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Detoxification of *Jatropha curcas* Seeds for Use in Nutrition of Monogastric Livestock as Alternative Feedstuff

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Abstract: An experiment was conducted to investigate the utilization of Jatropha seed cake by Albino rats. Jatropha Seed Cake (JSC) treated by boiling, fermentation followed by extraction with equal volumes of hexane and ethanol was included in diets at graded levels of 5, 10, 15, 20 and 25%. Data obtained on performance and body organ indices showed that rats tolerated up to 15% dietary JSC without adverse effects on the measured parameters in relation to the corn-soy reference diet ($p>0.05$). However, 20 and 25% inclusion levels elicited mortality in all the animal subjects receiving the diets within one week in the course of the experimental trial.

Key words: Jatropha seed cake, Albino rats, performance, organ weights indices

INTRODUCTION

As the world human population increases averaging seven billions, there is concomitant increase in demand and competition for conventional food/feedstuffs used both by man and monogastric livestock. This is especially true in underdeveloped and developing countries where food production cannot keep pace with the high growth in population. There is also an increase in the prices of these orthodox feedstuffs as a result of competition between feed industries and man. This has caused developing countries to embark on researches focused on novel feedstuffs, that are not staple for human consumption to alleviate the problems of shortage and competition for the available traditional feedstuffs. It is for these reasons that *Jatropha curcas* seeds are considered as alternative feedstuff in this experiment.

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, the percentage of essential amino acids and mineral content can be compared to those of other seeds (Makkar and Becker, 1999a). 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. Nevertheless, in order to search for alternative feeds, this experiment attempted to investigate the detoxication of Jatropha seeds to improve its nutritional value so that it could be used in monogastric nutrition.

MATERIALS AND METHODS

10 kg of Jatropha seeds were collected from Ilorin, Nigeria and sun-dried to constant weight. The seeds were boiled, fermented as described by Annongu *et al.* (1996) and soaked in equal volumes of hexane and ethanol for 24 h to remove some of the lipo-soluble toxins. After the chemical extraction, the seeds were milled to flour before inclusion in diet mixtures. Six diets of equal energy and protein content were formulated as given in Table 1 on diets composition. Treated Jatropha Seed Cake (JSC) meal was included in diets at 5, 10, 15, 20 and 25%. 72-Albino rats (at 3-weeks old) of equal sexes were randomly allotted to six dietary treatments made of a corn-soy reference diet and the other diets containing the processed JSC at the percentages given above. A treatment was made of two replicates with six rats per replicate and the experiment followed a completely randomized design, CRD.

Rats were fed to appetite for 21-days during which data was collected on performance and carcass characteristics. For carcass studies, one rat per replicate was sacrificed and the organs, heart, lungs, intestines and liver were removed for determination of absolute and relative organ weights.

Chemical analyses: Quantification of residual toxins in dietary JSC was carried out following the appropriate methods for tannins (Joslyn, 1970), phytic acid (Wheeler and Ferrel, 1971), cyanides (AOAC, 1990) while saponins were determined as outlined by Hudson and El-Difrawi (1979). The proximate chemical composition of the samples was carried out according to AOAC (1990).

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Table 1: Composition of the experimental diets on as fed basis

	Diets					
	1	2	3	4	5	6
Ingredients (g)	Control	5% JSM	10% JSM	15% JSM	20% JSM	25% JSM
Corn starch	516.00	516.00	516.00	516.00	516.00	516.00
Soybean meal	250.00	200.00	150.00	100.00	50.00	0.00
JSM	0.00	50.00	100.00	150.00	200.00	250.00
Sucrose	100.00	100.00	100.00	100.00	100.00	100.00
Cellulose	40.00	40.00	40.00	40.00	40.00	40.00
DL-methionine	4.00	4.00	4.00	4.00	4.00	4.00
Vitamin-premix	50.00	50.00	50.00	50.00	50.00	50.00
Total	1000	1000	1000	1000	1000	1000

Statistical analysis: Analysis on performance and organ weights data were made using the analysis of variance, ANOVA following the complete randomized design (Steel and Torrie, 1990).

RESULTS AND DISCUSSION

Table 2 presents data on performance characteristics of Albino rats fed graded levels of processed Jatropha Seed Meal Cake (JSM) in diets. There was no statistical significant difference in feed intake by the surviving groups of rats offered the test diets 2, 3 and 4 relative to the group fed the conventional diet ($p>0.05$). Body weight gain significantly increased as the inclusion level of treated JSM increased from 5-15% ($p<0.05$) in comparison with the control diet. There was however, no significant difference in feed to gain ratio among the treatments ($p>0.05$). Albino rats given diets 2, 3 and 4 containing 5, 10 and 15% processed dietary JSM gave 100% survival rate compared with the reference diet while all the rats offered diets 5 and 6 containing 20 and 25% JSM died within one week in the course of the experiment.

Feed intake on diets containing the test feedstuff at 5, 10 and 15% was comparable with the control diet since no significant difference was observed suggesting that Jatropha seeds boiled, fermented and extracted with hexane and ethanol could be included up to 15% in monogastric animal diets without adverse effects on feed consumption. Rats receiving diets with 10 and 15% dietary treated JSM were heavier in weight than those on the standard and 5% dietary JSM probably due to the high protein content of Jatropha seed cake meal. Previous works (Makkar and Becker, 1999a) showed that Jatropha seed cake or meal contains between 56-60% crude protein. In this study, JSM was included at the expense of soybean cake usually containing 44% protein. The higher protein content of JSM might have aided the increased weight gain on the diets in question. Efficiency of feed utilization on diets 2-4 was similar to the conventional diet indicating equality in nutritional composition. Similarly, no mortality was recorded on diets 2-4 containing substituted treated JSM at 5, 10 and 15% relative to the reference diet. However, 20 and 25% dietary JSM elicited death of all the animal subjects with in one week of the experiment. Mortality recorded on these diets suggested that inclusion of treated JSM at levels above 15% is not tolerated by the monogastric rats. The intolerance might be as result of cumulative effect of Jatropha seed phytotoxins which residual influence persisted in the processed test feedstuff in diets.

Analysis of diets containing the treated JSM for residual toxins of tannins, saponins, cyanides, phytic acid showed that the diets still contained residues of these toxic chemicals from Jatropha seed cake. This might also be true for lectins, trypsin inhibitors and phorbolesters undetermined in this experiment. The residues of these phytotoxins lend support to explain that even though dietary JSM was treated in this study, inclusion levels above 15% proved fatal due to the residual effects of the toxins.

Table 3 presents data on Absolute Organ Weights (AOW) in rats fed graded levels of JSM in diets. There were significant differences in absolute weights of the heart, lungs, liver and intestines compared with the organs of rats on the control diets ($p<0.05$). Weight of organs increased concomitant with increase in dietary treated JSM from 5-15%. Relative Organ Weights (ROW) data (Table 4) followed the trend similar to that on absolute weights. Results on AOW and ROW showed that intestines, liver, lungs and hearts of rats on the treated test feedstuff increased in weight as the inclusion level of the JSM increased up to the acceptable level of 15% by the rats. The increment in weight of the organs on these diets agreed with the increase in weight and could also be explained on the basis of higher protein content of JSM compared with soybean in the control diet.

Results of analyzed residual Jatropha seed toxins in diets and the proximate chemical composition in native JSM given in Table 5 and 6 presents residual cyanides, saponins, phytic acid and tannins besides haemagglutinins, trypsin inhibitors and phorbolesters in the virgin JSM respectively. The residues of these toxicants in the treated test feedstuff seemed to have deleterious effects on the nutrition of monogastric

Table 2: Performance characteristics of Albino rats fed graded levels of processed dietary JSM

	Diets						
Parameters	1	2	3	4	5	6	SEM
Avg. feed intake (g/r/d)	21.53	24.43	21.11	21.10	-	NS	1.6
Weight gain (g/r/d)	15.00[a]	15.40[a]	17.10[b]	17.30[b]	-	*	1.17
Feed efficiency (f/g)	1.40	1.58	1.20	1.22	-	NS	0.17
Survival rate (%)	100.00	100.00	100.00	100.00	-	-	-

[a-b]Mean values in rows not sharing common superscripts are significantly different ($p<0.05$).
NS, No significant difference ($p>0.05$)

Table 3: Absolute organ weights of Albino rats given graded levels of dietary treated JSM

	Diets						
Organs (g)	1	2	3	4	5	6	SEM
Heart	0.50[a]	0.85[b]	0.82[b]	0.83[b]	-	-	0.16
Lungs	1.40[a]	2.65[b]	2.60[b]	2.39[b]	-	-	0.58
Intestines	2.70[a]	4.76[b]	4.82[b]	4.69[b]	-	-	1.02
Liver	0.55[a]	1.01[b]	0.92[b]	0.92[b]	-	-	0.20

Table 4: Relative Organ Weights (ROW) of Albino rats fed graded levels of processed dietary JSM

	Diets						
ROW (g)	1	2	3	4	5	6	SEM
Heart	0.80[a]	0.85[c]	0.82[b]	0.84[c]	-	-	0.02
Lungs	2.47[a]	2.63[b]	2.55[b]	2.40[a]	-	-	0.09
Intestines	4.78[b]	4.76[b]	4.82[c]	4.69[a]	-	-	0.05
Liver	0.92[a]	0.92[a]	1.00[b]	1.01[b]	-	-	0.04

Table 5: Analyzed residual phytotoxins concentration in treated dietary JSM

	Diets					
Toxins	1	2	3	4	5	6
Cyanides (ppm)	-	1.01	1.09	1.12	1.15	1.20
Saponins (ppm)	-	0.70	0.75	0.82	0.85	0.90
Phytic acid (%)	-	5.15	5.36	6.18	6.80	7.83
Tannins (g/dm^3)	-	0.05	0.05	0.05	0.06	0.06

Table 6: Analyzed phytotoxins content in native JSM

Phytotoxin	Concentration
Phorbolesters	2.79 mg/g
Total phenols	0.36%
Tannins	0.04%
Phytates	9.40%
Saponins	2.60%
Trypsin inhibitors	21.3 mg/g
Lectins (1/mg meal/ml assay)	102 mg/g

animals like rats when included at levels above 15% in diets as observed in this study. Untreated cake or meal or oil from Jatropha seeds is not suitable for monogastric nutrition since it is extremely poisonous.

Conclusion: It is submitted that treating JSM by methods used in this experiment and including in diet at 15% has no deleterious effects on monogastric animals like Albino rats. Methods of detoxification to enable higher inclusion levels above 15% are receiving attention.

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