UNIVERSITI PUTRA MALAYSIA

FLAVOUR COMPONENTS AND THE EFFECTS OF ORGANIC ACIDS WASHING ON THE EARTHY FLAVOUR AND PHYSICAL ATTRIBUTES OF THE BLACK TILAPIA (0. MOSSAMBICA) FILLETS

NURUL IZZAH AHMAD

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By

NURUL IZZAH AHMAD

Thesis Submitted in Fulfilment of the Requirements for the Degree of Master of Science in the Faculty of Food Science and Biotechnology, Universiti Putra Malaysia

April 2000

Dedicated to my beloved.....

parent,
husband,
children,
sisters
and
brothers

Abstract of thesis presented to the Senate of Universiti Putra Malaysia
in fulfilment of the requirements for the Degree of Master of Science

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Supervisor : **Assoc. Prof. Dr. Jamilah Bakar**

Faculty : **Food Science and Biotechnology**

The selection and training of panelists for identification of earthy attributes in wild black tilapia was carried out using triangle test and Quantitative Descriptive Analysis procedures. Training was carried out in three stages. The first stage was the introduction to fish flavour characteristics while the second and third stages were the familiarization and discrimination stages, respectively. Earthy was the main characteristic for odour and flavour in freshwater fish, while shellfish, briny and sour characteristics were described for marine fish . The threshold level for geosmin was $0.1 \mu g ml^{-1}$. Earthy flavour attribute was more easily detected as compared to aroma or aftertaste attributes.

The volatile flavour compounds identified in black tilapia from three different water environments (cultured pond, lake and channel) were aldehydes, ketones, alcohols, acids and esters, aromatic compounds, furans, cyclic- and hydrocarbons, *N*-containing compounds and *S*-containing compounds. 62 compounds were detected in cultured black tilapia, 139 in black tilapia taken from lake and 89 in black tilapia

taken from channel. The major compound identified in all samples was 2,6-bis(tert-butyl)-4-methylphenol. Other abundant compounds were 1,1-(6-hydroxy-2,5-benzofurandiyl)bis-ethanone, butyl 2-methylpropyl 1,2-benzenedicarboxylate, hexadecanal, heptadecane and benzothiazole. The earthy flavoured compounds, geosmin and isoborneol were found in trace amount in all samples.

Acetic, citric and tartaric acids washings at 0.125, 0.25, 0.5, 1 and 2 % respectively, were carried out to determine their effects on the removal of the earthy odour and the physical attributes (hardness and colour) of black tilapia fillets. Washing with 0.5 % citric acid resulted in fillets with acceptable hardness and colour characteristics and showed a minimum denatured muscle zone. Washing with 0.5 % tartaric acid decreased ($P < 0.01$) the hardness, while washing with 0.5 % acetic acid increased the whiteness ($P < 0.05$) and imparted acetic acid smell. The sensory scores showed that washing with 0.5 % acetic, citric and tartaric acid respectively decreased 75, 65 and 48 % of earthy odour from uncooked black tilapia fillets.

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Oleh

NURUL IZZAH AHMAD

April 2000

Penyelia : **Prof. Madya Dr Jamilah Bakar**

Fakulti : **Sains Makanan dan Bioteknologi**

Pemilihan dan latihan panel untuk mengenalpasti bau atau rasa tanah di dalam ikan tilapia dijalankan dengan menggunakan ujian segitiga dan kaedah 'Quantitative Descriptive Analysis'. Tiga peringkat latihan telah dijalankan di mana pada peringkat pertama, panel telah diperkenalkan kepada pelbagai ciri bau, rasa dan citarasa ikan. Peringkat ke dua dan ke tiga adalah peringkat familirisasi dan diskriminasi, masing-masing. Bau tanah telah mencirikan rasa dan bau ikan air tawar sementara ciri bau seperti 'shellfish', 'briny' dan 'sour' untuk ikan laut. Kehadiran geosmin dikesan pada kepekatan $0.1 \mu g ml^{-1}$. Rasa tanah adalah lebih mudah dikesan berbanding dengan bau dan citarasanya.

Komponen meruap ikan tilapia hitam yang ditangkap dari 3 persekitaran yang berbeza iaitu kolam peliharaan, tasik dan parit adalah terdiri daripada komponen aldehid, komponen keton, komponen alkohol, komponen asid dan ester, komponen aromatik, komponen furan, komponen siklik- dan hidrokarbon, komponen yang mengandungi kumpulan *N* dan komponen yang mengandungi kumpulan *S*. Sebanyak

62 komponen meruap dikesan dari ikan peliharaan, 139 dari ikan yang ditangkap dari tasik dan 89 dari ikan yang ditangkap dari parit. Komponen utama yang ditemui di dalam semua sampel adalah 2,6-bis(ter-butyl)-4-methylphenol. Komponen utama yang lain adalah 1,1-(6-hydroxy-2,5-benzofurandiyl)bis-ethanone, butyl 2-methylpropyl 1,2-benzenedicarboxylate, hexadecanal, heptadecane dan benzothiazole. Geosmin dan isoborneol, iaitu komponen yang menyebabkan bau tanah telah dikesan dalam amaun yang sangat kecil di dalam tilapia hitam.

Kaedah pembasuhan menggunakan acid asetik, sitrik dan tartarik (0.125 - 2 % masing-masing) telah dijalankan untuk melihat kesannya keatas penyahbauan tanah dan ciri-ciri fizikal (kekerasan dan warna) kepada filet ikan tilapia hitam. Rawatan dengan 0.5 % asid sitrik menghasilkan ciri kekerasan dan warna yang paling diterima kepada filet tilapia hitam serta memberikan 'denatured muscle zone' yang minima. Rawatan menggunakan asid tartarik menyebabkab filet menjadi terlalu lembut ($P < 0.01$) manakala basuhan dengan 0.5 % asid asetik telah menukarkan warna filet kepada keputihan ($P < 0.05$) dan menyebabkan filet berbau asid asetik. Ujian penilaian deria menunjukkan bahawa rawatan menggunakan 0.5 % asid asetik, sitrik dan tartarik ke atas filet tilapia hitam telah merendahkan skor bau tanah sebanyak 75, 65 dan 48 % masing-masing.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTER I

GENERAL INTRODUCTION

Fish provides an important source of high quality protein food since its nutritional value is similar to that of meat and milk, although less than that of eggs. It is cheaper than other animal protein foods, geographically within the reach of most consumers and acceptable to most ethnic and religious groups, hence, resulting in a worldwide increase in the consumption of fish and fishery

In the 1980s, the growth of marine catches rose by almost one third in the decade. In contrast, the 1990s had showed a decline instead. This could be due to overcapacity of world fishing fleets, inadequate management and over-fishing. (Josupeit, 1994). The global increase of population and continuous demand for fish as a cheap source of animal protein, contributed towards dependence on aquaculture for increasing fish supply. Recent studies show that the aquaculture was the fastest growing food production subsection and over the past decade growing more than five times as fast as the global population and may keep growing at a similar pace until and beyond the turn of the century (Csavas, 1994).

The consumer acceptance on fishery products depends on safety, nutrition, flavour, texture, color, appearance and the suitability of the raw material for

processing and preservation (Haard, 1992). However, flavour attribute seems to be one of the most important factor which influence their acceptance. Although fish exhibits a similar recognizable flavour characteristic, however the flavour differences indicate uniqueness in attributes (Josephson, 1991). The flavour characteristic of fish are derived from both their volatile and nonvolatile taste constituents. The former which is associated with fish-like aromas in fish flesh are mostly non nitrogenous constituents such as aldehydes, alcohols, volatile sulfur and ketones (Jones, 1967), while the latter are amplified by nucleotides, amino acids and inorganic acids (Josephson, 1991; Jones, 1967; Tarr, 1966). The degree to which they contribute to the flavour is dependent on their recognition threshold value and on their concentration. Specific volatile aroma compounds contribute characterizing flavour to each species (Josephson, 1991).

Unacceptable flavours may be due to the exposure of the fish to contaminated environment or their diet. In spoiled fish, the development of off-flavour is due to a series of complex changes caused by reaction of indigenous enzymes and microbially-induced activity, which will lead to the development of 'rotten flavour' in freshwater fish and the characteristic of 'fishy' taste of trimethylamine in marine fish (Love, 1988). In fresh fish, the off-flavour is caused by chemical residue in polluted water (Berg, 1983; Vale, et al., 1970) and actinomycete metabolites (Gerber and Lechevalier, 1965; Yurkowski and Tabachek, 1980). Other aquatic organism either growing in the water or serving as food for fish such as algae are also the source of off-flavour (Juttner, 1983). These metabolites are present in the fish through the direct intake of contaminated water through the skin or the gills or through feeding of blue green algae (Haard, 1992; Reineccius, 1991 and From and Horlyck, 1984).

Earthy or muddy taints occurs commonly in fish or marine products. The off-flavour compounds responsible for the earthy defects in fish are generally geosmin or 2-methylisoborneol (Yurkowski and Tabachek, 1974; Yurkowski and Tabachek, 1980; Kuusi and Suihko, 1983). Both compounds are the metabolites of actinomycetes and blue green algae (Lovell, 1983; Gerber, 1983; Kuusi and Suihko, 1983). Each compounds have strong earthy odour characteristic, with threshold odour concentration as low as ngL^{-1} level in water (Sano, 1988).

Many studies have been conducted to remove the earthy odour/flavour in fish. Limited studies on removal of off-flavour from the processed and semi-processed fish have been reported such as soaking and cleaning in supernatant of banana (*Musa sp.*) leaf ash (Mohsin et al., 1999), salt solution (Rohani and Yunus, 1994), a mixture of salt, tamarind pulp and lemon juice or a mixture of tamarind pulp, salt and lemon grass (Anon, 1991) and 4 % acetic acid (El Sahl et al., 1990).

Gerber and Lechevalier (1965) and Gerber (1983) reported that earthy flavour components especially geosmin was destroyed by acid as it is converted into argosmin which had no odour. Washing with crude extract of organic acids such as tamarind pulp and lemon juice and vinegar has been a common practice among Malaysian housewives (Jamilah and Siti Aini, 1997). Since tamarind pulp, lemon juice and vinegar contain organic acids such as tartaric (Rasul, 1992), citric (Lawrence, 1974) and acetic acid (Wheaton and Lawson, 1985) respectively, these acids may removed the earthy odour/flavour characteristic during the washing of fish.

Aquaculture in Malaysia had its beginning in the early 20th century (Ang, 1990) and recently, the industry boost a total production of more than 100,000 metric tonnes (Anon, 1997). Black tilapia (*O. mossambica*) are abundant and among the main species cultured in freshwater ponds in Malaysia. In 1997 the production of this fish had reached 4,196.64 metric tonnes of which more than 95 % was produced from freshwater ponds in Sabah, East Malaysia (Anon, 1997). The increase in production may be due to its quick growth, easy reproduction, adaptability to wide range of environmental conditions and ready acceptance of artificial feed (Saxena, 1987). The retail value for the fish was RM 34 million (Anon, 1997). Inspite of its increasing production (Anon, 1994; Anon 1997) in freshwater ponds, there are many complaints from consumers on the presence of earthy odour and flavour of the fish (Mohsin et al., 1999; Jamilah and Siti Aini, 1997).

Hence, the objectives of this study are (1) to determine the flavour components and confirm the presence of geosmin and isoborneol in black tilapia (2) to determine the effects of acid washing for the removable of the earthy attributes (3) and to determine the effects of washing on the physico-chemical characteristics of the washed fillets. The study also included the selection and training of panelists on earthy attributes. The trained panelists were then used to evaluate earthy character in treated fillets.

CHAPTER II

LITERATURE REVIEW

Volatile Flavour Components in Fish

The flavour characteristics of fish are derived from both their non-volatile and volatile components. The taste active non-volatile compounds include nucleotides, free amino acids and inorganic salts. The volatile aroma compounds which formed in the living species are lipid derived compounds, sulfur-containing compounds, unsaturated hydrocarbons, isoprenoid related compounds, trimethylamine and related amines and carotenoids-derived compounds (Jones, 1967; Josephson, 1991). Not all volatile compounds present in fish are important because the degree to which they contribute to the flavour is dependent on their recognisation threshold value and on their concentration (Josephson, 1991).

Volatile Carbonyls

Eight-carbon volatile ketones have been found to occur in most seafood. They contribute to the distinct fresh plant-like and metallic aroma, however individually, these compounds exhibited mushroom and geranium aroma (Josephson et al., 1984a; Josephson, 1991). These volatile compounds were derived through