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Identification of Aroma, Earthy Flavour and Aftertaste in Tilapia Using Sensory Evaluation Technique

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ABSTRAK

Panel terlatih digunakan untuk mengenal pasti profil rasa yang merangkumi aroma, rasa dan rasa selepas ditelan bagi ikan tilapia hitam (Oreochromia mossambica). *Untuk tujuan perbandingan, 2 jenis ikan laut iaitu ikan kembung* (Rastrellinger kanagurta) *dan ikan aya* (Euthynnus affinis) *dan ikan* (Clarias batracus), *sejenis ikan air tawar, juga dinilai. Sepuluh, dan lapan ciri aroma, rasa dan rasa selepas ditelan telah dikenal pasti. Walau bagaimanapun, kehadiran ciri lumpur yang kuat hingga sederhana menguasai sifat aroma, rasa dan rasa selepas ditelan ikan tilapia yang juga sentiasa mendapat skor yang lebih tinggi daripada ikan keli kecuali bagi rasa selepas ditelan. Kehadiran geosmin di dalam otot ikan tilapia mungkin di dalam julat 1.0 hingga 10.0 μgml^{-1}. Aroma lumpur mungkin boleh dikurangkan dengan memasak.*

ABSTRACT

Trained panelists were used to identify the flavour profile which consists of aroma, flavour and aftertaste of wild black tilapia (Oreochromis mossambica). *For the purpose of comparison, 2 marine fish namely Indian mackerel* (Rastrelinger kanagurta) *and bonito* (Euthynnus affins) *and catfish* (Clarias batrachus), *a freshwater fish, were also evaluated. Ten and eight aroma, flavour and aftertaste attributes respectively were recognized in tilapia. However, the presence of kerosine-like attribute could be due to petrochemical contaminants. The presence of strong to moderate earthy attribute is dominantly recognized in its aroma and flavour which are consistently scored higher than that in catfish except for the aftertaste. The presence of geosmin in the tilapia muscle could most probably be in the range of 1.0 to 10.0 μmg^{-1}. The earthy aroma may be reduced upon cooking.*

INTRODUCTION

Acceptance of fishery products is dependent on safety, nutrition, flavour, texture, colour, appearance and the suitability of the raw material for processing and preservation. However, flavour seems to be the most important factor for acceptance (Haard 1992). Even though fish exhibits a similar recognizable flavour characteristic, each species has its unique attributes which are dependent on the non-nitrogenous constituents such as aldehydes, alcohols, volatile sulfur and ketones (Josephson 1991; Jones 1967). The consumer acceptance of muddy-flavoured catfish is very low (Mills *et al.* 1993). Black tilapia is abundant and easily cultured in Malaysia, but its marketability is mainly constrained by the unpopular presence of the muddy odour and flavour.

The detection and the quantification of this unique and complex flavour notes could be carried out instrumentally such as by gas chromatography, but this cannot be done with ease. It is also a common practice in quality control laboratories to assess the presence of any particular odour and flavour through sensory evaluation by trained panelists. Johnsen and Dupree (1991) reported using trained panelist to investigate the role of feed ingredients on the flavour quality of farmed

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catfish. The use of trained panelists to assess the lipid oxidation in frozen stored catfish was reported by Brannan and Erickson (1996). The use of trained panelist to monitor quality changes in strawberry industry has also been reported (Shamaila *et al.* 1992). Trained panelists are frequently used for sensory-instrumental correlation. They are consistent, superior in describing odour notes, are articulate and highly motivated (Foss 1981). General methods for the sensory evaluation of food products have been outlined by several researchers such as Amerine *et al.* (1965), Larkin (1969), Larmond (1971) and Spencer (1971). Specific training of panelists to the earthy odour of pure extracts of known important compounds that contribute to the characteristic of muddy odour such as geosmin and 2-methylisoborneol (MIB) has been reported by Persson (1980). It is crucial that the identification and quantification of these flavour notes recognised by the trained sensory panelists since the ultimate marketability of the fish and its products are dependent on its acceptability by the consumers particularly the sensory perception of the buyers. To date, the flavour note of black tilapia has not been reported. Hence, this study was carried out to identify and quantify the flavour note of black tilapia as well as to identify the concentration of geosmin in the fish muscle detectable by panelists.

MATERIALS AND METHODS

Materials

Wild black tilapia (150-300 g each) were caught by netting from a lake near the university. The marine fish (Indian mackerel and bonito) and catfish used for comparison purposes were bought from the local wet market. The geosmin standard (1% solution in propylene glycol) was kindly donated by Mr. Romke Hengst of Bush Boarke Allen, Singapore.

Sample Preparation

For the identification and quantification of the flavour profile, 2 pieces (5 g each) of Indian mackerel, bonito and tilapia muscle were placed in randomly labeled and sealed laminated aluminium pouches (7 x 6 cm) and cooked to an internal temperature of over 71°C (Sawyer *et al.* 1988). The internal temperature of the pouch was monitored by a thermocouple inserted in the centre of the pouch.

The samples for the quantification of the earthy characteristics were prepared as above. However, for raw sample evaluation, the sample was prepared by finely grinding 10 g of the muscle, placed in randomly labeled glass containers, and immediately evaluated.

Preparation of the Standard Geosmin Solution

The geosmin solutions were prepared at 0.0 (control), 0.1, 1.0, 10.0 and 100.0 µgm−1 concentrations. The series of standard solutions were arrived at after an initial trial to identify the threshold of the compound.

Sensory Evaluation

Seven panelists, consisting of 3 females and 4 males, aged between 23 and 40 years old who had been selected and trained were used in this experiment. The identification and quantification of the flavour profile and the earthy characteristics (aroma, flavour and aftertaste) were carried out both individually and through group discussion. The design of the group discussion was a modification of the procedure described by Winger and Pope (1981), Persson (1980) and Zook and Wessman (1977). The evaluation was repeated 5 times before the list of descriptions of the flavour profile was generally agreed to.

For the flavour profile description, each panelist was asked to list the sensory profile as much as possible and the evaluation was assisted by the list of fish attribute descriptions which were developed by Prell and Sawyer (1988) and Chambers and Robel (1993). These identified characteristics were then quantified by scoring them on a 7-point scale (1 = slight, 4 = moderate and 7 = strong) (Prell and Sawyer 1988).

In the quantification of the earthy attributes, each panelist was presented with four warm samples and was requested to evaluate the aroma, flavour and the aftertaste characteristics of the samples. These attributes of the muscle were to be scored against the standard geosmin solutions after dipping a paper strip (3 x 50 mm) and snipping it. Those attributes were scored on a 100 mm unstructured line anchored 0.5 mm from both ends by pairs of terms modified from the method outlined by Stone *et al.* (1974). The results were measured as the distance from the left end of the line.

The aroma was evaluated right after the pouch was snipped opened. For flavour, the panelists were asked to chew the sample for 60 sec before giving their evaluation and the aftertaste was recorded 60 sec after swallowing the samples (Chambers and Robel 1993). Only aroma was evaluated in raw samples.

Statistical Analysis

Statistical Analysis System (SAS) was used to analyse all the date for one way analysis of variance (ANOVA) and the difference between samples were analysed by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The description of the flavour profile which consists of aroma, flavour and aftertaste attributes of the muscle of Indian mackerel, bonito, catfish and tilapia are as in Tables 1, 2 and 3 respectively. Basically, the identified individual flavour profile of the fish used are not the same and thus support the earlier findings that each fish has its unique flavour characteristics which is mainly attributed to the presence of specific component, recognition of the threshold value and their concentration (Josephson 1991).

Six aroma characteristics were recognized in Indian mackerel, 8 for bonito, 9 for catfish and 8 for tilapia (Table 1). Fish oil aroma was identified as the strongest characteristic in Indian mackerel, bonito and catfish. However, sweet and sour aromas scored the highest in the black tilapia. 'Sour' aroma also scored the highest in bonito. The same characteristic was also recognised in the other three fish. The 'sweet', 'fish oil' and 'fresh fish' attributes which were scored high to moderate in all the four fish evaluated is most probably due to the presence of eight-carbon volatile ketones which were derived through lipoxygenase-mediated conversion of the polyunsaturated fatty acids which are abundant in seafoods (Josephson 1991). Earthy character scored highest in tilapia, although it is also recognizable in bonito and catfish. The concentration of this earthy compound, namely geosmin and MIB produced by blue-green algae accumulate in the muscle (Yukowski and Tabacher 1980; Kuusi and Shuiko 1983).

The earthy flavour characteristic was recognized in both the freshwater but not in the marine fish (Table 2). It was the dominant character detected in tilapia. Earthy aftertaste was not at all recognized in both marine fish studied. It is among the three characteristics that scored highest in tilapia. An equivalent score was also given to the earthy attribute in catfish.

The two additional attributes identified by the panelists were kerosene and blood which were not in the original listing as described by Prell and Sawyer (1988) and Chambers and Robel (1993). The kerosene-like character detected by panelists in black tilapia might be due to the contamination of the lake water by the petrochemical compounds discharged into it. The detection of the kerosene taint in mullet taken from the Moreton Bay and Brisbane River in Queensland, Australia was also reported by Vale *et al.* (1970) and Shipton *et al.* (1970) respectively. The detected blood

TABLE 1

The description and scores for aroma in cooked muscle of Indian mackerel, bonito, catfish and tilapia

	Sencory scores*			
Description	Indian Mackerel	bonito	catfish	tilapia
1. Briny	4	4	3	3
2. Blood	2	4	NR**	NR**
3. Earthy	NR**	2	3	8
4. Fish oil	6	7	6	5
5. Fresh fish	5	4	5	5
6. Musty	NR**	NR**	3	3
7. Scorched	NR**	6	3	NR**
8. Smoke	NR**	NR**	3	3
9. Sour	5	7	5	6
10. Sweet	5	4	5	6

- *scores of 1 = light; 4 - moderate and 7 - strong
- **NR- not recognized
- Scores are average of 5 evaluations

TABLE 2
The description and scores for flavour in cooked muscle of Indian mackerel, bonito, catfish and tilapia

	Sensory scores*			
Description	Indian Mackerel	bonito	catfish	tilapia
1. Bitter	NR**	4	NR**	3
2. Blood	2	NR**	NR**	NR**
3. Briny	NR**	NR**	3	NR**
4. Earthy	NR**	NR**	4	6
5. Fish oil	5	5	7	5
6. Fresh fish	5	4	5	4
7. Kerosene	NR**	NR**	NR**	4
8. Metallic	5	3	3	5
9. Mouth drying	6	6	5	4
10. Mouth filling	7	6	5	6
11. Salty	5	4	NR**	NR**
12. Scorched	NR**	5	NR**	NR**
13. Shell fish	5	6	NR**	NR**
14. Sour	6	5	NR**	4
15. Sweet	3	3	5	4

- *scores of 1- light; 4- moerate and 7 -strong
- **NR- not recognized
- Scores are average of 5 elevations

TABLE 3
The description and scores for aftertaste in cooked muscle of Indian mackerel, bonito, catfish and tilapia

	Sensory scores*			
Description	Indian mackerel	bonito	catfish	tilapia
1. Bitter	NR**	3	NR**	3
2. Blood	2	NR**	NR**	NR**
3. Briny	NR**	NR**	4	NR**
4. Earthy	NR**	NR**	5	5
5. Fish oil	6	5	6	5
6. Fresh fish	4	3	4	4
7. Kerosene	NR**	NR**	NR**	5
8. Metallic	NR**	NR**	2	2
9. Salty	3	4	NR**	NR**
10. Shell fish	4	5	NR**	NR**
11. Sour	3	6	NR**	4
12. Sweet	5	2	4	4

- *scores of 1 - light; 4- moderate and 7- strong
- ** NR- not recognized
- Scores are means of 5 evaluations

characteristic in Indian mackerel could be due to the presence of the haem pigments.

Table 4 shows the scores for geosmin standard solutions and the scores for cooked and raw tilapia muscle. The results of five evaluations by seven trained panelists clearly indicated that earthy flavour is the most detectable attribute followed by aftertaste and aroma. Based on the corresponding scores given to geosmin standard solutions, it could be possible that concentration of geosmin in the cooked tilapia muscle fall within the range of 1.0 to 10.0 μgml–1. Whether this concentration is acceptable to consumers is not validated here. However, the threshold value for trout was reported to be 0.6 μg/100 g (Yukowski and Tabacher 1974). These differences may be

TABLE 4
Sensory scores** (n = 35) for geosmin standard solutions, earthy attributes of cooked and raw muscle of black tilapia

Session	Geosmin solution (()gml^{-1})***					Cooked muscle***		Raw muscle***	
	0	.1	1	10	100	Aroma	Flavour	Aftertaste	Aroma
1	NR*	14±25^{Ca}	36±20^{Ba}	67±23^{Aab}	96±5^{Aa}	21±22^{ab}	34±21^{ab}	21±23^{bc}	30±12^{bc}
2	NR*	9±10Da	21±5^{Cb}	79±17^{Ba}	97±2^{Aa}	29±17^{a}	41±18^{a}	33±13^{a}	40±8^{a}
3	NR*	5±2Da	13±2^{Cb}	75±8^{Ba}	97±3^{Aa}	15±10^{b}	41±14^{b}	26±15^{ab}	33±8^{ab}
4	NR*	5±3Da	14±7^{Cb}	50±20^{Bbc}	88±3^{Ab}	13±5^{b}	25±8^{b}	18±12^{bc}	23±11^{c}
5	NR*	4±2Da	23±12^{Cb}	58±10^{Bbc}	90±1^{Ab}	21±10^{b}	26±11^{b}	13±14^{c}	25±13^{bc}
Overall	NR*	7±14	21±14	66±20	94±5	20±15	33±16	22±14	30±12

NR*- not recognized
** scores - mean scores (/100)
*** Means followed by the same capital letter in a row are not sognificantly different
**** Means followed by the same small letter in a column are not significantly different

due to the complexity of the flavour as well as variables such as age, body and physiological needs, experience and social custom (Lyman 1989). The lower scores given to aroma and aftertaste of the cooked muscle could be due to the loss of the volatiles upon cooking and also because only 20% of the respired air with the volatile compounds reaches the olfactory receptors during sniffing (Marniak and Mackey-Sim 1984). Chambers and Robel (1993) also reported similar findings while working on channel catfish from pond, raceway and Mississippi ponds whereby higher score (30-50%) intensity was given to taste compared to the score given to the cooked muscle. This may again indicate loss of volatiles during cooking.

CONCLUSION

In this study, the distinct flavour profile of the wild black tilapia is recognized through sensory evaluation. It consists of 8, 10 and 8 aroma, flavour and aftertaste attributes, respectively, which include the kerosene-like attribute which could most probably be due to the petrochemical contaminants. The aroma, flavour and aftertaste of black tilapia is mostly dominated by the earthy attributes which is scored from strong to moderate. The intensity of the sensory response most probably correlates to the presence of 1.0 to 10.0 µgml–1 geosmin in the fish muscle. The intensity of the aroma may be reduced by cooking.

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REFERENCES

AMERINE, M.A., R.M. PANFBORN and E.B. ROESSLER. 1965. *Principles of Evaluation of Food.* New York: Academic Press.

BRANNAN, R.G. and M.C. ERICKSON. 1966. Sensory assessment of frozen stored channel catfish in relation to lipid oxidation. *J. of Aqua. Food Pro. Tech.* **5(1)**: 67-80.

CHAMBERS, E. and A. ROBEL. 1993. Sensory characteristic of selected species of freshwater fish in retail distribution. *J. Food Sci.* **58(3)**: 508-512.

FOSS, D.A. 1981. Sensory characterization. In *Flavour Research Recent Advance,* eds. R. Teranishi, R. Flath, and H. Sugisawa. p. 125-174. New York: Marcel Dekker Inc.

HAARD, N.F. 1992. Control of chemical composition and food quality attributes of cultured fish. *Food Res. Int.* **25**: 289-307.

JOHNSEN, P.B. and H.K. DUPREE. 1991. Influence of feed ingredients on the flavour quality of farmed raised catfish. *Aquaculture* **96**: 139-150.

JONES, N.R. 1967. Fish flavours. In *Symposium on Food: Chemistry and Physiology of Flavours* eds. H.W. Schultz, E.A. Day and L.M. Libbey. p. 266-295. The AVI Publishing Company Inc.

JOSEPHSON, D.B. 1991. Seafoods. In *Volatile Compounds in Food and Beverages,* ed. H. Maarse. p. 179-201. Marcel Dekker Inc.

LARKIN, A.L. 1969. The organoleptic assessment of food flavour. In *Food Technology Australia.* p. 126-127.

LARMOND, E. 1971. Food Quality Evaluation: A review of sensory methods. In *Fish Inspection and Quality Control,* ed. R. Kreuser. p. 172-174. England: Fishing News (Books) Limited Ludgate House.

KUUSI, T. and M. SHUIKO. 1983. Occurrence of various off-flavours in fish in Finland from 1969-1981. *Water Sci. and Tech.* **15**: 47-58.

LYMAN, B. 1989. *A Psychology of Food - More than a Matter of Taste.* p. 69-84. New York: Van Nostrand Reinhold Company.

MARNIAK, J.A. and A. MACKEY-SIM. 1984. The senses of smell. In *Sensory Analysis of Foods,* ed. J.R. Piggott. p. 23. London: Elsevier Applied Science Publisher.

MILLS, O.E., S.Y. CHUNG and P.B. JOHNSEN. 1993. Dehydration products of 2-methylisoborneol are not responsible for off-flavour in the chanel catfish. *J. Agri. Food Chem.* **42**: 1690-1693.

PERSSON, P.E. 1980. Sensory properties and analysis of two muddy odour compounds, geosmin and 2-methylisoborneol in water and fish. *Water Res.* **14**: 1113-1118.

PRELL, P.A. and F.M. SAWYER. 1988. Flavour profiles on 17 species of North Atlantic fish. *J. Food Sci.* **53(4)**: 1036-1042.

SAWYER, F.M., A.V. CARDELLO and P.A. PRELL. 1988. Consumer evaluation of the sensory properties of fish. *J. Food Sci.* **53(1)**: 12-18.

SHAMAILA, M., W.D. POWRIE and B.J. SKURA. 1992. Sensory evaluation of strawberry fruit stored under modified atmosphere packaging (MAP) by quantitative descriptive analysis. *J. Food Science* **57(5)**: 1168-1172.

SHIPTON, J., J.H. LAST, K.E. MURRY and G.L. VALE. 1970. Studies on kerosene-like taint in mullet. II. Chemical nature of the volatile. *J. Sci. Food and Agric.* 21: 433.

SPENCER, H.W. 1971. Techniques in the sensory analysis of flavours. *Flavours Industry.* p. 293-302.

STONE, H., J. SIDEL, S. OLIVER, A. WOOSLEY and R.C. SINGLETON. 1974. Sensory evaluation by quantitative descriptive analysis. *Food Tech.* **28**: 24-32.

VALE, G. L., G.S. SIDHU, W.A. MONTOGOMERY and A.R. JOHNSON. 1970. Studies on a kerosene-like taint in mullet (Mugil cephalus). I. General nature of the taint. *J. Sci. of Food and Agric.* **21**: 429-432.

WINGER, R.J. and C.G. POPE. 1981. Selection and training of panelists for sensory evaluation of meat flavours. *J. Food Tech.* **16**: 661-669.

YUKOWSKI, M. and J.L. TABACHER. 1974. Identification, analysis and removal of geosmin from muddy flavoured trout. *J. Fisheries Res. Board Can.* **31**: 1951-1958.

ZOOK, K. and C. WESSMAN. 1977. The selection and the use of judges for descriptive panels. *Food Tech.* : 56-61.

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