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Impact of Dietary Rocket (*Eruca sativa*) Leaves or Seeds on Growth Performance, Feed Utilization, Biochemical and Physiological Responses of *Oreochromis niloticus*, Fingerlings

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ABSTRACT

Medicinal herbs have curative powers and are used in making medicines because of their healing properties. The present study aimed to evaluate the effect of dietary graded levels (0, 1, 2 and 3% kg^{-1} diet) of both Dried Rocket (*Eruca sativa*) Leaves (DRL) or Seeds (DRS) on the growth performance, feed utilization, chemical composition of body and physiological parameters of all male monosex Nile tilapia, *Oreochromis niloticus* fingerlings for 8 weeks in indoor feeding experiment. A total of 168 fish with average initial body weight 17.14±0.35 g were randomly distributed into eight treatments referred No. T_1, T_2, T_3 and T_4 for DRL and T_5, T_6, T_7 and T_8 treatments for DRS. Results revealed that T_4 and T_7 were the best treatments which were responsible for the significantly ($p \leq 0.05$) increased growth performance, feed utilization, chemical composition of the whole fish body, blood hematological and biochemical parameters among all treatments. Dietary DRS gave the best results compared with DRL. Thus, it is recommended that the inclusion of 3% DRL (T_4) or 2% DRS (T_7) as feed additives of all male monosex *O. niloticus* are more useful for improving their growth performance, feed utilization, chemical composition of the whole fish body and physiological responses.

Key words: Nile tilapia, rocket, growth performance, physiological parameters

INTRODUCTION

Nile tilapia, *Oreochromis niloticus* is currently considered to be the most important and commonly cultured tilapia species around the world and constitutes over 70% of the cultured tilapia (Fitzsimmons, 2004). Tilapia species constitute a major and important item in the Egyptian fish farming. It displays many favorable attributes as culture species, on the basis of its general hardness, resistance to diseases, high yield potential, ability to grow on a wide range of natural and cheap artificial foods (El-Sayed, 2006). So, tilapias are the second only to carps as the most widely farmed freshwater fish in the world (FAO., 2010). In Egypt, the total production of tilapia fish increased from 78.35 Mt in 1980 to 870.9 Mt in 2012 which consider as approximately 85.5% of the total aquaculture production (1017.7 Mt) (GAFRD., 2012).

The flora of Egypt includes about 2000 species of plants distributed in its different localities. In addition, many medicinal plants have been successfully introduced and acclimatized in Egypt, where there are more than 20 medicinal-aromatic plants are using to extract their oil for medicinal aspects (Omer, 2009). *Eruca sativa* L. which is commonly known as rocket is used in this study. It belongs to the Brassica plant family *Cruciferae* and is immensely used as vegetable and spice, it originated in Mediterranean region and now is found around the world (Al-Qurainy *et al*., 2010).

The plant also has a wide spread medicinal use. Production of rocket *E. sativa* meal in Egypt has been steadily increased for the strong demand to volatile oils for pharmaceutical purpose (Eisenberg *et al.*, 1993). As the generic name implies, rocket is high in erucic acid, C22:1 (cis-13-docosenoic acid). Essential oil from the leaves of *E. sativa* contains 67 volatile components, representing 96.52% of the oil. The oil is characterized by a high content of sulphur and nitrogen containing compounds (Miyazawa *et al.*, 2002). In addition, the major and functional component of *E. sativa* seeds is Ally isothiocyanate (Hamence and Taylor, 1978). Hence, Kim *et al.* (2004) reported that *E. sativa* is used as an appetizer, blood cleaner, sexual power enhancer and urine and phlegm discharger.

Recent years, in developing countries, a gradual revival of interest in the use of safe herbal medicines had been reported based on their biodegradable and environmental friendly compared with synthetic drugs (Obaroh and Achionye-Nzeh, 2011). Some studies have been done in which herbs, as dietary additives, were fed to fish. The focus of these studies includes their use as feeding attractants (Harada, 1991) and their effects on growth (Lee *et al.*, 2001), survival (Kim *et al.*, 2003) and immune system activity (Immanuel *et al.*, 2004).

It is well known the rocket seeds contain high percentage of oil reached 27.67% and crude protein (29.58%) (Flanders and Abdulkarim, 1985), where used it is a good source of feed supplement. However, few attempts incorporate rocket seeds in diets of fish, red tilapia (Abd Elmonem *et al.*, 2002), Nile tilapia (Mahmoud *et al.*, 2009) and African catfish (Fagbenro, 2004). Consequently, more nutritional and physiological evaluations of dietary rocket leaves and seeds by fish are still required. Therefore, the objectives of the present study were to evaluate the effects of graded levels (0, 1, 2 and 3% kg^{-1} diet) of Dried Rocket (*E. sativa*) Leaves (DRL) or Seeds (DRS) on growth performance, feed and nutrients utilization, chemical composition of the whole fish body, hematological and plasma biochemical parameters of all male monosex Nile tilapia *O. niloticus* for 8 weeks.

MATERIALS AND METHODS

Fish and experimental management: This study was conducted in Fish Laboratory Research, Animal Production Department, Faculty of Agriculture, Mansoura University, Al Dakahlia Governorate, Egypt. Fish were stocked in rearing tank for two weeks as adaptation period during this time they were fed the basal diet. A total of 168 male monosex *O. niloticus* fingerlings at average initial body weights of 17.14±0.35 g were randomly distributed. Then, the fish were stocked at rates of 7 fish per aquarium, where three aquaria were referred to a dietary treatment. Each glass aquarium (90×50×40 cm) was supplied with 108 L dechlorinated tap water and an air stone connected with electric compressor. The replacement of the aquaria water was done partially every day to re-new the water and to remove the wastes. Light period was controlled by a timer to provide a 14 h light: 10 h dark as a daily photoperiod. All treatments and experimental design are showing in Table 1.

Table 1: Experimental design and dietary treatments

Treatments	Details
T_1	Basal diet+0% dried rocket (*E. sativa*) leaves kg^{-1} diet
T_2	Basal diet+1% dried rocket (*E. sativa*) leaves kg^{-1} diet
T_3	Basal diet+2% dried rocket (*E. sativa*) leaves kg^{-1} diet
T_4	Basal diet+3% dried rocket (*E. sativa*) leaves kg^{-1} diet
T_5	Basal diet+0% dried rocket (*E. sativa*) seeds kg^{-1} diet
T_6	Basal diet+1% dried rocket (*E. sativa*) seeds kg^{-1} diet
T_7	Basal diet+2% dried rocket (*E. sativa*) seeds kg^{-1} diet
T_8	Basal diet+3% dried rocket (*E. sativa*) seeds kg^{-1} diet

Dietary treatments: A Basal Diet (BD) was formulated from the local commercial ingredients namely, 22% fish meal, 27% soybean meal, 21% yellow corn, 20% wheat bran, 3% corn oil, 5% molasses and 2% vit. and min premix (each 1 kg premix contains; Vit. A, 12000,000 IU; Vit. D_3, 3000,000 IU; Vit. E, 10,000 mg; Vit. K_3, 3000 mg; Vit. B_1 200 mg; Vit. B_2, 5000 mg; Vit. B_6, 3000 mg; Vit. B_{12}, 15 mg; Biotin, 50 mg; Folic acid 1000 mg; Nicotinic acid 35000 mg; Pantothenic acid 10,000 mg; Mn 80 g; Cu 8.8 g; Zn 70 g; Fe 35 g; I 1 g; Co 0.15 g and Se 0.3 g). However, the BD proximate chemical analysis (% on dry matter basis) was 89.89% Dry Matter (DM), 30.13% Crude Protein (CP), 4.42% ether extract, 11.91% ash, 53.54% total carbohydrate, 426.2 kcal 100/g DM Gross Energy (GE) and 70.69 mg CP $kcal^{-1}$ GE, P/E ratio.

The ingredients and additives (leaves and seeds of *E. sativa*), were bought from the local market. The leaves and seeds of *E. sativa* were cleaned and shade-dried in a drying oven at 50°C for 72 h. DRL and DRS were milled into fine particle size (<250 µm) and kept in a dry, air-tight transparent plastic container. Feed ingredients were ground and the different ingredients mixed manually, then the experimental diets were pressed by manufacturing machine (pellets size 1 mm). Fish fed the diets at a rate of 3% of their live body weight daily, six days a week. Experimental diets were introduced manually twice daily, at 8.00 am and 14.00 pm. The amount of food was adjusted bi-weekly based on the actual body weight changes.

Experimental procedures: At the end of the experiment, the remained fish were sampled from each aquarium and kept frozen for chemical analysis. The chemical analyses of the basal diet and whole fish body were carried out according to AOAC (2000). Water quality parameters included temperature (via a thermometer), pH (using Jenway Ltd., Model 350-pH-meter) and dissolved oxygen (using Jenway Ltd., Model 970- dissolved oxygen meter) were measured weekly. All tested water quality criteria were suitable for rearing Nile tilapia (*O. niloticus*) fingerlings as cited by Abd El-Hakim *et al.* (2002). Since, water temperature ranged between 24 and 28°C, pH values 6.55-7.60 and dissolved oxygen 5.50-8.80 mg L^{-1}. Body weight of individual fish was measured biweekly to point feed quantity and to calculate the growth performance parameters such as; Final Weight (FW, g); Total Weight Gain (TWG, g); Average Daily Gain (ADG, g per fish per day); Relative Growth Rate (RGR, %); Specific Growth Rate (SGR, % day^{-1}), Survival Rate (SR, %) and feed utilization parameters, Feed Intake (FI, g); Feed Conversion Ratio (FCR); Feed Efficiency (FE, %); Protein Efficiency Ratio (PER); Protein Productive Value (PPV, %) and Energy Utilization (EU, %).

Blood samples were collected from the caudal peduncle at the end of the experiment. Adequate amounts of whole blood in small plastic vials containing heparin were used for the determination of hemoglobin (Hb) by using commercial kits (Diamond Diagnostic, Egypt). Also, total Red Blood Cells count (RBCs) and total White Blood Cells count (WBCs) were measured on an A_o Bright -Line Hämocytometer model (Neubauer imroved, Precicolor HBG, Germany), as well as the Packed Cell Volume (PCV, %) was measured according to Stoskopf (1993). Other blood samples were collected and transferred for centrifugation at 3500 rpm for 15 min to obtain blood plasma for determination of plasma total protein according to Gornall *et al.* (1949), albumin according to Weichsebum (1946), globulin by difference according to Doumas and Biggs (1972) and total cholesterol (Tchol) according to the method described by Ellefson and Caraway (1976).

Statistical analysis: All data were statistically analyzed using General Liner Models (GLM) procedure according to SAS (2001) for users guide (SAS version 9.2), with factorial design (2×4) evaluated by using the following model:

$$Y_{ijk} = \mu+L_i+M_j+LM_{ij}+e_{ijk}$$

where, Y_{ijk} is the data of growth performance, feed utilization, carcass composition and hematological and biochemical parameters of male mono-sex Nile tilapia, μ is the overall mean, L_i is the fixed effect of the type of additives (rocket leaves or seeds), M_j is the fixed effect of rocket levels (0, 1, 2 and 3% kg^{-1} diet), LMij is the interaction effect between the type of additives and rocket levels and e_{ijk} is the random error. All ratios and percentages were arcsine-transformed prior to statistical analyses. The differences between mean of treatments were compared using Tukey's post hoc significant test and differences were considered statistically significant at $p\leq 0.05$.

RESULTS

Growth performance: Growth performance parameters (FW, TWG, ADG, RGR and SGR) of *O. niloticus* were illustrated in Table 2. Fish fed DRS was the highest significant ($p\leq 0.05$) than DRL in all growth performance parameters. Also, 3% gave the best dietary level ($p\geq 0.05$) followed by 2%, then 1% compared with the control group. On the other hand, SR not significantly affected ($p\geq 0.05$) by types or levels of additives. The interaction effect between types (DRL and DRS) and different levels of additives are presented in Fig. 1a-d, where the results showed that 3% DRL (T_4) and 2, 3% DRS (T_7 and T_8) gave the highest values ($p\leq 0.05$) in all growth performance parameters among other treatments.

Feed utilization: Data in Table 3 showed that fish fed DRS was significantly ($p\leq 0.05$) increased FE, PER, EU and gave the best FCR value compared with fish fed DRL while, FI and PPV were not affected by types of additives. On the other hand, the level 3% recorded the best values ($p\leq 0.05$) of all feed utilization parameters among all levels.

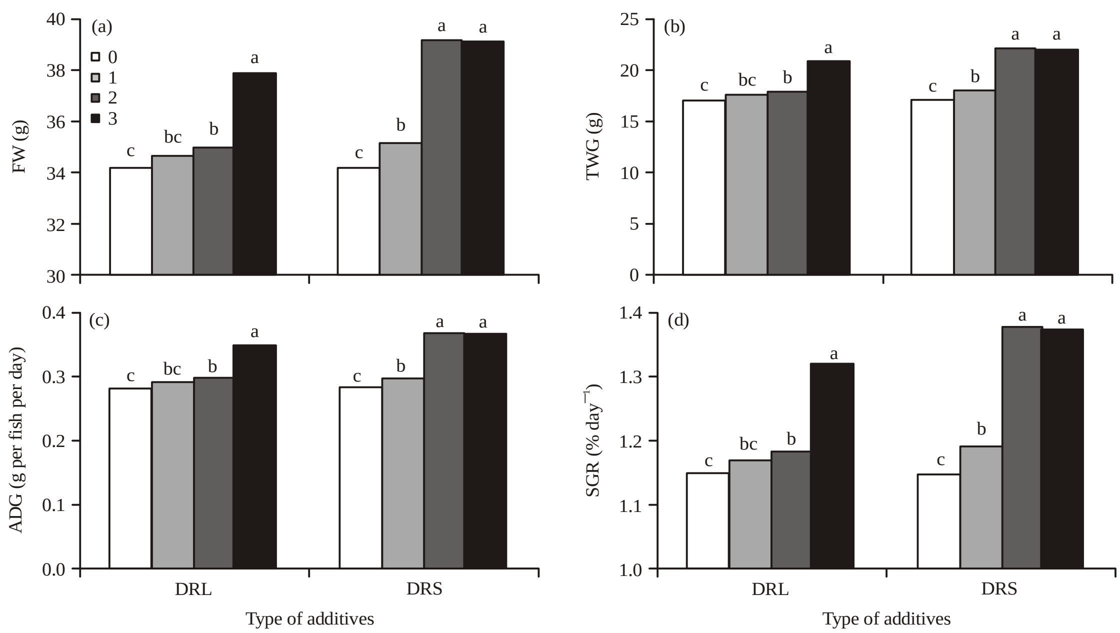

Fig. 1(a-d): Interaction effect between types (DRL and DRS) and different levels (0, 1, 2 and 3% kg^{-1} diet) of dried rocket leaves and seeds on growth performance parameters, (a) FW, (b) TWG, (c) ADG and (d) SGR of *O. niloticus*

Table 2: Overall mean of growth performance parameters of *O. niloticus* fed different levels of dried rocket leaves and seeds

Treatments	FW (g)	TWG (g)	ADG (g per fish per day)	RGR (%)	SGR (% day^{-1})	SR (%)
Type of additives						
DRL	35.37^{b}	18.23^{b}	0.304^{b}	106.3^{b}	1.21^{b}	94.64
DRS	36.87^{a}	19.73^{a}	0.329^{a}	115.0^{a}	1.27^{a}	96.43
Pooled±SE	0.123	0.123	0.002	0.724	0.005	1.630
p-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.450
Level (% kg^{-1} diet)						
0	34.14^{d}	17.00^{d}	0.282^{d}	99.19^{d}	1.14^{d}	92.86
1	34.84^{c}	17.70^{c}	0.295^{c}	103.3^{c}	1.18^{c}	92.86
2	37.02^{b}	19.87^{b}	0.332^{b}	115.9^{b}	1.28^{b}	96.43
3	38.47^{a}	21.33^{a}	0.357^{a}	124.4^{a}	1.35^{a}	100.0
Pooled±SE	0.175	0.175	0.003	1.024	0.007	2.306
p-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.127

Overall mean in the same column having different small letters are significantly different ($p \leq 0.05$), DRL: Dried rocket leaves, DRS: Dried rocket seeds

Table 3: Overall mean feed utilization parameters of *O. niloticus* fed different levels of dried rocket leaves and seeds

Treatments	FI (g)	FCR	FE (%)	PER	PPV (%)	EU (%)
Type of additives						
DRL	29.05	1.60^{a}	62.81^{b}	2.08^{b}	27.10	14.16^{b}
DRS	29.61	1.52^{b}	66.62^{a}	2.21^{a}	28.76	15.22^{a}
Pooled±SE	0.258	0.02	0.883	0.029	0.660	0.318
p-value	0.143	0.011	0.007	0.007	0.093	0.032
Level (% kg^{-1} diet)						
0	28.40^{b}	1.67^{a}	59.86^{c}	1.99^{c}	27.29^{b}	14.26^{b}
1	29.35^{ab}	1.65^{a}	60.35^{c}	2.00^{c}	26.38^{b}	14.12^{b}
2	29.91^{a}	1.52^{b}	66.71^{b}	2.21^{b}	27.58^{b}	14.47^{b}
3	29.67^{a}	1.39^{c}	71.94^{a}	2.38^{a}	30.47^{a}	15.92^{a}
Pooled±SE	0.365	0.028	1.249	0.041	0.934	0.450
p-value	0.047	0.0001	0.0001	0.0001	0.037	0.042

Overall mean in the same column having different small letters are significantly different ($p \leq 0.05$), DRL: Dried rocket leaves, DRS: Dried rocket seeds

Table 4: Overall mean of chemical composition of the whole body of *O. niloticus* fed different levels of dried rocket leaves and seeds

		On dry matter basis (%)			
Treatments	DM (%)	EE	Ash	CP	EC (kcal 100 g^{-1})
At the start of the experiment	14.10	22.32	16.71	60.97	554.59
At the end of the experiment					
Type of additives					
DRL	15.76	18.34	12.14	69.52	565.2
DRS	15.74	18.48	11.95	69.54	566.6
Pooled±SE	0.150	0.172	0.154	0.060	1.531
p-value	0.907	0.595	0.398	0.780	0.535
Level (% kg^{-1} diet)					
0	15.60	19.12^{a}	12.55^{a}	68.34^{c}	565.9
1	15.63	18.73^{ab}	12.09^{ab}	69.12^{b}	566.6
2	15.57	17.72^{bc}	12.07^{ab}	70.21^{a}	563.3
3	16.21	18.07^{c}	11.47^{b}	70.46^{a}	568.0
Pooled±SE	0.212	0.244	0.217	0.085	2.165
p-value	0.144	0.004	0.025	0.0001	0.502

Overall mean in the same column having different small letters are significantly different ($p \leq 0.05$). DM: Dry matter, CP: Crude protein, EE: Ether extract, EC: Energy content calculated according to NRC (1993), DRL: Dried rocket leaves, DRS: Dried rocket seeds

The interaction effect between types and levels of additives (DRL and DRS) are presented in Fig. 2a-d, where the results showed that levels 3% DRL (T_4) and 2, 3% DRS (T_7 and T_8) gave the highest values ($p \leq 0.05$) in all feed utilization parameters.

Chemical composition of fish body: The chemical composition of the whole fish body at the start and the end of the experiment are presented in Table 4 which were Dry Matter (DM),

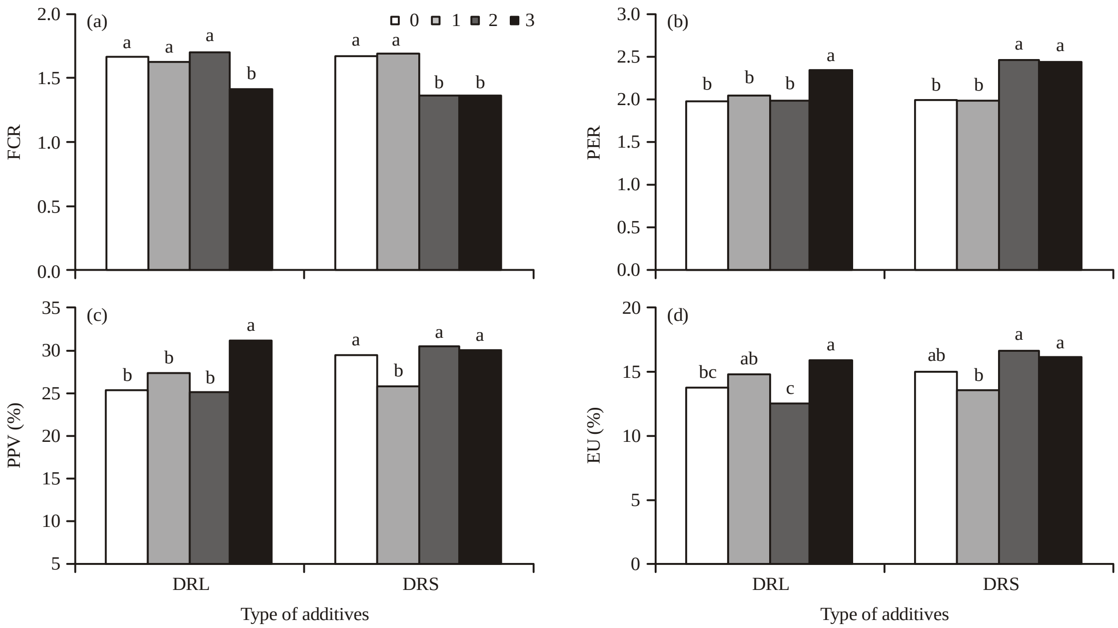

Fig. 2(a-d): Interaction effect between types (DRL and DRS) and different levels (0, 1, 2 and 3% kg^{-1} diet) of dried rocket leaves and seeds on feed utilization parameters, (a) FCR, (b) PER, (c) PPV and (d) EU of *O. niloticus*

Crude Protein (CP) and Energy Content (EC), these means at the end were highest than in the start of the experiment, while the Ether Extract (EE) and ash decreased in the end of experiment. However, no significant ($p \geq 0.05$) effects in DM, EE, ash, CP and EC between DRL and DRS. Results showed that increased levels of DRL and DRS significantly ($p \leq 0.05$) decreased of EE and ash and increased CP content in the whole fish body. Where, the level 3% recorded the lowest significant ($p \leq 0.05$) values of EE and ash and the highest significant values of CP among other levels. However, DM and EC contents have no significant ($p \geq 0.05$) differences among all levels of additives.

The interaction effect between types and levels of additives on chemical composition of the whole fish body are presented in Fig. 3a-d. Where, DM content in fish fed 1% DRL (T_2) and 3% DRS (T_8) recorded the best values ($p \leq 0.05$) among all treatments but the fish fed 0% DRL and DRS(control groups) were the highest values in EE content. On the other side, 2% DRL (T_3) and 3% DRS (T_8) gave the highest values ($p \leq 0.05$) of CP content, meanwhile 1% DRL (T_2) and 0% DRS (T_5) recorded the highest values in ash content than all treatments.

Blood analysis

Hematological parameters: Data in Table 5 indicated that the addition of DRS in diet at level 3% (T_8) significantly ($p \leq 0.05$) increased Hb concentration, RBCs count, PCV% and WBCs count among other levels and compared with DRL. While, fish fed DRL had highest significant ($p \leq 0.05$) values of MCV and MCH compared with DRS. However, no significant ($p \geq 0.05$) effect in MCHC between DRL and DRS was detected. On the other side, increasing the level of additives led to significantly ($p \leq 0.05$) decreased blood indices (MCV, MCH and MCHC).

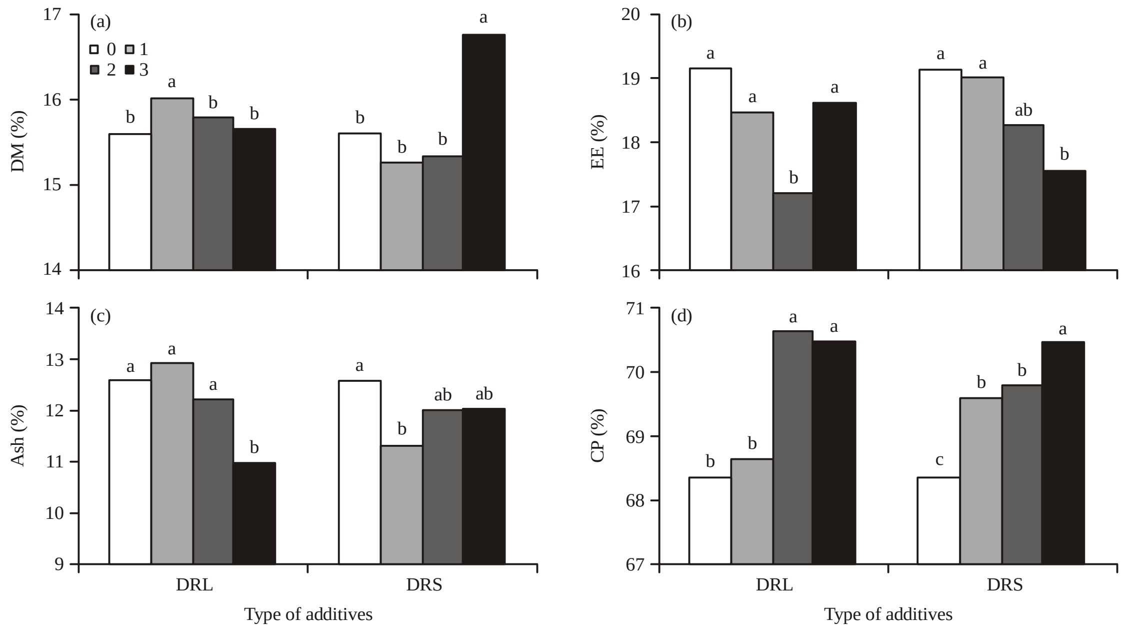

Fig. 3(a-d): Interaction effect between types (DRL and DRS) and different levels (0, 1, 2 and 3% kg^{-1} diet) of dried rocket leaves and seeds on chemical composition of the whole body, (a) DM, (b) EE, (c) Ash and (d) CP of *O. niloticus*

Table 5: Overall mean of hematological parameters of *O. niloticus* fed different levels of dried rocket leaves and seeds

				Blood indices			
Treatments	Hb (g dL^{-1})	RBCs ($\times10^6$ mm^{-3})	PCV (%)	MCV (μ^3)	MCH (pg)	MCHC (%)	WBCs ($\times10^3$ mm^{-3})
Type of additives							
DRL	5.28^b	1.78^b	12.01^b	68.50^a	30.13^a	44.13	421.3^b
DRS	5.98^a	2.46^a	13.79^a	58.38^b	25.63^b	43.75	480.0^a
Pooled±SE	0.106	0.067	0.207	1.863	0.649	0.772	7.954
p-value	0.0003	0.0001	0.0001	0.001	0.0002	0.735	0.0001
Level (% kg^{-1} diet)							
0	5.05^c	1.65^c	10.45^d	63.00^{ab}	31.00^a	48.50^a	390.0^c
1	4.85^c	1.73^c	11.80^c	69.00^a	28.25^{ab}	41.25^b	402.5^c
2	5.95^b	2.33^b	13.73^b	63.50^{ab}	27.50^{bc}	43.50^b	477.5^b
3	6.65^a	2.78^a	15.63^a	58.25^b	24.75^c	42.50^b	532.5^a
Pooled±SE	0.150	0.094	0.293	2.634	0.918	1.092	11.25
p-value	0.0001	0.0001	0.0001	0.027	0.014	0.0003	0.0001

Overall mean in the same column having different small letters are significantly different ($p \leq 0.05$). Hb: Hemoglobin, RBCs: Red blood cells, PCV: Packed cell volume, MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, MCHC: Mean corpuscular hemoglobin concentration and WBCs: White blood cells, RDL: Dried rocket leaves and DRS: Dried rocket seeds

The interaction effect between types and different levels of additives on blood hematological parameters was showed in Fig. 4a-f. The results indicated that 3% DRL (T_4) and DRS (T_8) recorded the highest significant ($p \leq 0.05$) values of Hb, RBCs, PCV and WBCs among all treatments. While, the highest significant values of MCV were detected in 2% DRL and 1% DRS compared with all treatments. On the other hand, 1% (T_2), 0% DRL (T_1), 0% (T_5) and 1% DRS (T_6), respectively gave the highest significant ($p \leq 0.05$) values of MCH among all treatments.

Biochemical parameters: Plasma total protein, albumin, globulin and albumin/globulin ratio and Tchol were illustrated in Table 6. Fish fed DRS significantly ($p \leq 0.05$) increased all plasma

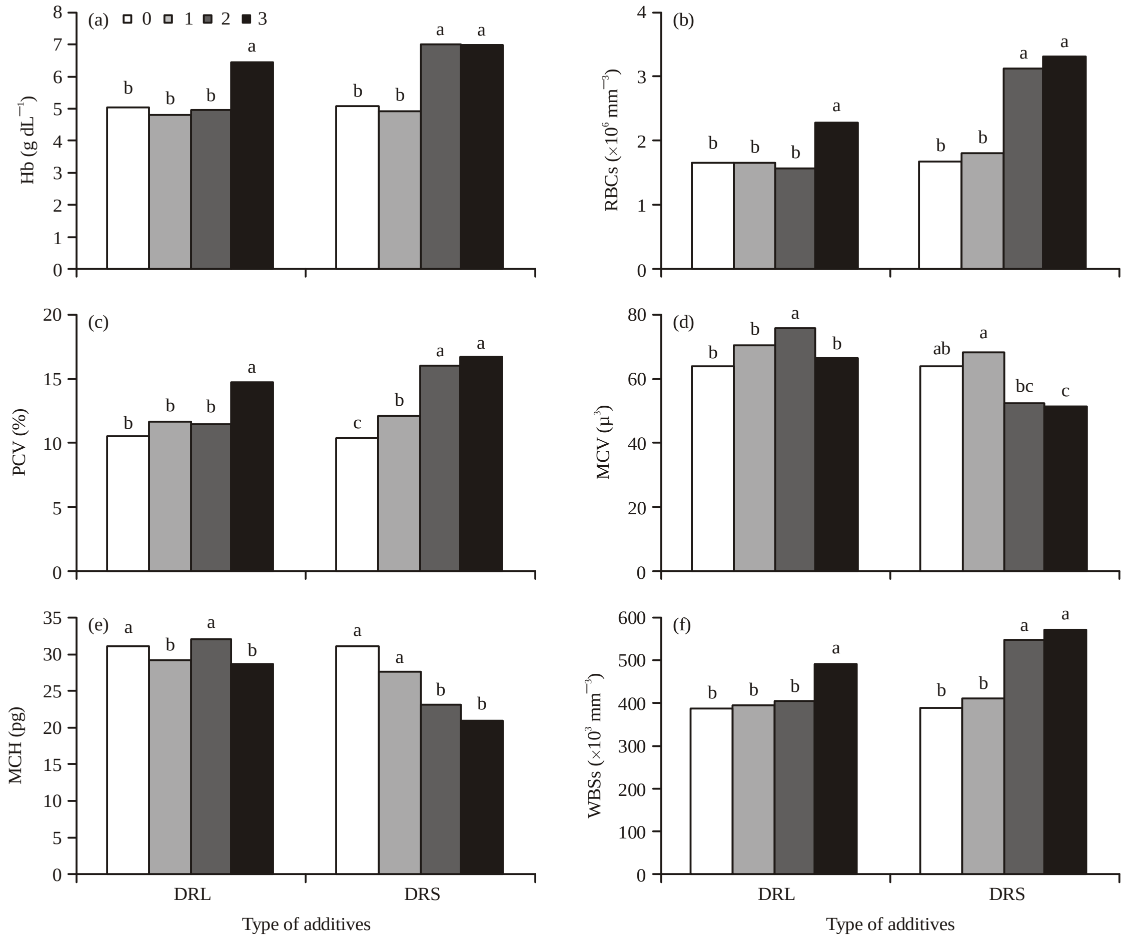

Fig. 4(a-f): Interaction effect between types (DRL and DRS) and different levels (0, 1, 2 and 3% kg^{-1} diet) of dried rocket leaves and seeds on hematological parameters, (a) Hb, (b) RBCs, (c) PCV, (d) MCV, (e) MCH and (f) WBCs of *O. niloticus*

Table 6: Overall mean of plasma biochemical parameters of *O. niloticus* fed different levels of dried rocket leaves and seeds

Treatments	Total protein (g dL^{-1})	Albumin (g dL^{-1})	Globulin (g dL^{-1})	Albumin/globulin ratio	Total cholesterol (mg dL^{-1})
Type of additives					
DRL	8.70^{b}	5.65^{b}	3.04^{b}	1.85^{b}	128.5^{b}
DRS	9.95^{a}	6.64^{a}	3.32^{a}	1.99^{a}	165.1^{a}
Pooled±SE	0.093	0.072	0.042	0.031	2.176
p-value	0.0001	0.0001	0.0003	0.007	0.0001
Level (% kg^{-1} diet)					
0	7.89^{c}	5.12^{c}	2.77^{c}	1.86^{b}	152.9^{b}
1	7.84^{c}	5.00^{c}	2.82^{c}	1.78^{b}	160.0^{a}
2	9.97^{b}	6.57^{b}	3.40^{b}	1.91^{b}	146.4^{ab}
3	11.61^{a}	7.89^{a}	3.72^{a}	2.12^{a}	128.1^{c}
Pooled±SE	0.131	0.103	0.059	0.044	3.077
p-value	0.0001	0.0001	0.0001	0.0004	0.0001

Overall mean in the same column having different letters are significantly different ($p \leq 0.05$), RDL: Dried rocket leaves and DRS: Dried rocket seeds

biochemical parameters than fish fed DRL. Also, plasma total protein, albumin, globulin and albumin/globulin ratio significantly ($p \leq 0.05$) increased with increasing the level of additives (DRL and DRS) to 3% (T_4 and T_8, respectively). Inversely, increasing the level of additives to 3% (DRL or DRS) led to significantly ($p \leq 0.05$) decreased of Tchol compared with other levels.

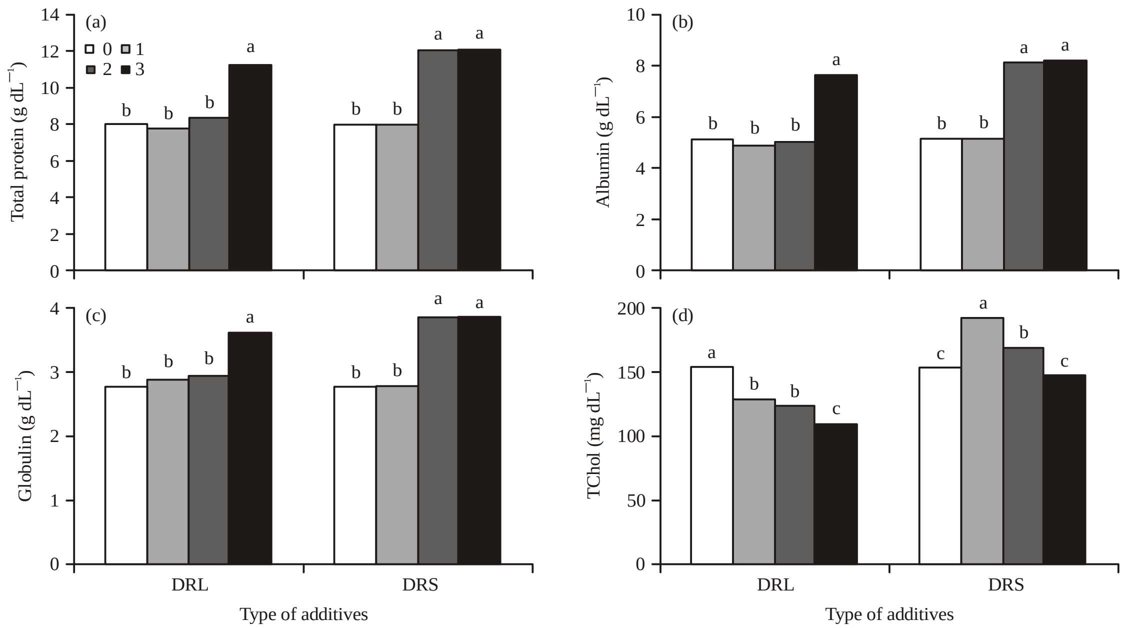

Fig. 5(a-d): Interaction effect of types (DRL and DRS) and different levels (0, 1, 2 and 3% kg^{-1} diet) of dried rocket leaves and seeds on plasma biochemical parameters, (a) Total protein, (b) Albumin, (c) Globulin and (d) TChol of *O. niloticus*

The interaction effect between types and different levels of additives on blood biochemical parameters are showed in Fig. 5a-d. The results indicated that 3% DRL (T_4) and 2, 3% DRS (T_7 and T_8) recorded the highest significantly ($p\leq 0.05$) values of plasma total protein, albumin, globulin and albumin/globulin ratio among all treatments. However, 0% DRL (T_1) and 1% DRS (T_6) significantly increased of Tchol compared with all treatments, meanwhile increasing levels of DRL and DRS significantly ($p\leq 0.05$) decreased of Tchol.

DISCUSSION

Results in the present study indicated that addition of DRL or DRS in diet of Nile tilapia led to improve all growth performance, feed utilization parameters compared by the control group. Moreover, the results showed that addition of DRS gave best results compared with DRL. These positive effects in fish growth performance may be related with supplementation of DRL and DRS which can enhance the palatability of feed. Where, Rocket Seed Meals (RSM) consisted of digestive and stimulant effect through their aromatic substance or essential oils, oil contains more than 100 components and it is a rich source of polyunsaturated fatty acids (palmitic, oleic, linoleic and linolenic) and nutrient components thiamin, riboflavin, pyridoxine, niacin, folacin and some heavy metals (Khalifea, 1995). Mono and polyunsaturated fatty acids like oleic acids (15%) cis-11- eicosenoic acid methyl ester (12.5%) and linoleic acid methyl ester (6.9%) were abundant. Presence of these fatty acids support edible uses of rocket seeds indicating that oil contained valuable fatty acids required for edible purposes (Flanders and Abdulkarim, 1985).

The results in the present study are in agreement with those reported by Abd Elmonem *et al.* (2002) who revealed that the dietary RSM significantly ($p<0.05$) improved the growth performance of red tilapia compared with the control group. Also, they added that increasing level of RSM to 3% increased these positive effects of growth performance among other levels. In this topic, Mahmoud *et al.* (2009) reported the same promising effects of RSM on Nile tilapia when compared with the control group. Also, Salem (2012) confirmed these positive findings of RSM on Nile tilapia growth performance and its role to alleviate the toxic effects of aflatoxin B_1. These positive effects of RSM on growth performance, not only found in tilapia but also in African catfish (Fagbenro, 2004) and in other laborite animals such as rabbits (Ibrahim, 2005) and broiler (Numur *et al.*, 1988). On the other hand, the improvement of growth performance and feed utilization attributed to improve of immunity of fish through increase of RBCs count, WBCs count, albumin, globulin and albumin/globulin ratio (Table 5 and 6).

Results in the current study indicated that addition of 3% DRL (T_4) and 2, 3% DRS (T_7 and T_8) caused increasing dry matter, crude protein, decreased ether extract and ash percentage of chemical composition fish body compared the control group. These positive effects on carcass composition of experimental fish may be due to the dietary supplementation with DRL and DRS which increased the growth performance compared with the control group (Table 2) or its role to enhance plasma total protein may be reflected to increase of muscle protein content (Table 6). The present results are in agreement with findings by Mahmoud *et al.* (2009) and Salem (2012) they concluded that the addition of RSM in diet of Nile tilapia have the promising effect on the whole fish body composition. However, the current results disagreement with those reported by Fagbenro (2004) in African catfish fed levels below 20% RSM had higher moisture and ash contents, as well as lower protein and lipid contents compared with the control treatment. Furthermore, Abd Elmonem *et al.* (2002) indicated that the body composition was not affected by Black Seed Meal (BSM) and RSM inclusion levels in the diet of red tilapia fry. In this respect, many medical plants and herbs improved the chemical composition of Nile tilapia body such as; BSM and marjoram leaves (Seden *et al.*, 2009), garlic (El-Saidy and Gaber, 1997), onion and garlic (Zaki and El-Ebiary, 2003) and fenugreek seed meal (Abdelhamid and Soliman, 2012). These positive effects of the experimental feed additives may be due to their active pharmacological (medical) substances.

Knowledge of the haematological characteristics is an important tool that can be used as an effective and sensitive index to monitor physiological and pathological changes in fishes. Normal ranges for various blood parameters in fish have been established by different investigators in fish physiology and pathology (Zhou *et al.*, 2009). Results in Table 5 and 6 showed that fish fed 3% DRL and 2 or 3% DRS had significantly ($p \leq 0.05$) increased of Hb, RBCs, PCV, WBCs, plasma total protein, albumin, globulin and albumin/globulin ratio compared with the control group. While, the blood indices (MCV, MCH and MCHC) were significantly decreased. These promising results in blood hematological and biochemical parameters led to increasing the immune responses and healthy status of fish. These positive findings were related to rocket inclusion of antioxidant constituents; carotenoids, vitamin C, flavonoids such as appiin and luteolin and glucosinolates the precursors of isothiocyanates and sulfaraphene (Barillari *et al.*, 2005; Hanafi *et al.*, 2010), volatile oils like myristicin and apiole β-phellandrene (Leung and Foster, 1996). Glucosinolates were found to have several biological activities including anticarcinogenic, antifungal and antibacterial plus their antioxidant action (Kim *et al.*, 2004). The major glucosinolate in seeds of rocket which is potentially capable of protecting cells against oxidative stress. In addition, rocket contain Zn, Cu, Fe, Mg, Mn and other elements (Abdo and Zeinab, 2003) which increase immune response. On the other hand, rocket is a good source of beta-carotene (Rinzler, 1990). Therefore, rocket seeds are rich source of vitamin A which is considered the most important vitamin in the body for normal growth, protective mucous membranes, reproduction and immune functions (Kim *et al*., 2004). responses are in agreement with Salem (2012) who concluded that RSM improved blood parameters (RBCs, WBCs, total protein, albumin and globulin) in Nile tilapia may be due to increase of immunity and reduce the negative effect of aflatoxin B_1 on fish. In this trend, many studies on tilapia indicated that using medical plants led to increase the immune status of fish such as *Origanum vulgare* (Seden *et al*., 2009); *Allium sativum* (Aboud, 2010); *Nigella sativa* (Abdelhamid *et al*., 2005; Elkamel and Mosaad, 2012); *Trigonella foenum-graecum*, *Eucalyptus citriodora* and *Matricaria recutita* (Zaki *et al*., 2012).

In the present study, results indicated that Tchol significantly decreased by increasing the levels of DRL and DRS. Similar results obtained by El-Gengaihi *et al.* (2004) in rats and in rabbits (Ibrahim, 2005). The reductions of blood Tchol by dietary DRL and DRS may be due to their contain of highly percentages of Unsaturated Fatty Acids (UFA), where UFA could be caused by changes in several parameters of cholesterol metabolism including fecal excretion of steroids (Grundy, 1975); hepatic synthesis of cholesterol (Grundy and Ahrens, 1970) and lipoprotein structure and metabolism (Cooper *et al*., 1982). Also, the addition of DRL led to reduce blood Tchol more than dietary DRS. This increasing of Tchol may be due to the DRS inclusion highly levels of oils up to 27.8% (Flanders and Abdulkarim, 1985). These results are in agreement with those reported by Zeweil *et al.* (2008) they revealed that Tchol was significantly increased of rabbits fed diets containing RSM.

Generally, DRL or DRS are known to have good biological quality. Thus, these positive findings mean that the addition of 3% DRL (T_4) and 2, 3% DRS (T_7 and T_8) led to significantly ($p \leq 0.05$) increases of plasma proteins which indicates the improvement of the nutritional values of the diet, the growth performance, carcass composition, physiological functions, immune responses and the healthy status of the experimental fish fed DRL or DRS. Whereas, many workers believed that antimicrobial activity of rocket oil is mainly due to higher concentration of erucic acid which was present in both free and triglyceride form (Khoobchandani *et al*., 2010). In addition, these improvements may be attributed to the properties of this material that act not only as antibacterial, antiprotozoal and antifungal, but also as antioxidant (Leung and Foster, 1996).

CONCLUSION

From the mentioned results in the present study, it could be recommended that the useful dietary supplementation of 3% dried rocket (*E. sativa*) leaves (DRL) kg^{-1} diet (T_4) or 2% Dried Rocket Seeds (DRS) kg^{-1} diet (T_7) for all male monosex Nile tilapia, *O. niloticus* fingerlings. These levels achieved the best growth performance, chemical composition of the whole fish body, hematological and biochemical parameters. Hence, further studies are required to evaluate the effects of rocket leaves or seeds extracts and/or active substances, as natural growth promoter or reproductive enhancer agents not only for adult or broodstock *O. niloticus*, but also for other fish species.

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