Consequences of Defattening and Cooking on the Proximate and Mineral Composition of *Jatropha curcas* Kernel Meal

Ojediran, T. K and Emiola , I. A.

Department of Animal Nutrition and Biotechnology
Ladoke Akintola University of Technology
P. M. B. 4000, Ogbomoso, Nigeria.
Correspondence: walemiola@yahoo.com 07069688075, 08034104295

ABSTRACT

The objective of the present study was to investigate the effect of different processing techniques on the proximate composition and mineral content of *Jatropha curcas* kernel meals. Three processing methods viz whole kernel meal (WKM, undefatted), defatted kernel meal (DKM) and cooked defatted kernel meal (CDKM) were used. There was no effect of processing on the dry matter (DM) content of the *Jatropha curcas* kernel. Compared with the WKM, the crude protein (CP) content was enhanced by processing in DKM (63.73%) and CDKM (58.0%). Crude protein content was higher in DKM (63.73%) when compared with CDKM. Ether extract was reduced by 28.50 and 16.78% in the DKM and CDKM, respectively, compared with the undefatted WKM. Extraction of oil in the DKM and CDKM resulted in an increase in the ash content by 27.92 and 20.83%, respectively. Removal of oil from the whole kernels influenced the mineral content of the meals. Nitrogen and phosphorus contents were enhanced in the DKM and CDKM compared with WKM. Compared with CDKM, defatted kernel meal was more abundant in nitrogen (6.17 vs 5.96%), phosphorus (1.24 vs 1.08%) and potassium (1.18 vs 0.86%). Processing methods reduced calcium content by 45.45% and 42.42% in DKM and CDKM, respectively. Iron content in the DKM and CDKM followed the same trend.

The results of this study indicate that defatting (DKM), and cooking (CDKM) prior to defatting of *Jatropha curcas* kernel meal improves the crude protein and ash contents of the kernel meals. Similarly, nitrogen, phosphorus, and zinc were enhanced by the processing methods. Defatted kernel meal and cooked defatted *Jatropha curcas* meal could be used as components of livestock feeds for the purpose replacing for other low protein and expensive feedstuffs. However, the content of the anti-nutritional factors need further investigation in the processed kernel meal.

Introduction

Several plants exist with high nutritive value and yet remain underexploited for human and animal benefits. One of such plants is *Jatropha curcas*. Oladele and Oshodi, (2008) reported that the seed weights between 0.53 - 0.86 g and the kernel contains 22 - 27% protein and 57 - 63% oil. This indicates that *Jatropha* seed is of good nutritional value. The seed kernels are known to contain high levels of oil, which can be used as fuel directly or as a substitute for diesel in the transesterified form. The oil is also used for making candles, soap, lubricants and varnishes and is used for illumination. The seed cake can be a good protein source for humans as well as for livestock (Makkar *et al*., 2008). Although, reasons for under-utilization of *Jatropha curcas* seed as a feedstuffs for monogastric animals and as food for humans are varied, the presence of potent anti-nutritional substances in this seeds is a significant factor. The anti-nutritional factors include toxic thermostable substances (saponin, tannins and phytate), liposoluble phorbolesters (PES) (Trabi *et al*, 1997) in addition to the thermo-labile lectins and trypsin inhibitors that are problems of anti-nutritional factors in other feedstuffs including soybean (Chaturvedi *et al*, 2004). Phorbolesters (Phorbol-12-myristate 13-acetate) are bioactive diterpene derivatives that have varied effects in cells (Panigrahi *et al*. 2007) and must be removed or lowered to a sub-lethal level before the meal or cake is included in animal diet (Marker *et al*, 1997, Chaturvedi *et al*, 2004). These effects limit the use of raw *Jatropha curcas*, although various processing techniques tend to reduce the anti-nutritional factor content of the seed. The use of heat treatment, chemical treatment and solid state fermentation using fungi had produce little or no result and where result are encouraging there were side effects such as chemical load and protein denaturation (Gross *et al*, 1997; Chaturvedi *et al*, 2000; Samson *et al*, 2001; Belewu and Sam, 2010).

Minerals are inorganic substances, present in all body tissues and fluids and their presence is necessary for the maintenance of certain physicochemical processes which are essential to life (Eruvbetine, 2003). *Jatropha curcas* seeds are rich in many micro-elements such as manganese, iron, and zinc as well as macro- elements, including potassium, calcium, sodium, magnesium and phosphorous (Abou-Arab *et al*, 2010).

Processing methods, such as soaking, germination roasting and autoclaving have been reported to improve the nutritional properties of plant seeds (Yagoub and Abdella, 2007). Processing techniques cause important changes in the biochemical, nutritional and sensory characteristics of legumes. In many parts of the world, legumes are often consumed after soaking and germination, during which the nutritional value is enhanced. During germination of food grains, it has been reported that certain minerals and vitamins were increased (Sangronis and Machado, 2007).

The aim of the present study was to investigate the effect of defatting and cooking on the proximate and mineral content of the *Jatropha curcas* kernel. This study could provide some basic information, which would help determine the value of processed *Jatropha curcas* kernel as a component of livestock feed.

Materials and Methods

Source of test material

Jatropha curcas seeds were obtained from Kano city in Kano State, Nigeria where the plant is used as boundry hedge and to demarcate farmlands and plots of land. It is also grown on a commercial scale in the state.

Preparation of processed sample

Jatropha curcas seeds were dehulled to remove the testa and the kernel was used as the experimental material. The kernel was divided into three parts for further processing. *Jatropha curcas* kernel was subjected to the following treatments:

Defatted kernel meal: A portion of the kernel was milled to paste and oil extraction was carried out using a hydraulic press. The product after the oil removal was sun-dried and referred to as defatted Kernel Meal (**DKM**).

Aqueous heating/Cooking: The dry seeds were added to boiling water at 121^0C in a cooking pot and heated for 30 minutes. Cooked seeds were then sun-dried for 4 days after which they were oven-dried at 85^0C for 48 hours. Cooked kernel was further defatted using hydraulic press to remove the oil content. This was referred to as Cooked Defatted Kernel Meal (**CDKM**).

Whole Kernel Meal: The dry *Jatropha kernel* was sun-dried to low moisture content and then milled. This was referred to as Whole Kernel Meal (**WKM**).

Chemical Analysis

Samples of raw *Jatropha curcas* and the processed forms were milled to pass through a 1-mm screen prior to chemical analyses. Samples were analyzed for Dry Matter (DM), Ether Extract (EE), Crude Fibre (CF), Ash, and Crude Protein (CP). Raw and processed *Jatropha curcas* kernel were subjected to proximate analysis using the methods of AOAC, (1994). Crude protein (estimated as % of kjeldal N × 6.25) was determined using thermal combustion (Leco NS 2000, Leco Corporation, St. Joseph, MI). The method of Pearson (1981) was used for the determination of crude fibre. Calcium and Phosphorus were determined using an inductively coupled plasma spectrometer (Vista-MPX, Varian Canada Inc., Mississauga, Ontario, Canada) after acid digestion (AOAC, 1994). Briefly, a 1-g sample was ashed at 600°C in a muffle furnace for 12 h and was digested with 10 mL of a solution containing 1% (vol/vol) HNO_3 and 5 *N* HCl for 1 h in a sonication bath preheated to 70°C. All analyses were done in duplicate.

Results and Discussion

This study was designed to examine the consequences of two processing regimes on the proximate composition and mineral contents of *Jatropha curcas* kernel meals. The result of the proximate composition of the whole kernel, defatted kernel and the cooked defatted kernel meals of *Jatropha curcas* are presented in Table 1. The whole kernel meal contains 23.57% crude protein which makes it a good source of protein. This result agrees with the findings of Belewu and Sam (2010). In contrast, Oladele and Oshodi (2008) reported 38.5% crude protein for *Jatropha cathartica*. Compared with the WKM, the crude protein (CP) content was enhanced by processing 63.73 and 58.0%, in DKM and CDKM meals, respectively. The result of the present study showing increased crude protein content in the DKM and CDKM could be attributed to the removal of oil which causes an increase in the concentrations of other nutrients in the kernel meals. Crude protein content was slightly higher in DKM (38.59%) when compared with CDKM (37.2%). Previous studies from our lab (Emiola *et al*., 2003, 2007) showed that aqueous heating tended to reduce the CP content possibly due to leaching and vaporization of some nitrogenous compound during processing.

The crude fibre is the sum total of all those organic compounds of the plant cell membranes and supporting structures which in chemical analysis of plants food stuff remain after removal of the crude protein, fat and nitrogen-free extract. Thus, the crude fibre in diet consists mostly of plant polysaccharides that cannot be digested by human and monogastric dietary enzymes such as cellulose, hemicellulose, and some materials that encrust the cell walls (Southland, 1975; Melon, 1980). Fibre content is a significant component of the diet. It increases stool bulk and decreases the time that waste materials spend in the gastrointestinal tract. Crude fibre value of 10.21% in the defatted kernel meal is lower than that reported for raw African locust bean (11.7%) and raw melon seeds (15.8%) (Omafuvbe *et al*., 2004), but are higher than values reported for cowpea (3.6%) and soybean (0.2%), (Saurez *et al*., 1999). The crude fibre content of the kernel meal is low, which makes it ideal for monogastric animals. Crude fibre was increased in the processed kernel meal. In contrast, Ukachukuwu and Obioha (2000) reported a decrease in crude fibre content of *M. cochinchinensis* as boiling time was increased. The consequence of defattening is the increase in the concentrations of other nutrients including crude fibre.

Fats and oils are the most abundant lipids found in nature. They are a heterogeneous group of organic compounds, which are important constituents of plant and animal tissues. High crude fat value of 52.04% in the kernel signifies high lipid content. This oil content is higher than the value recorded for *Bauhinia recticulata*, which belongs to the pea family (Amoo, 2003) but similar to the values reported for *Arachis hypogaea* (Irwin and Hegsted, 1971). The higher oil content of jatropha makes it one of the most appropriate renewable alternative sources of biodiesel in terms of availability and cost (Umer, *et al*. 2010). Ether extract was reduced by 28.50 and 16.78% in the DKM and CDKM, respectively, compared with the undefatted WKM and this reflects the effect of the defatting while CDKM had lower value probably because of fat loss during the cooking process.

Minerals are inorganic substances, present in all body tissues and fluids and their presence is necessary for the maintenance of certain physicochemical processes which are essential to life (Eruvbetine, 2003). Mineral contents in whole and processed *Jatropha curcas* kernel meals are presented in Table 2. Ilelaboye and Pikuda, (2009) reported that phosphorus is an essential component of nucleic acid and nucleoproteins, which are responsible for cell division reproduction and heredity. On the other hand, magnesium is very important in humans, especially in the formation of bones and teeth. The mineral content of plants can be significantly influenced by variety, location, and environmental conditions (Rao, 1996). The information of minerals in *Jatropha curcas* seeds are scantly in the literature. Azza and Ferial, (2011) reported that non defatted jatropha kernel meal from Egypt contain 163mg/100g phosphorus, 51.41mg/100mg Calcium and 36mg/100g of magnesium. The result of the present study is in agreement with the values reported Azza and Ferial, (2011) except that P content which has a higher value that those reported by Azza and Ferial, (2011).

Removal of oil from the whole kernels meal influenced the mineral content of the meals. Nitrogen and phosphorus contents were enhanced in the DKM and CDKM compared with WKM. Compared with CDKM, defatted kernel meal was more abundant in nitrogen (6.17 vs 5.96%), phosphorus (1.24 vs 1.08%) and potassium (1.18 vs 0.86%). Processing methods reduced calcium content by 45.45% and 42.42% in DKM and CDKM, respectively. Iron content in the DKM and CDKM followed the same trend. The observed differences in the mineral contents could be attributed to leaching into cooking water in the CDKM. The fact the calcium content was reduced by processing suggest that adequate supplementation with the minerals when the processed seed is used in feed formulation.

Although, the content of macro-elements in some cases is lower in Jatropha, these elements are very important. Phosphorus is an essential component of nucleic acid and nucleoproteins, which are responsible for cell division reproduction and heredity. Potassium is an essential nutrient and has important role in the synthesis of amino acids and proteins (Nzikou *et al*., 2009). Magnesium is very important for human, especially in the formation of bones and teeth. Calcium plays an important role in strengthening the tissues and bones of the body (IIelaboye and Pikuda, 2009).

Conclusion

The results of this study indicate that defatting and cooking prior to defattening of *Jatropha curcas* kernel meal improved the crude protein and ash content of the kernel meals. Similarly, nitrogen, phosphorus, and zinc were enhanced by the processing methods. Defatted kernel meal and cooked defatted *Jatropha curcas* meal could be used as components of livestock feed to replace other low protein and expensive feedstuffs. However, the content of the anti-nutritional factors need further investigation as does the Amino acid profile in the processed kernel meal so as to further define its feeding value for poultry.

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Table 1: Proximate composition of raw and processed *Jatropha curcas* kernel meals (%)

Composition	WKM[1]	DKM[2]	%(WKM-DKM)	CDKM[3]	%(WKM-CDKM)
Dry Matter (%)	94.26	95.26	1.06	95.62	1.44
Crude Protein(%)	23.57	38.59	63.73	37.24	58.00
Ether extract(%)	52.04	37.21	28.50	43.31	16.78
Ash (%)	4.80	6.14	27.92	5.80	20.83
Crude Fibre (%)	9.00	10.21	13.44	16.58	84.22

[1]WKM = whole kernel meal
[2]DKM = defatted kernel meal
[3]CDKM = cooked defatted kernel meal

Table 2: Mineral composition of raw and processed *Jatropha curcas* kernel meal

Composition	*WKM*[1]	*DKM*[2]	*% (WKM-DKM)*	CDKM[3]	*%WKM-CDKM)*
Nitrogen (%)	3.77	6.17	63.66	5.96	58.09
Phosphorus (%)	0.78	1.24	58.97	1.08	38.46
Potassium (%)	0.95	1.18	24.21	0.86	9.47
Calcium (%)	0.33	0.18	45.45	0.19	42.42
Magnessium (%)	0.36	0.39	8.33	0.39	8.33
Iron (ppm)	89.52	76.38	14.68	75.35	15.83
Zinc (ppm)	34.54	41.44	19.98	47.22	36.71

[1]WKM = whole kernel meal
[2]DKM = defatted kernel meal
[3]CDKM = cooked defatted kernel meal