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Studies on the Growth Performance and Feed Conversion Ratio of *Catlacatla* Fed with Different Levels of Animal and Plant based Dietary Lipids

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Abstract:

Current research was designed to estimate effect of plant and animal based dietary lipids on growth and body composition of *Catlacatla*. Fish feed ingredients were grouped with two categories i.e. animal based lipids and plant based lipids. Each treatment including control had two replicates. Maximum weight gain was observed in treatment T6 treated with 9% animal based unsaturated fats and the value is (48.58±17.44) and significantly lowest growth (<0.05) was measured in T0 group. In present study, maximum body weight was observed in T9 (49.3±19.48) and least was calculated in T21 (37.15±11.64). Maximum total length was measured in T2 (9.76±3.34) fed with 6% animal based saturated dietary lipids. Feed utilization was calculated by FCR. Top FCR (< 0.05) value was observed for T9 (0.40±0.06) that was given 9% plant based MUFA. Least FCR was calculated in T21 that is (1.05±0.69). Body composition of fish such as protein, ash and moisture contents was unchanged by different levels of lipid but lipid content was increased. It was concluded that synthetic feed supplemented with 6% and 9% dietary lipids either derived from animal or plant sources are acceptable for improved growth of *catlacatla* and with no negative impacts on growth performance.

Keywords: *Catlacatla*, Fish Growth, Lipid Requirement, FCR, Weight gain

INTRODUCTION:

Fish is considered as the main supplier of quality protein supplement around globe and vastly contribute in aquaculture production (Naz*et al*., 2012). In past few decades, global aquaculture has grown tremendously to extend of 52.5 million tons, providing half of the world's fish food. (Bostock*et al*., 2010).*Catlacatla* has turned into utmost valued fish in South Asian countries

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owing to rapid growth potential and consumer partiality (Jena, 2014).*Catlacatla is* the seventh most widely cultivated fish, accounting for around 6% of total aquaculture yield (FAO, 2018). Fish is a nutritious food source of vital omega-3 fatty acids. Along with the other necessary amino acids, these fatty acids have to be present in foods (Ismail, 2005). *Catlacatla* is the important cultured freshwater species with a great economic value owing to its delightful taste and abundance of protein and omega-3 fats, these include reduced triglyceride levels and help to reduce swelling in the body and sustain mental state (DAHDFF, 2017).

Quality of fish tissue and growth rate of fish is highly influenced by the kind and amount of feed taken by the fish (Ali &Jauncey, 2004). Nutritionally balanced artificial feed is the prime need of fish and is essential for fruitful and maintainable aquaculture (Singh *et al*., 2006). For feasible aquaculture, proper feeding practices and ample nutrition is necessary. The nutritional eminence, color, taste and texture of the fish is enhanced by dietary provision of essential nutrients in fish feed (Khan & Khan, 2020).

Lipid is one of the most important elements in feed since it has higher calorie content than over proteins and carbohydrates. Fish can almost completely absorb lipids and appear to be preferred as a source of energy than carbohydrates (Cowey& Sargent, 1977; Cho *et al*., 1985).

Dietary lipids in the diet provide latent energy, fat-soluble vitamins and necessary fatty acids. The fatty acid composition in body tissues is affected by lipids, which affects the value of farmed fish (Nematipour*et al*., 1992). Dietary lipid causes a noteworthy outcome on growth and meat reliability of land animals (Jaturasitha*et al*., 2002; Jung *et al*., 2003).

Plant oils are usually high in n-6 fatty acids, whereas fish oils are high in n-3 fatty acids. Plant oils are produced 100 times more globally than fish oils (FAOSTAT, 1990-98). For the aqua feed industry, plant oils are irrefutably more plausible source of lipids.

Polyunsaturated fatty acids are thought to help prevent and treat heart disease, mental illness, neurological development, high blood pressure, diabetes, obesity, tumor, thrombosis and pulmonary disease (Ackman, 2002). The omega-3 and omega-6 have received special attention among the fatty acids (PUFA). Both are long chain fatty acids. Omega-3 fatty acids have a three-carbon double bond apart from the methyl carbon, while omega-6 fatty acids have a six-carbon double bond apart from the methyl carbon (Barma&Goswami, 2013). Feed Conversion Ratio (FCR) is a significant way for measuring artificial diet acceptance in fish culture (Abid*et al*., 2009).

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Present study was done to conclude how different dietary fatty acid groups animal based and plant based saturated, unsaturated, MUFA and PUFA may influence the growth and feed intake of *Catlacatla*.

Objectives:

The objectives of the present work was

- To study the effect of plant based fatty acids on growth and FCR of *Catlacatla*
- To study the effect of animal based fatty acids on growth and FCR of *Catlacatla*
- To evaluate the effect of combined use of plant and animal based fatty acids on growth of *Catlacatla*

Materials and Method

The present experimental work was proceeded to examine the effect of different origin and quantities of dietary lipids in artificial feed on *Catlacatla* growth and feed utilization. The current trial was directed at Fish research farms, Department of Zoology, Wildlife and fisheries, University of Agriculture, Faisalabad.

Fish and Experimental conditions:

Catlacatla fingerlings were gathered from the Government Fish Hatchery in Faisalabad. Fingerlings were acclimatized in tanks and fed once a day on basal diets. Before carrying out experiment, these fingerlings were bathed in a solution of NaCl containing 5g/L. Dissolved oxygen (DO) of water medium was checked and maintained by using digital meter (model HI 9147). Water quality parameter i.e. temperature of water and pH was monitored by AMPROBE pH meter. Experimental tanks were given aeration by using aeration capillary system.

Formation of Experimental Diets:

Experimental diet ingredients were taken from local market. Before making diets these ingredients were chemically analyzed according to rules of AOAC (1995). The diets were formulated on the basis of plant origin (monounsaturated and polyunsaturated), animal origin (saturated and unsaturated) and combination of plant and animal origin dietary lipids. Each

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experimental diet formulated was made by supplementing different levels of lipids viz. 0%, 3%, 6% and 9% (El- Kasheif*et al.*, 2011).

Feeding Protocol and sample collection:

The fingerling was fed according to 2% of their wet body weight. 17 fingerlings were stocked in each experimental tank and duplicate tanks were given for each experimental diet. Fingerlings of *Catlacatla* was divided in 21 treatments which were given different percentages (3%, 6% and 9%) of animal, plant and combination of animal and plant origin lipids. After that un-consumed diets were collected from the tanks and tanks were washed and re-filled with fresh water. That un-consumed diet was dried in oven and was used in FCR determination.

T0 was the controlled treatment. Physicochemical water quality parameters were maintained throughout the trial period.

Proximate Composition Analysis:

Tissue samples of fish *Catlacatla*were examined by the standard techanique of AOAC (1995). Moisture content was calculated by dehydrating sample at 105^o C for 12 hours in oven. Crude protein was measured by micro kjeldahl method. Petroleum ether extraction method (Soxhlet method) was used for determination of crude fat (CF). Crude fiber was determined by loss in weight by igniting fat-free sample. This sample was made by digesting it with 1.25% H_2SO_4 and 1.25% NaOH. Carbohydrates were determined by deducting the crude protein percentage, crude fat percentage and crude fiber percentage from the dry matter. The composition of experimental diets were formulated based on animal origin, plant origin and combination of plant and animal origin dietary lipids given in table I (a, b, and c respectively) according to different lipid levels.

Table I (a): Composition of experimental diets with unsaturated and saturated animal-based lipids levels:

INGREDIENTS	Control	Animal lipids	Based In	Unsaturated diet	Animal lipids	Based in	Saturated diet
		3%	6%	9%	3%	6%	9%

Fish meal	45g	45g	45g	45g	45g	45g	45g
Fish oil	--	1.5g	3g	4.5g	--	--	--
Cod liver oil	--	1.5g	3g	4.5g	--	--	--
Beef Tallow	--	--	--	--	1.5g	3g	4.5g
Poultry fat	--	--	--	--	1.5g	3g	4.5g
Wheat Bran	29g	26g	23g	20g	26g	23g	20g
Rice Bran	24g	24g	24g	24g	24g	24g	24g
Ascorbic acid	1g	1g	1g	1g	1g	1g	1g
Vitamin & mineral mix	1g	1g	1g	1g	1g	1g	1g

Table I (b): Composition of experimental diets with Monounsaturated and Polyunsaturated plant-based lipids levels:

INGREDIENTS	**Control**	**Plant lipids Based in Monounsaturated Diet**			**Plant lipids Based in Polyunsaturated diet**		
		3%	**6%**	**9%**	**3%**	**6%**	**9%**
Fish meal	45g	45g	45	45g	45g	45g	45g
Canola oil	--	1.5g	3g	4.5g	--	--	--
Olive oil	--	1.5g	3g	4.5g	--	--	--
Sunflower oil		--	--	--	1.5g	3.0 g	4.5g
Soya bean		--	--	--	1.5g	3.0	4.5g

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oil						g	
Wheat Bran	29g	26g	23g	20g	26g	23g	20g
Rice Bran	24g	24g	24g	24g	24g	24g	24g
Ascorbic acid	1g	1g	1g	1g	1g	1g	1g
Vitamin & mineral mix	1g	1g	1g	1g	1g	1g	1g

Table I (c): Composition of experimental diets combination of (3%, 6% and 9%) plant with 3%, 6% and 9% animal-based lipid levels respectively

Plant Based lipids	**Control**	**3% canola oil + soybean oil**	**6% canola oil + soybean oil**	**9% canola oil + soybean oil**	**3% canola oil + soybean oil**	**6% canola oil + soybean oil**	**9% canola oil + soybean oil**	**3% canola oil + soybean oil**	**6% canola oil + soybean oil**	**9% canola oil + soybean oil**
(%) of diet		1.5 + 1.5 = 3	3 + 3 = 6	4.5 + 4.5 = 9	1.5 + 1.5 = 3	3 + 3 = 6	4.5 + 4.5 = 9	1.5 + 1.5 = 3	3 + 3 = 6	4.5 + 4.5 = 9
Animal based Fat		**Animal based Fat 3%**			**Animal based Fat 6%**			**Animal Based Fat 9%**		
Animal Based Fat	0.0g	3.0g	3.0g	3.0g	6.0g	6.0g	6.0g	9.0g	9.0g	9.0g

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Fish oil	0.0g	1.5	1.5g	1.5g	3g	3g	3g	4.5g	4.5g	4.5g
Poultry lipids	0.0g	1.5g	1.5g	1.5g	3g	3g	3g	4.5g	4.5g	4.5g
Fish meal	27.0g	26.0g	26.0g	26.0g	26.0g	26.0g	26.0g	24.0g	24.0g	24.0g
Rice bran	30.0g	28.0g	28.0g	28.0g	25.0g	25.0g	25.0g	24.0g	24.0g	24.0g
Wheat Flour	40.0g	40.0g	40.0g	40.0g	40.0g	40.0g	40.0g	40.0g	40.0g	40.0g
Ascorbic -acid	1g	1.0g	1.0g	1.0g	1.0g	1.0g	1.0g	1.0g	1.0g	1.0g
Vitamin Mineral	2g	2.0g	2.0g	2.0g	2.0g	2.0g	2.0g	2.0g	2.0g	2.0g

Growth performance and Feed utilization:

Growth performance was recorded by having weekly gross weights of fishes from each treatment. The body weight and length of fish individual were measured at the start of trial and fornightly to determine the increase in growth for consequent feed changes. Feed utilization was determined by collecting uneaten feed from the tanks of the fishes. Growth performance and feed

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utilization can be determined as an absolute weight gain (WG), weight gain (%), specific growth rate (SGR), survival rate (%) and feed conversion ratio (FCR).

Weight gain (%):

Weight gain was calculated by using formula:

$$\text{Weight gain \%} = \frac{\text{Final weight} - \text{Initial weight}}{\text{Initial weight}} \text{X100}$$

Absolute weight gain (AWG):

Absolute weight gain was measured by deducting the final weight from initial weight of fish.

Absolute weight gain (g) = Final weight (g) – Initial weight (g)

Feed conversion ratio (FCR):

Feed utilization was determined by calculating FCR.

$$\text{FCR} = \frac{\text{Total dry feed intake (g)}}{\text{Wet weight gain (g)}}$$

Statistical analysis:

Statistical analysis of data was made by operating ANOVA. Student Newman-Keuls test was performed for comparing means of data and probability was taken as $p < 0.05$ (Snedecor& Cochran 1991). Treatments are assembled along with sources and different levels of lipids in table II.

Table II: Following treatments were assembled according to origin of lipids and level of lipids:

T0	Control group	T11	6% plant based polyunsaturated dietary lipids (PBPU)
T1	3% animal based saturated dietary lipids	T12	9% plant based polyunsaturated dietary

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	(ABS)		lipids (PBPU)
T2	6% animal based saturated dietary lipids (ABS)	T13	3% animal based and 3% plant based dietary lipids (A3P3)
T3	9% animal based saturated dietary lipids (ABS)	T14	3% animal based and 6% plant based dietary lipids (A3P6)
T4	3% animal based unsaturated dietary lipids (ABUS)	T15	3% animal based and 9% plant based dietary lipids (A3P9)
T5	6% animal based unsaturated dietary lipids (ABUS)	T16	6% animal based and 3% plant based dietary lipids (A6P3)
T6	9% animal based unsaturated dietary lipids (ABUS)	T17	6% animal based and 6% plant based dietary lipids (A6P6)
T7	3% plant based monounsaturated dietary lipids (PBMU)	T18	6% animal based and 9% plant based dietary lipids (A6P9)
T8	6% plant based monounsaturated dietary lipids (PBMU)	T19	9% animal based and 3% plant based dietary lipids (A9P3)
T9	9% plant based monounsaturated dietary lipids (PBMU)	T20	9% animal based and 6% plant based dietary lipids(A9P6)
T10	3% plant based polyunsaturated	T21	9% animal based and 9% plant based dietary lipids

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	dietary lipids (PBPU)		(A9P9)

ABS (animal based saturated lipids), ABUS (animal based unsaturated lipids, PBMU (plant based mono unsaturated lipids), PBPU (plant based polyunsaturated lipids).

Results:

Growth Indices:

The effects of dietary fats from different sources in formulated diets on growth and feed utilization are presented in Table II. Table shows that growth of *Catlacatla* fingerlings was not only affected by dietary lipid concentration ($P < 0.05$) but also affected by the presence of animal or plant based source of lipid. As dietary lipid levels improved from 3% to 9%, either animal based or plant based, growth performance improved considerably but there was no additional improvement found at higher lipid level.

In comparison of animal and plant based lipid source, better growth was observed when *Catlacatla* were fed with diet having plant based PUFA. In present study, maximum weight gain was observed in T6 (48.58±17.44) fed with 9% animal based unsaturated fatty acids and significantly lowest growth (<0.05) was measured in T0 control group having no dietary lipids in their feed.

Treatment having diet of plant based PUFAs with a percentage of 9% showed greatest increase in body weight. Maximum body weight was observed in T9 (49.3±19.48) with plant based MUFA and least was calculated in T21 (37.15±11.64) (A9P9).

Results showed maximum total length in T2 (9.76±3.34) fed with 6% animal based saturated dietary lipids. Minimum total length was measured for T0 control group (6.63±2.00). Increased fork length was measured in T3 (9.86±3.25) with 9% saturated lipids (animal based) (ABS). And least was found in T7 (6.93±2.20) fed with diet having 3% plant based MUFA. The results demonstrated that feeding plant-based PUFAs to specimens had a good effect on growth metrics and was significantly different from other treatments.

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The control group was given protein diet without lipids and so the proteins could have been used for energy utilization rather than growth. Least growth was observed in control group T0.

FCR:

Significantly best FCR (< 0.05) value was observed for T9 (0.40±0.06) that was given 9% plant based MUFA. Reduced value of feed conversion ratio was recorded in T21 (1.05±0.69) for which a combination of animal based and plant based lipids were used in the diet (9% animal based+9% plant based). Growth indices of *Catlacatla*reared under treatments (T) getting different concentrations of dietary lipids are illustrated in table III.

Table III: Growth indices of *Catlacatla*reared under treatments (T) receiving different dietary lipids levels

Parameters	Maximum value	Minimum value
Average weight gain (g)	48.58±17.44	35.35±11.99
Average body weight (g)	49.3±19.48	37.15±11.64
Average final total length (cm)	9.76±3.34	6.63±2.00
Average final fork length (cm)	9.86±3.25	6.93±2.20
FCR	0.40±0.06	1.05±0.69

Discussions and conclusions:

Lipids are the finest energy constituent of feed and standardize body temperature. Fish prefer lipids over carbohydrates as an energy source since they are virtually edible (Cho &Kaushik, 1985). In addition to offering energy, dietary lipids are resources of necessary fatty acids. Dietary lipids affected flavor and consistency of fish diets and fish meat quality. Excess dietary lipids restrain fatty acid synthesis and limit the capacity of fish to metabolize the other nutrients leading to decreased growth. Excess lipids are also known to result in fatty fish and have negative impacts on the taste, consistency, and shelf life of final items.

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The current study advised the highest feasible lipid energy levels for maximum *Catlacatla* development, but also stated that there was no superiority between animal and plant-based dietary lipids. Results of this work may be helpful in preparing convenient diets that must meet our expenses.

During current experiment considerably greater growth performance, SGR and FCR were observed in T9 and T6 than other treatments and control which advocated that fish fed on plant based MUFA and animal based saturated lipids, performs finer than the rest of the combinations.

Fish growth and its related attributes are directly linked with quality and amount of their diet (Iqbal*et al*., 2014). The sparing effect of lipid has been used in feed manufacturing to formulate diets that diminish nutrient reservation while minimizing nutrient loss (Tacon, 1997). The optimal dietary lipid content for rohu growth was 9% (Gangadhar*et al*., 1997). Our present results are in accordance with that statement as *Catlacatla*(common carp) showed maximum growth at dietary lipid level of 9%.

The increasing levels of lipids to making meals containing 310–340 g kg crude protein had no discernible protein-saving benefits on the development of tilapia (*Oreochromisniloticus*). Therefore it was estimated that the low to medium fat diets were sufficient in meeting the fish's protein and energy requirements (Hanley, 1991). The results in this present work where growth was significantly high at 6% and 9% addition of lipids. Below and above these limits growth was curbed and not sufficiently sound.

El-Sayed&Teshima (1992) showed in his results that the *Oreochromisniloticus* given the diets having 30% protein and 40% depicted significantly enhanced weight. Kheir (1997) pointed out that fingerling of *Oreochromisaureus* grew to their maximum size on diets containing 6% lipid, then shrank when on a diet containing 8% dietary fat. Hassanen (1988) expressed that the dietary fat in formulated diets when enlarged from 3 to 6%, emerged to spare protein as revealed in greater protein deposition with higher fat level.

In the formulated diets, the lipid content must be retained at 9-10% while fulfilling necessary fatty acids (Paul &Giri, 2015). Fish when having elevated lipid diets, beyond a certain point, oxidation of membrane bound lipids can put a stress on growth (Hemre&Sandnes, 1999). The

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consequences of lipid oxidation may be to blame for fish development limitations when fed high-fat diets (Mishra &Samantaray, 2004).

Takeuchi found that adding 5% more maize oil or olive oil (plant-based) boosted are fed mixed diet. They consume more food. Their results recommended that presence of a feed consumption and development more than adding cod liver oil (animal based). The higher growth performance in fish might be explained by a balanced amount of n-3/n-6 fatty acids in the mixed diet, which is essential for better feed consumption and development in fish (Dalbir*et al*., 2015).

Dietary lipid levels may be raised to a point where undesirable effects such as lipid buildup in the body and impaired growth performance due to a shortage of critical nutrients due to decreased feed consumption may occur (Ali &Jauncey, 2005).

Hasan*et al*. (2005) also stated no significant changes between plant origin feed and animal origin feed in common carp. Our results indicated better positive effects on the growth and had considerably difference from other treatments. The Increased levels of supplementary feed for fish growth gave no more energy to the fish (Hanley, 1991). Feeding fish high-lipid diets beyond a certain point may put them under stress in terms of membrane-bound lipid oxidation (Hemre&Sandnes, 1999). Limited development with high-lipid feeds might be because of the consequences of lipid oxidation. Reduced total length and fork length was observed in treatments treated with diets low or no dietary lipids.

In common, sufficient fish development can be achieved if the diet meets all of the EFA demands. Warm-water freshwater fish have a well-known demand for both n-3 and n-6 polyunsaturated fatty acids (PUFA), and only n-6 fatty acids (Martino *et al*., 2002). So in our study, *catlacatla* showed requirement of plant origin polyunsaturated fatty acids supplementation in their formulated diets.

Long chain fatty acids are more digestible than short chain fatty acids. Rainbow trout can metabolize up to 100 percent of polyunsaturated fatty acids (Kaushik, 2004) and most commonly, the necessary PUFA exhibit the highest digestibility in this fish species (Kaushik,2004). *Catlacatla* also showed similar results as growth was enhanced when polyunsaturated fatty acids were added to artificial diets.

When Li *et al*. (2000) compared plant-based feed to animal-based feed, they found that plant based feed had a much higher FCR. The result of FCR revealed that utilization of formulated diet with 9% plant origin lipids had significantly best value. However, the lowest FCR was obtained in treatment having combination of mixed origin lipids in diet. Formulated diet exhibit a considerable rise in lipid value up to a certain level.

In current experiment, growth parameters, including weight gain, body weight, total length and fork length and FCR were significantly better in treatments fed with medium to high levels of dietary lipids in diet. This may indicate that excessive lipid may restrict protein consumption and consequently retard the growth. In fish diets, lipids supply necessary fatty acids (EFA) and energy. On the other hand, it seems that the 6% and 9% dietary lipid level improved digestion and absorption of nutrients which resulted in noticeable growth of *Catlacatla.* This study is helpful for aquaculture producers to select appropriate level of lipids in feed for *Catlacatla*in right amount to ensure efficient conversion of feed for maximum production.

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