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Full Length Research Paper

Analysis of food components of freeze-dried Alaska Pollack (Hwangtae)

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Physiochemical properties of freeze-dried Alaska Pollack (Hwangtae) were investigated. The moisture, crude ash and crude fat content of Hwangtae were 12.53, 5.91 and 0.94%, respectively. Contents of saccharides were found to be 3.69 mg/100 g in dried weight of glucose and 5.71 mg/100 g in dried weight of sucrose. Minerals in 100 g dry weight of Hwangtae include phosphorus (806.5 mg), calcium (612.7 mg), potassium (442.2 mg), sodium (283.5 mg), magnesium (89.9 mg), zinc (1.9 mg), iron (0.8 mg), manganese (0.3 mg) and aluminum (0.2 mg), respectively. Glutamic acid and aspartic acid were the major amino acids, containing 925.4 and 644.7 mol/g in dried weight, respectively. Fatty acids in Hwangtae were composed of monounsaturated fatty acids, polyunsaturated fatty acids and saturated fatty acids, containing 16.3, 41.2 and 42.5%, respectively. Our results suggested that this Hwangtae, a freeze-dried fish, can be used as a good nutrition source for human health.

Key words: Amino acid, docosahexaenoic acid, fatty acid, freeze-dried Alaska Pollack, Hwangtae.

INTRODUCTION

There is continuing public concern about increased meat consumption containing high cholesterol in patterns of food intake in Korea. High cholesterol accumulation in blood vessel is known to induce coronary sclerosis and cardiovascular disease (Kang et al., 2000). However, consumption of fish rich in unsaturated fatty acids, such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), has a beneficial effect on decreasing high cholesterol level in body (Lees, 1990; Augood et al., 2008; Miller et al., 2008).

Freeze-dried Alaska Pollack, also called Hwangtae in Korea, is a natural food. This is prepared by drying the intestine-removed from fish in cold winter condition. Drying period usually takes four months from late December to early April. Traditionally, Hwangtae has long been known to have detoxification effect from alcoholic damage and carbon monoxide poisoning. However, nutritional studies of Hwangtae, including physiochemical composition, have been rarely investigated, while several studies focused mainly on the food processing of Hwangtae (Kang and Park, 1975; Cho et al., 2003).

Therefore, we analyze nutritional components in Hwangtae. In this study, we measured the amounts of proximate chemical composition, mineral, amino acid, and fatty acid composition. This study presented basic data on Hwangtae nutrition, which could be useful in food companies.

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Abbreviations: DHA, Docosahexaenoic acid; **EPA,** eicosapentaenoic acid; **FAME,** fatty acid methyl esters; **PUFA,** polyunsaturated fatty acids; **HPLC,** high performance liquid chromatography; **ICP,** inductively coupled plasma; **GC,** gas chromatography; **FID,** flame ionization detector.

MATERIALS AND METHODS

Material preparation

Hwangtae, a product prepared in Yongdaeri (Inje, Korea), was used in this study. Sample was ground to make fine powder using liquid nitrogen with a mortar and a pestle. The powder was used for the analyses of minerals, amino acids, fatty acids and saccharides.

Proximate chemical composition

Analyses in this experiment were done in triplicates and the standard methods recommended by the Association of Official Analytical Chemists (AOAC, 1990) were followed. Moisture content was carried out with high pressure processing dry method while heat and the crude ash content were determined by calcinations in a furnace at 550°C. Crude fat content was determined by Soxhlet method (AOAC, 1990). Crude protein content was determined by the micro-Kjeldahl method (Shin, 1994).

Analysis of saccharides

Five grams of ground Hwangtae sample was treated with 10 ml of 80% ethanol in a 80°C water bath for 1 h. The treated sample was centrifuged at 3000 rpm for 10 min at 4°C and the supernatant was collected. The ethanol solvent was vacuum-evaporated at 40°C. The remaining was dissolved in 1.0 ml distilled water. The sample, infiltrated through a 0.45 µl filter (Millipore), was analyzed using a high performance liquid chromatography (HPLC) (Autochro 3000, Young-Lin Co., Korea) equipped with a RI detector column (750F, Young-Lin Co.). A carbohydrate analysis column (300 × 3.9 mm, Waters Co., USA) was utilized in the HPLC analysis. An isocratic system using 80% acetonitrile was employed. The mobile phase of the solvent was 1.5 ml/min with 10 µl of sample injection volume. Standards for saccharides in the HPLC analysis contained fructose, glucose, maltose and sucrose.

Analysis of inorganic components

For the analysis of each of Na, K, Fe, Mg or Cu content, 20 g of the sample pretreated by a dry ashing method were used; 2 g of the sample for the analysis of Al or P content. For the analysis of Ca content, 25 g of the sample was first dissolved in 1 N HCl and adjusted to 1,000 mg/kg by adding $LaCl_3$. Samples were dry-ashed in a 550°C electric furnace for 4 h. After cooling in a desiccator, each ashed sample was dissolved in 50 ml of 1 N HCl and infiltrated using a filter paper (Whatman #541). Prepared samples were analyzed using an inductively coupled plasma (ICP) emission spectrometer (SPECTRO CIROS CCD-ICP, ATL Co., USA).

Analysis of amino acids

Ground samples were prepared for amino acid determination by acid hydrolysis with 6 N HCl for 24 h at 110°C in vial under vacuum and N_2 atmosphere. Sample solution was evaporated and dissolved in sodium citrate buffer (pH 2.2). The hydrolysates were analyzed by a post-column derivative method using a HPLC, which was combined with a Pickering PCX5200 derivatizer (Pickering Laboratories, Inc., USA) and ion exchange column (3.0 × 250 mm, 8 µm). The identification of amino acids was spectrometrically performed by measuring at 570 nm.

Analysis of fatty acids

Fatty acids were extracted using a $CHCl_3$: MeOH (2:1, v/v) solution. The samples were centrifuged at 3,000 rpm. The supernatants collected were added with 0.9% NaCl solution and centrifuged at 3,000 rpm. The $CHCl_3$ phase was evaporated under nitrogen gas and treated with 14% boron trifluoride methanol solution (BF_3-MeOH) for 10 min at 100°C. After cooling to room temperature, 1.0 ml of water and 2.0 ml of pentane were added. The pentane phase was evaporated under nitrogen gas and dissolved in *n*-hexane. Fatty acid composition was analyzed using a gas chromatography (GC) (Acme 6000, Young-Lin Co.), which was equipped with a flame ionization detector (FID) and SPBTM-fused silica capillary column (130 mm × 0.25 mm, 0.25 µm, Supelco Co., USA). Nitrogen gas was used for the carrier. The injector and detector temperature were 150 and 280°C, respectively. The temperature gradient of the GC oven was programmed to be initiated at 180°C for 8 min and raised 3°C/min until it reached a final temperature of 230°C for 15 min. Individual fatty acid methyl esters (FAME) were quantified as a percentage of total FAME analyzed.

RESULTS AND DISCUSSION

Proximate chemical composition and saccharide content

The proximate composition of Hwangtae is shown in Table 1. Hwangtae was revealed to contain 12.53% moisture, 5.91% crude ash and 0.94% crude fat, respectively. Oh (1994) and Van Pelt et al. (1997) reported that moisture, crude ash and crude fat content in *Theragra chalcogramma* was 80 - 84, 1 - 3 and 1.4%, respectively. As expected, the moisture content of Hwangtae was decreased due to the drying processing. Hwangtae showed an increase in crude ash content, compared to that of *T. chalcogramma* (Oh, 1994; Van Pelt et al., 1997) Similar observation of crude fat content in Hwangtae was also found in a previous report (Cho et al., 2008). However, the fat content of Hwangtae was lower than that of sun-dried *T. chalcogramma* (Oh, 1994). The sucrose content of Hwangtae was found to be the highest (5.71 mg/100g D.W.) among tested saccharides. The glucose content was 3.69 mg/100 g D.W. However, other saccharides such as fructose and maltose were not detected (Table 1).

Analysis of inorganic components

The content of inorganic components was measured in Hwangtae. As shown in Table 2, the contents for P and Ca were relatively higher, having values of 806.5 and 612.7 mg/100 g in dried weight, respectively. The other inorganic contents in Hwangtae were found to be in the following order, K>Na>Mg>Zn>Fe>Mn>Al. No detection of Cu was observed in Hwangtae. It was reported that bones of fish contain a higher amount of P and Ca as a form of hydroxyapatite (Lee et al., 1997). However, our data showed that the fleshiness of Hwangtae contains a large amount of P and Ca. The observation of high contents of P and Ca in Hwangtae may be due to their transportation from bone to fleshiness because Hwangtae is manufactured without removal of bones, or a nutrition change in fleshiness during the drying processing.

Analysis of amino acids

A total 15 amino acids were detected in Hwangtae (Figure 1)

Table 1. Proximate composition and contents of saccharides in Hwangtae.

Component	Content (%)
Moisture	12.53 ± 0.01
Crude protein	74.26 ± 0.05
Crude ash	5.91 ± 0.06
Crude fat	0.94 ± 0.07
Saccharide	**mg/100 g dried weight**
Glucose	3.69 ± 0.2
Sucrose	5.71 ± 0.1

Each value represented mean ± standard derivation of triplicates

Table 2. Mineral contents in Hwangtae.

Mineral	Dried Alaska Pollack (mg/100 g dried weight)
P	806.5
K	442.2
Ca	612.7
Na	283.5
Mg	89.9
Zn	1.9
Fe	0.8
Al	0.2
Mn	0.3
Cu	0

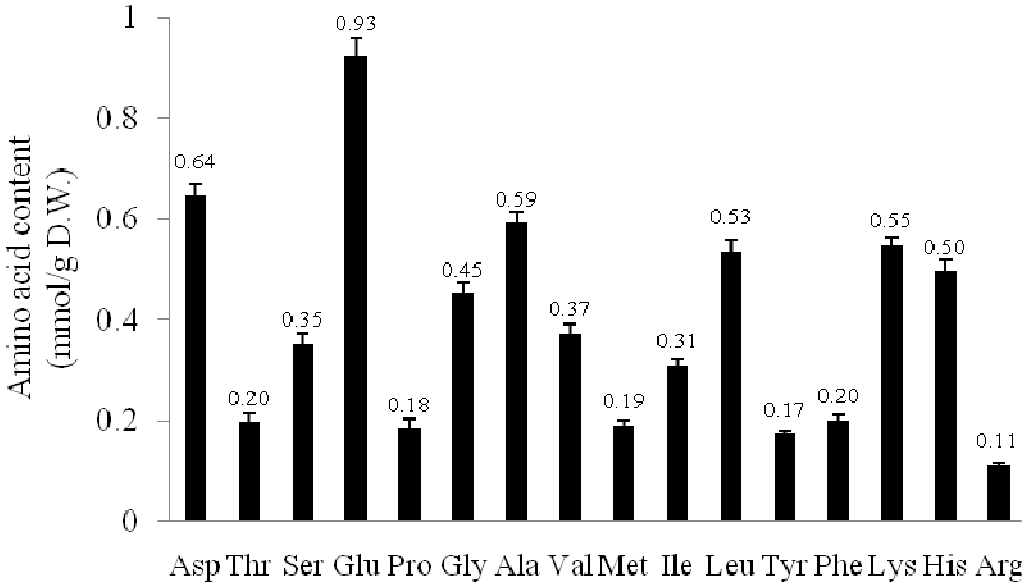

Figure 1. Comparison of amino acid contents in Hwangtae.

The content of glutamic acid (925.4mol/g D.W.) and aspartic acid (644.7 mol/g D.W.) was relatively higher compared to that of other amino acids. Arginine (111.1mol/g D.W.) was the lowest amid acid. We found

Table 3. Fatty acid composition in Hwangtae.

Fatty acid	Notation	Dried Alaska Pollack (%)
saturated		
Myristic acid	14:0	2.8 ± 0.0
Pentadecanoic acid	15:0	0.4 ± 0.0
Palmitic acid	16:0	29.7 ± 0.3
Stearic acid	18:0	7.2 ± 0.3
Tricosanoic Acid	23:0	0.7 ± 0.1
Lignoceric acid	24:0	1.7 ± 0.0
Total		42.5
Monounsaturated		
Palmitoleic acid	16:1(ω-7)	3.0 ± 0.1
Cis-10-heptadecanoic acid	17:1	0.3 ± 0.0
Oleic acid	18:1(ω-9)	11.3 ± 0.1
Eicosenoic acid	20:1(ω-9)	1.7 ± 0.1
Total		16.3
Polyunsaturated		
Linoleic acid	18:2(ω-6)	1.5 ± 0.1
Alpha-linolenic acid (ALA)	18:3(ω-3)	0.5 ± 0.1
Eicosatrienoic acid (ETE)	20:3(ω-3)	0.3 ± 0.1
Arachidonic acid (AA)	20:4(ω-6)	2.1 ± 0.1
Docosahexaenoic acid (DHA)	22:6(ω-3)	36.8 ± 0.2
Total		41.2

Each value represented mean ± standard derivation of triplicates.

that Hwangtae contain several essential amino acids, such as lysine, methionine, phenylalanine, threonine and valine. Na et al. (1986) reported that contents for valine, methionine, isoleucine, leucine and lysine were increased in semi-dried Gulbi. This suggest that the content of amino acids may be increased in Hwangtae. The distinctive flavor of Hwangtae may support changes in the content of amino acids having flavors such as glutamic acid (umami taste), lysine (sweet taste), alanine (sweet taste) and leucine (bitter taste).

Analysis of fatty acids

The fatty acid compositions and contents of Hwangtae are shown in Table 3. On the basis of 37 standard fatty acids, 15 fatty acids of Hwangtae were detected on GCThese include C14:0 (myristic acid methyl ester), C15:0 (pentadecanoic acid methyl ester), C16:0 (palmitic acid methyl ester), C16:1 (palmitoleic acid methyl ester), C17:1 (cis-10-heptadecanoic methyl ester), C18:0 (stearic acid methyl ester), C18:1 (oleic acid methyl ester), C18:2 (linoleic acid methyl ester), C18:3 (linolenic acid methyl ester), C20:1 (eicosenoic acid methyl ester), C20:3 (eicosatrienoic acid methyl ester), C20:4 (arachidonic acid methyl ester), C23:0 (tricosanoic acid methyl ester), C24:0 (lignoceric acid methyl ester) and C22:6 (docosahexaenoic acid methyl ester). Among saturated fatty acids, the content (29.7%) of palmitic acid (C16:0) was highest while pentadecanoic acid (C15:0) was lowest (0.4%). Among monounsaturated fatty acids, oleic acid (C18:1) was the highest (11.3%). High levels of oleic acid in food are known to be beneficial to sensory evaluation (Jiang and Sim, 1993). The content of DHA was the highest, belonging to polyunsaturated fatty acids (PUFA) that consist of 41.2% in total fatty acid contents of Hwangtae. It was reported that the types of n-6 and n-3 of PUFAs such as DHA and EPA decrease levels of blood plasma and low-density lipoprotein (LDL)-cholesterol, while saturated fatty acids increase these levels (Brussard et al., 1980; Van Elswyk et al., 1994). Hwangtae was found to contain a high amount of DHA, which can be used as a natural source for the purification of DHA. The content of DHA in Hwangtae was 36.8%. The DHA content of Hwangtae was much higher than that in other fishes reported by Kim et al. (2005), including skipjack tuna (27.0%), Spanish mackerel (24.7%), common mackerel (24.3%), chum salmon (21.6%) and a conger ell

(15.1%). Unsaturated fatty acid contents (57.5%) were 1.35-fold higher than saturated fatty acid contents (42.5%) in Hwangtae.

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