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*Full Length Research Paper*

# Evaluation and potential of cocoyam as carbohydrate source in catfish, (*Clarias gariepinus* [Burchell, 1822]) juvenile diets

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**The cost of feeding fish is about 60% of the total recurrent cost of fish farming, hence a need for non-conventional and cheaper ingredients to substitute the expensive ones. Seventy five juvenile of *Clarias gariepinus* mean weight 9.86 g were randomly stocked at 5 juveniles per tank of dimension 40 × 56 × 31 cm and fed five isonitrogenous and isocaloric diets containing graded levels of cocoyam at 0, 25, 50, 75 and 100% substituted for maize meal over a period of 70 days. The result of the experiment showed that diet 1 had the highest specific growth rate (SGR), 1.47%/day and diet 4 had the lowest of 0.89%/day. The best food conversion ratio (FCR), 1.81 was from diet 2 while the worst of 2.91 was from diet 4. Highest mean yield, net profit, benefit cost ratio and profit index of 26.58, 4.93, 1.23 and $16.11 respectively, were from diet 2 while the lowest of 22.91, 0.49, 1.02 and $9.47 were from diet 4. All indices considered were significantly different (p<0.05) between ≤50% cocoyam and ≥75% cocoyam treatments. The study showed that 25% replacement of cocoyam for maize is recommended for growth and economic benefit for sustainable aquaculture.**

**Key words:** Cocoyam, cost benefits, feed utilization, growth, maize, *Clarias gariepinus*.

## INTRODUCTION

In intensive and semi-intensive aquaculture system, dietary protein can be used as dietary energy source for fish and a number of studies have pointed out the importance of using less expensive energy sources such as lipids and carbohydrate in order to save protein (Garcia et al., 1994; Okoye et al., 2001). Carbohydrate has been shown to be a suitable energy source for either carnivorous, omnivorous or herbivorous fish. However it has been widely assumed that these latter species can utilize higher dietary levels of carbohydrate than carnivorous fish both at the digestive and metabolic levels (Lovell, 1989).

The utilization of carbohydrate by fish remains obscured and far below the consumption by man and other domestic animals. The relative utilization of dietary carbohydrate by fish varies and appears to be related to the level, source and complexity of the carbohydrate (Shiau and Lin, 1993). In a comparative study on the ability of trout and eel to utilize diets with different carbohydrates content, Garcia et al. (1991), showed that eels were comparatively better adapted to use higher dietary carbohydrates levels than eels.

Although grains and grain products are the main carbohydrate sources in the diets of cultivated fish (Tacon, 1993), an attempt at fulfilling the energy requirement of fish through the use of root and tubers could probably ameliorate the stiff competition with cereals and grains. Furthermore, to meet up with annual increase of fish production, research should be targeted towards the use of alternative unconventional feed ingredients such as root and tubers which could probably improve the feeds, water stability and nutrients retention, increase efficiency of digestibility and reduce cost of fish feed production (Falayi et al., 2003, 2004).

Cereals and grains are well competed for between man and livestock but only 10% of the world consumes cocoyam as staple food (Lee, 1999). The production of cocoyam otherwise called Taro is low compared to the other roots and tubers (Fagbenro and Adebayo, 2002)

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but its superiority in terms of digestibility of starch (98.8%), the size of starch grain ($^1/_{10}$th of potato), the sulphur amino acid and price per tonne makes it a better choice than cereals in fish feed production. Cocoyam has been found to contain 80 mg/100 g Calcium oxalate crystal and 85.5 mg/100 g and phytate (Marfo and Oke, 1988) whose effect could be minimized by boiling, baking and fermentation to make cocoyam an excellent source of carbohydrate.

*Clarias gariepinus* (Burchell, 1822) is one of the most suitable aquaculture species in Africa. This catfish has been credited for been hardy, resistance to stress, omnivorous, better growth and feed conversion ability. The high quality and better taste of its flesh makes it a highly demanded fish, hence there is a need to increase the local production of this species at cheaper production cost (Sogbesan and Ugwumba, 2008).

This study aimed at evaluating the effect of substitution of maize with cocoyam tuber on growth, nutrient utilization and economic benefits of *C. gariepinus* juvenile.

## MATERIALS AND METHODS

### Purchase and processing of feed ingredients

Cocoyam used for the research was purchased from local market in Lagos, Nigeria while other feed ingredients were purchased from a feed miller within the metropolis in Lagos, Nigeria. The cocoyam tuber was peeled and sliced. The thin sliced cocoyam was parboiled for 3 min and then sun dried for 3 – 4 days. Samples of the boiled dried cocoyam slices were submitted for proximate analysis (AOAC, 1997). Graded levels of cocoyam were substituted at 0, 25, 50, 75 and 100% for maize meal as shown in Table 2. Measured quantities of the different ingredients were mixed, blended together and passed through a meat mincer to give fish pellet of approximately 2 mm size.

### Experimental fish, water management and feeding procedure

Seventy-five juvenile of *C. gariepinus* mean weight 9.86 g acclimatised for seven days were randomly stocked at the rate of 5 juvenile per plastic tank in triplicate into 15 plastic tanks of dimension 40 × 56 × 31cm for the growth trials. Each of the diets was fed at 5% body weight twice daily (9:00 - 10:00 and 17:00 - 18:00) for 70 days and the quantity of feed was adjusted based on the new weight after 10 days. Each tank was monitored for survival rate.

Water parameter records were taken twice a week before feeding, temperature at (7:00 - 8:00) with Mercury-in-glass thermometer calibrated in degree centigrade (℃). Dissolved oxygen was determined by using the Winkler's solution and pH of water was determined with pH meter (E251) model.

## DATA COMPUTATION

The data on weight gain record and feed supplied were computed every 10 days and later used to compute the growth, feed utilization and economic parameters using the following formulae:

Mean weight gain (g) = Mean final weight – Mean initial weight
Specific growth rate (SGR) = $(\text{Log}W_2 - \text{Log}W_1) \times 100 / T_2 - T_1$, were $W_2$ and $W_1$ = final and initial weight; $T_2$ and $T_1$ =final and initial time.

Feed conversion ratio (FCR) = Feed fed (DM) / Fish weight gain
Protein efficiency ratio (PER) = Mean weight gain per protein fed
Protein Intake (PI) = Feed intake x crude protein of feed.

The cost was based on the current prices of feed ingredients in the experimental locality (Nigeria) as at the time of purchase. The economic evaluations of the diets were calculated from the method of New (1989) as:

Estimated Investment cost analysis (EICA) = cost of feeding (CoF) ($) + cost of fingerlings stocked.
Profit index (PI) = value of fish ($) / CoF $
Net profit = sales – expenditure
Benefit cost ratio (BCR) = total sales in ($) / total expenses ($).

### Statistical analyses

Results were analysed using analysis of variance (ANOVA). Duncan multiple range test (Duncan, 1955) was used to evaluate the mean differences among individual diets at 0.05 significant levels, correlation analysis and broken line model of Robbins et al. (1979) was used to estimate the optimal non-conventional feed inclusion levels based on the mean specific growth rate of the fish.

## RESULTS

The water parameters ranges were 27.5 - 29.5℃, 4.5 - 4.8mgL$^-$1 and 7.3 - 8.0 for temperature, dissolved oxygen and pH, respectively, for all the treatments.The proximate composition of the test ingriedient is shown in Table 1, while the composition of both the control and experimental diets are shown in Table 2. All diets are isocalorific and isonitrogenious. The feeding trials revealed that *C. gariepinus* responded to all the diets since increase in weights was recorded as shown in Table 3. The SGR were higher in the control up to 50% graded levels of cocoyam compared to ≥75% graded levels. The best FCR and PER values were recorded in treatment diet 1. All the parameters studied were significantly different ($p<0.05$) to the control and those at ≥75%. Lowest EICA and IC were from the control treatment.The highest BCR was also obtained for diet 1. *C. gariepinus* fed on the control and diet 2 treatments had the highest significantly difference correlation r = 0.994; $p<0.05$ compared to the parameter indices values used (Table 4). There were negative correlations between FCR and other indices considered except IC while the situation with SGR is vice-versa. The broken-line analysis showed that there was a low rank correlation $R^2 = 0.498$, $p<0.05$ between the SGRs recorded and the dietary treatments and a quadratic equation of Y (SGRs) = $y = -0.925x^2 + 0.617x$ (graded levels of cocoyam) + 1.120 (Figure 1).

## DISCUSSION

The proximate composition obtained for cocoyam in this experiment is similar to the values obtained by Agwunobi et al. (2002). All the diets have similar crude protein and energy values.

**Table 1.** Proximate composition of cocoyam (%dm).

| Composition | Value (%dm) |
|---|---|
| Crude protein | 5.19 |
| Crude fibre | 2.86 |
| Ether extract | 0.40 |
| Ash | 3.20 |
| Carbohydrate | 88.04 |

**Table 2.** Feed composition of experimental diets (kg).

| Ingredients | Control (%) | Diet 1 (%) | Diet 2 (%) | Diet 3 (%) | Diet 4 (%) |
|---|---|---|---|---|---|
| Fishmeal (72%) | 25 | 25 | 25 | 25 | 25 |
| Soybean meal | 38 | 38 | 38 | 38 | 38 |
| Maize | 30 | 22.5 | 15 | 7.5 | 0 |
| Wheat offal | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 |
| Oil | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 |
| Dicalcium phosphate | 2 | 2 | 2 | 2 | 2 |
| Premix* | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Cocoyam meal | 0 | 7.5 | 15 | 22.5 | 30 |

*, Vitamin and minerals: Vitamin A-10,000,000 IU; D3-2,000,000IU; E-23,000 mg; BI-3000 mg; B2-6000 mg; Nacin-50,000 mg; Calcium pathonate-10,000 mg; B6-5000 mg; B12-25.0 mg; Folic acid 1000 mg; Biotin-50.0 mg; Choline chlorine-400,000 mg; Manganese-120,000 mg; Iron-100,000 mg; Copper-8,500 mg; Iodine-1500 mg; Cobalt-300 mg; Selenium-120 mg; Anti-oxidant 120,000 mg.

**Table3.** Performance of *C. gariepinus* juveniles fed different experimental diets.

| | Control | Diet 1 | Diet 2 | Diet 3 | Diet 4 |
|---|---|---|---|---|---|
| Inclusion levels of cocoyam (%) | 0 | 25 | 50 | 75 | 100 |
| MWG (g) | 20.70$^{b}$ | 28.48$^{a}$ | 21.16$^{b}$ | 13.70$^{c}$ | 17.80$^{c}$ |
| SGR (%/day) | 1.01$^{b}$ | 1.47$^{a}$ | 1.10$^{b}$ | 0.94b$^{c}$ | 0.89$^{c}$ |
| FCR | 1.38$^{bc}$ | 0.86$^{c}$ | 1.89$^{b}$ | 2.64$^{a}$ | 2.91$^{a}$ |
| PER | 1.81$^{d}$ | 2.94$^{a}$ | 2.49$^{b}$ | 2.00$^{c}$ | 1.90$^{cd}$ |
| CoF | 1.53$^{c}$ | 1.65$^{c}$ | 2.09$^{b}$ | 2.42$^{a}$ | 2.42$^{a}$ |
| CoFS | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| EICA | 21.53 | 21.65 | 22.09 | 22.42 | 22.42 |
| Mean yield | 23.79$^{b}$ | 26.58$^{a}$ | 23.25$^{b}$ | 23.41$^{b}$ | 22.91$^{c}$ |
| NP | 2.26$^{b}$ | 4.93$^{a}$ | 1.76$^{c}$ | 0.99$^{d}$ | 0.49$^{c}$ |
| BCR | 1.11$^{b}$ | 1.23$^{a}$ | 1.08$^{b}$ | 1.04$^{bc}$ | 1.02$^{c}$ |
| PI | 15.55$^{b}$ | 16.11$^{b}$ | 11.41$^{c}$ | 19.67$^{a}$ | 9.47$^{d}$ |
| IC | 0.06$^{b}$ | 0.06$^{b}$ | 0.09$^{ab}$ | 0.10$^{a}$ | 0.11$^{a}$ |

Data on the same row with the different superscripts are significantly different at p=0.05. MWG=Mean weight gain,SGR=specific weight gain,FCR=feed conversion ratio,,PER=protein efficiency ratio,CoF= cost of feeding, CoFS= Cost of fingerlings. EICA = Estimated investment cost analysis, NP = net profit, BCR = benefit cost ratio, PI= profit index, IC = investment cost.
(PI) = Value of fish ($) / CoF $ (BCR) = Total.

The increase in weight recorded from each treatment shows that the fish fed were able to utilize each of the dietary treatment and justify the fact that the diets contain adequate dietary protein and other nutrients required by the fish. A similar result was obtained by Solomon et al. (2007) when they fed Tilapia (*Oreochromis niloticus*)

**Table 4.** Paired correlation of the performances indices of *C. gariepinus* fed the experimental diets.

| | FCR | SGR | PER | NP | BCR | PI | IC |
|---|---|---|---|---|---|---|---|
| FCR | 1 | | | | | | |
| SGR | -0.8483 | 1 | | | | | |
| PER | -0.63002 | 0.920441 | 1 | | | | |
| NP | -0.92582 | 0.970333 | 0.799891 | 1 | | | |
| BCR | -0.93818 | 0.96193 | 0.780521 | 0.999097 | 1 | | |
| PI | -0.24902 | 0.195896 | 0.047877 | 0.290869 | 0.279087 | 1 | |
| IC | 0.960439 | -0.69896 | -0.4021 | -0.83742 | -0.85672 | -0.3507 | 1 |

SGR = Specific weight gain,FCR = feed conversion ratio,,PER = protein efficiency ratio,CoF = cost of feeding, CoFS= cost of fingerlings, EICA = estimated investment cost analysis, NP = net profit, BCR= benefit cost ratio, PI = profit index,IC = investment cost.

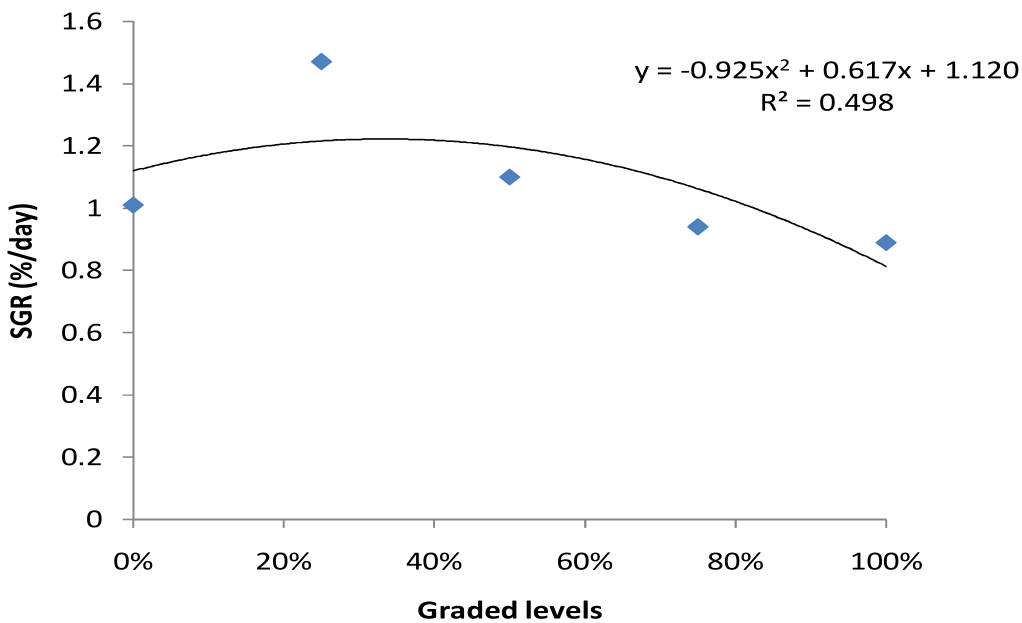


**Figure 1.** Broke-line analysis of the effect of cocoyam on the specific growth rate of *C. gariepinus*.

fingerlings on different grains.

The quadratic equation pattern observed in juvenile *C. gariepinus* conforms to the pattern noted for the fingerlings of *Heterobranchus longifilis* fed termite meal diets (Sogbesan and Ugwumba, 2008). Also similar observations had been reported for *Cirrhinus mrigala* fingerlings and fry fed diets of different protein contents (Hassan, 1993; Hassan et al., 1995). The result of the FCR clearly indicate that the graded levels of cocoyam for maize in the treatments showed a better utilization of the experimental diets at lower inclusions of cocoyam and higher maize than the vice-versa. This could be linked to the higher fibre content in cocoyam tuber than maize grain since high crude fibre of ingredient reduced digestibility of such ingredient (Madu et al., 2003; Ibiyo and Olowosegun, 2005). It could also mean that there is limitation to carbohydrate digestibility by *C. gariepinus* since it is a carnivorous/omnivorous fish and lacks serious cellulose activities in its gut for effective carbohydrate digestibility.

Increase in feed efficiency along with weight gain in fish reported in this study conforms to those of Shiau and Huang (1990). The higher fish growth recorded at 25% graded levels of cocoyam than the control indicated a synergetic effect between the utilization of the polysaccharides in maize and cocoyam in that the *C. gariepinus* juvenile fed was able to convert this into muscle for growth. Wilson and Poe (1987) had earlier reported that *Ictalarus punctatus* utilized polysaccharides for growth better than disaccharides. In another work by Agwunobi et al. (2002), boiled cocoyam fed to weaning piglet gave similar growth performance when compared with the control diet (maize based diet) even up to 50%. The result also agrees with the report of Solomon et al. (2007) that up to 57% inclusion level of cereal grain can be effectively utilised by tilapia. Since there was no significant difference between most of the measured indices considered in this study for catfish fed control, diet 1 and diet 2, supplementation of cocoyam for maize could still be recommended to 50% graded level. It had been documented by NRC (1993) that since carbohydrate is the least expensive source of dietary energy, the maximum tolerable concentration should be used as regards a particular fish species. The fact that highest correlation was recorded (Table 4) between the control and diet 2 treatments, indicate a very strong association between this treatment and possibility of replacing one for the other.

## REFERENCES


Agwunobi LN, Angwukam PO, Cora OO, Isiaka MA (2002). Studies on the use of Colocasia esculenta (Taro cocoyam) in the diet of weaned pigs.Trop. Anim. Health Prod. 34(3): 241-247.

AOAC (1997). Official Methods of Analysis, 16th ed. Association of Official Analytical Chemists: Washington.

Duncan D (1955). Multiple range tests and multiple F tests. Biometrics. 11: 1-42.

Fagbenro OA, Adebayo OT (2002). An overview of the animal feed industry in Nigeria. In: Livestock and fish feeds in sub-Saharan African. FAO fisheries technical paper: FAO, Rome.

Falayi BA, Balogun AM, Adebayo OT, Madu CT, Eyo AA (2003). Leaching of Feed nutrients, economic losses to fish farming. J. Aqua. Sci. 18(2): 119-124.

Falayi BA, Balogun AM, Adebayo OT, Madu CT, Eyo AA (2004). Comparison of seven locallyprepared starches Nigeria with sodium carboxyl methylcellulosefor water stability in African catfish (Clariasgariepinus) feeds. J. Sustainable. Trop. Agric. 9 : 104-108.

Garcia-Gallego MJ, Bazoco H, Akharbach MD, Suarez A (1994). Utilization of different carbohydrates by European eel. (Anguilla anguilla). Aquaculture 124: 99-108.

Garcia-Gallego M, Bazoco JH, Suarez MD, Sanz A (1991). A comparative study of the nutritive utilization of dietary carbohydrate by eel and trout.1v int.symp. Fish Nutr. Feed; 24-27 june, Biarritz (France).

Hassan MA (1993). Energy nutrition and biological aspects of energetic in selected cultivable fish species. PhD. Thesis, Aligarh Muslim University, Aligarh, 111 p.

Hassan MA, Kafri AK, Afreens SA, Rana S, Usman N (1995). Dietary energy and protein interaction- An approach to optimizing energy:protein ratio in indian major carp, Cirrhinus mrigala (Hamilton) fingerlings. J. Aqua. Tropics. 10: 183-191.

Ibiyo LM, Olowosegun T (2005). On-farm feed: The potential for improving profitability in aquaculture. In Proceedings of the 19th annual conference of Fisheries Society of Nigeria, Ilorin. (Araoye, P.A. ed.) pp. 45-53.

Lee W (1999). Taro (Colocasia esculenta) Southern Illinois University Carbondale / ethnotanial leaflets http:// www.siu.edu/ebl.

Lovell R T (1989). Nutrition and feeding of fish.Van Nostrand Reinhold: New York; p. 260.

Madu CT, Sogbesan OA, Ibiyo LMO (2003). Some Non-conventional fish feed resources in Nigeria. In:A.A. Eyo (Ed.), Proceeding Joint FISON/NIFFR/SPFS National workshop on Fish feed and Feeding Practices in Aquaculture held. NationalInstitute for Freshwater Fisheries Research, 15th -19thSeptember, 2003. New- Bussa; 73-82.

Marfo EK, Oke OL (1988). Changes in phytate content of some tubers during looking and fermentation. J. Nutr. p. 119.

National Research Council NRC (1993). Nutrient requirements of fish. National Academy press: Washington p. 114.

New MB (1989). Formulated Aquaculture Feeds in Asia: Some Thoughts on Comparative Economics, Industrial Potential, Problems and Research Need in Relation to Small-Scale Farmer. In report of the Workshop on Shrimps and Fin Fish Feed Development (Bahru, J.E. Ed.) ASEAN/SF/89/GGEN/11.

Okoye FC, Eyo AA, Aminu NG (2001). Growth of Tilapia, Oreochromis niloticus hybrid fingerlings fed lipid-based diets. In: Fish Nutrition and Fish Feed Technology (Eyo, A.A. Ed) pp. 53-58.

Robbin KR, Norton HW, Barker DH (1979). Estimation of nutrient requirements from growth data. J. Nutr. 109: 1710-1714.

Shiau SY, Lin SL (1993). Effect of supplemental dietary chromium and vanadium on the utilization of different carbohydrate in tilapia, Oreochremis niloticus (O. aureus). Aquaculture 110: 321-330.

Shiau SY, SL Haung (1990). Influence of varying energy levels with two protein concentration in diets for hybrid tilapia(Oreochromis niloticus xO.aureus) reared in sea water. Aquaculture 91: 143-152.

Sogbesan AO, Ugwumba AAA (2008). Nutritional Evaluation of Termite (Macrotermes subhyalinus) Meal as animal protein Supplements in the Diets of Heterobranchus longifilis (Valenciennes, 1840) Fingerlings. Turk. J. Fish. Aquat. Sci. 8: 149-157.

Solomon SG, Tiamiyu LO, Agaba UJ (2007). Effect of feeding different grain sources on the growth performance nd body composition of Tilapia (Oreochromis niloticus) fingerlings fed in outdoor hapas. Pakistan J. Nutr. 6(3): 271-275.

Tacon AGJ (1993). Feed ingredients for warm water fish: fishmeal and other processed feedstuffs. FAO Fisheries Circular No.856, FAO Rome.

Wilson RP, Poe WE (1987). Apparent digestibility of channel catfish to utilize dietary mono-disaccharides as energy sources. J. Nutr. 17: 280-285.