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RESPONSE OF *CLARIAS GARIEPINUS* TO DIETARY CASTOR SEEDS PROCESSED BY DIFFERENT METHODS

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ABSTRACT

Castor seed variously treated by boiling, roasting, boiling and roasting, decorticated *lyle* treated, boiling and fermenting was tested for improved nutrient content and elimination of toxins. 10% processed castor seed cake (CSC) was included in diets and fed to 180 catfishes for 4-weeks to assay the dietary castor seed based on performance and some biochemical indices. Processing methods other than boiling improved performance and other measured parameters and some diets containing treated CSC produced results even better than that obtained on the conventional diet ($p < 0.05$). Dietary boiled CSC elicited low feed intake, body weight gain, poor feed efficiency and high mortality of the fed fish relative to the control diet ($p < 0.05$). Similarly, boiled CSC in diet gave poor results on biological values of specific growth rate, net protein utilization, nitrogen metabolism, protein efficiency ratio compared to the control diet or diets containing CSC treated by methods other than boiling ($p < 0.05$). The best result was obtained on the diet containing castor seeds treated by boiling followed by roasting ($p < 0.05$). For optimum utilization of CSC in nutrition of fish, it has to be boiled and roasted.

KEYWORDS Castor seed cake (CSC), *Clarias gariepinus*, performance, biochemical indices.

INTRODUCTION

As the world's population grows, sources of protein for human nutrition become more valuable. High quality protein products are essential in human diet but they are also important components of diets fed to animals, for instance fish meal, meat meal etc. To avoid conflicts between human food requirements and livestock, especially monogastrics, finding viable alternative protein sources to sustain the animal agriculture sector is necessary.

Fish farming is expected to bridge the gap between supply of protein needed among Nigerians and feeding other farm animals since fish cuttings (heads, tails, gills) can be processed into fish meal for livestock feeds. However, the cost of production with regards to feeding represents high cost of fish farming because the conventional feedstuffs, particularly protein supplements are scarce and expensive as well as the problem of competition between man and monogastric animals. It is for these reasons that research on the use of non-conventional materials like castor seed cake and meal wastes are receiving attention to provide alternative feedstuffs for animals.

Castor seeds (*Ricinus communis*) is widely grown in the temperate, tropical and sub=tropical countries. The seeds contain about 50% oil. The meal or cake is obtained as a residue of oil extraction from castor seeds. The cake has high protein content of 39%, crude fibre 18%, 7.5% ash, 3% soluble carbohydrate and 40% ether extract (Devendra, 1988). In spite of the high nutrient content of the cake, its use in feeding animals is limited due to the presence of some toxicants namely ricin (a highly toxic protein), hydrocyanic acid, ricinine (a relatively harmless alkaloid) and an extremely potent allergen which is toxic to both man and animal (Sevkovic and Popovic, 1966). Besides, the cake is deficient in some essential amino acids like methionine, lysine and tryptophan. These deficiencies preclude the use of castor meal or cake as the main source of protein in rations for monogastric animals (Jenkins, 1963). Castor seed cake/meal is regarded as waste and is use as an organic fertilizer in Nigeria. It is against this background that the research in view attempts to detoxify CSC by different treatment methods in order to find the best processing method.

MATERIALS AND METHODS

Collection of materials and processing

Castor seeds were supplied by a commercial farm at Sango in Ilorin city. The seeds were milled and pressed using a hydraulic jack to remove excess oil. Further extraction was achieved by using the chemical n-hexane. The chemical was thoroughly mixed with the castor meal in a ratio of 2:1 before leaving for 4-hrs to extract. The mixture was thereafter decanted and the

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residue poured in a muslin cloth and properly tied. This was placed under a perforated manual screw jack oil extractor. The jack was adjusted frequently to ensure an oil-free cake. The cake was sun-dried for several days and kept for subsequent treatment.

Processing of raw castor seed cake (CSC).

Raw CSC was subjected to five different treatment methods: cooking, roasting, boiling and roasting, decorticated CSC treated with *lyle* and cooking followed by fermentation.

Cooking (humid) treatment: !kg of CSC was taken into a woven sac and immersed in 2-litres of water boiled at 100oC for an hour. Thereafter, the sac was removed and water strained from the cake which was sun-dried for three days to constant weight prior to inclusion in diet mixtures.

Roasting (dry heat) treatment: This process was conducted by frying a kilogram of CSC in a hot pot containing sand. The cake was roasted for 20 minutes and was allowed to cool. After cooling, it was sun-dried properly and stored for diet mixing.

Roasting and boiling: 2kg CSC was roasted for 20 minutes followed by boiling for an hour. The cake was removed after boiling and drained before sun-dying for 3-days prior to use.

***Lyle* treatment:** Plantain peels were collected, sun-dried and burnt to ashes. A given quantity of the ash was soaked in some litres of water for 48 hours to extract *lyle*. The mixture was decanted and strained via a muslin cloth to obtain clear filtrate. The filtrate (lyle) produced had a pH of about 12. Seed coat was removed from the seeds by soaking in water to soften, then the coat removed by manually applying pressure. The decorticated seeds were subjected to oil extraction as described earlier to obtain the cake. The cake was soaked in *lyle* for 24hrs. Thereafter, it was drained and sun-dried to constant weight before incorporation in the experimental diet.

Cooking and fermentation: 10kg CSC was boiled for an hour after which it was packed in a double layered polythene bag and placed in an air-tight container to ferment for 7-days. At the end of the 7th day, the material was removed and water drained from it before sun-drying for three days.

Diet formulation, feeding trial and management

Table 1a: Percentage composition of experimental diets on as fed basis

Diets	T1	T2	T3	T4	T5	T6
Ingredients						
Maize	21.50	17.50	17.50	17.50	17.50	17.50
Soya bean meal	50.00	44.30	44.30	44.30	44.30	44.30
Castor seed cake	0.00	10.00	10.00	10.00	10.00	10.00
Blood meal	18.00	17.70	17.70	17.70	17.70	17.70
Vit-min-premix	2.00	2.00	2.00	2.00	2.00	2.00
DL-methionine	0.75	0.75	0.75	0.75	0.75	0.75
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Vegetable oil	3.25	3.25	3.25	3.25	3.25	3.25
Starch	3.25	3.25	3.25	3.25	3.25	3.35
Lysine	0.75	0.75	0.75	0.75	0.75	0.75
Total	100.00	100.00	100.00	100.00	100.00	100.00

T1, Control diet; T2, Cooked CSC diet; T3, Roasted CSC diet; T4, cooked & roasted CSC diet; T5, Lyle treated decorticated CSC diet; T6, Boiled & fermented CSC diet.

Table 1 b: Analyzed nutrients composition of the experimental diets (%DM)

Diets	**Dry matter**	**Total ash**	**Crude protein**	**Nitrogen free extract**	**Crude fat**	**Crude fiber**
1	93.60	9.00	41.10	34.40	3.90	5.20
2	93.69	9.45	42.10	29.29	7.25	4.60
3	92.40	9.87	40.13	29.20	8.85	4.75
4	94.06	8.75	41.41	33.20	6.20	4.50
5	93.80	11.05	41.50	33.65	4.20	3.40
6	94.35	9.93	40.20	34.07	5.45	4.70

Six iso-nitrogenous diets were formulated as shown in Table 1 containing approximately 40% crude protein (NRC, 1993). The control diet (1) was a corn-soy based reference diet, while diets 2, 3, 4, 5 and 6 had 10% inclusion of cooked, roasted, cooked/roasted, *lyle*-treated and cooked/fermented CSC respectively. A complete randomized design was used for the experiment and there were six dietary treatments made of three replicates each. 180 *Clarias gariepinus* were randomly distributed in 18 large plastic bowls filled with ¾ clean water from the well. Nets were used to cover the tops of the bowls to prevent insects from entering and the fishes from jumping out of the bowls. The bowls were placed on tables according to the design used. The fishes were fed 4% of their body weight at feeding frequencies of 8 am and 4 pm daily. The quantity of feed offered to the fish was increased as the weight of the fish increased.

Other protocols observed include change of water every 48hrs to remove the ort, dirt and also monitoring of the water quality parameters whereby the physico-chemical indices were measured using Hannah's complete water analysis kit. Temperature of the water in the bowls was measured twice daily with a

Hannah thermometer while pH was measured once a day with a coning pH meter.

In the course of the experiment, data was collected on feed consumption, body weight gain and feed conversion ratio was calculated. Mortality was checked on daily basis. The biological data investigated were specific growth rate (SGR), net protein utilization (NPU), protein efficiency ratio (PER), nitrogen metabolism (NM), and percent survival rate (SR). The bio-data were determined using formulae based on certain relationships as follows:

$$SGR = \frac{\text{Ln } W2 - \text{Ln} W1}{T2 - T1} \times 100$$

W2 = weight at time T2 day, W1 = weight at time T1 day.

NPU is expressed as apparent NPU (ANPU) and computed as:

$$\text{*ANPU} = \frac{\text{Carcass protein (g)} \times 100}{\text{Protein fed (g)}}$$

$$PER = \frac{\text{Body weight gain of fish (g)}}{\text{Crude protein fed (g)}}$$

$$Nm = \frac{0.549\,(b-a)h}{2}$$

0.549 is the factor used for daily endogenous nitrogen losses in ruminants. However, this value is much as twice that obtained in monogastric animals such as *Clarias gariepinus* hence the denominator 2.

b = Final body weight of fish (g)
a = Initial body weight of fish (g)
h = The number of experimental days.

$$\% SR = \frac{\text{Initial number of fish stocked} - \text{Mortality} \times 100}{\text{Initial number of fish stocked}}$$

*ANPU, apparent net protein utilization

Chemical Analysis

The proximate analysis of the variously treated castor seed cake, the cooked, roasted, roasted/cooked, *lyle* treated and the cooked/fermented and the experimental diets were carried out according to the standard methods outlined by A. O. A. C. (1990)

Statistical analysis

Data was analyzed by analysis of variance using the model for a complete randomized design (Steel and Torrie,1980). Significant differences between treatment means were further determined by Duncan multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Results

The proximate composition of CSC processed by different methods is presented in Table 2. Treatments increased the nutrients content of CSC especially the protein, mineral matter and crude fat contents while organic matter (DM) and crude fiber contents were not different from the raw CSC.

Table 2: Proximate composition of raw and processed CSC (%DM).

Treatments	DM	Total ash	Crude protein	Nitrogen free extract	Crude fat	Crude fiber
1 Raw CSC	96.98	7.14	35.43	24.88	25.10	4.43
2 Boiled CSC	93.51	6.16	42.00	13.50	28.45	2.40
3 Roasted CSC	92.80	4.40	36.31	13.24	35.50	3.35
4 Boiled/roasted csc	93.65	6.75	37.41	21.09	24.20	4.20
5 *Lyle* treated csc	94.70	9.39	36.86	20.43	23.97	4.05
6 Boiled/fermented csc	94.25	10.00	37.14	16.86	23.30	5.40

The performance of *Clarias* fed dietary treated CSC is presented in table 3. Feed consumption on CSC processed by roasting, roasted and boiled, *lyle* treated and, boiled/fermented was similar or even better than the feed intake on the conventional corn-soy diet ($p < 0.05$). On the other hand, CSC treated by boiling reduced feed intake relative to the control diet or the diets treated by methods other than boiling ($p < 0.05$). Body weight gain followed a trend similar to the feed intake. The least weight gained was recorded on the diet containing boiled CSC as compared with the reference diet or the other diets with CSC treated by roasting, *lyle* treated and boiled/fermented (p <0.0%). Mortality rate was highest on the diet with boiled CSC, that is diet 2 with 60% death record ($p < 0.05$). While mortality, when occurred on diets other than diet 2 with boiled castor seeds, was not connected with dietary effect of CSC.

Feed conversion ratio was best by the fishes receiving the diet with CSC treated by roasting ($p < 0.05$) and the conversion of feed containing CSC treated by methods other than boiling was also improved relative to the reference diet ($p < 0.05$).

Table 3: Performance of fish fed dietary CSC processed by different methods

	DIETS						
Performance parameters	1	2	3	4	5	6	SEM
Mean feed intake (g/f/d)	3.38^{b}	1.21^{a}	3.33^{b}	4.70^{d}	4.80^{d}	4.00^{c}	0.02
Mean body wt. gain (g/f/d)	18.56^{c}	7.33^{a}	37.67^{e}	14.99^{b}	22.43^{d}	17.65^{c}	3.56
Feed conversion ratio (F/G)	0.18^{b}	0.16^{b}	0.08^{a}	0.31d	0.21^{c}	0.22^{c}	0.14
% SR	93.33	40.00	83.24	93.33	93.33	73.34	3.3

a-b-c-d-e treatment means in the same row not sharing common superscripts are significantly different ($p < 0.05$).

Table 4 shows some biological indices of fish given CSC based diets treated by different methods. Specific growth rate (SGR), protein efficiency ration (PER), nitrogen metabolism (NM) and net protein utilization (NPU) of the fishes offered diet 2 with boiled CSC was very low compared with the control diet or the other diets containing CSC treated by methods other than boiling ($p < 0.05$). CSC processed by methods other than boiling produced data on these parameters that were as high as or even higher than those recorded on the control diet ($p < 0.05$).

Table 4: Some biological indices of fish offered dietary CSC treated by the different methods

	DIETS						
Bio-indices	1	2	3	4	5	6	SEM
SGR	6.04^{b}	4.12^{a}	7.51^{d}	5.59^{b}	6.43^{c}	5.93^{b}	0.08
PER	$15,72^{d}$	7.97^{a}	28.28^{e}	13.38^{c}	11.71^{b}	11.12^{b}	0.09
NM	107.01^{d}	42.27^{a}	217.16^{f}	86.43^{b}	129.28^{e}	101.76^{c}	4.84
NPU	21.29^{d}	15.30^{a}	22.34^{e}	16.43^{b}	61.60^{f}	18.02^{c}	3.35

a-b-c-d-e-f treatment means n the same row not sharing common letters differed significantly ($p < 0.05$).

Table 5: Data on average water and temperature quality used for the fish in the course of the experiment

Replicates	pH	Temperature (^{o}C)
1A	7.0	26.0
B	7.4	26.0
C	7.4	26.5
2 A	7.0	26.5
B	7.3	26.5
C	7.2	27.0
3 A	7.1	28.5
B	7.2	26.5
C	7.3	26.5
4 A	7.25	26.5
B	7.1	26.5
C	6.5	26.0
5 A	7.1	27.0
B	7.3	26.5
C	7.1	26.5
6 A	6.8	26.0
B	7.1	26.5
C	6.9	26.5

DISCUSSION

Proximate analysis of raw and processed CSC showed that treatments increased the contents of some nutrients such as protein, ether extract, mineral matter while dry matter, soluble carbohydrates, crude fibre remained unchanged. The increment in nutrients value of CSC following treatments is of nutritional advantage to the fed fish or other animals.

Performance of fish maintained on CSC processed by different methods showed that treating CSC improved the performance of the fish. In particular, treatment by roasting or its combination with boiling, *lyle* treatment, boiling coupled with fermentation led to great improvement in performance, feed intake, body weight gain, feed conversion ratio and rate of survival. However, boiled CSC failed to support performance compared to the other methods of treatment or the conventional diet since the diet containing boiled CSC recorded low feed consumption, weight gain and poor feed efficiency in addition to the highest mortality (60%) recorded on this diet. Inferior biological and performance characteristics observed on the diet containing boiled CSC might be brought about by the effect of residual or resistant CSC anti-nutrients namely ricin, ricinine, hydrocyanides, allergins and lectins which could not be eliminated by the boiling treatment. Past works (Huet, 1972; Boyd, 1982; Annongu, 1997) reported similar findings when animal models were fed in experiments.

Bio-data results indicated that SGR, PER, NM and NPU were improved on diets containing CSC treated by methods other than boiling. Previous works (Boyd, 1982) obtained related results while experimenting on catfish.

In conclusion, castor seed, if to be used as an alternative feedstuff for animals, has to be processed to remove or eliminate the toxic factors, ricin, ricinine, allergens, hydrocyanides before good results can be obtained. The best performance is observed when the seed is roasted and boiled and included at 10% level in diet for fish.

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