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Effect of Artificial Diet and Culture Systems on Sensory Quality of Fried Fish Flesh of Indian Major Carps

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Abstract.- Two 90 days experimental trials were conducted to evaluate the effect of artificial diet (35% protein) on sensory quality of yearlings of Indian major carps (*Labeo rohita, Cirrhinus mrigala and Catla catla*). Experimental diet was given at 3% of fish wet body weight per day. After 90 days trial organoleptic study of fried fish was carried out by twelve panelists using hedonic scale for each species from treated and control ponds. In monoculture, C*atla catla* showed significantly higher score for flavour in treated ponds than control. *Labeo rohita* was found to be significantly different for juiciness and tenderness scores in treated ponds versus control. However, sensory scores of fried *Cirrhinus mrigala* did not exhibit any difference between treatments. In polyculture system, *Cirrhinus mrigala* was found to be significantly different with respect to sensory colour, tenderness, oiliness and over all acceptability in control than treated ponds. However, there were no differences in organoleptic quality of fried fish for *Catla catla* and *Labeo rohita* in polyculture system. It can be concluded from the present investigation that artificial diet can improve the sensory quality in monoculture system while in polyculture it has affected the flesh quality especially of bottom feeding fish *(Cirrhinus mrigala)* for various sensory attributes.

Key Words: Indian major carps, organoleptic/ sensory quality, artificial feed, semi-intensive system.

INTRODUCTION

Fish is considered a very nutritious food and it is one of the main sources of protein providing 26.2% of animal meat and is a growing food source in Asia and in developing countries (Delgado *et al.,* 2002; Louka *et al.,* 2004). Indian major carps, such as the catla, *Catla catla*; rohu, *Labeo rohita*; and mrigal, *Cirrhinus mrigala*, are the main candidate species of South Asia and is known to fish farmers in pond culture system since longtime (Chaudhuri *et al.*, 1974). Polyculture of these species results highest per acre production. This is mainly due to their compassionate behavior living together in same pond without competition (Ali, 1999).

Fish products provide excellent protein due to their balanced amino acid profile and protein digestibility that ranges from 85-90% (Rudolf, 1971; Choo and Williams, 2003; Astawan, 2004). Nevertheless, nutrition and artificial feeding play an important role in the sustained development of aquaculture. Improvement of feed and nutrition in aquaculture practices may provide an opportunity to further enhance the quantity as well as the nutritional quality of the fish.

Nutritional quality and organoleptic acceptability in terms of colour, texture, smell, flavour and appearance may be affected by the environmental degradation and quality of nutrition and feed provided during culture especially in semi-intensive and intensive culture systems compared to wild fish (Thomas, 1973; Grigorakis *et al.,* 2003). The attributes of off-flavour of fresh water fish reared under different water qualities and nutritional treatments was reported by Meyers (1975) with special reference to consumer acceptance other than conventional individual characteristics such as flavour, taste and appearance.

The data on organoleptic quality and consumer acceptability of fish flesh fed on variable dietary protein quantity and quality is scanty, however, there are quite a few studies on fish flesh quality with various other dietary ingredients. Studies on rainbow trout (Smith *et al.,* 1988) or yellowtail by Viyakarn *et al.* (1992) when fed soybean protein as partial substitute for fish meal

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did not exhibited any significant effect on flesh quality. In addition, studies on teleost fish have shown that nutritional factors, such as dietary protein sources (Kaushik *et al.,* 1995), manured and commercial diet (Moav *et al.,* 1977), fat sources (Guillou *et al.,* 1995), dietary fat content (Bjerkeng *et al.,* 1997), and vitamin E (Boggio *et al.,* 1985) can influence the physical and organoleptic flesh quality. Javed *et al.* (1995) observed significant differences for taste scores among *C. catla, L. rohita* and *C. mrigala* when cultured under different inorganic (N:P:K, 20:20:03) and organic fertilizers such as, broiler and layer droppings, cow dung, artificial feed and the control. The objective of this study was to evaluate the effect of artificial diet (35% protein) on the sensory quality of yearlings of Indian major carps flesh cultured in mono and polyculture system with same diet and feeding regimes.

MATERIALS AND METHODS

Location, study trials and design

The study was conducted at Research and Training Facilities, Department of Fisheries and Aquaculture, University of Veterinary and Animal Sciences (UVAS), Lahore, Ravi Campus Pattoki (Pakistan) using earthen ponds. The grow-out fish (yearlings) of Indian major carps (*L. rohita, C. mrigala* and *C. catla*) with average body weight 350.0 g were reared under monoculture and polyculture systems. Experimental fish species in both the trails were fed with 35% protein diet. The culture started from 1st September and was terminated on 30th November, 2009, during this period the water temperature varied from 21-30°C.

Pond preparation

Earthen ponds having an area of 0.03 ha each were prepared with the application of organic manure; cattle manure 90 kg pond^{-1} (3 ton ha^{-1}) (Jena and Das, 2006; Sahu *et al.,* 2007) and poultry manure 45 kg pond^{-1} (1.5 ton ha^{-1}) one week prior to stocking for the production of planktonic life. Afterwards, the ponds were filled with ground water up to 1.5 m depth and the experimental fish was stocked in the ponds. The same amount of cattle dung and poultry manure (90 and 45 kg pond^{-1}, respectively) along with 2.5 kg single super phosphate and 1.25 kg urea were applied fortnightly throughout the study period. Water level was maintained throughout the trials with application of fresh water, whenever needed.

Procurement and stocking of experimental fish

The experimental fish were collected from the Hatchery and Farm, Department of Fisheries and Aquaculture, Ravi Campus, UVAS, Pattoki. In monoculture, each species of fish were stocked at 2300 individual ha^{-1}. In polyculture, three species were stocked at ratio of 50 (*L. rohita*): 30 (*C. catla*): 20 (*C. mrigala*) fish pond^{-1} (3333 ha^{-1}). Fish were fed experimental diet at 3% of body weight day^{-1}. The same protocol was adopted for control fish (except for artificial feeding). The fish on experimental diet were fed twice a day by dusting method at 0900 and 1430 hours. The stocking ratio in polyculture system varies according to the carrying capacity of the system, regions, combination of species, and objective of farmer and demand of the local market (Ali, 1996).

Sample collection and preparation

After 90 days of the experimental trial, the fish were caught both from treated and control ponds by using drag nets. Five to seven fish samples from each treated and control ponds cultured under both systems were taken. The fish were gutted and washed with tap water. Equally sized small fillets with skin 3 cm x 7.5 cm with an average weight of 20-25 g were obtained for each species and each experimental trail for further preparation. The pieces were salted and marinated using one teaspoon common salt and fish spices. The marinated fish samples were frozen for two days in commercial small freezer at -21°C. Frozen samples were then defrosted and fried in cooking oil for ten minutes on stove and cooled to room temperature (25-27°C).

Organoleptic/sensory evaluation

Fillets were presented to 12 semi-trained panelists in transparent cups coded with three digit random number, along with distilled water to wash their mouth between the samples. The descriptors for various sensory attributes were defined (Table I)

and the panelists were asked to rate their acceptance for color, flavor, juiciness, tenderness, oiliness and overall acceptability 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). The panelist age ranged from 23 to 56 years (including three women) and regularly took fish in their usual diet, they were selected from students (8) and faculty members (4) of the UVAS, Lahore, Pakistan.

Table I.- Description of sensory attributes used for the fried fish flesh evaluation.

Attributes	Description of attributes
Colour	Intensity of "whitish"/"creamish" color, typical of fried fish flesh
Flavour	Intensity of perceived taste of typical fried fish flesh
Juiciness	Intensity of juiciness of fried fish flesh while chewing
Tenderness	Intensity of "softness" perceived at the time of chewing
Oiliness	Intensity of oiliness that perceived taste of a typical fried fish flesh
Overall acceptability	Overall impression of the fried fish flesh based on above attributes

Statistical analysis

The data were analyzed by applying completely randomized block design (RCBD), analysis of variance technique (ANOVA) while considering the mono and polyculture systems as blocks (Steel *et al.,* 1997). The comparison of means or significant difference was done using Duncan Multiple Range test (DMRt). The statistical significance was defined as $P \leq 0.05$. All the statistical analysis was performed using Cohort Software version 6.303 (Co-stat 2003).

RESULTS

In monoculture system significant variation (P=0.0454) was observed in flavour perception for *C. catla* while, juiciness (P=0.0581) and tenderness (P=0.0063) scores of *L. rohita* showed significant difference with artificial feeding as compared to control (Table II). Treated samples showed significant higher sensory quality versus control for the said attributes in both, *C. catla* and *L. rohita*. In *Cirrhinus mrigala* non-significant differences ($P \geq 0.05$) were observed for sensory quality among both treatment groups.

In polyculture system non-significant differences ($P \geq 0.05$) were observed in *C. catla* and *L. rohita* reared on artificial feed and control while, *Cirrhinus mrigala* showed variation for colour (P=0.0190), tenderness (P=0.0318), oiliness (P=0.0000) and overall acceptability (P=0.0009) which was found significantly higher in control than treated ponds (Table II).

The comparison of sensory scores for various attributes among fish reared under monoculture and polyculture systems is illustrated in Figure 1. The statistical analysis depicted significantly higher scores ($P \leq 0.05$) for tenderness (P=0.0135) in polyculture in comparison to monoculture system while, colour, flavour, juiciness, oiliness and overall acceptability of fried fish as judged by panelists was found to be non-significant ($P \geq 0.05$) between two culture systems (Fig. 1).

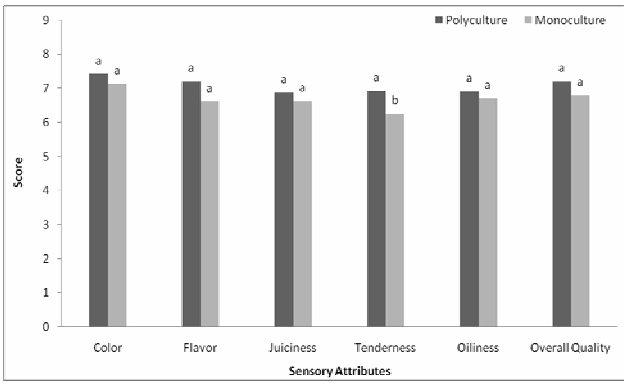

Fig. 1. Comparison of sensory attributes of grow-out fried fish flesh of monoculture and polyculture system (figure with different letters are significantly different $P \leq 0.05$).

DISCUSSION

The fried fish flesh for different sensory attributes evaluated for treated and control groups in both the culture systems (mono and polyculture) revealed some significant differences in monoculture trial for flavour in *C. catla,* juiciness and tenderness in *L. rohita* in treated compared to

Table II.- Sensory attributes of grow-out fried fish flesh in monoculture and polyculture systems.

Attributes	Species	Monoculture system		Polyculture system	
		Treated	Control	Treated	Control
Colour	*Cirrhinus mrigala* (Mori)	7.00±0.95*	7.25±1.05	6.91±0.79*	7.66±0.65
	Labeo rohita (Rohu)	7.58±0.66	7.25±0.96	7.41±0.90	7.41±0.66
	Catla catla (Thaila)	7.66±0.65	7.41±0.65	7.5±0.90	7.75±0.75
Flavour	*Cirrhinus mrigala* (Mori)	6.66±1.370	6.58±0.99	7.00±0.73	7.41±1.083
	Labeo rohita (Rohu)	7.41±0.79	6.91±0.90	7.33±1.15	7.08±0.99
	Catla catla (Thaila)	7.16±1.19*	6.16±1.11	7.08±0.90	7.41±0.90
Juiciness	*Cirrhinus mrigala* (Mori)	6.33±0.98	6.91± 0.79	6.83±0.93	7.33±0.88
	Labeo rohita (Rohu)	7.16±0.71*	6.41±1.08	6.91±0.79	6.83±0.71
	Catla catla (Thaila)	6.75±1.21	6.33±0.65	6.83±0.93	6.91± 0.79
Tenderness	*Cirrhinus mrigala* (Mori)	6.33±0.98	6.91± 0.79	6.58±0.66*	7.25±0.75
	Labeo rohita (Rohu)	7.16±0.71	6.41±1.08	6.91±0.79	6.91±0.79
	Catla catla (Thaila)	6.75±1.21	6.33±0.65	6.5±1.44	7.33±1.07
Oiliness	*Cirrhinus mrigala* (Mori)	6.66±0.88	6.75±0.75	5.66±0.77*	7.41±0.90
	Labeo rohita (Rohu)	7.16±0.83	6.50±1.00	7.08±0.99	6.75±0.75
	Catla catla (Thaila)	6.91±1.08	6.41±0.79	6.91±0.90	7.00±0.85
Overall acceptability	*Cirrhinus mrigala* (Mori)	6.66±1.15	6.91±0.79	6.66±0.49*	7.58±0.66
	Labeo rohita (Rohu)	7.5±0.79	6.91±0.90	7.33±0.65	7.08±0.66
	Catla catla (Thaila)	7.08±1.31	6.66±0.77	7.08±0.99	7.41±0.90

control group while non-significant differences were noticed in *Cirrhinus mrigala.* The significant differences for flavour in *C. catla* and juiciness and tenderness in *L. rohita* might be due to the effect of artificial feed and fat contents (40 g kg^{-1} of dry diet) that might have enhanced these sensory characters. Hassan and Javed (2000) also reported sensory variability with respect to taste scores for Indian major carps (*L. rohita, C. catla* and *Cirrhinus mrigala*); higher taste scores for fish in ponds fertilized with different ratio of poultry manure compared to control ponds. In polyculture system, no significant differences were observed in *C. catla* and *L. rohita* for different sensory attributes between treatments while, *Cirrhinus mrigala* showed significant higher scores for colour, tenderness, oiliness and overall acceptability in control ponds as compared to treated ones. *Cirrhinus mrigala* is detritus feeder and feed mostly on bottom to consume decaying organic matter, while *C. catla* is surface feeders and *L. rohita* is column feeder. Both these species preferred to feed on zooplankton and phytoplankton. This difference in *Cirrhinus mrigala* might be due the accumulation of uneaten artificial feed in treated ponds that along with decaying matter affect the above mentioned attributes of fish in treated ponds. The results of present study are in harmony with the findings of Javed *et al.* (1995) who reported significant differences among the taste scores of three fish species *C. catla*, *Cirrhinus mrigala* and *L. rohita* reared under inorganic fertilizers (N:P:K) and combination of organic manure (poultry and cow dung) and artificial feed. Allen and Hepher (1979) reported that fish reared in domestic waste treated ponds illustrated good taste than fish reared in waste free ponds. Culture system showed significant difference for tenderness while other attributes exhibited numerically higher scores in polyculture than monoculture system. Not evidently clear but such difference might be due to their niche specificity that results in efficient utilization of both natural and artificial feed at all level of ponds in polyculture versus monoculture system that exerted some changes in sensory attributes especially in tenderness. Comparison of species also indicated

some differences for flavour, juiciness and tenderness that might be due to variation in their composition and feeding niche. Our results are also supported by the findings of Hassan (1996); Jayaram *et al.* (1980) and Tahir (2008), they 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 feed. Similarly, Bjerkeng *et al.* (1997) also observed non-significant differences in over all quality with the fish fed high fat (HF) or medium fat (MF) diets.

CONCLUSIONS

It has been concluded from the present study that artificial feed improved some sensory attributes, like flavour, juiciness and tenderness thereby, increasing the overall acceptability of the finished product. Organoleptic quality of fish reared under polyculture system was higher only for tenderness, while non-significant for others compared to monoculture. However, this study was limited up to sensory characteristics; further study needs to be done on species chemical composition, volatile compounds and impact of natural feed on sensory attributes.

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