COST BENEFITS ANALYSIS OF CATFISH (*Clarias gariepinus*) FED GRADED GRASSHOPPER MEALS (*Zonocerus variegatus*) AS DIETARY INCLUSION

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ABSTRACT
This study was carried out to evaluate the cost benefit using 40% different levels of crude protein of Edible Grasshopper (*Zonocerus variegatus*) fed to African catfish Burchell 1822 (*Clarias gariepinus*) as a substitute to fish meal in order to determine the cost benefit of *Zonocerus variegatus* on the growth of African catfish. Four isocarloric and isonitrogenous diets were formulated to contain 0%, 10%, 20%, and 30% *Zonocerus variegatus* to replace equal weight of fish meal in order to evaluate the response and cost benefit fed to *Clarias gariepinus* at varrying inclusion Levels. All the four treatments diets were fed to catfish (*Clarias gariepinus*) fingerlins in replicate for 8 weeks. The best cost benefit were obtained in fish fed 30% *Zonocerus variegatus* inclusion. Fish fed 10% *Zonocerus variegatus* (grasshopper) inclusion had the lowest cost benefit. All the treatment diets showed that cost benefit due to increasing dietary *Zonocerus variegatus* meals were significant ($p<0.05$). This study revealed that the optimum requirement level of *Zonocerus variegatus* for cost benefit of *Clarias gariepinus* is 30% *Zonocerus variegatus* inclusion. It is therefore recommended *Zonocerus variegatus* meal at 30% inclusions for a successful aquaculture practice due to its high cost effective.
Key words: *C. gariepinus, Zonocerus variegatus,* cost benefit, isonitrogenous, diet.

INTRODUCTION
The production of nutritionally balanced diets for fish requires efforts in research, quality control, and biological evaluation (Charo-karisa *et al*., 2013). Much attention is given worldwide to the formulation of pelleted low cost fish feed suitable for small scale farmers (African Catfish (Arnold, 2018). Protein requirement for maximum growth for any species is a logical step to the development of a cost-effective feed for fish and entails determining the maximum amount required to produce maximum growth (Tom *et al*., 2019). The aim of this study was to evaluate the cost benefit of African catfish (*C. gariepinus*) under inclusion of Grasshopper (*Zonocerus variegatus*) as local feed ingredients without compromising the fish quality.

MATERIALS AND METHODS
The study was conducted in the Laboratory of the Department of Animal Science, Federal University, Kashere, Nigeria, in eight (8) rectangular plastic tanks (14 X 13.5 X 13.5 cm) for a period of 8 weeks. Each tank has a water holding capacity of 14 liters but it was maintained at the 7 liters levels throughout the study period (Olaleye, 2015). Four isocarloric and isonitrogenous diets were prepared to contain 0% (control), 10%, 20%, 30% Grasshopper (*Zonocerus variegatus*) to replace equal weight of fishmeal. Prior to processing, the feed ingredients and experimental feeds was ground individually to a fine powder by using hammer mill machine. The strands were cut into short pieces and sun dried for 3 days to remove moisture following the method of Ghosh *et al*. 2016. Thirty two (32) mixed sex African Catfish fingerlings (*C. gariepinus*) of average weight 7.50g, average standard length 6.60cm and average total length 7.75cm were obtained from Animal feeds shop Gombe, Gombe State, Nigeria. Eight (8) plastic tanks (14 liters) were randomly allocated to four (4) treatment diets in duplicates. The fish were randomly distributed into the tanks at a stocking density of four (4) fish per tank. Fresh borehole water was used at the rate of one change per 24hrs throughout the study period (Mwangi *et al*., 2019). The fish were fed at 5% of their body weight per day, twice daily. Temperature, pH, dissolved oxygen were measured and recorded (Adamu *et al*., 2022). At end of the research cost benefit was calculated.

Grasshopper sampling, identification and Processing
The sample of edible grasshoppers was purchased from the Kashere Market, Gombe state and identified in the Department of Biological Sciences, Federal University, Kashere. The sample was dewinged, all appendages were removed. The dried grasshopper was ground into fine powder and 30g out of the

resulting powder was analysed for proximate composition in the Department of Animal science, Faculty of Agric, Federal University Kashere, Nigeria (Dobermann *et al*., 2017).

Cost Benefit Analysis of the Experimental Diets

The cost benefit was analyzed to assess the cost effectiveness of the Grasshopper (*Zonocerus variegatus*) formulated fish diets used in the experimental treatments feeding trials. Only the cost of the feed and pelleting cost were involved in the calculations with the assumption that all other operating cost remained constant (Tom *et al*., 2019). The cost of one kilogramme (1kg) of each feed was calculated from the prevailing cost of the ingredients involved in the formulation as at the time of the experiment (Table 3).

Profit Index (PI) $= \frac{Net\ Profit\ value}{Cost\ of\ feed}$ (Tsado *et al*., 2021).

Statistical Analysis

The results obtained were subjected to one way analysis of variance (ANOVA) test by using the computer Statistical Package for Social Scientists (SPSS-15) windows and where Significant Difference were indicated, means were tested by Turkey test at the 5% level of Significance (Dobermann *et al*., 2017).

RESULTS AND DISCUSSION

Table 3 showed the results of Cost benefits analysis of the experimental diets obtained in this study was in Naira **(₦)** Currency. The highest cost of feed was obtained in treatment I (270.0) and the lowest was obtained in treatment IV (175.0). The highest investment cost was recorded in treatment I (378.0) and the lowest was recorded in treatment IV (245.0). The highest net profit (production) value was obtained in treatment IV (479.2 ± 0.03^{d}) and the lowest was obtained in treatment II (371.5 ± 0.04^{b}). The highest gross profit was obtained in treatment I (49.1 ± 0.04^{a}) and the lowest was obtained in treatment III (15.0 ± 0.02^{c}). The highest profit index was obtained in treatment IV (27.48 ± 0.02^{d}) and the lowest was obtained in treatment I (15.1 ± 0.02^{a}). The highest cost benefit ratio was obtained in treatment IV (1.96 ± 0.03^{d}) and the lowest was obtained in treatment I (1.13 ± 0.03^{a}).The results of the net profit (production) value obtained in this study (Table 3) were in conformity with those of Tsado *et al*. (2021) that fed African Catfish (*Clarias gariepinus*) with Grasshopper (Z. variegatus), and Tom *et al*. (2019) who studied on nutritional characteristics of selected insect in Uganda for use as Alternative Protein Sources. The above observation may be due to the environmental conditions and species used. This explanation is in agreement with Alfiko and Le (2022) who reported a lower net profit (production) value (270.40 ± 0.03 - 240.22 ± 0.02) for insects as feed ingredients for fish culture. The Gross profit and Profit index range values obtained in this study were in agreement with the findings of Olaleye (2015) that fed African Catfish (*Clarias gariepinus*) with Grasshopper (Z. variegatus). The best cost benefit ratio values were obtained in treatment IV and this suggests better feed utilization but similarity in cost benefit ratio values for all the treatment diets indicates palatability and acceptability of the feeds and better utilization by the experimental fish (Table 3). The results of this study showed that experimental diet IV (treatment IV) was the most economical with a significantly ($P<0.05$) higher Benefit Cost Ratio. This is in agreement with the finding of Ghosh *et al*. (2016) who fed short horned grasshopper, *Oxyahyla hylaserville* (*Orthotera: Acrididae*). and got higher Cost benefit Ratio which is an indicator of good quality fish feed and better utilization of the fish feed. Alfiko and Le (2022) reported higher cost benefit ratio values of grasshopper for fish culture. The slight differences may be from the difference in feed sources, environmental conditions and the differences in species used (Table 3). The fish fed on treatment IV had the highest cost benefit Ratio values and this might be because of its higher proportion of animal protein (grasshopper meal). This explanation is in support of that given by Tsado *et al*. (2021) who suggested that digestion of grasshopper meals by fish resulted in a higher cost benefit ratio because most had appreciable Crude Protein levels, are without antinutritional factors (Olaleye, 2015).

CONCLUSION

The findings of this study revealed that 30% Grasshopper (*Zonocerus variegatus*) inclusion obtained the best cost benefit of *C. gariepinus*. Cheap and locally available Grasshopper (*Zonocerus variegatus*) feed inclusion are cost-effective and recommend 30% *Zonocerus variegatus* supplementation in the diet of *C. gariepinus*.

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RECOMMENDATIONS

Catfish feed formulation should contain 30% supplement of Grasshopper (*Zonocerus variegatus*) meal for effective utilization.

It is recommended that Government should encourage feed formulation from Grasshopper (*Zonocerus variegatus*) by sponsoring more researches on fish feed formulation.

Table 1: Proximate Composition of Grasshopper (*Zonocerus variegatus*) Used in the Study

Composition parameters	**% Crude**
Crude Moisture	5.34
Crude Protein	40.96
Crude Fibre	2.14
Ether extract (Fat)	49.43
Crude Ash	11.62
Crude (CHO) Carbohydrate	29.64

Analysed in the Dept. of Animal Science Federal University of Kashere

Table 2: Percentage Composition of Experimental Diets (as Fed) in Different Treatments Feeding Trials

Treatments	**I**	**II**	**III**	**IV**
Ingredients	**0% (Control)**	**10%**	**20%**	**30%**
White Maize	57	57	57	57
Fish Meal	12.7	11.43	10.16	8.89
Grasshopper meal	0	1.27	2.54	3.81
Soya Beans	25.3	25.3	25.3	25.3
Wheat Middlings	1	1	1	1
Mineral premix	1	1	1	1
Vitamin premix	1	1	1	1
Vegetable oil	0.5	0.5	0.5	0.5
Bone meal	0.5	0.5	0.5	0.5
Salts	0.5	0.5	0.5	0.5
Methonine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Total (%)	**100**	**100**	**100**	**100**

Table 4: Cost Benefit or Economic Evaluation of the Experimental Diets.

Treatments Cost benefit Values (₦)	**I (Control 0 %)**	**II 10%**	**III 20%**	**IV 30%**
Culture period (days)	56	56	56	56
Stocking density per tank	4	4	4	4
Cost of fish stocked	140	140	140	140
Cost of feed	270	245	210	175
Cost of fish (per kg)	1200	1200	1200	1200
Investment cost	378.00	343.00	294.00	245.00
Net profit (production) value	427.1 ± 0.03^{a}	371.5 ± 0.04^{b}	444.0 ± 0.02^{c}	479.2 ± 0.03^{d}

Gross profit				
Profit index	49.1±0.04[a]	28.5±0.03[b]	15.0±0.02[c]	23.4±0.04[d]
Benefit cost ratio	15.1±0.02[a]	15.4±0.02[b]	21.1±0.03[c]	27.48±0.02[d]
	1.13±0.03[a]	1.08±0.04[b]	1.51±0.02[c]	1.96±0.03[d]

Means in rows with the same Supercripts are not significantly different (P>0.05) Values are means±standard deviations.

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