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RESEARCH ARTICLE
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CHEMICAL AND SENSORY ASSESSMENT OF HOT-SMOKED FISH PÂTÉ

Mustafa Ünlüsayın [1*], Şengül Bilgin [2], Levent İzci [2] and Ali Günlü [2]

[1]Fisheries Faculty, Akdeniz University, Antalya-Turkey

[2] Eğirdir Fisheries Faculty, Süleyman Demirel University, Isparta, Turkey

Abstract: Sea bass, sea bream and rainbow trout have been hot-smoked for fish pâté. Filets of each species were minced and prepared as fish pâté by adding various additives after hot-smoking. The chemical compositions, fatty acid profile, cholesterol content and sensory analysis for fish pâté were investigated. Significant differences (P < 0.05) were found in fat, ash and sodium chloride content among the samples. Palmitic acid methyl ester was the most abundant in the saturated fraction of different fish pâtés, and values were ranged from 29.98 (%) to 31.18 (%). Linoleic acid methyl ester was the main contributor of polyunsaturated fatty acid (PUFA), which was found between 22.89% and 24.17% in different fish pâtés. The lowest cholesterol level was found in rainbow trout pâté (243.82 µg /g). Sensory evaluation of all the pâtés was considered as acceptable for the panellist.

Keywords: fish pâté, sensory evaluation, fatty acids, cholesterol level

* **Correspondence to:** Assoc. Prof. Dr. Mustafa ÜNLÜSAYIN, Fisheries Faculty, Akdeniz University, Antalya-Turkey, Department of Fishing and Fish Processing Technology, Tel: +90 242 3106687 Fax: +90 242 2262013, E-mail: munlusayin@akdeniz.edu.tr

Introduction

Pâté is a processed product that has important gastronomic traditions and good sensory properties. Pâtés made from a variety of flesh foods including fish, which have become a popular item in delicatessens and supermarkets. The term of pâté is sometimes reserved for a product with a courser texture. In addition, while pastes and spreads are usually sold as a sterile product in cans or jars, pâtés are sometimes also sold as chilled products (Le Ba and Zuber 1996). Pâtés is traditionaly made with liver from goose or pig in the meat industry that have been taken as a reference by the fish industry for the development of similar products used with different fish species, such as salmon, tuna or anchovy (Echarte et al., 2004).

Due to the growth in demand in fish products in worldwide, fish industry is forced by using fisheries resource efficiently. Therefore, the aim of the work was to prepare different fish pâtés formula using aquaculture fish species (sea bass, sea bream and rainbow trout) by chemical (proximate composition, cholesterol levels and fatty acid profile) and sensory assessment.

Material and methods

Preparation of pâtés

Sea bass, sea bream and rainbow trout were used for this investigation. Sea bass (*Dicentrarchus labrax*) and sea bream (*Sparus aurata*) (300-330g) was purchased from a local marine culture farm (Agean Region - Bodrum ,Turkey). Rainbow trout (*Oncorhynchus mykiss*) (250-300g) was obtained from a local aquaculture farm (Dalaman - Muğla, Turkey). All fish were kept in boxes with ice flakes after catching. Chemical and sensory analysis was started after 24h of catching. Fish samples were prepared for hot smoking process using an AFOS-type mechanical kiln according to smouldering method previously described (Ünlüsayın et al., 2001). Briefly, the viscera of the fish were removed and the leftovers such as blood, mucus and tissue pieces were washed with large amount of water. Three fish species were kept in 20 % salt solution (w/w), (Fish-Brine solution rate one-to-one) at 16°C for a period of 45 min. The fish were then removed from the brine solution hung on the kiln, strained and kept at 20°C for about 20 min. Oak sawdust were used for smoking process. For the first 45 min, 30°C temperature was applied to fish. Over the next 3 hours the temperature was gradually increased to 50°C, 60°C and finally 70°C. The temperature was kept at 80°C during last 45 min. The whole smoking process took about 4.5 hours. The hot-smoked sea bass, sea bream and rainbow trout flesh's were filleted and minced. The samples were then used to prepare fish pâté's.

Three experimental pâtés were elaborated in a pilot plat. One formulation for experimental pâtés used for all raw materials. For formulation of hot-smoked fish, 50% fish flesh, 20% fresh butter and 30%water were used. This formulation was prepared according to procedure of Aquerrata et al. (2004) and modified. Other ingredients were added as follows (g/kg of raw material): sodium chloride (15), powdered milk (20), sodium caseinate (10), dextrose (7), polyphosphates (2), monosodium glutamate (2), powdered white pepper (3), powdered ginger (1) and powdered onion (2).

The manufacturing process for all fish pâté was as follows: fresh butter was scalded for 15 min at 80°C and then minced in a cutter. Subsequently, sodium caseinate, powdered milk, dextrose and polyphosphates were added and mixed. Hot water was then added slowly, followed by the hot-smoked fish flesh and the remainder of the ingredients. The whole mixture was completely minced. Finally, mixture was packed in a glass container and sterilised at 116°C for about 1.5 h.

Sensory analysis

Sensory evaluation was carried out according to method of Stone and Sidel (2004), Quantitative descriptive analysis (QDA) was done for the sensory quality of the different fish pâté. Ten trained panellists for flavour, texture, appearance and aroma examined samples. A continuous scale between 0 and 9 was used. A value of 0 corresponded to the lowest and a value of 9 to the highest intensity for each parameter.

Analytical procedures

Moisture content was determined according to method of AOAC (2002a). Crude protein content (Nx6.25) was calculated using the Kjeldahl method (AOAC, 2002b). Lipid content was determined according to Soxhlet method described in AOAC (2002c). Crude ash was determined according to AOAC (2002d) method. Sodium chloride was determined according to volumetric method described in AOAC (1995).

The method of Bligh and Dyer (Hanson and Olley 1963) was carried out for the lipid extraction. Fatty acid profile was determined by gas chromatography after methylation with sodium metoxide according to method of Izquierdo et al. (2002). The samples (0.5 µl) were injected into a gas chromatography working with a FID detector (Perkin Elmer Autosystem XL GC) fitted with a capillary column Cp SIL 88 (100m x 0.25 mm x 0.2 µm). The temperatures of the injection port and detector were both 240°C. The oven temperature was 175°C during 27 min running time, followed by an increase to 215°C at a rate of 4°C/min and 5 min at 215°C and followed by an increase to 240°C at a rate of 4°C/min and 15 min at 240°C. The carrier gas was helium (15 psi). The identification of peaks was done by comparison of their retention times with those of pure standard compounds (Sigma, St. Luis, MO, USA) was based on heptadecanoic acid methyl ester as internal standard.

The determination of cholesterol was done by gas chromatography, according to the method described by Kovaks et al. (1979). Perkin Elmer Autosystem XL GC equipped with Zebron ZB-1 column (15m x 0.32 mm i.d.). The oven temperature was 285°C. The temperatures of the injection port and FID detector were both 300°C. The sample (1µl) cholesterol was identified by comparing its relative and absolute retention times with those of cholestane (Sigma, St. Louis, MO, USA) as an internal standard.

Statistics analysis

Every parameter was measured in triplicate for each sample. Statistical analyses were performed using SPSS 9.0 for Window software (SPSS INC. Chicago, IL, USA). Analysis of variance (ANOVA) were used for statistical significance was at $P<0.05$.

Results and discussion

In this study, no significant differences ($P > 0.05$) were found between any of the samples of the flavour, texture and aroma attributes. Only appearance of fish pâtés was significantly different ($P<0.05$) (Table 1). The sensory evaluation panel also indicated that the most favourable fish pâté was sea bass pâté, followed by rainbow trout pâté and sea bream pâté. There are no differences for acceptability for all samples and all of them were considered to be acceptable as fish pâté for panellist. These results show that these types of fish could be used as raw materials for fish pâté.

Table 2 shows the results of chemical composition of experimental pâtés. Significant differences in fat, ash and sodium chloride content among the samples were found ($P<0.05$). However, no significant differences in moisture, protein and carbohydrate content among the samples were found ($P>0.05$). Pâtés are considered, in general, as high energy containing foods. According to the Aquerrata et al. (2002), the chemical composition of traditional formulation (pâtés made with goose/pork liver) was found to be 47-56% moisture, 25-33% fat, 12-14% protein, 1-2% ash, 4-5% carbohydrates and 0.7-1% sodium chloride. In this work, moisture was ranging from 56 to 59%, fat ranging from 15 to 18%, protein ranging from 13 to 14%, and carbohydrates ranging from 7 to 9% and sodium chloride ranging from 1 to 2% which implies less fat and high carbohydrates content in this experimental investigation (Table 2). This diversity was due to the differences in the moisture/fat ratio.

Palmitic acid methyl ester was the most abundant in the saturated fraction of every fish pâtés followed by myristic acid methyl ester (Table 3), highly contributing to the total amount of this fraction, whose values range from 29.98 (%) to 31.18 (%).Echarte et al. (2004) found the similar results, which palmitic acid values was abundant in fish pâtés between 1.8 g/100g and 5.98 g /100 g Oleic acid methyl ester was the most abundant fatty acid in the fish pâtés. This monounsaturated fatty acid was the main contributor of MUFA, between 9.80% and 11.24 % (Table 3). Similar data was found for experimental fish pâtés between 7.38 mg/100 g and 10.21 mg/100g by Aquerrata et al. (2002). Linoleic acid methyl ester was the main contributor of polyunsaturated fatty acid (PUFA) and found abundant in fish pâtés between 22.89% and 24.17% (Table 3). Aquerrata et al. (2002) observed that high values of linoleic acid (5.65-8.51 g/100g) in experimental fish pâtés. This result is parallel with in our study. Lauric acid, tridecanoic acid, cis-10-pentadecenoik acid, heptadecanoic acid, stearic acid, arachidic acid, linolenik acid methyl esters did not show significant differences in experimental fish pâtés (Table 3).

Table 1. Sensory analysis of experimental fish pâtés.

	A (Sea Bass Pâtés)	B (Sea Bream Pâtés)	C (Rainbow Trout Pâtés)
Flavour	7.25±1.41[a]	6.80±1.61[a]	7.15±1.31[a]
Texture	7.90±1.77[a]	6.88±1.73[a]	7.40±1.55[a]
Appearance	7.23±2.22[a]	5.15±2.03[b]	7.41±1.98[a]
Aroma	7.43±2.11[a]	6.63±2.14[a]	6.77±2.26[a]

* Different letters in the same row show significant differences among samples (P < 0.05). Values are shown as mean ± sd of triplicate measurements

Table 2. Chemical compositions of experimental pâtés.

	A (Sea Bass Pâtés)	B (Sea Bream Pâtés)	C (Rainbow Trout Pâtés)
Moisture (%)	58.74±1.13[a]	56.97±1.55[a]	58.39±0.11[a]
Protein (%)	13.30±0.81[b]	13.69±0.20[b]	13.47±0.68[b]
Fat (%)	15.44±0.13[b]	17.90±1.56[a]	15.24±0.11[b]
Ash (%)	3.61±0.03[b]	3.99±0.05[a]	3.98±0.06[a]
Carbohydrate (%)	8.91±1.59[a]	7.45±1.93[a]	8.92±0.71[a]
Sodium Chloride (%)	1.60±0.02[b]	1.67±0.11[ab]	1.73±0.03[a]

* Different letters in the same row show significant differences among samples (P < 0.05). Values are shown as mean ± sd of triplicate measurements

Table 3. Contents of fatty acids (%) and cholesterol (µg /g product) level of experimental fish pâtés.

Fatty acids	A (Sea Bass Pâtés)	B (Sea Bream Pâtés)	C (R. Trout Pâtés)
Butric acid ($C_{4:0}$)	1.57±0.31[b]	1.95±0.25[a]	2.00±0.41[a]
Caproic acid ($C_{6:0}$)	1.25±0.32[b]	1.37±0.14[ab]	1.44±0.30[a]
Caprylic acid ($C_{8:0}$)	0.74±0.19[b]	1.27±0.52[a]	1.21±0.28[a]
Capric acid ($C_{10:0}$)	2.11±0.38[b]	2.28±0.17[b]	2.54±0.37[a]
Lauric acid ($C_{12:0}$)	2.85±1.15[a]	2.65±0.16[a]	2.97±0.34[a]
Tridecanoic acid ($C_{13:0}$)	0.15±0.19[a]	0.14±0.02[a]	0.11±0.04[a]
Myristic acid ($C_{14:0}$)	9.24±3.00[b]	10.42±0.38[ab]	11.30±0.82[a]
Myristoleic acid ($C_{14:1,\ cis\ 9}$)	0.27±0.02[b]	0.31±0.07[b]	0.48±0.19[a]
Pentadecanoic acid ($C_{15:0}$)	0.54±0.12[b]	0.53±0.10[b]	0.69±0.22[a]
cis-10-pentadecenoik acid ($C_{15:1}$)	1.09±0.06[a]	1.10±0.20[a]	1.09±0.06[a]
Palmitic acid ($C_{16:0}$)	31.03±2.32[a]	29.98±0.47[b]	31.18±0.66[a]
Heptadecanoic acid ($C_{17:0}$)	2.33±0.89[a]	2.66±0.21[a]	2.38±0.16[a]
cis 10 –heptadecenoic acid ($C_{17:1}$)	0.43±0.12[b]	0.45±0.12[ab]	0.53±0.13[a]
Stearic acid ($C_{18:0}$)	0.22±0.03[a]	0.24±0.02[a]	0.23±0.05[a]
Oleic acid ($C_{18:1,\ cis\text{-}9}$)	11.24±1.72[a]	9.80±0.36[b]	10.53±0.62[a]
Linoleic acid ($C_{18:2,\ cis\text{-}9,12}$)	24.17±1.69[a]	22.89±1.03[b]	23.44±1.36[ab]
Arachidic acid ($C_{20:0}$)	3.05±0.88[a]	3.29±0.20[a]	3.01±0.71[a]
Linolenic acid ($C_{18:3,\ cis\text{-}9,12,15}$)	0.25±0.16[a]	0.24±0.09[a]	0.28±0.14[a]
Heneicosanoic acid ($C_{21:0}$)	0.48±0.10[a]	0.38±0.09[b]	0.27±0.13[c]
cis-4,7,10,13,16,19-docosahexaenoic acid ($C_{22:6}$)	1.74±0.22[b]	2.14±0.23[a]	2.06±0.23[a]
Σ SFA (%)	55.56	57.16	60.42
Σ cis-MUFA (%)	13.03	11.66	12.63
Σ cis-PUFA (%)	26.16	25.27	25.77
UFA/SFA	0.70	0.65	0.63
PUFA/SFA	0.47	0.44	0.43
Cholesterol (µg /g product)	340.64±8.46[a]	262.41±16.93[b]	243.82±5.72[b]

* Different letters in the same row show significant differences among samples (P < 0.05). Values are shown as mean ± sd of triplicate measurements

SFA, saturated fatty acids; **UFA**, unsaturated fatty acids; **MUFA**, mono unsaturated fatty acids; **PUFA**, polyunsaturated fatty acids.

In the analysed fish pâtés, cholesterol levels were found as 243.82 µg/g for rainbow trout pâté and 262.41 µg/g for sea bream pâté and 340.64 µg/g for sea bass pâté (Table 3). According to the Echarte et al. (2004), cholesterol level in analysed samples of fish pâtés was 31.4 mg/100g for anchovy pâté, 32.3 mg/100 g for cod pâté and 36.9 mg/100g for salmon pâté. The difference in cholesterol level was found to be significant (P<0.05) in our study. The result obtained from this study for cholesterol level in fish pâtés is contradictory with the report of Echarte et al. (2004). The reason for high cholesterol content in the pâtés could be due to use of butter in our different formulation. Recent epidemiological studies conclude that the type of fat used in the diets is an important factor in relation to health. It has been proved that the substitution of saturated fat by unsaturated fat is more effective in the decreased of risk of cardiovascular disease than only reduction of total fat intake (Hu et al. 2001). Furthermore, the influence of different types of saturated fatty acids (SFA) on the cholesterol levels and risk of cardiovascular disease has been determined.

Epidemiological studies also reveal that low incidence of cardiovascular pathologies in the Inuit (Eskimo) population, who are great fish consumers (Dyerberg and Bang 1979). This fact was related to the abundance of ω-3 long chain fatty acids in the fish fat, such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Further reports have demonstrated that the beneficial effects of these fatty acids are due to a complex interaction of a number of mechanisms, such as reduction of the plasma levels of triglycerides, decrease in platelet aggregation, their antiarrithmic effect and their beneficial effect on endothelial dysfunction (Goodfellow et al., 2000; Varlık et al., 2004).

Conclusions

The sensory evaluation showed that fish pâtés could be acceptable as a different type of the pâtés by panellist. The pâtés made with sea bass, sea bream and rainbow trout are products with an interesting chemical composition, having nutritional advantages as a new developed products compared with other fatty meat products, especially because of their omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Cholesterol level was generally found low concentration.

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