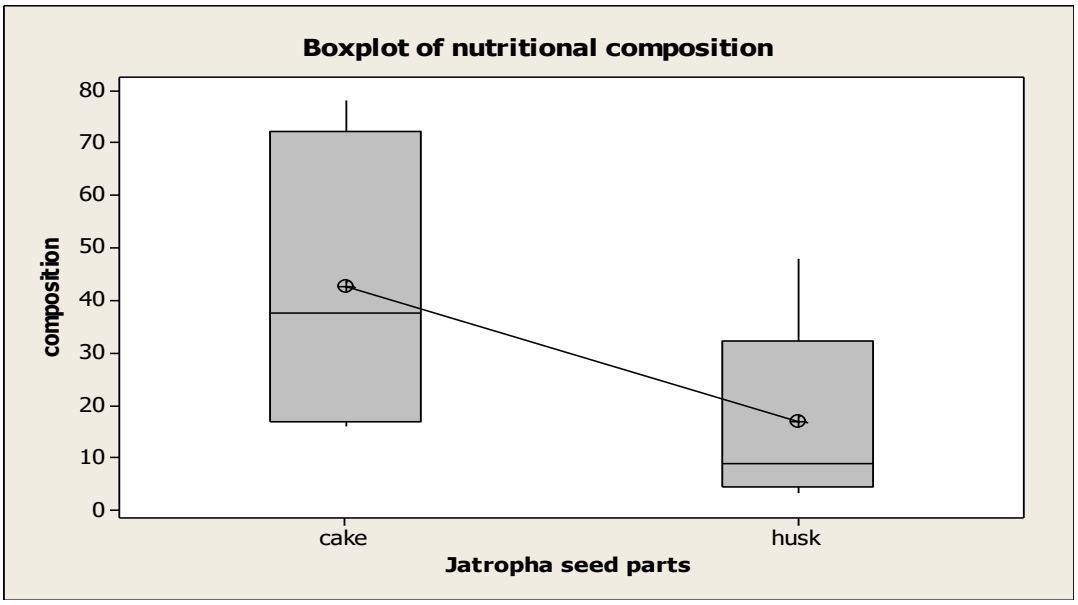

Fig.1: Box plot showing significant differences in nutrient composition in

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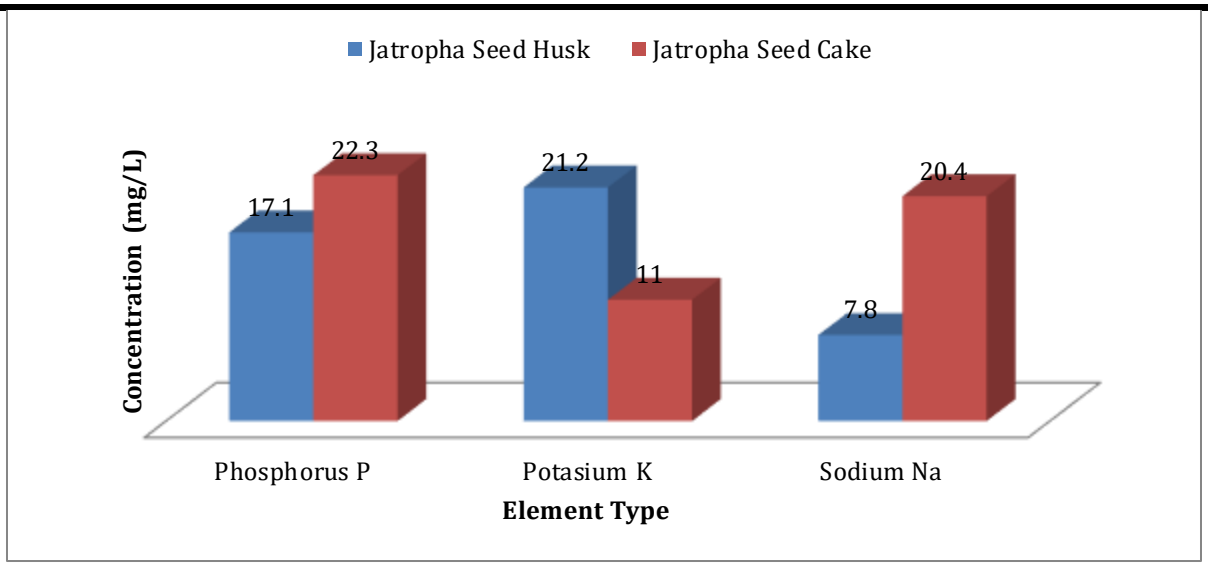

Fig.2: Macronutrients in Jatrophacurcas L Seed Husk and Cake

Table.2: Micro-elements in Jatrophacurcas Seed Husk and Cake

Element (ppm)	*Jatrophacurcas* Seed Husk	*Jatrophacurcas* Seed Cake
Zinc (Zn)	0.225	**1.980**
Arsenic (As)	0.360	0.360
Copper (Cu)	0.059	0.260
Iron (Fe)	**3.124**	**6.664**
Lead (Pb)	0.154	**1.618**

(t=2.243, p=0.05)

The seed cake after proximate analysis was found to have very high percentage of protein. This protein content obtained from the present report is far higher than similar report on *Jatropha* seed cake from India that contained 50% protein (Nepal *et al*., 2018). This difference may be attributed to the fact the seeds collected from Benue State is of higher qualitywhich maight be due to the soil fertility and higher amount of rainfall that characterize the climate in the study area (Aye and Haruna, 2018). This view agrees with similar findings that high rate of rainfall and soil fertility are required for better yield and optimum nutritive content in the plant (Matos *et al*., 2018), although Jatropha as a member of the Euphorbiaceae family can survive under low rainfall.

The outcome of this work strongly recommends *Jatropha* seed cake and husk asgood source of protein for animal feeds provided the protein can be rendered toxin free (Nepal *et al*., 2018). The present report agrees with earlier findings that *Jatropha*seed cake is an excellent source of protein but it contains some anti-nutritional factors (ANF) that can act as toxins and thus negatively affect the growth and health status of animals (Krome*et al*., 2018; Zhao *et al*., 2018). For instance, the concentrations of arsenic and lead as poisonous heavy metals are quite high in this report.Although toxin content can limit the consumption of *Jatrophacurcas* seed cake, detoxified *Jatrophacurcas* protein isolate (DJPI) may be a better option in combating malnutrition most especially in Africa (Musa, *et al*., 2018;Phulia*et al*., 2018).

Apart from high protein content, the cake also contains very high amount of carbohydrates (78%) of carbohydrate, little amount of lipids, crude fibre and ash. The quantity of iron is quite impressive. Hence, it is recommended as an excellent animal feed if detoxified. Detoxification should target the removal of poisonous lead and arsenic. The agrowaste can also serve as a source of organic manure. This is supported by the high amount of macronutrients such as phosphorus, potassium and sodium present in the seed cake and husk. The present study aligns with the work of Nepal *et a*l. (2018) where basic nutrients were reported in the seed cake and husk. In the proximate analysis and mineral composition of seeds of *Jatrophacurcas* from Pankshin Local Government Area of Plateau State (Magu*et al*. 2018), the percentages of micro, macronutrients and minerals contained in the cake and husk were smaller compared to the present findings.

From the above findings, the agricultural benefits of *Jatropha*plant are enormous. The plant can also be intercropped with many cash crops such as coffee, sugar, fruits and vegetables with the *Jatrophacurcas*offering both fertilizer and protection against livestock. *Jatrophacurcas* needs at least 60 mm of rain annually to thrive however it can survive three years of drought by dropping its leaves. *Jatropha*is excellent at preventing soil erosion, and the leaves it drops act as a wonderful soil enriching mulch (Baumer*et al*., 2018).The present report is in line with the work of Aguoruand Okibe(2015)where potential environmental pollutants were bioconverted into useful industrial products of global economic value.It also aligns with previous studies where *Jatropha* seeds had significant effects in the production of *Clariasgariepinus* fingerlings (Musa *et al*., 2008).

In conclusion, the seed cake and husks as agrowaste are rich organic sources of manure as it contains basic nutrients needed by plants to grow. The high amount of protein and carbohydrate makes the agrowaste perfect candidates as animal feeds when detoxified.From all indicators except in fibre and potassium contents, the seed cake is better than the seed husk. Thecombined strength and properties of both seed husk and cake as highlighted above should be exploited in Agricultural biotechnology. The two wastes are relevant in both crop and animal production when used as organic manure and animal feeds respectively.

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