Comparison of Extractive Components between Raw and Salted Alaska Pollack Roe ("Tarako")

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Alaska pollack roe and its salted product ("Tarako") were analyzed extensively for nitrogenous and nonnitrogenous extractive components to elucidate their changes during salting. The change in proximate composition was also examined. The results obtained are summarized as follows.

1) The protein content decreased somewhat, but the lipid content hardly changed during the salting. The content of ash increased remarkably due to salting, and the extractive nitrogen increased to some extent.

2) As for the nitrogenous extractive components in the roe, free amino acids, especially Tau, Ala, Glu, and Leu, were predominant. Considerable amounts of creatine, trigonelline, and trimethylamine oxide were also found. The levels of nucleotides and related compounds were rather low.

3) Among the analyzed nonnitrogenous extractive components in the roe, lactic acid and inorganic ions, such as Na^+ , K^+ , Cl^- , and PO_4^{3-} , were dominant. It is noticeable that a relatively large amount of sugar alcohols was detected.

4) The most striking changes in extractive components during the salting were the large decrease in Tau and the large increase in Na^+ and Cl^- .

5) Free amino acids and inorganic ions were found to constitute the most part of extractives from "Tarako", suggesting that they were the principal contributors to its flavor.

Succeeding the previous study, in which the changes in extractive components of mullet roe during the processing into salted and dried product (Japanese name, "Karasumi") were investigated,¹⁾ a similar study was conducted on Alaska pollack roe.

The Alaska pollack is one of the most economically important fish in Japan. Its catch amounted to about 1.4 million tons in recent years.²⁾ The flesh of the fish is mostly processed into "Surimi" which is used for the production of "Kamaboko" and related products. Its ovary, a by-product, is chiefly processed into salted product called "Tarako" in Japan. The production of "Tarako" showed a steady increase in recent five years and reached a level as high as 57,000 t in 1986,²⁾ since it is one of the most popular seafoods and in strong demand in our country. For these reasons, our studies on the extractive and flavor components in seafoods aimed at those in the roe and "Tarako" to examine their changes during the salting.

Materials and Methods

Roe Samples

Alaska pollacks *Theragra chalcogramma* caught in the northern Pacific Ocean in September, 1984 were used. The average body length, body weight, and gonado-somatic index were 44 cm, 650 g, and 2.6, respectively. After being removed and washed with sea water, the roes (raw material) were soaked in about 15% salt (sodium chloride) solution for 40-60 min and drained for about 1 h ("Tarako"). The raw material and "Tarako" from 20 fish each were frozen and stored at -30°C until analyses.

Prior to the proximate analysis and the preparation of extracts, the roe samples were thawed at 4°C overnight, the ovary membranes were discarded, and the eggs were mixed well in a mortar.

Methods

The methods used in this study for the proxi-

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mate analysis, the preparation of extracts, and the determinations of various extractive components in both samples were the same as those described previously.¹⁾

Results

Proximate Composition and Extractive Nitrogen

The proximate compositions of the raw material and "Tarako" are presented in Table 1. The moisture of raw material was 71.8%, while that of "Tarako" was 64.7%. The protein decreased slightly and the lipid hardly changed during the salting. The ash increased greatly from 8.2% in the raw material to 19.6% in "Tarako" due to the salting.

The extractive nitrogen (EN) which amounted to 606 mg (Unless otherwise stated, the amounts of EN and extractive components are expressed in terms of mg in 100 g dry matter.) in the raw material increased to 652 mg in "Tarako". The content of EN in the raw material is higher than that in the mullet roe,¹⁾ but still lower than those reported for eggs of sea water fish such as saury, flying fish, and flathead flounder.³⁾

Table 1. Proximate composition and extractive nitrogen (EN) of raw and salted Alaska pollack roe ("Tarako")

		(%)			
		On dry basis			
	Moisture	Protein	Lipid	Ash	EN
Raw material	71.8	78.7	6.7	8.2	0.606
"Tarako"	64.7	70.3	6.0	19.6	0.652

Free and Combined Amino Acids

The contents of free (FAA) and combined amino acids (CAA) are shown in Table 2. Among FAA in the raw material, Tau (1,103 mg) was prominent, amounting to 35% of the total FAA, but it decreased remarkably during the salting. On the contrary, most of the major FAA in the raw material such as Thr, Ser, Gln, Val, Leu, and Arg increased more or less during the salting. Consequently, the total amount of FAA hardly changed, but that of FAA excluding Tau gained an increase of 14%.

The levels of CAA in the raw material were rather low as compared with those of FAA except ethanolamine which exceeded 140 mg. Its origin is unknown at present and worth to study. At least, a part of combined glycine might be derived from nucleotides and related compounds.⁴⁾ Most

Table 2. Free and combined amino acids of raw and salted Alaska pollack roe ("Tarako")

	(mg/100 g dry matter)	
	Raw material	"Tarako"
Taurine	1,103	770
Aspartic acid	81 (20)*	94 (57)
Threonine	103 (26)	123 (38)
Serine	107 (42)	132 (57)
Glutamic acid	202 (38)	171 (95)
Glutamine	116	164
Proline	32 (6)	62 (54)
Glycine	68 (46)	81 (63)
Alanine	215 (13)	206 (48)
α -Aminobutyric acid	39	25
Valine	128 (8)	160 (39)
Cystine	10 (4)	8 (5)
Methionine	59	64 (19)
Cystathionine	12	8
Isoleucine	85 (9)	105 (27)
Leucine	180 (16)	240 (45)
Tyrosine	69 (10)	91 (26)
Phenylalanine	58 (10)	80 (23)
β -Alanine	99 (6)	64 (5)
β -Aminoisobutyric acid	8	6
Ethanolamine	64 (141)	58 (103)
Tryptophan	33	22
Lysine	123 (17)	128 (50)
Histidine	50 (7)	49 (14)
Arginine	62 (14)	149 (36)
Total	3,112 (439)	3,062 (804)
Nitrogen recovered (%)	68 (13)	65 (19)
Ammonia	30	56

* The amounts of combined amino acids are given in parentheses.

of CAA increased during the salting, indicating that a considerable amount of oligopeptides was produced.

Nucleotides and Related Compounds

Various kinds of nucleotides and related compounds were detected in the raw material, but their levels were very low (Table 3); the constituents exceeding 20 mg were only inosine and CMP. The Alaska pollack roe seemed to be a little more abundant in nucleotides and related compounds than the mullet roe.¹⁾ Most of these constituents declined more or less during the salting.

Other Nitrogenous Constituents

A relatively high level of creatine (85 mg) and a very low level of creatinine (1 mg) were present in the raw material (Table 4). In "Tarako", the former decreased considerably, while the latter

Table 3. Nucleotides and related compounds in raw and salted Alaska pollack roe ("Tarako") (mg/100 g dry matter)

	Raw material	"Tarako"
GDP	++	1
ADP	1	++
CDP	1	++
GMP	7	2
AMP	3	1
IMP	17	4
CMP	33	4
UMP	+	1
NAD ⁺	19	3
Guanosine	10	9
Adenosine	+	+
Inosine	43	40
Cytidine	16	16
Uridine	19	13
Guanine	+	+
Adenine	+	++
Hypoxanthine	19	12
Cytosine	2	3
Uracil	14	7

+, trace; ++, less than 0.4 mg/100 g dry matter.

Table 4. Other nitrogenous components in the extracts of raw and salted Alaska pollack roe ("Tarako") (mg/100 g dry matter)

	Raw material	"Tarako"
Creatine	85	54
Creatinine	1	3
Carnitine	1	+
Glycinebetaine	2	++
Homarine	7	5
Trigonelline	37	28
TMAO	46	4
TMA	5	12

+, trace; ++, less than 0.4 mg/100 g dry matter.

changed little.

As for quaternary ammonium bases in the raw material, trimethylamine oxide (TMAO, 46 mg) and trigonelline (37 mg) were the principal constituents, and homarine (7 mg), glycinebetaine (2 mg), and carnitine (1 mg) were the minor ones (Table 4). All of these compounds decreased during the salting, but the decreasing rate of TMAO was very high. The diminution of TMAO was accompanied by a rise of trimethylamine (TMA) from 5 mg to 12 mg.

Sugars and Organic Acids

Nine sugars were identified in both samples as

Table 5. Nonnitrogenous components in the extracts of raw and salted Alaska pollack roe ("Tarako") (mg/100 g dry matter)

	Raw Material	"Tarako"
Sugars:		
Glyceraldehyde	25	76
Glucose	10	26
D-Mannitol	37	51
Dulcitol	3	6
<i>myo</i> -Inositol	79	39
Sucrose	13	13
Maltose	1	1
Mannose	20	29
Glucuronic acid	3	1
Organic acids:		
Lactic acid	241	225
Succinic acid	13	1
Acetic acid	49	16
Inorganic ions:		
PO ₄ ³⁻	491	107
Cl ⁻	1,095	8,817
Na ⁺	399	5,135
K ⁺	367	354
Ca ²⁺	1	1
Mg ²⁺	1	5

shown in Table 5. Among them, *myo*-inositol, D-mannitol, glyceraldehyde, and mannose (20–79 mg) were the major sugar constituents in the raw material. Sucrose, glucose, dulcitol, glucuronic acid, and maltose were also present in small amounts. It is noteworthy that the Alaska pollack roe was rich in sugar alcohols. Most of the sugars increased during the salting, but *myo*-inositol, the most abundant sugar component, was reduced by half.

With respect to organic acids, a large amount of lactic acid (241 mg) was found in the raw material with smaller amounts of acetic (49 mg) and succinic (13 mg) acids. During the processing into "Tarako", lactic acid declined little, but the other two acids dropped sharply.

Inorganic Ions

As demonstrated in Table 5, Cl⁻, PO₄³⁻, Na⁺, and K⁺ were detected as the major inorganic ions in the raw material. In "Tarako", the contents of Cl⁻ and Na⁺ were increased substantially due to the brine treatment. On the other hand, the level of PO₄³⁻ was lowered to less than one fourth, and K⁺ was kept at the almost same level.

Distribution of Various Components in the Extracts

The nitrogen distribution in the extracts is

Fig. 1. Nitrogen distribution in the extracts of raw and salted Alaska pollack roe ("Tarako"). The figures at the top of the columns indicate the recovery on nitrogen basis.

Fig. 2. Distribution of various components in the extracts of raw and salted Alaska pollack roe ("Tarako"). The figures at the top of the columns indicate the recovery on weight basis.

presented in Fig. 1, which clearly shows that FAA are the most prominent nitrogenous components, occupying 68% and 65% of EN in the raw material and "Tarako", respectively. The recoveries of EN were very high, being more than 95% in both extracts.

Fig. 2 shows the distribution of the analyzed components in the extracts. The recoveries of

dry matter of the extracts were 91% for the former and 95% for the latter. It is apparent from the figure that the extractives of "Tarako" consisted mostly of minerals and FAA, suggesting that those components are most influential to its flavor.

Discussion

"Tarako" is produced from Alaska pollack roe by a simple procedure, *i.e.*, brine-salting. Since "Tarako" is reputed to be much more palatable than the raw material, it has been anticipated that considerable changes in taste-active components must occur during the simple processing. However, the changes in FAA that have been proved to be important flavor components in some seafoods,⁵⁻⁷⁾ were not so remarkable, differing from the mullet roe whose FAA increased considerably during the processing.¹⁾ Furthermore, the umami-giving nucleotides such as GMP, IMP, and AMP were decreased. The taste-active components that increased significantly during the processing were only two inorganic ions, Na^+ and Cl^- . But it should be pointed out that the amount of FAA in the raw material of "Tarako" (Alaska pollack roe) was considerably higher than that in the raw material of "Karasumi" (mullet roe) and was even superior to that in "Karasumi". Thus it may be reasonable to assume that the large amount of increased FAA contributes to the flavor in the case of "Karasumi", whereas the large amount of inherent FAA does in the case of "Tarako".

The importance of Na^+ and Cl^- in producing the flavor of seafoods has been recognized.⁵⁻⁷⁾ They should participate not only in salty taste of "Tarako" but also in its characteristic flavor jointly with FAA.

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