Effects of Different Dietary Carbohydrate Sources on Growth Performance and Liver Histology of Nile Tilapia (Oreochromis Niloticus) Fingerlings

Original Article

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ABSTRACT

Background: Carbohydrates are the cheapest source of energy available in plentiful quantities at low prices and have a protein-sparing effect in some lower protein diets and for bind other ingredients.

Aim of the Study: This study was conducted to evaluate the effect of different dietary sources and levels of wheat bran, corn and sorghum on the growth performance, feed utilization, blood parameters, body composition and histopathological examination of fingerlings Nile tilapia (Oreochromis niloticus).

Materials and Methods: Eighteen full glass aquaria measuring (75×40×35cm) were distributed into six treatments and each treatment was represented in three replicates (25 fish in each aquarium with an initial body weight of 9.2±0.37g). Six diets were formulated by using three different sources of carbohydrate (wheat bran, corn and sorghum) and each source was incorporated as two levels (15 and 30%) of the diet. Fish samples of (blood, histological examination of liver and spleen and proximate composition of fish) were detected.

Results: The results demonstrated that the growth performance and nutrient utilization were increased with dietary sorghum starch in the two levels of sorghum. No significance differences (P>0.01) were obtained in blood parameters values and whole-body composition of fish. The histopathological examinations showed that sorghum supplemented with low dose improve liver and spleen structures.

Conclusion: The appropriate dietary sorghum can incorporate up to 30% in feed formulation, without compromising effects on growth parameters, proximate composition and liver structure of Nile tilapia (Oreochromis niloticus) fingerlings.

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Key Words: Carbohydrate source, growth performance, liver histology, nile tilapia, sorghum.

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INTRODUCTION

Nile tilapia is internationally widely distributed in different site of the world. It constitutes the largest percentage of fish production in Egypt because it can persist in different environmental conduction. Utilization of carbohydrates relate to the digestive tract and metabolic efficiently, but, in general, fish are deemed glucose intolerant because their incompetence to reinstate glycaemia value after a glucose load[1].

Enough amount of carbohydrate would enhance growth performance and immunity[2,3,4]. Besides, carbohydrate of starch origin is crucial in improving feed physical quality with good binding and expansion properties[5]. In omnivorous and warm water fishes such as carps, carbohydrate can highly use compared to other species[6]. It is interest to provide sufficient carbohydrate in the diet with a view to reduce the catabolism of protein for energy and glucose synthesis, which reducing nitrogen release to the environment[7]. Detecting the optimal level of protein and the protein-sparing effect of carbohydrate may be beneficial to reduce fish diet cost[8].

Carbohydrate is the macronutrient that is most ordinarily oxidized and used as an energy source by herbivores and many omnivorous fish[9]. Carbohydrates are the most cheapest source of energy available in plentiful quantities at low prices and have a protein-sparing effect in some lower protein diets and for bind other ingredients[10]. Carbohydrate digestibility is highly in freshwater and warm water fishes than that in marine and cold water fishes[11].

Omnivorous fish species such as Nile tilapia and common carp, which fed at low trophic levels, can efficiently use high dietary levels of carbohydrates (30-50%) in comparison to the high trophic level carnivorous fish species[12].

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The optimal dietary carbohydrate level of Nile tilapia (Oreochromis niloticus) still need to investigated. Therefore, this study was designed to evaluate the effect of different dietary sources and levels of wheat bran, corn and sorghum on the growth performance, feed utilization, body composition and histopathological examination of fingerlings Nile tilapia (Oreochromis niloticus).

MATERIALS AND METHODS

Experimental fish

A total number of 500 apparently healthy fingerlings of Oreochromis niloticus were obtained from Fish Research Centre, Suez Canal University. Fish were transported in strong plastic bags filled with sufficient natural fresh water and oxygen. They were transported to the lab of Fish Diseases and Management Department, Faculty of Veterinary Medicine-Suez Canal University. Eighteen full glass aquaria measuring (75×40×35cm) were used for rearing fish. Fish were distributed into six treatments and each treatment was represented in three replicates of glass aquaria, which contain 25 fish in each aquarium with an initial body weight of 9.2±0.37g.

Aquaria

The aquaria were supplied with aerated de-chlorinated fresh water and changed continuously. Continuous aeration was maintained in each aquarium by using air pump. Thermostatic heaters were used during the experiment to maintain temperature at 25+2°C. Physicochemical characteristics of water glass aquaria were examined every two weeks[13] and water quality values measured within the recorded optimal ranges for this species, where dissolved oxygen (7.4±0.1 mg dL-1), temperature (25.2±1.2°C), salinity (1.16±0.6) and pH (7.4±0.1)[14]. Each diet was fed to visual satiation twice daily (9:00 and 15:00 hrs) for 90 days from (April to June, 2015). Fish were weighted every two weeks to adjust the amount of feed consumed during the experimental study.

Experimental diet

The experimental diets were formulated by using the available local ingredients. Sorghum was obtained from a local market in Shaksouk-Fayoum-Egypt and then soaked with tap water for three days and exposed to solar drying before crush. The ingredients were ground into fine powder through 175-µm mesh before pelleting. All ingredients were finely ground, thoroughly mixed, and pelleted using a pellet mill (California Pellet Mill,USA) through a 2 mm die and air dried until use. Six diets were formulated by using three different sources of carbohydrate (wheat bran, corn and sorghum) and each source was incorporated as two levels (15 and 30%) of the diet. The proximate composition of ingredients and feed formulation of the diets are presented in (Tables,1&2).

Table 1: Proximate composition of raw ingredients (%DM basis).

Ingredients[1]	DM	CP	EE	NFE1	CF	Ash
Fish meal	91.5	70.0	12.2	-	-	17.8
Soya bean meal	91.7	46.2	4.2	38.1	4.0	7.5
Poultry by-product meal	93.0	55.0	14.4	12.8	2.4	15.4
Sunflower meal	91.2	40.2	7.6	33.7	12.0	6.5
Corn	91.1	8.4	2.2	77.5	5.2	6.7
Sorghum[2]	90.8	8.5	2.4	76.6	7,2	5.3
Wheat bran	90.1	14.0	3.2	65.8	8.4	8.6

1-Ingredients content calculated by differences, Nitrogen free extract (NFE) = [100-(CP+EE+CF+Ash)].
2-Tannin = 0.01.

Table 2: Feed formulation and chemical composition of experimental diets.

Diets[1]	Carbohydrate levels %					
	W15	W30	C15	C30	S15	S30
Fish meal	4	6	4	6	4	6
Poultry-by product meal	4	6	8	10	8	10
Soybean meal	10	10	10	16	10	20
Sunflower seed meal	46	35	43	26	43	26
Wheat bran	15	30	-	-	-	-
Corn meal	-	-	15	30	-	-
Sorghum meal	-	-	-	-	15	30
Fish oil	3	3	3	3	3	3
Cotton seed oil	3	3	3	3	3	3
Microcrystalline cellulose	13	5	12	4	12	-
Vitamin min. mix[2]	2	2	2	2	2	2
Chemical composition (%DM basis)						
Dry matter	92.2	91.8	92.1	91.6	92.4	92.1
Crude protein	30.21	30.39	30.36	30.06	30.37	30.09
Either extract	13.76	13.03	13.47	12.82	13.57	12.82
Nitrogen free extract	34.54	40.03	35.72	40.74	35.22	40.42
Fiber	8.37	7.19	7.72	6.52	7.72	6.47
Ash	13.12	11.24	12.73	9.86	13.12	10.2
Growth energy (MJ/kg/ diet)[3]	18.76	19.48	18.89	19.4	18.84	18.78
Metabolizable (ME/kg diet)[4]	15.68	16.1	15.78	16.23	15.74	16.19

1. Diets: W= (wheat bran, 15&30%), C= (corn,15&30%) and S= (sorghum,15&30%).
2. Vitamin mineral premix (mg·kg-[1]diet): VA 20,VD 3 10,VK3 20,VE400,VB110, VB215,VB615,VB128,VC1000,calcium pantothenate40, niacinamide 100, inositol 200,biotin2,folic acid 10, choline chloride 2000, corn gluten meal 2150, $FeSO_4 \cdot H_2O$300,$ZnSO_4 \cdot H_2O$200,$CuSO_4 \cdot 5H_2O$10, $MnSO_4 \cdot H_2O$ 100, KI(10%) 80, $CoCl2 \cdot 6H_2O$(10%Co)5,Na_2SeO_3(10%Se)10,NaCl 100, Zeolite 695
3. Growth energy (MJ kg-[1] diet) was calculated by using the following calorific values: 23.9, 39.8 and 17.6 kjg-1 diet for protein, either extract and nitrogen free extract, respectively[15].
4. Metabolizable energy (MJ kg-1 diet) was calculated by using the following calorific values: 18.9, 35.7 and 14.7 kj g-1 diet for protein, either extract and nitrogen free extract, respectively[15].

Growth performance

Growth performance and feed parameters were measured by using the following equations:

Body weight gain WG = (FW–IW).

FW=Final weight (g) IW=Initial weight.

Specific growth rate SGR (%/day) =100 × (ln FW-ln IW)/T.

FW = final weight. IW= initial weight.

Ln = Natural logarithm T = period (days).

Survival rate (SR %) = (final fish Number / initial Number of fish)×100.

Condition factor (K) =(W/L3)×100.

Where: W =fish weight (g) L=fish length (cm).

Feed conversion ratio (FCR) =Feed intake (g)/Weight gain (g).

PER (%)=Weight gain (g)/Protein intake (g).

Net protein utilization (NPU%) = (Final body protein-Initial body protein/protein intake)×100.

Hepatosomatic index =(Weight of the liver/fish body weight) ×100.

Blood sampling

The haematological analyses were done by sampling blood from the caudal blood using vessels 3-mL heparinized and sterilized syringes and needle. Red blood cell (RBC) and white blood cell (WBC) counts were performed in hemocitometer (Neubauer chamber) diluents[16]; haematocrit evaluation, Haemoglobin, platelets followed the micro haematocrit method[17].

Chemical analysis

Analyses of ingredients, diets and carcass composition were carried out according to the standard methods[18]. Moisture was determined by drying in an oven

(Labostar-LG 122, Tabai Espec, Osaka, Japan) at 105 0C for 24 h; ash by burning in a muffle furnace (Isuzu Seisakusho, Tokyo, Japan) at 550 0C for 18 h; crude protein by the Kjeldahl method (N×6.25) using an automatic Kjeldahl System (Buchi 430/323, Flawil, Switzerland); and crude lipid by the chloroform/methanol (2:1, v/v) extraction procedure[19]. Tannin content of sorghum meal was determined using a modified version method[20].

Histological examination

After blood sampling the fish were desiccated; liver and spleen were removed and prepared for further studies. Tissue specimens of liver and spleen were fixed in 10% neutral buffered formalin for 24 hrs. The fixed tissues were rinsed in tap water, dehydrated through graded series of alcohols, cleared in two changes of xylene and embedded in paraffin wax[21]. Five µm thick sections were cut and stained with Hematoxylin and Eosin (H & E) and followed by examination using light microscopy.

Statistical analysis

Data of the present study were analyzed using Tow-ways Analysis of Variance (ANOVA) procedures for testing significance among groups[22]. Means separation and pairwise comparisons were carried out by Duncan's Multiple Range test were applied[23]. All analysis were performed using SPSS[24] version 20, (2016) SPSS Institute, Cary, NC, USA). Results are considered significant and highly significant at probability levels of 0.05, ($P \leq 0.05$).

RESULTS

Growth performance

The effect of carbohydrate sources and levels on growth performance as (final weight, weight gain, specific growth rate and condition factor) were presented in (Table 3). The highest values were obtained in fish fed the two sorghum levels followed by a significance difference ($P<0.05$) in fish fed wheat bran and corn diets. Fish fed on sorghum at 15% was significantly higher than sorghum at 30% of final WG. However, fish fed on corn (30%) was the lowest (FW,WG, SGR and CF) between groups. Consequently, feed efficiency indices in terms of (FCR, PER and NPU) showed high significance difference in fish fed on sorghum (15 and 30%) compared with other groups.

Blood parameters

As shown in (Table 4), RBC,WBC, PL,HB and HCT not affected by dietary carbohydrate diets.

Body composition

Whole body composition values are shown in (Table 5). No significance difference ($P>0.05$) were obtained in all proximate composition of Nile tilapia from (dry matter, crude protein, crude lipid and ash) between different sources and levels of carbohydrate.

Histological examination

The histological changes were seen in the hepatic and splenic tissues of the treated groups. These changes were alleviated to variable degrees in the challenged groups fed different dietary carbohydrate sources (wheat bran, corn and sorghum) as shown in (plate 1-3).

Liver

In the present study, fish fed on wheat bran (15 and 30%) served as control group and showed focal to diffuse vacuolar degeneration of hepatocytes, the vacuoles were severe and diffuse in group treated with wheat bran (30%) along with focal leucocytic infiltration (plate 1). In fish fed with corn (15%) liver appeared to have diffuse degeneration of hepatocytes, focal necrosis and leukocytic infiltration, meanwhile fish fed (b-30% corn) showed severe degeneration with focal necrosis represented by pyknotic nuclei as illustrated in (plate 2). The fish fed with sorghum showed normal structure of liver with mild focal vacuolar degeneration of hepatocytes as (plate 3).

Spleen

In control wheat bran (a,15%) showed depletion of white pulp and (b-30%) showed depletion and necrotic changes of white pulp with hyperplasia of melanomacrophage centres (plate 4). However, in the treated group with sorghum (15 and 30%) was better than corn and showed normal structure of spleen with normally distributed melanomacrophage centres, normal intact lymphoid follicles and well preserved hyperplastic melanomacrophage centres (plate 6). Moreover, in the corn group (15 and 30%) prominent depletion of lymphoid follicles of white pulp and severe degeneration and necrosis of lymphoid follicles were observed (plate 5).

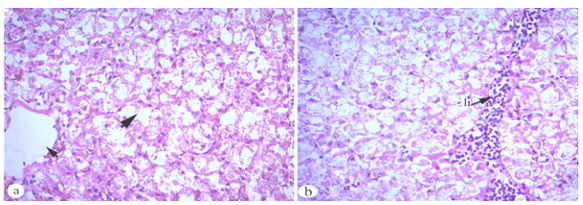

Plate 1: Liver of fish fed wheat bran in each two levels, where (a-15%) showing multi focal to diffuse vacuolar degeneration of hepatocytes and (b-30%) showing severe degeneration along with focal leucocytic infiltration (li). (H&E,×40).

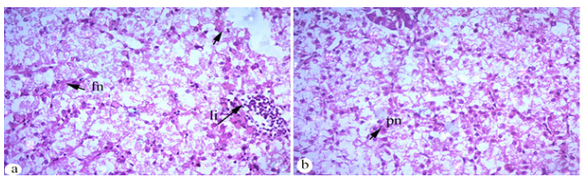

Plate 2: Liver of fish fed corn, where (a-15%) showing diffuse degeneration of hebatocytes, focal necrosis (fn) and leukocytic infiltration (li) and (b-30%) showing severe degeneration with focal necrosis represented by pyknotic nuclei (pn),(H&E,×40). Plate (2): Liver of fish fed corn (a-15% and b-30%).

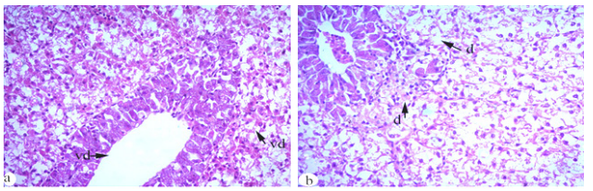

Plate 3: Liver of fish fed sorghum, where (a-15%) showing mild facuolar degeneration (vd) of hepatocytes with prominent locate nuclei and (b-30%) showing moderate to severe degeneration (d), (H&E,×40).

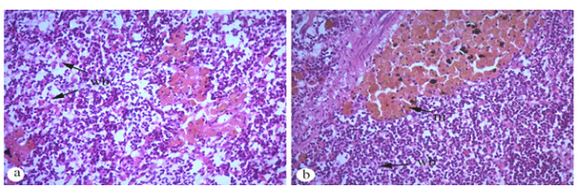

Plate 4: Spleen of fish fed wheat, where (a-15%) showing depletion of white pulp (wb) and (b-30%) showing depletion and necrotic changes of white pulp with hyperplasia of melanomacrophage (m) centers (H&E,×40). Plate (4): Spleen of wheat group (a-15% wheat and b-30% wheat).

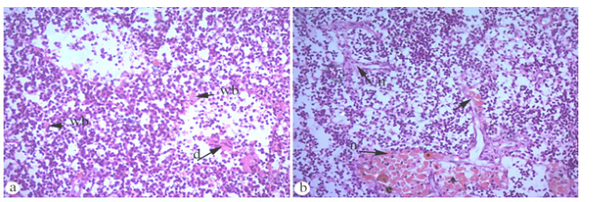

Plate 5: Spleen of fish fed corn , where (a-15%) showing prominent depletion (d) of lymphoid follicles of white pulp and (b-30%) showing severe degeneration and necrosis (n) of lymphoid follicles (H&E,×40).

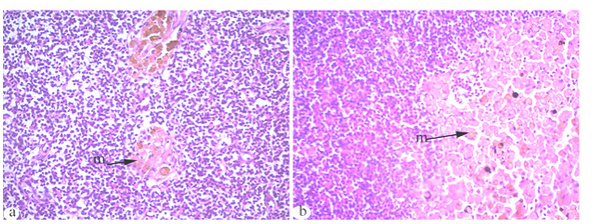

Plate 6: Spleen of fish fed sorghum group, where (a-15%) showing normal splenic structure with normally distributed melanomacrophage centers (m) and (b-30%) showing normal intact lymphoid follicles and well preserve dhyperplastic melanomacrophage (m) centers (H&E,×40).

Table 3: Growth performance and feed efficiency of Nile tilapia fed on different dietary carbohydrate sources (Mean±SD n=3).

Parameters	Carbohydrate levels %					
	W15	W30	C15	C30	S15	S30
Initial body weight (g/fish)	9.2^{a}±0.37	9.0^{a}±0.37	8.7^{a}±0.37	9.5^{a}±0.37	9.54^{a}±0.37	9.38^{a}±0.37
Final body weight (g/fish)	29.76^{d}±0.22	33.02^{c}±0.34	30.55^{d}±1.25	29.24^{d}±0.32	44.34^{a}±0.26	41.18^{b}±0.98
Total weight gain (g/fish)	20.56^{d}±0.23	24.02^{c}±0.26	21.85^{d}±0.99	19.74^{d}±0.23	34.80^{a}±0.21	31.80^{b}±0.22
Specific growth rate(%/day)	1.84^{d}± 0.04	2.36^{c}±0.03	2.00^{c}± 0.05	1.75^{d}± 0.04	3.12^{a}±0.03	2.96^{ab}±0.02
Condition factor (g/cm^3)	1.4^{c}±0.07	1.5^{c}±0.02	1.61^{ab}±0.04	1.31^{c}±0.02	1.84^{a}±0.04	1.76^{a}±0.05
Survival rate (%)	97	97	98	98	98	98
Feed consumed(g)	37.5	42.4	41.5	44.5	42,5	43.5
Feed conversion ratio	1.82^{b}±0.05	1.78^{b}±0.03	1.90^{b}±0.06	2.25^{a}±0.03	1.22^{d}±0.04	1.37^{c}±0.03
Protein efficiency ratio	1.82^{b}±0.03	1.86^{b}±0.01	1.73^{b}±0.004	1.47^{c}±0.02	2.70^{a}±0.06	2.43^{a}±0.05
Net protein Utilization (%)	26.41^{d}±0.36	29.94^{c}±0.28	24.84^{d}±0.24	21.22^{c}±0.23	38.80^{a}±0.35	34.75^{ab}±0.33
Hepatosomatic index (HSI %)	1.60±0.01	1.62±0.03	1.54±0.02	1.58^{a}±0.03	1.60±0.04	1.64±0.02

Values with different superscripts letters are significantly different (P<0.05).

Table 4: Blood parameters of Nile tilapia fed on different dietary carbohydrate sources (Mean±SD n=3).

Parameters*	Carbohydrate levels %					
	W15	W30	C15	C30	S15	S30
RBCs	1.88±0.03	1.86±0.02	1.84±0.04	1.87±0.01	1.89±0.03	1.87±0.01
WBCs (x10^3)	81.45±0.65	82.27±0.47	81.78±0.62	82.68±0.48	81.95±0 .56	82.12±0.45
PL	80.50±1.50	79.50±0.50	81.10±2.50	81.40±1.20	80.22±1.00	81.60±1.00
HB (g/dL)	7.49±0.40	7.65±0.55	7.70±0.42	7.61±0.48	7.70±0.38	7.58±0.43
HCT (%)	33.25±0.35	33.78±.41	33.12±.45	33.14±.60	33.32±0.03	33.51±0.01

RBCs, red blood cells, WBCs, white blood cells,PL, platelates,HB, haemoglobin and HCT, haematocrit.

Table 5: Whole proximate composition of Nile tilapia fed on different dietary carbohydrate sources (Mean±SD n=3).

Parameters*	Carbohydrate levels %					
	W15	W30	C15	C30	S15	S30
Dry matter	27.43±0.39	27.25±0.28	27.15±0.34	27.85±1.15	28.12±1.62	28.23±0.38
Crude protein	14.84±0.22	14.72±0.22	14.65±0.48	14.75±0.81	14.62±1.21	14.58±0.54
Crude lipid	7.11±0.08	6.78±0.22	6.86±0.11	6.54±0.26	6.77±0.83	7.81±0.20
Ash	5.48±0.36	5.75±0.23	5.64±0.15	6.56±0.25	6.73±0.53	5.59±0.28
Growth energy (MJ/kg/diet)	6.38	6.22	6.23	6.12	6.18	7.59

DISCUSSION

Protein is generally the most expensive component in aquaculture diet, thus feed manufacturers search to use alternative cheap sources of carbohydrates to replace it. Cereal grains, especially corn which, form the high bulk of energy in fish diets are in shortage stock as a result of industrial and human demands. The competition between different consumed for available feed resources can increase the cost of animal production. This leads to search for alternative sources such as sorghum, which can be use in feed formulation. Carbohydrate utilization varies greatly among fish species and its appropriate amount can improve growth and feed efficiency[11,25].

The present study focused on the use of different inclusion levels and sources from wheat bran, corn and sorghum as alternative source of carbohydrate in the diet of Nile tilapia. In the last decade large number of effort has been conducted towards the use of alternative carbohydrate ingredients as a source of energy and had a protein- sparing effect on fish diets. The suitability of this replacement in terms of growth performance and feed efficiency is highly variable among fish species and experimental conditions. There is interest to increase cultivation of some developing crops, which can be grown in the semi-arid regions to help alleviate feed shortage such as sorghum. This study showed that the sorghum can be used as source of carbohydrates in Nile tilapia (Oreochromis niloticus) diets.

The present study showed that WG, SGR, K, FCR, PER and NPU of Nile tilapia significantly increased with two dietary sorghum levels, where, diets with corn showed less improvement in the previous parameters. The growth performance and feed efficiency of the present experimental showed that Nile tilapia can use sorghum meal up to 30% in their diets without exerting any deleterious effect on growth performance and feed efficiency. These results are comparable with the previous results in tilapia, which can incorporated up to 40% of dietary (maize or sorghum) starch sources in their diets[25,26,27,28,29]. On the other hand[30], recorded a high inclusion level of low tannin sorghum 0.4% tannin up to (44% of diet) can be used in feeding of Nile tilapia. The same author suggests a great potential for sorghum meal to replace maize in feeding of tilapia, without compromising growth or protein utilization. The above finding was agree with the present result, where 30% sorghum diets contain 0.3% tannin and this level was less than 0.4%, which recorded by[30].

No significant differences from RBC,WBC,PL,HB and HCT among fish fed different sources and levels of carbohydrate and the values within the normal levels recorded in tilapia (Oreochromis) hybrid[31,32]. Similar results were obtained in Oreochromis niloticus[33].

The knowledge on body composition of fish and factors affecting it allows the assessment of fish health, determination the efficiency of transfer nutrients from food to the fish make it possible to predictably carcass composition[26]. The body composition contents in the present study were accordance with the growth performance results. No effect of carbohydrate sources or levels were recorded on body contents of tilapia. Similar results were obtained in different species: tilapia[27,34], trout[35] and grouper[3,36]. On the contrast, a positive increase in lipid contents by increase carbohydrate levels were recorded in other fish species such as trout (Salmo gairdneri)[26] and catfish (Clarias gareipinus)[37,38].

The histopathological changes were observed in the hepatic and splenic of the dietary treatments were alleviated to variable degrees in the challenged groups fed dietary carbohydrate sources (wheat, corn and sorghum). In this study, there have been varying changes from degeneration of hebpatocytes, focal necrosis and leukocytic infiltration in liver and spleen tissues between different treatments and these changes were more severe with the high inclusion levels (30%). However, the group of fish fed with sorghum showed normal structure of liver with mild focal vacuolar degeneration of hepatocytes. This finding was comparable with the observation of[39], where no changes were recorded in spleen and liver tissues of Atlantic salmon fed with genetically modified maize.

However, the changed in liver and spleen, which revealed in the present study were in accordance with the results obtained with different fish species fed with plant sources, where an structural damage was recorded in fish fed plant protein diet compared with fish meal diet[40-43].

CONCLUSION

With higher prices of raw materials, especially wheat bran and corn, which represent the greatest part for carbohydrate in fish diets, it was necessary to search for cheap, low-priced sources. From the nutritional point of view sorghum can introduce as alternative and cheap source in fish feed. The results of the presented study

concluded that sorghum can be use with the two inclusion levels (15 and 30%) in the diet of Nile tilapia without any adversely effects on growth performance, nutrient utilization, blood values and liver histology of fish. Further research should be conducted to examine the possibility to increase the inclusion level of sorghum and detect the apparent digestibility coefficient of this ingredient in practical tilapia diet.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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الملخص العربى

تأثيراستخدام مصادر كربوهيدراتية مختلفة على اداء النمو والتركيب الهستولوجى للكبد لاصبعيات اسماك البلطى النيلى

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تعد الكربوهيدرات من المصادر العلفية الرخيصة السعر والتى يمكن ان تمد الاسماك بالطاقة الازمة لها وخاصة فى العلائق المنخفضة فى البروتين كما ان لها فعل توفيرى عند استخدامها فى علائق الأسماك.

هدف البحث: هدفت الدراسة لتقيم تأثيرمصادر الكربوهيدرات المختلفة على معدلات النمو, قياسات الدم , التركيب الهستولوجى للكبد والتركيب الكيميائى لجسم أسماك إصبعيات البلطى النيلى.

مواد وطرق البحث: وزعت الاسماك فى 18 حوض زجاجى سعة (75×40×35cm) باستخدام 6 معاملات تجريبية ومُثلت كل معاملة بثلاث مكررات وسُكنت الاسماك بمعدل 25 سمكة/حوض ووزن أولى (2 ، 9 ± 37 ، 0 جم). استخدمت 6 علائق باستخدام مصادر مختلفة من الكربوهيدرات (الردة , الذرة الصفراء والذرة الرفيعة) ومثل كل مصدر بنسبة 15 و30 % من العليقة واستمرت التجربة 90 يوم. تم اخذ العينات لدراسة اثر العلائق المستخدمة على معدلات الاداء, قياسات الدم , التركيب الكيميائى لجسم الأسماك وتم عمل قطاعات هستولوجية لكل من الكبد والطحال لأسماك البلطى النيلى.

النتائج: أوضحت نتائج الدراسة ان معدلات الأداء للنمو و كفاءة استخدام الغذاء ازدادت مع استخدام كلا المستويين من الذرة الرفيعة ولم تظهر قياسات الدم والتركيب الكيميائى اختلافات معنوية عند مستوى (01، 0) بين العلائق المختلفة. اظهر الفحص الهستولوجى لكل من الكبد والطحال أن استخدام الذرة الرفيعة فى المستوى المنخفض حَسن من تركيب الكبد والطحال للأسماك المختبرة مقارنة بالعلائق الأخرى.

الخلاصة: بالاعتماد على نتائج النمو,الكفاءة الغذائية, تركيب جسم الأسماك والفحص الهستولوجى فإنه يمكن استخدام الذرة الرفيعة حتى نسبة 30% من العليقة بدون تأثيرات معاكسة على معدل الأداء, التركيب الكيميائى وتركيب الكبد لإصبعيات البلطى النيلى.