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SOME NUTRITIONAL AND TOXICOLOGICAL STUDIES OF *JATROPHA CURCAS* SEED MEAL IN POULTRY NUTRITION

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ABSTRACT

Combined physical, chemical and biochemical methods were used to process virgin seed meal of *Jatropha curcas* into Treated Jatropha Seed Meal (TJSM). 5 % TJSM processed by the various methods was included in test diets 2 to 6 which were fed to cockerel chicks at hatch compared to a maize-soybean conventional diet (diet 1). 144-olympiad cockerel chicks were used in a single factor design experiment and fed ad libitum the six experimental diets for a period of one month. Dietary performance traits gave no significant differences in feed consumption and weight gain on the test diets relative to the control diet ($p > 0.05$). However, significant difference was recorded on feed efficiency between the reference diet and the test diets whereby the test diets gave less efficiency compared with the control ($p < 0.05$). Highest mortality rate (83 %) was observed on the diet with JSM which was boiled, roasted and fermented. The biochemical determinants measured on the Jatropha based diets were comparable with those of the conventional diet ($p > 0.05$) except the value on the blood cholesterol level which was elevated on the Jatropha containing diets ($p < 0.05$). Also, no significant differences were recorded on AST and ALP activities between the control and test diets ($p > 0.05$) except the activity of ALT ($p < 0.05$) which increased on diets with the treated Jatropha. Parameters investigated on haematological parameters such as PCV, RBC and Hb were not significantly affected by dietary treated JSM compared to these values on the control diet ($p > 0.05$). Similar non-significant effect of dietary treated JSM was observed on the WBC differential counts ($p > 0.05$). It was established in this study that inclusion of 5 % treated Jatropha seed meal had no deleterious effects on poultry. Further researches are recommended to investigate the acceptability of treated JSM at higher inclusion levels in poultry or other livestock.

Keywords *:* JSM, cockerels, performance, biochemical and haematological indices

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ÉTUDES NUTRITIONNELLE ET TOXICOLOGIQUE DES GRAINES DE *JATROPHA CURCAS* DANS L'ALIMENTATION DE LA VOLAILLE

RÉSUMÉ

Une combinaison de méthodes physiques, chimiques et biochimiques a été utilisée pour traiter la farine des graines de *Jatropha curcas* (TJSM). 5 % de farine de graines de *Jatropha curcas* traitée par différentes méthodes ont été incorporés dans les aliments expérimentaux 2 à 6 des poussins coquelets en comparaison à l'aliment témoin (aliment 1). Au total, 144 poussins coquelets de souche olympiad ont été utilisés pour l'expérimentation. Les animaux ont été nourris *ad libitum* avec les 6 aliments expérimentaux pendant un mois. Les performances zootechniques ont donné des différences non significatives ($p > 0.05$) en ingestion alimentaire et en gain de poids pour les aliments tests comparativement à l'aliment témoin. Cependant, l'efficacité alimentaire des aliments expérimentaux était significativement plus faible ($p < 0.05$) que celle de l'aliment témoin. Le taux de mortalité le plus élevé (83 %) a été observé sur les aliments contenant la farine de graine de Jatropha bouillie, torréfiée et fermentée. Les déterminants biochimiques mesurés sur les animaux ayant reçus les aliments expérimentaux sont similaires ($p > 0.05$) à ceux de l'aliment témoin, excepté la valeur du taux de cholestérol dans le sang qui a été plus élevé chez les animaux nourris par les aliments expérimentaux. Aussi, aucune différence significative n'a été enregistrée sur les activités des AST et ALP entre l'aliment contrôle et les aliments expérimentaux ($p > 0.05$). Cependant, les activités des ALT ont été significativement plus élevées ($P < 0.05$) dans les aliments contenant du Jatropha traités. Pour ce qui est de l'hématologie, les paramètres tels que l'hématocrite, le globule rouge et l'hémoglobine n'ont pas été significativement affectés ($p > 0.05$) par les traitements alimentaires. Aucun effet significatif ($p > 0.05$) des aliments contenant de la farine de graines de Jatropha traité n'a été observé sur le taux de globule blanc. Il a été établi dans cette étude que l'incorporation à un taux de 5 % de la farine de graine de Jatropha traité n'a eu aucun effet délétère sur les poulets. D'autres recherches sont recommandées pour étudier l'acceptabilité des farines de graines de Jatropha traitées à un taux d'incorporation plus élevé chez les volailles et autres animaux d'élevages.

Mots-clés : Farine de graine de jatropha, coquelets, performances, indices biochimiques et hématologiques

INTRODUCTION

The potential for finding novel feedstuffs that can be used as alternatives to the conventional foodstuffs used by man as staple foods and monogastric animals is enormous. Sequel to this objective, researches are on the increase in developing and underdeveloped countries on the use of lesser known feedstuffs with significant nutritive value to feed farm animals to avoid the over dependence on the limited conventional foodstuffs especially proteins and carbohydrates. It is for reason that *Jatropha curcas* seeds are given consideration in this experiment. *Jatropha curcas*, which belongs to the family of Joannesieae, Crotonoideae of Euphorbiaceae, is a multipurpose drought tolerant plant native to Mexico and central America, but presently grown in large quantities in many tropical countries like Latin America, Asia and African countries. The generic name Jatropha is derived from the Greek which implies medicinal uses. The family contains approximately 170 known species. According to the binomial nomenclature of species Plantarum, Linnaeus was the first to name this shrub *Jatropha curcas* L.

Other names of this plant include Pourghere or Pignondinde (French), Purgiernuß or Brechnuß (Germany), Physic or purging nut (English), Purgeernoot (netherland), Purgueira (Portuguese), Habelmeluk (Arab), Kanananaeranda Parvataranda (Sanskrit), Bagbherenda, Jangliarandi, Safedarand, Ratanjyoti (Hindi), Yu-lu-tzu (Chinese), Sabudam (Thailand), Pinoncillo (Mexico) and Tempate (Costa Rica) (Heller, 1996). Jatropha is cultivated mainly for its seeds which are rich source of oil (55-60 %). The small tree yields about five tons of seeds per year per hectare of plantation (Raina & Gaikwad, 1987 ; Makkar & Becker, 1997). After oil extraction from the seeds, the cake/meal left is discarded or used as organic manure because it is not suitable as animal feed due to its toxicity to both monogastric and ruminants animals including fish, hence in this study, efforts were made to detoxify the full-fat seeds and used as test feedstuff in nutrition of cockerels.

MATERIALS AND METHODS

Over 72 kg Jatropha seeds were obtained from ripped fruits harvested from plantation in Ilorin. Seeds were sun-dried before milling into Jatopha Seed Meal (JSM) using an attrition miller. The JSM was divided into equal parts of 12 kg and each portion was subjected to a different treatment method. Six diets were formulated made of a corn-soy control diet (diet 1) while diet 2 contained JSM that was boiled, roasted and fermented; diet 3 had JSM soaked, boiled and roasted; diet 4 had JSM boiled, roasted, fermented & soaked in ethanol for 24h; diet 5 had JSM boiled, fermented & soaked in equal volumes of hexane and ethanol for 24h; diet 6 had JSM boiled, roasted & soaked in equal volumes of petroleum ether and ethanol for one day. Tap water was used for soaking for two days while all boiling at 100^{o}C took 60min. Roasting was carried out for 20 minutes while fermentation in a carbon dioxide environment was carried out as described by Annongu *et al* (1996). JSM that was soaked in ethanol (for diet 4), ethanol & hexane (diet 5), petroleum ether and ethanol (diet 6) was sieved and pressed to extract oil that might contain some of the Jatropha anti-nutrients soluble in lipids. The cake after oil extraction was sun-dried and pulverized before inclusion in the various diet mixtures. The six diets were formulated to contain similar protein and caloric value (22 % & 2800 kcalkg^{-1}). Treated Jatropha Seed Meal (TJSM) was incorporated at 5 % level in all the test diets (that is 2-6). The composition of the experimental diets on as fed basis is shown on Table 1. 144-Olympiad cockerel chiks at hatch were used and randomly distributed to the 6-dietary treatments, each diet containing 24-chicks in three equal replicates. The experimental design followed a one-way classification. The

birds were housed in an electrically heated metabolic battery brooder cage partitioned in units to enable replication. They were fed the experimental diets ad libitum for a time lag of one month.

Table 1. Composition of the experimental diets on as fed basis (%)

Diets	Control	*BRF-JSM	SBR-JSM	BRFE-JSM	BFHE-JSM	BRPE-JSM
Ingredients (%)						
Maize	60.000	62.500	62.500	62.500	62.500	62.500
Soybeanmeal	36.725	31.725	31.725	31.725	31.725	31.725
TJSM	0.000	5.000	5.000	5.000	5.000	5.000
DLmethionine	0.500	0.500	0.500	0.500	0.500	0.500
Premix	0.500	0.500	0.500	0.500	0.500	0.500
Salt	0.200	0.200	0.200	0.200	0.200	0.200
Bone meal	0.225	0.225	0.225	0.225	0.225	0.225
Oyster shell	0.250	0.250	0.250	0.250	0.250	0.250
Total	100.0	100.0	100.0	100.0	100.0	100.0

NB : 2, BRF-JSM-boiled-fermented Jatropha seed meal ; 3, SBR-soaked, boiled & roasted JSM ; 4, BRFE-boiled, roasted & fermented JSM soaked in ethanol ; 5, BFHE-boiled, fermented JSM soaked in hexane & ethanol ; 6, BRPE-boiled, roasted JSM soaked in petroleum ether & ethanol

Data Collection on Response Criteria

In the course of the trial, data were recorded on dietary performance traits of feed intake, body weight gain, efficiency of feed utilization and percent mortality. At the termination of the experiment, two sets of blood samples were collected from the cockerels through the jugular vein using needle and syringe. Blood for serological studies was collected from 3-cockerels of each diet, that is from each replicate A-C. Blood samples were collected in test tubes without anti-coagulant and centrifuged at 250 rpm to obtain clear sera. Chemical analyses were performed on serum total protein which was determined by the biurette method described by Clowick & Kaplan (1955). Serum albumin was analyzed by the procedures of Doumas & Biggs (1972) while serum creatinine was determined as outlined by Scott (1965). Blood total cholesterol, urea, uric acid and globulin levels were determined according to the methods of AMA (Adewuyi & Olatunji, 1995). Activities of the transaminases, serum aspartate aminotransferase (AST/GOT ; EC 2.6.1.1) and alanine aminotransferase (ALT/GPT ; EC 2.6.1.2) were determined according to the colorimetric method of Reitman and Frankel (1959) while alkaline phosphatase activity (ALP ; EC 3.1.3.1) was determined by the kinetic method of Frajola *et al.* (1965). Whole blood samples were collected in sample bottles containing anti-coagulant (EDTA) for the analysis of packed cell volume (haematocrit/PCV) carried out with a micro-haematocrit centrifuge, red blood cell (erythrocytes/RBC) and white blood cell (leukocytes/WBC) counts determined with a haemocytometer.Haemoglobin

concentration (Hb) was analyzed by the Wedemeyer & Yasutake method (1977) while the WBC differential counts on eosinophils, lymphocytes, monocytes, neutrophils were carried out by counting stained blood smears with a light microscope (Leishmans' model).

Statistical analysis

Data collected on the performance characteristics, serological and haematological parameters were analyzed by ANOVA, analysis of variance, of a single factor design. Treatment means were further separated based on significance using Duncan (1955) multiple range test.

RESULTS

Table 2 presents results on dietary performance of cockerels given the differently processed JSM in diets compared with the reference diet. There were no significant differences in average daily feed consumed and body weight gain ($p > 0.05$) at the termination of the one month trial compared with the value of these parameters on the control diet. However, significant difference was recorded on feed conversion ratio between the reference diet and the JSM based diets ($p < 0.05$). Percent survival rate was lowest on the diet containing JSM that was boiled, roasted and fermented (that is diet 2 ; 17 %) while diet 5 with JSM boiled and fermented before extraction of oil with hexane and ethanol gave the reverse result (highest survival rate of 89.40 %).

Table 2. Dietary performance of cockerels fed treated Jatropha Seed Meal in diets

Diets	Control	BRF-JSM	SBR-JSM	BRFE-JSM	BFHE-JSM	BRPE-JSM
Parameters						
Mean daily feed intake (g/d)	133.30	93.30	70.00	100.0	103.0	100.0
Mean daily weight gain (g/d)	217.00	67.00	67.00	83.30	93.30	77.00
Feed conversion ratio (g feed/G)	0.61[a]	1.30[b]	1.04[b]	1.20[b]	1.10[b]	1.29[b]
Mortality rate (%)	13.00	83.00	20.80	33.00	10.60	25.00

a-b : Treatment means in rows not sharing common letters differed significantly ($p < 0.05$)

The positive influence of processing the JSM before feeding was also manifested in the results obtained on the biochemical and haematological determinants (Table 3 and Table 4). Treating JSM before feeding in diets caused biochemical indices of serum total protein, serum albumin and globulin in cockerels fed the test diets to be comparable with the values of these parameters on the control diet ($p > 0.05$). Similarly, the activities of enzymes, AST, ALP in cockerels receiving treated Jatropha based diets were not different from those on the conventional diet ($p > 0.05$) indicating that treatment of the seed meal effected to some extent, the detoxification of Jatropha seed anti-nutrients. Besides, no significant differences were observed on the measured metabolites of uric acid and creatinine ($p > 0.05$) in birds offered the test feedstuff in diets compared to the control diet.

Table 3. Influence of dietary processed Jatropha Seed Meal on some biochemical determinants in cockerels

Diets	Control	BRF-JSM	SBR-JSM	BRFE-JSM	BFHE-JSM	BRPE-JSM
Indices						
Total Protein, g/l	54.33	48.67	54.33	48.67	43.33	42.67
Albumin, g/l	21.33	18.67	24.67	20.67	22.33	21.67
Globulin, g/l	33.00	30.00	29.67	28.00	21.00	21.00
Cholesterol,mmol/l	3.53[a]	3.97[b]	4.63[b]	4.47[b]	4.00[b]	3.93[b*]
Uric acid, mmol/l	0.32	0.33	0.53	0.38	0.48	0.35
Urea, mmol/l	3.87[b]	2.20[a]	2.73[a]	2.00[a]	3.20[b]	3.23[b]
Creatinine, µmol/l	76.33	70.00	72.00	69.00	77.00	71.68
AST (IU/L)	13.67	9.67	9.00	13.33	13.67	9.33
ALT (IU/L)	8.00[a]	8.87[a]	9.00[a]	16.33[b]	14.67[b]	10.67[b]
ALP (IU/L)	88.00	103.67	102.33	110.00	108.33	102.33

a-b : Treatment means in rows not sharing common letters differed significantly ($p < 0.05$).

No significant differences were obtained on the haematological parameters of PCV, RBC, Hb ($p > 0.05$) in birds fed the test diets relative to the control diet except on the leukocytes (WBC) count ($p < 0.05$), but there were no statistical

significant differences in the WBC differential counts of the lymphocytes, eosinophils, monocytes and neutrophils ($p > 0.05$).

Table 4. Effects of dietary treated Jatropha Seed Meal on blood composition in cockerels

Diets	Control	BRF-JSM	SBR-JSM	BRFE-JSM	BFHE-JSM	BRPE-JSM
Parameters						
PCV (%)	26.00	26.30	20.67	20.30	25.30	20.00
WBC x 10^9/l	8.40^b	8.23^b	7.10^a	7.16^a	9.53^b	8.56^b
RBC x 10^{12}/l	6.70	6.43	5.07	5.37	6.70	5.86
Hb (g/dl)	4.57	4.00	3.57	3.83	4.57	3.37
%Neutrophils	15.33	19.67	16.63	17.33	13.00	16.67
%Eosinophils	0.67	0.33	0.67	0.67	1.00	0.67
%Lymphocytes	84.00	79.33	82.53	81.67	86.00	82.35
%Monocytes	0.50	0.67	0.67	0.33	0.50	0.67

a-b : Treatment means in rows not sharing common letters differed significantly ($p < 0.05$)

DISCUSSION

The insignificant differences obtained on feed intake and weight gain from groups of cockerels fed the test diets compared with the control diet suggested that treated dietary JSM was reduced in its phytochemicals that usually limit the availability and utilization of nutrients in the fed animals. The superior feed conversion ratio recorded on the control diet relative to the diets containing JSM could be due to the less potential of the treatment methods used to totally eliminate the JSM toxins which might leave residual adverse effects on feed utilization efficiency. This claim is especially true of the result obtained on diet 2 that recorded the highest mortality (83 %). Findings on performance characteristics in this research agreed with the report of Annongu *et al* (1996) who fed processed feedstuff containing anti-nutritional/toxic factors. Past studies (Makkar & Becker, 1999) reported that due to the presence of the many poisonous chemicals in untreated Jatropha products (leaves, seeds, cake, meal, oil), the use of these products is not suitable in nutrition of man or animals. However, this study has proved that there may be prospects of using the Jatropha products or residues in nutrition of farm animals when properly processed.

The absence of significant differences in metabolites of uric acid and creatinine as well as the other serological indices investigated in this experiment could be attributed to the feasibility of the treatment methods used in eliminating the Jatropha noxious phytochemicals, since Guyton & Hall (2000) noted that the phytochemicals in the virgin Jatropha have

significant physiological impact on the body system which could be harmful or beneficial depending on the dosage ingested.

The similarity in blood composition of the control group cockerels and those receiving processed JSM in diets could be due to the improvement in the nutritional value of the seed meal following treatments. Similar treatment methods other than boiling-roasting-fermenting (BRF)should be tried in further researches with increasing inclusion level of treated seed meal above 5 % as in this study.

CONCLUSION

This study indicated that to some extent, all the treatments of the Jatropha seed meal did had effected the detoxification of Jatropha seed anti-nutrients and allows its utilization in broilers feeding. The JSM boiled, fermented & soaked in equal volumes of hexane and ethanol for 24 h seems to be the best treatment for the detoxification of Jatropha seed anti-nutrients. This method could be used for the feeding of other animal species.

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