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Quality Comparison of Commercial Boiled-dried Anchovies by Different Catch Methods

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This study was conducted to compare the quality among commercial boiled-dried anchovies caught by different methods. Regardless of catch methods, the moisture, salinity and acid-insoluble ash contents of commercial boiled-dried anchovies ranged from 23.2~25.2%, 6.8~7.4% and 0.32~0.46%, respectively. By sensory evaluation, these anchovies were less than 5% in break-age, whitish or yellowish in color and had a foul smell. Judging from the above results and Korean Standards (KS) for foods, these anchovies were classified into special grade. There was no difference in total amino acid content. While, in a major mineral content, boiled-dried anchovy caught by set net (BA-SN) was the highest, and those caught by lift net (BA-LN) and tow net (BA-TN) followed in order. The lipid oxidation progressed at the slowest rate in the BA-SN, and then no difference in the lipid oxidation was found between the BA-LN and BA-TN. Judging from the results of chemical analysis and sensory evaluation, the BA-TN was the worst quality among the commercial boiled-dried anchovies. No difference in quality was found between the BA-LN and the BA-SN.

Key words: Commercial boiled-dried anchovy, Boiled-dried anchovy, Food component, Anchovy

Introduction

Anchovies constitute one of the largest fish groups caught in the coastal area of Korea (The Fisheries Association of Korea, 1998). They are highly nutritive, depending mainly on essential amino acids, functional mineral such as calcium and ferrum (Cho et al., 2001) and highly unsaturated fatty acid such as EPA (eicosapentaenoic acid, 20:5) and DHA (docosapentaenoic acid, 22:6) (Jeong et al., 1995a; 1995b). However, despite of the abundant amount of fish caught and the high nutritive quality of anchovy, it is difficult to utilize as a raw material for food processing due to the unique and specific characteristics that make it an unusual and often difficult material, namely; the tendency of anchovy freshness to decrease rapidly; occurence of rapid post-mortem changes causing its protein to denature easily; high proporation of high proteolytic activity enzyme in anchovy viscera and muscle tissue accelerates autolytic degradation of tissue proteins (Pyeun et al., 1995). For these reasons, anchovies are mainly used as a raw material of boiled-dried product and fish sauce having quality stability in Korea. There is 160,000~250,000 ton caught each year in Korea. Most of them are usually caught by tow net, set net, lift net, etc. By the report on Korean Standards (KS) for foods of processed seafood products, grading of boiled-dried anchovy was established as special grade and high grade regarding present distributional conditions. Quality criteria of sensory properties were established about its shape, color and flavor. Moisture content was limited to not less than 28%, and salt content not less than 8%. The maxium content of other size anchovy and broken anchovy in a single packaging unit were established not to exceed 5% in special grade and 10% in high grade. Also, acid-insoluble ash content was established not to exceed 1.0% in special grade and 1.5% in high grade (Korea Food Research Institute, 1998). Among

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these quality criteria of boiled-dried anchovy, organoleptic properties were generally determined by catch condition (method, area and catch amount per day), drying condition (temperature, method and time) and storage condition (temperature, method and time). This study was conducted to compare the quality among the commercial boiled-dried anchovies caught by different methods.

Material and Methods

Samples

Commercial boiled-dried anchovy caught by tow net (BA-TN) was purchased from Kumjeong Fisheries Inc. (Tongyeong, Korea), and commercial boiled-dried anchovies caught by set net (BA-SN) and lift net (BA-LN) were purchased from Samjin Fisheries Inc. (Goseung, Korea). The raw anchovy (*Engraulis japonicus*) of these commercial boiled-dried anchovy (body length: 6.21 ± 0.69 mm, body weight: 0.7 ± 0.1 g) were caught on the sea near Tongyeong and Goseung in October 2000.

Proximate composition and acid-insoluble ash

Proximate compositions were determined according to AOAC (1990); moisture content by air oven method, crude lipid by Soxhlet method, crude protein by semimicro Kjeldahl method and crude ash by direct ashing method.

Acid-insoluble ash was determined according to Korean Industrial Standard (1998).

Salinity and VBN (volatile basic nitrogen)

Salinity was determined according to the method of Mohr (Pharmaceutical Society of Japan, 1980) and the contents of VBN were determined by Conway micro-diffusion method (Ministry of Social Welfare of Japan, 1960).

Total amino acid and mineral contents

Total amino acids were analyzed with an automatic amino acid analyzer (LKB-4150α, England) after hydrolysis of the commercial boiled-dried anchovy powders with 6 N HCl at 110℃ for 24 hrs in an evacuated seal tube.

The samples for the measuring of mineral and phosphorus were pretreated according to Tsutagawa et al. (1994), and then, the treated samples were analyzed by inductively coupled plasma (ICP) spectrophotometer (Atomscan 25, Thermo Electron Co., Waltham, MA).

Fatty acid composition and Hunter's b values

Total lipid was extracted and purified according to the method of Bligh and Dyer (1959). Fatty acid composition was determined after methylation (AOCS, 1990) and analysis by gas-liquid chromatography (Shimadzu GC 14A, Shimadzu Seisakusho, Co. Ltd., Kyoto, Japan) using an Omegawax 320 fused silica capillary column (30 m×0.32 mm, ID., Supelco Park, Bellefonte, PA, USA). The injector and the flame-ionization detector temperature were maintained at 250℃ and the column was programmed to operate from 180℃ (initial time 8 min) to 230℃ at 3℃/min with the final time set for 15 min. Helium was used as a carrier gas at the constant inlet pressure of 1.0 kg/cm^2 with a split ratio of 1:50. Fatty acids were identified by comparison to authentic standards (Sigma Chemical Co., St. Louis, MO, USA) and a sample of oyster which had been analyzed by Koizumi et al. (1990). Data was calculated as the peak area percent of the total area of fatty acids.

The samples for measuring Hunter's b value were powdered and determined using a color difference meter (Nippon Denshoku Kogyo Co., Ltd., ZE-2000, Japan).

Sensory evaluation and statistical analysis

Sensory evaluation was measured on color, odor, texture and appearance of commercial boiled-dried anchovies by 7 sensory panels. The scoring method with 5 hedonic scale (4, 5, superior to quality of commercial boiled-dried anchovy caught by tow net; 3, the same quality as quality of commercial boiled-dried anchovy caught by tow net; 1, 2, in-ferior to quality of commercial boiled-dried anchovy caught by tow net) was used.

Statistical analysis was conducted with ANOVA to investigate relative correlations among items of each experiment, and the SPSS (Statistical Package, SPSS Inc.) system was used for the data analysis.

Results and Discussion

Proximate composition and salinity

The proximate composition and salinity of boiled-dried anchovies caught by different methods are shown in Table 1. Regardless of catch methods, the proximate composition on dry basis of commercial boiled-dried anchovies ranged from 68.2~68.9% in crude protein, 8.4~9.6% in crude lipid and 21.1~21.9% in crude ash, respectively, and showing no appreciable difference. These results indicate that there were no difference in drying condition among BA-TN, BA-SN and BA-LN. The contents of acid-insoluble ash and salinity in the boiled-dried anchovies ranged from 0.32~0.46% and 6.8~7.4%, respectively, and there were no differences by different catch methods. By sensory evaluation, these anchovies were less than 5% in breakage, whitish or yellowish in color and had a foul smell.

Table 1. Comparison in proximate composition and salinity among commercial boiled-dried anchovies caught by different methods (g/100 g)

Proximate composition		Catch methods		
		Tow net	Set net	Lift net
Moisture		23.2±0.2	25.2±0.4	23.2±0.8
Crude proteir		52.4±0.0(68.2)*	51.5±0.0(68.9)	52.5±0.1(68.4)
Crude lipid		7.2±0.2(8.4)	7.2±0.2(9.6)	7.1±0.2(9.3)
Ash	Crude	16.6±0.4(21.6)	15.8±0.1(21.1)	16.8±0.1(21.9)
	Acid-insoluble	0.32±0.05	0.46±0.06	0.43±0.03
Salinity		7.4±0.3	6.8±0.1	7.4±0.3

*Numbers in the parentheses mean values on dry basis.

Judging from the above results and Korean standardization (Korea Food Research Institute, 1998), these anchovies were classified into special grade.

Total amino acid and mineral contents

Total amino acid contents and compositions of commercial boiled-dried anchovies caught by different method are shown in Table 2 on dry basis. The contents of total amino acids of BA-TN, BA-SN and BA-LN were 65,745.1 mg/100 g, 66,096.7 mg/100 g and 65,648.0 mg/100 g, respectively, and showing no appreciable difference. Regardless of catch methods, the important and abundant total amino acids of commercial boiled-dried anchovies were aspartic acid (6,825.0~6,989.5 mg/100 g), glutamic acid (10,008.9~10,097.6 mg/100 g) and lysine (6,242.4~6,507.5 mg/100 g). The total contents of these 3 kinds accounted for 34.9~36.3% of the total amino acids.

Table 2. Comparison in total amino acid contents and compositions among commercial boiled-dried anchovies caught by different methods (mg/100 g, dry basis)

Amino acids	Catch methods		
	Tow net	Set net	Lift net
Asp	6,825.0(10.4)*	6,894.9(10.4)	6,989.5(10.6)
Thr	3,390.7(5.2)	3,279.6(5.0)	3,212.5(4.9)
Ser	3,396.5(5.2)	2,995.6(4.5)	2,933.0(4.5)
Glu	10,097.6(15.4)	10,008.9(15.1)	10,383.0(15.8)
Pro	2,954.2(4.5)	2,818.7(4.3)	2,674.8(4.1)
Gly	3,787.5(5.8)	3,872.1(5.9)	3,706.9(5.6)
Ala	4,323.5(6.6)	5,446.1(8.2)	4,422.5(6.7)
Val	3,574.9(5.4)	3,122.7(4.7)	3,653.7(5.6)
Met	1,836.8(2.8)	1,940.5(2.9)	1,925.2(2.9)
Ile	2,855.4(4.3)	2,983.8(4.5)	3,232.7(4.9)
Leu	5,025.9(7.6)	5,392.3(8.2)	5,634.3(8.6)
Tyr	1,513.7(2.6)	1,703.6(2.6)	1,528.5(2.3)
Phe	2,932.6(4.5)	2,793.2(4.2)	2,908.3(4.4)
His	2,908.7(4.4)	2,543.4(3.8)	2,178.5(3.3)
Lys	6,291.5(9.6)	6,242.4(9.4)	6,507.5(9.9)
Arg	4,030.7(6.1)	4,058.8(6.1)	3,757.9(5.7)
Total	65,745.1(100.0)	66,096.7(100.0)	65,648.0(100.0)

*Numbers in the parentheses are the percentage to total amino acid contents.

Mineral contents of commercial boiled-dried anchovies caught by different methods are shown in Table 3 on dry basis. Regardless of catch methods, the abundant minerals of commercial boiled-dried anchovies were calcium, phosphorus and potassium and the other minerals were low level. In the case of minerals in commercial boiled-dried anchovies caught by different methods, the contents of calcium and phosphorus were showing significant difference, while those of the other minerals were showing no appreciable difference. The contents of calcium and phosphorus of commercial boiled-dried anchovies were high in the following order; BA-SN≥BA-LN>BA-TN. In general, the difference of the mineral content in the same fish species may be due to the ratio difference between collagen and mineral by the maturity (Kim et al., 2001) and the difference of scale drop by different catch and processing methods (Hamada and Kumagai, 1988).

Table 3. Comparison in mineral and phosphorus contents among commercial boiled-dried anchovies caught by different methods (mg/100 g, dry basis)

Minerals	Catch methods		
	Tow net	Set net	Lift net
Calcium	1,911.8 ± 22.3	2,398.3 ± 67.1	2,414.3 ± 33.4
Phosphorus	1,609.1 ± 18.5	2,158.8 ± 14.4	2,172.6 ± 18.3
Magnesium	204.3 ± 19.7	276.5 ± 7.2	222.4 ± 7.7
Potassium	1,503.6 ± 18.9	1,697.1 ± 32.3	1,689.5 ± 17.3
Zinc	3.38 ± 0.23	4.85 ± 0.43	4.36 ± 1.22
Manganese	3.30 ± 0.05	3.65 ± 0.08	1.83 ± 0.04

Therefore, The difference of calcium and phosphorus contents among commercial boiled-dried anchovies might be due to the difference of scale drop by different catch methods.

Fatty acid composition, ratio of the polyenoic acids to the saturated and monoenoic acids and Hunter's b values

The fatty acid composition of total lipid in commercial boiled-dried anchovies caught by different methods are shown in Table 4. The prominent fatty acids in all samples were 16:0, 18:1n-9, EPA (20:5 n-3) and DHA (22:6n-3), there was a difference in the major fatty acid compositions among commercial boiled-dried anchovies caught by different methods. The fatty acid profiles of commercial boiled-dried anchovies caught by different methods were similar to those reported by Takiguchi (1987) and Heu and Kim (2002), but different from those recorded in the fatty acid composition table (National Fisheries Research and Development Agency, 1989) and those reported by Lee et al. (1986). These differences were considered to be due to seasonal variation, different drying methods and the difference in the column used in GLC analysis (Jeong et al., 1995a). In the percentages of polyunsaturated fatty acids to total fatty acids, BA-SN was the highest, and there was no difference between BA-LN and BA-TN. While, in those of saturated fatty acids, BA-SN was the lowest, and there was no difference between BA-LN and BA-TN.

Fig. 1 shows the comparison of the ratio of the polyenoic acids (PA) to the saturated (SA) and monoenoic acids (MA) of total lipid in each sample, in order to illustrate more clearly the lipid oxidation. In the ratio of the PA to the SA and MA, BA-SN was the highest, and there was no difference between BA-LN and BA-TN. According to Park et al. (1995) and Takiguchi (1986), the percentage of SA and MA in dried fish increased with processing time, espicially drying time, while that of PA decreased.

The Hunter's b values in commercial boiled-dried anchovies caught by different methods are shown in

Table 4. Comparison in fatty acid composition among commercial boiled-dried anchovies caught by different methods

Fatty acids (Area %)	Catch methods		
	Tow net	Set net	Lift net
14:0	7.8	5.2	7.7
15:0iso	0.8	0.7	0.5
15:0	0.9	0.5	1.0
16:0iso	0.2	0.2	0.2
16:0	24.8	22.9	23.8
17:0	0.6	0.8	1.3
18:0	6.6	7.8	6.8
20:0	1.8	1.2	1.5
22:0	0.3	0.3	0.2
Saturates	43.8	39.6	43.0
16:1n-7	5.3	5.8	5.2
16:1n-5	0.3	0.2	0.3
18:1n-9	8.1	6.4	8.5
18:1n-7	3.1	3.2	3.1
18:1n-5	0.1	0.1	0.1
20:1n-9	0.3	0.3	0.3
20:1n-7	0.2	0.5	0.4
22:1n-7	0.1	0.1	0.1
24:1n-9	0.2	0.3	0.3
Monoenes	17.7	16.9	18.3
16:2n-4	0.7	0.7	0.8
16:3n-4	0.4	0.6	0.4
16:4n-3	0.8	0.5	1.0
18:2n-6	1.1	1.4	1.4
18:2n-4	0.2	0.1	0.1
18:3n-4	0.1	0.2	0.4
18:3n-3	0.9	0.7	0.1
18:4n-3	1.2	1.2	1.0
20:2n-9	0.2	0.3	0.1
20:4n-6	1.2	1.6	1.5
20:4n-3	0.3	0.3	0.3
20:5n-3	10.6	11.3	10.4
21:5n-3	0.3	0.3	0.3
22:4n-6	0.1	0.2	0.2
22:5n-6	0.5	0.7	0.5
22:5n-3	1.0	1.7	1.1
22:6n-3	18.9	21.7	19.1
Polyenes	38.5	43.5	38.7

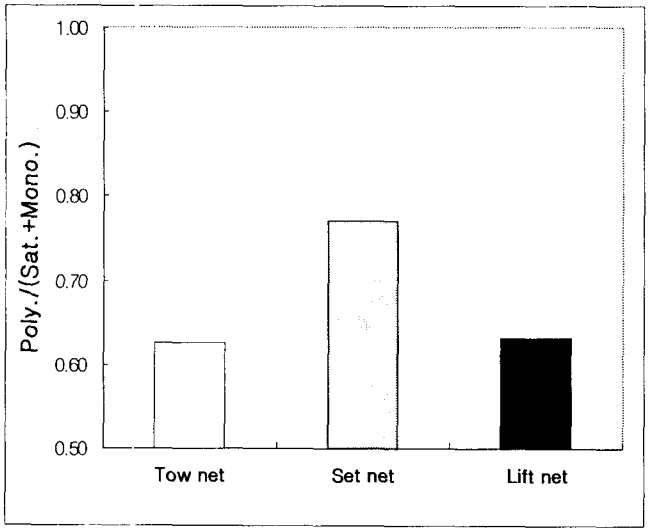

Fig. 1. Comparison of polyenoic acids to saturated and monoenoic acid of total lipid in the commercial dried-anchovies caught by different methods.

Fig. 2. In the case of Hunter's b values, BA-SN was the lowest, and there was no difference between BA-LN and BA-TN.

These results suggest that lipid oxidation progressed at the slowest rate in the BA-SN, and there was no difference between BA-LN and BA-TN. This might be due to difference of catch time, processing times and fish handling.

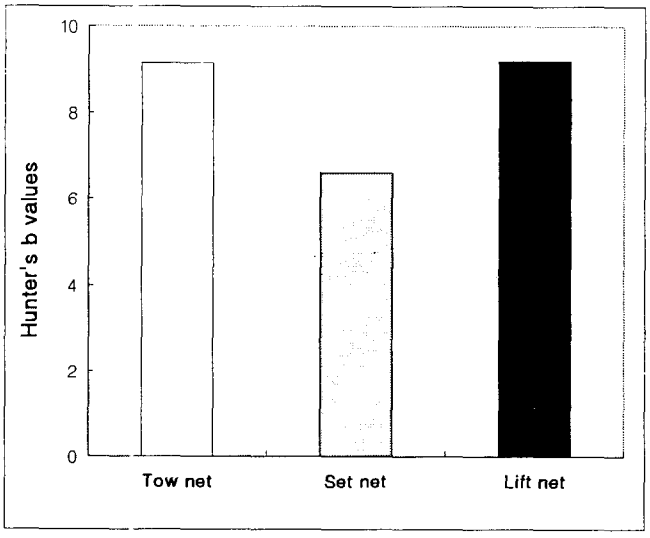

Fig. 2. Comparison in Hunter's color values among commercial boiled-dried anchovies caught by different methods.

VBN (Volatile basic nitrogen) content

VBN contents in commercial boiled-dried anchovies caught by different methods are shown in Fig. 3. In commercial boiled-dried anchovies caught by different methods, the BA-SN had the lowest content, while no difference was found between the BA-LN and BA-TN. This might be due to the delaying extent of processing time by the difference of catch amount. According to Korean Standards (KS, Korean Food Research Institute, 1998) for foods,

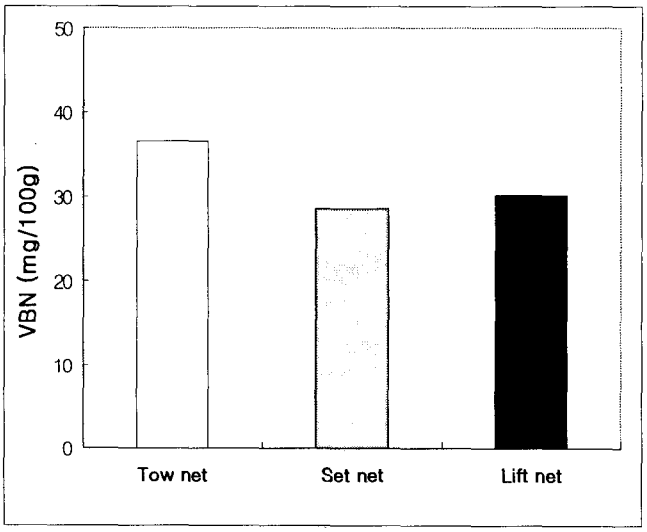

Fig. 3. Comparison in volatile basic nitrogen (VBN) contents among commercial boiled-dried anchovies caught by different methods.

Table 5. Comparison of the results in sensory evaluation among commercial boiled-dried anchovies caught by different methods

Sensory items	Catch methods		
	Anchovy tow net	Set net	Lift net
Color	3.0[b]*	4.1 ± 0.4[a]	3.2 ± 0.2[b]
Odor	3.0[a]	3.2 ± 0.4[a]	3.2 ± 0.3[a]
Texture	3.0[a]	3.2 ± 0.2[a]	3.4 ± 0.4[a]
Appearance	3.0[a]	3.0 ± 0.2[a]	3.1 ± 0.2[a]

*The same letters in each items indicates insignificant difference at the 5% level using Ducan's mutiple range test. Five scale: 4, 5, superior to quality of commercial boiled-dried anchovy caught by tow net; 3, the same quality as quality of commercial boiled-dried anchovy caught by tow net; 1, 2, inferior to quality of quality of commercial boiled-dried anchovy caught by tow net.

customer's interest is responsible for the volatile basic nitrogen content. Judging from the results of VBN content, the product caught by set net was the best quality among the commercial boiled-dried anchovies.

Sensory evaluation

The results of sensory evaluation in commercial boiled-dried anchovies caught by different methods are shown in Table 5. In color of sensory evaluation, BA-SN had a significantly higher score than BA-TN and BA-LN, while there was no difference between BA-LN and BA-TN. In odor, texture and appearance of sensory evaluation, there was no significant difference in all products.

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