Length Weight Relationship of Heteroclarias Fingerlings Fed Different Replacement Levels of Moringa Oleifera Leaf Meal

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Abstract
This study examined the influence of *Moringa oleifera* leaf meal (MOLM) as a partial replacement for soybean meal on the length–weight relationship of hybrid African catfish (Heteroclarias) fingerlings. Four iso-nitrogenous diets containing 40% crude protein were formulated using locally sourced ingredients, with MOLM included at 0%, 15%, 30%, and 45% levels. Fresh M. oleifera leaves were harvested, shade-dried for three days, milled, and incorporated into the experimental diets. A total of nine fingerlings were randomly stocked per treatment in duplicate, using twelve 30-L plastic tanks. Fish were fed at 3% of their body weight twice daily (09:00 and 17:00 h) over an eight-week period. Bi-weekly measurements of length and weight were taken, and feed quantities adjusted accordingly.
Results indicated that fingerlings in treatments 1, 2, and 4 exhibited negative allometric growth, with regression coefficient (b) values of 0.6143 ± 0.0860, 0.5315 ± 0.1435, and 2.1140 ± 0.1471, respectively. In contrast, treatment 3 (30% MOLM) demonstrated positive allometric growth (b = 3.0330 ± 0.3402). Overall, the regression slope values ranged between 0.6114 and 3.033. The findings suggest that dietary inclusion of M. oleifera leaf meal enhances growth performance and nutrient utilization in Heteroclarias fingerlings when compared with the control diet.

Keywords: Heteroclarias, length–weight relationship, Moringa oleifera, soybean meal

Introduction

The demand for fish continues to rise due to increasing human population and the recognized health benefits of fish consumption. Consequently, aquaculture has become the fastest-growing food-producing sector in the world (FAO, 2000; FAO, 2006). As fish farming intensifies, the feed industry is increasingly challenged to supply nutritionally balanced diets that can support optimum growth of cultured fish. Protein and energy supplements constitute the major components of fish feeds. Tiamiyu et al. (2015) reported that conventional feedstuffs are becoming scarce as a result of rising prices. Moreover, many of these ingredients are also in high demand for human consumption. To reduce this competition between humans and animals, there is a need to explore locally available, inexpensive, and widely accessible materials to replace costly conventional feed ingredients.

Moringa oleifera is a fast-growing plant widely distributed in tropical and subtropical regions of Africa, with numerous industrial and medicinal applications. Recently, it has attracted considerable attention from researchers. Moringa is an indigenous plant originally found growing wild in Northern India and Pakistan. It was later introduced into Southeast Asia and is now cultivated throughout the tropics, where it is also found in a naturalized state in many areas.

The inability of aquaculture to bridge the widening gap between fish supply and demand in Nigeria is attributed to several factors,

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including the lack of quality feeds. In many cases, compost materials and occasional animal droppings serve as the main feed inputs in ponds. However, these inputs only support limited growth, as further development is restricted by insufficient nutrients from primary production (Edwards et al., 2000). Enhanced growth can only be achieved through the provision of supplementary feeds to meet the increased nutritional demands.

The high cost, fluctuating quality, and uncertain availability of fish meal have necessitated the search for alternative protein sources in fish feed formulation. To achieve moreeconomical, sustainable, environmentally friendly, and viable aquaculture production, research has increasingly focused on the evaluation of non-conventional plant protein sources. Aquaculture researchers are exploring cheaper alternative proteins to replace fish meal in aquafeeds. The decline in global fish meal production further indicates that the sustainability of the industry will depend on the consistent supply of plant-based protein sources. At present, many fish farmers rely on cereal bran, kitchen waste, and green leaves as feed inputs.

The length–weight relationship (LWR) is an important tool in fisheries assessment, as it helps predict weight from length measurements, which are essential in yield estimation and biomass calculations (Kubicki *et al.,* 2005). The parameters of the LWR ("a" and "b") and the condition factor (K) are influenced by factors such as feeding intensity, food availability, fish size, age, sex, season, stage of maturation, gut fullness, degree of muscular development, amount of stored fat, and life history (Bagenal and Braum, 1978).

In sampling programmes, it is usually easier to measure length than weight, and the LWR of a species can be used to convert between these parameters. It also enables morphometric comparisons among species and populations. Furthermore, the LWR allows for the estimation of fish condition, providing valuable information about the structure and functioning of fish populations (Bagenal and Braum, 1978). The condition factor is an index that reflects the interaction between biotic and abiotic factors affecting the physiological state of fish (Thomas, 2005).

It indicates the general well-being of the population at different stages of the life cycle. The analysis of fish condition has become a standard practice in fisheries management, serving as a measure of both individual and group (age or size class) fitness. The condition factor is generally described as the overall health status of an individual fish and is commonly estimated by comparing its weight at a given length to a standard weight. It can also be assessed through physiological parameters related to energy reserves, such as tissue lipid content and reproductive condition (Pauly, 1993). The condition factor typically increases as sexual maturation approaches. Its values vary among individuals and may fluctuate annually within the same population. Environmental factors, such as temperature, can also influence the condition factor by affecting fish behaviour, metabolism, and food availability**.**

Materials and Methods

Study Location

The experiment was conducted at the Hatchery Complex of the Department of Fisheries and Aquaculture, Federal University Dutse, Jigawa State, Nigeria. It is located on latitudes 11° 70' North and longitude 9° 33' East and altitude of 431m above sea level (Elevation-map, 2019).

Experimental Fish

Seventy-two Heteroclarias fingerlings were obtained from a commercial hatchery in Kano State and acclimatized for seven days prior to the feeding trial.

Experimental Design

A Completely Randomized Design (CRD) was adopted for the experiment. Nine (9) Heteroclarias fingerlings were randomly stocked in duplicate for each treatment and fed twice daily at 3% of their body weight for a period of eight (8) weeks.

The treatments consisted of graded levels of *Moringa oleifera* leaf meal at 0%, 15%, 30%, and 45% dietary inclusion. Four diets containing 40% crude protein were formulated and designated as T1 (control, 0%), T2 (15%), T3 (30%), and T4 (45%). The feed ingredients were weighed using a sensitive digital scale, thoroughly mixed, pelleted, and sun-dried. The pellets were then properly labeled and stored at room temperature until use, following the method of Falayi (2003).

Identification, Collection and Preparation of Test Ingredient (*Moringa oleifera* leaf meal)

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The plant was identified and authenticated at the Department of Crop Science, Faculty of Agriculture, Federal University Dutse, Jigawa State, Nigeria.

Moringa oleifera leaves were collected from the domestic garden of Zaharaddeen Aliyu in Jahun Local Government Area, Jigawa State, Nigeria. The leaves were washed to remove contaminants, air-dried, milled into powder, sieved, and then stored in an airtight container until use, following the method of Farombi and Fakoya (2005).

Experimental Procedure and Management

Fish weight and length were measured using a top-loading sensitive digital scale and a measuring board, respectively. The measurements for all fish were taken on a bi-weekly basis.

Experimental Diets

Forty (40) percent crude protein diets were formulated using Pearson's square method.

Table 1. The table shows the proportions of different ingredients used in the formulation.

Ingredients	MOM1 (0%)	MOM2 (15%)	MOM3 (30%)	MOM4 (45%)
Fishmeal	12.96	12.96	12.96	12.96
Soybean	51.86	44.08	36.30	28.52
White maize	10.06	10.06	10.06	10.06
Wheat offal	20.12	20.12	20.12	20.12
MOM	0.00	7.78	15.56	23.34
Vegetable oil	1.50	1.50	1.50	1.50
Vit-Min Premixes	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50
Binder	1.00	1.00	1.00	1.00
Total	100	100	100	100

Water Quality Assessment

The water quality parameters monitored included temperature, pH, and dissolved oxygen. After feeding the fish for eight (8) weeks, growth performance and nutrient utilization were evaluated.

Condition factor (K)

The condition factor of Heteroclarias fingerlings were calculated according to (Madu *et al.*, 2003).

$$(K) = \frac{W \times 100}{L^3}$$

Where: W = Final weight of fish (g),
L = Final total length of fish (cm)

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Statistical Analysis

The data obtained were subjected to analysis of variance (ANOVA) to determine the level of significance at the 0.05 probability level. Where significant differences occurred, the means were separated using Duncan's Multiple Range Test (DMRT) with the aid of SPSS software.

Results

Assessment of Length-Weight Relationship

Treatment 3 indicated an isometric growth with b value of 3.033±0.14 while treatment 1, 2, and 4 indicated a negative allometric growth.

Table 2. Shows Length-Weight Relationship of the Experimental Fish

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Treatments	a	b	Equation	GP		
1	0.3869±0.1108	0.6143±0.0860	Y=0.6143*X+0.3869	NA		
2	0.5466±0.1853	0.5315±0.1435	Y=0.5315*X+0.5466	NA		
3	-2.289±0.4513	3.0330±0.3402	Y=3.033*X-2.7890	IS		
4	1.5260±0.1959	2.1140±0.1471	Y=2.1140*X-1.5260	NA		

KEYS: **a**= intercept of regression line, **b**= slope of regression, **GP**= growth pattern, **NA**= negative allometric**,** **IS**= isometric growth, when **b=3** represents isometric growth, **b<3** signifies negative allometric and **b>3** indicates positive allometric.

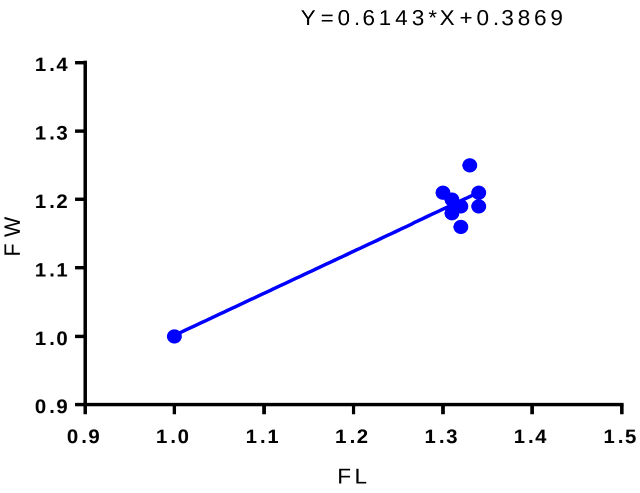

Figure 1. Length-Weight Relationship of Experimental Fish Fed Treatment 1

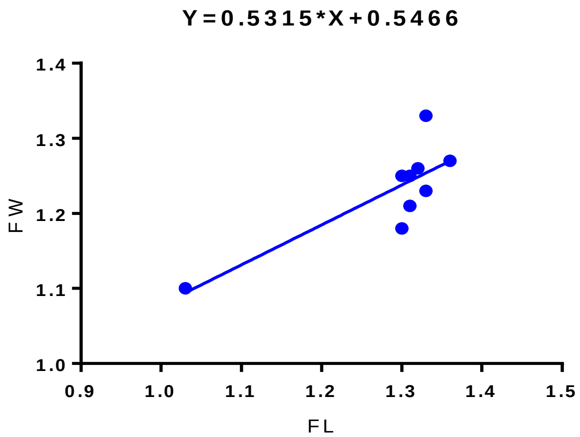

Figure 2. Length-Weight Relationship of Experimental Fish Fed Treatment 2

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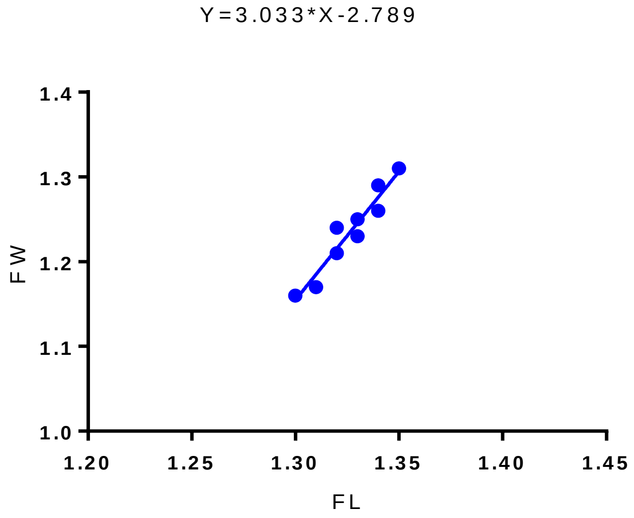

Figure 3. Length-Weight Relationship of Experimental Fish Fed Treatment 3

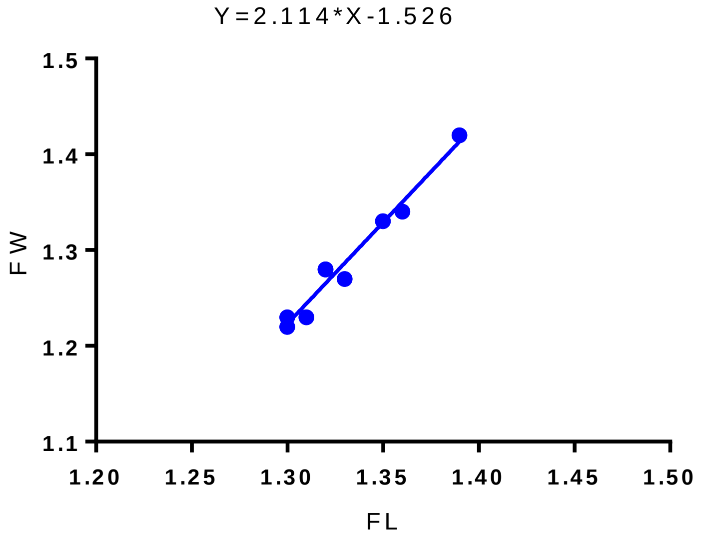

Figure 4. Length-Weight Relationship of Experimental Fish Fed Treatment

Discussion

Assessment of Length-Weight Relationship

The assessment of the length–weight relationship of Heteroclarias in this study showed that the simple linear regression slope (b) ranged between 0.6114 and 3.033. This result contradicts the findings of Getso *et al.* (2017), who reported a slope (b) ranging from 0.1173 to 0.8058 in their assessment of the length–weight relationship and condition factor of *C. gariepinus* and O. niloticus from Wudil River, Kano, Nigeria.

In the present study, Heteroclarias exhibited a negative allometric growth pattern in all treatments, except Treatment 3, which showed positive allometric growth. This agrees with the findings of Anibeze (2000), who reported negative allometric growth for both sexes of H. longifilis in the assessment of length–weight relationship and relative condition factor from Idodo River, Nigeria. However,

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the present result disagrees with the findings of Davies *et al*. (2013), who reported a positive allometric growth pattern (b = 7.87) for Clarias gariepinus juveniles reared in concrete tanks.

Conclusion

The results of this study showed that the inclusion of *Moringa oleifera* leaf meal at varying levels in the diet of Heteroclarias resulted in improved growth and better nutrient utilization compared to the control diet. It can therefore be concluded that, under the experimental conditions, *Moringa oleifera* leaf meal can be safely included in the diet to enhance fish growth without any adverse effects on Heteroclarias at inclusion levels of up to 45%.

Recommendations

The findings of this study indicate that *Moringa oleifera* leaf meal has good potential to substitute soybean meal as a relatively inexpensive and high-quality plant protein source. The study suggests that, for both growth performance and economic considerations, *Moringa oleifera* leaf meal can replace soybean meal in a 40% crude protein diet for Heteroclarias fingerlings.
Further studies are recommended using different processing methods of *Moringa oleifera* leaves to evaluate the possibility of total replacement in the diet of Heteroclarias.

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