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Evaluation of sensory and proximate properties of reservoir grown tilapia (*Oreochromis niloticus*) and cage cultured genetically improved farmed tilapia (gift)

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Abstract
Sensory and nutritional properties of GIFT reared in cages installed at Kattakaduwa reservoir, Hambantota District, Sri Lanka over O. niloticus caught from the same reservoir was compared**.** Cage cultured fish were fed with four different formulated diets having 26% and 30 % protein content and each diet having 12% and 8% lipid content in their feed. Three fish from each sex having 200-250 g were collected from each treatment as well as from the reservoir. A trained panel evaluated five sensory characteristics; overall acceptance, flavour, juiciness, oiliness and tenderness of the steam cooked fish fillets. Sensory scores were assessed through Friedman non parametric and proximate data were assessed through one way ANOVA. Cage cultured fish in all treatments obtained higher scores for flavour indicating better taste and the values were significantly different ($p < 0.05$) from the fish captured from the reservoir. Overall acceptance of fish fillets with lower fat content (8%) showed no significant difference with reservoir fish. In contrast, fish fed with higher fat content (12%) acceptance was significantly different when compared to reservoir fish. Protein, lipid, dry matter and ash contents were significantly different ($p < 0.05$) among four formulated diets. Reservoir grown fish recorded lowest values for all proximate parameters and were significantly different ($p < 0.05$) from all cage culture treatments. Present study reveals that GIFT raised in cages with supplementary feed rich with fat irrespective of protein levels, gives better flavour and acceptance than O. niloticus that feed on naturally available food in reservoir.

Keywords: GIFT, *O. niloticus*, sensory, flavour, proximate analysis, cage culture.

1. Introduction
The acceptance of fish or fishery products by the consumers depends on several attributes of fish quality. They are nutrient content, microbial load, and biochemical and physiochemical properties like flavour, texture, odor and colour [2]. Key factors that affect the chemical and sensory properties of both wild and cultured fish are endogenous and exogenous factors. Species, sex, size, age and strain of the fish are the major endogenous factors of fish and feeding, nutrition, seasonal variation, environmental factors, culture practices and processing conditions are the exogenous factors [7]. Tilapia is known to be an omnivorous and/ or herbivorous fish species which can be raised on wide variety of natural food low down the food chain [11] as well as on artificial feeds. Genetically Improved Tilapia is known to be a fast growing strain of *O. niloticus* which is widely used in variety of culture systems in Asia [5]. Culture of tilapia has been well established in both in extensive and cage culture systems in countries like, China, India, Bangladesh, The Philippines, Thailand and Vietnam [15]. Cage culture is not a well-established aquaculture practice in Sri Lanka. Having large number of reservoirs scattered in Sri Lanka, cage culture is one of the best options for development of aquaculture in inland waters. Under fisheries and aquaculture development plan of the government of Sri Lanka, aquaculture has given a high priority (http://www.naqda.gov.lk). As such to promote the cage culture, the nutritional and flesh quality of fish reared in cages should be revealed. Present study was carried out with that aim and the objectives of the study were to compare the sensory characteristics and chemical composition of tilapia (GIFT) reared in cages established in a reservoir with the tilapia (*O. niloticus*) grown under natural conditions in the same reservoir.

2. Materials and Methods

Four formulated diets containing fish meal, soya bean meal, maize, coconut poonac, rice bran and mixture of vitamin and mineral were prepared. Diets were formulated to contain 26% and 30% crude protein levels and each protein levels formulated at two fat level 8% and 12%. Ingredient percentages used for each diet are described in Table 1. All ingredients were ground, mixed, watered and the fillets were prepared by filleting machine and finally air dried in sun light. Feeds were stored in room temperature in polythene bags. The study was carried out in a perennial reservoir at Kattakaduwa in Hambantota District. Sixteen cages each with dimensions (1 m X 1 m X 2 m) made of 2 mm nylon mesh were used. Each treatment was tested in four replicate after randomly stocking GIFT fingerling at a 75/ m^{-3} stocking density with an average weight (2.94 ± 1.47 g). They were fed according to standards described by Schmittou (2006) for 120 days.

Table 1: Percentage ingredient composition of four formulated experimental diets

Ingredients in %	Diet A	Diet B	Diet C	Diet D
Fish meal (local)	20	20	25	25
Soya bean meal (Indian)	20	20	27	27
Coconut poonac	20	20	20	20
Maize	26	4	18	3
Rice polish	13	34	9	24
Vitamin & mineral pre mix	1	1	1	1
Vitamin E	-	1	-	1

End of the study period of 120 days, six GIFT fish (3 male and 3 Female) with average weights 200 - 225 g were randomly selected from each treatment. In parallel six *O. niloticus* averaging 200 – 250 g captured from the reservoir. Fish were sacrificed by immersing in chilled water, skinned and filleted. Fresh fillets were stored in –18 ^{0}C in sealed freezer bags. The sensory analysis was carried out at sensory lab in Department of Zoology, University of Ruhuna. Frozen fish fillets were thawed to room temperature and cut into pieces to contain about 10 g in size and wrapped in food grade aluminum foil. Fish samples were steam cooked for 10 minutes without adding any spices. Each sample was coded with three digit number and the samples were randomly placed in serving plates and presented to the panelists. A clean water bottle was supplied to each panelist to rinse mouth between each sample testing. Fifteen panelists age ranging from 26 to 40 years were selected based on frequency of fish consumption. They were pre-trained for the sensory properties; flavour, juiciness, tenderness and overall acceptability using modified five point hedonic scale for taste described by Eyo (2001) [6] for tilapia fish. A questionnaire was supplied to each assessor asked to taste samples randomly then to rate the samples on sensory properties described using 5 point hedonic scales (1-5 intensity scale with 1 = bad quality and 5 = excellent quality). Four sensory evaluation tests were conducted in two different sessions as described in Table 2. Proximate analysis was conducted for composite samples of fish fillets at the Department of Zoology laboratory in University of Ruhuna. Protein, fat, ash, dry matter and moisture content were determined in fish samples using approved methods described by Anon (2000). Data of proximate analysis were subjected to one way analysis of variance (ANOVA) and sensory data were analyzed for Friedman non parametric test in SPSS version 16. The significance level was assessed at $p = 0.05$.

3. Results

Reservoir captured Nile tilapia fish had the lowest scores for all indicators of flesh quality. There were significant difference ($p < 0.05$) in scores obtained for the flavour of the captured fish from the reservoir and the fish fed with formulated diets (Table 2). There was no significant difference in juciness between reservoir and cage cultured fish. Oiliness was significantly different only in female fish groups tested. Fish fed with high fat level diets (12%) gained higher scores for overall acceptance (Table 2) both in males and females groups when compared to that with reservoir fish. The fish fed with lower fat levels (Diet A and C) had no significant difference in overall acceptance with reservoir fish both in female and male groups.

Table 2: Sensory scores obtained for tested fish fillets (mean ± SD, n = 15)[1]

Test 01	Sensory quality parameters				
	Flavour	Juiciness	Oiliness	Tenderness	Overall Acceptability
Male fish fillet					
Diet A	3.66±0.72^{ab}	3.40±1.18^{a}	2.80±1.08^{a}	3.40±1.4^{a}	3.31±0.67^{a}
Diet C	3.86±0.91^{a}	3.20±1.01^{a}	3.13±0.83^{a}	3.33±0.72^{a}	3.38±0.61^{a}
Reservoir captured	2.46±1.24^{b}	2.90±1.36^{a}	2.63±1.24^{a}	2.48±1.10^{a}	2.66±1.22^{a}
p-value	0.01	0.60	0.31	0.59	0.09
Female fish fillet					
Diet A	3.66±0.89^{a}	3.53±0.99^{a}	2.93±1.96^{a}	3.20±1.08^{ab}	3.33±0.66^{a}
Diet C	3.40±0.98^{ab}	3.13±0.99^{a}	2.73±1.03^{ab}	3.26±1.03^{a}	3.21±0.65^{a}
Reservoir captured	2.55±1.12^{b}	2.85±1.26^{a}	1.89±1.18^{b}	2.33±0.89^{b}	2.46±0.83^{a}
p-value	0.04	0.46	0.01	0.04	0.60
Test 02 Male fish fillet					
Diet B	3.33±1.04^{a}	3.20±0.77^{a}	2.53±1.18^{a}	3.46±1.18^{ab}	3.13±0.71^{ab}
Diet D	3.73±1.09^{a}	3.33±1.17^{a}	2.86±1.11^{a}	3.66±1.11^{a}	3.40±0.65^{b}
Reservoir captured	2.40±1.04^{b}	2.80±1.26^{a}	2.53±0.79^{a}	2.46±1.18^{b}	2.56±1.02^{a}
p-value	0.01	0.70	0.86	0.02	0.04
Female fish fillet					

Diet B	3.53±0.63[a]	3.20±0.86[a]	2.60±1.18[a]	3.93±1.03[a]	3.31±0.63[a]
Diet D	3.66±1.17[a]	3.20±0.94[a]	2.60±0.98[a]	3.80±1.08[a]	3.31±0.63[a]
Reservoir	2.53±1.00[b]	2.78±.1.20[a]	1.80±1.14[b]	2.40±0.90[b]	2.36±0.70[b]
p-value	0.02	0.20	0.02	0.00	0.00

[1]Different letters in the same column indicate significant difference (P<0.05). A-D; fish fed with formulated diets in cage culture.

Table 3 presents the chemical composition of composite samples of fish fillet taken for the sensory evaluation. There were significant differences ($p < 0.05$) between cage reared and reservoir captured fish fillets for protein, lipids, ash and dry matter. The lowest protein, fat, ash and dry matter were observed in reservoir captured female fish.

Table 3: Proximate composition of GIFT fish fillets and Nile tilapia fillets (mean ± SD, n = 2)[1]

Treatments		Sex	Composition %			
			Crude protein	Crude fat	Crude ash	Dry matter
8% crude fat in diet	Diet A	Male	16.88±0.00[a]	2.39±0.01[a]	1.15±0.00[a]	20.49±0.5[a]
		Female	16.43±0.02[b]	2.34±0.00[b]	0.99±0.00[b]	19.79±0.02[b]
	Diet C	Male	19.00±0.00[c]	2.02±0.03[c]	1.11±0.01[c]	22.16±0.02[c]
		Female	18.24±0.01[d]	2.50±0.00[d]	0.88±0.00[d]	21.63±0.00[d]
12% crude fat in diet	Diet B	Male	17.43±0.00[e]	2.36±0.00[ab]	1.24±0.01[e]	21.08±0.00[e]
		Female	14.89±0.01[f]	4.00±0.00[e]	0.98±0.00[fb]	19.94±0.07[f]
	Diet D	Male	20.19±0.02[g]	2.46±0.02[f]	1.38±0.00[g]	24.05±0.01[g]
		Female	20.11±0.01[h]	2.36±0.00[a]	1.01±0.00[h]	23.53±0.01[h]
	Reservoir	Male	16.14±0.01[i]	1.58±0.00[g]	0.97±0.00[if]	18.70±0.04[i]
		Female	14.04±0.02[j]	1.47±0.01[h]	0.73±0.00[j]	16.22±0.04[j]

[1]Different letters in the same column indicate significant difference (P<0.05), A-D; fish fed with formulated diets in cage culture.

4. Discussion

The sensory attributes for this study revealed that farmed fish (GIFT) gained significantly higher scores for flavor, tenderness, oiliness and overall acceptability than reservoir grown fish (Nile tilapia). This difference could be related mainly to supplementary feeding. Similar study conducted on sensory changes of farm raised and wild captured *Labio rohita* by Alam *et al*. (2012) [2] described significantly higher scores for flavor, tenderness, overall acceptability when compared those in wild fish. Jamilah *et al*. (2001) [9] recorded earthy flavour in wild tilapia fish and shows that it is related to accumulation of

Geosmin and 2-methylisoborneol (MIB) in fish muscles produced by blue-green algae in culture environments. Having no accessibility to the muddy reservoir bottom and aquatic vegetation, compounds leading to undesirable flavours may not have accumulated in cage fish. GIFT is a genetically improved strain of *O. niloticus* and the difference in the strain which is an endogenous factor may also responsible for the flavor. The proximate composition assessed in this study revealed that the cage farmed GIFT fish fed by formulated diets have high protein, fat, ash, and dry matter contents than the *O. niloticus* fish captured from the same reservoir. This is a general phenomenon which has been observed for variety of fish species cultured in both fresh and sea [1, 14]. Karapanagiotidis *et al*. (2006) [10] reported that higher fat content was found in fish fed with commercial diets in intensive and semi-intensive culture systems of tilapia and red tilapia than in wild tilapia fish. Alam *et al*. (2012) [2]. In his study reported that significantly higher dry matter content was found in farmed *Labio rohita* than the wild *Labio rohita*. A survey conducted by Karapanagiotidis *et al*. (2006) [10]. On fatty acid profile of intensively cultured group of Nile and Red tilapia recorded increased amount of saturated fatty acid, mono unsaturated fatty acids and poly unsaturated fatty acids per gram of body weight when compared to wild fish and less intensively cultured fish. Fish feeding on supplementary diets having ingredients such as soya bean meal, rice bran and domestic by products are rich with linoleic acid (18:2n-6) which is an unsaturated fatty acid. Fish fed with such diets increases the amount of 18:2n-6 in fish (Bergstrom 1989 [4]; Serot *et al*. 1998) [13]. Diets having 8% and 12% crude lipid levels in diets in the present study also were rich with soya bean meal, rice bran and house hold by products recorded high linoleic acid content in cage cultured GIFT (unpublished data).

5. Conclusion

Cage cultured GIFT results higher body composition (fat, protein, ash) and overall acceptance in fillets than the Nile tilapia grown in the reservoir. Composition of the feeds and culture practices mainly contribute to the better quality and the better flavor of cage cultured GIFT fish than the free ranging tilapia that feed on naturally available feeds found in the reservoir.

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