Abbassa Int. J. Aqua., V0l.10 No.(1) 2017. *62-79*

REDUCING FEED COST BY USING SUB-GRADED SWEET POTATO TUBER AS A NON-TRADITIONAL ENERGY SOURCE IN NILE TILAPIA, *Oreochromis niloticus* DIETS

Medhat E. Seden[1*]; Nader E. El-Tawil[1]; Talaat N. Amer[1]; Mohammad. H. Ahmad[1] and Tharwat I. Dawood[2]

[1]Department of Fish Nutrition, [2]Department of Fish Economic, Central Laboratory for Aquaculture Research, CLAR, Agriculture Research Center, Egypt.

*Corresponding author's e-mail: m.saydain@yahoo.com.

Received 16/ 4/ 2017 *Accepted 28/ 5/ 2017*

Abstract

This study was conducted to assess the nutritional and economical value of using sub-graded sweet potato, *Ipomea batata*s L. tuber (SPT) as a non-traditional source of energy instead of yellow corn (YC) in practical diets of Nile tilapia (3.1±0.04 g). Five isonitrogenous and isolipidic diets (30% crude protein and 8.4 % crude lipid) were formulated to contain different levels of SPT replaced 0.0 (control), 25, 50, 75 or 100% of yellow corn meal. Each diet was fed in triplicate groups two times a day for 12 weeks to apparent satiation. Results demonstrated that, SPT had good potential as a level 100% substitute of the energy supplied by YC for Nile tilapia. No significant differences were observed (P>0.05) in growth performance, feed conversion ratio and protein utilization values compared to fish fed on control diet. Also, results indicated that fish proximate chemical analysis was not significantly affected by partial or total replacement of SPT for YC in fish diet. Moreover, the economic evaluation showed that diet containing 100% SPT reduced the feed cost by 13.78% compared to fish fed on control diet. These results suggest that sweet potato tuber could substitute up to 100% of yellow corn meal as an energy source in Nile tilapia diet without adverse effects on growth performance and with an irresistible increase in profit margin by reducing the feed cost.

Keywords: Sweet potato tuber, Nile tilapia, growth performance, feed utilization, economic evaluation.

INTRODUCTION

Tilapia aquaculture is rapidly expanding with a global production of about 3.95 million metric tons in 2011 and estimated to increase to 9.2 million metric tons by the year 2030 (FAO, 2014). One of the problems facing the aquaculture industry today is the high cost of fish feed. Nutritionist all over the world are constantly searching for the dietary protein and energy sources in which fish will maximize growth and increase production within the shortest possible time and at lowest cost (Bairagi *et al.,* 2004). The growth in aquaculture production in the last decade, and the need for cost-efficient feed have resulted in increased demand for alternative feed sources of similar qualities to fully or partly replace conventional feed ingredients. Okoye and Sule (2001) stated that the decline in the local production of African countries in recent years, has led to attempts to replace or supplement the maize component of fish feed with cheaper non conventional energy sources.

Corn is the major source of metabolisable energy in most compounded diets because it is readily available and digestible. However, the increasing and prohibitive cost of this commodity has necessitated the need to search for an alternative source of energy. Agbabiaka (2012) and Agbabiaka *et al.* (2013) reported that many researchers made attempts to increase the use of nonconventional plants and animal materials to replace conventional feed ingredients like maize and fish meal in fish feed for the purpose of nutritional and economic benefits. Sogbesan *et al.* (2016) showed that soaked plantain peel meal (SPPM) can serve as a complete replacement for maize in *Clarias gariepinus* diet and it may be more profitable to fish farmers as maize is more expensive than SPPM, which is considered as waste.

Sweet potato (*Ipomea batata*s L.) derived from the family *Convolvulaceae* is a very important vegetable crop food in many countries including Egypt (Alloush, 2015). It is considered one of the many possible solutions that are waiting to be discovered to produce lower cost fish diets. It ranks the seventh most important food crop in the world and fourth in tropical countries (FAOSTAT, 2004). Sweet potatoes are rich in β-carotene, anthocyanins, total phenolics, dietary fiber, ascorbic acid, folic acid and minerals (Bovell-Benjamin, 2007; ILSI, 2008). Abo-Donia *et al.* (2005) found that residues of sweet potato tuber could be efficiently used as source of energy instead of yellow corn at harvesting season of sweet potato. Moreover, Noblet *et al.* (1990) stated that SPT could be used as satisfactory sources of energy in rations of fish since it contains the same energy as corn. Carbohydrates generally make up between 80 to 90% of the dry weight of sweet potato roots but the uncooked starch of the sweet potato is very resistant to the hydrolysis by-amylase (Dominguez, 1992).

During the potato production season in Egypt, large amounts of low-value sub-graded sweet potatoes are available which are not used for feeding purposes. Therefore, the aim of the present work is to study the effect of using sub-graded sweet potato tuber as non-traditional source of energy instead of yellow corn in practical diets of Nile tilapia on growth performance, nutrient utilization and its economical value.

MATERIALS AND METHODS

Diets preparation:

Five diets were formulated to be isonitrogenous (30 % crude protein) and isolipidic (8.4% fat) with different levels of sub-graded sweet potato, *Ipomea batatas* L. tubers (SPT) replacing yellow corn (YC). The composition and proximate analyses (dry-matter basis) of these diets are given in Table 1. All diets were formulated to contain the same protein and lipid contents to complete the requirement of the fish. The control diet (T_1) was prepared with 100% YC. The remaining four diets (T_2 to T_5) were prepared at graded levels of SPT with 25, 50, 75, or 100%, respectively of substituted YC. SPT were obtained from local market as remnants of sweet potato crop.

Table 1. Ingredients and chemical analysis of the experimental diets (On dry matter basis).

Ingredients	Sweet Potato tuber (SPT) levels (%)				
	T_1 0.0	T_2 25	T_3 50	T_4 75	T_5 100
Herring fish meal [1]	12.50	12.50	12.50	12.50	12.50
Soybean meal [2]	36.50	36.50	36.50	36.50	36.50
Yellow Corn	32.00	24.00	16.00	8.00	0.00
Sweet Potato	0.00	8.00	16.00	24.00	32.00
Wheat bran	10.00	10.00	10.00	10.00	10.00
Corn oil	2.50	2.50	2.50	2.50	2.50
Fish oil	1.50	1.50	1.50	1.50	1.50
Starch	2.00	2.00	2.00	2.00	2.00
Vitamins premix [3]	1.50	1.50	1.50	1.50	1.50
Minerals premix [4]	1.50	1.50	1.50	1.50	1.50
Total	100.00	100.00	100.00	100.00	100.00
Chemical analyses:					
Moisture	9.53	10.11	10.15	10.00	10.15
Crude protein	30.11	30.15	29.98	30.10	30.06
Ether extract	8.22	8.16	8.65	8.52	8.51
Crude fiber	6.25	6.15	6.12	6.13	6.11
Ash%	10.54	10.61	10.71	10.96	10.84
Nitrogen-free extract [5]	44.88	44.93	44.54	44.49	44.23
GE (kcal/100g) [6]	430.55	430.77	431.08	431.35	430.78

1 - Danish fish meal72% protein, 14.2% crude fat, and 11.0% ash obtained from TripleNine Fish Protein, DK-6700 Esbjerg, Denmark.

2 - Egyptian soybean flour 44% protein, 1.1% crude fat, and 7.9% ash obtained from National Oil Co., Giza, Egypt.

3 - Vitamin premix (per kg of premix): thiamine, 2.5 g; riboflavin, 2.5 g; pyridoxine, 2.0 g; inositol, 100.0 g; biotin, 0.3 g; pantothenic acid, 100.0 g; folic acid, 0.75 g; para-aminobenzoic acid, 2.5 g; choline, 200.0 g; nicotinic acid, 10.0 g; cyanocobalamine, 0.005 g; a-tocopherol acetate, 20.1 g; menadione, 2.0 g; retinol palmitate, 100,000 IU; cholecalciferol, 500,000 IU.

4 - Mineral premix (g/kg of premix): $CaHPO_4.2H_2O$, 727.2; $MgCO_4.7H_2O$, 127.5; KCl 50.0; NaCl, 60.0; $FeC_6H_5O_7.3H_2O$, 25.0; $ZnCO_3$, 5.5; $MnCl_2.4H_2O$, 2.5; $Cu(OAc)_2.H_2O$, 0.785; $CoCl_3..6H_2O$, 0.477; $CaIO_3.6H_2O$, 0.295; $CrCl_3.6H_2O$, 0.128; $AlCl_3.6H_2O$, 0.54; Na_2SeO_3, 0.03.

5 - Nitrogen-free extract = 100 – (crude protein + total lipid + crude fiber + total ash).

6 - Gross energy (GE) was calculated from (NRC, 1993) as 5.65, 9.45, and 4.1 kcal/g for protein, lipid, and carbohydrates, respectively.

SPT were thoroughly washed with tap water to remove dirt and debris, properly drained and cut to small parts. Then, they were exposed to sunlight until completely dried and were milled until they became a powder. The chemical analysis of herring fish meal FM, soybean meal SBM, SPT and YC are present in Table (2). The dietary ingredients were thoroughly mixed and moistened by the addition of 100 ml warm water per kg diet and then made into pellets by a mincing machine. Pellets were manually cut into shape, dried in an oven at 85°C until a constant weight was achieved. All diets were packed in sealed plastic bags and kept stored in a freezer until use.

Table 2: Proximate chemical analysis of feed ingredients (On dry basis).

Chemical composition (%)	Herring fish meal (FM)	Soybean meal (SBM)	Sweet potato tuber (SPT)	Yellow corn (YC)
Dry matter	92.50	93.8	88.51	89.17
Crude protein	72.02	44.11	7.87	8.12
Ether extract	13.98	1.27	2.88	3.34
Crude fiber	0.70	6.42	2.2	3.14
Ash	11.05	7.87	2.13	1.51
Nitrogen-free extract	2.25	40.33	84.47	83.60
GE (kcal/Kg)	548.27	426.98	419	420

Fish and culture technique:

Nile tilapia, *Oreochromis niloticus* (L) with an average initial body weight of 3.1 g/fish were obtained from the fish hatchery ponds, Central Laboratory for Aquaculture Research (CLAR). Fish were kept in indoor tank for 2 weeks as an acclimation period to the laboratory conditions. Fish were divided into 5 groups (3 replicates per treatment), each containing 15 fish/aquarium. Each subgroup of fish was randomly transferred into a 100 L glass aquarium. De-chlorinated tap water was used throughout the study. In order to avoid accumulation of the metabolites, one half of water of each aquarium was changed daily. Each aquarium was also supplied with air produced by a small electric compressor unionized. The photoperiod was set on a 12 hour light-dark cycle using fluorescent tubes as the light source. During the course of the experiment, all fish from each aquarium were collected every two weeks and collectively weighed. Fish were fed at satiation 6 days per week, two times daily for 12 weeks.

Parameters of growth performance and feed utilization:

Growth and feed utilization parameters were calculated as follows:

Weight gain (g) = $W_2 - W_1$;

Specific growth rate (SGR; (% / day) = 100 [Ln W_2 – Ln W_1] /T, Where W_1 and W_2 are the initial and final weights, respectively, and T is the experimental period (days);

Feed conversion ratio (FCR) = feed intake (g)/weight gain (g);

Protein efficiency ratio (PER) = weight gain (g) / protein intake (g);

Protein productive value (PPV %) = 100 (protein gain/protein intake) ;

Energy utilization (EU %) = 100 [Energy gain in fish / energy intake in diet].

Proximate chemical analysis:

Sweet potato tubers, experimental diets and fish were analyzed according to standard methods (AOAC, 1990) for moisture, crude protein, total lipids, and ash. Moisture content was estimated by drying samples in an oven at 85°C until constant weight was achieved. Nitrogen content was measured using a micro-Kjeldahl apparatus, and crude protein was estimated by multiplying total nitrogen content by 6.25. Total lipid content was determined by ether extraction for 16 h, and ash was determined by combusting samples in a muffle furnace at 550°C for 6 h. Crude fiber was estimated according to (Goering and Van Soest, 1970). Gross energy was calculated according to (NRC, 1993).

Water analysis:

Water samples were collected biweekly for chemical analysis. Dissolved oxygen and temperature were measured on site using an oxygen meter (YSI, model 58, Yellow Spring Instrument Co., Yellow Spring, OH). Unionized ammonia was measured using a HACH kit (HACH Co., Loveland, CO). The pH was measured using a pH–meter (Fisher Scientific, Denver, CO).

Statistical analysis:

The obtained data were subjected to one-way ANOVA to evaluate the effect of SPT supplement. Differences between means were tested at the 5% probability level using Duncan Multiple Range test (Duncan, 1955). All the statistical analyses were done as described by Dytham (1999) using SPSS, version 10 (SPSS Inc. 1999).

Economical evaluation:

The cost of feed required to produce a unit of fish biomass was estimated using a simple economic analysis. The estimation was based on local retail sale market price of all the dietary ingredients at the time of the study. These prices(LE/kg) were as follows: herring fish meal,16; soybean meal, 3.75; corn meal, 2.75; wheat bran, 2.25; starch, 6.0; fish oil, 60.0; corn oil,10.0; vitamin premix, 10.0; mineral mixture,7.0; sub-graded sweet potato tuber, 0.20 LE/kg.

RESULTS

The values of water quality parameters showed that temperature range was 28 to 29 °C, dissolved oxygen range was 5.3–6.3 mg/L, pH range was 7.8–8.1 and total ammonia range was 0.6 to 0.9 mg/L.

Results presented in Table (3) show that all experimental fish became accustomed to the experimental diets and were observed to feed actively throughout the duration of this study. Growth performance parameters including final body weight, weight gain, daily growth rate (g/day) and specific growth rate were insignificantly ($P>0.05$) influenced by the inclusion of the dietary SPT (Table 3). Insignificant differences ($P>0.05$) were observed in survival rate among treatments since its range was 91.11 to 95.55 %.

Table 3. Growth performance for Nile tilapia fed diets containing different levels of sweet potato tuber (SPT) for 12 weeks.

Items	**SPT levels (%)**				
	T_1	**T_2**	**T_3**	**T_4**	**T_5**
	0.0	**25**	**50**	**75**	**100**
Initial weight (g)	3.04±0.04	3.10±0.05	3.04 ±0.05	3.05 ±0.05	3.06± 0.06
Final weight (g)	31.14±0.20	31.71±0.17	29.94±0.86	29.21±1.42	28.96 ±0.28
Weight gain (g)	28.10±0.20	28.61±0.13	26.90±0.85	26.17±1.46	25.90 ±0.33
Daily growth rate (g/day)	0.33±0.00	0.34 ±0.00	0.32±0.01	0.31±0.02	0.31 ±0.01
SGR (% g/day)	3.32±0.02	3.32 ±0.02	3.26±0.04	3.23±0.09	3.21 ±0.04
Survival rate (%)	95.55±1.78	95.55±1.78	91.11±2.03	93.33±1.85	95.55 ±1.78

Results of feed utilization parameters are shown in Table (4). Results showed that there was insignificant difference (P>0.05) in the feed intake in all groups during the experiment compared to the control diet. Indeed, as fish grew, feed conversion ratio showed similar values for fish fed on diets from T_1 to T_5, it varied between 1.62 in fish fed on T_1 (control diet) and 1.65 in T_5. Similarly, PPV, PER, and EU% values showed insignificant differences (P>0.05) among the different treatments (T_1 to T_5) and their ranges were 33.54-32.21%, 2.05-2.03%, and 19.84-18.36%, respectively.

The chemical composition of the whole fish body is shown in Table 5. All fish displayed a change in the whole body composition (compared with that at the start of the experiment), which was manifested as a decrease of moisture percentage and a corresponding increase in total lipid content. No significant changes in moisture, crude protein, total lipid, and total ash contents in fish body were detected (P>0.05) due to the inclusion of SPT in fish diets and their ranges were 74.06-75.40%, 62.82-61.62%, 19.86-20.70%, and 17.02-18.33%, respectively.

Table 4. Feed utilization for Nile tilapia fed diets containing different levels of sweet potato tuber (SPT).

Items	SPT levels (%)				
	T_1 0.0	T_2 25	T_3 50	T_4 75	T_5 100
Feed intake (g/fish)	45.52±0.25	46.63 ±0.27	43.85±2.32	42.66±0.51	42.74 ±2.80
FCR	1.62± 0.01	1.63± 0.01	1.63 ±0.06	1.63 ±0.01	1.65 ±0.08
PER (%)	2.04± 0.01	2.03± 0.01	2.05 ±0.08	2.04 ±0.02	2.03 ±0.09
PPV	32.21±0.23	32.89 ±0.27	33.74±1.19	32.83±0.40	33.54 ±1.61
ER (%)	19.14±0.20	18.36 ±0.11	19.09±0.64	19.84±0.48	19.19 ±0.91

Table 5. Proximate chemical analyses (%; on dry weight basis) of Nile tilapia whole-body fed diets containing different levels of sweet potato tuber (SPT).

Body composition	SPT levels (%)				
	T_1 0.0	T_2 25	T_3 50	T_4 75	T_5 100
Moisture %	74.68 ±0.17	75.40 ±0.09	74.89 ±0.07	74.06 ±0.32	74.87 ±0.05
Crude protein %	62.29 ±0.14	62.82 ±0.44	62.38 ±0.37	62.07 ±0.12	61.62 ±0.11
Total lipid %	20.70 ±0.28	19.86 ±0.18	20.0 ±0.17	19.98 ±1.00	20.06 ±0.07
Total ash %	17.02 ±0.84	17.42 ±0.33	17.32 ±0.11	17.93 ±0.32	18.33 ±0.10

Economic evaluation of the experimental diets is shown in Table (6). Results showed that the incorporation of SPT (T_2 toT_5) reduced the price of one kg diet as compared to the control group. Average cost to produce on kg feed for T_1 to T_5 ranged between 6.05 and 5.12 L.E., respectively. However, the reduction in feed cost to produce one kg fish gain ranged between 4.69 to 13.78 % in the fish fed on SPT inclusion compared to fish fed on control diet.

Table 6. Economic efficiency for production of one kg gain of Nile tilapia fed diets containing different levels of sweet potato tuber (SPT).

Items	SPT levels (%)				
	T_1 0.0	T_2 25	T_3 50	T_4 75	T_5 100
Price/ kg feed (L.E)	6.05	5.73	5.52	5.21	5.12
FCR (kg feed/kg gain)	1.62	1.63	1.63	1.63	1.65
Feed cost / kg gain (L.E)	9.80	9.34	8.99	8.49	8.45
Reduction in feed cost/ kg gain (L.E)*	0.0	0.46	0.81	1.31	1.32
Reduction in feed cost/ kg gain (%) comparing with the control**	0.0	4.69	8.27	13.38	13.78

* Reduction in feed cost per kg gain (L.E.) = feed cost per kg gain of FM-based treatment (L.E.) - feed cost per kg gain of SPT treatments (L.E.).

** Reduction in feed cost per kg gain (%) = 100 [Reduction in feed cost per kg gain (L.E.) / feed cost per kg gain of control (L.E.)].

DISCUSSION

The values of water quality parameters showed that temperature, dissolved oxygen, pH and total ammonia values were within the tolerance limits for tilapia (Boyd, 1990).

Results of the present study showed that growth performance values of fish fed diets containing various levels of SPT were similar to those of fish fed on control diet. This implies that the feed value of the diets contained SPT meal was adequate for Nile tilapia and the replacement of corn with SPT meal in the experimental diets did not reduce its nutritional quality. All replacement ratios of YC by SPT in the present study coincide with the results obtained by Hagag (2010) who reported that using sweet potato at rate 50 to 100% in Nile tilapia diets neither reduced the fish growth nor had a negative effect on feed utilization. The isonitrogenous and isocaloric nature of the experimental diets in the present study resulted in no disparity in growth response of fish and efficiency of feed utilization. Omoregie *et al.* (2009) revealed that *Oreochromis niloticus* could tolerate up to 15% of inclusion of sweet potato peel. Also, Olkunle (2006) evaluated the potential of sweet potato peel (SPP) meal as a replacement for maize in African catfish (*Clarias gariepinus*) diets. Four diets were formulated to contain graded levels of SPP meal replacing 0, 25, 50 and 75%. The author reported that, the diets did not significantly (P > 0.05) affect fish performance within treatments. Samoluobasa *et al.* (2013) showed that maize can be replaced at 50% level by toasted African breadfruit seed meal without affecting growth and nutrient utilization in the practical diet of African catfish (*C. gariepinus*) fingerlings.

In the present study, No significant differences were observed in survival rate (P>0.05) which ranged between 91.11 to 95.55%. These observations suggested that the SPT diets contained all the necessary energy required by tilapia, such as yellow corn (Huarg, 1987; Abo-Donia *et al.*, 2005). The high survival rate recorded in all the treatments in the present study may be attributed to the good culture conditions and the balanced formulated diets. The replacement of YC by SPT did not exert any effect on the survival rate of tilapia among treatments in the present study. These results were similar to those obtained by (Sogbesan *et al.*, 2016) who indicated that feeding *Clarias gariepinus* on diet containing soaked plantain peel meal (SPPM) does not lead to mortality in fish. Also, Abu *et al.* (2010) did not find any significant differences in mortality rates when hybrid catfish fed on cassava root meal. Agbabiaka *et al.* (2016) indicated that star apple kernel meal has a little or no deleterious effect on the health status of fish. Cardoso *et al.* (2005) observed that good processing of cassava enhance survival and healthy state of fish at all stages of their life.

In the present study, there were no significant differences (P > 0.05) in feed utilization parameters (FCR, PER, PPV and ER %) of Nile tilapia fed different experimental diets. These findings may be due to the better digestibility, utilization and retention of nutrients by the experimental fish, when fed diets containing SPT as well as those fed the CY diet (Huarg, 1987). However, these results in agreement with those found by Abo-Donia *et al.* (2005) who indicated that sweet potato tuber could be efficiently used as a source of energy instead of yellow corn.

These results coincide with Hagag (2010) who found that best FCR was recorded with fish fed diets contained 50 to 100% sweet potato and control group. Furthermore, fish fed on diets containing 50 or 100% sweet potato recorded highest moral values of protein efficiency ratio compared with fish fed diets containing 25% sweet potatoes without any significant differences between those groups and the control group. Olukunle (2006) studied four levels (0, 25, 50, 75%) of sweet potato peel (SPP) meal to replace maize in African catfish (*Clarias gariepinus*) diets. The author reported that, the best FCR and PER values were observed in diets containing 25% SPP meal. They found that SSP meal utilization efficiency decreases at higher levels of inclusion. Also, Abu *et al.* (2010) reported that the best growth performance and nutrient utilization values of hybrid catfish were recorded with fish fed diet containing 66% of cassava root meal. On the other hand, Lawal *et al.* (2011) observed significant decrease in growth parameters of *Clarias gariepinus* when fed diet containing ripe and unripe banana based diets instead of maize compared to control diets.

With respect to the proximate chemical analysis of whole-fish body, results showed that, insignificant changes ($P > 0.05$) were observed between treatments in whole-body composition. These results indicated that the partial or complete replacement of YC by SPT did not alter the nutritional value of the fish produced. These results also suggested that Nile tilapia fish efficiently ingested, digested, assimilated and utilized energy from SPT similar to YC.

This is in agreement with the results of Hagag (2010) who reported that replacing corn energy in the diet of Nile tilapia by sweet potatoes did not have any significant effect on whole-body composition of fish. Similar results were found by (Olukunle, 2006) who replaced maize with sweet potato peel (SPP) meal in African catfish (*Clarias gariepinus*) diets. The author revealed that no significant effect on fish carcass composition.

In the present study, the economic evaluation showed that diets containing different levels of SPT were cheaper than diets containing of YC. Small-scale fish farmers in developing countries are constrained by both the availability and the cost of pelleted fish diets produced commercially. Hence, there is a real need to encourage fish farmers to formulate their own pelleted diets using SPT produced near their farms as far as possible. Calculations of economical efficiency of the tested diets based on cost one kg gain in weight of Nile tilapia in comparison with the control group are shown in Table 6. The cost of diet to produce one kg fish gain was gradually reduced, thereby increasing the profitability of producers. It's clear that, using 75 and 100% SPT diet reduced feed cost to produce 1kg of fish gain by13.38% and 13.78% respectively, compared to the control diet. That would save 6.69% and 6.89% of fish culture costs respectively, because feeding represents over than 50% of the operational costs of aquaculture (El-Tawil *et al.* 2014). These results are in agreement with Abu *et al.* (2010) who reported that, replacement of maize with cassava in hybrid catfish diets could be more profitable to fish farmer as maize is more expensive than cassava. Sogbesan *et al.* (2016) showed that replacement of maize with SPPM in *Clarias gariepinus* diets could be more profitable to fish farmers as maize is more expensive than SPPM.

As a conclusion of this study, it is suggested that sub-graded sweet potato tuber could safely replace yellow corn up to 100% as an alternative energy source for Nile tilapia in practical diets without any negative effect on fish growth performance. These results allow for formulation of less expensive diets for Nile tilapia and reduce the feed costs for farmers.

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خفض تكلفة الغذاء باستخدام فرزة درنات البطاطا كمصدرغير تقليدى للطاقة فى علائق أسماك البلطى النيلى

مدحت السعيد سيدين[١]، نادر عزت عبد العظيم الطويل[١]، طلعت ناجى على عامر[١]، محمد حسن أحمد[١]، ثروت إسماعيل على داود[٢]

[١]قسم بحوث تغذية الأسماك – [٢] قسم بحوث الاقتصاد

المعمل المركزى لبحوث الثروة السمكية – مركز البحوث الزراعية

الملخـص العربــى

أجريت هذه الدراسة لتقديرالقيمة الغذائية والاقتصادية لاستخدام فرزة درنات البطاطا كمصدرغير تقليدى للطاقة بدلاً من الذرة الصفراء فى علائق أسماك البلطى النيلى. تم تجهيز خمس علائق متساوية فى نسبة البروتين (٣٠٪) و متساوية أيضاً فى محتواها من الدهون (٨٪). تم استبدال الذرة الصفراء فى العلائق بمسحوق فرزة درنات البطاطا بالنسب التالية: ٠٪ (كنترول) ، ٢٥٪ ، ٥٠٪ ، ٧٥٪ ، ١٠٠٪ على التوالى. كل معاملة تم تكرارها فى ثلاث أحواض زجاجية سعة ١٠٠ لتر و تم تخزينها بمعدل ١٥ سمكة / حوض بمتوسط وزن إبتدائي ٣.١ جم / سمكة. تم تغذية الأسماك مرتين يومياً إلى حد الإشباع لمدة ١٢ أسبوع. أشارت النتائج إلى إمكانية إحلال فرزة درنات البطاطا فى علائق أسماك البلطى النيلى بدلاً من الذرة الصفراء حتى نسبة ١٠٠٪ من العليقة ، كما أوضحت النتائج أن الاستبدال الكلى أو الجزئى للذرة الصفراء فى العلائق بفرزة درنات البطاطا لم يؤثر على محتوى جسم الأسماك من المادة الجافة ، البروتين ، الدهون أو الرماد مقارنةً بالأسماك المغذاة على العليقة الكنترول. أيضاً أوضحت نتائج التقييم الاقتصادى أن العليقة المحتوية على ١٠٠٪ من فرزة درنات البطاطا قد خفضت من التكلفة الكلية للغذاء بنسبة ١٣.٧٨٪. مما سبق تشير الدراسة إلى أن فرزة درنات البطاطا يمكن استخدامها كمصدرغير تقليدى للطاقة بنسبة ١٠٠٪ فى علائق أسماك البلطى النيلى بدلاً من الذرة الصفراء بدون أى تأثير سلبى على أداء النمو مع زيادة هامش الربح عن طريق خفض تكلفة الغذاء.