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Freshness assessment of European eel (*Anguilla anguilla*) by sensory, chemical and microbiological methods

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Abstract

Freshness assessment of European eel (*Anguilla anguilla*) stored in ice and in boxes without ice at 3 ± 1 °C was assessed by sensory, chemical (total volatile basic nitrogen (TVB-N), thiobarbituric values (TBA), peroxide value (PV), free fatty acid (FFA), and pH) and microbiological (total viable counts, TVC) methods. The limit for sensory acceptability of eel stored in ice was ~12–14 days, and ~5–7 days at 3 ± 1 °C. TVB-N level of about ≥10 mg TVB-N 100 g^{-1} flesh could be regarded as the limit of acceptability. PV values and the release of FFA increased during storage in ice and at 3 ± 1 °C but the increases were greater at 3 ± 1 °C. Values of pH showed no statistically significant ($P > 0.05$) changes for eel stored in ice and at 3 ± 1 °C. Water losses of fillets stored at at 3 ± 1 °C were higher ($P < 0.05$) than those stored in ice. TBA values were found to fluctuate under both storage conditions. This study shows that sensory analysis of eel correlated well with microbiological analysis. The acceptability of eel decreased as TVB-N, FFA, PV and TVC values increased.

Keywords: European eel; Freshness indicators; Fish quality

1. Introduction

Eels are generally classified as warmwater fish and 19 species, including subspecies of the *Anguilla* genus, are distributed throughout the world (Arai, 1991). There are four species which are commercially important. These are *Anguilla anguilla* in Europe, *Anguilla japonica* in the Far East, *Anguilla rostrata* in North America and *Anguilla australis* in Australia and New Zealand. Eels are usually processed before retailing and process techniques include smoking, jellying, pickling and *kabayaki* for the Japanese market. Eels (*A. Anguilla*) are an economically important fish species along the eastern and southern coasts of Turkey. The market demand for fresh eel has increased markedly due to its aroma and high flesh yield. In addition, the increase in demand from European countries has resulted in the exporting of wild eel. Therefore, the study of freshness quality of eel is of interest to retailers and consumers.

Freshness is the most important attribute when assessing the quality of fish. Sensory characteristics of whole fish are clearly visible to consumers and sensory methods are still the most satisfactory for assessing the freshness quality since they give the best idea of consumer acceptance (Connel, 1995). Non-sensory methods, using biochemical, physical and microbiological analyses, are also used to assess the freshness quality of fish (Gill, 1992). Biochemical and physical methods measure the concentrations of breakdown products from bacterial or enzymatic activity. A number of spoilage indicators have been used, including total volatile basic nitrogen (TVB-N), trimethylamine (TMA) and

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formation of biogenic amines (Botta, Lauder, & Jewer, 1984a, 1984b; Hebard, Flick, & Martin, 1982; Mietz & Karmas, 1978), whereas nucleotide degradation product ratios (such as hypoxanthine, K, K_i values) have been used as freshness indicators (Saito, Arai, & Matsuyoshi, 1959; Karube, Matsuoka, Suzuki, Watanabe, & Toyama, 1984; Luong & Male, 1992).

Lipid oxidation is a major quality problem. It leads to the development of off-flavour and off-odours in edible oils and fat-containing foods, called oxidative rancidity (Nawar, 1996; Hamilton, 1994). Eel fillets are rich in polyunsaturated fatty acids which are susceptible to peroxidation. Because of their high degree of unsaturation, they are less resistant to oxidation than other animal or vegetable oils (Nawar, 1996). Free radicals react with oxygen to produce fatty acid peroxides. The fatty acid peroxides are free radicals which can attack another lipid molecule, resulting in peroxide and a new free radical (Hamre, Lie, & Sandnes, 2003). The primary product of lipid oxidation is the fatty acid hydroperoxide, measured as peroxide value (PV). Peroxides are not stable compounds and they break down to aldehydes, ketones and alcohols which are the volatile products causing off-flavour in products. PV and thiobarbituric values (TBA) are the major chemical indices of oxidative rancidity (Melton, 1983a, 1983b; Rossell, 1989). TBA value measure secondary products of lipid oxidation. TBA consists mainly of malondialdehyde as a representative of aldehydes. The oxidation process can also lower nutritional quality and modify texture and colour (Lie, 2001).

There are studies on the effects of slaughtering methods on the quality of raw and smoked eels (Vishwanath, Lilabati, & Bijen, 1998; Morzel & van de Vis, 2003) and on quality and welfare of eel (van de Vis et al., 2001). However, there is limited information on the shelf life and freshness quality of eel. The objectives of this study were to investigate the shelf life and freshness quality of eel stored in ice and in boxes without ice (3 ± 1 °C) in terms of sensory, chemical (TVB-N, TBA, PV, free fatty acid (FFA), and pH) and microbiological (total viable counts, TVC) methods.

2. Materials and methods

2.1. Sample preparation and storage of eels

Eels purchased from a local fish processing company were one-day post capture on arrival at the laboratory in ice. Eels (average weight: 228.5 ± 21.98 g) were gutted, washed and divided into two lots in ice. One lot was stored in ice at a fish-to-ice ratio of 2:1 (w/w), the second lot was stored in boxes without ice. All boxes were then stored in a refrigerator (3 ± 1 °C) for up to 19 days. Sensory and chemical analyses were performed on days 1, 5, 8, 12, 15 and 19 whereas PV and FFA were analysed on days 2, 6, 9, 13, 16 and 20 after extraction of fat. Data were obtained using three fish which were minced for each sampling.

2.2. Proximate analysis

The eel fish samples were analysed in triplicate for proximate composition: lipid content by the Bligh and Dyer (1959) method, moisture content by AOAC (1990) method, total crude protein by Kjeldhal method (AOAC, 1984), and ash content by AOAC (1990) method.

2.3. Analytical methods

The TVB-N content of eel was determined according to the method of Antonocopoulus (1973) and expressed as mg TVB-N per 100 g eel muscle. The value of TBA was determined according to Tarladgis, Watts, and Yonathan (1960) in eel fillets to evaluate the oxidation stability during storage and the results expressed as TBA value, milligrammes of malondialdehyde per kg flesh. FFA analysis, expressed as % of oleic acid was done by the AOAS (1994) method. PV, expressed in milliequivalents of peroxide oxygen per kilogramme of fat, was determined according to AOAS (1994). The pH of eel fillets was determined using a pH meter (315i, Germany). The sample was homogenised in distilled water in the ratio 1:10 (w/v) and the measurement was done by pH meter. The water-holding capacity (WHC) of raw sample was determined as ''centrifuge drip'' in each fish sample. About 5g of fish, without skin and bones, were weighed into dry clean centrifuge tubes and centrifuged at 3000 rpm for 30 min at −4 °C. Water-holding capacity was calculated on a wet weight basis as $100 \times (1 - S/V)$, where S is the weight of the expelled water, V is the initial weight of sample (Del Valle & Gonzales-Inigo, 1968).

2.4. Sensory analysis

For sensory analysis, triplicate samples, from each of the two storage conditions, were taken at regular intervals. Sensory analysis was assessed using the Tasmanian Food Research Unit scheme (Branch & Vail, 1985) with modifications for eel. Table 1 shows the modified Tasmanian Food Research Unit freshness assessment scheme. This sensory assessment approach evaluates freshness by giving demerit points according to certain aspects of general appearances (e.g. skin, slime, eyes, belly, odour). Each assessment was carried out by a minimum of six trained panellists Panellists were asked to state whether or not the fish were acceptable. This was