Growth Performance and Body Composition of *Clarias gariepinus* Fingerlings Fed Varying Inclusion Level of *Canarium schweinfurtii* (African *Elemi*) Oil

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Abstract**—**Three hundred Clarias gariepinus fingerlings with mean weight of 1.01±0.00g were fed at five different inclusion level diets for fifty six (56) days in 15 circular plastic tanks measuring 60 cm x 30 cm x 30 cm. The experiment was conducted to utilize Canarium schweinfurtii oil as replacement for vegetable oil. At the end of the experiment, the result showed significant differences (P<0.05) in the growth parameters among the diets fed. Diet 2 containing 4% Canarium oil exhibited best FCR, SGR, PER, and digestibility values. This indicated that, Canarium oil can be utilized by Clarias gariepinus in its diets and it is therefore recommended as a substitute for vegetable oil in the diet of Clarias gariepinus fingerlings.

Keywords**—**Canarium oil, Clarias gariepinus Fingerlings Inclusion level, Growth performance.

I. Introduction

THERE is no doubt that nutrition research scientists have carried out several researches on fish nutrition and commonly concluded that high quality and quantity of protein in diets are essential for optimal production of fish especially in intensive aquaculture system where fish depend solely on artificial feed. Globally, consumer demand for fish continues to rise, developing nations import about 33 million tonnes of fish worth over US$61 billion yearly and about 77 percent of fish consumed globally as food is supplied by developed countries [1].

Success in aquaculture depends on the ability of the farmer to cost effectively meet the nutritional demands of the cultured fish species. This is because feed type as well as feed quality may have consequences on both growth efficiency and feed utilization [2]. The knowledge of fish nutrition equips the farmer with the technical knowhow of making nutritionally balanced feed from available raw materials. In view of producing nutritionally balanced commercial diets that will permit optimal growth and health, research into fish nutrition has increased dramatically in recent years [3]. Many developing nations depend on imported feeds which are very expensive, while local feeds made from some conventional ingredients are also expensive because of the demand for conventional feed ingredients by other sector and human consumption [4].

The fact that fish feed account for at least 50 – 60% of the total cost of production [5]. [6] has motivated the research for cheap and locally available or improvised feed ingredients that are unsuitable for direct human consumption but can serve as alternative energy feed for fish with the aim of reducing the cost of production without compromising feed quality. *Clarias gariepinus* is a catfish species and belong to the family *Clariidae*, the air breathing catfish [7]. The fish was introduced all over the world in the early 1980s for aquaculture purposes and is therefore found in countries far outside its natural habitat like Brazil, Vietnam, Indonesia, and India. *Clarias gariepinus* has an average adult length of 1-1.5 meters reaching a maximum length of 170 cm (67.0 inches) [7]. These fishes have slender bodies, a flat bony head, notably flatter than in the genus Siluris, and a broad, terminal mouth with four pairs of barbels. They also have a large, accessory breathing organ composed of modified gill arches. Also, only the pectoral fins have spines. They can weigh up to 29 kg [7]. It grows fast and feeds on a large variety of agriculture by-products. It is hardy and can tolerate adverse water quality conditions. It can be raised in high densities resulting in high net yields (6–16 t/ha/year). In most countries it fetches a higher price than tilapia as it can be sold live at the market. It has fast growth rate and easily reproduce in captivity [7].

Fishes are known to digest and metabolize fat more efficiently as an energy source than some carbohydrates. Since fat has a sparing effect on protein, it is very useful in the feeds for fry and fingerlings where protein needs for growth are very high. Fats are immediate source of energy for fish and most studies have shown that fish can utilize 20-30% of the dry diet ingredients as fats provide adequate amount of chlorine, methionine and tocopherol present in the ration to prevent fatty acid, oxidation, chain rapture and subsequent toxic reactions in the liver and spleen [8]. *Canarium schweinfurtii* oil is an agricultural product whose utilization in fish diet has not been extensively researched into. Thus, this study was aim at determining the utilization of *Canarium*

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schweinfurtii oil in the diet of *Clarias gariepinus* for a sustainable aquaculture production. C. *schweinfurtii* is an important economic plant that originates from Africa. In some communities the flesh of the fruit is eaten after subjected to warm water for about 15-20 minutes while in other places the oil is extracted for domestic use.

Lipids (fats and oils) are easily digested source of concentrated energy, having more than twice as much energy as an equal amount of carbohydrates. They play several important roles in an animal's metabolism, including supplying essential fatty acids (EFA), helping absorb fat-soluble vitamins, and other important functions. Also, including lipids in the diet may increase food intake. Lipids stored in body tissues affect the flavor of the flesh. The type and amount of lipid in catfish diets is based on EFA requirements, economics, constraints of feed manufacture, and quality of fish flesh desired [9]. Lipid levels in commercial feeds for food-sized catfish rarely exceed 5 to 6 percent.

II. Materials and Method

Experimental Procedure

The experiment was carried out at Toxicology unit of Water Resources, Aquaculture and Fisheries Technology (WAFT) Fish farm, Bosso campus, Federal University of Technology (FUT), Minna for 56 days. Laboratory analysis was done at WAFT Laboratory Gidan-kwano Campus, FUT. Minna. *Clarias gariepinus* fingerlings with an average weight 1.01g were transported from.private fish farm Ilorin and acclimatized for two weeks. The feed ingredients used include maize meal, fish meal, vegetable oil, vitamin mineral premix as well as *Canarium schweinfurtii* oil. The feed ingredients were milled separately and feedstuffs were then analyzed for their crude protein, lipid, crude fibre, ash and moisture content. Person's square method of feed formulation was used to formulate five diets with crude protein level of 50% for each diet. The feedstuffs were mixed thoroughly with a little quantity of water to form consistent dough for each diet. The dough was then pelleted and sun dried. The proximate composition of the diet (D1-D5) was carried out. Fish were randomly selected and 20 each stocked in 15 plastic bowl tanks measuring 30 x 60 x 20cm width, length and depth respectively filled with 25 litres clean water. The fish were fed with the test diets at 3%, 5%, 7%, and 9% body weight progressively. The amounts of feed were calculated and readjust every 14 days (bi-weekly) according to change in the body weight. Water was exchanged on daily basis and faecal matter siphoned in the morning and uneaten feed 30 minutes post feeding. The water quality parameters monitored regularly include temperature, dissolved oxygen, pH and conductivity.

Experimental diets

Five diets were prepared, this include Diet 1 with (0% *Canarium schweinfurtii* oil and 4% vegetable oil) which serve as control. Diet 2, 3, 4 and 5 had 4%, 8%, 12% and 16% *Canarium schweinfurtii* oil inclusion levels respectively with 0% vegetable oil.

TABLE I
FORMULATED DIETS (D1-D5) AND PROXIMATE PROXIMATE COMPOSITION

FEED STUFF	D1	D2	D3	D4	D5
Fishmeal	68.13	68.13	65,23	62.33	59.43
Maize meal	25.87	25.87	24.77	23.67	22.57
Canarium oil	0.00	4.00	8.00	12.00	16.00
Vegetable oil	4.00	0.00	0.00	0.00	0.00
Vitamin-Mineral Premix	2.00	2.00	2.00	2.00	2.00
	100.00	100.00	100.00	100.00	100.00
Proximate compositions (%)					
Crude protein	49.00	47.25	50.75	49.00	47.25
Crude lipid	6.50	23.90	15.30	15.20	11.60
Crude fibre	3.10	12.56	9.65	8.77	7.98
Ash	9.43	22.93	11.88	9.95	12.55
Moisture	10.12	14.69	9.20	14.67	14.15

intake (g)= Feed intake x crude protein of feed**.**

The Proximate Chemical Analysis

This includes analysis for crude protein, lipid, crude fibre, ash and moisture content. This was carried out according to methods described [11].

Crude protein =<u>TV x MA x nf x df x % xpcf</u>

Weight of Samples

Where, TV = Titration Value; MA = Molarities of Acid (0.05M); nf = Nitrogen Factor (0.014), df = Dilution Factor (10); pcf = Protein Conversion Factor (6.25).

Percentage Lipid = <u>Weight of Extracted lipid</u> x 100

Weight of Samples Percentage Crude Fibre
=<u>Total weight of fibre</u> x 100
Weight of Samples

Percentage Ash =<u>Total weight of extracted ash</u> x 100
Weight of Samples

Percentage Moisture Content
=<u>Weight loss</u> x 100
Weight of sample

Nitrogen Free Extract (NFE): The Nitrogen free extract was estimated by difference.

%NFE = 100 % (Ash + Crude Fibers + Fat Content + Protein).

Apparent Net Protein Utilization (NPU)

This expressed and calculated as apparent net protein utilization (ANPU);

%ANPU =
<u>Carcass Protein gain (g)</u> x 100
Protein fed

Apparent Digestibility Coefficient (ADC)

%ADC = 100 – <u>(100 x %AIA of diets x %Nutrient in Faecal)</u>
%AIA of faecal x %Nutrient in diet

AIA = Acid Insoluble Ash

III. Statistical Analysis

The experimental design was one-way Anova and data generated were analysed using statistical package Minitab Release 14 and at 5% significant level. Mean were separated using Duncan Multiple range test.

IV. Results

The result in Table 3 showed significant difference (P<0.05) in the growth parameters among the diets fed Clarias gariepinus fingerling. Diets 2 and 5 with 4% and 16% Canarium oil respectively recorded highest mean weight gain (MWG) of 1.31g and 1.18g which differed significantly (P<0.05) between the two diets. However, diets 1, 3 and 4 gave a low mean weight gain (g) of value (1.14, 1.13 and 1.11 respectively) which does not differed (P>0.05) significantly.

The feed conversion ratio (FCR) of diets 1 (1.13), 2(1.14) and 5 (1.12) were significantly different (p<0.05) from each other. The specific growth rate (SGR) of diets 1, 3, 4 and 5 showed no significant difference (p>0.05) among each other. Diets 3 (0.90) and 4 (0.93) differed significantly (p<0.05) from each other. Diet 4 had the highest mortality which differed significantly (p<0.05) from others. Table 4 shows the body composition of the initial and final carcass. The crude protein, fibre and ash in diet 2 differed significantly (p<0.05) from other diets while lipid and moisture content in diets 1 and 3 also differed significantly (P<0.05) from other diets. Table 5 shows the apparent digestibility coefficient (ADC) of the nutrients fed to the fish. Diets 1 and 4 differed significantly (P<0.05) from others in of crude protein while in lipid diets 2 and 3 differed significantly (P<0.05) from others. Crude fibre and ash content differed significantly (P<0.05) from others and dry matter in diets 3 and 4 differed significantly (P<0.05) from other diets. The growth response curve in Figure 1 shows the growth pattern of the diets, which indicated good utilization of Canarium oil at the inclusion levels with diets 2 exhibiting the best growth response.

TABLE II
GROWTH RESPONSE OF CLARIAS GARIEPINUS FINGERLINGS FED CANARIUM SCHWEINFURTII OIL FOR 56 DAYS

Growth Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SD±
Mean Initial Weight {MIW (g)}	1.01±0.00	1.01±0.00	1.01±0.00	1.01±0.00	1.01±0.00	0.00
Mean final Weight Gain {MFWG (g)}	2.15±0.15	2.32±0.41	2.14b±0.23	2.12±0.43	2.19±0.17	0.23
Mean Weight Gain {MWG (g)}	1.14b±0.15	1.31a±0.41	1.13b±0.23	1.11±0.04	1.18±0.17	0.23
Feed Conversion Ratio(FCR)	1.13±0.01	1.14a±0.01	1.09±0.01	1.09±0.01	1.12±0.01	0.01
Specific Growth Rate SGR (%/day)}	1.34±0.01	1.47a±0.01	1.34±0.01	1.32b±0.01	1.38±0.01	0.01
Protein Efficiency Ratio(PER)	0.88c±0.01	0.88±0.01	0.90±0.01	0.93a±0.01	0.90±0.01	0.01
%Mortality	5.00±0.01	5.00±0.01	8.33±0.01	10.00±0.01	6.67±0.01	0.45

Mean data on the same row carrying different superscripts differ significantly from each other (p<0.05)

TABLE III
BODY COMPOSITION OF CLARIAS GARIEPINUS FINGERLINGS FED GRADED LEVELS OF CANARIUM SCHWEINFURTII OIL FOR 56 DAYS

Body compositions	Initial	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SD±
Crude Protein (CP)	57.87±0.01	59.80±0.01	61.42±0.01	60.33±0.01	59.93±0.01	60.50±0.01	0.01
Lipid	21.34±0.01	27.84±0.01	22.38±0.01	24.44±0.01	24.23±0.01	22.88±0.01	0.01
Crude Fibre (CF	5.66±0.01	7.46±0.01	8.67±0.01	7.66±0.01	7.87±0.01	7.97±0.01	0.01
Ash	9.61±0.01	9.89±0.01	12.43±0.01	11.25±0.01	11.37±0.01	12.40±0.01	0.21
Moisture Content (MC)	96.29±0.01	97.17±0.01	96.71±0.01	97.36±0.01	95.80±0.01	96.58±0.01	0.01

Means row values carrying same superscripts are not significantly different (P>0.05)

TABLE IV
% APPARENT DIGESTIBILITY COEFFICIENT (%ADC)

Parameters	D1 0% CO	D2 4% CO	D3 8% CO	D4 12% CO	D5 16% CO	SD
% Crude protein	94.79±0.01	75.41±0.01	84.50±0.01	96.69±0.01	59.58±0.01	0.01
% Lipid	58.73±0.01	24.97±0.01	64.25±0.01	23.17±0.01	15.74±0.01	0.01
% Fibre	59.93±0.01	24.97±0.01	48.81±0.01	34.72±0.01	5.94±0.01	0.01
% Ash	35.82±0.01	4.17±0.01	4.36±0.01	5.58±0.01	19.63±0.01	0.03
% Dry Matter	24.97±0.01	86.45±0.01	94.59±0.01	90.38±0.01	87.43±0.01	0.01

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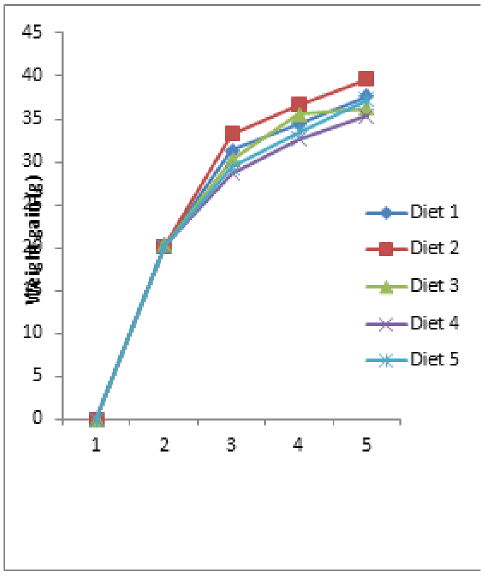

Fig. 1. Growth response of *Clarias gariepinus* fingerlings fed *Canarium schweiifurti* oil for 56 days.

V. Discussion

From the results, there was a better growth performance of *Clarias gariepinus* fingerlings fed *Canarium* oil at inclusion level of 4% compared with other diets. This concurred the findings of [12] that dietary lipid played essential role in the growth and development of fish. Diet 2 exhibited the highest weight gain, lowest FCR, highest SGR and best PER, this agrees with the work of [13] on the utilization of potato peel as dietary carbohydrate (energy) source in the diet of *Oreochromis niloticus*. The performance was an indication of positive contribution to growth of the fish as opined by [3], they stated that good nutrition in animal production system is essential to economically produce a healthy, high quality product. The growth curve in the Figure indicates that diet 2 peaked faster than other diets, while diet 4 was the lowest in growth phase. This could be attributed to balance energy sources from *Canarium* oil inclusion levels of 4% each compared with 8% and 12% *Canarium* oil of diet 4.

The growth curves from week 0-2 represent the slow growth phase while week 6-8 represent the marginal growth phase. This is in line with natural growth situation, as growth in fish is exponential [14], [15]. This is normal relationship between growth parameters in a nutritional requirement study [14]. The poor values observed for mean weight gain (MWG), feed conversion ratio (FCR), specific growth rate (SGR) and protein efficiency ratio (PER) in diets 1, 3, and 4 were indication of inefficient utilization of feed. Diet 2 performs best among other diets, this performance effect in the flesh and it's in agreement with the work of [15], [16], they stated that carcass composition should reflect the diet.

The apparent digestibility for crude protein in this study is concurred with the report of [14] [15], they observed that apparent digestibility coefficient for crude protein of fish meal in carp, was 88.9%. This study showed that Clarias gariepinus conveniently digest the fatty acid content of Canarium oil based diet as high as 16%. The general digestibility of the nutrients were optimal however at inclusion level higher than 8% Canarium oil, the digestibility of nutrients dropped this was as a result of the high lipid inclusion level in the diet containing 12% Canarium oil [1].

VI. Conclusion

From the study experiment 4% *Canarium* oil inclusion level in the diet of *Clarias gariepinus* fingerlings was utilized efficiently for its growth. This indicated that, *Canarium* oil could replace vegetable oil up to 4% in the fish feed composition. This level of inclusion is significant in the feed since *Canarium* oil is an agricultural product.

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