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Proximate analysis of some Jatropha curcas L. (Jatropha) Germplasm from Sokoto and Kebbi States

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Abstract
Jatropha curcas (Linnaeus) belongs to the family Euphorbiaceae and is closely related to other important cultivated plants like rubber tree and castor. Nigeria being a tropical country has wide variations in climatic and soil conditions and therefore has a wide variety of oil crops such as Jatropha. But the paucity of information on the proximate composition and utilization of its seeds in Nigeria is a problem when it comes to the genetic improvement of the crop. Information about nature and extent of genetic variability present in the Jatropha germplasm and association of various proximate compositions is a pre-requisite in planning successful breeding programme. The objectives of the study were to determine the variation in the proximate composition of some Jatropha curcas L. genotype seeds, determine the correlation among the proximate compositions in the Jatropha and suggest the best genotypes in terms of the proximate composition. The experiment was conducted in the laboratory of Product Development Research Programme of the Institute for Agricultural Research, Ahmadu Bello University, Zaria. Data were collected on the proximate compositions of the seeds: moisture, ash, protein, lipid, fibre and carbohydrate content and analyzed. Phenotypic correlations were computed for all the proximate compositions. Rank summation index was generated to identify the best genotype in terms of the proximate compositions. Significant differences were observed for all proximate compositions studied except the lipid which showed highly significant variation for all the genotypes. Highly significant correlations were observed between protein and lipid content (r = 0.67). Sokoto3 and Kebbi10 ranked first and last with rank summation indices of 14 and 118 respectively. The results obtained indicated the presence of appreciable amount of variability within the genotypes to be exploited for improvement. Sokoto3 was found to be the best genotype in terms of the proximate composition.

Keyword: *Jatropha, germplasm, rank index, correlation*

Introduction

Globally, there has been great increase in the biochemical investigation of a large number of oil seed crops in the world (Nzikou et al., 2009). There exists a wide variety of oil crops ranging largely from the highly-utilized to under-utilized oil seed crops in Nigeria (Oseni and Akindahunsi, 2011). There a number of under-utilized oil crops that have not been well studied for their potential uses. One of such crops is J. curcas. The growing interest to save resources spent on buying oil for domestic and industrial uses has created a novel search for using these under-utilized oil crops in order to complement the already existing indigenous sources of oil (Akubugwo and Ugbogu, 2007).

Jatropha curcas L. is a perennial, monoecious shrub which belongs to the family Euphorbiaceae, native to Central America but widely spread across the tropics and sub-tropics (Maghuly et al., 2011). It is stress tolerant, drought resistant, grows in semi-arid, marginal lands, as well as does not compete with conventional food or feed crops for land and water, which makes it as an ideal choice to

make use of vast presently underutilized land resources (Abdelgadir and Van Staden, 2013). It has attracted a great deal of attention worldwide, regarding its potential as a new energy plant. It contains 30-45% oil (Openshaw, 2000). Due to its indispensable benefits to mankind it was classified among the first plant in 1753 with a botanical name "Jatropha" derived from the Greek word "Jatro" meaning doctor and "pha" meaning nutrition. Botanically this is known as Jatropha curcus (Linnaeus).The growing interest in Jatropha curcas as a biodiesel crop will help rid the energy crisis and generate income in rural areas of developing countries which has made people call it "the miracle tree" (Benge, 2006). Jatropha is known with several names by different tribes such as Physic nut, Barbados nut, Poison nut, bubble bush or purging nut in English, Binidazugu or lakwa-lakwa in Hausa, Oriokwu in Igbo, Lapalapa in Yoruba, Muaayiin Gbagyi, Kasha in Nupe, Ebe'bro in Yala (Highina et al., 2011). Plant species, which provide a diesel fuel substitutes, have received the interest globally in recent years (Farooqi et al., 2004).

The wood and fruit from jatropha plant can be used for many purposes including fuel. In the past, Jatropha oil was used for lighting lamps, but today, rural communities continue to use it for its medicinal value and for local soap production (Gübitz et al., 1997). The oil from the seed is viscous, as such suitable for use in the manufacture of candles and soap, in cosmetic industry, as well as a diesel substitute. Its characteristics along with its versatility makes it of crucial importance to developing countries (Kumar and Sharma, 2008). The use of biodiesel has grown dramatically over the last few years. With no competing food uses, this characteristic turns attention to Jatropha curcus L., which grows in tropical and sub-tropical climates across the developing world (Openshaw, 2000). India and many countries in Africa use Jatropha plant as a living hedge to keep out grazing livestock (Halilu et al., 2011).

All parts of Jatropha (seeds, leaves and bark) have been used in traditional medicine and veterinary purposes over a long period of time (Heller, 1996). There is increasing interest on Jatropha's potential as a petroleum fuel substitute has long been recognized, as well as its other uses in industries for use in pharmaceuticals, cosmetics and bio pesticide industry for use in drugs, glycerine, body cream, soap production, paints and lubricants (Henning, 2004).

There is paucity in the availability of information on the existence of variation in terms of the proximate composition in the seeds of Jatropha curcas L. in Nigeria. Comprehensive knowledge of germplasm diversity and variation in the proximate composition of the crop is invaluable aid in its genetic improvement. Information about nature and extent of genetic variability present in the Jatropha germplasm and association of various proximate analyses is a pre-requisite in planning successful breeding programme (Sujatha, 2013).The progress in developing a superior variety depends largely on the genetic basis of selection from diverse parents and the breeding approach followed. In any crop most of the economic traits are highly influenced by environmental factors.

The progress in breeding for such traits are determined by the magnitude and nature of interaction between their genotypic and phenotypic variability under varying soil and climatic conditions.

For a rational approach towards the improvement of seed content, selection has to be made through proximate analysis. However, the heritable variation is often masked by non-heritable variation, which creates difficulty in selection programme. Knowledge of association between yield and its attributes obtainable through proximate analysis helps a great deal in formulating selection strategies in

order to develop suitable genotypes (Nabiswa, 2012). Jatropha curcas is becoming an increasingly popular oleaginous crop in many developing countries for its proposed value in the lipids, pharmaceuticals, cosmetics and bio pesticide industry. Jatropha oil gives a very good foaming, white soap with positive effects on the skin, partly due to the glycerine content of the soap (Henning, 2000). Jatropha soap is said to have medicinal characteristics as can be seen by its use for various skin diseases and people sensitive to regular soap (Warra, 2012). The 36% linoleic acid (C18:2) content in Jatropha kernel is of possible interest for skin care products. The oil is also an ingredient in hair conditioners (Johnson et al., 2011). The use of Jatropha for soap industry and cosmetics is regarded as one of its non-energy use (Warra et al., 2012, Rijssenbeek et al., 2007).

The progress in breeding for such traits is determined by the magnitude and nature of interaction between their genotypic and phenotypic variability under varying conditions of soil and climate.

However, the heritable variation is often masked by non-heritable variation, which creates difficulty in selection programme. This study is designed with the aim of determining the correlation and proximate compositions of some Jatropha curcus L. genotypes under study.

Materials and Methods

The genetic materials used in this study were obtained from two locations; Sokoto and Kebbi are shown on Table 1.

Table 1. Genetic Materials

S/No.	Accession	Source
1	Sokoto 1	Sokoto State
2	Sokoto 2	Sokoto State
3	Sokoto 3	Sokoto State
4	Sokoto 4	Sokoto State
5	Sokoto 5	Sokoto State
6	Sokoto 6	Sokoto State
7	Sokoto 7	Sokoto State
8	Sokoto 8	Sokoto State
9	Sokoto 9	Sokoto State
10	Sokoto 10	Sokoto State
11	Kebbi 1	Kebbi State
12	Kebbi 2	Kebbi State
13	Kebbi 3	Kebbi State
14	Kebbi 4	Kebbi State
15	Kebbi 5	Kebbi State
16	Kebbi 6	Kebbi State
17	Kebbi 7	Kebbi State
18	Kebbi 8	Kebbi State
19	Kebbi 9	Kebbi State
20	Kebbi10	Kebbi State

Laboratory determination of proximate composition

The proximate analysis was carried out in the laboratory of Product Development Research Programme of the Institute for Agricultural Research, Ahmadu Bello University, Zaria. Carbohydrates were calculated by difference while moisture, ash, protein, lipid and fibre were determined through methods described by AOAC (1990).

Determination of moisture content (AOAC 1990)

Principle: This was done based on the difference between the net weight and weight after drying to a constant (At 100^0C for 24 hours).

Procedure: Crucibles were washed and dried to a constant weight in an air oven at100^0C, they were later removed and cooled in a desiccators and weighed (W_1), 2gram of the grounded samples was placed in the weighed moisture dish (W_2), the crucible containing the sample was kept in an oven at 100^0C for 24 hours and weighed.

It was kept back in the oven and reweighed after about 3 hours to ensure a constant weight(W_3). The percentage moisture content was calculated as;

$$\%\,Moisture = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1}$$

Where;

W_1 = Weight of empty crucibles (g),

W_2 = Weight of empty crucibles + samples (g),

W_3 = Weight of empty crucibles + dry sample (g).

Determination of ash content (AOAC 1990)

Principle: The ash content was determined from the loss in weight that occurs during igniting at 550^0C in muffle furnace which is enough to allow all organic matter to burn off without permitting any appreciable decomposition of the ash constituents.

Procedure: 2.0 g of the powdered sample was weighed into a pre-weighed labelled crucible and placed in the muffle furnace at a temperature of 550°C for 8 hours. The furnace was allowed to cool before removing the crucible with its content. The crucible was later cooled in a desiccator and reweighed to get the ash content.

The percentage of ash content was calculated as;

$$\%\,Ash = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1}$$

Where;

W_1 = Weight of empty crucibles (g),

W_2 = Weight of empty crucibles + samples (g),

W_3 = Weight of empty crucibles + dry ignited sample (g).

3.3.3 Determination of protein content (AOAC 1990)

Principle: These are the major compounds containing nitrogen (minor nitrogenous ingredients of food includes; amino acid, purines, ammonium salts and vitamin B1).So nitrogen is used as an index of the protein termed 'crude protein' as distinct from true protein.

Procedure: The analysis was carried out in three (3) stages which are digestion stage, distillation stage and titration stage.

Digestion stage: The powdered sample was weighed out 5 g into a 250 ml kjeldahl flask. 2 g each of the kjeldahl catalysts (Copper Sulphate and Sodium Sulphate) were weighed into the kjeldahl flasks. Anti-bumping granule was added and 30 ml of concentrated Sulphuric Acid.

Distillation stage: was also added to the flask. The digestion flask was then placed on the heating mantle for an hour before being transferred to electric stove. The digestion process proceeds with occasional swirling until a clear solution was obtained. The clear solution was transferred into a 100 ml standard flask and made up to the mark with distilled water.

The 10 ml of the digest was measured into the micro distillation apparatus. 12.5 ml of 1.25% N_aOH was also added to the flask. A condenser was connected from the distillation apparatus to a volumetric flask containing 10ml of 5% boric acid and 2 drops of double indicator (methyl red and methyl blue). The distillate was collected in a flask and then titrated with 0.1 ml standard hydrochloric acid until a pale pink colour end point was obtained.

Percentage of total nitrogen per sample was calculated as;

$$\%\,nitrogen = \frac{ml\ of\ HCl\ (sample) - ml\ of\ HCl\ (black) \times molarity\ of\ HCl \times 100 \times 100 \times 14}{weight\ of\ sample\ \times\ ml\ of\ digest\ \times\ 1000}$$

%Protein = % Nitrogen + % Protein factor.

Determination of lipid content (AOAC 1990)

Principle: This is the continuous extraction of the fat content from the sample using suitable solvent e.g. petroleum ether (60□-80□) in a soxhlet extractor. Principle is that non–polar component of the sample is easily extracted into organic solvent ether.

Procedure: 5.0 g of the powdered sample was put into the soxhlet extractor thimble wrapped with a filter paper and plugged tightly with cotton wool. 150 ml of petroleum ether (60□-80□ bpt) was poured into 300 ml round bottom flask containing anti-bombings and the soxhlet extractor assembled. The sample was extracted for 4hrs until the extract become colourless. The extract was poured into a dried pre-weighed beaker and the thimble rinsed with a little quantity of petroleum ether back into the beaker. The beaker was heated on a steam bath to drive off the solvent. The extracted fat left in the beaker was dried in one desiccator and weighed.

The percentage of lipid content was calculated as;

$$\%\,lipid = \frac{C_3 - C_1}{C_2 - C_1} \times \frac{100}{1}$$

C_1 = Weight of empty round bottom flask,
C_2 = Weight of round bottom flask+ sample,
C_3 = Weight of round bottom flask + dry lipid.

Determination of fibre content (AOAC 1990)

Principle: The 5.0 g of powdered sample was put in a pre-weighed beaker. 50 ml of 1.25% H2SO4 solution was added and made up to 200 ml with distilled water and stirred. The mixture was heated with continuous stirring for thirty (30) minutes and allowed to cool and settle. Distilled water was added and allowed to settle then decanted, decantation was repeated for six (6) times consecutively to make the mixture acid free. 50 ml of 1.25% NaOH was added to 200 ml with distilled water in a beaker and heated for thirty (30) minutes with continuous stirring. It was cooled and allowed to settle. Distilled water was added and decanted for six (6) times consecutively. The mixture was filtered with filter paper and kept for forty-five (45) minutes for water to drain completely and the weight taken.

The percentage of fibre content was calculated as;

$$\%\,fibre = \frac{d_3 - d_1}{d_2 - d_1} \times \frac{100}{1}$$

d_1 = Weight of empty beaker (g),
d_2 = Weight of empty beaker (g),
d_3 = Weight of empty beaker + dry fibre (g).

Determination of carbohydrate content

This was obtained by taking each percentage value of protein, lipid, fibre and ash content from the total dry matter.

Analysis of variance

The data collected were analysed using Statistical Analysis Software (SAS) version 9.0 to compute for Analysis of Variance (ANOVA). The statistical model used for the analysis of variance and determination of expected mean square was based on the linear model for CRD randomized complete block

design according to (Kaps and Lamberson, 2004).

Correlation analysis

Phenotypic correlation analysis was done according to (Singh and Chaudhary, 1985) using Statistical Analysis Software (SAS) version 9.0.

Rank Summation Index (RSI)

For the purpose of selection, an index, called Rank Summation Index (RSI) according to (Mulamba and Mock, 1978) was generated from the 6 proximate compositions namely moisture, ash, protein, lipid, fibre and carbohydrate. (Mulamba and Mock, 1978) described the rank summation index and called it "parameter- free" index. The index was formed by ranking each trait in descending order. Entry with high values in terms of the six proximate compositions ranked first while the reverse ranked last.

Results

Mean Squares

All the genotypes showed significant variation ($P \leq 0.05$) for all the proximate compositions except lipid which indicated highly significant variation ($P \leq 0.01$) among the 20 Jatropha curcas L. genotypes studied as shown on Tables 2.

Table 2. Analysis of variance for the proximate composition of 20 Jatropha curcas L. genotypes

Source	DF	Moisture	Ash	Protein	Lipid	Fibre	CHO
Genotype	19	0.03*	0.06*	5.22*	17.97**	3.86*	9.49*
Error	38						

DF = Degree of Freedom, CHO = Carbohydrate.
*Significant at ($P \leq 0.05$), **highly significant at($P \leq 0.01$).

Mean performance

The mean performance for the proximate composition among the 20 Jatropha curcas L. genotypes studied is presented on Table 3. The mean performance for moisture content was 8.29% and ranged from 8.2%-8.5% for Sokoto 3. Ash content has a mean of 2.63% and ranged from 2.3%-2.9% for Kebbi 3 and Sokoto 3 respectively. The protein content ranged from 10.6% for Kebbi 10 to 16.9% for Sokoto 1 and Sokoto 2 with a mean of 16.03%. On the other hand, lipid has a mean of 37.21 and ranged from 29.8%-40.7% for Kebbi and Sokoto 1 respectively. Fibre content however, had a mean of 22.2% and ranged from 20.8%-26.5% for Kebbi and Sokoto 1. Lastly, Carbohydrate had a mean of 34.9% and ranged from 31.8% for Kebbi 10 to 38.1% for Sokoto 1.

Correlation coefficients

Phenotypic correlation coefficients were computed for the proximate composition in the 20 Jatropha curcas L. genotypes (Table 3). Highly significant correlation was observed between protein content and lipid content (r = 0.67). Highly significant but negative correlation was observed between protein content and fibre content (r = -0.81). Significant but negative correlation was also observed between lipid content and fibre content (r = -0.55). Significant correlation was observed between protein content and carbohydrate content (r = 0.46). Finally, significant correlation was observed between fibre content and carbohydrate content (r = 0.49).

Table 3. Mean performance for the proximate composition of 20 Jatropha curcas L. genotypes

Entry	Moisture	Ash	Protein	Lipid	Fibre	Carbohydrate
Sokoto1	8.2	2.5	16.9	40.7	26.5	38.1
Sokoto2	8.4	2.7	16.9	39.9	22.8	37.7
Sokoto3	8.5	2.9	16.6	39.6	22.7	37.3
Sokoto4	8.4	2.6	16.5	39.5	22.6	36.9
Sokoto5	8.3	2.7	16.5	39.2	22.5	36.7
Sokoto6	8.4	2.7	16.5	38.6	22.5	36.0
Sokoto7	8.4	2.5	16.3	38.5	22.3	35.7
Sokoto8	8.3	2.7	16.3	38.5	22.3	35.4
Sokoto9	8.3	2.6	16.3	38.0	22.3	35.1
Sokoto10	8.2	2.6	16.2	37.7	22.0	34.8
Kebbi1	8.3	2.8	16.2	37.5	21.9	34.4
Kebbi2	8.3	2.5	16.2	36.8	21.9	34.3
Kebbi3	8.3	2.3	16.2	36.5	21.8	34.1
Kebbi4	8.2	2.4	16.2	36.4	21.8	33.8
Kebbi5	8.2	2.8	16.2	36.3	21.7	33.8
Kebbi6	8.2	2.7	16.0	35.9	21.6	33.8
Kebbi7	8.2	2.8	16.0	35.4	21.5	33.4
Kebbi8	8.2	2.7	16.0	34.8	21.5	33.2
Kebbi9	8.2	2.5	15.9	34.7	21.3	32.1
Kebbi10	8.2	2.5	10.6	29.8	20.8	31.8
LSD	0.2	0.4	3.4	6.4	2.8	5.8

LSD = Least Significant Difference.

Table 3. Correlation coefficients between proximate composition traits in 20 Jatropha curcas L. genotypes

	Ash	Protein	Lipid	Fibre	Carbohydrate
Moisture	0.01	-0.19	-0.19	0.07	-0.048
Ash		-0.18	-0.11	0.11	-0.18
Protein			0.67**	-0.81**	0.46*
Lipid				-0.55*	-0.22
Fibre					0.49*

*Significant at ($P \leq 0.05$), **highly significant at ($P \leq 0.01$).

Rank Summation Index (RSI)

The rank summation indices on the six proximate compositions, moisture, ash, protein, lipid, fibre and carbohydrate content as computed according to (Mulamba and Mock, 1978), is presented on Table 4. The results showed Sokoto3, Sokoto2 and Sokoto1 ranked first, second and third with rank summation indices of 14, 15 and 30 respectively, while Kebbi 10 ranked least with rank summation index of 118.

Table 4: Rank Summation Index (RSI)

Entry	Moisture	Ash	Protein	Lipid	Fibre	CHO	Rank
Sokoto3	1	1	3	3	3	3	14
Sokoto2	2	5	2	2	2	2	15
Sokoto1	12	14	1	1	1	1	30
Sokoto4	3	11	4	4	4	4	30
Sokoto5	6	6	5	5	5	5	32
Sokoto6	4	7	6	6	6	6	35
Sokoto8	7	8	8	8	8	8	47
Sokoto7	5	15	7	7	7	7	48
Kebbi1	9	2	11	11	11	11	55
Sokoto9	8	12	9	9	9	9	56
Sokoto10	13	13	10	10	10	10	66
Kebbi2	10	16	12	12	12	12	74
Kebbi5	15	3	15	15	15	15	78
Kebbi3	11	20	13	13	13	13	83
Kebbi4	14	19	14	14	14	14	89
Kebbi6	16	9	16	16	16	16	89
Kebbi7	17	4	17	17	17	17	89
Kebbi8	18	10	18	18	18	18	100
Kebbi9	19	17	19	19	19	19	112
Kebbi10	20	18	20	20	20	20	118

CHO = Carbohydrate.

Discussion

Significant correlations ($P \leq 0.05$) were seen for all the proximate compositions studied except lipid which indicated highly significant correlation ($P \leq 0.01$) among the 20 Jatropha curcas L. genotypes. This is an indication of the presence of high amount of genetic variability among the 20 genotypes for the traits studied which implies the possibility for improvement in the 20 genotypes for all traits studied through selection. This implies that as protein is improved, lipid content is also improved in the same direction. `

Result for the moisture content showed that Sokoto 3 ranked 1st with the highest moisture content in comparison with the other genotypes. This is followed by Sokoto 2 and Sokoto 4 which ranked 2nd and 3rd respectively while Kebbi 10 had the lowest moisture content. This revealed that Sokoto 3 will have the shortest shelf life in comparison to other genotypes, followed by Sokoto 2 and Sokoto 4. However, Kebbi 10 will have a longer storage life. This is because the moisture content of crops determines their shelf life. The higher the moisture content, the more susceptible the crop will be to microbial attack hence reducing its shelf life. This is in line with the observations made by(Magu et al., 2018). High moisture content accelerates all types of food deterioration like chemical, enzymatic and microbial actions (Qasim et al., 2016).

Findings for ash showed that Sokoto 3 which ranked 1st had the highest ash content when compared with the other genotypes. This is followed closely by Kebbi 1 and Kebbi 5 which ranked 2nd and 3rd respectively while Kebbi 3 showed the lowest. This implies that Sokoto 3, Kebbi 1 and Kebbi 5 were the highest in terms of mineral content while Kebbi 3 has the least mineral content. The ash content of a plant based food is the function of mineral elements present which has been proven to aid in establishing and maintaining

acid-alkaline balance in the blood system (Ilodibia et al., 2014, Vinson and Hawkins, 1998).

The results for the protein content showed that Sokoto 1 having the highest protein value in comparison with the other genotypes. This was followed closely by Sokoto 2 and Sokoto 3 which ranked 2nd and 3rd respectively while Kebbi 10 showed the lowest protein content ranking last. This shows that Sokoto 1, 2 and 3 can be used as alternative source of protein. This indicates that Sokoto 1 has the potential of appreciable amount of protein. This was however reported in the findings by (Qasim et al., 2016) who stated that the Jatropha provides sufficient protein which functions in maintenance of fluid balance, optimal functioning of hormones, enzymes and immune function.

As for the lipid content, the results from the analysis showed Sokoto 1 having the highest lipid content in comparison with the other genotypes under study. This was followed by Sokoto 2 and Sokoto 3 which ranked 2nd and 3rd respectively while Kebbi 10 showed the lowest lipid content ranking last. It can be deduced from our results that Sokoto 1, 2 and 3 can be used as alternative source of lipid for both industrial and commercial purpose going by the findings of (Ayodele et al., 2000) on *Sterculia setigera*.

For fibre our results revealed that Sokoto 1 had the highest fibre content followed by Sokoto 2 and Sokoto 3 which ranked 2nd and 3rd respectively, while Kebbi 10 showed the least fibre content among the genotypes studied. Judging from the results, Sokoto 1, 2 and 3 could be classified as an important source of fibre. Fibre is important in maintaining human health and has been observed to reduce cholesterol levels in the body (Chinyere et al., 2009). Fibre plays a crucial role in preventing diseases by reducing cholesterol, high blood pressure and constipation (Hassan et al., 2011). It also aids in stool bulk and decreases the time of digestion (Qasim et al., 2016). Nevertheless studies have shown that, the fibre is not readily digestible by human dietary enzymes such as cellulose and hemicelluloses brought about by the presence of plant polysaccharides(Hassan et al., 2011, Ayodele et al., 2000).

The result of the analysis for carbohydrates shows that Sokoto 1 had the highest CHO followed by Sokoto 2 and Sokoto 3 while Kebbi 10 had the lowest. This revealed that Sokoto 1, 2 and 3 are excellent sources of carbohydrate. The function of carbohydrate in the body is to supply energy (Qasim et al., 2016).

In summary the ANOVA showed that significant differences were observed for all the traits of Jatropha curcas L. genotype studied except the lipid which indicates highly significant variation, while in terms of rank summation index, Sokoto3, Sokoto2 and Sokoto1 ranked first, second and third with rank summation indices of 14, 15 and 30 respectively, and Kebbi10 ranked last with rank summation index of 118.Similarly, significant and highly significant, positive and negative correlations were recorded for some of the traits. This indicates the presence of appreciable variability within the genotypes, which is a pre-requisite for any crop improvement programme.

At the end of this study, significant variations ($P \leq 0.05$) has been observed for all the proximate contents except lipid which indicated highly significant variation ($P \leq 0.01$) among the 20 Jatropha curcas L. genotypes. Also, highly significant correlation was observed between protein content and lipid content (r = 0.67). Highly significant and negative correlation was observed between protein content and fibre content (r = -0.81). Significant and negative correlations was also observed between lipid content and fibre content (r = -0.55). Significant correlation was observed between protein content and

carbohydrate content (r = 0.46). Significant correlation was also observed between fibre and carbohydrate contents (r = 0.49). Based on RSI, Sokoto 3, Sokoto 2 and Sokoto 1 are the best in terms of proximate composition among the 20 Jatropha genotypes studied.

Further studies should be carried out on how the seed and seed oil can be more useful in human nutrition, livestock feed production, proper industrial uses as well as for export in Nigeria.

References

Abdelgadir, H. and Van Staden, J. (2013). Ethnobotany, ethnopharmacology and toxicity of Jatropha curcas L. (Euphorbiaceae): A review. *South African Journal of Botany*, 88, 204-218.

Akubugwo, I. and Ugbogu, A. (2007). Physicochemical studies on oils from five selected Nigerian plant seeds. *Pakistan Journal of Nutrition*,6, 75-78.

Ayodele, J., Alao, O. and Olagbemiro, T. (2000). The chemical composition of Sterculia setigera. Nigerian Journal of Animal Science, 3: 69-76.

Benge, M. (2006). Assessment of the potential of Jatropha curcas, (biodiesel tree,) for energy production and other uses in developing countries. USAID report.

A. O. A. C. (1990). Official Methods of Analysis: Changes in Official Methods of Analysis Made at the Annual Meeting. Supplement, Association of Official Analytical Chemists.

Chinyere, C. G., Akubugwo, E., Chinenye, N. and Ugbogu, A. (2009). Nutritive value of Lagenaria sphaerica seed (wild bottle gourds) from South-Eastern Nigeria. Pakistan Journal of Nutrition, 8, 284-287.

Farooqi, A., Srinivasappa, K. and Keneddy, R. (2004). Jatropha—the biofuel plant. I Map Today, 2, 4-9.

Gübitz, G. M., Mittelbach, M. and Trabi, M. (1997). Biofuels and industrial products from Jatropha curcas, Dbv-Verlag für die Technische Universität Graz.

Halilu, A., Misari, S., Echekwu, C., Alabi, O., Abubakar, I., Saleh, M., Adeyanju, A. and Ogunwole, J. (2011). Survey and collection of Jatropha curcas L. in the northwestern Savannas of Nigeria. *Biomass and Bioenergy*, 35, 4145-4148.

Hassan, L., Umar, K., Dangoggo, S. and Maigandi, A. (2011). Anti-nutrient composition and bioavailability prediction as exemplified by calcium, iron and zinc in Melocia corchorifolia leaves. *Pakistan Journal of Nutrition*, 10, 23-28.

Heller, J. (1996). Physic nut, Jatropha curcas L, *Bioversity International*, 5: 4-8

Henning, R. (2000). The Jatropha Manual. A guide to the integrated exploitation of the Jatropha plant in Zambia. Germany: Deutsche Gesellschaft für Technische Zusammenarbeit GTZ.

Henning, R. (2004). Integrated rural development by utilization of Jatropha curcas as raw material and as renewable energy. Rothkreuz II, D-83138, Weissensberg, Germany.

Highina, B., Bugaje, I. and Umar, B. (2011). Biodiesel production from Jatropha caucus oil in a batch reactor using zinc oxide as catalyst. *Journal of Petroleum Technology and Alternative Fuels*, 2, 146-149.

Ilodibia, C. V., Ugwu, R. U., Okeke, C., Ezeabara, C. A., Okeke, N. F., Akachukwu, E. E. and Aziagba, B. O. (2014). Determination of proximate composition of various parts of two Dracaena species. *International Journal of Botany*, 10: 37-41.

Johnson, T. S., Eswaran, N. and Sujatha, M.

(2011). Molecular approaches to improvement of Jatropha curcas Linn. as a sustainable energy crop. *Plant Cell Reports* 30: 1573-1591.

Kaps, M. and Lamberson, W. 2004. Biostatistics for animal science., (CABI Publishing: Wallingford, UK).

Kumar, A. & Sharma, S. (2008). An evaluation of multipurpose oil seed crop for industrial uses (Jatropha curcas L.): a review. *Industrial Crops and Products*, 28, 1-10.

Maghuly, F., Jankowicz-Cieslak, J., Calari, A., Ramkat, R., Till, B. and Laimer, M. (2011). Investigation of genetic variation in Jatropha curcasby Ecotilling and ISSR. BMC proceedings, Springer, O50.

Magu, T., Louis, H., Nzeata-Ibe, N., Sunday, E. and Udowo, V. (2018). Proximate Analysis and Mineral Composition of Jatropha curcas Seeds Obtained from Pankshin Local Government Area of Plateau State of Nigeria. *Journal of Physical Chemistry and Biophysics*, 8, 2161-2165.

Mulamba, N. and Mock, J. (1978). Improvement of yield potential of the ETO blanco maize (Zea mays L.) population by breeding for plant traits [Mexico]. *Egyptian J of Gen. and Cyt.*

Nabiswa, A. W. (2012). The assessment of the genetic diversity present in Jatropha curcas L germplasm cultivated in Kenya as a potential biofuel feedstock. University of Nairobi, Kenya.

Nzikou, J., Matos, L., Moussounga, J., Ndangui, C., Kimbonguila, A., Silou, T., Linder, M. and Desobry, S. (2009). Characterization of Moringa oleifera seed oil variety Congo-Brazzaville. Journal of Food Technology, 7, 59-65.

Openshaw, K. (2000). A review of Jatropha curcas: an oil plant of unfulfilled promise. *Biomass Bioenergy*, 19, 1-15.

Oseni, O. and Akindahunsi, A. (2011). Some phytochemical properties and effect of fermentation on the seed of Jatropha curcas L. *American Journal of Food Technology*, 6, 158-165.

Qasim, M., Aziz, I., Rasheed, M., Gul, B. and Khan, M. A. (2016). Effect of extraction solvents on polyphenols and antioxidant activity of medicinal halophytes. *Pakistan Journal of Botany*, 48, 621-627.

Rijssenbeek, W., Togola, I. and Rue, F. S. (2007). Jatropha Village Power in Garalo, Mali: A New Dimension for People, Planet and Profit Actions. Mali Folk Centre (MFC) Nyetta, Mali.

Singh, R. and Chaudhary, B. (1985). Biometrical Methods in Quantitative Genetic Analysis. Ludhiana. New Delhi: Kalyani Publishers.

Sujatha, M. (2013). Genetic diversity, molecular markers and marker assisted breeding in Jatropha. Jatropha, Challenges for a New Energy Crop. Springer.

Vinson, M. R. and Hawkins, C. P. (1998). Biodiversity of stream insects: variation at local, basin, and regional scales. *Annual review of Entomology*, 43, 271-293.

Warra, A. (2012). Cosmetic potentials of physic nut (Jatropha curcas Linn.) seed oil: A review. *American J. Science Industrial Research*, 3, 358-366.

Warra, A., Wawata, I., Umar, R. and Gunu, S. (2012). Soxhlet extraction, Physicochemical analysis and cold process saponification of Nigerian Jatropha curcas L. seed oil. *Canadian Journal of Pure and Applied Science*, 6, 1803-1819.