# Effect Of Dietary Lipid Level On Growth, Feed Utilization And Body Composition By Nile Perch Juveniles (*Lates Niloticus*)

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doi: 10.19044/esj.2016.v12n9p423 URL:http://dx.doi.org/10.19044/esj.2016.v12n9p423

**Abstract:**

The present study was designed to determine the optimum dietary lipid of juveniles Nile perch for better growth performances. Four isonitrogenous (45 %) experimental diets were formulated to contain 9; 11; 13 and 15 g crude lipid 100 $g^{-1}$ feed, and fed in triplicate groups of Nile perch (mean weight : 3.28 ± 0.04 g) reared in twelve 50 L tank for 8 weeks. At the end of the experimental period the group of fish fed 11 % and 9 % lipid, had a significantly higher SGR and body weight gain than the rest of experimental groups. The lowest body weight (13.28 g) was achieved by group of fish fed 15 % lipid. The FCR were significantly lower for fingerling Lates fed diet containing 11 % and 9 % lipid than the rest. The increase of the dietary lipid level in the diet affected significantly the Protein Efficiency Ratio (PER). Body moisture content decreased significantly with the increase of dietary lipid. Body lipid increased significantly with the increase of dietary lipid. Under the experimental conditions applied, the optimum dietary lipid requirement for juvenile *Lates niloticus* is estimated to be 9.79 %.

**Keywords:** Nile perch, *Lates niloticus*, lipid levels, growth

## Introduction:

The Nile perch, *Lates niloticus* (Linnaeus 1758), Family centropomidae, is a freshwater carnivorous fish of wide geographical distribution throughout the Ethiopian Region of Africa, occurring commonly in all major river basins including the Nile, Chad, Senegal, Volta and Congo. Most *Lates niloticus* in their natural environment feed on fish and insects. Moreover, Nile perch is of great social economic importance in the East

African region (Gumisiriza et al., 2009; Beuving, 2010). The Nile perch fishery is however under threat due to the intensive fishing pressure on the fishery that has resulted in a tremendous decline of its populations (Njiru et al., 2009). Current strategies for increasing Nile perch production point towards the culture of this species (Gregory, 2006). The culture development of this species will depend mainly on the availability of its seed and the development of well balanced and suitable feed. Little information is available on the dietary requirements of Nile perch, and, in particular, there is no information on dietary lipid requirement.

Dietary lipids play an important role as potential supplier of Energy, essential fatty acids and fat soluble vitamins. They also affect the quality of cultured fish because of their influence on the fatty acid composition of body tissues (Guillon et al., 1995). The addition of lipids in fish diets contributes to protein sparing by increasing their digestible energy value (De silva al., 1991).

However, fish are able to utilize dietary lipids up to a certain level, beyond which growth may be retarded owing to reduced feed consumption (Daniels & Robinson, 1986; Ellis & Reigh, 1991).

Moreover, a high lipid intake may cause an increase in body lipid deposition and affect carcass quality (Hillestad & Johnsen, 1994).

The determination of *Lates niloticus* nutritional requirements is essential for optimizing its aquaculture production. To our knowledge, data concerning the optimal dietary lipid level for *Lates niloticus* juveniles have not been published. Given this lack of information on the basic nutrient requirements of this species, the present study has been undertaken to conduct experimentation with different lipid level diets from 9 % to 15 % to determine growth performance and body composition of *Lates niloticus* juveniles.

## MATERIALS AND METHODS

### Experimental conditions

Wild Juvenile, *Lates niloticus*, weighing around 3.28 g at the beginning of the feeding trial were used in this study. These fish were obtained from a local fish dealer at the Diama dam, Saint- Louis, Senegal. Fish were acclimated to the experimental conditions for a period of two weeks. During this period, they were fed with a commercial catfish diet obtained from the National Aquaculture Agency hatchery located in Richard Toll district.

At the beginning of the experiment, fish were bulk-weighed and counted. Each experimental diet was randomly assigned to triplicate with 10 fish (mean weight: 3.28 ± 0.04 g) per glass tank. Water levels in each glass tank were maintained at 50 L and aerated constantly.

Experimental diets were hand-fed three times a day at 08: 00; 12: 00 and 17: 00 to apparent satiation, over a 30-min period for 8 weeks.

Fish were subjected to a photoperiod of 12-h dark and 12-h light and all tanks had similar light conditions. Dissolved oxygen levels and water temperature were monitored daily and averaged 7 mg/l and 30°C, respectively. Fish were bulk weighed every 2 weeks with fish being starved for 24 h prior to weight measurements and 12 h after. All aquaria were cleaned up every day in the morning by scrubbing and siphoning off accumulated waste materials. Each meal after feeding the uneaten food was removed manually to estimate food consumption.

**Experimental diets**

Four experimental diets were formulated to contain 9 %; 11 %; 13 % and 15 % lipid. Fish meal and shrimp meal were used as protein sources, fish oil and soy oil as lipid sources. Fish meal and shrimp meal were finely grounded and poured through a sieve of 425 μm mesh. Vitamin and mineral premix were mixed separately with the cellulose and the binder before being added to the main ingredient mixture. Diets were supplemented with fish oil after the addition of water (Table 1). The semi-moist mixture was then pressure pelleted in the food grinder, dried at 35°C for two days, cut to desired sizes, packaged into plastic bag and stored frozen until its usage. The diets were screened prior to feeding in order to remove the fines.

**Table 1:** Formulation of the experimental diets of Nile perch (*Lates niloticus*).

| | Diet | | | |
|---|---|---|---|---|
| Ingredient (g/100g) | 9% | 11% | 13% | 15% |
| Fish meal | 52 | 53 | 53 | 53 |
| Shrimp meal | 27 | 27 | 27 | 27 |
| Corn meal | 15 | 12 | 10 | 8 |
| Fish oil : soy oil (7:3) | 2 | 4 | 6 | 8 |
| Vit mix[a] | 2 | 2 | 2 | 2 |
| Min mix[b] | 2 | 2 | 2 | 2 |
| Total | 100 | 100 | 100 | 100 |

[a] Vitamin mixture (mg or IU. $Kg^{-1}$): Biotin, 0.25 ; folic acid, 0.75 ; choline chloride, 250 ; ascorbic acid, 50; vitamin B12, 0.05; vitamin K3 : 100.

[b] Mineral mixture (mg/Kg mixture): Ca, 0.3 g; Fe, 2 g; $CoCl_2$, 0.01g; Zn, 1.32 g; Se, 0.019g; $CuCl_2$, 0.1g; Na, 0.34g; Mn, 1.8g.

**Sampling and analytical methods**

At the beginning of the feeding trial, 10 fish were randomly sampled from the initial fish and at the end of the 8-week experiment 3 fish from each tank were sampled and all the sample are freeze-dried for subsequent proximate analyses.

The experimental diets and samples of the fish carcasses were analyzed for proximate composition according to the Association of Official Analytical Chemists: AOAC (1984) procedures. Crude lipid was determined by the ether extraction method by Soxtec System HT (Soxtec System HT6; Tecator); crude protein was determined with a Kjeltec system 1002 (Tecator); crude fiber was determined by the Fibertec system M 1020 hot extractor (FOSS Tecator); crude ash by incineration in a muffle furnace at 550°C for 24 h, and dry matter by drying in an oven at 105°C for 24 h;

Several parameters were routinely monitored to ensure good water quality maintained. Water temperature and dissolved oxygen was measured everyday using YSI Model 58 oxygen meter (Yellow Springs Instrument, Yellow Springs, OH, USA). Water pH was measured everyday by pH tester DMT-30 Series.

**Calculations and Statistical Analysis**

Growth response parameters were calculated as follows: Weight gain (%) = 100* ( (final mean body weight - initial mean body weight)/ initial mean body weight); Specific Growth Rate (SGR, % /day) = 100* ((In Wt- In Wi) /T), where Wt is the weight of fish at time t, Wi is the weight of fish at time 0 and T is the rearing period in days; Feed Conversion Rate (FCR) = total dry feed fed g/ fish / total wet weight gain g/ fish. Survival rate (%) = 100* (number of fish which survived/initial number of fish). Protein efficiency ratio (PER) was calculated using the following formula: wet weight gain (g)/protein intake (g). The optimum lipid required was estimated by taking the first derivative of Y on the polynomial regression model with respect to the relevant X.

Results are presented as mean ± SEM. Data were subjected to one-way analysis of variance (ANOVA) to test the effect of four dietary lipid levels as main effect. Treatment effects were considered significant at $p \leqq 0.05$; Duncan's new multiple range tests was used to compare significant difference among treatments. The survival data were transformed into a normal distribution using the arcsine square root prior to analysis of variance. All statistical analysis was carried out using the SAS/PC statistical software.

**RESULTS**

During the experiment water temperature monitored ranged from 29 to 30°C; dissolved oxygen was 6.5 ± 0.5 mg/L and pH ranged from 7.5 to 8. All parameters are considered to be suitable for fish growth and survival. Survival was similar ($p > 0.05$) among dietary treatments and ranged from 86.67 ± 0.06 % to 76.67 ± 0.07 % over the eight-week trial (Table 3). The effects of dietary lipid levels on weight gain, specific growth rate, feed

intake, feed conversion ratio and protein efficiency ratio of Lates fingerlings fed the experimental diets are presented in Table 3.

**Table 2:** Proximate analysis of the experimental diets of Nile perch (*Lates niloticus*).

| Chemical analysis | 9% | 11% | 13% | 15% |
|---|---|---|---|---|
| Moisture | 6,7 | 6,8 | 6,6 | 6,6 |
| Crude protein | 45,83 | 45,94 | 45,81 | 45,73 |
| Crude fat | 9,13 | 11,1 | 13 | 15,2 |
| Crude fiber | 2,8 | 2,7 | 2,6 | 2,6 |
| Crude ash | 10,9 | 10,8 | 10,8 | 10,7 |
| NFE | 19,4 | 17 | 15 | 13,6 |
| Gross Energy (kcal/100gm) | 458,99 | 469,37 | 483,66 | 490,59 |
| P/E Ratio | 109,15 | 107,59 | 103,99 | 102,32 |

Average body weight (g) of juveniles Lates fed experimental diets at the start did not differ, indicating that groups were homogenous. At the end of the experimental period the group of fish fed 11 % and 9 % lipid, had a significantly ($p \leqq 0.05$) higher SGR and body weight gain than the rest of experimental groups. The lowest body weight (13.28 g) was achieved by group of fish fed lipid level 15 %. However, SGR were 2.77, 2.82, 2.63 and 2.48 for groups of fish fed on diet containing 9, 11, 13 and 15 % lipids, respectively.

**Table 3**: Growth performance, and survival of *Lates niloticus* fed the experimental diets. Values are means ± standard deviation (n = 3). Within a row, means with different superscript letters differ significantly ($p \leqq 0.05$).

| | Diet | | | |
|---|---|---|---|---|
| Parameters | 9% | 11% | 13% | 15% |
| Initial body weight (g) | 3.27±0.22 | 3.28±0.05 | 3.26±0.05 | 3.30±0.03 |
| Final body weight (g) | $15.43\pm0.46^{a}$ | $15.89\pm0.56^{a}$ | $14.22\pm0.11^{b}$ | $13.28\pm0.47^{c}$ |
| Weight gain (%) | $372.20\pm11.24^{a}$ | $385.06\pm23.82^{a}$ | $336.22\pm3.17^{b}$ | $302.23\pm17.99^{c}$ |
| SGR (%) | $2.77\pm0.04^{a}$ | $2.82\pm0.09^{a}$ | $2.63\pm0.01^{b}$ | $2.48\pm0.08^{c}$ |
| Feed intake | $24.26\pm0.51^{a}$ | $24.3\pm0.44^{a}$ | $22.93\pm0.50^{ab}$ | $22.93\pm0.50^{b}$ |
| Feed conversion ratio | $1.99\pm0.05^{b}$ | $1.93\pm0.07^{b}$ | $2.09\pm0.06^{ab}$ | $2.26\pm0.24^{a}$ |
| Protein efficiency ratio | $1.11\pm0.03^{a}$ | $1.15\pm0.04^{a}$ | $1.06\pm0.03^{ab}$ | $0.99\pm0.10^{b}$ |
| Survival rate (%) | 83.33±0.15 | 76.67±0.06 | 83.33±0.06 | 86.67±0.06 |

The FCR were significantly lower ($p \leqq 0.05$) for fingerling Lates fed a diet containing 11% and 9 % lipid than the rest of experimental groups. The highest FCR (2.26) was achieved by group of fish fed 15 % lipid level.

The increase of the dietary lipid level in the diet affected significantly the Protein Efficiency Ratio (PER) ($p \leqq 0.05$). PER increased with the dietary lipid level up to 11 % and decreased later on. The lowest PER was found with the diet with 15 % of lipid (Table 2). PER in 9% and 11% lipid diet was

higher than PER in 15% lipid diet. However, there was no difference in PER among 9%, 11% and 13% lipid diet and also between 13% and 15% lipid diet (Table 3).

**Table 4:** Body composition (on wet weight basis) of Nile perch fingerlings fed the experimental diets. Values are means ± standard deviation (n = 3). Within a row, means with different superscript letters differ significantly ($p \leqq 0.05$).

| Parameters | Lipid level (%) | | | |
|---|---|---|---|---|
| | 9 | 11 | 13 | 15 |
| Moisture | 80.61±0.12$^{a}$ | 79.28±0.18$^{b}$ | 78.46±0.33$^{c}$ | 77.51±0.15$^{d}$ |
| Protein | 52.33±0.21 | 52.47±0.23 | 52.33±0.21 | 52.3±0.1 |
| Lipid | 11.73±0.15$^{d}$ | 12.43±0.21$^{c}$ | 12.96±0.09$^{b}$ | 13.84±0.14$^{a}$ |
| Ash | 20.43±0.09 | 20.25±0.06 | 20.74±0.1 | 20.21±0.09 |

The effect of dietary lipid levels on body composition is presented in table 4. Body moisture content decreased significantly with the increase of dietary lipid. Body lipid increased significantly with the increase of dietary lipid ($p \leqq 0.05$). Body protein and ash content was not affected by the dietary treatments ($p > 0.05$).

When the second-order regression was employed, based on specific weight gain for estimating the dietary lipid requirement of *L. niloticus* (Fig. 1), the regression equation was as follows: $Y = -0.0121x^2 + 0.2369x + 1.6301$. The optimum dietary lipid requirement for juvenile Lates is estimated to be 9.79 %.

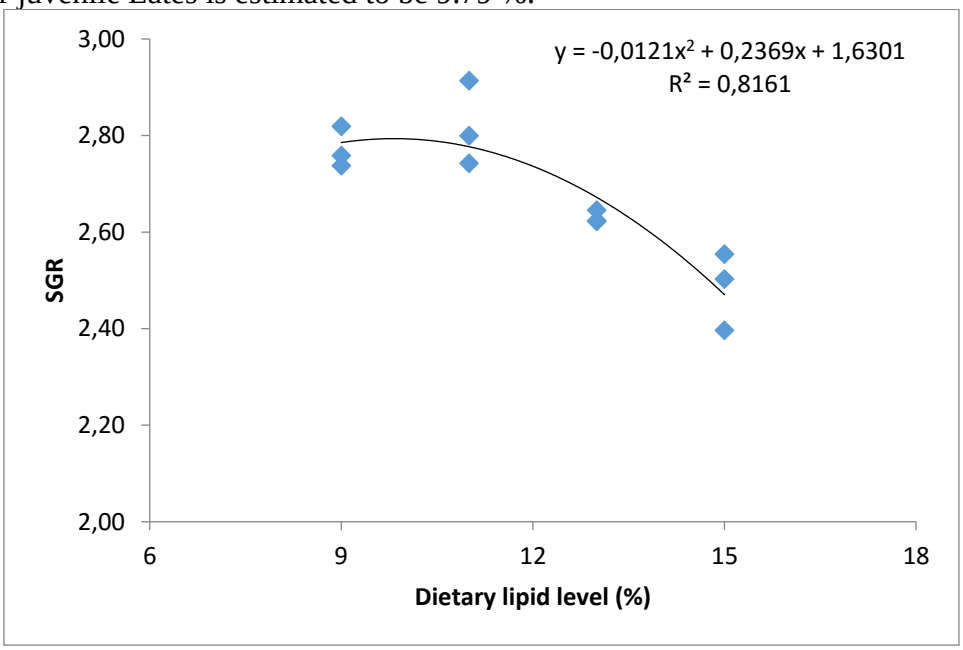


**Figure 1:** Second order regression of SGR on dietary lipid level for *L. niloticus.*

## DISCUSSION

During the experiment water temperature monitored ranged from 29 to 30°C; dissolved oxygen was 6.5 ± 0.5 mg/L and pH ranged from 7.5 to 8. All parameters are considered to be suitable for fish growth and survival.

The present study is the first report to our knowledge regarding dietary lipid needs of Nile perch during their juvenile stage. It is well known that Dietary lipids are an important source of energy that also provide essential fatty acids, phospholipids, sterols and fat-soluble vitamins necessary for proper functioning of physiological processes and maintenance of biological structure and function of cell membranes (Sargent et al., 1989). They also affect the quality of cultured fish because of their influence on the fatty acid composition of body tissues (Guillon et al., 1995).

The establishment of the dietary lipid level for optimal growth performance and body composition of juvenile Nile perch is a contribution towards the development of specific feeds for on-growing Nile perch.

Generally, the increase of dietary lipid level improves growth, feed and protein efficiency, as it spares proteins that could otherwise have been catabolized and used as an energy source (De Silva et al., 2001). However, the excessive supplement of dietary lipid could destroy growth and health of fish owing to the abnormal lipid deposition in fish body (Lee & Kim, 2005; Wang et al., 2006). In addition fish have an optimum level of dietary lipids over which dietary fat can cause growth depression (Daniels & Robinson, 1986; Pei et al., 2004). This observation was confirmed in the present study in which the optimum dietary lipid is estimated to be 9.79 %. The growth reduction at high lipid levels could be due to the limited ability to digest and absorb high amounts of lipid or a reduction in feed intake.

The results of this study showed that, PER increased with the dietary lipid level up to 11 % and decreased later on; WG tended to decrease, but FCR tended to increase, with increasing the dietary lipid level from 11 to 15 %. These results indicate that elevating the dietary lipid level from 11 % to 15 % could not induce protein-sparing effect in Nile perch. Similarly, no protein-sparing effects of excessive dietary lipid in other fish species were observed in *Pseudobagrus ussuriensis* Fingerlings (Wang et al., 2013); *Lates calcarifer* juveniles (Catacutan & Coloso, 1995); and *Paralichthys olivaceus* juveniles (Lee & Kim, 2005).

In contrast, a protein-sparing effect of lipid has previously been documented in channel catfish (Page & Andrews, 1973) and Japanese seabass *Lateolabrax japonicus* (Ai et al., 2004). Thus, it is important to provide an appropriate ratio of protein and non-protein energies for the formulation of cost-effective and environment friendly fish feed.

Chemical analysis at the end of the experiment is frequently used to determine the influence of feed on fish composition. Both environment and diet are exogenous factors that affect the proximate composition of cultured fish. It should be noted that, the composition of the feed is the only factor, which could have influenced the difference chemical composition of fish, as other endogenous factors were maintained uniform during the study work.

Data on the body composition content of fish allows assessing the efficiency of transfer of nutrients from feed to fish and also helps predict the overall nutritional status.

The results of the present study indicated that the dietary lipid level significantly affected the body composition of fish. . Body moisture content decreased significantly with the increase of dietary lipid. Body protein and ash content in Nile perch was not affected by the dietary treatments.

A significant increase in body fat deposition was noticed with increase in dietary lipid level, this is consistent with others previously findings for African catfish (Ali & Jauncey, 2005), black catfish (Salhi et al., 2004), cobia *Rachycentron canadum* (Craig et al., 2006); red drum (Ellis & Reigh, 1991; Serrano et al., 1992); and grey mullet (Rangaswamy et al., 1998). In addition, flounder (Lee & Kim, 2005), largemouth bass *Micropterus salmoides* (Bright et al., 2005), cuneate drum (Wang et al., 2006) and blackspot seabream (Figueiredo-Silva et al., 2010), exhibited significantly increased body lipid content when fed at high dietary lipid levels.

The survival rate of *L. niloticus* juveniles under different treatments ranged from 76 to 86 % over the eight-week trial. The survival was not significantly affected by the dietary lipid level. On the contrary, in some species, differences were observed in the survival rate due to the different dietary lipid levels, such as in juveniles Kutum (Ebrahimi & Ouraji, 2011); darkbarbel catfish (Zheng et al., 2010)

**Conclusion:**

In conclusion, data from the present study indicate that the optimum dietary lipid requirement for juvenile *Lates niloticus* is estimated to be 9.79 % to maintain a good overall growth performance.

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