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Potential use of tropical wild plant *Cissus populnea* meal as alternative to soybean meal in the diet *Clarias gariepinus* (African catfish) juvenile

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Abstract: The availability of conventional ingredients for fish feed is limited by increasing demand for human consumption and by other animal feed industries. Wild plants can offer a convenient but cheaper source of nutrients required in tropical fish diet. In this study, we evaluate the growth performance of *Clarias gariepinus* (African catfish) juvenile fed practical diet of *Cissus populnea* root meal (CpRM) as a partial and total protein replacement for soybean meal to achieve a least cost production ration. Three dietary treatments feed were formulated such that diet 1 serves as control diet (0% CpRM), while diets 2 and 3 were formulated from the meal with *Cissus populnea* root substituting soybean meal at 50% and total replacement at 100% respectively and fed to *C. gariepinus* of average weight of 7±2g for 10 weeks in adapted aquaria. The feeding trials revealed that *Clarias gariepinus* responded to all the diets, Mean weight gain decreased as inclusion level increased thus the diet with highest inclusion of CpRM (100%) gave the poorest performance in all the value that is lower than the other diets though not significantly different. The best mean weight gain, SGR, FCR, PER, and PER value were 318.5, 0.72% /day, 1.62, 1.55, 2.94g were obtained in the control diet and this was not significantly different ($p>0.05$) from the value recorded for diets 2 and 3. The total amount spent on feed formulation of diets 1, 2 and 3 are ₦872.26 (), ₦772.37 and ₦692.68 while economic conversion ratio were ₦1413.06, ₦1390.27 and ₦1946.43 respectively at exchange rate of ₦155.60 to $1. Though soybean meal as a protein source was superior in converting the feed than *Cissus populnea* root meal, however, inclusion of CpRM in the diet at 50% dietary level produced similar results and the fish grew relatively well with least economic conversion rate. This has economic significance considering that soybean has become expensive, being competed for as food by man and livestock in many developing countries including Nigeria.

Key words: *Cissus populnea,* dietary, least cost, replacement, utilization, wild plant

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1. Introduction

Nigerian feed resources is declining in recent years, because of the stagnant or diminishing output of certain traditional crops such as soybean, maize, sorghum groundnut. Recent statistics demonstrate that the country increasingly relies on imports to meet the needs of an expanding livestock and aquaculture industry (FAO, 2008). This has culminated in the increase in prices of food and feed resources in the country. This high cost constitute 40-60% of the recurrent cost of most intensive fish farm venture which negates the economic viability of the farm when cheaper alternatives are not available (Madu *et al.*, 2003).

Soybean meal is a prominent ingredient used in prepared diets, often constituting 50 to 60% of the total formulation for the aquacultural production of numerous fish species. As a group, various freshwater fish species that exhibit omnivorous feeding behavior historically have been fed prepared diets containing relatively high levels of soybean meal (up to 60% by weight). This group of fish constitutes the largest sector of world aquaculture production by tonnage (Anonymous, 2002), and are a major user of soybean products. Despite increase in global soybean production from 15 million metric tonnes in 1961 to about 261 million metric tonnes in 2010 (FAO, 2012), soybean is still in short supply due to increase in demand and high costs. Hence, there is growing demand to substitute soybean with less expensive protein-rich plant (Fagbenro *et al.*, 2010; El-Sayyed, 1999) and in this respect, wild plant could be an alternative especially in animal and fish diets.

Edible wild plant species are consumed frequently in Nigeria especially in rural communities where varieties of such plants abound. Some of these are cultivated while others grow in the wild (Nadro and

Umaru, 2004). Wild plant offer a convenient but cheap means of providing adequate supplies of carbohydrate, fat, mineral and protein required in tropical animal diet (Eromosele *et al.*, 1991). *Cissus populnea* is one of these plants.

The demand, increasing cost and uncertain availability of soybean has made research interest to be focused on alternative protein sources ingredients in fish feed. However, exploration and utilization of root and tubers could probably ameliorate the stiff competition with cereals and grains (Agbede *et al.*, 2002). Furthermore to meet up with annual increase of fish production, research should be targeted towards the use of alternative or unconventional feed ingredients such as root and tubers which could probably improve the feed water stability and nutrient retention, increase efficiency of digestibility and reduce cost of fish feed production (Falayi, *et al.*, 2003; Falayi, *et al.*, 2004). Amongst these plant species is *Cissus populnea* root because of its better quality and fairly consistent nutrient content (Alaye *et al.*, 2012). Here we investigate the use of *Cissus populnea* root as an alternative to soybean in the diets of *Clarias gariepinus* for cheaper alternative protein source.

2. Material and method

2.1 *Cissus populnea* root (CPR), soybean collection, processing and analysis

Cissus populnea root (CpR) were collected from Federal College of Wildlife Management Estate, Nigeria. The roots were clean, dry and hammer mill to pass through 1mm sieve while soybean was purchased from the local market, roasted and dehulled. The resulting meals were then analyzed for proximate composition using standard methods (AOAC, 1990).

2.2 Experimental diets

Three dietary treatments of feed were formulated such that diet 1 serves as control diet without *Cissus populnea* root meal (0% CPRM), while diets 2 and 3 were formulated from the meal with *Cissus populnea* root substituting soybean meal at 50% and total replacement at 100% respectively.

2.3 Management of experimental fish, water supply and feeding

Sixty-three (63) juvenile of *Clarias gariepinus* with an average weight of 7±2g each with no history of any disease outbreak were used for the experiment. The fish were procured from Kofo Farm New in Bussa, Nigeria. The fishes were allowed to acclimatize for a period of 14 days and starved for 24 hours before the commencement of the experiment. Fishes were allocated randomly into three (3) dietary treatments 21 fishes each with three (3) replicates of 7 fish per replicate in a 30 liter plastic aquarium filled with 15 liter of water. The positioning of the tanks allowed a natural photoperiod of 12 hours of sunlight and 12 hours of darkness throughout the experiment. The water was changed fortnightly to prevent foul smell resulting from food residues. Water was sourced from Borehole Water Station of Federal College of Wildlife Management, New Bussa, Nigeria. Fish diets were initial 5% of fish biomass daily, divided into 3% and 2% which were administered in the morning and evening respectively for 70 days. Fishes were bulk weighed with sensitive scale subsequently every 5 days until the end of experiment.

Table 1: Gross composition of experimental diets

INGREDIENTS	DIET 1 (CONTROL)	DIET 2 (50% CPRM)	DIET 2 (100% CPRM)
Fish meal	22.63	21.16	21.17
Soybean meal	45.27	21.16	--
Cissus populnea root meal	--	21.16	42.33
Maize	28.30	32.73	32.70
Bone meal	2.50	2.50	2.50
*Fish premix	0.50	0.50	0.50
Vitamin C	0.10	0.10	0.10
Salt	0.25	0.25	0.25
Vegetable Oil	0.45	0.45	0.45
TOTAL	**100**	**100**	**100**
%CRUDE PROTEIN	**40**	**35**	**32.5**

*Fish premix composition: Vitamins, Minerals, Amino acid antioxidant.

2.4 Data Collection

The feed consumed and average weight gains were recorded after every 5 days and later used to calculate the growth, feed utilization and economic parameters.

Mean Weight Gain (g) = Mean Final Weight – Mean Initial Weight

Specific Growth Rate (SGR %/day) = (LogW2 - LogW1/T) x100,

Where W2 and W1 = final and initial weight; T = Culture period (in days) respectively.

Feed Conversion Ratio (FCR) = Total feed fed (Dm) /Total fish weight gain

Protein Efficiency Ratio (PER) = Mean weight gain per protein fed

Protein Intake (PI) = Feed intake x crude protein of feed.

2.5 Economic estimates

Based on the price of each raw material (in Nigeria naira (₦)) and the amounts that were required to make the different diets, Feed was calculated on cost/kg per diet. The raw material prices used were average prices during the experimental period, due to the significant changes in price feed ingredient throughout the year. The economic conversion ratio (ECR) was then determined using: (Piedecausa *et al.*, 2007).

ECR = Cost of diet x Feed conversion ratio

2.6 Statistical analysis

Growth and feed utilization data were subjected to analysis of variance (ANOVA) and significant means were separated using Duncan multiple range test (Duncan, 1955).

Table 2: Proximate analysis of *Cissus populnea* root and Soybean seed.

Nutrients	*Cissus populnea* root meal (%)	Soybean meal (%)
Moisture content	6.50	19.91
Ash content	5.37	6.89
Crude fiber	3.30	5.89
Crude protein	32.45	46.22
Crude fat	1.45	3.01
Carbohydrate	50.93	21.09

3. Results and discussion

3.1 The proximate composition of *Cissus populnea* root meal and soybean meal

The proximate composition of crude protein level in the *Cissus populnea* root (32.45%) was lower than soybean (46.22%) but higher than *Canavalia ensiformis* (Jack bean; 28.25%) which was used successful to replaced soybean in the diet of hybrid catfish for 56 days without any deleterious effects on the fishes (Osuigwe *et al.*, 2005).

The ash content of *Cissus populnea* (5.34%) which indicated the presence of mineral elements was close to that of soybean seed (6.89%) and even closer to that of Sunflower meal (5.89) which was reported to be iso-nitrogenous to soybean (Fagbenro *et al.*, 2010). The fat (1.45%), fiber (3.30%), moisture (6.50%) and carbohydrate (50.93%) contents were also evaluated for *Cissus populnea* while (46.22%, 3.01%, 5.89%, 6.89%, 19.91% and 21.09%) were recorded for soybean respectively.

Table 3: Growth performance and nutrients utilization of *Clarias gariepinus* fed varying level of *Cissus populnea* meal as replacement for soybean meal.

Parameters	T_1(Control)	T_2 (50% CpRM)	T_3 (100% CpRM)
Initial weight (g)	147a	147 a	147 a
Mean final weight(g)	465.5 a	430.5 a	330 a
Mean Weight gain (g)	318.5 a	283.5 a	183 a
% SGR / day	0.72 a	0.67 a	0.50 a
FCR	1.62 a	1.8 a	2.81 a
PER	1.55 a	1.57 a	1.09 a
P.I	2.94 a	2.57 a	2.39 a

*Mean values in a row followed by similar superscripts are not significantly different (P>0.05)
**CpRM is *Cissus populnea* Root Meal
SGR = Specific Growth Rate
FCR = Feed Conversion Ratio
PER = Protein Efficiency Ratio
P.I = Protein intake\

Table 4: Economic analysis of *Clarias gariepinus* fed varying level of *Cissus populnea* meal as replacement for soybean meal

INGREDIENTS	DIET 1 (CONTROL)	DIET 2 (50% CPRM)	DIET 2 (100% CPRM)
Fish meal	22.63	21.16	21.17
Fish meal	1,131.50	1,058	1059
Soybean meal	905.40	432.20	--
Cissus populnea root meal	--	--	--
Maize	170	196.38	196.2
Bone meal	25	25	25
Fish premix	50	50	50
Vitamin C.	10	10	10
Salt	15	15	15
Vegetable Oil	90	90	90
Total amount for 10kg	2,397	1,867.58	1,445.20
Quantity of feed used	530g	530g	530g
Amount of feed used	452.26	352.37	272.68
Cost of Juvenile@₦20	420	420	420
Total amount spent	872.26	772.37	692.68
FCR	1.62	1.80	2.81
ECR	1413.06	1390.27	1946.43

*****Exchange rate was ₦155.60k = $1

3.2 Growth performance and nutrients utilization of *Clarias gariepinus* fed varying level of *Cissus populnea*.

The effect of dietary level on the growth performance of juvenile catfish was shown in Table 3. The initial weight was 7±2g for all the experimental fish. There was no significant different in all the parameters measured (Weight gain, SGR, FCR, PER, and PER) from the Juvenile fed with varied inclusion level of *Cissus populnea* root meal (CpRM) and the control diets. The feeding trials revealed that *Clarias gariepinus* responded to all the diets, Mean weight gain was decreased with inclusion of CpRM, thus the diet with 100% CpRM gave the poorest performance in all the measured parameters though not significantly different. The best of mean weight gain, SGR, FCR, PER, and PER value 318.5, 0.72% /day, 1.62, 1.55, 2.94g were obtained in the control diet and this was not significantly different ($p>0.05$) from the value recorded for diets 2 and 3.

3.3 Economic analysis of *Clarias gariepinus* fed varying level of *Cissus populnea* meal as replacement for soybean meal.

Based on the price of each raw material (in Nigeria Naira = ₦), the cost/kg of each diet were calculated. The raw material prices used were average prices during the experimental period, due to the fact that there may be significant changes throughout the year.

The highest feed cost of ₦452.26 ($2.91) was recorded for the control diet and as observed cost of feed decreases with inclusion of *Cissus populnea* root meal. The juvenile catfish were purchased at the cost of ₦20 ($0.13) each. 21 fish were used per treatment bringing the cost of fish to ₦420 ($2.70) per treatment. The total amount spent on feed formulation of diets 1, 2 and 3 are ₦872.26 ($5.61), ₦772.37 ($4.96) and ₦692.68 ($4.45) while economic conversion ratio were ₦1413.06 ($9.08), ₦1390.27 ($8.94) and ₦1946.43 ($12.51) respectively.

Economic analysis revealed that economic conversion ratio was lowest on 50% *Cissus populnea* root meal diet and highest on the 100% *Cissus populnea* root meal diet.

4. Conclusion

The nutritional quality of *Cissus populnea* root meal as determined by growth and economic indices was observed in this study. This is evident as there was improved weight gain in all the experimental fish and no mortality was recorded during the feeding trial. Though there was superior growth and nutrient utilization with fish fed with soybean meal than *Cissus populnea* root meal, however, soybean meal is relatively expensive especially in many developing countries including Nigeria. Our study may suggest that soybean meal in diets formulated for *C. gariepinus* may be replaced with *Cissus populnea* root meal (up to 50%).

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Competing Interests

There are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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