EFFECTS OF DIFFERENT SOURCES OF DIETARY FIBRE ON THE LENGTH-WEIGHT RELATIONSHIP OF LEMON FIN BARB

HYBRID (*BARBONYMUS GONIONOTUS* ♀ (BLEEKER, 1850)×*HYPSIBARBUS WETMOREI* ♂ (H.M. Smith, 1931)) FINGERLINGS

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**Abstract:** The effect of different sources of dietary fibre on the length-weight relationship of lemon fin barb hybrid (*Barbonymus gonionotus* ♀ *×*$×$ *Hypsibarbus wetmorei* ♂) was examined in a 56-day study using five dietary treatments; control and test dietary treatments containing different leaf meals of high dietary fibre added at the 10% inclusion level to a basal diet containing fish meal, soybean meal and rice bran. The weight of fish in each treatment was measured using a sensitive weighing balance while the total length was measured with a 15-cm-long ruler following standard procedures. The logarithmic transformation of the values obtained from the weight and length measurements was depicted using scatter diagrams. SPSS version 17.0 was used in regressing length against the weight to obtain the various components of the regression equations. The Levene test of homogeneity and interaction between covariate LogL and independent variable (treatments) was not significant – F(4.85)=0.838 and F(4.84)=1.345 respectively indicating that our data have not violated the assumption of homogeneity of variance. The various regression models developed for fish across various dietary treatments were statistically significant (p<0.01). The t-values for components of the regression equation such as intercept/constant (a) and slopes were all statistically significant except the t-value for the intercept/constant (a) of control. There was no significant effect of dietary treatments on LogW after controlling for logL, F(4.84)=1.296, revealing that the regression lines were not significantly different from each other. This shows that the regression models could be used interchangeably.

**Key words:** ANCOVA, dietary fibre, regression model, lemon fin barb hybrid.

**Introduction**

Dietary fiber in fish feed has been identified to have not only the growth-promoting effect but also the health-enhancing effect on fish (Haidaret al*.*, 2016). Including different sources of dietary fibre in fish feed is an attempt to maximize their potentiality to bring about the desired objectives of growth improvement and health enhancement (Buttriss and Stokes, 2008). The health and growth benefits of fiber consumption in animals are well recorded (Cummings and Stephen, 2007; Elia and Cummings, 2007). Though fibers are not digested in the small intestine, they are fermented in the large intestine producing short-chain fatty acids (SCFAs) which lower the pH of the colon preventing the growth of undesirable bacteria that could produce toxic substances. Short-chain fatty acids have a beneficial effect on lipid and glucose metabolism (Gray, 2006; Scottet al*.*, 2008). They stimulate the growth of beneficial gut bacteria such as bifidobacteria and lactic acid bacteria (Gibsonet al., 2004; Nugent, 2005) which enhance host health (Gibson and Roberfroid, 1995). Napier grass (*Pennisetum purpureum*), gliricidia (*Gliricidia sepium*) leafmeal, alfalfa (*Medicago sativa*) leafmeal and ipomea (*Ipomea aquatica*)were chosenas the high fiber feed ingredients to be used in this study because they constitute parts of the supplements being used by Malaysian Fish Farmers (Kamarudin Personal Communication, 2017). What is common to these ingredients used by Malaysian farmers is the high dietary fiber each of them contains (Jimohet al., 2019). Foschiaet al. (2013) reported that an ingredient as a dietary fibre source should contain at least 3% of dietary fibre.

The development of a regression model for the purpose of prediction or estimation is very important in the aquaculture industry wherein nutrition alone, which plays a veritable role in the growth of individual fish species, could be 60% of the variable cost of production (Jimoh et al*.*, 2015). A comparative study has shown that the use of the length-weight relationship for the purpose of prediction or estimation in cultured fisheries is very low relative to captured fisheries. Dattaet al*.* (2013) developed a model for *Channa punctata* under different feeding regimes. Similarly, Kumaret al. (2013) established the length-weight relationship for *Anabas testudineus* and *Channa species* under different culture systems. The length-weight relationship elucidates the possibility of predicting the weight of fish given its length (Giarrizzoet al*.*, 2011). This study, therefore, attempts to develop regression models for lemon fin barb hybrid (*Barbonymus gonionotus* ♀ *×*$×$ *Hypsibarbus wetmorei* ♂) fed diets containing different dietary fibre sources. Developing a tool for prediction or estimation and establishing whether significant variations exist among the various models developed that could imply interchangeability of model usage is still very new in aquaculture research.

Lemon fin barb hybrid, which is enjoyed by Malaysians for its nutritional value, is a new aquaculture species with many of its nutritional requirements yet to be determined (Suharmili et al., 2015). The present research, as far as our knowledge is concerned, represents the first study undertaken to examine the length and weight relationship under different high dietary fibre sources as dietary treatments for lemon fin barb hybrid (*Barbonymus gonionotus* ♀ *×*$×$ *Hypsibarbus wetmorei* ♂) and also establish whether significant variations exist among the various models developed.

**Materials and Methods**

A 56-day feeding trial was conducted using five dietary treatments; control and test dietary treatments containing different leaf meals of high dietary fibre (Table 1); Napier grass (*Pennisetum purpureum*); gliricidia (*Gliricidia sepium*), ipomea (*Ipomea aquatica*)and alfalfa (*Medicago sativa*) leaf meals were added at the 10% inclusion level to a basal diet containing fish meal, soybean meal and rice bran. Lemon fin barb hybrid (*Barbonymus gonionotus* ♀ *×*$×$ *Hypsibarbus wetmorei* ♂) was obtained from the Perlok Aquaculture Extension Centre, Jerantut, Pahang, Malaysia and acclimated for 15 days in a 1000L circular tanks of the wet laboratory of the Department of Aquaculture, Universiti Putra Malaysia. Two hundred twenty-five fingerlings were randomly distributed to 15 rectangular tanks at the beginning of the experiment. Each of the five dietary treatments was randomly allocated to different tanks with three replications per treatment. The fingerling fish were fed 4% body weight/day divided into equal proportion in the morning and evening. At the end of the feeding trial, the length and weight of the fish were measured to the nearest cm for length and to 0.1g for weight using a ruler and a sensitive weighing balance respectively.

Length-weight relationship

The weight (g) of fish in each treatment was measured using a sensitive weighing balance while the total length (cm) was measured with a 15-cm-long ruler following the procedures explained in Datta et al*.* (2013). The logarithmic transformation of the values obtained from the weight and length measurements was done and depicted using scatter diagrams.

The formula $W=aL^{b}$ of Le Cren (1951) on the fish length-weight relationship was linearized by taking the common log of both sides:

$$Log W=Loga+bLogL$$

where a = intercept; b = slope.

Table 1. The feed and proximate composition, and fibre differentials (% as fed basis) of the experimental diets containing different sources of high fibre feed ingredients.

|  |  |
| --- | --- |
| Feed ingredients | Diet |
| Control | Ipomea | Alfalfa | Napier | Glyricidium |
| Fishmeal  | 11.00 | 7.74 | 10.21 | 12.91 | 9.15 |
| Rice bran | 15.40 | 8.25 | 5.4 | 2.97 | 7.24 |
| Soybean meal | 50.00 | 50.00 | 50.00 | 50.00 | 50.00 |
| Tapioca starch | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| *Ipomea aquatica* meal | 0.00 | 10.00 | 0.00 | 0.00 | 0.00 |
| Alfalfa meal | 0.00 | 0.00 | 10.00 | 0.00 | 0.00 |
| Napier grass meal | 0.00 | 0.00 | 0.00 | 10.00 | 0.00 |
| Gliricidia meal | 0.00 | 0.00 | 0.00 | 0.00 | 10.00 |
| aVitamin premix | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| bMineral premix§ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Crude palm oil | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 |
|  | 100 | 100 | 100 | 100 | 100 |
| Proximate composition |  |  |  |  |  |
| Moisture | 4.74±0.87 | 5.29±0.14 | 4.99±0.28 | 5.31±0.06 | 5.51±0.26 |
| Crude protein | 31.55±0.22 | 31.55±0.22 | 32.34±0.18 | 33.72±0.01 | 31.64±0.20 |
| Crude lipid | 5.38±0.96 | 6.33±0.25 | 4.35±0.18 | 5.15±0.05 | 4.71±0.12 |
| Ash | 9.89±0.09 | 10.58±0.04 | 9.74±0.01 | 10.32±0.03 | 9.03±0.02 |
| Crude fiber | 5.61±0.71b | 7.03±0.19a | 4.93±0.12b | 7.59±0.14a | 5.17±0.36b |
| NFE | 42.83±20.32 | 39.21±0.41 | 43.63±0.19 | 37.90±0.21 | 43.92±0.17 |
| Fibre differential |  |  |  |  |  |
| Hemicellulose | 24.64±1.29 | 18.28±0.13 | 21.07±5.10 | 18.22±2.89 | 19.61±0.12 |
| Cellulose | 11.48±0.54 | 13.49±0.81 | 11.30±2.60 | 16.12±1.80 | 9.12±0.01 |
| Lignin | 1.90±0.06 | 3.10±0.47 | 1.64±0.06 | 1.76±0.13 | 2.95±0.40 |
| NFCϕ | 10.42±0.05 | 11.38±0.36 | 14.57±0.04 | 9.4±0.14 | 17.43±0.03 |
| Gross energy (kJ/g) | 17.70±0.02 | 17.70±0.00 | 17.70±0.02 | 17.70±0.00 | 17.74±0.01 |

Vitamin premix (g kg-1 premix): ascorbic acid, 45; myo-inositol, 5; choline chloride, 75; niacin, 4.5; riboflavin, 1; pyridoxine, 1; thiamin mononitrate, 0.9; Ca-pantothenate, 3; retinyl acetate, 0.6; cholecalciferol, 0.08; vitamin K menadione, 1.7; α-tocopheryl acetate (500 IU g-1), 8; biotin, 0.02; folic acid, 0.1; vitamin B12, 0.001;cellulose, 845.1.

§. Mineral premix (g kg-1 premix): KCl, 90; KI, 0.04; Ca(H2PO4).H2O,500; NaCl, 40; CuSO4.5H2O, 3; ZnSO4.7H2O, 4; CoSO4,0.02; FeSO47H2O, 20; MnSO4.H2O, 3; CaCO3, 215; MgOH, 124; Na2SeO3, 0.03; NaF, 1.

ϕ NFC Non-fibre carbohydrates

$NFC=Total Carbohydrates\left(NFE+CF\right)-Hemicellulose-Cellulose-lignin$

Statistical analysis

SPSS version 17.0 was used in regressing the length against the weight to obtain the various components of the regression equations. A one-way analysis of covariance (ANCOVA) was used to compare variations among the treatment regression lines of the length-weight relationship while controlling for LogL after the data had been subjected to and found to have passed the Levene test of homogeneity of variance indicating that our data did not violate the assumption of homogeneity of variance for the ANCOVA test. The partial eta-squared results were compared with Cohen’s guidelines (0.2 – small effect, 0.5 – moderate effect, 0.8 – large effect).

**Results and Discussion**

Length-weight relationship

Figure 1 shows the graphs representing a logarithmic regression of the final length and weight of lemon fin barb hybrid (*Barbonymus gonionotus* ♀ *×*$×$ *Hypsibarbus wetmorei* ♂) fed diets containing various sources of high fibre leaf meals.



Figure 1. Graphs showing the logarithmic regression of the final length and weight of lemon fin barb hybrid (*Barbonymus gonionotus* ♀ *× Hypsibarbus wetmorei* ♂) fed diets containing various sources of high fibre leaf meals.

Table 2 presents an analysis of the length-weight relationship of lemon fin barb hybrid (*Barbonymus gonionotus* ♀ *×*$×$ *Hypsibarbus wetmorei* ♂) fed diets containing various sources of high fibre leaf meals. The various regression models developed for fish across various dietary treatments were statistically significant (p<0.01). The t-values for components of the regression equation such as intercept/constant (a) and slopes were all statistically significant except the t-value for intercept/constant (a) of CTR. The slope (b) ranged from 2.116 in the regression model for control to 2.945 in the regression model for the Gliricidium fed group. The ‘r’ values (0.788–0.958) indicate a positive correlation meaning that as the Log of length increases, the Log of weight also increases.

Table 2. The analysis of the length-weight relationship of lemon fin barb hybrid (*Barbonymus gonionotus* ♀ *×*$×$ *Hypsibarbus wetmorei* ♂) fed diets containing various sources of high fibre feed ingredients.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Dietary treatment | Regression equation | R2 | F-statistics for the equation | t-statistics for the constant(a) | t-statistics for LogL | ANCOVA probability |
| Control | $$Log W=2.116LogL-log0.901$$ | 0.621 | F(1,16)=26.10\*\* | t=-2.03ns | t=2.12\*\* | F(4.84)=1.296, P>0.05 |
| Ipomea | $$Log W=2.416LogL-log1.200$$ | 0.885 | F(1,16)=122.63\*\* | t=-0.51\*\* | t=11.07\*\* |
| Alfalfa | $$Log W=2.600LogL-log1.429$$ | 0.876 | F(1,16)=112.56\*\* | t=-5.407\*\* | t=10.61\*\* |
| Napier | $$Log W=2.765LogL-log1.608$$ | 0.958 | F(1,16)= 365.92\*\* | t=-10.33\*\* | t=19.13\*\* |
| Glyricidium | $$Log W=2.945LogL-log1.786$$ | 0.896 | F(1,16)=137.26\*\* | t=-6.498\*\* | t=11.72\*\* |

\*\* = (p<0.01); R2 = Coefficient of determination; Ns = Not significant.

The r-values were statistically significant from the Pearson’s correlation output (Table 3). The coefficients of determination (R2) which show how much of the variance in the dependent variable (weight) is explained by the independent variable (length) were all very high (0.621–0.958). The Levene test of homogeneity and interaction between the covariate LogL and the independent variable (treatments) was not significant F(4.85)=0.838, p>0.05; F(4.84)=1.345, p>0.05 respectively indicating that our data have not violated the assumption of homogeneity of variance. Similarly, there was no significant difference (p>0.05) among the five regression lines.

Table 3. Estimated marginal means of dietary treatments.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dietary treatment | Estimated marginal means | (r) | Adjusted R2 | F-Statistics |
| Control | 1.38±0.12 | 0.788 | 0.856 | F(4.84)=1.296(P>0.05) |
| Ipomea | 1.39±0.14 | 0.941 |
| Alfalfa | 1.37±0.12 | 0.936 |
| Napier | 1.36±0.18 | 0.979 |
| Glyricidium | 1.43±0.11 | 0.946 |

There was no significant effect (p>0.05) of dietary treatments on LogW after controlling for logL, F(4.84)=1.296 p>0.05, revealing that the regression lines were not significantly different from each other. Partial eta squared of 0.058 means that the effect size of the dietary treatment was very small explaining 5.8% of the variation in weight and partial eta squared of 0.86 was recorded for LogL meaning its effect size was very high and that 86% of the variation in LogW was explained by LogL. In contrast to results obtained from treatments, the covariate, LogL, had a significant effect (P<0.05) on the dependent variable, logW, (F(1,84)=515.15, p<0.001), showing that LogL had a significant impact on the outcome of dependent variables (logW).

Comparing the estimated marginal means (Table 3) for each dietary treatment group based on the influence of the covariance, revealed that the Napier fed group recorded the lowest value of LogW while the highest value of LogW was recorded for the Glyricidia fed group. A logarithmic regression of the final length and weight of lemon fin barb hybrid (*Barbonymus gonionotus* ♀ *×*$×$ *Hypsibarbus wetmorei* ♂) fed diets containing various sources of high fibre feed ingredients to elucidate the interchangeability of the various selected leaf meals was presented in Figure 2.

Figure 2. The graph showing a logarithmic regression of the final length and weight of lemon fin barb hybrid (*Hypsibarbus wetmorei* x *Barbonymus gonionotus*) fed diets containing various sources of high fibre feed ingredients.

The regression model provides reliable information about the growth pattern and the estimation of the fish weight (W) using a known length (L) (Froese, 2006; Schneideret al., 2000) and could be applied to studies on nutrition (Beyer, 1987). The various regression models developed in this study across various dietary treatment groups that were significant show that each of the models could be used for the purpose of the prediction and estimation of the weight of fish once its length is known. The r-values that were high in this study indicated that a strong positive correlation existed between the length and weight of fish exposed to various dietary fibre treatments. The high R2-value recorded in this study revealed that a significant proportion of variance in weight could be explained by the variation in length. Jisret al. (2018) have reported that a high coefficient of determination recorded in the assessment of length-weight relationships implies a good quality of the prediction of linear regression for the analyzed fish species. The t-value for the intercept (a) showed that the intercepts were significantly different from zero. The interpretation of regression parameters (regression coefficient and regression constant) of the various models developed in this study is consistent with what was reported in Hintonet al. (2014). The trend of the slope recorded in this study showed that the higher the value of slope (b) in the regression model, the faster the growth in terms of length and weight. Dattaet al. (2013) made a similar observation when estimating the length-weight relationship of spotted snakehead *Channa punctata* (Bloch) under different feeding regimes. In this study, the slope of regression models of the dietary fibre sources was higher than that of the control. This implies a better growth performance among the fish fed dietary fibre sources. This is in consonance with the earlier report by Jimohet al. (2019) that dietary treatments containing high fibre feed ingredients improve growth. The negative allometric growth pattern recorded in this study is in tandem with the report of Aliet al*.* (2002), Haniffaet al. (2006), Dua and Kumar (2006), Khanet al. (2011) and Dattaet al. (2013). Wootton (1991) has reported that the slope value less than the critical value (3) is regarded as a negative allometric growth pattern. Negative allometry implies that the fish becomes slimmer as the length increases (Jisret al., 2018). This might be attributed to morphological features specific to this species as they are laterally compressed fish species. Phenotypic features such as body forms and shapes could affect the allometric growth pattern (Karachle and Stergiou, 2012; Tsoumaniet al*.*, 2006). The regression lines developed in this study were not significantly different from one another, meaning the regression models could be used interchangeably.

**Conclusion**

This study serves as the first information report recorded on the development of predictive models for the lemon fin barb hybrid fed high fibre feed ingredients. The negative allometric growth pattern was recorded plausibly owing to the body shapes and forms of the fish. Each of the regression models developed was statistically significant, indicating their suitability for weight prediction or estimation once the length of fish is known. The statistical similarity was recorded for the various regression models depicting their usage interchangeability.

**Acknowledgements**

Dr W.A. Jimoh’s postdoctoral fellowship was sponsored by the Universiti Putra Malaysia with the research work conducted under the grant of the Malaysian Ministry of Higher Education FRGS 07-01-15-1651FR, and the World Academy of Sciences (TWAS) FR number: 3240293138 (Air fare Expenses). The two bodies are hereby appreciated. We acknowledge the donation of lemon fin barb hybrid fingerlings by the management of the Perlok Aquaculture Extension Centre, Jerantut, Pahang, Malaysia. The Animal Feed Division of the Malaysian Agriculture Research and Development Institute (MARDI) is hereby recognized for the production of experimental diets at no cost.

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Received: October 23, 2019

Accepted: December 2, 2020

UTICAJI RAZLIČITIH IZVORA VLAKANA U OBROKU NA DUŽINU I TEŽINU MLAĐI HIBRIDA (*BARBONYMUS GONIONOTUS* ♀ (BLEEKER, 1850)× *HYPSIBARBUS WETMOREI* ♂ (H.M. SMITH, 1931))

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R e z i m e

Uticaj različitih izvora vlakana u hrani na povezanost dužine i težine hibrida (*Barbonymus gonionotus* ♀ *× Hypsibarbus wetmorei* ♂) ispitivan je u 56-dnevnom istraživanju korišćenjem pet hranidbenih tretmana; kontrolni i ogledni tretmani su sadržali različita lisna brašna sa visokim procentom vlakana, koja su dodavana na nivou od 10% osnovnom obroku koji je sadržao riblje brašno, sojinu sačmu i pirinčane mekinje. Težina ribe u svakom tretmanu merena je osetljivom vagom, dok je ukupna dužina merena lenjirom dužine 15 cm prema standardnim procedurama. Logaritamska transformacija vrednosti dobijenih merenjima težine i dužine prikazana je pomoću scater dijagrama. SPSS verzija 17.0 korišćena je za izračunavanje regresije dužine prema težini, kako bi se dobile različite komponente regresionih jednačina. Leveneov test homogenosti i interakcije između kovarijantnog LogL i nezavisne promenljive (tretmani) nije bio značajan – F (4,85) = 0,838 odnosno F (4,84) = 1,345, ukazujući da naši podaci nisu prekršili pretpostavku homogenosti varijanse. Različiti regresioni modeli razvijeni za ribe u različitim dijetetskim tretmanima bili su statistički značajni (p<0,01). Vrednosti *t* za komponente regresione jednačine, kao što su konstanta (a) i nagibi, bile su sve statistički značajne, osim vrednosti *t* za konstantu (a) kontrole. Nije bilo značajnog uticaja dijetetskih tretmana na LogV nakon kontrole logL, F (4,84) = 1,296, što pokazuje da se regresione linije međusobno nisu značajno razlikovale. To pokazuje da bi se regresioni modeli mogli međusobno zamenjivati.

**Ključne reči:** ANCOVA, vlakna, regresioni model, hibrid (*Barbonymus gonionotus* ♀ *× Hypsibarbus wetmorei* ♂).

Primljeno: 23. oktobra 2019.

Odobreno: 2. decembra 2020.

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