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Cost - Benefit of *Clarias gariepinus* (Burchell, 1822) Hatchlings Fed Different Levels of Maca (*Lepidium meyenii* Walp.) Root Powder as Feed Additive

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Abstract

Cost - benefit of Clarias gariepinus hatchlings fed different levels of maca root powder as feed additive was carried out at the National Biotechnology Research and Development Agency, Billiri, Gombe State. *The aim was to evaluate the cost/benefit of maca root powder and feeding Clarias gariepinus hatchlings using natural growth promoters (maca root powder as feed additive). Maca root powder in form of feed additive* was incorporated into *Coppens fish feeds (0.2 - 0.5mm) with 49% crude protein* at *0.0g/100g (L_0), 0.25g/100g (L_1), 0.5g/100g (L_2,) 0.75g/100g (L_3) and 1.0g/100g (L_4) inclusion levels*, diet without *maca root powder* served as the control (L_0), in triplicates. Diets were fed to *hatchlings (n = 1,500, 0.25±0.0g)* for a period of 28 days in *15 plastic hatchery tanks (n = 100). Hatchlings 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 was calculated for each of the diets. Mean net profit value ((₦16.30)), profit index value (3.64) were better along treatments with the least (best) incidence of cost value (₦2.30) and the better benefit cost ratio value (2.33) in hatchlings fed diet L_3, while the mean net profit value of ₦14.80 was least in hatchlings fed control diet (L_0), profit index value (3.44) were least in both the hatchlings fed diet L_4 and the control diet (L_0) respectively. Incidence of cost value (₦2.40) was highest (poor) in hatchlings fed diet L_4, while benefit cost ratio value (2.18) was least in hatchlings fed diet L_0. Findings from this study indicated that the inclusion of maca root powder as feed additive* at *0.75g/100g in the diet of Clarias gariepinus hatchlings was a profitable venture. Maca root powder is recommended to be included into the diets of Clarias gariepinus hatchlings in order to minimize the cost of production.*

Keywords: Cost - benefit, Clarias gariepinus, *hatchlings, maca root powder, feed additive.*

Cost - Benefit of *Clarias gariepinus* (Burchell, 1822) Hatchlings Fed Different Levels of Maca (*Lepidium meyenii* Walp.) Root Powder as Feed Additive

Introduction: A Cost - benefit analysis (CBA) is a technique applied in calculating the economic performance of appropriating fund to meet decisive human needs (Wambua, 2018). A CBA can be used to evaluate the complete or likely causes of actions, or to approximate the value against the cost of a resolution, program, or strategy (Ali, Maisheru. Ekaette, Yusuf, Nababa, Useni, and Ogunmefun, 2024). It is always used in commercial transactions, businesses or in the course decisions making (especially public policies), and project investments (Mohammed, Umar, Aliyu, Suleiman. and Gamawa, 2020). CBA is associated and regulated with 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 values, regardless of whether they are incurred at different times (Ali *et al.,* 2024). Other associated principles include; cost - utility analysis, risk - benefit analysis, economic impact analysis, fiscal impact analysis, and social return on investment (SROI) analysis (Umar, Mohammed, Modu and Shettima. 2019). The CBA in a fish farming enterprise involved relating the costs, both the fixed and variable costs, to the sources of revenues and other benefits that flows over time (Wambua, 2018). *Clarias gariepinus* also known as the African mud catfish is the most cultured fish species in Nigeria (Nababa, Idris, Yahaya, Ogunmefun, Ekaette, Yusuf, Yusuf and Ali, 2024), but its culture is threatened and the rearing is becoming unattractive due to the scarcity and high cost of quality fish feeds (Ali, Abubakar. and Sogbesan, 2022; Sogbesan, 2023). The increasing cost of starter feed for the *Clarias gariepinus* hatchlings is a constraint to the *Clarias gariepinus* breeders particularly in Nigeria (Ali, Yusuf, Ibeagi, Remkyes, Yakubu and Useni, 2023). This has necessitated the need for alternative starter food and or feed like special starter fish feed incorporated with feed additives which served as growth promoters by positively affecting the body weight gain without any negative effect on public health and consumers (Ali *et al.*, 2022). Then, there is generally demand for the use of natural sources of herbal as feed additives; among of this herbal is maca also known as Peruvian ginseng root powder (Mahdy, Abuol - Omran, Desoky, Omnia, Abd El - Salam, Abo - Farw, El - Kholany, Ahmed and Khalifa, 2023). Maca (*Lepidium meyenii* Walp.) is a vegetable root native to Peru in South America (Gül, Olgun, Yıldız, Tüzün and Sarmiento - García, 2022), in Hausa language its known as "sauyar maca" or "albasar tamoji" while in Yoruba language it's known as ''Isu baka'' (Garba, Gaddafi and Yahaya, 2022). Maca is rich in crude protein, crude lipid, essential acids, and a pharmacological compound (Mahdy *et al.*, 2023). A dry maca root powder contains 10.2% crude proteins, 59% carbohydrates, 2.2% crude lipids, 8.5% crude fibre, 40.1% free fatty acids (linoleic, palmitic, and oleic acids) and 52.7% saturated fatty acids and unsaturated fatty acids (Mahdy *et al.*, 2023). This study is focused on the cost - benefit of *Clarias gariepinus* hatchlings fed different levels of maca (*Lepidium meyenii)* root powder as feed additive.

Materials and Methods

Study Area

The study was carried out at the Aquaculture section of the National Biotechnology Research and Development Agency, Billiri local government area (LGA), Gombe State. Billiri LGA lies within latitude 9°50' and 11°09''N and longitude 9.833°and 11.150°E. It covers an area of 737km² and is 50 km away from Gombe the State capital.

Experimental Fish

The *Clarias gariepinus* hatchlings for the experiment were bred at the hatchery room of Lay - Joy fish farm Billiri, Gombe State. The *Clarias gariepinus* hatchlings were 4 days old at the commencement of the feeding trial and the study lasted for a period of 28 days.

Experimental Diets

Coppens fish feed (0.2 - 0.5mm) was used as the basal diet for this study and was obtained from feed suppliers at Gombe, while the maca root powder 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 maca root powder as feed additive at four graded levels; 0.25g, 0.5.0g, 0.75g and 1.0g/100g feed, into Coppens fish feeds (0.2 - 0.5mm), while diet without maca root powder i.e. 0.0g/100g feed served as the control diet and were coded as L_0 (0.0g), L_1 (0.25g), L_2 (0.5g), L_3 (0.75g) and L_4 (1.0g) respectively. The maca root powder was included at the measured quantity for each diet and were diluted into 5 ml of warm water (35^0C) to form a solution. The solution was sprayed onto the Coppens fish feed (0.2 - 0.5mm), fish oil was added to all the experimental diets with maca root powder to reserve the maca root powder additive. The Coppens fish feed (0.2 - 0.5mm) with the maca root powder additive was prepared in 100g each time.

Experimental Design

Each of the treatment diets were fed to *Clarias gariepinus* hatchlings (n = 1,500; 0.25±0.0g) in triplicate making a total of 15 plastic hatchery tanks (semi flow - through system) i.e. (n = 100 per tank). Water quality parameters such as; temperature, pH, dissolved oxygen (DO) and ammonia (NH_3) were monitored weekly using Horiba U-22 XD multi - parameter water quality checker. *Clarias gariepinus* hatchlings 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 as recommended by Ukwe, Edun. and Akinrotimi. (2018). The initial body weight of each set of *Clarias gariepinus* hatchlings was measured using a digital weighing balance before stocking and subsequently bulk weighing of *Clarias gariepinus* hatchlings 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 *Clarias gariepinus* Hatchlings Fed Different Levels of Maca Root Powder as Feed Additive

The cost - benefit analysis of the *Clarias gariepinus* hatchlings fed different levels of maca root powder as feed additive were calculated using the method of Sogbesan and Ekundayo (2014) as follows:

Investment cost analysis (ICA)
= cost of feed (₦)
+ cost of fish stocked (₦)

Profit index (PI)
= net profit (₦)/cost of feed (₦)

Incidence of cost (IC)
= cost of feed (₦)
/weight of fish produce (g)

Benefit cost ratio (BCR)
= net profit (₦)
/investment cost analysis

Cost benefit analysis was based on the following:

i. A major assumption was that all other operating costs for the *Clarias gariepinus* hatchlings 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 *Clarias gariepinus* hatchlings feed as at the time of purchase (that is time of commencement of the experiment).
iii. Value of *Clarias gariepinus* hatchlings produced (cost of fish cropped) depends on the selling price of *Clarias gariepinus* hatchlings per gram (12/g) in the markets around Gombe as at the end of the experiment.
iv. Cost of producing maca root powder additive diet depended on the cost of obtaining the maca root powder.
v. Total weights of *Clarias gariepinus* hatchlings produced were obtained from the total weight of fish recovered at the end of the feeding trial.

Data Analysis

The data collected were analysed using the cost - benefit analysis models as described by Ali (2022).

Results

The proximate composition of the Coppens fish feeds (0.2 - 0.5mm) fed to the *Clarias gariepinus* hatchlings is presented in Table 1. The diet contained 49% crude protein, 12% crude lipid, 6.0% crude fibre, 8.0% ash, 1.5% calcium, 8.0% moisture and 1.5% phosphorus.

The cost - benefit analysis of the *Clarias gariepinus* hatchlings fed different levels of maca root powder as feed additive is shown in Table 2. Hatchlings fed diet L_3 (maca root powder at 0.75g/100g) had the highest mean final body weight value (1.94g), while hatchlings fed the control diet L_0 (maca root powder at 0.0g/100g) had the least mean final body weight value (1.80g). There was an increased in the mean cost of feed from the value (₦4.30) from hatchlings fed control diet (L_0) to the value (₦4.54) in hatchlings fed diet L_4 (maca root powder at 1.0g/100g) respectively. The least mean cost of feed value was recorded from the hatchlings fed diet L_0 (₦4.30). The investment cost analysis values were higher in hatchlings fed diet L_4

Table 1: Proximate Composition of Coppens Hatchlings Feeds (0.2 - 0.5 mm) Used for the Study

Nutrients	Percentage (%)
Crude protein	49
Crude lipid	12
Crude fibre	6.0
Ash	8.0
Calcium	1.5
Moisture	8.0
Phosphorus	1.5

Source: Field Survey (2024).

(₦7.04) followed by those hatchlings fed diet L_3 (₦6.98), L_2 (₦6.92) and L_1 (₦6.86) respectively, while the least value was recorded from hatchlings fed diet L_0 (₦6.80). The highest mean net profit value (₦16.30) was recorded from the hatchlings fed diet L_3, while the least value (₦14.80) was recorded from the hatchlings fed the control diet (L_0). The highest profit index value (3.64) was recorded from the hatchlings fed diet L_3, while the least value (3.44) was recorded from both the hatchlings fed diet L_4 and the control diet (L_0) respectively. The least (better) incidence of cost value (₦2.30) was recorded from the hatchlings fed diet L_3, while the highest (poor) value (₦2.40) was recorded from the hatchlings fed diet L_4. The result also indicated that hatchlings fed diet L_3 had the highest benefit cost ratio value (2.33), while the hatchlings fed the control diet (L_0) has the least value (2.18).

Table 2: The Cost - Benefit Analysis of *Clarias gariepinus* Hatchlings Fed Different Levels of Maca Root Powder as Feed Additive

Parameters	L_0	L_1	L_2	L_3	L_4
Mean final weight (g/fish)	1.80	1.86	1.87	1.94	1.89
Mean cost of feed/g (₦)	4.30	4.36	4.42	4.48	4.54
Cost of fish (₦/fish)	2.50	2.50	2.50	2.50	2.50
Investment cost analysis (₦)	6.80	6.86	6.92	6.98	7.04
Cost of fish/g (₦)	12.00	12.00	12.00	12.00	12.00
Mean yield cost/fish (₦)	18.10	18.30	26.00	18.60	18.80
Mean net profit (₦)	21.60	22.32	22.44	23.28	22.68
Profit index	3.44	3.54	3.51	3.64	3.44
Incidence of cost (₦)	2.39	2.34	2.36	2.30	2.40
Benefit cost ratio	2.18	2.25	2.24	2.33	2.22

Keys:
L_0 - Maca root powder (0.0g/100g)
L_1 - Maca root powder (0.25g/100g)
L_2 - Maca root powder (0.5g/100g)
L_3 - Maca root powder (0.75g/100g)

L_4 - Maca root powder (1.0g/100g)

Discussion

The mean final body weight values, 1.80g - 1.94g recorded from this study were comparable with the values 1.81g - 2.60g reported by Ali *et al.* (2024) for *Clarias gariepinus* fry fed dietary betaine hydrochloride based diet and significantly higher than the values, 1.18g - 1.52g reported by Nababa *et al.* (2024) for *Clarias gariepinus* hatchlings fed baker's yeast, egg yolk and milk powder as starter diets. This indicated that the experimental diets were well utilized by the *Clarias gariepinus* hatchlings. Nwanna, Ogundowole, and Nwanna (2014) reported that the dietary treatment with the highest weight gain also produced fish with the highest value for *Clarias gariepinus* fed plantain peel based diets. The mean net profit values, ₦14.80 - ₦16.30 obtained from this study were comparable with the values, ₦11.19 - ₦16.24 reported by Sogbesan and Bashir (2018) *for Oreochromis niloticus* fed fermented cassava (*Manihot esculentus*) leaf meal supplemented diets and lower than the values, ₦11.30 - ₦19.05 reported by Ali *et al.* (2024), but higher than the values, ₦6.10 - ₦9.30 reported by Nababa *et al.* (2024). This revealed that the used of maca root powder as feed additive provided higher mean net profits in this study. The profit index values, 3.44 - 3.64 recorded from this study were higher than the values, 1.53 - 1.69 reported by Elezuo (2016) for *Clarias gariepinus* juveniles fed roasted almond (*Terminalia catappa*) kernel meal. and the values, 1.83 - 3.20 reported by Nababa *et al.* (2024). The highest profit index values obtained from this study indicated that more profit was generated, this finding further buttresses the fact that the diets were better utilized. The incidence of cost values, 2.30 - 2.39 recorded from this study were higher than the values, ₦0.61 - ₦0.84 reported by Ali (2022) for *Clarias gariepinus* fingerlings fed dietary β - glucan additive diet, but lower than the values, ₦9.49 - ₦15.53 reported by Mohammed *et al.* (2020) for masculinised *Oreochromis niloticus* using camel testicles - based diet. The variations in these values could be attributed to the variance in the cost of feed ingredients and other input cost used in the various studies. The low incidence of cost values observed form this study shows that using maca root powder as feed additive produced the most cost effective diets. The benefit cost ratio values, 2.18 - 2.33 recorded from this study were higher than the values, 0.72 - 1.27 reported by Sogbesan and Bashir (2018) and the values, 1.41 - 1.55 reported by Umar *et al.* (2019) for *Oreochromis niloticus* fed camel testicles - based diet. Babale (2016) and Wambua (2018) reported that when the benefit cost ratio value is greater than one or equal to one it indicates profitability, but less than one shows lack of viability or unprofitability of the venture. Therefore, since the ratio values in all the diets were greater than one, it indicated that feeding *Clarias gariepinus* hatchlings with different levels of maca root powder as feed additive is economically efficient and beneficial; the stream of benefits exceeds the costs incurred over the study period.

Conclusion

Feeding *Clarias gariepinus* hatchlings with different levels of maca root powder as feed additive, specifically at 0.75g/100g feed produced hatchlings with the highest mean net profit and profit index values (₦16.30 and 3.64, respectively). The least (better) incidence of cost value (₦2.30) and the highest benefit cost ratio value (2.33) were also found in hatchlings fed 0.75g/100g maca root powder as feed additive. The inclusion of 0.75g/100g maca root powder as feed additive into the diet of *Clarias gariepinus* hatchlings proved to have higher potentials for catfish breeders due to its higher benefit and net profit.

Recommendations

Maca root powder should be included to the diets of *Clarias gariepinus* hatchlings at 0.75g/100g in order to minimize the cost of production especially for catfish fingerlings producers. Further study should also be conducted on other phyto additives for their effectiveness as feed additives in the diets of *Clarias gariepinus* hatchlings as well as determining their cost implications.

References

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. 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. *Proceedings of the 37th Annual Conference of the Fisheries Society of Nigeria (FISON)*. Pp. 133 - 137.

Ali, M. E., Maisheru, J. A., Ekaette, E. E., Yusuf, Z. A., Nababa, A. S., Useni, S. S. and Ogunmefun, G. S. (2024). Cost - benefit analysis of African mud catfish (*Clarias gariepinus*, Burchell, 1822) fry fed dietary betaine hydrochloride based diet. *Proceedings of the 49th Conference of the Nigerian Society for Animal Production (NSAP)*. Pp. 216 - 219.

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). *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. Ph.D. Thesis, Department of Biological Sciences, Ahmadu Bello University Zaria, Zaria, Nigeria. Pp. 164.

Elezuo, K. O. (2016). Growth performance of *Clarias gariepinus* juveniles fed processed almond (*Terminalia catappa L.*) kernel meal. Ph.D. Thesis, Department of Aquaculture and Fisheries Management, University of Ibadan, Ibadan, Nigeria. Pp. 197.

Garba, M. G., Gaddafi, S. and Yahaya, M. A. (2023). Additive effect of maca (*Lepidium meyenii*) powder on semen characteristic and testicular histo - morphology of red Sokoto bucks in Sudan savannah zone Nigeria. *Acta Scientific Veterinary Sciences*, 4(7): 35 - 41.

Gül, E. T., Olgun, O., Yıldız, A., Tüzün, A. E. and Sarmiento - García, A. (2022). Use of maca powder (*Lepidium meyenii*) as feed additive in diets of laying quails at different ages: Its effect on performance, eggshell quality, serum, ileum, and bone properties. *Veterinary Sciences*, 9: 418. https://doi.org/10.3390/ vetsci9080418

Mahdy, T. M. M., Abuol - Omran, M. A., Desoky, A. L. I., Omnia, M. Abd El - Salam, A., Abo - Farw, M. A., El - Kholany, M. M., Ahmed, M. I., and Khalifa, E. I. (2023). Effect of add maca powder to the base diet on weaning lambs and ram's semen characteristics. *Egyptian Journal of Sheep and Goat Sciences*, 19(2): 13 - 30.

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.

Nababa, A. S., Idris, M., Yahaya, I., Ogunmefun, G. S., Ekaette, E. E., Yusuf, S. K., Yusuf, Z. A. and Ali, M. E. (2024). Analysis on the cost benefit of *Clarias gariepinus* (Burchell,1822) hatchlings fed baker's yeast, egg yolk and milk powder as starter diets. *Proceedings of the 49th Conference of the Nigerian Society for Animal Production (NSAP)*. Pp. 2003 - 2006.

Nwanna, L. C., Ogundowole, O. E. and Nwanna, E. E. (2014). Use of plantain (*Musa paradisiacal*) peels in low cost diet for enhancement of growth and carcass quality of African catfish. *Journal of Applied Aquaculture*, 26(1): 1 - 10.

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.

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. 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.

Ukwe, O. I. K., Edun, O. M. and Akinrotimi, O. A. (2018). Comparative growth performance and survival of African catfish (*Clarias gariepinus*) fed with artemia and acartia live feeds. *Journal of Aquatic Science and Marine Biology*, 1(3):.24 - 28.

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. *Proceedings of the 34th Annual Conference of the Fisheries Society of Nigeria (FISON).* Pp. 165 - 167.

Wambua, M. M. (2018). *A cost - benefit analysis of the fish farming enterprise productivity program project in Kenya. The case of implementation of the aquaculture development component in Meru County*. United Nations University Fisheries Training Programme, Iceland [final project]. Pp. 38. http://www.unuftp.is/static/fellows/document/moses15prf.pdf