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RESEARCH ARTICLE

Effect of Artificial Feed on Sensory Attributes of Flesh of Indian Major Carps (*Labeo rohita, Catla catla* and *Cirrhinus mrigala*) Fed in Monoculture and Polyculture Systems

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ABSTRACT

The study was designed to assess the impact of artificial feeding on sensory attributes of steamed fish at fingerling stage reared in monoculture while at grow-out stage reared both in mono and polyculture. The fingerlings of *Labeo rohita, Catla catla* and *Cirrhinus mrigala* fed on 40% protein feed showed non-significant effect on sensory attributes compared with control. Similar results were obtained in grow-out monoculture when fed on 35% protein. In polyculture the *C. mrigala* showed significantly ($P<0.05$) higher scores for color, oiliness and overall acceptability compared to control and other two species. All three species showed significant differences for flavor, and tenderness in polyculture compared to monoculture. The control fish in polyculture were slightly more yellowish resulting in increased hue angle values. It is concluded that the artificial feed can be used to enhance the growth performance at fingerling stage without interfering the overall sensory quality of fish.

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INTRODUCTION

Carps especially *L. rohita, C. catla* and *C. mrigala* are the indigenous species of South Asia and dominate the natural waters as well as cultivated in public and private sector (Khan *et al.,* 2004; Hussain *et al*., 2011). Due to environmental degradation of natural aquatic environment and increasing trend of semi-intensive aquaculture practices with supplementary feed has affected the taste and quality of fish flesh. Consumers have become accustomed to the taste of fish from natural waters and they have concerns about the farmed fish due to application of different inputs. Different factors like interspecies variation, intraspecific factors, and culture conditions affect the chemical composition and quality of farmed fish (Kilincceker and Kurt, 2010; Khan *et al.*, 2011; Nazish and Mateen, 2011).

Artificial feed play a significant role in the sustained development of aquaculture industry and may also affect the sensory acceptability of the finished food. Improvement of feed ingredients and nutritional quality in aquaculture practices may improve the sensory quality of the finished fish products (Shioya *et al.*, 2011; Yang *et al.*, 2011). Nutritional value, color, texture, smell and appearance, may all be affected by the quality of nutrition and feed provided during culture especially in semi-intensive and intensive culture systems (Khan *et al*., 2011). Some studies on these sensory attributes of fish flesh has been already conducted by various scientists with respect to water quality, nutritional treatments, artificial feeding (Oliveira *et al.,* 2006; Kilinc *et al.,* 2009; Ng and Bahurmiz, 2009; Sehgal *et al.,* 2010; Brinker and Reiter, 2011).

Some studies conducted on nutritional aspects of feed quality in Teleosts, such as dietary protein sources (Kaushik *et al.,* 1995; Rubbani *et al*., 2011) and amount of dietary fat content can influence the physical and organoleptic flesh quality (Bjerkeng *et al.,* 1997). Very little work has been conducted to evaluate the organoleptic quality of the fish flesh as affected by dietary protein level. The objective of this study was to evaluate the effect of artificial feed on sensory attributes of fingerlings of three species of Indian major carps in monoculture and their grow-outs both in mono and polyculture.

MATERIALS AND METHODS

Experimental site and study trials: The study was conducted in the Department of Fisheries & Aquaculture, University of Veterinary and Animal Sciences, Lahore, Ravi Campus Pattoki (Pakistan) using earthen ponds. The whole study consisted of three trials. The first trial was conducted on fingerlings (31.0 g) in monoculture system. Second and third trials were on their grow-outs (340 to 350 g) in monoculture and polyculture.

Pond preparation and stocking of experimental fish: Ponds having an area of 0.03 ha each were fertilized with organic cattle manure 90 kg/pond (3 tons/ha) (Sahu *et al.,* 2007) and 45 kg poultry manure, 2.5 kg single super phosphate and 1.5 kg urea/pond one week prior to stocking of experimental fish for the production of planktonic life followed by fortnightly application of same amount of organic and inorganic fertilizers. Afterwards, the ponds were filled with ground water up to 1.5 m depth and the experimental fish were stocked in the ponds.

The fingerlings of Indian major carps (*C. catla, L. rohita* and *C. mrigala*) were procured from Punjab Government Fish Hatchery, Chenawan, Gujranwala, Pakistan. The fish were randomly stocked to their respective ponds under monoculture system at 2666/ ha. The fish were fed twice a day at 4% body weight/ day with 40% protein (Table 1) by dusting method at 0900 and 1630 hours. Grow-out fish were collected from local Fish Hatchery and Farm and stocked in monoculture system at 2300/ ha while, in polyculture three species were stocked at ratio of 30:50:20 (2300/ ha) and were fed at 3% body weight/day with 35% protein (Table 1) using above mentioned method.

Table 1: Composition of experimental feeds

Ingredients	For Fingerlings (g kg^{-1})	For grow-out (g kg^{-1})
Fish meal	200	250
Soy bean meal	300	320
Canola meal	-	150
Maize gluten	240	-
Wheat bran	50	50
Rice polish	30	50
Maize grains	80	80
Molasses	80	80
Vitamins	10	10
Mineral mixture	10	10
Total	1000	1000

Sensory evaluation: Sensory evaluation was performed at the end of each trial. Five to seven fishes were collected through drag net from treated and control ponds of each culture system. The fish were gutted and cleaned with tap water. Equal sized small fillets (3 x 7.5 cm) with an average weight of 20-25 g were taken from each species and each experimental trail for further processing. The pieces were salted with one teaspoon common salt and steamed in oven at medium high temperature for ten minutes. The cooked samples were cooled at room temperature (23-25°C) and then presented to judges for evaluation.

Fillets were organoleptically evaluated by 12-membered semi-trained panelists from students and faculty from University of Veterinary & Animal Sciences, Lahore, Pakistan. The descriptors for various sensory attributes were defined as color; intensity of whitish/ creamish color, typical of steamed fish flesh, flavor; intensity of perceived taste of typical steamed fish flesh, juiciness; intensity of juiciness of steamed fish flesh while chewing, tenderness; intensity of softness perceived at the time of chewing, oiliness; intensity of oiliness that perceived taste of a typical steamed fish flesh and overall acceptability; Overall impression of the steamed fish flesh based on above attributes. On the day of evaluation, the samples were presented in all glass transparent quarter plates coded with three digit random number, along with mineral water to wash their mouth between the samples. The panelists were asked to rate their acceptance for above sensory attributes according to hedonic scale: 1= dislike extremely; 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neither like nor dislike; 6 = like slightly; 7 = like moderately; 8 = like very much; 9 = like extremely (Meilgaard *et al.,* 2007). Sensory tests for each trial were performed on the same date under white incandescent lights.

Instrumental color analyses for lightness, redness, yellowness, chroma and hue angle of fresh fish flesh cultured under mono and polyculture systems were performed with a Minolta Color Meter (Model: PCM/PSM S# 3001330, Color-Tec, USA). Three pieces from each species were taken and three measurements were made directly on each piece by rotating at right angle for lightness, redness and yellowness values, however, chroma and hue angel were calculated from redness and yellowness values.

Statistical analysis: The data were analyzed by applying completely randomized block design (RCBD) through analysis of variance technique (ANOVA). Mean values were compared using LSD and DMRt. The significance was defined as $P \leq 0.05$. The analysis was performed using Cohort Software version 6.303 (Co-stat 2003).

RESULTS

Color evaluation of raw fish flesh: Mean values for hunter color, chroma and hue angle of grow-out raw fish flesh reared in monoculture for different species are illustrated in Table 2. The values of lightness were significantly higher ($P = 0.0013$) for *L. rohta* in control ponds than treated group. The difference was non-significant for lightness in *C. catla* and *C. mrigala* in both treatments. There was non-significant difference for redness, yellowness, chroma and hue angle, among species and treatments.

In polyculture, *C. mrigala* was found to be significantly higher ($P=0.0020$) for lightness in control group than treated while other two species *C. catla* and *L. rohita* showed non-significant differences between treatments. The values of redness, yellowness, chroma and hue angle in polyculture system were also found non-significant among species and treatments (Table 2).

Sensory evaluation of fish flesh: The values (Mean±SD) for color, flavor, juiciness, tenderness, oiliness, and overall quality showed non-significant difference between treatments (treated and control) for fingerlings (Table 3). Table 4 shows the mean values for different sensory

Table 2: Hunter color values of grow-out raw fish flesh reared under mono and polyculture systems

Species and Color Parameters	Monoculture			Polyculture		
	Treated (D2)	Control	P value	Treated (D2)	Control	P value
L						
C. mrigala	36.66± 0.54[a]	36.71± 0.30[a]	0.9023	33.49±0.50[a]	33.81±0.59[b]	0.0020
L. rohita	33.18± 0.43[a]	37.22± 0.75[b]	0.0013	33.25±0.29[a]	33.16±0.50[a]	0.7916
C. catla	36.83± 0.51[a]	36.54± 0.57[a]	0.5554	32.60±0.56[a]	33.34±0.34[a]	0.1227
Mean	36.19[a]			33.27[b]		
A						
C. mrigala	-4.62± 0.34[a]	-4.57± 0.19[a]	0.8559	-4.62±0.38[a]	-4.51±0.46[a]	0.9436
L. rohita	-4.70± 0.07[a]	-4.78± 0.64[a]	0.8533	-4.57±0.40[a]	-4.61±0.20[a]	0.8753
C. catla	-5.30± 0.53[a]	-4.61± 0.52[a]	0.1806	-5.01±0.21[a]	-4.75±0.50[a]	0.4509
Mean	-4.67[a]			-4.76[a]		
B						
C. mrigala	9.15±0.56[a]	8.44±1.09[a]	0.3740	8.97±1.21[a]	9.38±0.34[a]	0.8726
L. rohita	7.81±0.92[a]	7.42±0.99[a]	0.6413	5.64±1.31[a]	7.43±0.75[a]	0.1093
C. catla	7.19±1.11[a]	6.56±0.69[a]	0.4538	7.02±0.90[a]	6.05±0.49[a]	0.1765
Mean	7.76[a]			7.41[a]		
Chroma						
C. mrigala	-0.96± 0.01[a]	-0.95±0.02[a]	0.3295	-0.96±0.012[a]	-0.97±0.010[a]	0.6433
L. rohita	-0.93± 0.03[a]	-0.91±0.01[a]	0.4989	-0.83±0.075[a]	-0.92±0.035[a]	0.1565
Catla catla	-0.87± 0.05[a]	-0.89±0.02[a]	0.5734	-0.88±0.026[a]	-0.85±0.060[a]	0.5216
Mean	-0.90[a]			-0.91[a]		
Hue angle						
C. mrigala	10.25± 0.65[a]	9.61±0.99[a]	0.4043	9.98±1.21[a]	10.09±0.48[a]	0.8802
L. rohita	9.12±0.76[a]	8.82±1.18[a]	0.7305	7.29±1.12[a]	8.76±0.53[a]	0.1103
C. catla	8.96±0.95[a]	8.02±0.84[a]	0.2689	8.63±0.84[a]	7.70±0.28[a]	0.1453
Mean	9.13[a]			8.81[a]		

* Figures with different superscripts in rows differ significantly (P≤0.05) in each culture system.

Table 3: Sensory attributes of fingerlings steamed fish flesh reared under monoculture

Species	Treated (D1)	Control (D0)	P value
Color			
C. mrigala	7.00±1.28[a]	7.25±1.36[a]	0.6469
L. rohita	6.83±1.19[a]	7.00±1.28[a]	0.7445
C. catla	7.00±1.35[a]	6.67±1.15[a]	0.5221
Flavor			
C. mrigala	6.25±1.48[a]	6.92±0.79[a]	0.1839
L. rohita	6.50±1.24[a]	6.83±1.27[a]	0.5221
C. catla	6.75±1.36[a]	6.75±0.97[a]	1.0000
Juiciness			
C. mrigala	5.92±1.62[a]	6.50±1.17[a]	0.3229
L. rohita	6.67±1.23[a]	6.33±1.44[a]	0.5477
C. catla	6.33±1.30a	6.50±1.31a	0.7580
Tenderness			
C. mrigala	6.58±1.38[a]	6.50±0.67[a]	0.8525
L. rohita	6.25±1.06[a]	6.58±1.31[a]	0.4999
C. catla	6.67±1.30[a]	6.42±1.38[a]	0.6525
Oiliness			
C. mrigala	6.25±1.42[a]	6.33±1.44[a]	0.8877
L. rohita	6.42±0.90[a]	5.92±1.24[a]	0.2706
C. catla	6.67±1.44[a]	6.25±1.36[a]	0.4726
Overall Acceptability			
C. mrigala	6.67±0.78[a]	7.25±0.97[a]	0.1174
L. rohita	6.67±1.37[a]	6.67±0.98[a]	1.0000
C. catla	7.17±1.19[a]	6.67±0.89[a]	0.2567

* Figures with different superscripts in rows differ significantly (P≤0.05).

attributes of grow-out steamed fish in mono and polyculture systems. Results revealed non-significant variation for various sensory attributes such as color, flavor, juiciness, tenderness, oiliness and overall acceptability in case of monoculture. In polyculture, the values for color (P=0.0150), oiliness (P=0.0011) and overall acceptability (P=0.0126) showed significantly higher scores for *C. mrigala* in control when compared with treated group (Table 4). *C. catla* and *L. rohita* revealed non-significant differences for any of the above mentioned sensoric attributes in polyculture (Table 4).

The comparison of sensory scores for various attributes among grow-out fish reared under monoculture and polyculture systems is illustrated in Table 4. The results revealed significantly higher scores (P≤0.05) for flavor and tenderness (P=0.0135) in polyculture when compared with monoculture.

DISCUSSION

It was observed that culture system and treatment significantly affected the lightness while, non-significant effect was observed for rest of the parameters. The studies of Grigorakis *et al.* (2003) supported our results that cultured fish showed more whiteness than wild fish which may be due to higher fat contents. In present study minor variations regarding treatments were observed for lightness, redness and yellowness. Bjerkeng *et al.* (1997) reported higher lightness, redness and yellowness values in Atlantic salmon (*Salmo salar*). Collins *et al.* (2011) evaluated the effect of linseed oil with vitamin E, butylated hydroxytoluene and lipid encapsulation on objective color parameters in rainbow trout and reported higher redness and yellowness values of fish flesh fed on fish oil compared to fish fed any of the linseed oil.

The results regarding sensory evaluation of fish flesh are in accordance with the findings of Hassan (1996) who studied the organoleptic characteristics of Indian major carps and found non-significant differences among species for taste and overall quality when reared under different organic manures and artificial feeding. Brinker and Reiter (2011) replaced fish meal by plant protein substitution and guar gum addition in trout feed. They reported that flesh quality parameters revealed slight differences between treatments, without any significant alteration in organoleptic quality. Mathis *et al.* (2003) observed no effects of feed with respect to physiological or sensory properties of the fish flesh of Eurasian perch (*Perca fluviatilis*). Nandeesha *et al.* (2000) incorporated non-defatted silkworm larvae (pupae) in the diet of farmed carp (*Cyprinus carpio*) and reported non-significant differences in aroma, texture and flavor of carp

Table 4: Sensory attributes of steamed grow-out fish flesh reared under mono and polyculture

Species and Sensory attributes	Monoculture			Polyculture		
	Treated (D2)	Control	P value	Treated (D2)	Control	P value
Color						
C. mrigala	6.83±1.02[a]	6.83±1.19[a]	0.4548	5.33±1.87[a]	7.00±1.12[b]	0.0150
L. rohita	7.00±1.04[a]	6.66±2.01[a]	0.6160	6.00±1.04[a]	6.25±0.96[a]	0.5488
C. catla	6.83±1.02[a]	7.08±1.08[a]	0.5683	7.25±0.75[a]	6.91±1.08[a]	0.3912
Mean	6.87[a]			6.45[b]		
Flavor						
C. mrigala	6.00±1.53[a]	6.83±1.33[a]	0.1705	5.83±1.46[a]	7.00±1.53[a]	0.0704
L. rohita	6.08±1.56[a]	6.00±2.04[a]	0.9117	6.41±0.99[a]	5.66±1.30[a]	0.1274
C. catla	6.75±1.95[a]	6.25±2.09[a]	0.5521	7.00±1.41[a]	6.5±1.24[a]	0.3676
Mean	6.31[b]			6.40[b]		
Juiciness						
C. mrigala	5.91±1.56[a]	6.25±1.48[a]	0.5977	5.91±1.50[a]	6.83±0.93[a]	0.0871
L. rohita	5.91±1.16[a]	6.75±1.13[a]	0.0901	6.25±1.71[a]	5.83±1.11[a]	0.4873
C. catla	6.16±1.85[a]	5.66±1.87[a]	0.5177	6.5±1.16[a]	6.5±1.44[a]	1.0000
Mean	6.11[c]			6.30[c]		
Tenderness						
C. mrigala	5.83±1.89[a]	6.25±1.35[a]	0.8525	5.83±1.94[a]	7.00±1.20[a]	0.0914
L. rohita	6.58±1.56[a]	6.25±1.37[a]	0.4999	6.16±1.69[a]	6.00±1.20[a]	0.7841
C. catla	6.66±1.80[a]	6.41±1.90[a]	0.6525	6.16±1.58[a]	6.08±1.50[a]	0.8962
Mean	6.04[a]			6.20[b]		
Oiliness						
C. mrigala	5.75±1.13[a]	6.08±1.24[a]	0.4999	5.50±1.24[a]	7.33±1.15[b]	0.0011
L. rohita	6.08±1.16[a]	5.91±1.37[a]	0.7521	5.91±1.62[a]	5.83±1.52[a]	0.8981
C. catla	6.25±1.42[a]	5.91±2.02[a]	0.6449	6.33±2.05[a]	6.16±1.26[a]	0.8135
Mean	6.00[a]			6.18[a]		
Overall acceptability						
C. mrigala	6.66±1.23[a]	7.08±1.16[a]	0.4035	6.08±1.16[a]	7.41±1.24[b]	0.0126
L. rohita	6.33±1.23[a]	6.5±2.06[a]	0.8126	6.50±1.16[a]	6.25±1.21[a]	0.6125
C. catla	6.58±1.62[a]	6.41±2.10[a]	0.8302	6.91±1.31[a]	6.33±1.23[a]	0.2733
Mean	6.59[a]			6.58[a]		

* Figures with different superscripts in rows differ significantly (P≤0.05) in each culture system.

flesh between control and treatment groups. Similar non-significant findings have also been reported by Martins *et al.* (2011), while evaluating the effect of partial replacement of fish oil by flaxseed oil on sensory quality of fish flesh.

In polyculture the artificial diet significantly affected the color, oiliness and overall acceptability of *C. mrigala* in treated ponds compare to *C. catla* and *L. rohita*. In this case our results are in harmony with the findings of Javed *et al.* (1995) who found significant differences among the taste scores of three fish species *C. catla*, *C. mrigala* and *L. rohita*. Such differences among species in the same culture condition and artificial feed might be due their different feeding niches and genetic makeup.

Conclusion: The flesh quality of fingerlings and their grow-outs was not affected by artificial feed in monoculture while, the grow-outs when cultured in polyculture showed some effects in color, oiliness and overall acceptability in *C. mrigala*.

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