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Effects of replacing soya bean meal with fermented African locust bean (*Parkia biglobosa*) meal on the growth performance and condition factor of *Tilapia zilli* fingerlings

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ABSTRACT: The study was conducted to evaluate the performance characteristics of *Tilapia zilli* fingerlings fed with locust bean meal as a replacement for soya bean meal in the diet. Two hundred and ten (210) heterogeneous sexes of *Tilapia zilli* fingerlings with mean weight of 15.24±0.01g were reared for 84 days in five rectangular glass tanks measuring 0.9 m x 0.45 m x 0.45 m and partitioned into three replicates with 14 fingerlings in each replicate. Five experimental diets were formulated at 0% (soya bean meal only), 25%, 50%, 75% and 100 % locust bean meal inclusion levels at T1, T2, T3, T4, and T5 respectively. Results showed that there were no significant differences (p>0.05) among the treatments as compared to mean weight gained, feed intake, feed conversion ratio, specific growth rate, protein efficiency, mortality/survival rate. Fish fed 100% locust bean meal showed the best growth performance in body weight gain, food conversion ratio and specific growth rate (SGR) but with poor condition factor and high mortality rate (54.76%). The study indicated that fermented African locust bean meal could be included in the diets of *Tilapia zilli* at 50% inclusion level from the view point of low mortality rate and final condition factor over other treatments. African locust bean meal could also be recommended for food security management purposes in replacing soya bean meal in order to reduce conflict that could emanates from the wide range of usage for other dietary purposes.

Keywords: Fingerlings, fish, performance characteristics, plant protein meal, substituting.

INTRODUCTION

Aquaculture industry has been globally recognized as the fastest growing food producing industry. According to NACA (2004), aquaculture contributes more than 19 million tons of fish annually to the world fish supply, thus the industry plays important roles in meeting the ever increasing demand for fish by the teaming world population. In the same vain, aquaculture in Nigeria is gaining importance through employment creation and income generation, particularly in the socio-economically weaker fishers' folks which represent the poorest section of the society in many developing countries. The growth and intensification of aquaculture for fish production has raised several issues that need to be addressed for the sustainability of the industry such as development of fish feed from high quality, inexpensive sources as well as method for making the feed free from anti-nutritional factors by using cheap, unconventional, and readily available source of feed ingredients for fish feed formulation (NACA, 2004).

Fish nutrition is an integral part of modern commercial aquaculture practices that provides balanced nutrition required by cultured fish by providing a broad knowledge of the function of each of it constitutes in the choice of the most suitable commercial ration for the fish in formulating diets (Houlihan et al., 2001). According to Tom and Van-Nostrand (1986), there are progressive studies on fish nutrition within the last few years with the development of original balanced commercial diets for optimal growth and health of fish. Good nutrition is essential in the production of aquatic animals because it enables production of healthy and high quality product. The development of new species-specific diets formulations from feed ingredients that supplies protein, carbohydrates, vitamins lipids and minerals requirement supports the aquaculture industry as it expands to satisfy increasing demand for affordable, safe and high quality fish and seafood products (NRC, 1993).

Oke and Umoh (1987) reported that some of the aquaculturist in the developing country cannot afford the animal products which are rich in sources of essential amino acid in the diets of their fish which led to the search for plant protein and vitamin substitutes. The research carried out in Nigeria by ICLARM (2007) on the replacement of soya meal with another plant protein sources in the production of animal feed most especially fish feed. To meet the increasing demand of animal feeds with adequate protein content most especially in the Tilapia culture gave impetus in the use of plant protein source in the replacement of animal protein source.

Plants provide nearly 2/3 of the world supply of food protein for human and animal in which 10 TO 15% come from legumes. Among the leguminous plants used by man is the African locust bean tree (*Parkia biglobosa*) (Fetuga et al., 1974). African locust bean (*Parkia biglobosa*) has been found useful especially in the fermented form with nutritional composition of 38.50% crude protein, 21.17% fat, 2.00% crude fiber, 1.80% ash and 36.13% carbohydrate (Odebunmi et al. 2010). This plant belongs to the family, Fabaceae and seed of the plant is dicotyledons as documented by Odebunmi et al. (2010).

Tilapia is a genus of fish in the cichlid family and a native to Africa in warm freshwater habitat in many countries. There are about 100 species of the cichlid family with the common name of Tilapia. *Tilapia zilli* is one of the most common farmed Tilapia species in the world. *Tilapia zilli* is exceptionally hardy and required little or no expensive high protein feed to grow quickly. An herbivorous fish that will readily accept feed containing plant materials as feed. The adult reaches sexual maturity at age of 5 to 6 months and grow to 60 cm in length and up to 4.2kg in weight within one year under a good growth condition as highlighted by Froese and Pauly (2013).

This study is focused on the replacement of soya bean meal with fermented African locust bean meal (*Parkia biglobosa*) in formulating fish diets using *Tilapia zilli* as a test animal.

MATERIALS AND METHODS

The study was conducted in the Grow-out Unit of Fisheries Technology Department, Lagos State Polytechnic, Ikorodu Lagos. Two hundred and ten (210) heterogeneous sexes of *Tilapia zilli* fingerlings with mean weight 15.24±0.01 g sourced from hatchery unit of department was used as test animal. The test animals were acclimatized by undergoing starvation therapy for 24 hours. Fresh water from departmental overhead tank supplied by water borehole was used throughout the experimental periods. Electronic weighing scale, models SP-60 calibrated to 2- decimal place was used to take the routing weight of the test animals. Water test kit that contains Hand-held digital pH meter, Dissolved oxygen meter and temperature gauge of model PCT-407 was used to monitor water quality parameters during the experiment. Air pump aerator of model 9.5 Supreme 950 GPH was also used to improve dissolved oxygen level.

The culture system consisted of five rectangular glass tanks measuring 0.9 m x 0.45 m x 0.45 m partitioned into three (replicates) for completely randomized experimental design. Fourteen tilapia fingerlings were stocked randomly in each partitioned glass tank filled with water from overhead water tank system. The fermented locust beans (*Parkia biglobosa*) (Oladunmoye, 2007) used in the diet was sundried for 18 days and then oven dried for 30 minutes at temperature of 40°C to make the locust beans brittle for ease of grinding and adequate pulverization with other feed ingredients to formulate 15.055kg diets each for 5 experimental units at gradient levels of replacement of locust beans with soya beans meal (full fat) at 35% crude protein using Pearson's Square Method (extension.colostate.edu, 2018) as shown in Table 1. Africa locust beans meal (FALBM) was substituted with soya beans meal (SBM) at gradient levels of 0% (T1), 25% (T2), 50% (T3), 75% (T4) and 100% (T5) respectively.

The initial mean weight of fish in each experimental treatment was taken prior to the commencement of the feeding trial. The fishes were fed twice a day between 7.00 hours and 16.00 hours at the rate of 5% body biomass which was adopted for 12 weeks. The daily ration was divided into two halves, one for morning feeding allotment and second half for afternoon feeding allotment. Feeding rates were adjusted weekly for 12 weeks based on the weight gain of the test animal in each experimental unit/ treatment.

The left over feed and fecal materials were siphoned every day to reduce water pollution from decayed food and metabolites. The water in the glass tanks was changed twice in a week from overhead water tank supply to improve water quality. During the experimental period, the essential water quality parameters were monitored with water test kits.

Experimental diet evaluation on the performance characteristics of *Tilapia zilli* fingerlings are based on growth indices such as Mean Weight Gain (WG) = Final weight of fish - Initial weight of fish), Specific Growth Rate (SGR) (% per day) = (Log_e W2-Log_eW1)/T2-T1x100. Where W2 is weight of fish at time T2 (final) and W1 is weight of fish at time T1 (initial). Feed Conversion Ratio (FCR= Total feed consumed by fish (g)/Weight gained by fish (g), Protein Efficiency Ratio (PER) = Wet weight gain/ Protein fed). Mortality rate (M) = (N_o-N_t x 100%/N_o). Where, N_0 is the number at the start of the experiment and N_1 is the number at the end of the experiment. The Condition factor (K) was calculated using mathematical notation of K =W × 100/ L^3. Where: W = Weight of fish and L = Standard length of fish.

The experiment was conducted using completely randomized design where each treatment was randomly replicated with 14 fingerlings of *Tilapia zilli*. The data collected on the growth performance of *Tilapia zilli* fingerlings were statistically analyzed using one–way analysis of variance (ANOVA) according to Little and Hills (1978).

RESULTS

Table 1 shows the experimental diets formulation with percentage inclusion of each food ingredients.

The results on performance characteristics and growth indices of *Tilapia zilli* fingerlings fed with gradient replacement of soya bean meal (SBM) with fermented African locust bean meal (FALBM) in the diet over 12 weeks period are presented in Table 2. Table 2 shows that *Tilapia zilli* fingerlings fed with 100% (T5) replacement of fermented African locust bean meal (FALBM) over soya bean meal (SBM) provides the highest weight gain, best food conversion ratio and the lowest feed intake in the experimental diets. However, T5 (100%) inclusion of FALBM had the highest mortality rate and lowest condition factor. However, fishes in T1 (0% FALBM) had the least weight gain, FCR and SGR.

There were no significant differences ($p>0.05$) in the mean weight gain, feed conversion ratio (FCR), specific growth rate (SGR), initial condition factor and final condition factor in all the experimental diets but there was significant difference ($p<0.05$) in mortality rate.

Table 3 shows the mean values of the essential physicochemical parameters. The mean values were marginally different from each other in the treatment and coincidentally falls within the culturable limits for *Tilapia spp.* culture except Nitrite and Nitrate that are high in concentrations. All the nutrients and water quality characteristics were not significantly different ($p>0.05$).

DISCUSSION

The competitive use of soya bean for man and animals has been observed in the recent past especially with the increase in the awareness in nutritional value it provides, this has brought both animals and man into dietary collusion path in the use of this nutritive crop, therefore, the need to find alternative by using other source of plant protein in the diet of animals with minimal range in use for other dietary purposes that will also improve the growth characteristics is a necessity.

The present study showed the effects of replacing fermented African locust beans meal (FALBM) with soya bean meal on the growth performance of *Tilapia zilli*. Weight gain, food conversion ratio and specific growth rate increased significantly with increase in the levels of replacement of SBM with FALBM might be guided in the insight of crude protein value in FALBM that surpasses SBM (full fat) as reported by Odebunmi et al. (2010). The nutrients utilization of FALBM by *Tilapia zilli* could also be one of the responsible factors for the corresponding increment in the measured growth parameters in the experiment, this agreed with the report of Tom and Van-Nostrand (1986). However, the use of FALBM in the diet of *Tilapia zilli* should not be viewed with the intention of conflicting with human food security interest as reported by Amisah et al. (2009) as it is being used as food condiment in Africa delicacy but from the view point of crude protein content for better yield in Tilapia production because, FALBM contains 38.50% crude protein whereas SBM contains 37.51% crude protein as reported in the scientific publications of Babatunde et al. (2010) and FAO (2004).

The experimental diet that contains 100% FALBM (T5) level of inclusion performed better than any other diets in the experiment. The reason could be the effect of characteristics aroma of FALBM in the diet T5 which serves as food condiment (Babalola et al., 2016) and add flavor for better food intake, digestibility and the enhanced nutrient bioavailability in the fish as mentioned by Odunfa, (1986). No significant differences ($p>0.05$) were observed in all the experimental diets probably due to the fact that both test diets are from plant protein source that lacks essential amino acids.

The least growth parameters recorded in T1 shows that fermented African locust bean meal has more crude protein than soya bean meal, this corroborate the findings of Babatunde et al. (2010) and FAO (2004). It is obvious from the results obtained that the increase in the percentage inclusion of FALBM affects the fish growth exponentially.

Consequently, T5 had the best FCR which shows that it takes less feed to produce one kilogram of fish. This is an indication that an increase in the level of feeding can reduce FCR but in this study, T5 had the lowest feed intake which gave best FCR. This agreed with the findings of Wenk et al. (2003).

However, high mortality recorded in treatment T5 is as a result of high level of turbidity observed in the treatment from high percentage inclusion of FALBM which reduces dissolved oxygen in the water and affect over all water quality for fish survival as reiterated by Babalola and Fiogbe (2017).

The condition factor of the experimental fish is the determination of their well-being as proposed by Fulton (1904). The condition factor 'K' (Initial and Final) of all the

Table 1. Composition of experimental diets (kg) for *Tilapia zilli* fingerlings.

Ingredients	T1 (0% LBM)	T2 (25% LBM)	T3 (50% LBM)	T4 (75%LBM)	T5 (100%LBM)
Fish Meal	3.000	3.000	3.000	3.000	3.000
SBM	2.900	2.200	1.400	0.700	-
FALBM	-	0.700	1.400	2.200	2.900
Maize	8.300	8.300	8.300	8.300	8.300
Bone meal	0.750	0.750	0.750	0.750	0.750
Lysine	0.015	0.015	0.015	0.015	0.015
Methionine	0.015	0.015	0.015	0.015	0.015
Salt	0.015	0.015	0.015	0.015	0.015
Premix	0.030	0.030	0.030	0.030	0.030
Vitamin c	0.030	0.030	0.030	0.030	0.030

Table 2. Growth indices of *Tilapia zilli* fingerlings fed gradient levels of replacement of soya bean meal with processed locust bean mean (0-12) weeks.

Performance Parameters	T1	T2	T3	T4	T5
Initial weight	12.89	12.53	12.61	12.61	12
Final weight	17.59	17.95	17.85	17.85	18.28
Weight gain (g)	2.35	2.71	2.61	2.61	3.04
Feed intake (g)	2.27	2.27	2.36	2.26	2.23
Feed conversion ratio	0.97	0.84	0.90	0.87	0.70
Specific growth rate (%/fish/g per day)	0.052	0.059	0.056	0.058	0.071
Initial condition factor (K)	0.51	0.57	0.56	0.97	0.74
Final condition factor (K)	0.35	0.20	0.49	0.36	0.15
Mortality (%)	7.14	7.14	9.52	16.67	54.76

Table 3. Mean values of essential physicochemical parameters.

Parameters	T1	T2	T3	T4	T5
pH	6.4	6.2	6.1	6.4	6.7
Dissolved oxygen (mg/l)	7.20	7.21	7.00	7.80	7.24
Temperature (°C)	26.50	26.53	26.58	26.52	26.54
NO_3 (mg/l)	0.22	0.32	0.41	0.45	0.66
NO_2 (mg/l)	0.038	0.038	0.038	0.040	0.042

experimental fishes was below 1.0 indicating that the test animals before and after the feeding trials are not in good physiological conditions. Consequently, the Condition Factors were not significantly different (p>0.05) for all the treatments. This observation corroborates the work of Datta et al. (2013). This condition factor that falls below recommended standard of 1.0 is attributed to the fact that the test animals are in captivity for feeding trial of formulated feed which are void of natural feed with balanced ration found in natural body of water as reported by Amisah et al. (2009).

It was observed during the experiment that the water in culture tanks was turbid, the higher the percentage inclusion of FALBM the higher the turbidity and mortality respectively. Similarly, the progressive increase in mortality of the fish between T2 and T5 could also be attributed to the increase in the inclusion of FALBM in the diet with the attendant negative effect of excess natural organic matter from FALBM in the fish diets on the water quality. This observation supports the report of Minnesota Pollution Control Agency (2008) on the effect of pollution through feeding on the survival of aquatic organisms.

Another phenomenon observed from experimental glass tanks with FALBM inclusions that are responsible for progressive increase in mortality was the gas bubbles emanating from the glass tank water. These gas bubbles were as a result of bacterial action on residual decayed FALBM in the uneaten food that releases Ammonia Nitrogen into the air. Nitrite is toxic to aquatic animals as reported by EIFAC (1973) and cited by Babalola and

Fiogbe (2017). It causes methemoglobin which inhibits the passage of oxygen in aquatic animals causing “fish kill” (Brown and Mcleay, 1975). Also, residual effect of anti-nutritive factor in the processed locust bean meal as reported by Gernah et al. (2007) could also be responsible for the high mortality rate recorded.

The replacement of soya bean meal with fermented African locust bean meal has the potential to make considerable contributions to the performance of *Tilapia zilli* when included at the moderate levels in their diets and also, reduce the competition with other feed ingredients that are useful for other purposes. The use of plant protein source had been tried by various researchers in animal nutrition by either replacing or mixing of plant protein source in the diet of fish but the findings from such research works are not fully implemented in Nigeria because fish farmers still depend on the use of old fashion in the formulation of fish feed which takes about 40 to 50% in the production cost as explained by Bardach et al. (1986). The need for alternative use of plant protein in the fish feed formulation was corroborated in the works of El-Sayed (1999) and Amisah et al. (2009).

Conclusion and recommendations

The results from this study showed that fermented African locust beans meal could be used at recommended level of inclusion to promote growth of *Tilapia zilli* and also, serves as a good plant protein supplement that can be used to replace soya bean meal in their diet but not at high level of inclusion which could have lethal effect on the fish as shown in Table 2 but at moderate level that can enhance better performance.

This study revealed that, the use of fermented African locust beans meal as a replacement for soya bean meal in the diet of *Tilapia zilli* were not significant (p>0.05) in the weight gain, feed intake and feed conversion ratio in all the treatments but there were significant differences when compare the growth performance of fish in T5 with other treatments in the experiment. However, this cannot be recommended from the view point of high percentage mortality recorded and lowest feed intake in T5. Fermented African locust beans meal is hereby recommended to be included in the diet of *Tilapia zilli* at 50% level of inclusion which shows better condition factor and highest feed intake. This experiment should be repeated in ponds to see if better results could be obtained outside laboratory and more efforts should be geared towards effective management of water quality at T5 which affect their condition factor and increases mortality percentage.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Amisah, S., Oteng, M. A., & Ofori, J. K. (2009). Growth performance of the African catfish, *Clarias gariepinus* fed varying inclusion levels of *Leucaena leucocephala* leaf meal. *Journal of Applied Sciences and Environmental Management*, 13(1), 21-26.

Babalola, O. A., & Fiogbe D. E. (2017). Hydrology and heterogeneous distribution of water quality characteristics in the complex Porto-Novo lagoon ecosystem *Journal of Aquatic Sciences* 32(1B), 145-158.

Babalola, O. A., Onigemo. M. A., & Okochi. A. N. (2016). Growth response of *Oreochromi niloticus* fingerlings fed fermented *Parkia biglobosa* diets. *Journal of Aquatic Sciences,* 31(2B), 365-372.

Babatunde, R. O., Olagunju, F. I, Fakayode, S. B., & Adejobi, A. O. (2010). Determinants of participation in off-farm employment among small-holder farming households in Kwara State, Nigeria. *Production, Agriculture and Technology*, 6(2), 1-14.

Bardach, J. E., Ryther, J. H., & McLarney, W. O. (1986). Aquaculture, the farming and husbandry of Freshwater and marine organisms. Wiley-Inter Science Inc. New York. 868p.

Brown, D. A., & McLeay, D. J. (1975). Effect of nitrite on methemoglobin and total hemoglobin of juvenile rainbow trout. *The Progressive Fish-Culturist*, 37(1), 36-38.

Datta, S. N., Kaur, V. I., Dhawan, A., & Jassal, G. (2013). Estimation of length-weight relationship and condition factor of spotted snakehead *Channa punctata* (Bloch) under different feeding regimes. *SpringerPlus*, *2*(1), 436.

EIFAC (1973). *water quality criteria for European freshwater fish*. Available at http://www.fao.org/docrep/017/. Accessed 6th October, 2018.

El-Sayed, A. F. M. (1999). Alternative dietary protein sources for farmed tilapia, Oreochromis spp. *Aquaculture*, 179(1-4), 149-168.

Extension.colostate.edu. (2018). “*Fall Forum”.* Available at http://extension.colostate.edu/forum/. Accessed 6th October, 2018.

FAO (2004). *Protein sources for the animal feed industry*. FAO, Animal Production and Health Proceedings ISBN 92-5-105012-0.

Fetuga, B. L., Babatunde, G. M., & Oyenuga, V. A. (1974). Protein quality of some unusual protein foodstuffs. Studies on the African locust-bean seed (Parkia filicoidea Welw.). *British Journal of Nutrition*, 32(1), 27-36.

Froese, R., & Pauly, D. (2013). *Fish stocks*. Encyclo-pedia of Biodiversity (ed S. Levin), 3rd edn. Academic Press, Cambridge, MA, Pp. 477-487.

Fulton, T. W. (1904). The rate of growth of fishes. *Twenty-second Annual Report*, 141-241.

Gernah, D. I., Atolagbe, M. O., & Echegwo, C. C. (2007). Nutritional composition of the African locust bean (*Parkia biglobosa*) fruit pulp. *Nigerian Food Journal*, *25*(1), 190-196.

ICLARM (2007). *Oreochromis niloticus.* Available at http://issg.org/database/species/ecology/. Accessed 6th October, 2018.

Little, T. M., & Hills, F. J. (1978). *Agricultural experimentations–Design and analysis*. Wiley, New York. p. 350

Minnesota Pollution Control Agency (2008). Strategic Plan. Available at https://www.pca.state.mn.us/sites/. Assessed 6th October, 2018.

NACA (2004). *Sustainability in Aquaculture: designing for the future*. Report no. 04.2.081E. NL – 2500 EK The Hague. ISBN:

90 – 5059 – 230 – 9
National Research Council (NRC) (1993) *Nutrient requirements of fish*. National Academy Press, Washington DC. 114p.
Odebunmi, E. O., Oluwaniyi O. O., & Bashiru, M. O. (2010). Comparative Proximate Analysis of some Food Condiments. *Journal of Applied Sciences Research,* 6(3), 272-274.
Odunfa, S. A. (1986). *Dawadawa In: Legume based fermented of foods*. Ed. Reddy, N. R., Pierson, M. D., Salunkhe, D. K. (eds.). CRC Press Inc. Boca Raton, Florida.
Oke, O. L., & Umoh, I. B (1987). Lesser-known, oil seeds chemical composition. *Nutri. Rep. Int*., 17, 293-297.
Oladunmoye, M. K. (2007). Effects of fermentation on nutrient enrichment of locust beans (*Parkia biglobosa*, Robert bam). *Research Journal of Microbiology*, 2(2), 185-189.
Tom, L., & Van-Nostrand, R. (1986). *Nutrition and feeding of fish*. New York. p. 260.
Wenk, C. Pfirter, H. P., & Bickel, H. (2003). Energetic aspects of feed conversion in growing pigs. *Livestock Production Science,* 7(5), 483-495.