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Full Length Article

Biochemical composition of Predatory carp (*Chanodichthys erythropterus*) from Lake Dianshan, Shanghai, China

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ABSTRACT

Information related to the chemical composition of fish species is very much necessary to ensure that they meet requirements of man's diet. This study is focused on providing nutrient contents information of the wild east Asian native species Predatory carp (*Chanodichthys erythropterus*). The specimens were collected from Lake Dianshan, Shanghai-China. The body muscles of randomly selected fish species were dried at 105 °C in an oven and used for biochemical analysis. Protein, carbohydrate, ash, and moisture contents found in the experimental fish and their proportions were 48.7%, 14.1%, 5.1%, and 9.4%, respectively. Methionine is the major essential acid determined whiles Alanine was also the abundant for non-essential amino acids although ten of the most essentials were present. Stearic acid, a saturated fatty acid had the highest proportion while oleic acid was the main monounsaturated fatty acid. Alpha-linolenic acid was the dominant polyunsaturated fatty acid determined. The ratio of n3/n6 fatty acids was 2.82 showing that this species meat is optimal for nutritional purpose. The results of this study showed *Chanodichthys erythropterus* muscle is a valuable food with high quality protein and well balanced amino acids for promoting good health, prevention and healing of diseases in the human body.

Introduction

Fishes are valuable sources of high-grade protein and other organic products. Its consumption offers important nutrients to many communities around the world. Information related to the chemical composition of fishes is very much necessary to ensure that they meet requirements of man's diet. The contents of proximate composition are traditionally used as indicators of the nutritional value of fish [1]. Proximate composition varies widely and depends on several factors, like species, size, sex, maturity, season and feeding regimes. Information on daily dietary intake of nutrients, especially cholesterol, is quite important for especially those with cardiovascular problems [2].

Fish is a good source of essential fatty acids such as polyunsaturated fatty acids (PUFAs), which are known to regulate prostaglandin synthesis and hereafter induce wound healing [3,4]. PUFAs such as n−3 and n−6, have been considered essential fatty acids and have been shown to have curative and preventive effects on cardiovascular diseases, neurodevelopment in infants, cancers and fat glycemic control [5,6]. Essential fatty acids are (n−3 and n−6 PUFAs); are known to have curative and preventive effects on human diseases such as cardiovascular diseases, neurodevelopment in infants, cancers, fat glycemic control, rheumatoid arthritis, and inflammation [7]. Health experts suggest two to three servings per week of seafood consumption by pregnant women, children and elderly people in order to meet the recommended level of essential fatty acids. The protein quality of food depends on their digestibility and content of essential amino acids like leucine, Lysine and Phenylalanine [8–10]. Certain amino acids like aspartic acid, glycine and glutamic acid are also known to play a key role in the process of wound healing [11]. However, the composition of fish amino acids as one of the main protein component is influenced by various factors such as species, size, food resource, fishing season, water salinity and temperature [10].

Cyprinids are largely concentrated in lakes although they multifariously located worldwide in various water bodies. Predatory carp *Chanodichthys erythropterus* (Cypriniformes, Cyprinidae, Cultrinae) is a small-sized cyprinid fish, widely distributed in East Asia. It is one of the most important commercial freshwater fish in China [12,13]. This East Asian freshwater cyprinid ranges from the Amur River south to Taiwan and the Red River, as well as Lake Buir in Mongolia. This species reaches 102 cm in length and 9 kg in

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weight [14]. The Dianshan lake is composed of about 40 fish species belonging to more than 15 families. Amongst these species, members belonging to the family Cyprinidae are always very dominant in the Lake and are often preferred by the population as a food source. It is therefore important to know its nutrient contents. The flesh of this species is used for the preparation of good recipes in most east Asian homes; because of health cognizance, these days many people are interested in consuming more fish in view of its relatively higher nutritious qualities. The preference for its consumption therefore makes it important specie to study and to know its nutritional make up.

Presently, the composition of fishery products has been widely investigated to analyze their nutritional quality [15]. However, no study has been carried out focusing on the chemical composition of this fish species. This study is expected to provide the nutrient qualities of the Predatory carp (*Chanodichthys erythropterus*) for the benefit of consumers and scientific community as a whole. Therefore, the present study was carried out to analyze the proximate composition, fatty and amino acids compositions of the *Chanodichthys erythropterus* captured from lake Dianshan, China as one of the main commercial fish species (native in China).

Materials and methods

Description of study area

Geographically, the Dianshan Lake is found on Latitude 31°11′N and longitude 120°96′E. It is the largest freshwater lake in Shanghai with a total area of 63.7 square kilometers at an average depth of 2.5 m, and also with the deepest recorded depth to be 6.39 m. It is located in between Shanghai, Zhejiang and Kunshan of Jiangsu Province. This Lake supports a lucrative fishery in Shanghai, and fishermen involved in fishing bring in commercially important fish species.

Sampling design and sample preparation

A total of 20 fish species were selected from catches between October and December 2016. They were caught with the help of gillnets and trawls. Gillnets (10 m length; 1.5 m width) ranging from 2.0 to 10.0 cm mesh size were employed at each sampling point. Trawl nets (1.5 m height; 3.0 m length; 2.0 m width), 2.0 cm mesh size, was also used. The sampling was done during morning hours and the randomly captured samples were selected, morphometrically identified and measured. Specimens collected were quickly sorted out then stored in coolers containing ice and later transported to the laboratory. The separated muscle samples were homogenized and stored at −2 °C temperature. These muscle tissues were dried in a lyophilizer (VIRTIS 6KBEL85) for 24 h to remove the water content in the samples. The samples were then ground in an agate pestle and mortar in order to obtain muscle powder. The muscle powder was then later used for proximate composition, fatty and amino acids analyses.

Proximate composition

To determine the moisture contents, fish muscle duplicate samples were kept in an oven, at 105 °C for 24 h. Fat content muscle sample was determined with the help of Soxhlet apparatus (Germany) using the non-polar organic solvent hexane. Both moisture and fat contents analyses were carried out according to the method in AOAC [16]. For the protein determination, nitrogen (N) contents of the fish muscle samples were determined by the method in AOAC [17]. The N content was multiplied by 6.25 to estimate the protein of these samples. Ash content was determined by burning the organic components from the known weight of the homogenized dried fish muscle by using a furnace at 550 °C [17]. On the other hand, total Carbohydrates was estimated by Phenol-Sulphuric acid method [18].

Amino acid composition analysis

The finely ground dried samples were used for estimating the amino acids in high performance liquid chromatography (HPLC) (Merck hitachedL-7400) following the method of Baker and Han's [19].

Fatty acid profile-GC–MS analysis

Fatty acid composition of the powdered muscle sample was analyzed by GC–MS using a Varian Saturn 2000R gas chromatograph (Hewlett Packard 5890 model) equipped with an OV-225 capillary column (30 m × 0.25 mm), programmed from 500 °C to 2250 °C (400 °C min^{-1}), then kept constant for 30 min. FAMEs were identified by their typical electron impact MS spectra and retention times (*R*t), shown by comparison with standards (Sigma), and quantified according to their relative peak areas [20].

Results

Proximate composition

Protein, carbohydrate, ash, and moisture contents were found in the experimental fish and their proportions were 48.7%, 14.1%, 5.1%, and 9.4%, respectively.

Amino acid composition

The percentage composition of essential and non-essential amino acids is shown in Table 1. A total of twenty amino acids were found from *Chanodichthys erythropterus*. The levels of different amino acids (essential and non-essential) were found

Table 1
Amino acid composition of the muscle of *Chanodichthys erythropterus* (mg/100 g).

	Essential amino acid	Ratio (mg/100 g)	Non-essential amino acid	Ratio (mg/100 g)
1	Methionine	1432.3	Alanine	3173.8
2	Valine	1035.7	Aspartic Acid	1345.6
3	Tryptophan	908.7	Proline	704.95
4	Phenylalanine	903.2	Glutamic Acid	596.7
5	Glutamine	785.9	Serine	493.7
6	Iso-Leucine	784.6	Tyrosine	301.8
7	Leucine	693.4	Cysteine	293.3
8	Histidine	403.4	Asparagine	190.3
9	Lysine	356.9	Arginine	189.6
10	Threonine	329.3	Glycine	136.7
	Total essential amino acid	**7633.4**	Total non-essential amino acid	**7426.45**
	Total amino acid (essential + non-essential amino acids)			**15059.85 mg**

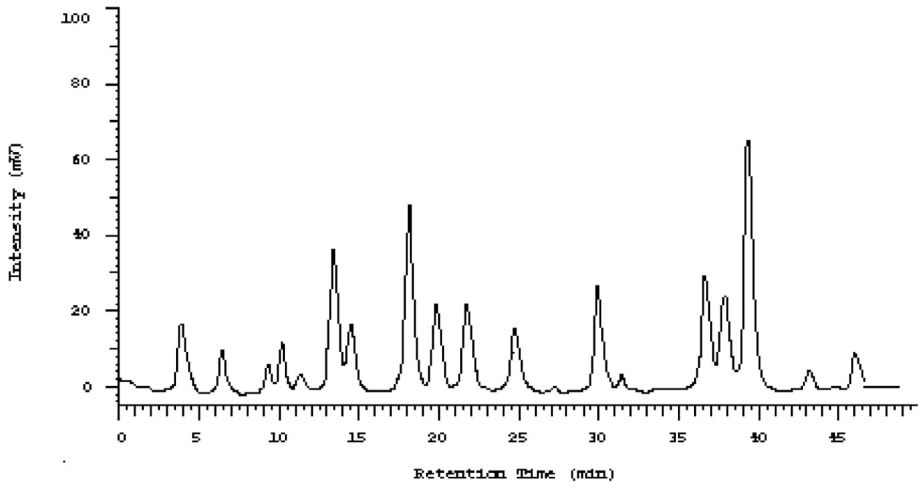

Fig. 1. The standard graph of amino acids.

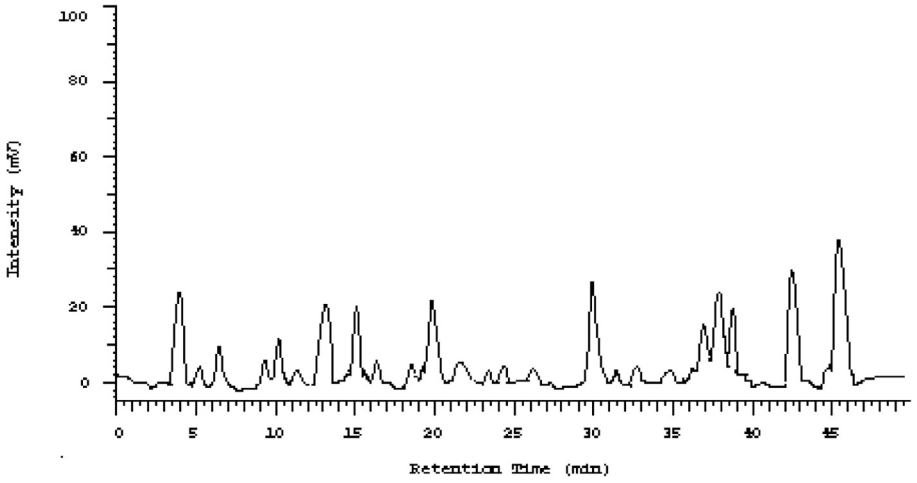

Fig. 2. Estimation of amino acids in *Chanodichthys erythropterus* muscle.

fluctuating between 136.7 mg (Glycine) and 3173.8 mg (Figs. 1 and 2). The major essential amino acid was Methionine (1432.3 mg) while Alanine (3173.8 mg) ranked the first in the list of non-essential amino acids.

Fatty acid composition

The fatty acid composition (mg/100 g) of *Chanodichthys erythropterus* is summarized in Table 2. Fatty acids were found fluctuating between 7834.3 mg and 34.251 mg (Figs. 3 and 4). A total of seven fatty acids were analysed for the fish samples. For the saturated fatty acids (SFA), Stearic acid (C18:0) had the highest proportion while Oleic acid (C18:1) was the main monounsaturated fatty acid (MUFA). Alpha Linolenic acid (n−3) (C18:3) was the dominant polyunsaturated fatty acid (PUFA).

Discussion

Biochemical studies from the nutritional point of view are very important. Protein exists in large quantities in all nutrients to form

Table 2
Fatty acid composition of the muscle of *Chanodichthys erythropterus* (mg/100 g).

	Fatty acids	No. of carbon atoms	Fatty acid type	Ratio (mg/100 g)
1	Oleic acid	C18:1	MUFA	7834.3
	Total monounsaturated fatty acids			**7834.3**
2	Margaric acid	C17:0	SFA	893.3
3	Palmitic acid	C16:0	SFA	4857.3
4	Stearic acid	C18:0	SFA	5493.9
	Total Saturated fatty acids			**11244.5 mg**
5	Alpha Linolenic acid (n−3)	C18:3	PUFA	3085.9
6	Linoleic acid (n−6)	C18:2	PUFA	1093.78
7	Stearidonic acid (SDA) (Morotic acid)	C18:4	PUFA	136.8
	Total polyunsaturated fatty acids			**4316.48 mg**

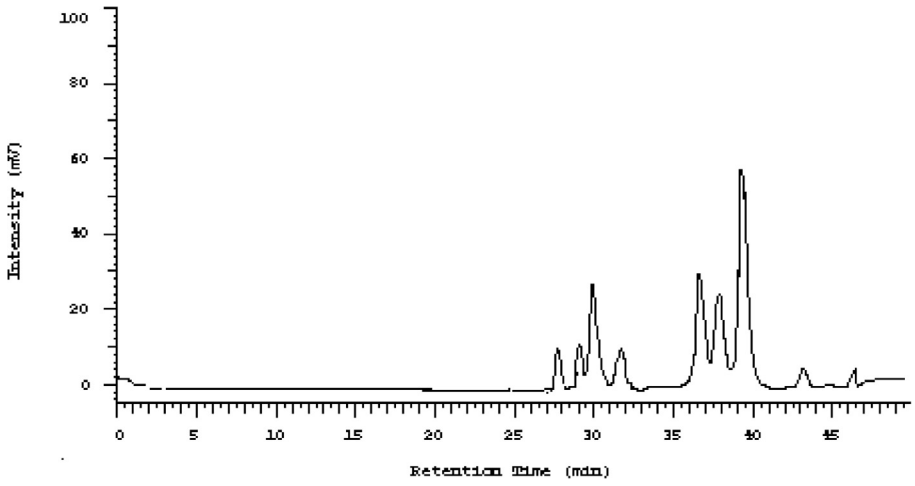

Fig. 3. The standard graph of fatty acids.

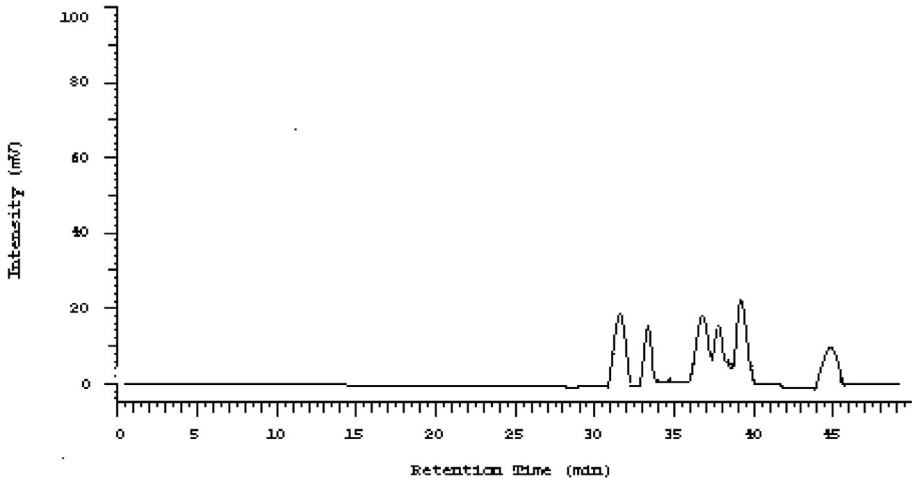

Fig. 4. Estimation of fatty acids in *Chanodichthys erythropterus* muscle.

the components of the human body which is essential for the sustenance of life. Information concerning the chemical composition of freshwater fishes in general is valuable to nutritionists concerned with readily available sources of low-fat, high protein foods such as most freshwater fishes [21,22]. The adequacy and easy digestibility of fish proteins make it very valuable in combating protein malnutrition, especially in children. The protein of fish has a high biological value with its capacity of promoting growth. Fish occupy an important part in the world protein supply, accounting for about 10% of the total protein supply [2]. About 60% of the population in developing countries depends on 40% or more of their total animal protein supplies from fish.

Proximate composition

It was indicated that, *Chanodichthys erythropterus* contain a higher proportion of protein and lower ash content as indicated from the results obtained. Previous studies on proximate analysis by Buchtová et al. [23] on a different fish species from the same family confirms the results obtained in this research, however, reports from Ashraf et al. [24] are not in concordance with it as they reported higher moisture content and relatively lower protein content for silver carp. This difference might be due to genetical factors as well as extrinsic factors such as feeding regimes and/or exercise significant change in some structural and flesh quality parameters of different fish species. Thus, there is no hard and fast rule applicable universally to all the fish species.

Amino acid composition

Amino acids are the building blocks of protein, and are key to building strong, healthy muscles. Fish muscle consist of an excellent amino acid composition and is a unique source for nutrients and easily digestible protein [22]. Besides, the constituent of amino acids of protein act as precursors of many coenzymes, hormones, nucleic acids, and other molecules essential for life. Thus, an adequate supply of dietary protein is essential to maintain cellular integrity and function, and for health and reproduction. There is growing recognition that besides their role as building blocks of proteins and polypeptides, some amino acids (functional amino acids) such as arginine, cysteine, glutamine, leucine, proline, and tryptophan regulate key metabolic pathways that are necessary for maintenance, growth, reproduction, and immunity [25]. The amount of non-essential amino acids in *Chanodichthys erythropterus* muscle was equal to the essential amino acids (Table 1) from the twenty different amino acids identified. The essential amino acid identified is within the spectrum of an index of

biological value of fish protein; this shows that fish protein is well balanced with essential amino acids. According to FAO/WHO/UNU Expert Consultation on Protein and Amino Acid Requirements in Human Nutrition [26], essential amino acids are required daily by humans for healthy living. This fish therefore provides a good source of EAA for human consumption since the human system cannot synthesize it.

Özden [27], and Iwasaki and Harada [28] reported aspartic acid, glutamic acid and lysine as the main amino acids of fishes. However, this is very different from the results obtained in this study. The predominant amino acids recorded were Alanine, Methionine, Aspartic acid and Valine acids. Glycine, proline and arginine play an important role in metabolic regulation, anti-oxidative reactions and neurological function. Thus, these nutrients have been used to prevent tissue injury, enhance anti-oxidative capacity, promote protein synthesis and wound healing, and improve immunity to various inflammatory diseases [29]. In aquaculture, the concentrations of lysine and methionine in fish food are regarded as important indicators of nutritional value of the diet [30]. They are known to have significant antioxidant properties as synergists or primary antioxidants and believed to be important metal chelators present in fish and most amino acids had significant antioxidative potential in linoleic acid and methyl esters of linoleic acid system. It is therefore highly recommended that Amino acids necessary for growth and maintenance must be included in diets. Accordingly, *Chanodichthys erythropterus* fish muscle is wealthy in both essential and non-essential important amino acids and could be used as a valuable food source for human beings.

Fatty acid composition

Fatty acids are the main components of food fats, oils and fat deposits in animals and man. Result obtained in this study is in accordance with those presented by Özden [27] and Testi et al. [31] who found that, PUFA was the highest in rainbow trout. Osibona [32] reported that, similar studies on tropical and temperate freshwater fishes showed the dominance of these fatty acids (SFA, MUFA, PUFA) in their tissues. Although alpha-linolenic acid seems to benefit the cardiovascular system and might reduce the risk of heart disease, further studies is yet to be done in order to confirm its effectiveness in cholesterol reduction. Palmitic Acid is a common fatty acid found in plants and animals. The body converts excess carbohydrates into Palmitic Acid, thus Palmitic Acid is the first fatty acid produced during fatty acid synthesis as well as a precursor for longer fatty acids. In humans, one analysis found it to make up 21–30% (molar) of human depot fat [33] and it is a major, but highly variable, lipid component of human breast milk [34]. Omega-6 and omega-3 fatty acids influence gene expression which may be modulated by amino acids. According to Piggott and Tucker [35], the n−3/n−6 ratio is a better index in identifying nutritional value of fish oils of different species. In the present study, the n−3/n−6 ratio was found to be 2.82 in *Chanodichthys erythropterus* meat, while a ratio from 1:1 and higher is considered to be optimal for nutritional purpose [36,37]. The compositions of fatty acids in fish are also highly depending on feeding conditions, their habitats, and physiological conditions such as maturity stage.

Conclusion

This study has provided scientific information and detailed knowledge of the proximate composition of this important commercial fish species, *Chanodichthys erythropterus* from the lake Dianshan, China. The results obtained from this study show that, *Chanodichthys erythropterus* harvested from Lake Dianshan has high-quality protein, presents a good source of fatty acids and essential amino acids which provides a good source of nutrients for its consumers.

Conflict of interest

None declared.

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