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Evaluation of Apparent Digestibility Coefficients of Different Dietary Maltose Levels In Nile Tilapia (*Oreochromis niloticus*) Fingerlings.

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ABSTRACT

The objective of this study to determine the apparent digestibility coefficients (ADCs) of dry matter, protein, lipid, nitrogen free extract (NFE), ash and gross energy of five pelleted fish feed with different levels of maltose, 0, 20, 25, 30 and 35%) on performance of Nile tilapia fingerlings, using chromium dioxide as an inert bio- marker. Feeds were prepared to be isonitrogenous (33.53%±0.90) and isocaloric (19.08±0.48 kJg^{-1}). Proximate compositions of experiment feeds, fecal matter and chromium contents also were determined. Results shown the maximum value of ADCs for dry matter (DM) was found in fish fed with 20% maltose (92.62%), while the minimum value was found in control feed (81.82%). Similarly, the apparent digestibility of protein, lipid, nitrogen free extract (NFE), ash and gross energy were significantly higher ($p<0.05$) in fish fed with 20% maltose and lower in fish fed with 35% maltose. There was no effect of the dietary maltose levels on survival rate. The study has shown that Nile tilapia efficient maximum digestion to nutrients is only up to 30% inclusion of dietary maltose in the feed.

Keywords: Apparent digestibility, dietary maltose, Nile tilapia

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INTRODUCTION

A feed ingredient may perform from its chemical composition to be an excellent source of nutrients but will be of little real value unless it can be digested and absorbed in the target species (Köprücü and Özdemir, 2005). Information of nutrient digestibility of the several feed ingredients used in formulating fish feeds is necessary. Thus the effective replacement of one ingredient for another may be successful. Jimoh *et al.* (2010), reported that the chemical analysis and digestibility determination may provide a more thorough consideration of the nutrient availability in feedstuffs and can be used to select ingredients that optimise the nutritional value and cost of formulated diets (Fagbenro, 1999). The effect of dietary carbohydrate on fish growth appears to depend on the source, dietary level and digestibility (Krogdahl *et al*., 2005, Gumus and Ikiz, 2009). In addition, heat treatment also effects the carbohydrate digestibility in fish (Ahmad *et al.,* 2012). Rawles and Gastlin (1998) observed greater than 88% digestibility for glucose and maltose, whereas for dextrin it was 55% in Striped bass. However, at the same dietary level (25%), glucose, maltose and dextrin, digestibility was 69, 61 and 44% respectively in Sunshine bass (Rawles and Gastlin, 1998). However, information regarding the utilization of purified maltose by tilapia is rather limited at this time. Thus, the main objective of the present study was to determine the effects of different dietary maltose levels on the nutrient digestibility in Nile tilapia (*Oreochromis niloticus)* fingerlings.

MATERIAL AND METHODS

Feeds formulation

Table1. Show the recipe for five feeds formulated for Nile tilapia. Fish meal (12%) was used as the animal protein source, while soya meal (38%) was used as plant protein source' according to Abo-state et al. (2009). Palm oil was used as the lipid source. Cellulose was replaced gradually by maltose extracted from barley according to Ahamad (1982); and Rawles and Gatlin (1998). The levels of maltose used in the feeds were 0.0, 20, 25, 30 and 35% as the carbohydrate sources. Carboxymethycellulose (0.5%) was added as binder. Chromic oxide (0.1%) was added as an inert biomarker.

Table 1: Proportions of different ingredients in the formulated feeds

Feed ingredient	Feed A (0.0% Mal)	Feed B (20% Mal)	Feed C (25% Mal)	Feed D (30% Mal)	Feed E (35%Mal)
Fish meal	12	12	12	12	12
Soya bean	38	38	38	38	38
Wheat flour	10	10	10	10	10
Maltose	0	20	25	30	35
Cellulose	35	15	10	5	0
Palm oil	3	3	3	3	3
Mineral premix [a]	0.5	0.5	0.5	0.5	0.5
Vitamin premix [b]	0.5	0.5	0.5	0.5	0.5
Vitamin C	0.4	0.4	0.4	0.4	0.4
Binder (CMC) [c] Chromic oxide [d]	0.5 0.1	0.5 0.1	0.5 0.1	0.5 0.1	0.5 0.1
Total	100	100	100	100	100

Experiment fish

The experiment was run at the Fresh Water Hatchery, Faculty of Fisheries and Aqua-Industry (FPAI), Universiti Malaysia Terengganu (UMT), Malaysia. Nile tilapia, *Oreochromis niloticus* (0.2-0.5g body weight) were obtained from Pusat Pengembangan Akuakultur Jitra, Kedah. The fish were selected and transferred into 15 fibreglass tanks. The experimental fishes were acclimatised about two weeks and fed on control diet during the acclimatisation period.

Fish faeces collection

Faecal matter was collected once a day at about 10.00 to 12.00 am and one hour after the first feeding for 4 weeks to obtain large enough samples, using a modified method described by (Shiau and Liang, 1994). Faecal samples were collected by simple siphoning from the bottom of each tank. The faeces were then freeze-dried and stored at -20^{0}C until required for analysis (Shiau and Liang, 1994; Usmani *et al.,* 2003).

Table 2: Mean ±S.E. proximate composition and gross energy of the test feeds (% dry matter).

Item	Feed A (0.0 % Mal)	Feed B (20 % Mal)	Feed C (25 % Mal)	Feed D (30 % Mal)	Feed E (35 % Mal)
Moisture	8.86±0.93	8.39±0.82	9.22±0.49	9.82±0.63	9.62±0.03
Protein	33.27±0.87	33.70±0.43	33.85±0.29	33.56±0.73	33.27±0.44
Lipid	4.67±0.04	4.83±0.04	4.68±0.08	4.83±0.17	4.67±0.01
Ash	4.44±0.02	4.77±0.02	4.81±0.02	4.94±0.09	4.88±0.26
Fiber	13.62±0.68	11.23±0.09	8.93±0.20	8.71±0. 20	8.71±0.03
NEF	35.14±0.94	37.08±0.57	37.91±0.50	8.14±0.61	38.85±0.32
Energy(kJ g^{-1})	18.94±0.89	18.66±0.13	19.17±0.19	19.67±0.49	19.26±0.22

Chemical analysis

Proximate analyses for moisture, protein, lipid, ash and crude fibre, were determined using the following Association of Official Analytical Chemists procedures (AOAC, 1990), and presented in Table 2. Chromic oxide in feeds and faeces was analysed according to the method of Furukawa and Tsukahara (1966). The procedure depends upon the digestion of the sample by concentrated nitric acid and subsequent oxidation of chromic oxide with 70% perchloric acid. The yellow colour formed by the oxidation of chromium III to chromium VI is read on a spectrophotometer (UV1800) at 350 nm against distilled water. All samples were analyzed in triplicate.

Calculations

The apparent digestibility coefficients (ADCs) of dry matter, protein, lipid, ash and energy for the test ingredients and diets were calculated as follows (Cho and Slinger, 1979):

ADC of dry matter (%) = 100 x [1 - (Cr_2O_3 in diet / Cr_2O_3 in faeces)]

ADC of nutrients or energy (%) = 100 x [1 – (Cr_2O_3 in diet / Cr_2O_3 in faeces) x (% nutrient in faeces / % nutrient in diet)]

Statistical analysis

All the results were subjected to analysis of variance (ANOVA). Duncan multiple range test (Duncan, 1955) was further used to evaluate the mean differences at 0.05 significant levels.

RESULT AND DISCUSSION

Table 3: Mean ±S.D. The apparent digestibility coefficients (ADC) of protein, lipid, ash, NFE* and dry matter of Nile tilapia fingerlings fed with diets containing maltose.

Composition	Feed A (0.0 % Mal)	Feed B (20 % Mal)	Feed C (25 % Mal)	Feed D (30 % Mal)	Feed (35 % Mal)
ADC $_{\text{dry matter}}$	81.82±1.20c	92.62±1.68a	89.89±2.17a	85.69±1.85b	83.58±1.20bc
ADC $_{\text{crude protein}}$	95.21±0.31b	97.81±0.40a	95.36±1.24b	91.46±0.73c	85.78±2.01d
ADC $_{\text{crude lipid}}$	96.87±0.36a	98.13±1.02a	97.15±0.90a	96.46±0.44a	91.32±1.81b
ADC $_{\text{ash}}$	85.46±1.10c	95.65±0.84a	94.28±1.17a	91.69±1.18b	90.98±0.92b
ADC $_{\text{NFE}}^{*}$	92.20±0.51c	96.46±0.81a	94.55±1.25b	91.74±0.94c	88.57±0.92d
ADC $_{\text{gross energy}}$	89.75±0.67b	95.66±1.00a	93.42±1.39a	89.62±1.18b	84.93±2.38c

*NFE= Nitrogen-Free Extract (carbohydrate)
Mean with a common letter shown in rows are not significantly different, (N = 30)

The apparent digestibility coefficients of experimental diets are shown in Table 3. Results showed, no significant difference (P<0.05) in the apparent digestibility of dry matter of fish fed with feed E compared with control, followed by feed D. Fishes fed with feed B, and feed C had the highest values (92.62±1.68 and 89.89±2.17 %) respectively. The apparent digestibility of protein was significantly higher (p<0.05) in fish fed with feed B (97.81±0.40%), and lower in fish fed with feed E (85.78±2.01%). The protein digestibility in the present study was affected by the dietary maltose, and tended to decrease when maltose was increased in the diet, but in the normal range suggested by NRC (1993). On other hand, lipid digestibility was slightly higher than the values reported by NRC (1993). Similarity, the lowest apparent digestibility of gross energy was obtained in fish fed with feed E (84.93±2.38 %) increasing to (95.66±1.00%) in fish fed with feed B (p<0.05). This result agreement with Stone *et al*. (2003) which indicated, the energy digestibility of the dietary carbohydrates is affected by levels and type of carbohydrate. In addition, the apparent digestibility of carbohydrates (NFE) in the present results (88.57- 96.96%) is similar to previous study on carbohydrate digestibility for Nile tilapia (Köprücü and Özdemir, 2005). Similar results were obtained for *Striped bass* and *Sunshine bass* using glucose, maltose and dextrin in diets (Rawles and Gatlin, 1998). In general, the tilapia fed with feed B had higher protein, lipid, carbohydrate, energy and dry matter digestibility than those fed other feeds. In conclusion, the results demonstrated high digestibility for all the feed ingredients tested. The efficient maximum digestion to nutrients is only up to 30% inclusion of dietary maltose in the feed, indicating their quality as ingredients for formulated Nile tilapia diets. This information might be useful to precisely formulate high-quality diets for Nile tilapia that minimize production costs and waste production.

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