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Research Article

Determination of the Amino Acid and Chemical Composition of Canned Smoked Mussels (*Mytilus galloprovincialis*, L.)

Gülgün F. ŞENGÖR[1], Hüseyin GÜN[2], Hanife KALAFATOĞLU[2]

[1]Department of Seafood Processing Technology, Faculty of Fisheries, İstanbul University,
Ordu Cad. No: 200 34470 Laleli-İstanbul - TURKEY

[2]TÜBİTAK-MAM, The Institute of Food Science and Technologies, Gebze-Kocaeli - TURKEY

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Abstract: In this research smoking and canning techniques were applied to cultured mussels (*Mytilus galloprovincialis*, L.) from the Çanakkkale Strait in Eceabat, Turkey. Mussels that were smoked by liquid and traditional methods were canned in different sauces. The chemical composition and amino acid composition of the canned smoked mussels were determined by the results of laboratory analyses. As a result of smoking and canning mussels, a food with high nutritional value was obtained. It was determined that the heat applied to the product during smoking and canning did not effect amino acid composition negatively and that if any losses occur, they may be replaced by the sauce contents.

Key Words: Liquid smoke, traditional smoke, canning, amino acid composition, chemical composition

Tütsülenmiş-Konservelenmiş Midye (*Mytilus galloprovincials*,L.)'nin Amino Asit ve Kimyasal Kompozisyonunun Belirlenmesi

Özet: Bu araştırmada Çanakkale boğazı Eceabat mevkii'nde kültür yoluyla üretilen midye (*Mytilus galloprovincialis*, L.)'ye tütsüleme ve konserveleme teknikleri uygulanmıştır. Likid ve geleneksel yöntemle tütsü aroması kazandırılmış midyeler, farklı sos içeriklerinde konservelenmiştir. Tütsülenmiş-konservelenmiş midyelerin kimyasal kompozisyon ve amino asit kompozisyonu laboratuvar analiz sonuçları ile belirlenmiştir. Midyelerin tütsülenerek konservelenmesi neticesinde besin değeri yüksek bir ürün ortaya çıkmıştır. Tütsüleme ve konserveleme sonucu ürünlere uygulanan sıcaklığın amino asit kompozisyonunu olumsuz yönde etkilemediği; olabilecek kayıpların ise; konserve sos içerikleriyle giderildiği tespit edilmiştir.

Anahtar Sözcükler: Likid tütsü, geleneksel tütsü, konserveleme, amino asit kompozisyonu, kimyasal kompozisyon

Introduction

Turkey has potentially rich sources of seafood, in terms of variety and species. Contrary, consumption of mollusks and crustacean is considerably low. The majority of the seafood consumed in Turkey is fresh rather than processed products. The cause of this consumption preference is consumer habits and the marketing and distribution network of seafood products. However, increased production of canned fish products has recently shown that consumption habits are changing. Fresh water fish and sea fish are the dominant groups consumed in Turkey. Until now, the consumption of crustaceans and mollusks in Turkey has been minimal. Meanwhile, a very small amount of crustaceans and mollusks are processed as fresh, frozen, and marinated product. Turkey's export of mollusks is about 2686 tons as live, canned, pickled, chilled, and frozen (1). Exported mollusks from Turkey are mainly the black mussel (*Mytilus galloprovincialis*), the bearded horse mussel (*Modilus barbatus*), the clam (*Tapes decussatus*), the warty venus (*Venus verrucosa*), the babyclam (*Venus gallina*), and the oyster (*Ostrea edulis*). It was reported by Alpbaz (2) that the black mussel is widespread in Turkey, from the South Aegean coast to all along the Black Sea

* E-mail: sengor@istanbul.edu.tr

coast in the north. Turkish seawaters provide highly suitable conditions, in terms of salinity, temperature, and nutritious elements, as well as being unpolluted, for raising mollusks, and one of the best bodies of water is the Çanakkale Strait. In this study smoking and canning techniques were applied to mussels from the Çanakkale Strait that were cultivated by a private enterprise in Eceabat, and the chemical and amino acid content of the canned smoked mussels were investigated.

Materials and Methods

As the research material, mussel (*Mytilus galloprovincialis*) 6-8 cm long and 25-30 g in weight that were cultivated at Eceabat in the Çanakkale Strait were used. The mussels were cleaned, steamed, and frozen as block, then transferred to the TÜBİTAK Food Science and Technologies Institute, Gebze, where technological processes and studies were performed.

Processing Techniques

Block frozen mussels were left to defrost at 5 ± 1 ºC overnight. The defrosted mussels were then treated with 2 different solutions. The traditional smoked mussel (MTE) group, was treated for 1 h in a 3% salt and 1% monosodium glutamate (MSG) solution, with a brine ratio of 1:1. The liquid smoked mussel (LSE) group was kept in a solution containing 0.4% liquid Aromsa smoke aroma (TR 6442) for 13.5 h at 5 ± 1 ºC. Both groups were put into baskets after they were taken out of the solutions and remained there until the water was drained. Then, the MTE group was smoked in wire mesh trays in a mechanical kiln (AFOS-Torry Mini Kiln); 15 min for drying and 45 min in oak wood smoke. During smoking, as the moisture level of the mussels was too high, the kiln temperature and the temperature of the mussel meat did not exceed 55 ºC and 35 ºC, respectively. Subsequently, mussels from both groups were canned. Before canning, both groups were heated to 75 ºC in order to obtain vacuum during canning. Then, both groups of mussels were put in 200-g cans with a daphne leaf and 1 of 2 different sauces (tomato puree sauce; S_1, curry sauce; S_2). The can lids were clinched on and the cans were exhausted in steam for 10-15 min. The cans were then seamed, washed, and thermal sterilized at different temperatures in a vertical still-retort equipped with a lethal rate measuring system. The integrated lethal rate measured every 1.0 sec during the entire sterilizing process was F_0-value. The come-up time to processing temperature (120 ± 1 ºC) was 5.2 ± 0.1 min.

Main Group Codes

CON: Control group (steamed mussels).

LSE: Mussels which were kept in brine and liquid smoke solution.

MTE: Traditional smoked mussels.

Caned Smoked Mussels Group Codes

S_1M: Traditional smoked mussels canned with tomato puree sauce.

S_1L: Liquid smoked mussels canned with tomato puree sauce.

S_2M: Traditional smoked mussels canned with curry sauce.

S_2L: Liquid smoked mussels canned with curry sauce.

Methods of Analysis

Mussels that went through different smoking processes were analyzed and compared to CON. Protein, moisture, and ash content were determined according to AOAC (3); lipid content according to the Bligh and Dyer (4).

Amino acid analysis of 0.1-mg samples hydrolyzed with 1 mL 6 N HCl for 24 h was made with an Eppendorf Biotronik LC 3000 (Eppendorf Cooperation, USA; 1999) microprocessor controlled amino acid analyzer.

Statistical analyses were evaluated according to one-way analysis of variance using the Excel 98 package program.

Results

The chemical composition of mussels before and after smoking and canning are shown in Table 1.

The protein content of the steamed mussels was reduced by different processing steps; however, the highest level was observed in the MTE group. When the moisture levels of all groups were compared it was observed that due to the smoking and canning process used for the canned smoked mussels, it was less than the 73% moisture level of CON; not much difference was observed between the CON, and S_1L and S_2L groups, whereas a significant difference was observed between

Table 1. Chemical composition of mussels (*Mytilus galloprovincialis*, L.) before and after canning (g/100 g wet weight).

Sample	Protein[a]	Lipid[a]	Ash[a]	Moisture[a]
CON	17.3 ± 0.04	4.0 ± 0.28	1.8 ± 0.19	73.0 ± 0.07
LSE	16.5 ± 0.12	3.3 ± 0.57	2.2 ± 0.11	72.8 ± 0.80
MTE	20.4 ± 0.45	4.9 ± 1.30	2.4 ± 0.02	69.4 ± 0.23
S_1L	12.4 ± 0.16	6.7 ± 0.14	2.8 ± 0.01	73.4 ± 0.31
S_1M	12.7 ± 0.46	8.1 ± 0.14	3.1 ± 0.14	70.2 ± 0.62
S_2M	12.2 ± 0.47	10.6 ± 0.57	2.8 ± 0.01	71.1 ± 0.29
S_2L	11.7 ± 0.31	8.7 ± 0.28	2.6 ± 0.02	73.8 ± 0.04

[a]Values are mean ± standard deviation (n = 3).

the CON and MTE groups. When the chemical composition results of the canned groups were examined, the protein content of all the groups varied slightly; however, the protein content of all the products, except MTE, decreased in comparison to that of CON. The highest protein content among the canned smoked groups was determined in the S_1L and S_1M groups. When the ash and lipid content of the mussels were examined, a significant increase occurred in all of canned groups in comparison to CON: however, the LSE group had lower lipid content than CON.

The amino acid composition of the analyzed mussels before and after canning is presented in Table 2. All groups, except MTE, had a decrease in protein content. The 2 most abundant essential amino acids in canned

Table 2. Amino acid composition of mussels (*Mytilus galloprovincialis*, L.) before and after canning (g/100 g).

Amino acid	CON	LSE	MTE	S_1L	S_2L	S_1M	S_2M
Aspartic acid	1.36	0.834	1.478	1.241	0.949	1.249	0.969
Threonine*	0.718	0.449	0.824	0.694	0.531	0.655	0.519
Serine	0.812	0.469	0.992	0.793	0.598	0.711	0.589
Glutamic acid	1.784	1.028	2.081	1.847	1.433	1.854	1.463
Proline	1.523	1.096	1.073	1.673	0.532	0.987	0.366
Glycine	0.801	0.368	0.998	0.682	0.550	0.625	0.528
Alanine	0.704	0.410	0.977	0.666	0.623	0.607	0.519
Cystine	0.261	0.201	0.277	0.258	-	0.233	0.216
Valine*	0.66	0.461	0.719	0.610	0.471	0.569	0.468
Methionine*	0.249	0.149	0.288	0.237	0.137	0.208	0.181
Isoleucine*	0.592	0.375	0.651	0.543	0.406	0.507	0.413
Leucine*	0.954	0.587	1.062	0.861	0.660	0.809	0.657
Tyrosine	0.683	0.485	0.730	0.669	0.511	0.621	0.527
Phenylalanine*	0.844	0.645	0.847	0.775	0.671	0.751	0.614
Histidine*	0.426	0.291	0.466	0.395	0.307	0.374	0.315
Lysine*	1.046	0.590	1.770	1.068	0.902	0.976	0.811
Arginine*	0.869	0.459	1.490	0.937	0.806	0.846	0.758
Total amino acid	14.286	8.897	16.723	13.949	10.087	12.582	9.913
EAA/NEAA	0.802	0.819	0.943	0.782	0.941	0.827	0.915

EAA*: Essential amino acids. NEAA: Non-essential amino acids.

smoked mussels were arginine and lysine, which accounted for 14.85% and 17.13% in S_1M, 15.31% and 28.92% in S_1L, 16.47% and 18.44% in S_2L, and 16.00% and 17.12% in S_2M of the essential amino acid total, respectively. Non-essential amino acids in the smoked mussels, of which aspartic acid and glutamic acid were the most abundant, accounted for 18.13% and 26.92% in S_1M, 15.85% and 23.59% in S_1L, 18.26% and 27.57% in S_2L, and 18.71% and 28.25% in S_2M of the amino acid total, respectively. Therefore, it can be stated that the nutritional value of canned smoke mussels was enhanced by adding sauces.

Discussion

Muller and Tobin (5) reported that the edible part of mussels is 80% water, 10% protein, 1.5% lipid, 3% carbohydrate, and 2% ash, with 275 kj of energy. As can be seen from the chemical composition results, traditional smoking is the most convenient method, as it decreases the moisture level in the food. The research results demonstrated similarity to Chellappan's (6) steamed oyster meat, with a moisture content of 71.36%. According to the one-way analysis of variance of the chemical composition of the canned smoked mussels differences in the protein and moisture levels were statistically significant ($P < 0.05$). Application of liquid and traditional smoking affected the chemical composition of the canned smoked mussels, especially moisture content ($P < 0.05$). Slabyj and Carpenter (7) reported that there is an increase in ash content, whereas there is a decrease in the amount of dry materials and carbohydrate content of canned or frozen mussels. In contrast, there is a significant increase in the amount of dry material, and a decrease in the carbohydrate and ash content of steamed mussels. Furthermore, Slabyj and Carpenter (7) stated that raw mussel meat contained 81.2% moisture, 3.29% protein, 0.81% lipid, 0.41% ash, and 0.75% carbohydrate, steamed mussel meat contained 74.6% moisture, 2.73% protein, 0.62% lipid, 0.24% ash, and 0.32% carbohydrate, and canned mussel meat contained 75.7% moisture, 2.90% protein, 0.72% lipid, 0.27% ash, and 0.20% carbohydrate. These results, which were obtained through the canning process, are similar to those of our chemical composition results. As a result of the canning process the chemical composition of mussels changed to that of steamed mussels.

The nutritional quality of protein is connected to the quantity of the essential amino acids in food (8). Through the smoking and canning processes the relative changes in the content of free amino acids of canned smoked mussels resulted in levels that were reasonably comparable to those of steamed mussels. It's estimated that water conditions where the mussels were cultivated and the additives used for pre-processing before smoking and canning might have been responsible. The amino acid content of *Mytilus galloprovincialis* mussels was rather stable and a slight increase in essential and nonessential amino acids content was observed at low temperatures (9). Lopez (10) reported that glutamic acid, which is a widely known amino acids, is an important source of nitrogen, although it's a non-essential amino acid and is usually used to improve or balance the taste of monosodium glutamate. She also stated that glutamate exists naturally in many foods, such as meat, milk, fish, poultry, and vegetables, in varying amounts. When all the groups were examined, glutamic acid content of mussel meat, before and after canning, was rather high. No negative effects on glutamic acid content due to either smoking or canning were found. Domah et al. (11) reported that fresh, cooked, and canned mussels are richer in terms of lysine, methionine, cystine, threonine, phenylalanine, tyrosine, tryptophan, and arginine when compared to those of beef or FAO reference protein. It's been reported that boiling or frying increases the nutritional value of mussels, as demonstrated by our amino acid composition results. It was also reported that the nutritional value of fried canned mussels was high (11). When the amino acid composition of canned smoked mussels (liquid or traditional smoked) were evaluated, the biological value of all canned smoked mussels was very high. Having cysteine and methionine in low quantities is a positive result of smoking, as these amino acids contain sulfide. Low cysteine and methionine content in all the groups indicated that no darkening occurred. Naczk and Artyukhova (12) reported that the loss of amino acids occurs during sterilization with heat; after 60 min of sterilization at 120 ºC amino acids and proteins are degraded. It has been determined that the amino acid composition in almost all of the groups increased due to the contributions of canning and sauces. It can therefore be surmised that the protein quality of canned smoked mussels was positively affected by the smoking and canning processes.

As a result of smoking and canning mussels, a food with high nutritional content was obtained. It was determined that the heat applied to the mussels as a result of smoking and canning did not negatively affect the amino acid composition; and that if any losses did occur, these may have been compensated for by sauce contents. Smoking and canning techniques did not affect the amino acid content mussels. Canned smoked mussels serve as a good protein supplement to the human diet because of their high essential amino acid content.

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