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Sensory evaluation of four red hybrid tilapia (*Oreochromis Sp*.) strains among fish consumers

Zharif Ramli

Faculty Agro-Based Industry, Universiti Malaysia Kelantan, Jeli Campus 17600 Jeli, Kelantan, Malaysia.

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✉*Corresponding author:

Dr. Mohd Zharif Bin Ramli
Faculty Agro-Based Industry
Universiti Malaysia Kelantan
Jeli Campus 17600,
Kelantan, Malaysia.
Email: zharif.r@umk.edu.my

Abstract

The viability of tilapia in the aquaculture industry is due to the market demands that consumers decide. Since every aquaculture species had distinct sensory attributes, a hedonic sensory evaluation was performed to assess the sensory characteristics of the flesh of four red hybrid tilapia strains: (i) ♂*O.niloticus x* ♀*O.niloticus* (A)(MF280061), ♂*O.mossambicus x* ♀*O.mossambicus* (B) (MF509596), ♂*O.niloticus x* ♀*O.mossambicus* (C)(MF509597) and ♂*O.mossambicus x* ♀*O. niloticus* (D)(MF509598). Hedonic and ranking tests were carried out by 120 participants who assessed each strain's 25 g steamed flesh. The sensory analysis was carried out by using five hedonic scales. They participated through a volunteer invitation. The surveyed population participated by 62.50% and 37.50% females and males, respectively. Participants were asked to complete the questionnaires, including demographic questions hedonic scores, and rank according to their preferences. Means of sensory attributes were analysed using the Kruskal-Wallis test at $p<0.05$. No significant differences ($p>0.05$) exist between strains in the sensory attributes related to taste, odour, and juiciness. Strain D had the highest scores in all sensory attributes compared to other strains. However, only the texture (3.97±0.71) attribute was found to be significantly different ($p<0.05$). Overall acceptability by participants demonstrated that the variations between strains were not statistically different ($p>0.05$). Nevertheless, strain D (141.00) was ranked significantly higher compared to other strains. Thus, the participant's distinct, undistinguishable sensory attributes revealed that all strains could be commercialised as table fish.

1. INTRODUCTION

Red hybrid tilapia is widely farmed in Malaysia and highly favourable by consumers, representing 97 % of tilapia production in 2013 (Azzam-Sayuti et al., 2021). This situation forced the local farmers to farm red hybrid tilapia. Several strains of red hybrid tilapia were found in Malaysia, such as *O.niloticus*, *O.mossambicus*, and *Oreochromis* spp. (Zharif et al., 2016). These strains were introduced since consumers highly accepted them compared to other strains. For example, Genetic Improved Farmed Tilapia (GIFT) failed to strike local production of red tilapia. Generally, consumer acceptance is based on phenotypes that include a muscular body and the common skin colour of the species (Gjerdrem and Baranski, 2009). These physical appearances give early judgment for consumers to buy or consume the fish where this hybrid variety has gained commercial importance due to its desirable traits, such as colouration resembling high-value marine fish like red snappers (Ng et al., 2019). The composition of the fish carcass is not only controlled by the diet, as genetic variation also controls the composition and sensory attributes of the flesh (Muchiri et al., 2015).

Market demand is swiftly changing due to the fluctuations in consumer preference and eating behaviour, leading to the aquaculture industry's concerns about the sensory attributes of the species, such as flesh colour and flavour (Kilcast, 2011; Silva et al. 2015). The aquaculturist emphasised this characteristic through breeding, culture methods, optimally tailored foods, and suitable management procedures to meet market demand (Hernández et al. 2001; Hernández et al. 2007). Hence, sensory attributes are susceptible to consumer preference, which may change the breeding goal, trait evaluation, and other farming practices (Gjerdrem and Baranski, 2009).

Sensory analysis is crucial in evaluating tilapia products' quality and consumer acceptance of different tilapia fish strains. Various studies have focused on evaluating the sensory properties of tilapia products to comprehend consumer preferences and acceptance levels. Research has shown that sensory evaluation of tilapia gauges the fish attribute variation since it is simple, quick, and provides direct information (Khalfalla et al. 2015; Khoshnoudi-Nia and Moosavi-Nasab,2019). More recently, Zin et al. (2020) evaluated the sensory evaluation

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in GIFT tilapia strain between tank and pond culture where both treatments received high positive acceptance by the consumers. Improving the sensory attributes is one factor determining the viability of aquaculture species in the market, and it depends on the acceptance of consumers (Hernández et al. 2001). Recently, participants evaluated four strains of red hybrid tilapia through hedonic analysis to observe the relationship between strain variation and sensory attributes as in breeding goals.

2. MATERIALS AND METHODS

2.1. Sample Preparation

These fish were transferred from the earthen pond into a holding tank within 24 hours without feeding to ensure these fishes were in similar conditions (Hernández *et al*. 2001). Then, the sensory analysis took place the following day. On the next day, live fish were stunned by immersing in crushed ice to keep fresh. All fish were descaled and gutted. The flesh was filleted, and the gut section, which contained high fat, was removed (Hernández *et al*. 2001).

For sensory analysis samples, fillets were covered in aluminium foil and cooked in the steamer for 30 min. Samples were kept warm in the steamer for 30 minutes and served within 10-15 minutes. The samples were divided into approximately 25g each for participants to taste. Samples were served in a random pattern with three digits coding generated to minimise the knowledge of sample details, every participant was evaluated in different order of code samples.

2.2. Fish Source

The experiment was started by producing four strains of red hybrid tilapia; (i) ♂*O.niloticus x* ♀*O.niloticus* (A), (ii) ♂*O.mossambicus x* ♀*O.mossambicus* (B), (iii) ♂*O.niloticus x* ♀*O.mossambicus* (C) and (iv) ♂*O.mossambicus x* ♀*O. niloticus* (D) (Fig.1). These strains were raised in the earthen pond and fed commercial pellets until they reached 350-400 g weights. All experimental fish were reared in the Aquaculture Research Centre (ARC), Universiti Malaysia Kelantan, Jeli Campus, Kelantan.

Figure 1: Four strains of red hybrid tilapia.

2.3. Sensory Evaluation Conditions

The participants were among the staff and students at Universiti Malaysia Kelantan Jeli Campus, Kelantan. They were requested to participate through voluntary participation. Sensory evaluation was executed in the food laboratory between 9.00 a.m. and 1.00 p.m. The test was conducted in an open space in the laboratory where the distance between participants was about three meters. Four portions of steamed flesh in the labelled polystyrene box (10 cm x 10 cm x 5cm) were served to every participant. They were instructed to drink plain water between sample tastings to avoid the carry-over effect. They were not permitted to speak with other participants or during each session, which consisted of ten participants. All participants were required to complete questionnaires that elicited information about the sensory characteristics of tilapia flesh.

2.4. Characteristics of the population

Participants (untrained evaluators) were selected from regular consumers of several shops selling freshwater fish-based diets at the UMK cafeteria. They were identified to be free from illness or flu. This criterion is essential for selecting the tasting panel, which may influence sensory judgment (Hernández *et al.* 2001). A summary of the participant's demographic is shown in Table 1.

Table 1: Demographic information about participants

	Class	Number of participants (n)	Percentage (%)
Age	21-30	106	88.33
	31-40	11	9.17
	41-50	3	2.50
Gender	Male	45	37.50
	Female	75	62.50
Races	Malay	85	70.83
	Chinese	21	17.50
	Indian	12	10.00
	Others	2	1.67

2.5. Evaluation of sensory attributes

All participants were required to rate the number of sensory attributes such as flavour, odour, texture, juiciness, and overall acceptability using a modified five hedonic scale to evaluate satisfaction level (Silva et al. 2015) (1= Strongly Dislike and 5 = Strongly Like). At the end of this evaluation, the participants were required to rank their samples based on their preferences in ascending order (1= Least preferred to 4 =Most preferred).

2.6 Statistical analysis

The values were compared by using Kruskal-Wallis to identify statistical differences between treatments. The mean significant differences were compared by using a Mann-Whitney test at $p<0.05$.

3. RESULT AND DISCUSSION

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Generally, participants accepted all red hybrid tilapia strains through sensory analysis. Recently, five-point hedonic scales were used in the satisfaction level evaluation, in which participants might be able to differentiate the fish flesh attributes. Whole sensory attributes of the tilapia flesh were recorded above three out of five hedonic scales for all treatments. The score corresponds to the average level, equivalent to "moderate." The finding agreed with the participants' preference test on farmed sharp snout sea bream, whereby the overall score assigned at point 4/7 paralleled the moderate level (Hernández et al. 2001). Eyng et al. (2013) applied nine points of hedonic scales assessed by the trained panels on odour, flavour, colour, texture, and overall quality. Previous works performed the sensory analysis of seven and five hedonic scales using the untrained panel (Hernández et al. 2001; Hernández et al. 2007). Hence, using a five-point scale anticipated participants' ability to differentiate attributes between the points.

In the evaluation exercise, 120 participants (untrained panels) agreed on the panel size proposed by Svensson (2012). The large panel size could result in high variability, affecting the sensitivity and statistical analysis. Since this sensory evaluation was carried out on the UMK campus, the participants' age was mainly less than 30 years old. The trained panel may measure the degree of sensory attribute more accurately than the untrained panel. It is a fact that exercise is very laborious, expensive, and time-consuming, as has been highlighted (Gjerdrem and Baranski, 2009; Worch et al. 2009). In the present study, only the healthy participants were involved in assessing the fish flesh. On the other hand, earlier findings revealed that smokers were not significantly influenced by sensory judgment (Hernández et al. 2001). There is variability in the ratings of the samples tested by untrained panels revealed in the current study. However, this finding contradicts the results of the previous study, whereby no significant differences were observed between the trained and untrained panels (Worch et al. 2009).

Four strains of red hybrid tilapia were positively scored for every attribute (Table 2). They were scored above 3, which corresponded to 'average' satisfaction. The results showed no significant difference between strains concerning taste, odour, and juiciness attributes. The highest score in overall acceptability was found in strain A, while the lowest was in strain B. However, this attribute was not statistically different ($p>0.05$). Significantly differences ($p<0.05$) were found in the sensory attribute related to texture, whereby the highest score was in strain D. Strains B and C have similarly scored (Table 2).

The highest score was obtained by strain A in the overall acceptability, followed by strains D, C, and B (Table 1). This finding agreed with the earlier study, irrespective of the attributes compared to GIFT and red tilapia strains by regular consumers (Khaw et al. 2006). Several studies discussed these attributes related to the economic importance of aquaculture production (Attalla and Mikhail, 2008; Gjerderm and Baranski, 2009). Texture attribute is the most significant trait in the sensory test for fish where the initial impression was influenced by the visual and touch (Khaw et al. 2006; Kilcast, 2011). Recently, red hybrid tilapia was raised in the earthen pond and fed by commercial pellets, which are believed to have influenced fish flesh. Earlier research claimed that the fish flesh should be firm, have no mucus, cohesive, elastic properties, and be felt by hand when consumed (Hernández et al. 2007; Martinsdottir et al. 2009). For example, Hernández et al. (2007) found a soft texture for sharp snout bream fed by soybean meal. Thus, the texture of fish is probably influenced by the feed given to them.

Table 2: Sensory rating differences obtained from four red hybrid tilapia strains

Attributes	Strain A	Strain B	Strain C	Strain D
Taste	3.76±0.81	3.78±0.74	3.76±0.79	3.92±0.72
Odor	3.70±0.86	3.76±0.83	3.72±0.71	3.80±0.64
Texture	3.88±0.59^{at}	3.71±0.78^{a}	3.71±0.83^{a}	3.97±0.71^{b}
Juiciness	3.76±0.89	3.61±0.79	3.69±0.69	3.73±0.71
Overall acceptability	3.86±0.71	3.77±0.71	3.79±0.79	3.85±0.68

* All values are mean scores of the strains group, and values in the same row with different superscripts are significantly different ($p<0.05$).

Their hardness and juiciness determined flesh texture attributes. Recently, texture attribute was recorded moderately, which signified an average like. Participants were able to discriminate the texture attribute as medium-firm and not separated. The texture differences could be affected by the heat, protein content, fat content, and amount of connective tissue, as Hernández et al. (2001) suggested. Another study reported that the appearance of the flesh texture is related to the fresh and processing conditions (Martinsdottir et al. 2009). Recently, fillets stored in the freezer had lowered the period of rigour mortise, subsequently influencing the flesh quality. Rigour mortise caused a loss in flesh toughness, making breaking easier (Stroud, 2001).

Table 3 summarises the correlations among the attributes in the sensory test. All attributes have positive correlations with each other. However, the relationship is considered weak, which is significant at 0.01. Flavour, Odour, Texture, and juiciness positively affected the overall acceptability. Nevertheless, the effect is considered weak. Then, Table 4 showed four strains of red hybrid tilapia that participants ranked based on 4 priority points, i.e. "1= Least preferred" and "4= Most preferred". The mean values were compared by using Kruskal-Wallis.

Table 3: Summary of correlation coefficients between sensory attributes for four red hybrid tilapia strains.

Attribute	Overall Acceptability	Juiciness	Texture	Odour	Flavour
Flavour	0.184*	0.259*	0.212*	0.189*	1

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Odour	0.248*	0.162*	0.223*
Texture	0.307*	0.285*	
Juiciness	0.259*		

* Correlation is significant at the 0.01 level.

Table 4: Ranking of four red hybrid tilapia strains.

Strains	Mean Rank
A	126.04[b]
B	114.96[b]
C	113.54[b]
D	141.00[a]

* All values are mean scores of the mean rank, and different superscripts indicate significant different ($p<0.05$).

Likewise, the juiciness of the flesh was related to its texture. Flesh with high-fat content was reported to be strongly associated with the level of juiciness as found in sharp snout bream fed different diets of soybean protein (Hernández et al. 2001; Hernández et al. 2007). The findings from the present study showed averagely acceptable flavour and odour attributes. As expected, participants could detect the earthy flavour of the fish flesh. This finding revealed the geosmin off-flavour in pond raised freshwater fish as evaluated by an untrained panel. The flavour is the main attribute for sensory evaluation, which discovered that farmed tilapia raised in the earthen pond, tanks and fed by testing feed exhibited off-flavour, earthy and musty odour (Hernández et al. 2007; Martinsdottir et al. 2009; Silva et al. 2015). Silva et al. (2015) described the geosmin-off flavour in tilapia due to the cyanobacteria species that existed in high-nutrient-load ponds, and the uptake of this bacteria occurred through the gills or skin. Furthermore, the odour stimulus and the flavour acuity can be detected from the food matrix during the mastication of food (Kilcast, 2011).

4. CONCLUSION

The variation of red hybrid tilapia strains did not influence the sensory attributes. Thus, any combination of crossbreeding in red hybrid tilapia is likely to produce fish with similar sensory acceptance. Hedonic analysis has provided promising results for future works in improving organoleptic attributes.

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