EFFECT OF FEEDING NILE TILAPIA FINGERLINGS TWO ESSENTIAL AMINO ACIDS (LYSINE AND ARGININE) SUPPLEMENTED WITH (FISH OIL AND SUNFLOWER OIL) ON: 1- GROWTH PERFORMANCE, FEED UTILIZATION, BODY COMPOSITION AND BLOOD PARAMETERS

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SUMMARY

The current study aims to study the effect of supplementing commercial diets used to feed fish with some amino acids (lysine or arginine), by mixing each of them with fish oil or sunflower oil, and its effect on growth performance, feed utilization efficiency, body composition, and blood chemistry characteristics. Where 5 diets were made, the experimental diets were fed to five groups of fish (each group represents by 3 tanks) as follows: (T1) is the control group, which was fed as the basal diet (contains 38% crude protein and 4100 kcal/Kg feed without any additives, the second group (T2) was fed the basal diet, which was supplemented with the addition of 21 g lysine and 15 g fish oil/kg of diet, and the third group (T3) was fed the basal diet mixed with 21 g lysine plus 15 g sunflowers/ kg feed. The fourth diet (T4) was fed the basal diet mixed with 29.4 g arginine and 15 g fish oil/ kg feed. The fifth group (T5) was fed the basal diet mixed with 29.4 g arginine + 15 g sunflower oil/ kg feed. The fish were fed the experimental diet for 128 days. The results of this study showed significant increase ($P < 0.05$) in growth performance (BWG), relative growth rate (SGR), and feed utilization efficiency (FCR, PER, PPV) between the different treatments and the control group. The results of the third treatment (T3), which was supplemented with 21 g lysine + 15 g sunflower oil/kg feed, were significantly superior ($P<0.05$) in growth rate (BWG, SGR) and best feed conversion efficiency (FCR, PER, PPV) compared to the other groups. Blood analysis results for fish fed the third diet showed a decrease in the levels of aspartate transferase and alanine aminotransferase. The results of the current experiment indicated that adding 21 g lysine + 15 g Sun flower oil is an appropriate amount that improves the performance of Nile tilapia fingerlings.

Keywords; *Amino acids, fat sources, growth, tilapia, blood analysis.*

INTRODUCTION

Recently, a lot of research has been conducted to raise the nutritional value of the feed used in feeding tilapia fingerlings. Recent research has shown the importance of adding some nutritional enhancers, such as some free amino acids in addition to fatty acids, with the aim of improving the utilization of these feeds (*Rodrigus et al*., 2020). This may face the natural development that is occurring in the field of Nile tilapia farming. It is worth noting here that nutritional requirements have not been reviewed since 2011 by the NRC until now *(Furuya et al., 2023).* Global tilapia production is expected to continue to grow until 2030 through sustainable management, optimal use of natural resources, new farming techniques and improve feeding practices (FAO, 2021). On this basis, the growth, reproduction, and health performance of tilapia fish is improved through genetic selection breeding programs combined with precise nutritional strategies to meet this increasing needs. However, these needs have generated challenges for tilapia production, including reviewing considerations related to food security, food safety, feed ingredient shortages, disease protection and environmental conservation. Optimizing growth performance and supporting fish health through precise amino acid (AA) nutrition is well-accepted in current Nile tilapia (*Oreochromis niloticus*) farming. Much research has shown that deficiency of one essential AA may lead to the decline of several physiological functions, which will be reflected in growth performance (Rodrigus *et al.*, 2020, DO-Nascimento *et al.*, 2020, Diogenes *et al.*, 2016). Amino acids act as molecules to regulate protein synthesis

(Araujo *et al.*, 2021 and Gaye-Siessegger *et al*.,) and energy metabolism in Nile tilapia *Oreochromis niloticus* (Li *et al*., 2020a). Therefore, providing tilapia feeds that cover optimal amino acid requirements is a primary goal of improving feed utilization, reducing feeding costs, and mitigating nitrogen loss to the environment. Fish muscle tissue has significant quantities of lysine, an essential amino acid. It promotes growth and is required for the transportation of long-chain fatty acids into the mitochondria, where they are converted to energy (Furuya *et al*.,2012). In addition to dietary arginine supplementation has been demonstrated to enhance protein optimization and, consequently, growth performance for a number of fish species. There have been reports of tilapia with improved somatic development, feed efficiency (Neu *et al*., 2016; Yue *et al*., 2015). Fish require more fats with a low degree of saturation, which is reflected in oils, for their capacity to absorb them better. Fatty acids are split into oils and fats. Fatty acids are often quite important when feeding fish because they are the primary source of energy, such as sunflower oil and fish oil (Barlow, 2000).

While lysine and arginine are the highest amount needed of EAA for optimum growth of Nile tilapia fish (Furuya *et al*., 2023) and necessary for efficient utilization of other essential amino acids and energy; both were tested in the present research in a combination with two oil sources (fish oil and sunflower oil) and were fed to tilapia fingerling to investigate its effects on the growth performance, feed utilization, body composition and blood indices of Nile tilapia fingerlings.

MATERIALS AND METHODS

Experimental fish and rearing system:

The fingerlings were purchased from a private hatchery in Kafr El-Sheikh Governorate. At the beginning of the experiment, the average starting body weight was (1.7 g). Fish (300 tilapia fingerlings) were acclimatized to lab conditions for two weeks and were fed daily 5% of their life body weight for 6 days a week with commercial feed (38% crud protein and 4100 Kcal/g). The experimental fish were randomly distributed among fifteen 108 liters' quadrate fiber glass tanks (20 fish/ tank). The tanks related to a recirculate system's (RAS) provided with mechanical and biological filters in the Fish Production Branch, Department of Animal Production, Faculty of Agriculture, Ain Shams University, Cairo, Egypt.

Water quality parameters:

Water quality was assessed by measuring the water temperature and the oxygen saturation daily at 8:00 am using portable dissolved oxygen meter (Lurton model Do – 5509), on one hand, the pH was measured on a weekly base by a pH model (Coming Co. pH meter model 345), and on the other hand, the nitrite and ammonia were estimated every two weeks; through the following analytical methods, ammonia-nitrogen ($NH4^+$), nitrite (NO_2), and nitrate (NO_3) were measured using the techniques outlined by Sauter and Stoub (1990). The parameters for water quality were provided in (Table 1).

Table (1): Averaged water quality determinations during the experimental period.

Parameter	Reading
Average Temperature (°C)	28 ±2
Oxygen (mg / L)	5
pH	7.8
Ammonia (mg / L)	0.08
Nitrite (mg / L)	0.32

Feeding experiments:

In the present study, fish were fed extruded commercial diet and were acclimatized for 2 weeks, during which they were fed a control extruded diet (38% crude protein and 4100 Kcal/ kg feed). Feed was brought from a commercial fish feed factory. According to the feed product label, ingredients of the feed were: fish meal (65% CP) and soymeal (46% CP), wheat middling, corn gluten (60% CP), yellow corn, rice bran, fish oil, soya bean oil, mono-calcium phosphate, salt and premix no (9228) Egypt.

After the acclimation feeding period, the commercial feed was grinded and divided into 5 equal portions. The first portion (T1), which consider as the control group (no additives were added), the second

portion (T2), where, 21 g lysine and 15 g fish oil/ kg feed) were added, the third group (T3) where 21g lysine and 15 g sunflower oil/ kg feed were added, the fourth group (T4) where 29.4 g arginine and 15 g fish oil/ kg feed were added and the fifth group (T5) where 29.4 g arginine and 15 g sun flower oil/ kg were added. The feeding diets were again pelleted, dried and were kept in the refrigerator at 4 °C during the feeding period. Fish were fed daily at a rate of 5% of their total biomass 3 times (six days a week). Daily feed allowances were readjusted according to the new biomass every two weeks. The feeding trial lasted 128 Days.

Chemical analysis:

The dry matter, crude protein, ether extract, and ash contents of the feed and fish composition were analyzed according to the methods described by (AOAC, 2012).

Table (2): Chemical analysis of commercial feed used in the experiment.

Chemical analysis	**% (DM bases)**
Moisture	10.89
Crude protein	37.80
Ether extract	5.80
Crude fiber	4.40
Ash	14.18
NFE *	37.82
GE (Kcal/kg feed)	4100

**NFE = 100 – (CP + EE + CF + ash)*

Feed nutritional index values, including weight gain (WG), average daily gain (ADG), specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER) and protein productive value (PPV%) were calculated as follow:

- Weight Gain (WG, g/ fish) = Final weight (g) – Initial weight (g)
- Average Daily Gain (ADG, g/day) = $\frac{\text{Final weight (g) – Initial weight (g)}}{\text{Time}}$
- Specific Growth Rate (SGR, %/day) = $\frac{\{\text{ln final weight (g) – ln of initial weight (g)}\} *100}{\text{Time}}$
- Feed Conversion Ratio (FCR, g feed/g/ gain) = $\frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}$
- Protein Efficiency Ratio (PER, g weight gain/ g protein intake) = $\frac{\text{Weight Gain (g)}}{\text{Protein intake (g)}}$
- Protein Productive Value (PPV%) = $\frac{\{\text{Protein gain in fish (g)}\} *100}{\text{Protein feed intake (g)}}$
- Hepatosomatic index HSI (%) = (Liver weight / body weight) * 100
- Viscera somatic index VSI (%) = (Visceral weight / body weight) * 100

Hematological and biochemical assay:

Blood samples were collected from six fish of the three replicates to obtain sufficient amount for examination. The same operator handled the samples three times. The automated blood testing device Rayto RT7200 auto hematology analyzer was utilized to measure hematocrit (HCT), white blood cells (WBC), red blood cell (RBC), and hemoglobin (Hb). The remaining samples were centrifuged at 3500 rpm for 20 minutes in accordance with the manufacturer's instructions in order to obtain blood for the spectrophotometric commercial kits' assays of alanine transaminase (ALT) and aspartate transaminase (AST); (Biomed Diagnostic, Egypt), respectively. This was done in accordance with **Barham and Trinder (1972)** and **Henry (1974)**.

Statistical analysis:

One-way analysis of variance (ANOVA) was used for all numerical data. In every instance, significance was determined by $p < 0.05$. The SPSS-20 statistical analysis program was used. The means of the control and treated groups were compared using (Duncan's ,1955) multiple range tests.

$$Yij = \mu+ti+eij$$

Where $Y_{IJ} =$ observations; μ = overall mean and Ti = effect of the treatment and eij = error

RESULTS

Growth performance parameters:

The results of the final body weight (FBW) are presented in Table 3. The group of fish that were fed the T3 diet, where 21 g lysine and 15 g sunflower oil were added, showed a positive effect ($P < 0.05$) and recorded the highest growth value (66.70 g/fish, while fish group fed the control diet (T1), where no additives were added showed the lowest significant ($P<0.05$) growth values (34.38 g/fish). Average weight gain (AWG) of fish fed T3 (21 g lysine + 15 sunflower oil/ kg diet) recorded the highest value (64.90 g/fish). While the fish group fed the control diet (no AA and no Oil additive) showed the lowest significant ($p<0.05$) average weight gain (32.38.18 g/fish). Average Daily Gain (ADG, g/ day) and Specific Growth Rate (SGR, %/ day) of fish fed the third group (T3) showed the highest significant values (0.50 g/d and 3.74%/ day), respectively. Whereas AWG and SGR of fish group fed the control diet showed the lowest significant values ($P<0.05$). The average values of weight gain, average daily gain and specific growth rate of fish fed diet included 29.4 g arginine and 15 g fish oil/ kg diet (T4) followed with significant differences the values of T3 group ($P<0.05$).

Table (3): Fish growth parameters mean ± S.E. of the experimental groups fed different experimental diets.

Growth parameters	Control(T1)	LF(T2)	LS(T3)	AF(T4)	AS(T5)
IBW (g/fish	1.74±0.15	1.55±0.12	1.80±0.05	1.76±0.01	1.85±0.00
FBW (g/fish)	34.38^{c}±0.54	53.22^{c}±.70	66.70^{a} ±1.74	61.32^{b}±1.82	48.87^{d}±.72
AWG (g/fish)	32.64^{e}±0.69	51.67^{c}±.82	64.90^{a}±1.77	59.55^{b}±1.81	47.01^{d}±.76
ADG (g/day)	0.25^{e}±0.00	0.40^{c} ±0.00	0.50^{a}±.01	0.46^{b} ±.01	0.37^{d}±0.00
SGR (%/day	3.11^{c} ±0.08	3.63^{ab}±0.07	3.74^{a}±0.04	3.67^{a} ±0.02	3. 45^{b}±0.06

Values in the same raw, with different superscripts are significantly different (P<0.05).LF: lysine +fish oil; LS: lysine +sunflower oil; AS: arginine +fish oil: and AS: arginine sunflower oil.

Feed utilization parameters:

The results of feed utilization parameters are presented in table 4. Where, feed conversion ratio (FCR) of fish groups fed diets supplemented with amino acids improved significantly compared with the control group ($P<0.05$). Numerically T4 showed the best feed conversion ratio (1.06 g feed/ g gain). No significant differences ($P>0.05$) were observed between the four treatments (T2, T3, T4 and T5). While the fish of the group fed with the control diet (without feed additives) showed the worst value (1.82 g feed/g gain). Protein efficiency ratio (PER) showed that the fish of the T4 group scored the highest significant value (2.52). While the control fish (without feed additives) showed the lowest value (1.50). While no significant differences ($P>0.05$) were observed in the protein productive value (PPV%) between the different treatments including the control.

Table (4): Fish feed utilization means ± S.E. of the experimental groups fed different experimental diets.

Feed utilization parameters	Control (T1)	LF (T2)	LS(T3)	AF(T4)	AS(T5)
Feed Intake (g/fish)	59.32±8.3	59.91±0.85	73.99±6.9	62.65±3.92	66.89±2.7
FCR (g feed/g gain)	1.82^{a}±0.26	1.16^{b}±.02	1.13^{b} ±0.07	1.06^{b}±0.10	1.42^{ab} ±.04
PER	1.50^{c} ±0.20	2.27^{ab} ±0.05	2.34^{ab}±0.15	2.52^{a}±0.21	1.86^{b}±0.05
PPV%	41.87±.77	38.17± .50	33.05±3,19	40.10±2,21	39.10±1.40

Values in the same raw, with different superscripts are significantly different (P<0.05).

Proximate analysis of whole-body composition:

The body composition data of tilapia fish fed the experimental diets are presented in Table (5). No significant difference was detected in dry matter content of all treatments (P>0.05). Also, ash content of the T3 group was less significant than the other experimental groups (P<0.05). Protein content of all the experimental fish bodies (fed diets supplemented with either lysine or arginine) showed higher values compared with the zero group. Although group T2 (Lysine + fish oil) had the highest lipid content (18.83 %) among the other experimental groups. The lowest significant (p<0.05) lipid content (14.79 %) was obtained by group T5, where fish were fed diet provided with arginine + sunflower oil.

Table (5): Chemical analysis of Nile tilapia fish (dry basis) fed different experimental diets.

Items	Zero group	Control (T1)	LF (T2)	LS (T3)	AF(T4)	AS(T5)
DM%	41.04±0.32	48.22±2.57	44.07±2.28	42.43±2.31	47.43±2.64	41.98±1.63
ASH%	10.23^{c}±0.14	15.76^{ab}±0.39	16.79^{a}±0.55	14.80^{b}±0.95	16.70^{a}±0.37	16.26^{ab}±0.44
E.E%	16.27^{ab}±0.03	16.44^{ab}±0.74	18.83^{a}±1.67	15.93^{ab}±0.40	16.74^{ab}±1.30	14.79^{b}±0.18
CP%	51.33^{b}±0.23	62.52^{a}±2.53	60.16^{a}±0.18	63.30^{a}±3.13	65.78^{a}±2.57	68.97^{a}±4.84

Hepatosomatic and viscera somatic index:

Fish group fed diet (T3) showed the highest hepatosomatic index (HSI) value compared with the other experimental group including the control group (Table 6). The lowest HSI was obtained by the control group where fish fed the basal diet (no amino acids nor fat added). Viscera somatic index observed in the present experiment showed significant (P<0.05) increases among the other treatment including the control. The lowest value (P<0.05) was obtained by fish group fed diet T4, where arginine and fish oil were added.

Table (6): Hepatopancreas and viscera index as percentage of body weight of Nile tilapia fed different experimental diets.

Items	Control (T1)	LF (T2)	LS (T3)	AF(T4)	AS(T5)
Hepatosomatic index	1.87^{b}±0.23	1.89^{b}±0.19	2.82^{a}±0.39	2.49^{ab}±0.19	2.30^{ab}±0.11
Viscera somatic index	7.55^{ab}±0.39	8.86^{a}±0.64	8.26^{ab}±0.33	7.19^{b}±0.46	8.43^{ab}±0.37

Values in the same raw, with different superscripts are significantly different (P<0.05).

Blood Parameters:

The blood parameters had revealed that T3, where fish group fed diet supplemented with lysine plus sunflower oils (LS) scored the highest values as shown in (Table 7). Furthermore, it had a significant effect on blood cell counts and hemoglobin at (P<0.05) among all treatments. The RBCs count in T3 treatment was highest compared to other treatments (1.82 $*10^6/mm^3$), and the least count was obtained by the control (1.38$*10^6/mm^3$). The Hb and HCT values were the highest in treatments T3 compared to the other treatments included the control group. In addition, the total WBCs count in T3 showed the highest value among all treatments (187.2$*10^3/mm^3$) and the least significant value was recorded by the control group (160.3$*10^3/mm^3$). Blood chemical analysis indicated that liver enzymes ALT and AST for the control treatment were 215±30 and 189±10, respectively which were significantly higher than those of other treatments (Table 8). While the treated groups showed a significant decrease in both enzymes, especially at T3 (76 ± 6) for AST and (87 ± 2.1) for ALT.

Table (7): Blood plasma chemistry indices comparing control Vs. treated groups.

Parameters	Control (T1)	LF (T2)	LS (T3)	AF(T4)	LS(T5)
RBCs ($*10^6/mm^3$)	1.38^{e}±0.33	1.58^{c}±0.40	1.82^{a}±0.10	1.67^{b}±0.17	1.49^{d}±0.11
Hb(g/dl)	9.4^{d} ±1.86	13.3^{c}±0.64	15^{a}± 0.77	14.7^{b}±0.46	13^{c}±0.17
HCT%	11.4^{d}±5.00	31.5^{c}±4.63	41.8^{a}±14.47	34^{b}±1.82	30.8^{c}±11.95
WBCs($*10^3/mm^3$)	160.3^{c} ±6.48	170.5^{c}±13.07	187.2^{a}±3.98	179^{b}±9.67	164.5^{d}±13.18

Values in the same raw, with different superscripts are significantly different (P<0.05).

Table (8): Liver function enzymes in blood plasma of Nile tilapia fed different experimental diets.

Parameters	Control (T1)	LF (T2)	LS (T3)	AF(T4)	LS(T5)
ALT(U/L)*	215^{a}±30	144^{c}±20	87^{e}±5	96^{d}±10	156^{b}±22
AST (U/L)**	189 ^{a}±10	132^{c}±15	76^{e}±6	10 ±116^{d}	141^{b}±10

Values in the same raw, with different superscripts are significantly different (P<0.05).

* *Alanine aminotransferase (ALT)*

** *Aspartate aminotransferase (AST)*

DISCUSION

To study the state of growth, fish groups were weighing every two weeks. The obtained results highlighted that body weight was found to be increased throughout the experimental period, where fish were able to double their weight every 4 weeks. The average initial fish body weight (IBW) was 1.5 g while the final fish FBW was 66.70 g/ fish in the 3rd treatment followed by 61.32 g/ fish in the 4th treatment while the lowest fish weight was obtained by the control group (34.38 g/ fish). Data of fish growth rate and feed utilization throughout the experimental periods are presented in Table (3&4). The results of the present study agreed with the results of Rodrigus *et al.* (2020) and Furuya *et al.* (2023), who concluded that lysine is the dominant essential amino acid in the feed and the whole bodies of tilapia at different production stages. These results are corresponding to those reported by Dong *et al.* (2017), who revealed that dietary arginine/lysine level of 29.4/21.0 g/kg produced the best growth performance, suggesting that a better growth performance in *Macrobrachium rosenbergii* culture in terms of final (WG, SGR), feed utilization parameters (FCR, PER) in 63 days' experiment. Similar values were recorded by Mahbub *et al*. (2018) who found that the growth rate was boosted by lysine supplementation up to 2.05%, while supplementation of lysine enhanced the feed efficiency of tilapia fish. This may be due to the fact that lysine increases the muscle growth in fish by rapidly increasing size and length of muscle fibers through hyperplasia and hypertrophy (Valente *et al.*, 2013; Michelato *et al*., 2016).

Chemical composition analyses of the experimental fish showed that dry matter and ash content in the fish body were not affected by the experimental diets. However, the percentage of protein and fat increased in the various treatments in the 128 days' experimental period. These results are agreed with Furuya *et al*. (2012) who found that dietary lysine levels had little impact on protein and ash body content, but a quadratic influence on fat deposition rate and body lipids was seen as the amount of lysine in the diet increased.

The results in Table 6 showed no significant effect of the fat source on the hepatosomatic and viscera somatic index of tilapia fingerlings. These results are in agree with the results of Qiu *et al.* (2017), where they obtained no significant effect of different dietary lipid sources (fish oil or plant oils) on either the hepatosomatic or viscera somatic indexes of the large yellow croaker (*Larmichthys crocea*) fish.

Blood parameters as revealed in (Table 4 and 5) showed that supplementing diets with (lysine + sunflower oil) in T3 treatment had significant effect on all the measured parameters (P<0.05) among all treatments. The highest RBCs count in the 3rd treatment and the least count was obtained by the control. Hematological variables also exhibit considerable changes with the addition of each Lys inclusion level. Maximum hemoglobin (Hb), hematocrit (HcT) and red blood cell (RBC) count were also noted at 21.50 g/kg Lys fed diet. The Hb and HcT values were the highest in treatment T3 compared to control. In addition, the total WBCs count in T3 showed the highest value among all treatments and the least count was recorded by the control group. These results agree with the findings of Khan and Abidi (2011). The blood indicators hematocrit and hemoglobin were dramatically impacted by (T3), where fish were diet containing 15g Lysine + 15 sunflower oil/ kg achieved the highest significant hematocrit values. The lowest value was observed for the groups fed the control diet. To the same results came by Michelato *et al.* (2016) and *Zaminhan et al.* (2018) that lysine has been shown to improve body weight, feed efficiency, and fillet yield in Nile tilapia. Accordingly, this may lead to an increase in oxygen concentration in the blood and improve metabolic processes, which leads to increased growth rates. The liver enzymes AST and ALT for the treated groups showed significant decline for both; especially in T3 (87 ±5) and T4 (96 ±10) for ALT and (76±6) in T3 and T4 (116 ± 10) for AST. Ahmed *et al.* (2022) suggested that plasma aspartate transaminase (AST) demonstrated substantial (p <0.05) changes between the treatments with

increasing arginine concentrations up to 17.5 g/ kg diet. This is agreed with the results of Li *et al.* (2020a, b) who found that the control group (without arginine supplementation) showed that hepatic activities of alanine aminotransferase, aspartate aminotransferase, lactate dehydrogenase, and hepatic concentration of malondialdehyde were reduced but these for catalase and superoxide dismutase, which were enhanced by dietary supplementation with 2% arginine.

CONCLUSION

The results of the present study on tilapia fish represented that using lysine and arginine supplemented with some oils such as fish oil and sunflower oil for 128 days showed positive significant effect on growth performance, feed utilization, body composition and blood parameters. This study indicated the needs to review the current amino acid recommendations for Nile tilapia and suggests some amendments that may help to improve the level of nutritional requirements of tilapia fish so that the tilapia industry can grow.

REFERENCES

Ahmed, I.; I. Ahmad, B. A. Malla, B. A. Shah, Z. A. Wani, Y. M. Khan (2022) Dietary Arginine Modulates Growth Performance, Hemato-Biochemical Indices, Intestinal Enzymes, Antioxidant Ability and Gene Expression of TOR and 4E-BP1 in Rainbow Trout, *Oncorhynchus mykiss* Fingerlings. Marine science, (2022): 822.

A.O.A.C. (2012): "Official Methods of Analysis of the Association of Official Analytical Chemistry." (A.O.A.C.) International, 19th ed., Gaithersburg, Maryland, USA.

Araújo, F.E.; M. Michelato., M.O. Schemberger., A.L. Salaro., L.V.O. Vidal., T.P. da Cruz., V.R.B. Furuya., W.M. Furuya (2021). Assessment of isoleucine requirement of fast-growing Nile tilapia fingerlings based on growth performance, amino acid retention, and expression of muscle growth-related and MTOR genes. Aquaculture, (539) :736645.

Barham, D.; P. Trinder (1972) An Improved Colour Reagent for the Determination of Blood Glucose by the Oxidase System. Analyst, 97, 142-145. http://dx.doi.org/10.1039/an9729700142

Barlow, S (2000). Fishmeal and fish oil: sustainable feed ingredients for aquafeeds. Global Aquacult. Advocate 4: 85-88. (cited by NG, W-K.; C-Y. CHONG (2004). An overview of lipid nutrition with emphasis on alternative lipid sources in tilapia feeds. In: *Proceedings of the Sixth International Symposium on Tilapia in Aquaculture*. Manila, Philippines: Bureau of Fisheries and Aquatic Resources, (2004): 241- 248.

Diógenes, A.F.; J.B.K. Fernandes, J.C.P. Dorigam, N.K. Sakomura, F.H.F. Rodrigues, B.T.M. Lima, F.H. Gonçalves (2016). Establishing the Optimal Essential Amino Acid Ratios in Juveniles of Nile Tilapia (*Oreochromis niloticus*) by the Deletion Method. Aquaculture Nutrition (22):435–443.

Do-Nascimento, T. M.T.; C. F. M. Mansano, H. Peres, F. H. F. Rodrigues, K.U. Khan, R.S. Romaneli, N.K. Sakomura, J.B.K. Fernandes (2020) Determination of the Optimum Dietary Essential Amino Acid Profile for Growing Phase of Nile Tilapia by Deletion Method. J. A*quaculture*, 523:735204.

Dong, x. J.; j. Wu; Y. Shen, j. Y. Chen, S. Y. Miao, X. J. Zhang, l. S. Sun (2017). Effects of different arginine/lysine level on growth performance, body composition and digestive enzyme activity of *Macro brachium rosenbergii*. Aquaculture nutrition, *4*(3): 1101-1111.

Duncan, D. B (1955). Multiple range and multiple F-tests. *Biomet.* 11: 1-15.

FAO (2021) Food and Agriculture Organization, Fishery and Aquaculture Statistics FAO; Rome, Italy.

Furuya, W.M.; T.P. da Curz, D.M. Gatlin (2023). Amino Acid Requirements for Tilapia. Animals (Basel). Published online 2023 Mar1. doi: 10.3390/ ani 13050900.

Furuya, W. M.; T. S. Graciano; L. V. O. Vidal; T. O. Xavier; L. D. Gongora; J. S. Righetti; V. R. B. Furuya (2012). Digestible lysine requirement of Nile tilapia fingerlings fed arginine-to lysine - balanced diets. *Revista Brasileira de Zootecnia*, (41) :485-490.

Gaye-Siessegger, J.; U. Focken, H. Abel, K. Becker (2007). Influence of dietary non-essential amino acid profile on growth performance and amino acid metabolism of Nile tilapia, *Oreochromis niloticus* (L.). *Comp. Biochem. Physiol. Part A.* (146) :71–77.

Henry, C. (1974). Investment Decisions Under Uncertainty: The "Irreversibility Effect. "*American Economic Review*, 64 (6),1006: 12.

Khan, M. A.; and S. F. ABidi (2011). Effect of dietary L-lysine levels on growth, feed conversion, lysine retention efficiency and hematological indices of *Heteropneustes fossilis* (Bloch) fry." Aquaculture Nutrition, 17(2): 657-667.

Li, L.Y.; D.L. Lu, Y. Jiang, S. M. Limbu, F. Qiao, L.Q. Chen, M.L Zhang, Z.Y. Du (2020a). Dietary L-Carnitine Improves Glycogen and Protein Accumulation in Nile Tilapia via Increasing Lipid-Sourced Energy Supply: An Isotope-Based Metabolic Tracking. Aquaculture Reproduction, (17): 100302.

Li, S.; Y. Zhang, N. Liu, J. Chen, L. Guo, Z. Dai, C. Wang, Z. Wu, G. Wu (2020b) Dietary L-arginine supplementation reduces lipid accretion by regulating fatty acid metabolism in Nile tilapia (*Oreochromis niloticus*). Journal of Animal Science and Biotechnology, 11:82: https://doi.org/10.1186/s40104-020-004867.

Mahbub, J., M. M. Iqbal, M. S. Hossain, S. Mian, M. N. Jabed, A. K. M. Hasan (2018). Effects of L-Lysine on growth and histological changes in liver and intestine of GIFT Strain *Oreochromis niloticus*. *Bangladesh J. Fish*, 30(1) : 27-35.

Michelato, M., L. V. DE. Vidal, T. O. Xavier, L. B. De Moura, L. F. V. DE Almeida, V. B. Pedrosa, V. R. B. Furuya, W. M. Furuya (2016). Dietary lysine requirement to enhance muscle development and fillet yield of finishing Nile tilapia. Aquaculture, 457 (2019):142-130.

Neu, D., W. Boscolo, M. Zaminhan, F. Almeida, C. Sary, W. Furuy (2016). Growth performance, biochemical responses, and skeletal muscle development of juvenile Nile tilapia, Oreochromis niloticus, Fed with Increasing Levels of Arginine. The world aquaculture society, 47(2): 248–259.

Qiu, H., M. Jin, Y. Lu, Y. Hou, Q. Zhou (2017). Dietary lipid sources influence fatty acid composition in tissue of large yellow crocker (*Larmichthys crocea*) by regulating triacylglycerol synthesis and catabolism at transcriptional level. https://doi.org/10.1371/journalpane.0169985

Rodrigues, A. T., C. F. M. Mansano, K. U. Khan, T. M. T. Nascimento, A. Z. Boaratti1, N. K. Sakomura, J. B. K. Fernandes (2020). Ideal profile of essential amino acids for Nile tilapia (*Oreochromis niloticus*) in the finishing growth phase. Aquaculture Research, 51(11): 4724 - 4735.

Sauter, A. and K. Stoub (1990). Official methods of analysis. Association of official analytical chemists, Inc. 5 Th Edn. (Eds), Suite 400, ARLINGTON, Virginia 22201, USA

Valente, L. MP.; K. A. Moutou, L. Ec. Conceição, S. Engrola, J.M.O. Fernandes, L.A. Johnston (2013). What determines growth potential and juvenile quality of farmed fish species? Rev. Aquaculture, 5(8) :168-193

Yue, Y.; Z. Zou; j. Zhu; D. Li; W. Xiao; J. Han; H. Yang (2015). Effects of dietary arginine on growth performance, feed utilization, haematological parameters and non-specific immune responses of juvenile Nile tilapia (Oreochromis niloticus L). Aquaculture Research, 46 (2015):1801–1809.

Zaminhan, M.; M. Michelato, V.R.B.B. Furuya, W.R. Boscolo, F.E. Araújo, T.P. Cruz, A.V. Urbich, W.M. Furuya (2018). Total and Available Tryptophan Requirement of Nile Tilapia, *Oreochromis niloticus*, Fingerlings. Aquatic Nutrition, (24):1553–1562.

تأثير تغذية إصبعيات البلطي النيلي على حمضين أمينيين أساسيين (ليسين ، أرجينين) مدعمين بزيت السمك أو زيت عباد الشمس على: 1- أداء النمو والاستفادة من الغذاء وخصائص الدم.

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تهدف الدراسة الحالية إلى دراسة تأثيراستكمال علائق تجارية تستخدم لتغذية الأسماك ببعض الأحماض الأمينية (ليسين أو الأرجينين) ، عن طريق خلط كل منها مع زيت السمك أو زيت عباد الشمس ؛ لدراسة تأثيرها على أداء النمو ، وكفاءة الاستفادة من الأعلاف ، وتركيب الجسم ، وخصائص كيمياء الدم ، حيث تم عمل 5 علائق تم تغذية العلائق التجريبية لخمس مجموعات من الأسماك (ويمثل كل مجموعة 3 أحواض) على النحو التالي : (T1) وهي المجموعة الضابطة والتي تم تغذيتها على العليقة الغذائية القاعدية والتي تحتوي على 38 ٪ بروتين خام و 4100 كيلو كالوري/ جرام وبدون أي إضافات ، المجموعة الثانية (T2) والتي تم تغذيتها على العليقة الغذائية القاعدية والتي تستكمل بإضافة 21 جم ليسين و15 جم زيت السمك /كجم من العليقة ، والمجموعة الثالثة (T3) كان يتم تغذيتها بالعليقة القاعدية مخلوطا بها 21 جم ليسين بالإضافة إلى 15 زيت جم عباد شمس/ كجم علف ، العليقة الرابعة (T4) والتي كان يتم تغذيتها بالعليقة الغذائية القاعدية مخلوطا بها 29.4 جم أرجنين مضافا إليها 15 جم زيت سمك/ كجم علف أما المجموعة الخامسة (T5) كانت تتغذى على العليقة القاعدية مضافا لها 29.4 جم أرجينين + 15 جم زيت عباد الشس/ كجم عليقة. تم تغذية الأسماك بالعلائق التجريبية لمدة 128 يومًا. أظهرت نتائج هذه الدراسة زيادة معنوية ($P < 0.05$) في أداء النمو (BWG)، ومعدل النمو النسبي (SGR) ، وكفاءة استخدام الغذاء (RCR، PER، PPV) بين المعاملات المختلفة ومجموعة الكونترول. وتفوقت نتائج المعاملة الثالثة (T3) المكملة ب 21 جم ليسين +15 جم زيت عباد شمس/ كجم عليقة تفوقا معنويا ($P<0.05$) في معدل النمو (BWG ، SGR) وأفضل كفاءة تحويل غذائي (PPV ، PER، FCR) مقارنة مع باقي المجموعات. أظهرت نتائج تحليل الدم للأسماك التي تغذت على العليقة الثالثة انخفاضا في مستويات أسبارتيرانسفيراز الأسبارتات والألانين أمينوترانسفيراز. أشارت نتائج التجربة الحالية إلى أن إضافة 21 جم لايسين + 15 جم زيت عباد الشمس/ كجم عليقة هي كمية مناسبة تعمل على تحسين أداء إصبعات البلطي النيلي.