COST - BENEFIT ANALYSIS OF AFRICAN MUD CATFISH (CLARIAS *GARIEPINUS*, BURCHELL, 1822) FRY FED DIETARY BETAINE HYDROCHLORIDE BASED DIET

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ABSTRACT

This study was carried out at the Aquatic Bio - Resources Unit, National Biotechnology Development Agency, Katsina, Katsina State. One of the objectives was to evaluate the cost - benefit of Clarias gariepinus fry fed dietary betaine hydrochloride based diet. Betaine hydrochloride was incorporated *in the form of a feed additive* at *T_0 (0.0g/100g,), T_1 (0.25g/100g), T_2 (0.5g/100g), T_3 (0.75g/100g) and T_4 (1.0g/100g) inclusion levels, respectively* into *0.2 – 0.5mm size Coppens fish feeds containing 49% crude protein.* Diet without *betaine hydrochloride* served as the control (T_0), in triplicates. Diets were fed to fry *(n = 1,500. 0.26±0.0g)* for 28 days in *15 plastic hatchery tanks (n = 100). Fry were fed at a fixed feeding rate of 10% body weight 6 times daily between the hours of 07:00 and 23:00 at regular interval. Cost - benefit analysis was calculated for each of the diets. Mean net profit value (₦19.05), benefit cost ratio value (2.74) were better along treatments with the least incidence of cost value (₦1.67) in fry fed diet T_2, while the mean net profit value of ₦11.30 was least in fry fed the control diet (T_0), benefit cost ratio value (1.65) was least from both the fry fed diet T_1 and diet T_3, while the highest (poor) incidence of cost value of ₦2.37 was recorded from both fry fed diets T_3 and T_4 respectively. This study indicated that the incorporation of dietary betaine hydrochloride into C. gariepinus fry feed containing 0.5g/100g level was a profitable venture for African mud catfish breeders, considering the highest profit index value (4.37).*

Keywords: **Cost - Benefit, *Clarias gariepinus*, Fry, Betaine hydrochloride, Diet.**

INTRODUCTION

Clarias gariepinus also called African mud catfish is the most cultured fish species in Nigeria (Abdulkarim *et al.*, 2018), but its culture is threatened and the rearing is becoming unattractive due to the scarcity and high cost of quality fish feeds (Ali, 2022). Despite the vast aquatic resources, oil seeds and legumes which Nigeria is endowed with, most of the fish feed manufacturers in Nigeria rely on imported feed ingredients and fish feeds from foreign countries (Sogbesan, 2023). The importation of fish meal and other feed ingredients makes fish farming to be very capital intensive because fish feeds account for 70 % – 80 % of the cost of production depending on the location (Aduku and Bolorunduro, 2016). The solution to this problem must be sought through a combination of holistic approach towards lowering the cost of production by incorporating natural feed additives such as betaine hydrochloride a by - product of sugar beet into the fish diets which serves as growth promoters and which in turn reduce the cost of fish production and maximise profits (Ali *et al.,* 2022; Ali *et al.,* 2023).

Cost-benefit analysis (CBA), also called benefit costs analysis (BCA), is a practical reach to evaluate the strengths and weaknesses of ways out used to decide freedom of choice which give the ideal focus onto successfully bringing an advantage or profit at the same time preserving savings (for instance, in transaction, activities, and functional business necessity) (Umar *et al.,* 2019). A CBA can be used to estimate absolute or possible causes of actions, or to approximate (or assess) the value against the cost of a resolution, program, or strategy (Mohammed *et al.,* 2020). It is frequently used in commercial transactions, business or the course decision making (especially public policy), and project investment. CBA is associated and regulated for the time value of money; all flows of benefits and cost over time are demonstrated on a common basis in terms of their net present value, regardless of

whether they are incurred at different times. Other related techniques include cost-utility analysis, risk-benefit analysis, economic impact analysis, fiscal impact analysis, and social return on investment (SROI) analysis (Umar *et al.,* 2019). Thus, this study is focused on the cost - benefit analysis of *C. gariepinus* fry fed dietary betaine hydrochloride additive diet.

MATERIALS AND METHODS

Study Area

The study was carried out at the hatchery room of the Aquatic Bio-Resources unit of the National Biotechnology Development Agency (Bio-resources Development Centre) Katsina, Katsina State. The state lies between latitude 11° 7' and 13° 22' north and longitude 6° 52' and 9° 2' east. It has a total land area of about 23,930 km², with an estimated human population of 5.2 million of which majority live in the rural areas. The fry for experiment were bred at the hatchery room of Aquatic Bio-Resources unit of the Bio-Resources Development Centre, Katsina. The fry were 4 days old at the commencement of the feeding trial

Experimental Diets

Coppens fish feeds (0.2 - 0.5mm) was used as the basal diet for this study and was obtained from feed suppliers at Katsina, while the betaine hydrochloride was purchased from Bon - Amour Pharmacy Limited Lagos, Nigeria, imported from Piping Rock Health Products, Ronkonkoma, New - York, USA. Experimental diets were prepared by incorporating betaine hydrochloride additive in powder form at four graded levels: 0.25g, 0.5g, 0.75g and 1.0g/100g feed, into Coppens fish feeds (0.2 - 0.5mm) while diet without the betaine hydrochloride (0.0g/100g) feed served as the control diet. The diets were coded as T_0 (0.0g), T_1 (0.25g), T_2 (0.5g), T_3 (0.75g) and T_4 (1.0g). The betaine hydrochloride was included at the measured quantity for each diet and diluted into 5ml of warm water (35^{0}C) to form a solution. The solution was sprayed onto the Coppens fish feeds, fish oil was added to all the experimental diets with betaine hydrochloride to preserve the betaine hydrochloride in the Coppens fish feed (0.2 - 0.5mm) and was prepared in 100g each time.

Experimental Design

Each of the diets were fed to *C. gariepinus* fry (n = 1,500; initial body weight = 0.26±0.0g) in triplicate making a total of 15 plastic hatchery tanks (semi flow – through system) with 100 fry per tank. Water quality parameters such as pH, dissolved oxygen (DO), temperature and ammonia were monitored weekly. Fry were fed 6 times daily between the hours of 07:00 and 23:00 at regular interval for a period of 28 days at a fixed feeding rate of 10% body weight. The initial body weight of each set of fry was measured using a digital weighing balance before stocking and subsequently bulk weighing of fry in each tank was done after every 7 days, the growth performance parameters were examined. Data on cost - benefit analysis were collected.

Cost - Benefit Analysis of *C. gariepinus* Fry Fed Dietary Betaine Hydrochloride Additive Diet

The cost - benefit analysis of the *C. gariepinus* fry fed dietary betaine hydrochloride additive diet were calculated using the method of Sogbesan and Ekundayo (2014) as follows:

$$\text{Investment cost analysis (ICA)} = \text{cost of feed (₦)} + \text{cost of fry stocked (₦)}$$

$$\text{Profit index (PI)} = \text{net profit (₦)} / \text{cost of feed (₦)}$$

$$\text{Incidence of cost (IC)} = \text{cost of feed (₦)} / \text{weight of fish produce (g)}$$

$$\text{Benefit cost ratio (BCR)} = \text{net profit (₦)} / \text{investment cost analysis}$$

Cost benefit analysis was based on the following:

i. A major assumption was that all other operating costs for the *C. gariepinus* fry production remained the same for all the dietary treatments. Thus, cost of feed was the only economic criterion (expenditure) considered in this study.
ii. Cost of feed was based on the prevailing market prices of the *C. gariepinus* fry feed as at the time of purchase (that is time of commencement of the experiment).
iii. Value of *C. gariepinus* fry produced (cost of fish cropped) depends on the selling price of *C. gariepinus* fry per gram (10/g) in the markets around Katsina as at the end of the experiment.
iv. Cost of producing betaine hydrochloride additive diet depended on the cost of obtaining the betaine hydrochloride.
v. Total weights of *C. gariepinus* fry produced were obtained from the total weight of fish recovered at the end of the feeding trial.

Statistical Analysis
The data collected were analysed using the cost - benefit analysis models.

RESULTS AND DISCUSSION

The cost benefit analysis of the *C. gariepinus* fry fed dietary betaine hydrochloride additive diet is shown in Table 1. Fry fed diet T_2 (betaine hydrochloride at 0.5g/100g) had the highest mean final body weight value (2.60g) while fry fed the control diet B_0 (betaine hydrochloride at 0.0g/100g) had the least mean final body weight value (1.81g). There was an increase in the mean cost of feed from the value (₦4.20) from fry fed diet T_0 (control) to the value (₦4.45) in fry fed diet T_4 (betaine hydrochloride at 1.0g/100g) respectively. The least mean cost of feed was observed in the fry fed diet T_0 (₦4.20). The mean total expenses were higher in fry fed diet T_4 (₦7.05) followed by those fry fed diet T_3 (₦7.00), T_2 (₦6.95) and T_1 (₦6.90) while the least value from fry fed diet T_0 (₦6.80). The highest mean net profit value of ₦19.05 was recorded from the fry fed diet T_2; the least value of ₦11.30 was recorded from the fry fed the control diet (T_0). The range of the mean net profit values (₦11.30 - ₦19.05) recorded from this study were higher than the values (₦*11.19* - ₦16.24) *reported by* Sogbesan and Bashir (2018) *for Oreochromis niloticus* fed fermented cassava, *Manihot esculentus* leaf meal supplemented diets. The result also indicated that fry fed diet T_2 has the highest benefit cost ratio value (2.74) while the fry fed diets T_1 and T_3 has the least value (1.65) respectively. The benefit cost ratio values (1.65 - 2.74) obtained from this study were better than the values (1.41 - 1.55) reported by Mohammed *et al.* (2020) for masculinising *Oreochromis niloticus* using camel testicles - based diet. The least (better) incidence of cost value (₦1.67) was recorded from the fry fed diet T_2 while the highest (poor) value (₦2.36) was recorded from the fry fed diets T_3 and T_4 respectively. The incidence of cost values (₦1.67 - ₦2.36) obtained from this study were higher than the values (₦0.55 - ₦0.67) reported by Ali (2022) for *C. gariepinus* fingerlings fed dietary betaine hydrochloride additive diet. The variation in the values could be associated with the variance in the cost of feed ingredients and other input cost used in the various researches. Babale (2016) reported that when the benefit cost ratio is greater than one or equal to one it indicates profitability, but less than one shows lack of viability or unprofitability of the venture. Since the ratios in all the diets were greater than one, therefore it is considered that, the incorporation of dietary betaine hydrochloride additive into *C. gariepinus* fry feed is a profitable venture, especially at 0.5g/100g feed inclusion level with the highest profit index value of 4.37 which was in agreement with the findings of Ali *et al.* (2023) who reported the highest growth performance for *C. gariepinus* fry when betaine hydrochloride was incorporated into the diet at 0.5g/100g feed. Abed Ali and Al - Faragi (2017) reported that the incorporation of betaine hydrochloride at 0.5g/100g feed as additive into the diet of common carp (*Cyprinus carpio*) fingerlings resulted to better growth and higher profits.

Table 1: Cost - Benefit Analysis of *C. gariepinus* Fry Fed Dietary Betaine Hydrochloride Additive Diet

Parameters	T_0	T_1	T_2	T_3	T_4
Mean cost of feed/g (₦)	4.20	4.30	4.35	4.40	4.45
Cost of fry (₦/fry)	2.60	2.60	2.60	2.60	2.60
Investment cost analysis (₦)	6.80	6.90	6.95	7.00	7.05
Mean final weight (g/fry)	1.81	1.83	2.60	1.86	1.88
Cost of fry/g (₦)	10.00	10.00	10.00	10.00	10.00
Mean yield cost/fry (₦)	18.10	18.30	26.00	18.60	18.80
Mean net profit (₦)	11.30	11.40	19.05	11.60	11.75
Benefit cost ratio	1.66	1.65	2.74	1.65	1.66
Incidence of cost (₦)	2.32	2.34	1.67	2.37	2.37
Profit index	2.69	2.65	4.37	2.63	2.64

Keys:
T_0 - betaine hydrochloride (0.0g/100g)
T_1 - betaine hydrochloride (0.25g/100g)
T_2 - betaine hydrochloride (0.5.g/100g)
T_3 - betaine hydrochloride (0.75g/100g)

T_4 - betaine hydrochloride (1.0g/100g)

Conclusion

The incorporation of dietary betaine hydrochloride at 0.5g/100g (T_2) feed inclusion level into the diet of *C. gariepinus* fry proved to have the higher potentials by lowering the cost of production of fry with the highest mean net profit (₦19.05), highest (better) benefit cost ratio (2.74) along with the least (better) incidence of cost (₦1.67) and highest profit index (4.37).

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REFERENCES

Abdulkarim, M., Yusuf, Z. A., Misau, A. B., Garba, A. M. and Mahmood, S. (2018). Realistic Interpretation of Condition Factor with Stomach Content Analysis of *Clarias gariepinus* in Gwallaga River, Bauchi – Nigeria. *Nigerian Journal of Fisheries,* 15 (2):1440 – 1443.

Abed Ali, H. H. and Al - Faragi, J. K. A. (2017). Efficiency of betaine and β - glucan as feed additives on the growth performance and survival rate of common carp (*Cyprinus carpio* L.) fingerlings. *Journal of Entomology and Zoology Studies,* 5(4): 27 - 31.

Aduku, A. O. and Bolorunduro, P. I. (2016). *Practical livestock and fish feeds production in the tropics*. Revised Edition, T. W. Press and Publishers, 3, Keffi/Lagos Street, Kaduna, Nigeria. Pp. 20 - 34. ISBN-2528-20-X.V.V.

Ali, M. E. (2022). Performance and cost benefit of African mud catfish *Clarias gariepinus* (Burchell, 1822) fed different levels of dietary betaine, β - glucan and co - mixed additives diets. Unpublished Ph.D. Thesis, Department of Fisheries, Modibbo Adama University, Yola, Nigeria. Pp. 183.

Ali, M. E., Abubakar, K. A. and Sogbesan, O. A. (2022). Growth performance and nutrient utilization of *Clarias gariepinus* (Burchell, 1822) fingerlings fed dietary betaine additive diets. In: *Proceedings of the 37th Annual Conference of the Fisheries Society of Nigeria (FISON)*. Pp. 133 - 137.

Ali, M. E., Yusuf, Z. A., Ibeagi, M. C., Remkyes, M. S., Yakubu, M. and Useni, S. S. (2023). Effect of different levels of dietary betaine hydrochloride on the growth response of fry of *Clarias gariepinus* (Burchell, 1822). In: *Proceedings of the 57th Annual Conference of the Agricultural Society of Nigeria (ASN)*. Pp. 989 - 992.

Babale, M. Y. (2016). Growth performance at various growth stages of *Clarias gariepinus* (Burchell, 1822) fed various inclusion levels of processed water melon (*Citrullus lanatus,* mansf.) seed cake diets. Published Ph.D. Thesis, Department of Biological Sciences, Ahmadu Bello University Zaria, Zaria, Nigeria. Pp. 164.

Mohammed, Z. B., Umar, H. M., Aliyu, M., Suleiman, S. B. and Gamawa, A. I. (2020). Cost - benefit analysis of masculinising Nile tilapia *(Oreochromis niloticus,* Linnaeus 1758*)* using camel testicles - based diet. *Nigerian Journal of Animal Science and Technology,* 3 (1):124 – 129.

Sogbesan, O. A. and Ekundayo, T. M. (2014). Cost benefits of fermented groundnut shell meal as supplemented feed in the diets of *Clarias gariepinus* fingerlings. *Nigerian Journal of Fisheries and Aquaculture,* 2(2): 30 - 41.

Sogbesan, O. A. and Bashir, S. Y. (2018). Utilization and cost benefit analyses of *Oreochromis niloticus* fed fermented cassava, *Manihot esculentus* leaf meal supplemented diets. *Journal of Aquaculture and Marine Biology,* 7(4):199 – 204. DOI: 10.15406/jamb.2018.07.00209

Sogbesan, O. A. (2023). Bio - recycling of some organic wastes in reducing fish production cost and attainment of food security. 26th Inaugural Lecture, Modibbo Adama University, Yola, Nigeria. Pp. 98.

Umar, H. M., Mohammed, Z. B., Modu, B. M. and Shettima., H. M. (2019). Cost - benefit analysis of masculinising Nile tilapia *(Oreochromis niloticus,* Linnaeus 1758*)* using camel testicles - based diet. In: *Proceedings of the 34th Annual Conference of the Fisheries Society of Nigeria (FISON).* Pp. 165 – 167.