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Optimal Dietary Lipid Requirement for Grey Mullet, *Mugil cephalus*

Debasis De*, T.K.Ghoshal, Joydeep Kundu and S.A.Ali

Kakdwip Research Centre of CIBA (Central Institute of Brackishwater Aquaculture), Kakdwip, South 24 Parganas, West Bengal 743347, India

ABSTRACT

Study on dietary lipid requirement was carried out to evaluate the optimum level of lipid for formulating cost effective feed of *Mugil cephalus*. A 42-day of experiment was conducted with twenty five fishes of average wt. ranging from 0.76 to 0.84 g per replicate and were stocked in fibre reinforced plastic (FRP) tanks containing 400 liter strained clear brackish water in triplicate. Four iso-proteinous (CP-30%) purified diets were prepared with supplemented lipid level of 0, 3, 6 and 9 % and were fed to fishes of groups I, II, III and IV, respectively, @ 10% body weight. Total live weight gain (g) and weight gain percent was higher in group supplemented with 6 % lipid. Feed conversion ratio (FCR) was found to be significantly ($P<0.01$) lower in fish supplemented with 6 % lipid than that of fish fed other test diets. Protein efficiency ratio was significantly higher ($p<0.01$) in fish fed diet with 6 % lipid. Therefore it can be concluded that optimum dietary lipid requirement of *Mugil cephalus* fry is 6%.

Key words: Mugil cephalus, Lipid requirement, Growth, FCR

INTRODUCTION

The grey mullet (*Mugil cephalus* Linnaeus) is a euryhaline marine teleost widely distributed mainly in the coastal waters and estuaries of the tropical and sub tropical zones of all seas in the world (Thomson, 1966). It is commonly available in brackish water of coastal including estuaries and lagoons in India. The species fetches high market value and has good consumer's preference in the states like West Bengal, Orissa and Tamilnadu. It has been reported that among mullets *Mugil cephalus* is one of the commercially important brackishwater finfish species abundantly available in Sunderban area of West Bengal (Pillay, 1954; Gopalakrishanan, 1968; Luther, 1973; Rao and Gopalakrishnan, 1975; Thakur, 1975, Chandra and Sagar, 2010). Due to its benthic feeding behavior it is considered an efficient bioremediator in aquaculture (Lupatsch et al., 2003). Moreover in some cases, it is used in polyculture systems to improve sediment quality also (Sarig, 1981). In Asian and Mediterranean markets, mullet roe is a high-priced product, supplementing the fish flesh (Aizen et al.,2005). These commercial and environmental attributes make mullet an important candidate for domestication. However, it is necessary to ascertain the qualitative and quantitative requirement of dietary nutrients for development of cost effective feed for successful culture of the species. Lipid is an important dietary nutrient, primary function of which is to provide energy and

* Corresponding Author: Sr. Scientist, KRC of CIBA, Kakdwip, South 24 Pgs, W.B. 743347, e-mail- debasiskrc@yahoo.com , dedebasis47@gmail.com

essential fatty acids. Lipid is also needed for absorption of fat-soluble vitamins. It acts as a source of phospholipids and sterols. However, excess dietary lipid has been reported to cause inadequate protein intake and suppress growth. Excess dietary lipids result in an imbalance in DE: CP ratio and excessive fat deposition in the body results in decline in product quality and storage (NRC, 1993). The fatty acid composition of the dietary lipid has a significant influence on the tissue fatty acid composition of the fish (Watanabe, 1982; Henderson and Tocher, 1987; Sargent et al., 1989). Fishes are unable to synthesize essential fatty acid (EFA) de novo and should be supplied through diet. EFA deficiency leads to fin rots, myocarditis, reduced growth rate, reduced feed efficiency, decreased reproductive capability and increased mortality (NRC, 1993; Tacon, 1996). Pellet feed manufactured with excess lipid tend to be of poor quality and get rancid when stored (SRAC, 1998).

In the present study, in order to formulate a nutritionally balanced and cost effective feed for maximum growth, experiments were conducted to determine optimum lipid requirement for *M. cephalus*

MATERIALS AND METHODS

Twenty five *M. cephalus* fry of average wt. ranging from 0.76 ± 0.04 to 0.84± 0.06 g were stocked in each FRP tank containing 400 litre strained clear brackish water in triplicate for four treatment groups. The fry were obtained from local seed dealer at Sunderban area and acclimatized to the laboratory condition for two weeks. Fishes were fed with formulated polyculture feed developed by KRC of CIBA. After acclimatization, fishes of groups I, II, III and IV were fed with purified diet with different level of fat A (fat- 0 %), B (fat- 3 %), C (fat- 6%) and D (fat- 9%), respectively . The main composition of the casein- gelatin based diets used in this study was procured from Hi Media Laboratories, Mumbai, India. All the diets were in pelleted form, with guar gum as a binder and made into pellets using a hand pelletizer. The pellets were dried at 60±100 ^{o}C in hot air oven and manually ground into granules of approximately 1mm. A weighed quantity of diet was offered @ 10 % of body weight at 0700 and 1600 hours daily. The experiment was continued for 42 days in experimental yard at Kakdwip Research Centre of CIBA, Kakdwip, West Bengal. Routine examination of reared fishes was done regularly for health assessment and fish sampling was done fortnightly. Half of the rearing tank water was replaced every morning at 0600 hours. Water parameter such as temperature, dissolved oxygen, pH,

Table 1. Composition of purified diet for *M. cephalus* with different level of fat supplementation

Ingredient	Type I (EE-0%)	Type II (EE-3%)	Type III (EE-6%)	Type IV (EE-9 %)
Casein	25	25	25	25
Egg albumin	4	4	4	4
Gelatin	4	4	4	4
Dextrin	50	50	50	50
Cellulose	6	6	6	6
Amino acid mix	1	1	1	1
Vitamin mix	3	3	3	3
Attractant	1	1	1	1
Mineral mix.	3	3	3	3
Guar gum	3	3	3	3
cod liver oil	-	3	6	9

salinity and alkalinity were measured (APHA, 1998) at weekly interval to assess the water quality in experimental tanks. Leftover feed was siphoned out after two hours of feeding, dried and subtracted from the feed offered for computing the feed consumed.

The proximate composition of feed sample was determined following AOAC (1995) method. The different parameters for evaluation of diets were calculated as follows:

$$\text{Specific growth rate (SGR)} = \frac{\ln(\text{Final body weight}) - \ln(\text{Initial body weight})}{\text{No. of days of experiment}} \times 100$$

$$\text{Protein efficiency ratio (PER)} = \frac{\text{Body weight gain}}{\text{Protein intake}}$$

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Total feed consumed}}{\text{Total weight gain}}$$

At the end of the experiment, fishes were slaughtered and body compositions were analyzed. The experimental data were subjected to analysis of variance (ANOVA) to test the significance among the treatments. All the parameter described under this experiment were analysed by using GLM procedure of SPSS (2008) software. The method of least significant difference (LSD) was applied for comparison between the treatments as per Snedecor and Cochran (1973).

RESULTS AND DISCUSSION

In the present study, four iso-proteinous (CP-30%) purified diet with different level of lipid (Table 1) were prepared. The actual lipid contents (%) of four diets (I, II, III and IV) were 0.77, 3.76, 6.77 and 9.78, respectively (Table 2). Water parameter such as temperature, dissolved oxygen, pH, salinity and alkalinity of the water of different tanks were found in the range of 31.5-33.5oC, 5.2-5.8 ppm, 7.54-7.69, 3.0-6.5 ppt and 118-124 ppm, respectively.

The statistical analysis of the data at the end of the experiment revealed that live weight gain and weight gain percent was significantly ($P<0.05$) higher in fishes of group III than that of groups I and II (Table 3). FCR was significantly ($P<0.01$) lower in group III supplemented with 6 % fat as compared to group I (Control) and group II. PER was significantly ($P<0.01$) higher in group III than that of group I and II. Fat supplementation above 6 % did not show any improvement in weight gain, FCR and PER. No significant ($P>0.05$) difference was observed in regards to SGR among the groups fed different level of fat.

Carcass composition analysis revealed that with the increasing level of lipid in diet, body fat % increased (Table 4). However, protein and ash content of carcass reduced with the increase level of dietary lipid. Carbohydrate content of the fish did not follow any trend.

In the present study, it was found that feed conversion ratio was significantly lower (P<0.01) and protein efficiency ratio was significantly higher (P<0.01) in fish fed diet with 6 % lipid. Total weight gain (g) and weight gain percent was also higher in group supplemented with 6 % lipid. However, the total weight gain of the four groups could not be positively correlated with increased dietary lipid levels which corroborated with the finding of several investigators as reported for turbot, Psetta maxima (Regost et al., 2001), Salmon (Silverstein et al., 1999), rainbow trout, *Oncorhynchus mykiss* (Weatherup et al., 1997), carp (Murai et al., 1985), Grass carp, *Ctenopharyngodon idella* (Du et al., 2005) and brackish water cat fish, *Chrysichthys nigrodigitatus* (Igbinosun and Talabi, 1982). Nematipour et al.(1992) reported similar growth or feed efficiency in hybrid striped bass fed diets with as little as 2.5% lipid up to 10% lipid. In the present study, crude protein and ash content in body significantly (P<0.01) decreased when the dietary lipid supplementation level increased from 3-9%. PER increased with increasing level of fat (0 to 6 %) in diet beyond which it started declining. When lipid was supplemented up to a level of 6%, feed protein was properly utilized. As a result protein efficiency ratio was higher. Beyond 6 % of dietary lipid there was imbalance in energy: protein ratio and PER was less. Body lipid level was increased with increased level of dietary lipid. However, dietary lipid beyond optimum level would result in an imbalance of the energy: protein ratio and in excessive fat deposition in the

Table 2. Chemical composition of purified diet of *M. cephalus*

Parameter	Type I	Type II	Type III	Type IV
Dry matter (DM)	97.29	97.39	97.53	97.25
Organic matter (OM)	97.00	96.50	96.85	96.63
Crude protein (CP)	29.79	29.77	30.01	29.98
Ether extract (EE)	0.77	3.76	6.77	9.78
Ash	3.00	3.50	3.15	3.37
Acid insoluble ash (AIA)	0.22	0.22	0.23	0.25

Table 3. Performance of *M. cephalus* fed different level of fat

Parameter	Group I (Control)	Group II	Group III	Group IV
Initial body wt. (g)	0.81 ± 0.06	0.84 ± 0.06	0.82 ± 0.04	0.76 ± 0.04
Final body wt. (g)	2.10 ± 0.06	2.20 ± 0.11	2.35 ± 0.08	2.39 ± 0.04
Total wt. gain (g)*	1.29 ± 0.09[a]	1.36 ± 0.18[a]	1.64 ± 0.06[b]	1.53 ± 0.05[b]
Weight gain percent*	162.90 ± 21.77[a]	168.21 ± 36.79[a]	217.93 ± 17.29[c]	186.96 ± 5.21[b]
FCR**	4.23 ± 0.15[b]	3.97 ± 0.04[bc]	3.39 ± 0.19[a]	3.74 ± 0.10[ab]
PER**	0.79 ± 0.03[a]	0.85 ± 0.07[a]	0.99 ± 0.05[b]	0.90 ± 0.02[ab]
SGR(%)	2.28 ± 0.21	2.31 ± 0.31	2.75 ± 0.13	2.51 ± 0.04

* p<0.05, ** p<0.01 Values bearing different superscripts in a row differ significantly

Table 4. Carcass composition (DM basis) of *M. cephalus* fed different level of fat

Carcass composition (%)	Group I (Control)	Group II	Group III	Group IV	SEM
Organic Matter (OM)**	81.71 ± 0.36^{ab}	81.57 ± 0.55^{a}	83.09 ± 0.48^{bc}	83.99 ± 0.12^{c}	0.38
Protein**	52.34 ± 0.21^{b}	54.38 ± 0.22^{d}	53.18 ± 0.13^{c}	49.56 ± 0.25^{a}	0.21
Fat**	17.19 ± 0.16^{a}	19.63 ± 0.31^{b}	22.87 ± 0.17^{c}	24.90 ± 0.14^{d}	0.21
Ash**	18.29 ± 0.36^{b}	18.43 ± 0.55^{b}	16.75 ± 0.55^{a}	16.01 ± 0.12^{a}	0.41
Acid Insoluble Ash (AIA)	0.38 ± 0.006	0.38 ± 0.008	0.35 ± 0.02	0.36 ± 0.03	0.02
Nitrogen free Extract (NFE)**	12.08 ± 0.35^{c}	7.56 ± 0.41^{a}	7.23 ± 0.64^{a}	9.53 ± 0.20^{b}	0.43

** $p<0.01$ Values bearing different superscript in a row differ significantly visceral cavity and tissue, adversely affecting yield, product quality and storage. When excess of dietary lipid was provided, a part of this dietary lipid was deposited in the body as fat (Zhou et al. 2007). The diet without lipid supplement reduced protein and fat level in *M. cephalus* which was similar with the report of Watanabe et al. (1975) who showed low protein and fat and increased moisture in the muscle, heart, liver and tissues of carp when fed diet without lipid supplementation. The results obtained in the present study showed that optimum dietary lipid requirement was less as compared to higher lipid requirements in some species (Yone et al. 1971, Stickney and Andrews, 1972; Lee and Putman, 1973; Adndron et al. 1976; Takeuchi et al. 1978). Therefore, it can be concluded from the present study that *M. cephalus* require 6% dietary lipid for its optimum growth.

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REFERENCES

Adndron, J.W., A. Blair, C. B. Cowey, and A.M. Shanks. 1976. Effects of dietary energy level and dietary energy source on growth, feed conversion and body composition of turbot (*Scophthalmus maximus* L.). Aquaculture. 7: 125-132.

Aizen, J., I. Meiri, I. Tzchori, B. Levavi-Sivan and H. Rosenfeld. 2005. Enhancing spawning in the grey mullet (*Mugil Cephalus*) by removal of dopaminergic inhibition. Gen. Comp. Endocrinol. 142(1-2):212-221.

AOAC. 1995. Official Methods of Analysis. Association of Official Analytical Chemists 16th Ed. Arlington, Virginia, USA.

APHA.1998. Standard Methods for the Examination of Water and Wastewater, American Public Health Association. Washington DC.

Chandra, G. and R.L.Sagar. 2010. Fisheries in sundarbans: problems and prospects. Fisheries in Sundarbans paper doc. http://ebookbrowse.com/fisheries-in-sundarbans-paper-doc-d26340339.

Du, Z. Y., Y.J. Liu, L.X. Tian, J.T. Wang, Y. Wang, and G.Y. Liang. 2005. Effect of dietary lipid level on growth, feed utilization and body composition by juvenile grass crap (*Ctenopharyngodon idella*). Aquacult. Nutr. 11: 139-146.

Gopalakrishnan, V. 1968. Collection of brackishwater fish seed from Hooghly estuary. In: Seminar on production of quality fish seed for fish culture. Cent. In-land. Fish Res. Inst., Barrackpore, India.

Henderson, R. J., and D.R. Tocher.1987. The lipid composition and biochemistry of freshwater fish. Prog. Lipid Res. 26: 281-347.

Igbinosun, J.E., and S.O. Talabi. 1982. Studies on the Nutrition of brackishwater cat fish-Chrysichthys nigrodigitatus I: preliminary investigation on the probable use of vegetable oil in catfish feeds. Manuscript presented at the second annual conference of the fisheries society of Nigeria, Calabar, 24-27 January, 1982. Technical paper no. 6.

Lee, D. J., and G.B. Putman. 1973. The response of rainbow trout to varying protein and /energy ratios in a test diet. J. Nutr. 103: 916-922.

Lupatsch, I., T. Katz, and D.L. Angel. 2003. Assessment of the removal efficiency of fish farm effluents by grey mullets: a nutritional approach. Aquacult. Res. 34:1367-1377.

Luther, G. 1973. The grey mullet fishery resources in India. In: Proceedings of symposium on living resources of the seas around India. CMFRI, Spl. Pub. pp. 455-460.

Murai, T., T. Takeuchi, T. Watanabe, and T. Nose. 1985. Effect of dietary protein and lipid levels on performance and carcass composition of fingerling carp. Bull. Jpn. Soc. Sci. Fish. 51: 605-608.

Nematipour, G.R., M.L. Brown and D.M. III. Gatlin. 1992. Effect of dietary carbohydrate:lipid ratio on growth and body composition of hybrid striped bass. J. World Aquacult. Soc. 23:128-132.

NRC. 1993. Nutrient requirement of fish. National Academy Press, Washington, DC, pp. 1-15.

Pillay, T. V. R. 1954. The ecology of brackishwater bheri with special reference to fish culture practices and biotic interaction. Pro. Nat. Inst. Sci. India. 20:399-427.

Rao, A.V.P and V. Gopalakrishnan. 1975. Seed resources and bionomics of cultivable brackishwater fishes of India. J. Inland Fish Soc. India. 7:142-155.

Regost, C., J. Arzel, M. Cardinal, J. Robin, M. Laroche, and S. J. Kaushik. 2001. Dietary lipid level, hepatic lipogenesis and flesh quality in turbot (Psetta maxima). Aquaculture. 193:291-309.

Sargent, J., R. J. Henderson, and D. R. Tocher. 1989. The lipids. Pp. 153-218 in fish Nutrition, 2d ed., J.E. Halver, ed. New York: Academic Press.

Sarig, S. 1981. The mugilidae in polyculture in fresh and brackish water fishponds. In: O.H. Oren (Ed.), Aquaculture of Grey Mullet, Cambridge University Press, Cambridge, UK: 391-409.

Silverstein, J. T., K. S.Shearer, W. W. Dickhoff, and E.M. Plisetskaya. 1999. Regulation and nutrient intake and energy balance in Salmon. Aquaculture. 177: 161-169.

Snedecor, G. W., and W. G. Cochran, 1973. Statistical Methods, 6th ed. Iowa: The Iowa State University Press.

SPSS Base Application Guide 17.0, 2008. © SPSS, USA.

SRAC. 1998. Dietary protein and lipid requirements of golden shiners and Goldfish. Southern Regional Aquaculture Centre Publication no. 124.

Stickney, R.R., and J.W. Andrews. 1972. Effects of dietary lipids on growth, food conversion, lipid and fatty acid composition of channel catfish. J. Nutr. 102: 249-258.

Tacon, A.G.J. 1996. Lipid nutritional pathology in farmed fish. Arch. Anim. Nutr. 49:33-39.

Takeuchi, T., T. Watanabe, and C. Ogino. 1978. Optimum ratio of protein to lipid in diets of rainbow trout. Bull. Jpn. Soc. Sci. Fish. 44: 683-688.

Thakur, N.K. 1975. Observation on the availability of brackishwater fish seed in the Kulti estuary, West Bengal. J. Inland Fish. Soc. India. 7:105-108.

Thomson, J. M. 1966. The grey mullets. In- H Barnes ed. Oceanography and marine biology - an annual review. London: Allen and Unwin, pp.

301-355.

Watanabe, T., T, Takeuchi, and C. Ogino, 1975. Effects of Dietary methyl Linoleate and Linolenate on Growth of Carp - II Bull. Jap. Soc. Sci. Fish. 41 (2): 263.

Watanabe, T. 1982. Lipid nutrition in fish. Comp. Biochem. Physiol. 73B:3-15.

Weatherup, R. N., K.J. McCracken, R. Foy, D. Ride, J. McMkendry, R.J. Maris, and R. Hoey. 1997. The effects of dietary fat content on performance and body composition on farmed rainbow trout *Oncorhynchus mykiss*. Aquaculture. 15: 173-184.

Yone, Y., M. furuichi, and K. shitanda. 1971. Vitamin requirements of the red sea bream . 1. Relationship between inositol requirements and glucose levels in diet. Bulletin of. Jpn. Soc. Sci. Fish. 37: 149-155.

Zhou, QC., J.B. Zhou., SY. Chi, QH. Yang, CW. Liu. 2007. Effect of dietary lipid level on growth performance, feed utilization and digestive enzyme of juvenile ivory shell, *Babylonia areolata*. Aquaculture.
272: 535-540.