Fatty Acid Profile of Differently Processed *Jatropha curcas* Kernel meals

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

Department of Animal Nutrition and Biotechnology,

Ladoke Akintola University of Technology, P. M. B. 4000, Ogbomoso, Nigeria.

Corresponding author: walemiola@yahoo.com 07069688075, 08034104295

ABSTRACT

The purpose of this study was to investigate the fatty acid profile of differently processed *Jatropha curcas* kernel meals. A portion of the kernel was milled and subjected to oil extraction using hydraulic press and was referred to as Raw Defatted Meal (RDM). Raw milled kernel was roasted for 20 minutes until the kernel become crispy to the touch and turn brown, as this was referred to as Toasted Defatted Meal (TDM). A portion of the raw kernel was cooked at 120^{O}C for 30 minutes, dried and then defatted using the hydraulic press as this was referred to as Cooked Defatted Meal (CDM). The Fatty acid analysis is carried out with a split injection onto an analytical column with a polar stationary phase and an FID detector. Major fatty acids present in the oils were influenced by various treatment methods. The most abundant fatty acid in RDM (Raw defatted meal) is linoleic acid (26.00%), oleic (22.62%), stearic (21.94%) and palmitic acid (16.39%) respectively, while in TDM (Toasted defatted meal): linoleic acid (29.68%), oleic (22.52%), stearic (20.40%) and palmitic acid (14.91%) respectively, but in CDM (Cooked defatted meal): oleic (36.85%), linoleic (25.37%), palmitic (17.34) and linolenic (12.68%) respectively. R

INTRODUCTION

The increase in the prices of orthodox feedstuffs as a result of competition between feed industries and man has caused developing countries to embark on researches that are focused on novel feedstuffs, which are not staple for human consumption to alleviate the problems of shortage and competition for the available traditional feedstuffs.

Jatropha curcas is regarded as a wonder plant because of its numerous attributes; the seeds contain up to 60% oil with a fatty acid pattern similar to that of edible oil, which is used for many purposes such as lighting, as a lubricant, for making soap (Rivera-Lorca and Ku-Vera, 1997) and most importantly as biodiesel.

Jatropha seed contains approximately 24.60% of crude protein, 47.25% of crude fat, and 5.54% of moisture contents (Akintayo, 2004). The oil fraction of *Jatropha* contains saturated fatty acids mainly palmitic acid (16:0) with 14.1% and stearic acid (18:0) with 6.7%. Unsaturated fatty acids consisted of oleic acid (18:1) with 47.0%, and linoleic acid (18:2) with 31.6%. The oil with high percentage of monounsaturated oleic and polyunsaturated linoleic acid has a semi-drying property (partially hardens when the oil is exposed to air). This semi-drying oil could be an efficient substitute for diesel fuel (Augustus *et al.*, 2002).

The percentage of essential amino acids and mineral content can be compared to those of other seeds (Makkar and Becker, 1999a). The defatted meal has been found to contain a high amount of protein in the range of 50–62%, and the level of essential amino acids except lysine is higher than the FAO reference protein (Makkar *et al*., 1998).

The use of Jatropha in animal nutrition is however faced with several problems of anti-nutritional factors such as lectins, saponins,tannins, phytic acid, trypsin inhibitors, hydrocyanides and phorbolesters (Makkar and Becker, 1999b). Due to these phytotoxins, the seeds, cake or its oil cannot be used for human or animal consumption. But, nevertheless, there have been several attempts to investigate the detoxication of Jatropha seeds to improve its nutritional value so that it could be used in monogastric nutrition (Annongu, *et al*, 2010).

Various processing methods, such as soaking, germination, roasting and autoclaving has beeni. reported to improve the nutritional properties of plant seeds (Yagoub and Abdella, 2007). Some simple and inexpensive processing techniques,ii. such as soaking, germination and cooking are commonly employed for legumes (Prodanov *et al*., 2004). Processing techniques cause important changes in the biochemical, nutritional andiii. sensory characteristics of legumes, which detoxifies the feedstuffs for a better utilization by livestocks.

Farmers in the tropics usually employs these improvement techniques so as to make the livestocks better utilize the processed feeds because of the high nutrients which are sometimes higher than in the expensive convectional feedstuffs.

This experiment focuses on the effect of various local improvement techniques on the resultant oil from defatting jatropha meal as a potential biofuel feedstock because of the fatty acid profile.

MATERIALS AND METHODS

Experimental site: Ladoke Akintola University of Technology Teaching and Research Farm, Ogbomoso, Oyo State, Nigeria.

Source of test material: Dry seeds of *J. curcas* was purchased from Kano state where it is presently grown on a commercial scale.

Seed dehulling and processing: Dry seeds of *J. curcas* were screened to separate whole seeds from dirt and extraneous matter. The seeds were dehulled to separate the kernel from the shell. Dehulling was done manually.

The extraction of oil followed similar manner to that of other oil seeds such as cotten seed cake,cashew nut meal, castor seed cake (Belewu, 2010b, Odunsi *et al*, 2002). Briefly, clean seeds of *J. curcas* was dehulled. After dehulling, the kernels were divided into three portions for ease of processing. Three different processing methods were adopted.

RDM: - A portion of the kernel was milled and subjected to oil extraction using hydraulic press and was referred to as Raw Defatted Meal (RDM).

TDM:- Raw milled kernel was roasted for 20 minutes until the kernel become crispy to the touch and turn brown, as this will be referred to as Toasted Defatted Meal (TDM)

CDM: - A portion of the raw kernel was cooked at 120^{O}C for 30 minutes, dried and then defatted using the hydraulic press as this will be referred to as Cooked Defatted Meal (CDM)

Fatty acid determination :The Fatty acid analysis is carried out with a split injection onto an analytical column with a polar stationary phase and an FID detector. The configuration used here is the PerkinElmer® Clarus® 600 Gas Chromatograph (GC), fitted with a capillary split/splitless injector and FID.

Instrument Parameters EN 14103.

Gas Chromatograph: PerkinElmer Clarus 600 GC

Inlet Temperature: 250 °C
Column Flow: 1 mL/min
Split Flow: 50 mL/min

Injection Volume: 0.5 µL
Oven Program Initial Temp: 210 °C
Hold Time 1: 13.00 min
Ramp 1: 5 °C/min
Oven Program Final Temp: 230 °C
Hold Time 2: 15.00 min
Equilibration Time: 0.0 min
Column: Elite-Famewax, 30 m x 320 µm x 0.25 µm film
Carrier Gas: Helium
FID Temperature: 250 °C
H2 Flow: 45 mL/min
Air Flow: 450 mL/min
Range: 1
Attenuation: -5

RESULTS AND DISCUSSION

Figure 1 shows the comparism of major fatty acids present in the oils as influenced by various treatment methods. The most abundant fatty acid in RDM is linoleic acid (26.00%), oleic (22.62%), stearic (21.94%) and palmitic acid (16.39%) respectively, while in TDM: linoleic acid (29.68%), oleic (22.52%), stearic (20.40%) and palmitic acid (14.91%) respectively, but in CDM: oleic (36.85%), linoleic (25.37%), palmitic (17.34) and linolenic (12.68%) respectively. These varies from the result of Adebowale and Adedire, (2006) which states that the most abundant fatty acid in *Jatropha curcas* oil is linoleic (47.3%) followed by stearic (17.0%), oleic (12.8%), palmitic (11.3%) and arachidic (4.7%) acids. The variation could be due to varietal differences and environmental factors due to the souce location. RDM and TDM follows similar trend while CDM had no strearic acid but linolenic acid. This validates the findings of Prodanov *et al.*, (2004) and Yagoub and Abdella, (2007) about legume seeds and the influence of processing methods on their nutritional properties, biochemical and sensory characteristics. Cooking the kernel before oil extraction improves the amount of oleic acid in CDM.

Figure 2 shows the effect of various treatments on the fatty acid types of the extracted oils: RDM (50.84%) has the highest level of saturated fatty acids, followed by TDM (47.68%) and then CDM (24.86%) but the case of the monounsaturated fatty acid is different with CDM (37.09%) while RDM and TDM had similar levels of 22.88% and 22.64% respectively. The polyunsaturated fatty acid is also higher in CDM (38.05%) followed by TDM (29.68%) and RDM (26.29%) respectively. These shows that cooking the kernels before oil extraction has impact on the type of fatty acid predominant in the oil.

Considering the table below:Oil	Saturated	Monounsaturated	Polyunsatuerated
Soybean oil	16%	23%	58%
Cottonseed oil	26%	18%	52%
Palm oil	49%	37%	9%
Palm Kernel oil	81%	11%	2%
Coconut oil	90%	6%	2%
Peanut/Groundnut oil	17%	46%	32%

*approximated values- actual values vary depending on individual plant and extraction methods.
(Makebiodiesel.org 2011)

From the above table, all the oils are edible oils which in the production of biofuel could aggravate the food-feed competition. Meanwhile jatropha oil is inedible because of the toxic component in the toxic genotype.

Tropical plant oils like coconut and palm are also high in saturated fats. When this type of fat is used to make biodiesel, the biodiesel is usable, but will cloud and gel at higher temperatures than biodiesel made from unsaturated fats such as most plant oils. Thus, this kind of biodiesel would only be usable in warm climates, because when it clouds or gels it will plug the fuel filter and fuel lines. (bioLyles biodiesel workshop, 2011). Oils containing mostly unsaturated fats, such as canola, safflower, or soy will produce biodiesel that has lower cloud and gel points than those made from tropical plant oils. Thus, the biodiesel made from non-tropical plants is better to use in cooler climates. The biodiesel made from high saturated fat oils may be slightly more stable however, plus the tropical plants usually yield much more oil per plant than other plants.

The lower the saturated fat content, the lower the gel point of the biodiesel made from it. Fatty acids containing double bonds are called unsaturated. The double bonding site is somewhat unstable and can break off or be chemically altered in the presence of heat and water. Unsaturated fats tend to spoil faster than saturated fats. If an oil contains too many double bonded sites the oil becomes a "drying oil" (www.makebiodiesel.org)

Drying oils are not good for making biodiesel as they break down quickly. They usually contain three double bonds per fatty acid. Just to give you an idea, they are used in paints and varnish and dry quickly to form a tough film. Drying oils will age and turn acidic quickly, sometimes the biodiesel made from drying oils will degrade overnight. Examples of drying oils include Linseed oil, Walnut oil, and Poppy oil (www.makebiodiesel.org).

Cooking oils actually make some of the best biodiesel. These are unsaturated oils with a single double bond per fatty acid (monounsaturated). Canola is probably the best oil for making biodiesel, since it ages slowly, remains liquid to low temperatures. Olive oil is another good oil for making biodiesel. It has slightly a higher gel point, is slightly less stable, and has about the same energy content as Canola oil due to it's slightly increased polyunsaturated and saturated content (www.makebiodiesel.org). Meanwhile canola and Olive are temperate crops and they produce edible oil.

From figure 2, (with the introduction of treatments), the level of saturation drops while the mono and poly unsaturation increases.Among the treatments considered, because of the high level of monounsaturated fatty acid in CDM and the level of oleic acid therein, it would be a better stock for biodiesel production. It agrees with the findings of Augustus *et al*., 2002. Meanwhile it will be better if it can be converted to biodiesel before being oxidised, else it would be altogether be a drying oil good for paints and vanish.

Grain, 2007 reported that First generation biodiesel production from palm oil is in demand globally. Palm oil is also a primary substitute for rapeseed oil in Europe, which too is experiencing new demand for biodiesel purposes. Palm oil producers are investing heavily in the refineries needed for biodiesel. In Malaysia companies have been merging, buying others out and forming alliances to obtain the economies of scale needed to handle the high costs caused by increased feedstock (palm oil) prices. New refineries are being built across Asia and Europe.

The success recorded by using palm oil as a feedstock for biodiesel in Asia despite its edible makes RDM and TDM a good stock too because of the similar fatty acid saturation type and their oxidative stability makes them a good alternative to CDM.

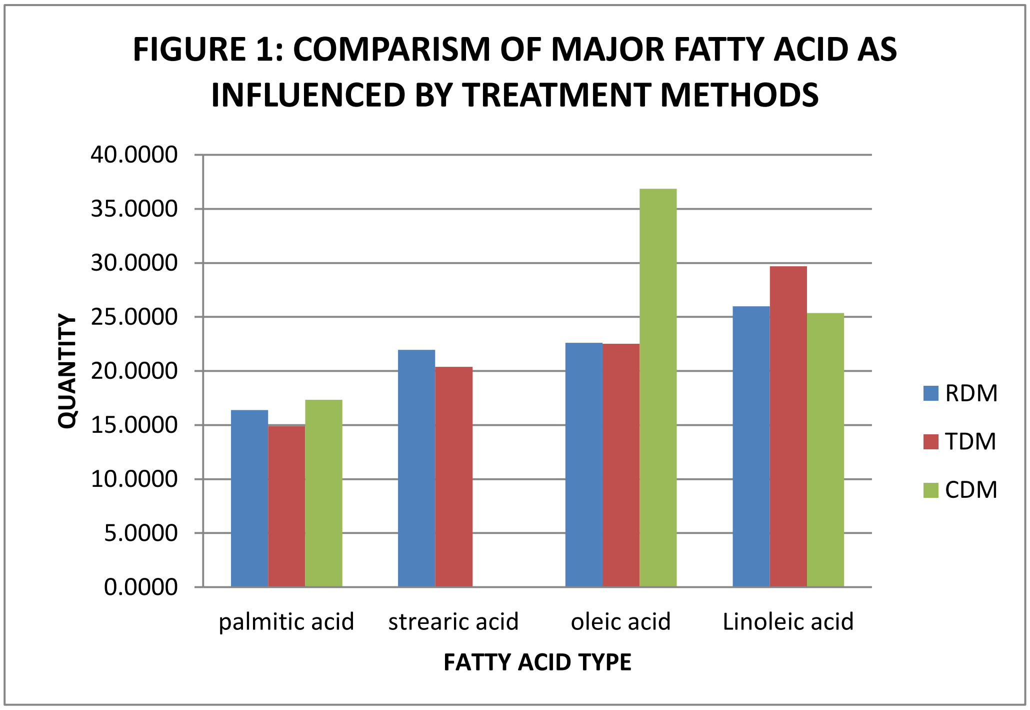
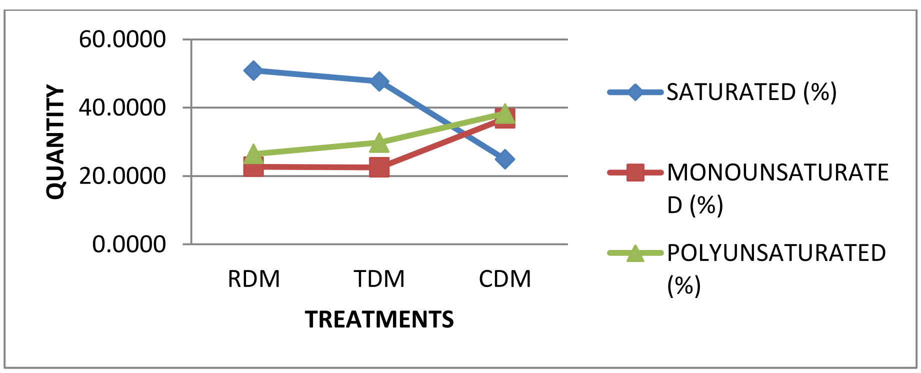


FIGURE 2: EFFECT OF VARIOUS TREATMENTS ON FATTY ACID TYPES



References

Adebowale, K. O. And Adedire, C. O. (2006). Chemical composition and insecticidal properties of the underutilized Jatropha curcas seed oil. Afr. J. Biotechnol., 5: 901-906

Akintayo, E.T. (2004). Characteristics and composition of *Parkia biglobbossa* and *Jatropha curcas* oils and cakes. Bioresour. Technol. 92, 307–310.

Annongu, A. A., Joseph, J. K., Apata, D. F., Adeyina, A. O., Yousuf, M. B. And Ogunjimi, K. B. (2010). Detoxification of *Jatropha curcas* Seeds for Use in Nutrition of Monogastric Livestock as Alternative Feedstuff. Pakistan Journal of Nutrition 9 (9): 902-904, 2010).

Augustus, G.D.P.S., Jayabalan, M., Seiler, G.J., (2002). Evaluation and bioinduction of energy

Belewu, M. A. and R. Sam(2010). Solid state fermentation of *Jatropha curcas* kernel cake:

components of *Jatropha curcas*. Biomass Bioenergy 23, 161–164.

Grain, (2007). www. the palm-oil–biodiesel nexus

Makkar, H.P.S. and K. Becker, (1999a). Edible provenances of *Jatropha curcas* from Quinta RPP state of Mexico and effect of roasting on antinutrients and toxic Factors in seeds. J. Agric. Food Chem., 45: 3152-3157.

Makkar, H.P.S. and K. Becker, (1999b). Plant toxins and detoxification methods to improve feed quality of tropical seeds. Asian Aust. J. Anim. Sci., 12: 467-480.

Makkar, H.P.S., Becker, K., Schmook, B., (1998). Edible provenances of *Jatropha curcas* from Quintana Roo state of Mexico and effect of roasting on antinutrient and toxic factors in seeds. Plant Foods Human Nutr. 52, 31–36.

Odunsi, A. A., Akande, T. O., Yusuph, A. S. And Salami, R. I. (2002). Comparative utilization of high inclusion rates of four Agro-industrial by-products in the diets of egg type chickens. *Archivos de zootecnia* 51(196): 456-468.

Prodanov, M., I. Sierra and C. Vidal-Valverde, (2004). Influence of soaking and cooking on the thiamin, riboflavin and niacin contents of legumes. Food Chem., 84: 271-277.

Proximate composition and antinutritional components. *Journal of Yeast and Fungal Research* Vol. 1(3), pp. 44-46, May 2010. www.academicjournals.org/JYFR bioLyles biodiesel workshop, (2011) (www. bioLyles biodiesel worksho p.com)

Rivera-Lorca, J.A., Ku-Vera, J.C., (1997). Chemical composition of three different varieties of *J. curcas* from Mexico. In: Gubitz, G.M., Mittelbach, M., Trabi, M. (Eds.), Biofuels and Industrial Products from *Jatropha curcas*. DBV Graz, pp. 47–52.

Yagoub, A.A. and A.A. Abdella, (2007). Effect of domestic processing methods on chemical, in vitro digestibility of protein and starch and functional properties of bambara groundnut (*Voandzeia subterranean*) seeds. Res. J. Agric. Biol. Sci., 3: 24-34