

RESEARCH ARTICLE

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EFFECT OF FEED COLOURS ON GROWTH, FEED UTILIZATION AND BIOCHEMICAL PARAMETERS OF BLUE TILAPIA (*OREOCHROMIS AUREUS*, STEINDACHNER, 1864)

ABSTRACT:

Higher final weight of fries of *Oreochromis aureus* was attained due to feeding on the tested coloured feeds rather than basal diet. Non-significant changes were reported for most of growth parameters for fries. However, they have significant reduction of specific growth rate (SGR) due to feeding on blue and yellow feeds. On the other hand, fingerlings fed with basal diet exhibited a better growth performance than those fed with different feed colours. Significant reduction in final weight (Wf), weight gain and average daily weight gain (ADG) of fingerlings fed brown feed colour were reported compared to control. Aspartate aminotransaminase (AST, E.C 2.6.1.1) and alanine aminotransaminase (ALT, E.C 2.6.1.2) activities were significantly reduced in fries fed with blue and brown feeds compared to control. Similarly, alkaline phosphatase (ALP, E.C.3.1.3.1) activity and albumin level were significantly reduced in case of fries fed with brown feed colour. For fingerlings, there were significant differences found among the experimental groups, in total protein, albumin, AST, ALT, and cholesterol. Glutathione (GSH) and water content were generally reduced in fingerlings fed with the examined tested coloured feeds. Blue and brown feed colours induced significant reduction in most of the tested biochemical parameters from those of the control. The present study suggests that using coloured feeds did not promote growth of *Oreochromis aureus*, both fries and fingerlings. Also, adverse biochemical changes for those fed with coloured feeds were reported. Therefore, ordinary basal diet is recommended.

KEY WORDS:

Feed colours, Growth, Biochemical parameters, Fries, Fingerlings, *Oreochromis aureus*.

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INTRODUCTION:

Tilapia fish is an omnivorous grazer that feeds on phytoplankton, periphyton, aquatic plants, small invertebrates, benthic fauna, detritus and bacterial films associated with detritus (FAO, 2012). They are currently cultured in more than 100 countries around the world especially in tropical and subtropical region of Asia, Africa and Americas (El-Sayed, 2004). Nile tilapia (*Oreochromis niloticus*), is by far the most important farmed tilapia species representing more than 80% of total production of farmed tilapia (El-Sayed, 2004). There is great interest of tilapia aquaculture all over the world, with special interest in Egypt as their native habitat. This is related to that they have excellent biological characteristics and highly acceptable as food throughout the world (El-Sayed, 2006).

Extensive research efforts have been given to study the biological and environmental conditions related to improvement of tilapia production (Khallaf *et al.*, 2003; Fridman *et al.*, 2012). Special attention has been projected for tilapia nutrition in order to maximize their growth and feed utilization (Abdel-Tawwab and Ahmed, 2009; Abdel-Tawwab *et al.*, 2010; Fortes-Silva

and Sánchez-Vázquez, 2012). Nutrition and feeding influences growth, reproduction, and health of fish, as well as their response to physiologic and environmental stressors and pathogens (Lall and Tibbetts, 2009). Type of feed and feeding frequency has a direct effect on tilapia growth welfare and the response of the immune system (Garcia and Villarreal, 2009). Dietary protein level has been used extensively to induce promotion of growth performance and spawning activity of Nile tilapia, *Oreochromis niloticus* (El-Sayed *et al.*, 2003; El-Sayed and Kawanna, 2008). Some authors have found fish growth promotional effect of a temperature along with dietary protein (Qiang *et al.*, 2013).

Studies on effect of feed colour on fish larvae are scarcity such as those recorded by El-Sayed (2004) and El-Mezayen (2011) for Nile tilapia, *Oreochromis niloticus*; El-Sayed and El-Ghobashy (2010) for thin mullet and *Liza ramada*; and Ginetz and Larkin (1973) for Rainbow trout, *Onchorhynchus mykiss*. Blue tilapia (*Oreochromis aureus*, Steindachner, 1864) can tolerate cold water up to 8°C. Thus, their propagation is more preferable. Therefore, the present study is proposed as an attempt to use feed colours as a promoter to increase fish feed ingestion and thoroughly maximizing growth performance. Furthermore, to examine biochemical alterations due to feeding with different feed colours.

MATERIAL AND METHODS:

The present study was carried out in two consecutive experiments to investigate the effect of feed colour on growth, feed utilization efficiency, survival and biochemical changes for fries and fingerlings of blue tilapia (*Oreochromis aureus*, Steindachner, 1864).

Diet formulation:

The diet was prepared to give 29.7 ± 0.0058 g% crude proteins (Table 1). The solid feed ingredients such as fish meal and wheat flour were dried for 24 h at 65°C in an electric oven. Then, they were sieved out to get rid of all large hard bone particles or fine spines or any solid particles and to obtain well-mixing for all feed ingredients. To produce one Kg of larval diet, 550 g of fish meal 48% crude protein and 360 g of wheat flour were weighed in a dry clean plastic bowl. Ten grams of vitamins and minerals were added to the mixture. Carboxymethyl cellulose (20 g) was added as a binder to improve feed stability in water and to minimize the leaching of nutrients. It was mixed until a homogenous compound was obtained. Then, 20 g of fish oil and 30 g of soybean- sunflower were added drop by drop with continuous mixing to attain a homogenous distribution. The feed was then divided into four equal parts; each part was assigned into one feed colour.

Table 1. Diet ingredient and composition

Ingerredients	%
Fish meal	55
Wheat flour	36
Fish oil	2
Soyabean-sunflower	3
Vitamins & minerals	2
CMC	2
Total	100
Proximate analysis	%
Crude protein	29.7±0.0058
Crude lipid	8.34±0.0058
Ash content	0.1188±12.0888
Water content	0.0109±0.0227

Vitamins mixture: Vit. A = 15000 I.U., Vit. D3 = 1500 I.U., Vit. E = 2.0mg, Vit. K3 = 2.0mg, Riboflavin (B2) = 2.5 mg, Calcium-D-pantothenate = 5.5 mg, Nicotinamide (B3) = 10.0 mg, PyridoxineHCl (B6) = 3.0 mg, Thiamine HCl (B1) = 2.0 mg, Vit. B12 = 5.0 mg, Folic acid = 2.0 mg, Niacin = 1.0 mg.

Minerals mixture: Mn = 60.0g, Fe = 30.0 g, Cu = 4.0 g, Zn = 50.0 g, I = 300 mg, Co = 100 mg, Se = 100 mg, CaCO₃ = to 1Kg.

Three commercial food colourants were used to colour the diets. These colourants were: blue, brown and yellow colours. Each food colourant was dissolved in a predetermined volume of warm distilled water (250 ml kg⁻¹ feed). The coloured water was slowly added to feed mixture with mixing until homogenous dough was obtained. Distilled water was used for control diet (yellowish brown colour). These doughs were passed through a commercial feed grinder to give spaghetti-like threads, which then were spread on meat plates and dried in electric oven at about 60°C for 24 h. Finally, the dried diet threads were pelleted into small pellets which were passed through different sized sieve-set to separate these pellets into different size groups that will be appropriate for fish mouths depending on their living stages. These pellets were then labeled and stored in refrigerator until using.

Experimental groups:

The present study was conducted at aquaculture laboratory of Zoology Department, Faculty of science, Benha University, Egypt. Blue tilapia (*Oreochromis aureus*, Steindechner, 1864) fries were obtained from a private aquaculture hatchery (El-Abassa, AboHamad, Sharqueia, Egypt). The fish were transported in Nylon bags which were half filled with water from the hatchery and then completed with oxygen.

Experiment 1:

Acclimation of the fish fries to laboratory conditions was carried out for 3 days in well aerated tanks. Then the fish fries (Wi = 0.0426 ± 0.0089) were stocked in 8 glass aquaria at a density of 1 fry per litter. The

aquaria were divided into four duplicate groups. The first group fed with blue feed, 2nd group fed with brown feed, 3rd group fed with yellow feed and 4th group fed with basal diet (control). Faeces were siphoned and replaced by new fresh dechlorinated tap water. During the experiment the average of water quality parameters (were temperature = $28.7143 \pm 0.2857^{\circ}\text{C}$, pH = 7.8962 ± 0.0276 and conductivity = $366.6667 \pm 33.333 \mu\text{S}$) measured weakly. Temperature, pH and conductivity measured by thermometer, digital GOOD pH meter and digital conductivity meter (HANNA instrument), respectively. Photoperiod was set at 14L: 10D using 24 timer controlled fluorescent light lamps.

Feeding frequencies were done two times a day (9:00 and 16:00), 7 days a week, for 8 weeks. Fish were fed experimental diets at feeding ration gradually increasing from 7-10% of total body weight as follows: 7% of fish body weight during the first 14 days (as training for fry to ingest artificial food) and then at 10% until the end of feeding period. Each group of fish was weighed at the start and every two weeks throughout the experimental period. Dead fries were counted, removed from aquaria every morning, and then survival rates were calculated accordingly.

Experiment 2:

In this experiment, fingerlings of 0.3665 - 0.4179 g were used to test the various feed colours, through 8 weeks feeding experiment, as set in experiment I.

Growth parameters:

The average body weights were recorded every two weeks for both experiments to calculate the feed ration size. The initial weight (W_i , g), final body weight (W_f , g), weight gain (W_t gain, g), weight gain (%), average daily weight gain (ADG, g/d), specific growth rate (SGR, %/d), condition factor (K , g/cm³), feed intake (FI, g), feed conversion ratio (FCR, g/g) and survival rate (%) were recorded in both experiment using the following formulae:

Growth:

Weight gain (g) = $W_f - W_i$, Weight gain (%) = $(W_f - W_i / W_i) \times 100$, Average daily weight gain (ADG, g/d) = $(W_f - W_i / \text{time in days}) \times 100$, Specific growth rate (SGR, % day⁻¹) = $(\ln W_f - \ln W_i / \text{time in days}) \times 100$, Condition factor (K , g/cm³) = $(\text{fish weight (g)} / \text{fish length}^3 \text{ in Cm}^3) \times 100$.

Feed utilization:

Feed conversion ratio (FCR, g/g) = feed intake / body weight gain, Protein efficiency ratio (PER, g/g) = weight gain / protein intake.

Biochemical parameters and body composition:

1- Moisture content was estimated by drying pre-weighed sample in oven. The weighed samples were maintained into an

oven at 105°C for 24 h. The samples were reweighed. The difference of weight indicated the moisture content.

2- Ash content was determined by drying samples in muffle furnace at 550°C for 8 h. It was estimated as % reduction of its weight.

3- Crude protein and crude lipids were analyzed according to A.O.A.C (1995) methods.

Whole fry fish body was homogenized in 0.8% sucrose solution using glass tissue homogenizer. Supernatant were obtained for determination of some enzyme activities and metabolite levels.

4- Total protein was measured colorimetrically using diagnostic kit, (Diamond, Cairo, Egypt). Proteins give an intensive violet-blue complex with copper salts in an alkaline medium (Young, 2001). The intensity of the colour formed is proportional to the total protein concentration in the sample. Colour intensity was measured at 546 nm. The sensitivity limit is 1 g/dL = 0.07A, and accuracy limit include correlation coefficient = 0.9918.

5- Albumin was measured using diagnostic kit (Diamond, Cairo, Egypt). Albumin react with bromocresol green at a slightly acid pH, produces green blue colour (Young, 2001). The colour was measured at 630 nm using spectrophotometer. The sensitivity is 1 g/dL = 0.126A, and accuracy include $r = 0.99$.

6- Aspartate aminotransaminase (AST) and alanine aminotransaminase (ALT) activities were photometrically measured following enzymatic degradation of NADH (Young, 2001) using spinreact diagnostic kit (Santa Coloma, Spain), catalogue no 1001160-1001162, 1001170- 1001172. Sensitivity detection limits are 1 U/L = 0.0017 $\Delta\text{A}/\text{min}$. (AST) & 0.000557 $\Delta\text{A}/\text{min}$. (ALT) and accuracy expressed as $r = 0.99$.

7- Alkaline phosphatase (ALP) activity was colorimetrically measured using spectrum diagnostic kit (catalog no. 217001-217003). Enzymatic reaction is involved. P-Nitrophenyl phosphate is converted to p-Nitrophenol and phosphate by alkaline phosphatase. The increase of absorption at 405 nm is proportional to alkaline phosphatase concentration in sample (Zawta *et al.*, 1994). Sensitivity limit include 5U/L minimum detection.

8- Glutathione reduced (GSH) was measured by colorimetric reaction of 5, 5'-dithiobis (2- nitrobenzoioc acid) (DTNB) with glutathione (GSH) to produce a yellow compound (Beutler *et al.*, 1963). The resulted colour was measured at 405 nm. GSH was quantified using bio-diagnostic kit (Giza, Egypt). Catalog no. GR2511.

9- Cholesterol was measured by enzymatic colorimetric method using spectrum

diagonistic kit (Catalogue no. 230001-230009) following (Trinder, 1969) protocol. MDSS GmbH, Schiffgraben 41, 30175 Hannover, Germany). Sensitivity limit (minimum-limit) is 5 mg/dL.

Statistical analysis

The data of the present work were presented as a mean \pm SE. Data computation and statistical analysis (one way ANOVA, using Tukey HSD test) among experimental groups were done using Biostat software; Biostat, v 2.5, 2008, (Pipkin, 1984).

RESULTS:

Growth performance:

Fries:

The highest final weight was obtained for fries fed with blue feed followed by those fed with brown feed and then those fed with yellow feed. The lowest value of final weight and weight gain were obtained in fries fed with basal diet. Same order was obtained for weight gain (g), Weight gain (%), and average daily weight gain (ADG). Non-significant increase was reported for specific growth rate (SGR) for fries fed with brown feed colour. Blue and yellow feeds induce significant reduction in SGR compared with those fed with basal diet (Table 2a). Non-significant changes from the control in K, FCR was observed for fries fed with tested coloured feeds. PER values were significantly increased over those of the control, in case of fish fed with blue and brown feeds. The survival ratio was reporting high values for all experimental groups. Its range was 90% - 97.5%.

Table 2a. Effect of feed colour on growth performance of *Oreochromis aureus* fries

	No.	Control	Blue feed colour	Brown feed colour	Yellow feed colour	F value
I wt	2	0.0426 \pm 0.0089	0.0426 \pm 0.0089	0.0426 \pm 0.0089	0.0426 \pm 0.0089	-----
Wt final	2	0.4672 \pm 0.0772	0.6643 \pm 0.1357	0.5938 \pm 0.0563	0.5188 \pm 0.0187	06741.
Wt gain	2	0.4372 \pm 0.0772	0.6343 \pm 0.1357	0.5637 \pm 0.0563	0.4854 \pm 0.0154	06741.
Wt gain %	2	1457.4068 \pm 257.46	4.2846211 \pm 452.38	1879.17 \pm 187.5	1470.3535 \pm 221.313	17041.
ADG	2	0.0072 \pm 0.0072	0.0104 \pm 0.0022	0.0093 \pm 0.001	0.008 \pm 0.0003	971.01
SGR	2	4.199 \pm 0.3539	2.8514 \pm 0.20054a	4.8865 \pm 0.1558	2.7163 \pm 0.0408a	23.0234*
K	2	1.5091 \pm 0.2494	1.4042 \pm 0.2869	1.5618 \pm 0.148	1.8198 \pm 0.0288	0.7467
FCR	2	1.9293 \pm 0.3188	1.765 \pm 0.3566	1.8249 \pm 0.1729	1.9472 \pm 0.0703	0.1073
PER	2	1.8809 \pm 0.0221	2.1428 \pm 0.0217 a	2.0655 \pm 0.0106 a	1.8486 \pm 0.0041 bc	74.8033*
Survival	2	95.5 \pm 2.5%	95.5 \pm 5%	97.5 \pm 2.5%	90.00 \pm 10%	-----

* Significant at $p < 0.05$, a significantly varied from control at $p < 0.05$, b significantly varied from blue colour at $p < 0.05$, c significantly varied from brown

colour at $p < 0.05$, wt gain: weight gain (g), wt gain %: weight gain (%), ADG: Average daily weight gain (g/d), SGR: specific growth rate (%/d), K: condition factor (g/cm³), FCR: food conversion ratio (g/g), PER: protein efficiency ratio (g/g), NO: Number of observations.

Fingerlings:

The final weight of fingerlings attained for control group was 2.8811 g compared to the initial weight (0.417 g). Fingerlings fed with tested feed colours do not exhibit significant changes in their Wt gain (%), SGR and K, from those of the control group (Table 2b). Significant reduction in final weight (Wf), weight gain and ADG were reported in case of brown feed colour.

Table 2b. Effect of feed colour on growth performance of *Oreochromis aureus* fingerlings

	No.	Control	Blue feed colour	Brown feed colour	Yellow feed colour	F value
I wt	2	0.417 \pm 0.027	0.385 \pm 0.045	0.3448 \pm 0.0499	0.3665 \pm 0.0035	-----
Wt final	2	2.8811 \pm 0.007	2.4389 \pm 0.2611	1.409 \pm 0.1723 a	2.0171 \pm 0.3021	8.3131*
Wt gain	2	2.4642 \pm 0.0341	2.0539 \pm 0.2161	1.0792 \pm 0.1374 a	1.6506 \pm 0.3056	8.7168*
Wt gain %	2	593.942 \pm 46.622	534.2182 \pm 6.3112	326.4217 \pm 7.168	451.2058 \pm 87.6923	5.396
ADG	2	0.0411 \pm 0.0006	0.0342 \pm 0.0036	0.018 \pm 0.0023 a	0.0275 \pm 0.0051	8.7177
SGR	2	3.2249 \pm 0.1121	3.0786 \pm 0.0166	2.4169 \pm 0.028	2.8235 \pm 0.2674	5.8946
K	2	1.3069 \pm 0.0208	1.0848 \pm 0.0548	1.0911 \pm 0.0526	1.1653 \pm 0.0761	3.5549
FCR	2	0.1836 \pm 0.002	0.1855 \pm 0.002	0.2457 \pm 0.0119 a	0.1964 \pm 0.0236	4.8197
PER	2	0.1241 \pm 0.0003	0.1044 \pm 0.0099	0.0723 \pm 0.0057 a	0.0869 \pm 0.0058 a	12.1633*
Survival	2	92.5 \pm 7.5%	92.5 \pm 2.5%	94.56 \pm 0.44%	98.15 \pm 1.85%	-----

* Significant at $p < 0.05$, a significantly varied from control at $p < 0.05$, b significantly varied from blue colour at $p < 0.05$, c significantly varied from brown colour at $p < 0.05$, wt gain: weight gain (g), wt gain %: weight gain (%), ADG: Average daily weight gain (g/d), SGR: specific growth rate (%/d), K: condition factor (g/cm³), FCR: food conversion ratio (g/g), PER: protein efficiency ratio (g/g), NO: Number of observations

FCR was generally increased reporting significant differences for fingerling fed with brown feed colour. Significant reductions of PER were recorded for fingerlings fed brown and yellow feeds. High survival values were recorded for fingerling fed with basal diet and those fed with different feed colours (Table 2b).

Biochemical parameters:

Fries:

The total protein content was non-significantly reduced for fries fed with the tested coloured feeds than those fed with basal diet (Table 3a). Albumin content showed non-significant changes for yellow and blue feed from the control. In case of

brown feed, it was significantly reduced as compared to the control value.

Table 3a. Effect of feed colour on biochemical parameters of *Oreochromis aureus* fries

	NO.	Control	Blue feed colour	Brown feed colour	Yellow feed colour	F value
Total protein	6	74.4446 ± 5.2497	53.3672 ± 7.0427	66.6208 ± 5.6345	53.7263 ± 3.6695	3.4779*
Albumin	5	15.9138 ± 1.0662	11.1679 ± 1.8751	4.9133 ± 0.8881a	20.6818 ± 1.2548 c	25.8713*
AST	4	19.5239 ± 2.2167	2.86 ± 0.3674 a	5.3906 ± 0.9409 a	4.2348 ± 0.5867 a	38.2707*
ALT	4	9.0096 ± 0.2465	2.0289 ± 0.4165 a	2.7237 ± 0.5492 a	2.2008 ± 0.434 a	62.3122*
ALP	4	152.089 ± 1.9739	155.6262 ± 16.3196	88.5785 ± 16.6986 ab	132.0022 ± 12.0951	5.4594*
GSH	4	51.3019 ± 0.1821	65.4837 ± 0.2911 a	42.6246 ± 2.3919 ab	47.0288 ± 2.6254 b	30.8194*
cholesterol	3	21.41 ± 0.8325	13.3462 ± 1.2421 a	11.0555 ± 0.4507 a	18.5842 ± 2.9196 c	8.1969*
Water content	4	1.742 ± 0.245	1.7282 ± 0.6714	0.8818 ± 0.0752	1.4598 ± 0.09949	1.2323*
Ash content	3	17.7897 ± 0.2343	18.762 ± 0.9498	16.0301 ± 0.2063	16.1731 ± 0.7294	4.5361*

* significant at $p > 0.05$, a significantly varied from control at $p < 0.05$, b significantly varied from blue colour at $p < 0.05$, c significantly varied from brown colour at $p < 0.05$, Total protein mg/g fresh tissue, Albumin mg/g fresh tissue, AST aspartate aminotransferase U/g fresh tissue, ALT alanine aminotrasferase U/g fresh tissue, Alp alkaline phosphatase U/g fresh tissue, GSH glutathione reduced mg/g fresh tissue, Cholesterol mg/g fresh tissue, Water content %, Ash content %, NO. Number of observations

Aspartate aminotransaminase (AST) and alanine aminotransaminase (ALT) activities showed significant reduction than those of the control, for fries fed with the tested coloured feeds. Its lowest reduction was reported for fries fed blue feed. It induced significant increase of alkaline phosphatase (ALP) activity compared to the control group. In contrary, brown and yellow feed colours promote reduction of ALP activity. The value was only significantly reduced in case of brown feed colour.

Comparing with the control, glutathione (GSH) showed significant increase, and reduction in case of fries fed with blue and brown feeds, respectively. Cholesterol showed general reduction in fries fed the tested coloured feed. It was significantly varied in case of blue and brown feeds. Water content and ash content values for fries fed with different coloured feeds exhibited non-significantly changes than those of the control (Table 3a).

Fingerlings:

The total protein content for all fingerlings was reduced significantly than the control as a result of feeding with blue feed. In contrary, yellow and brown feeds induced non-significant changes of its content. Significant variation for total protein content

was observed for blue feed colour vs brown and yellow feed colours. Variation of the total protein content among the tested groups was significant at $p < 0.05$ (Table 3b). Similarly, albumin content showed significant reduction for all fingerling fed with the blue and brown feeds compared to the control. F value for the whole variations among the tested groups was also significant.

Table 3b. Effect of feed colour on biochemical parameters of *Oreochromis aureus* fingerlings

	No	Control	Blue feed colour	Brown feed colour	Yellow feed colour	F value
Total protein	6	69.242 ± 1.362	44.976 ± 3.474 a	66.390 ± 3.347 b	71.574 ± 4.616 b	12.889 *
Albumin	6	55.882 ± 5.0731	26.0788 ± 3.9241 a	37.7972 ± 2.8717 a	41.9747 ± 4.9967	9.351 *
AST	6	119.935 ± 5.957	60.554 ± 7.50 a	65.28 ± 5.99 a	64.37 ± 3.889 a	22.45 *
ALT	6	51.541 ± 7.204	30.833 ± 3.780 a	30.457 ± 2.898 a	45.833 ± 4.223	4.932 *
ALP	6	39.444 ± 4.303	49.278 ± 9.220	52.862 ± 7.719	55.833 ± 8.081	0.8902
GSH	6	31.701 ± 7.520	15.946 ± 1.799	12.080 ± 2.703 a	20.7146 ± 2.920	3.817*
cholesterol	6	62.8736 ± 5.2374	31.8646 ± 4.0625 a	42.8243 ± 6.7742	55.1297 ± 5.942 b	8.7658*
Water content	6	13.0624 ± 1.9281	9.4397 ± 1.2313	5.5746 ± 0.8691 a	8.9735 ± 2.0678	1.282*
Ash content	3	7.0492 ± 2.0593	3.3542 ± 0.6864	2.4069 ± 0.7063	4.6502 ± 1.3858	2.4784

* significant at $p > 0.05$, a significantly varied from control at $p < 0.05$, b significantly varied from blue colour at $p < 0.05$, c significantly varied from brown colour at $p < 0.05$, Total protein mg/g fresh tissue, Albumin mg/g fresh tissue, AST aspartate aminotransferase U/g fresh tissue, ALT alanine aminotrasferase U/g fresh tissue, Alp alkaline phosphatase U/g fresh tissue, GSH glutathione reduced mg/g fresh tissue, Cholesterol mg/g fresh tissue, Water content %, Ash content %, NO. Number of observations

AST and ALT activities were generally reduced due to feeding with examined coloured feeds. The reduction was significantly varied from the control group at all tested coloured diets for AST. For ALT the reduction was significantly varied than the control in case of fingerling fed with blue and brown feeds. Alkaline phosphatase (ALP) activity was increased non-significantly than those of the control group. Similarly, the whole variations among the experimental groups were also non-significant.

Glutathione (GSH) as an antioxidant biomarker was generally reduced in blue tilapia fingerlings fed with the examined tested coloured feeds. The reduction was significantly varied from the control group in case of fingerlings fed with brown feed. Cholesterol content showed irregular non-significant fluctuations for fingerling fed the tested coloured feed from those reported for fingerling fed with the basal diet. Only those fed with blue feed colour exhibited significant

reduction in its level from those of the control. Water and ash content for tilapia fingerling fed the coloured feeds were reduced non-significantly from those of the control (Table 3b). Only brown feed induced significant reduction in water content.

DISCUSSION:

Tilapia fish, as well as many fishes that live in euphotic zone are visual feeders during their early developmental stages (Marchesan *et al.*, 2005; El-Sayed and Gohbashy 2010). Their feeding ability can be affected by light intensity, background colour and feed characteristics (Helfman 1979&1993; Mills *et al.*, 1986; Utne-Qalm, 1999; Papoutsoglou *et al.*, 2000).

In the present study, higher final weight was attained due to feeding tilapia (*Oreochromis aureus*) fries with the tested coloured feed rather than basal diet. The different tested coloured feeds showed non-significant changes in weight gain of fries compared to the control. This promotion of weight gain was concomitant with average daily weight gain (ADG). This indicates that feed colours promote feeding stimulation. Earlier studies showed growth performance promotion for Nile tilapia, *Oreochromis niloticus* by Nass *et al.* (1996), Downing and Litvak (1999), El-Sayed (2004), Martinez-Cardenas and Purser (2007), and El-Sayed and El-Ghobashy (2010).

Specific growth rate (SGR) was slightly higher than those of the control for fries fed with brown feed colour. This is due to the fact that darker feeds resulted in higher growth than lighter one (El-Sayed and El-Ghobashy, 2010). SGR reported lower values for blue and yellow feeds. This denotes that the basal diet was in balanced ratio and promotes better growth.

For blue tilapia fingerling, growth as expressed in final weight (Wf) and weight gain was retarded with the different tested feed colour rather than those fed with the basal diet. Similarly, SGR was higher in the control than those fed with the different coloured feeds. This growth retardation could be explained by reduction of weight gain. These results are contradictory to those reported for Nile tilapia, *Oreochromis niloticus* by El-Sayed (2004). This is may be ascribed on species specificity. This was reported by Fanouraki *et al.* (2011).

Oreochromis niloticus had better growth and feed efficiency for darker coloured diets (red and dark blue) than those fed lighter diets. The red diet produced the best fish performance, followed by dark blue, the control, and light green. The poorest performance resulted in fish fed the yellow diet (El-Sayed, 2004). Fish survival was not affected by feed colour, and was over 90% in

all treatments. Feed colour could be a key factor for feed acceptance in farmed tilapia. Red or dark-blue pellets seemed preferable to light-coloured yellow and lightgreen feed (El-Sayed, 2004).

The zebrafish, *Danio rerio* larva has first emerging visually mediated behavioral response is the visual startle response, where the larvae respond with a rapid increase in body movements to sudden decrease in brightness (Neuhauss, 2010).

Thin mullet, *Liza ramada* larvae have the best performance and survival for fish fed on dark coloured diets (red, dark blue, and dark brown). Light coloured diets (yellow, light green, and light brown) results in inferior performance (El-Sayed and El-Ghobashy, 2010). Rainbow trout, *Salmo gairdneri* show the following feed colour preference, blue, red, black, orange, yellow, and green (Ginetz and Larkin, 1973). Light-coloured tanks should be used for rearing thinlip mullet, *L. ramada* larvae, while dark-coloured diets are more preferable to light coloured diets (El-Sayed and El-Ghobashy, 2010).

Since most fish larvae are visual feeders, food colour enhances food capture efficiency. However, visual feeders may also depend on physical characteristics of feed, such as pellet density (sinking vs. floating), size, colour and developmental stage of fish (El-Sayed, 2006).

Biochemical parameters tested in the present study exhibited general reduction of the total protein and albumin content for whole fries and fingerlings fed with the tested coloured feeds compared to control. Similarly, there was reduction of transaminases activities (AST and ALT). This denotes inhibition of protein metabolism due to inhibition of transamination process. Inhibition of protein metabolism of fish was reported earlier (Lin and Luo, 2011). In the present study, reduction of total protein in addition to inhibition of transamination process reported for fries fed with the tested coloured feeds coincide with reported growth retardation.

GSH as an antioxidant molecule specific for scavenging free radicals was higher in fingerlings fed with basal diet rather than those fed with the examined coloured feeds. Therefore, antioxidant capacity was harmfully reduced in case of feeding with brown feed. Water content was generally reduced. Those fed with brown feed colour exhibited lonely significant reduction from the control. Ash content was apparently not-varied due to feeding with coloured feeds. In conclusion, the present study indicated that using the coloured feeds did not promote growth of *Oreochromis aureus* larvae. Also, it is reporting harm biochemical changes for fish larvae fed the examined tested coloured feeds. So, further study on toxicity assessment of feed colourants is a pre-requisite. Therefore, the ordinary basal diet is more useful.

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تأثير الغذاء الملون علي اداء النمو والتغيرات البيوكيميائية لاسماك البلطي الازرق (*Oreochromis aureus*)

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البروتين ومحتوي الاليومين والكولستيرول في حالة الاصبغيات. كذلك اوضحت النتائج الى ان العلائق ذات اللون البني والازرق تسبب نقصا معنويا في معظم العوامل البيوكيميائية التي تم دراستها مقارنة بالمجموعة الضابطة. ولوحظ نقص في GSH في الاصبغيات المتغذية علي الغذاء ذو الالوان المختلفة □ وكان هذا النقص معنويا في حالة الاصبغيات التي تغذت علي غذاء ملون باللون الازرق والبني. وهذا يتوافق مع النقص في نمو كل من البرقات والاصبغيات. ولقد اوضحت الدراسة الحالية ان استخدام الغذاء الملون لا يعمل علي تحفيز معنوي لنمو البلطي الازرق بالاضافة الي وجود تغيرات بيوكيميائية قد تؤثر علي تلك الاسماك. وبالتالي يفضل استخدام العليقة العادية.

تم تغذية برقات اسماك البلطي الازرق بعلائق ملونه بالوان مختلفه. و لقد اوضحت نتائج البحث ان التغذية بالغذاء الملون نتج عنه اعلي وزن نهائي في ليرقات البلطي مقارنة بالغذاء غير الملون. بالرغم من ذلك فان التغيرات غير معنوية ليرقات الاسماك المتغذية علي الغذاء الملون بالالوان المختبرة. تشير نتائج البحث ان هناك نقص معنوي في معدل النمو النوعي نتيجة التغذية بالغذاء الملون باللون الازرق والاصفر. وعلي الجانب الاخر سجلت الاصبغيات المتغذية علي غذاء غير ملون اعلي معدلات نمو مقارنة بتلك تم تغذيتها علي الغذاء ذو الالوان المختلفة. كذلك اوضحت النتائج وجود تغيرات غير معنوية في الوزن النهائي مقارنة بتلك المتغذية علي غذاء غير ملون وذلك بصفة عامة.بالاضافة الى وجود نقص معنوي في نشاط ALT و AST في حالة البرقات المتغذية علي غذاء ملون باللون الازرق والبني. وبالمثل وجد نقص معنوي في محتوى البروتين ومحتوي الاليومين في حالة برقات الاسماك المتغذية علي الغذاء الملون باللون البني. ولكن لا يوجد تغيرات معنوية بين المجموعات المختلفه في نشاط انزيمات ALT و AST و محتوى

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