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Is it Possible to Feed Nile Tilapia the Diets Containing Wastes of *Opuntia ficus-indica*?

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ABSTRACT

An indoor feeding experiment was conducted to evaluate the effects of replacing diet's corn by meals of fruit skin and leaves of Teen Barshomy (Teen Shoky) "*Opuntia ficus-indica*" on productive performance of all-males mono-sex Nile tilapia, *Oreochromis nilotucus* (17 g initial body weight and a total length of 9.2 cm). Ten glass aquaria (70 x 35 x 40cm) were stocked with 10 fish / aquarium. The feeding trial lasted for 75 days at a daily feeding rate 3% of the actual biomass. Five experimental diets were formulated to replace 25 and 50% of dietary corn by fig skins and fig leaves in diets (D) No. 2, 3, 4, and 5, respectively besides the control one (diet No. 1). All experimental diets were formulated and pelleted into sinking diets with an average pellets diameter and length of 2mm and 1 cm, respectively. Diets were offered to fish 6 days a week at 2 meals (8 am and 2 pm) daily. The obtained results revealed no changes in the rearing water quality criteria. Fig skin and leaves are to some extent chemically similar, but it seems that the fig skin may be more nutritious than the leaves. The replacement affected the chemical composition of the experimental diets. The dietary inclusion of fig wastes decreased the feed consumption of the experimental diets than the control, improved ($P \leq 0.05$) each of final body weight (FBW), total body gain (TBG), daily body gain (DBG), specific growth rate (SGR), relative growth rate (RGR), and feed conversion ratio (FCR) as well as whole fish body composition. Thus, it is possible to feed mono-sex Nile tilapia the diets containing fig wastes as replacers for dietary corn without adversely effects on productive performance parameters of fish.

Keywords: Teen Shoky, Fruit skin, Leaves, Corn replacers, Tilapia performance.

INTRODUCTION

Much information is given (Willem Van Cotthem, 2012) about *Opuntia ficus-indica* as an aloes. Therefore, the aim of the present study was evaluating the possibility of using powders of either fruits' skins or leaves of the Egyptian Teen Shoky as replacers for dietary corn in all-males mono-sex Nile tilapia, *Oreochromis niloticus* diets and their effects on fish performance for 75 days. This is an attempt to ameliorate feed costs by substituting such costless wastes in fish diets to replace somewhat imported dietary ingredients to save foreign money.

MATERIALS AND METHODS

Experimental animals and their management:

Hundred all-males mono-sex Nile tilapia, *O. niloticus* fingerlings weighed on average 17 g and had on average a total length of 9.2 cm purchased from a private fish hatchery (Al-Emam) at Tolompat 7 (Kafer El-Sheikh Governorate) were transferred in plastic bags to Sakha Aquaculture Research Unit. Then, the experimental fish were adapted in a plastic tank of $1m^3$ on the experimental Lab. conditions for one week. Thereafter, these fish were randomly divided into 10 glass aquaria at a stocking rate of 10 fish / aquarium that had dimensions of 70 x 35 x 40cm and filled with 65 liter of fresh water each. The feeding trial duration was 75 days (from 10/7/2017 till 25/9/2017); during which, each two aquaria (replicates) were singed to each treatment. Fish were initially weighed and biweekly thereafter to readjust the feed quantity must be offered per each aquarium according to the actual body weight changes, maintaining the daily feeding rate at 3% of the biomass. The aquaria water was partially changed via syphoning five times weekly and once totally every week.

The rearing water was dechlorinated tap water, since fresh tap water was aerated in a large tank to remove chlorine before be used. Some quality criteria of fish rearing water were periodically measured throughout the experimental duration. The source of light in the experimental lab. was naturally about 10 hours light and 14 hours darkness. Fish rearing water temperature was kept constant via heaters with thermometers.

Experimental diets:

Five experimental diets were formulated to replace 25 and 50% of dietary corn by fig skins and leaves in diets (D) No. 2, 3, 4, and 5, respectively besides the control one (diet No. 1) as shown in Table 1. All dietary ingredients were purchased from the local market (Makka Factory for fish diets, Kafr El-Sheikh). Fig fruit skins as well as fig plant leaves were collected and separately sun dried then ground. All experimental diets were formulated by manually mixing all ground ingredients, then pressed and pelleted into sinking diets with an average pellet diameter and length of 2 and 1 mm, respectively using an electric pelleting machine. Diets were offered to fish 6 days a week at 2 meals (8 am and 2 pm) daily.

Table 1. Formulation of the experimental diets

Ingredients, %	D1	D2	D3	D4	D5
Yellow corn	40	30	20	30	20
Soybean meal	32	32	32	32	32
Wheat bran	15	15	15	15	15
Fig fruit skin	0	10	20	0	0
Fig leaves	0	0	0	10	20
Fish meal	8	8	8	8	8
Fish oil	3	3	3	3	3
Di-calcium phosphate	1	1	1	1	1
Minerals mixture	1	1	1	1	1
Total	100	100	100	100	100

D1: control, D2: 25% fig fruit skin, D3: 50% fig fruit skin, D4: 25% fig leaves and D5: 50% fig leaves.

Measurements of the evaluation:

At the start and at the end of the experiment, fish body weight, and fish total length were measured biweekly. Feed consumption was also measured. Growth rates, condition factor, and feed conversion ratio were calculated (Froese, 2006 and Abdelhamid, 2009); where:

Specific growth rate (SGR, %/day) = 100 [In W2 – In W1] / period, days

Relative growth rate (RGR, %) = 100 [W2 – W1] / W1

Condition factor (KF, %) = 100 (Fish weight, g / fish length, cm^3)

Feed conversion ratio (FCR) = Consumed food, g / fish body gain, g

Mortality rate (MR, %) = 100 (No. of die fish / No. of fish at the beginning of the experiment).

Some measurements in fish rearing water were carried out to determine the suitability of water quality for rearing the experimental fish rearing according to Abdelhamid (1996). Proximate analysis was carried out for the tested dietary ingredients, diets, and whole fish body (in 5 fish per aquarium) according to AOAC (2000). Dressing percentage, boneless meat percentage (fillet) and water holding capacity were calculated too (Abdelhamid *et al*., 2012).

Statistical analysis:

The obtained numerical results were statistically analyzed using SAS (2006) and Duncan (1955) for statistical differentiation between treatment's' mean.

RESULTS AND DISCUSSION

Fish rearing water quality criteria:

Table 2 shows that there were no marketable effects of the dietary treatments on the water quality criteria measured, and the registered values are within the suitable ranges required for rearing Nile tilapia cited by Abdelhamid (1996) and Abdelhakim *et al.* (2002).

Table 2. Averages of some water quality criteria of rearing the experimental fish

Treatments	Temp., C°	pH	DO, ppm	Salinity, ‰	Ammonia, ppm
D1	28.8	6.7	5.9	0.32	0.35
D2	28.7	6.4	5.9	0.30	0.29
D3	28.8	6.3	5.4	0.33	0.32
D4	28.8	6.7	5.8	0.34	0.36
D5	28.9	6.6	4.9	0.31	0.35

D1: control, D2: 25% fig fruit skin, D3: 50% fig fruit skin, D4: 25% fig leaves and D5: 50% fig leaves. Temp.: temperature, DO: dissolved oxygen.

Experimental diets' composition:

Both tested materials were chemically analyzed (Table 3). Teen Shoky fruit skin (peel) (TSFS) contains less dry matter, crude fiber and silica than Teen Shoky leaves (TSL). However, both materials are to some extent chemically similar, except the higher levels of crude fiber, ash, and silica in leaves than the fruit skins but the last contains higher fat and nitrogen free extract than the leaves. That perhaps means that the fruit skin may be more nutritious agent than the leaves.

Table 3. Proximate analysis of the tested materials, % dry matter basis

Composition	Fruit skin (peel, TSFS)	Leaves (TSL)
Moisture	94.78	91.64
Crude protein	8.55	8.51
Crude fat	2.52	1.66
Crude fiber	14.89	23.44
Ash	16.53	18.28
Silica	0.21	1.14
Nitrogen free extract	57.51	48.11

TSFS: Teen Shoky fruit skin; TSL: Teen Shoky leaves.

The other dietary ingredients used in the experimental rations were also chemically analyzed (Table 4). Soybean meal is a plant protein source, since it contained 35.41% crude protein (CP); yet, the fish meal (from the local market) used herein as an animal protein source was of low CP content (16.33%). Wheat bran as a carbohydrate source contained lowest percentages of CP, crude fat and ash but the highest crude fibers (CF) and carbohydrates (nitrogen free extract, NFE) among the tested dietary ingredient.

Table 4.Proximate analysis of main dietary ingredients, % fresh matter basis

Composition	Soybean meal	Fish meal	Wheat bran
Moisture	6.13	17.09	19.03
Crude protein	35.41	16.33	6.41
Crude fat	17.09	5.84	2.98
Crude fibers	12.56	5.12	15.58
Ash	6.74	7.92	3.47
Total carbohydrates	34.63	9.86	68.11

The tested rations were chemically analyzed too (Table 5). Their moisture and crude fat contents were decreased to some extend by the dietary inclusion of fig wastes, particularly with TSL than TSFS and with increasing the inclusion level from 25 to 50%. The opposite trend was recorded for CP and CF that gradually increased in diets 2, 3, 4, and 5 than D1 and in D3 and D5 than D2 and D4. However, total carbohydrates content was equal in different diets. These slight variations in chemical composition of the experimental diets are due to the nature (chemical composition, Tables 3 and 4) and level of the fig wastes (TSFS and TSL) used herein. Usually any replacement affects the dietary composition as found by many authors used different dietary replacers (Abdelhamid and Saleh, 2015; Abdelhamid *et al*., 2016 and 2018).

Table 5. Proximate analysis of the tested diets, % fresh matter basis

Composition	D1	D2	D3	D4	D5
Moisture	18.73	18.27	17.38	17.89	16.93
Crude protein (CP)	24.66	25.19	26.57	25.82	27.14
Crude fat (EE)	15.39	15.32	14.06	14.73	13.48
Crude fiber (CF)	6.49	6.85	7.69	7.27	8.13
Ash	5.18	5.54	8.18	5.78	6.56
Total carbohydrates	35.51	35.68	35.81	35.78	35.89

D1: control, D2: 25% fig fruit skin, D3: 50% fig fruit skin, D4: 25% fig leaves and D5: 50% fig leaves.

Feed consumption:

The dietary inclusion of fig wastes; particularly with 50% TSFS (D3) and 25% TSL (D4) decreased ($P \leq 0.05$) the feed consumption (Table 6) of the experimental diets than the control (D1). That may be attributed to higher contents of CF and ash (Table 5) in fig wastes, particularly in TSL than the corn.

Table 6. Feed consumption (g/fish) throughout the whole experimental period(75 days) (means* ± standard error)

D1	D2	D3	D4	D5
42.55^{a}	41.02^{b}	37.76^{d}	38.10^{d}	40.61^{c}
±1.97	±0.39	±1.57	±1.66	±0.52

a-d: Mean superscripted with different letters in the same row differ significantly ($P \leq 0.05$). D1: control, D2: 25% fig fruit skin, D3: 50% fig fruit skin, D4: 25% fig leaves and D5: 50% fig leaves. *: means for all fish in both aquaria/treatment.

Growth performance:

Dietary inclusion of TSFS and TSL improved (P≤0.05) either of FBW, TBG, DBG, as well as SGR and RGR (Table 7), particularly at 25% TSFS and 50% TSL. On the other side, these substitutes increased the MR of the fish as reported too by Abdelhamid *et al*. (2018). Table 8 shows that final total length and condition factor of the experimental fish did not affect (P>0.05) by the dietary treatments; although, FBW was significantly (P≤0.05) affected, since it was the highest with D2 and D5 (Tables 7 and 8). It is proved that increased dietary CP (Table 5) significantly elevate FBW and RGR (Table 7) as found by Abdelhamid *et al*. (2001) and Khalil *et al*. (2001). Moreover, some replacing agents significantly improved FBW, FBL and FCR (Abdelhamid *et al*., 2000).

Table 7. Performance of the experimental fish as affected by the dietary treatments for 75 days (means* ± standard error)

Items	D1	D2	D3	D4	D5
Average final body weight (FBW), g/fish	28.32^{e} ± 0.42	33.24^{a} ± 0.13	30.54^{c} ± 1.08	30.49^{d} ± 1.51	32.19^{b} ± 0.82
Average total body gain(TBG), g/fish	11.37^{e} ± 0.37	16.24^{a} ± 0.13	13.54^{c} ± 1.08	13.49^{d} ± 1.51	15.19^{b} ± 0.82
Average daily body gain (DBG), g/fish	0.152^{e} ± 0.01	0.217^{a} ± 0.00	0.181^{c} ± 0.01	0.180^{d} ± 0.02	0.203^{b} ± 0.01
Average mortality rate (MR), %	5.00^{c} ± 5.00	15.0^{a} ± 5.00	10.0^{b} ± 0.00	15.0^{a} ± 5.00	15.0^{a} ± 5.00
Specific growth rate (SGR), %/d	0.68	0.89	0.79	0.79	0.85
Relative growth rate (RGR), %	66.59	95.53	79.65	78.82	89.35

a-e: Mean superscripted with different letters in the same row differ significantly (P ≤ 0.05). D1: control, D2: 25% fig fruit skin, D3: 50% fig fruit skin, D4: 25% fig leaves and D5: 50% fig leaves. *: means for all fish in both aquaria/treatment.

Table 8. Performance of the experimental fish as affected by the dietary treatments for 75 days (means* ± standard error)

Items	D1	D2	D3	D4	D5
Average final body weight (FBW), g/fish	30.12^{b} ±1.38	33.25^{a} ±1.14	30.53^{b} ±1.23	29.84^{b} ±1.36	32.14^{a} ±1.59
Average final total body length (FBL), cm	12.57 ±0.35	12.72 ±0.13	12.36 ±o.18	12.09 ±0.28	12.46 ±0.32
Average final condition factor (FKF)	1.54 ±0.03	1.61 ±0.036	1.53 ±0.09	1.69 ±0.07	1.68 ±0.0
Average final dressing percentage	62.19^{a} ±3.82	55.29^{c} ±1.78	55.39^{c} ±1.76	53.82^{d} ±1.71	57.97^{b} ±2.71
Average final boneless meat, %	34.28^{a} ±0.73	30.41^{b} ±0.98	26.97^{c} ±1.78	27.71^{c} ±1.1	30.40^{b} ±0.95

a-c: Mean superscripted with different letters in the same row differ significantly (P ≤ 0.05).
***: Mean for all fish in both aquaria / treatments. D1: control, D2: 25% fig fruit skin, D3: 50% fig fruit skin, D4: 25% fig leaves and D5: 50% fig leaves. *: means for all fish in both aquaria/treatment.**

Feed utilization:

Feed utilization expressed as feed conversion ratio (FCR) presented in Table 9 for the experimental fish for the whole period of the feeding trial clears the replacement of corn by fig wastes improved the FCR than on the control diet (D1), particularly it was significantly (P≤0.05) the best with D2 and D5. Abdelhamid *et al*. (2005) recorded better results with Nile tilapia by a dietary replacement concerning their growth performance, feed utilization, and their body CP content.

Table 9. Feed conversion ratio (g food/g fish gain) throughout the whole experimental period (75 days) (means* ± standard error)

D1	D2	D3	D4	D5
3.74^{a} ±0.05	2.53^{c} ±0.01	2.80^{b} ±0.11	2.88^{b} ±0.16	2.68^{c} ±0.11

a-c: Mean superscripted with different letters in the same row differ significantly (P ≤ 0.05). D1: control, D2: 25% fig fruit skin, D3: 50% fig fruit skin, D4: 25% fig leaves and D5: 50% fig leaves. *: means for all fish in both aquaria/treatment.

Fish body composition:

The chemical composition of the experimental fish at the start composed of 13.67% protein and 2.95% fat. After 75 days of the experimental feeding period, crude protein increased (17.42 – 19.25%) than at the start of the experiment, since dry matter content naturally increased by age and therefore all nutrients increased too. However, the tested material gradually increased (P≤0.05) both of protein and ash contents gradually as the level of these materials increased in the diet from 25 % (D2 and D4) to 50% (D3 and D5) and then the control (D1, without fig wastes). The opposite trend was recorded for the fat content that decreased by dietary inclusion of fig wastes (than the control), particularly with increasing the fig waste levels (P≤0.05). Generally, the negative correlation between protein and fat percentages is a fact (Ali, 2008; Salem *et al*., 2008; Saad, 2010 and Farrag *et al*., 2013). Yet, other researchers found a positive relation between CP and EE contents of fish body (Eweedah *et al*., 2006; Gaber, 2006 and Soltan *et al*., 2008). Others did not find effect of dietary treatments on fish body composition (Mohamed and Hanafy, 2002; Soltan, 2002 and El-Dakar, 2004). Anyhow, some wastes fed to fish may reduce fish body fat content and increase ash content (Hassanen *et al*., 1995).

Also, Kheir and Sweilum (1997) reported that increased dietary CP content led to increase fish body CP and lower its ash content. However, the carbohydrates level is naturally low thus did not affect by the dietary treatments (Table 10) which confirmed also by Abdelhamid *et al.* (2018).

Table 10. Chemical composition (% fresh weight basis) of the experimental whole-fish as affected by the dietary treatments for 75 days (*means ± standard error)

Nutrients	Experimental diets				
	D1	D2	D3	D4	D5
Moisture	73.05^{a} ± 0.131	72.58^{a} ± 0.338	71.61^{ab} ± 0.180	72.12^{ab} ± 0.113	71.13^{b} ± 0.130
Protein	17.42^{c} ± 0.090	17.84^{c} ± 0.107	18.82^{a} ± 0.095	18.24^{b} ± 0.069	19.25^{a} ± 0.090
Fat	4.36^{a} ± 0.089	3.85^{b} ± 0.110	2.98^{c} ± 0.078	3.40^{b} ± 0.095	2.53^{c} ± 0.098
Ash	2.06^{c} ± 0.087	2.48^{b} ± 0.061	3.38^{a} ± 0.098	2.97^{ab} ± 0.087	3.75^{a} ± 0.092
Total carbohydrates	3.11 ± 0.231	3.25 ± 0.330	3.21 ± 0.244	3.27 ± 0.191	3.34 ± 0.150

a-c: Mean superscripted with different letters in the same row differ significantly (P ≤ 0.05).
D1: control, D2: 25% fig fruit skin, D3: 50% fig fruit skin, D4: 25% fig leaves and D5: 50% fig leaves. *: means for all fish in both aquaria/treatment.

Dietary replacements may improve FBW, TBG, DBG, RGR, SGR, FCR, and fish body CP (Abdelhamid *et al*., 2011). Consequently, many authors (Abdelhamid and Soliman, 2012; 2013; Abdelhamid *et al*., 2015 and Khadr, 2018) recommend replacing conventional feed ingredients with unconventional ones without any harms on fish health and performance. Although, some other replacers from polluted sources could be harmful for fish, thus did not recommend to be used in feeding fish (Abdelhamid *et al*., 2010a & b).

CONCLUSION

Based on the currently obtained findings, it is possible to feed all-males mono-sex Nile tilapia, *O. niloticus* diets containing fig wastes as replacers for dietary corn, particularly at replacement rates of 25% fig skin and 50% of fig leaves without adversely effects on productive performance parameters of fish.

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هل بالإمكان تغذية البلطى النيلى على علائق محتوية مخلفات التين الشوكى؟

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تم اجراء تجربة تغذية معملية بهدف تقييم تأثيرات الإحلال الجزئى (25 و 50%) لجلد ثمار التين الشوكى وأوراق نبات التين الشوكى محل الأذرة فى علائق أسماك البلطى النيلى وحيد الجنس – كله ذكور. بعد أقلمة مائة سمكة ذكور بلطى نيلى بوزن أولى 17جم وطول كلى 9.2سم لمدة أسبوع، تم توزيعها على 10 أحواض زجاجية بأبعاد70×35×40سم بمعدل تخزين 10 سمكات للحوض، واستمرت التغذية التجريبية لمدة 75 يوما. وخُصص حوضين لكل معاملة. وتم وزن الأسماك فى البداية ثم بعد ذلك كل أسبوعين لتعديل كمية العلف المقدمة لكل حوض على أساس الوزن الفعلى لأسماك كل حوض بناء على التغير فى وزن الأسماك، مع المحافظة على معدل تغذية يومى 3% من كتلة الأسماك. تم تكوين 5 علائق لإحلال 25 و 50% من أذرة عليقة المقارنة (عليقة رقم 1) بقشر (جلد) ثمار التين الشوكى (عليقة رقم 2 و 3) وأوراق (ألواح) نبات التين الشوكى (عليقة رقم 4 و 5) الجافة والمطحونة، على الترتيب، وذلك بخلط المكونات يدويا ثم كبسها بماكينة كبس كهربائية لعمل محببات بقطر 2مم وطول 1سم. تم تقديم العلائق على وجبتين لمدة 6 أيام أسبوعيا. من النتائج المتحصل عليها كانت قيم قياسات جودة مياه رعاية الأسماك التجريبية فى المدى المناسب لتربية البلطى النيلى. تشابه لحد ما التركيب الكيماوى لكل من قشر ثمار التين الشوكى مع ألواح نبات التين الشوكى، وربما تكون قشور الثمار أغنى غذائيا عن الألواح. تأثر تركيب العلائق التجريبية بهذا الاستبدال. أدى هذا الاستبدال الى خفض استهلاك العلائق التجريبية مقارنة بالعليقة المقارنة رقم 1 الخالية من مخلفات نبات التين الشوكى. وجود مخلفات نبات التين الشوكى فى العلائق قد حسّن معنويا من قيم كل من وزن الأسماك النهائى، زيادة وزن الجسم الكلية واليومية، ومعدلات النمو النسبى والنوعى، ومعدل التحويل الغذائى، كما أدى الاستبدال الى زيادة بروتين جسم الأسماك وانخفاض دهنه تدريجيا عن العليقة المقارنة (رقم 1) الخالية من مخلفات التين الشوكى. الخلاصة: من الممكن تغذية البلطى النيلى وحيد الجنس بعلائق محتوية على مخلفات نباتات التين الشوكى كبديل للأذرة فى العليقة بمعدل 25% قشور (جلد) ثمار تين شوكى أو 50% أوراق (ألواح) نباتات تين شوكى بدون آثار سلبية على قياسات الكفاءة الإنتاجية للأسماك.