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Nutrient composition of milkfish (C*hanos chanos*, Forskal) from Pangkep, South Sulawesi, Indonesia

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ABSTRACT

Introduction: Milkfish is a potential source of animal nutrition, especially for supplying human protein needs. In the present paper, we provide complete data on nutrient content of milkfish that can be used as a reference for diet formulation and for the further processing of milkfish. **Methods:** Proximate analysis, amino acid and fatty acid composition, and vitamin and mineral content of milkfish were determined. **Results:** The results showed that milkfish contained high concentration of protein (24.18%) and high proportion of monounsaturated fatty acids as oleic acid (32.11%). The amino acid found in the highest concentration was glutamic acid (1.28%). The macro-minerals in the milkfish were calcium (Ca), magnesium (Mg), sodium (Na) and potassium (K). Among the micro-minerals present were iron (Fe), zinc (Zn), copper (Cu) and manganese (Mn), and the main vitamins present include A, B1 and B12. **Conclusion:** Based on their protein content, milkfish may be classified as a source of high protein. Glutamic acid which is the highest amino acid in milkfish as well as fatty acid content of oleic acid makes milkfish a healthful fish.

Keywords: Amino acids, fatty acids, milkfish, minerals, proximate, vitamins

INTRODUCTION

Milkfish is one of the most cultivated fish species in Indonesia, because these fish have a high tolerance to the various environmental conditions of tropical waters and are resistant to many pests and diseases. One of the districts that has developed milkfish cultivation in Indonesia is the Pangkep Regency where it is one of the main commodities produced.

Milkfish is the most consumed fish by the people of South Sulawesi and even Indonesia because of their success in the brackish aquaculture sector. Thus it is important to have information about the nutritional content of milkfish for consumers and the fisheries processing industry for storage and processing needs.

The nutritional content of milkfish is influenced by internal and external factors. Influential internal factors include gender, age and reproductive phase. Influential external factors include cultivation location or habitat,

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feed formulation and conditions of the quality of the waters of the fish farm (Hafiludin, 2015).

This was a preliminary study that was conducted in the Pangkep Regency to determine the nutritient composition of milkfish from pond culture. This study is the initial stage of a series of research in making premix powder from milkfish surimi.

MATERIALS AND METHODS

Materials

A total of 20 fresh milkfish were obtained from ponds in Mandalle District in the Pangkep Regency of South Sulawesi, Indonesia, in September 2017. The milkfish samples that were chosen were of uniform size. The fish samples were put in an insulated box containing ice, with a fish to ice ratio of 1:2 (w/w) and transported to the Chemical Analysis Laboratory, State Polytechnic of Ujung Pandang, Indonesia. Other materials used in this study were chemicals for proximate analysis, and the determination of minerals, vitamins, amino acids, and fatty acids profiles. The standards of fatty acid methyl ester (FAME) were obtained from Supelco Inc., Bellefonte, PA (Supelco 37 Component FAME Mix) and all other chemicals or reagents were from Merck, Germany.

Sample preparation

Five samples were taken randomly from the 20 fish obtained for analysis. Length (cm) and weight (g) measurements of the milkfish samples were taken using digital micrometres and digital scales, respectively. The fish were descaled and dissected with a cleaned stainless steel knife. After morphometric measurements, the central vertebra of each fish was completely removed. The head and viscera were discarded. The edible part, i.e. the flesh and skin, which represent the parts consumed by the local population, was filleted (deboned), cut into small pieces and homogenised. The homogenised sample were stored at -40°C for 12 h and used for food composition analyses, except for those specifically mentioned below. The multiple analysis for proximate composition and single analysis for other analysis were applied.

Proximate composition analysis

For lipids analysis, the fresh edible parts of the milkfish were immediately used. For proteins, ash and mineral analyses, the samples (edible parts or clean central vertebrae) were dried in an oven at 45°C for 48 h and were homogenised thoroughly in a food blender with stainless steels cutters. The proximate composition analysis was carried out by following the methods of the Association of the Official Analysis Chemists. The moisture content was determined by using a hot air oven, drying the sample at 105°C±2°C until a constant weight was obtained (AOAC, 1990). Total lipid was determined by the Soxhlet method. The crude protein content was determined by converting the nitrogen content obtained by Kjeldahl's method (N×6.25) (AOAC, 1990). Ash was obtained after the incineration of moisture-free dry samples in a tube furnace at 600°C for 6 h (AOAC, 2006). Total carbohydrate was determined by subtracting the sum of fat content, protein content, ash content and moisture from 100.

Mineral analysis was undertaken using the S2 Ranger X-ray Spectrometer, according to the user manual XRF (2012) by Bruker AXS GmbH, Ostiche Rheinbruckenstr, 49.76187 Karlsruhe, Germany. Fatty acid compositions were determined by gas chromatograph mass spectrometer (GC-MS) QP 2010 Shimadzu (Japan). Lipids were esterified by the method adapted from Metcalfe (1961), which consisted of lipid saponification with 0.5 M potassium hydroxide (KOH) in methanolic solution and catalysed by boron trifluoride-methanol reagent. The sample was solubilised by dichloromethane, from which 1 μL was injected for GC analyses. To separate and quantify the esterified FA mixture, the GC-MS QP 2010 by Shimadzu equipped with split/split less injector, capillary column RTX®-1 (30 m×0.25 mmID×0.25 μm) was used. Helium was used as the carrier gas at a flow rate of 1.25 mL/min. The injector and detector temperatures were set to 260°C. The chromatographic conditions for separation were: column initial temperature of 50°C, raising to 200°C at a rate of 6°C/min, holding during 4 min. The second step consisted of increasing the heating rate at 2°C/min to 240°C, and held for 10 min. FAME peaks were identified by comparing their retention times with equivalent chain length standards of FAME.

The amino acid composition was determined by following the method of Ishida, Fujita & Asai (1981). Muscle protein was hydrolysed with 6N hydrochloric acid (HCl) at 110°C under anaerobic condition for 24 h. The hydrolysed samples were neutralizsd with 6N sodium hydroxide (NaOH) and were derivatised using a kit (AccQ-Fluor Reagent, WAT052880, Waters, USA). The derivatised samples were injected into high performance liquid chromatography (HPLC) (1525, Waters) equipped with a C18-RP column and a fluorescence detector (2475, Waters). The amino acids were identified and quantified by comparing with the retention times and peak areas of standards (WAT088122, Waters). For the tryptophan analysis, the minced meat was digested with 5% (w/v) NaOH for 24 h and neutralized to pH 7.0 with 6N HCl. The tryptophan content was measured spectrophotometrically at 530 nm (Sastry & Tammuru, 1985).

Data analysis

The analytical data that was obtained from this study was compared with previously published results of the nutritional composition of milkfish from fish farms in Bangkalan Madura, East Java, Indonesia and Narasapur West Godavari, Andhra Pradesh, India.

RESULTS

The average weight and length of the fish used in this study were 191.70±12.13 g and 28.25±2.41 cm, which are approximately the sizes of the milkfish consumed in many households. The results of proximate analysis, that of the content of minerals and vitamins, and the amino acid and fatty acid profile of milkfish are presented in Table 1, 2, 3, and 4.

DISCUSSION

Proximate composition

Our results showed that water is the main constituent of milkfish. The

Table 1. Proximate composition of milkfish (%)

Component	*Pangkep, Indonesia*†	*Bangkalan, Indonesia*‡	*Narasapur, India*§
Moisture	70.79±0.23	70.78	72.18±0.39
Crude Protein	24.18±0.36	24.18	20.37±0.50
Crude Fat	0.87±0.05	0.85	3.84±0.39
Total Ash	1.40±0.02	1.41	4.02±0.08
Carbohydrate	2.77±0.21	2.78	NA

†Primary data from this study
‡Hafiludin (2015); no SD values reported by the author
§Murthy *et al.* (2016)

Table 2. Content of main minerals and vitamins of milkfish

Component	*Pangkep, Indonesia*†	*Bangkalan, Indonesia*‡	*Narasapur, India*§
Minerals (mg/100 g)			
Calcium	54.92	56.22	355.50
Copper	0.04	0.04	0.30
Iron	0.03	0.03	8.00
Potassium	320.01	318.73	845.50
Magnesium	39.97	40.10	NA
Manganese	0.06	0.06	NA
Sodium	61.89	83.67	NA
Zinc	0.08	0.08	10.56
Vitamins			
Vitamin A (mg/100 g)	0.02	0.01	NA
Vitamin B1 (mg/100 g)	0.06	0.05	NA
Vitamin B12 (mg/100 g)	3.81	3.97	NA

†Primary data from this study
‡Hafiludin (2015)
§Murthy *et al.* (2016)

Table 3. Amino acid profile of milkfish (%)

Amino Acid	*Pangkep, Indonesia*†	*Bangkalan, Indonesia*‡	*Narasapur, India*§
Alanine	0.73	0.78	5.80
Arginine	0.26	0.29	2.10
Aspartic acid	0.80	0.79	12.00
Glutamic acid	1.28	1.27	16.20
Glycine	0.28	0.27	2.60
Histidine	0.49	0.49	6.10
Isoleucine	0.34	0.35	4.90
Leucine	0.67	0.67	8.00
Lysine	0.57	0.52	7.30
Methionine	0.25	0.22	3.00
Phenylalanine	0.34	0.34	6.70
Proline	0.41	0.41	0.70
Serine	0.29	0.29	4.70
Cysteine	0.14	0.14	0.40
Tyrosine	0.26	0.26	3.20
Threonine	0.45	0.45	4.40
Valine	0.46	0.47	5.90

†Primary data from this study
‡Hafiludin (2015)
§Murthy *et al.* (2016)

Table 4. Fatty acid profile of milkfish (%)

Fatty acid	*Lipid Number*	*Group*	*Pangkep, Indonesia*[†]	*Bangkalan, Indonesia*[‡]	*Narasapur, India*[§]
Myristic	C14:0	SFA	4.13	4.04	1.09
Palmitic	C16:0	SFA	41.00	41.48	29.82
Stearic	C18:0	SFA	4.20	4.01	7.28
Oleic	C18:1	MUFA	32.11	31.40	26.10
Linoleic	C18:2	PUFA	6.72	6.04	10.90
Linolenic	C18:3	PUFA	3.81	3.46	0.89

[†]Primary data
[‡]Hafiludin (2015)
[§]Murthy *et al.* (2016)
SFA: saturated fatty acid; MUFA: monounsaturated fatty acid; PUFA: polyunsaturated fatty acid

moisture content of milkfish was 70.79±0.23% and high levels occurred in the edible parts. The moisture content in fish has been reported to be 70% and 80% of the total weight (Ackman, 1989). The moisture content of fresh fish determines its durability from decay caused by microbial growth and enzyme activity (autolysis) at room temperature. Higher moisture content accelerates fish rot. The high water content of fresh milkfish meat causes the fish to require proper handling after harvest to maintain its quality or for further processing into food products.

The protein content of the edible parts of milkfish was 24.17±0.36%. This indicated that the milkfish contained high levels of protein, and can thus be used as a source of animal protein. The high protein content of >15% of milkfish placed it in the high-protein fish category (FAO, 2016). The fat content was 0.87±0.05%. This, according to the Ackman classification (1989), placed it in the low-fat category of <2%. Fish can be classified based on the composition of fat and protein. If it contains fat content <5% and protein content >20%, then it is considered as fish with low fat content and high protein (Stansby, 1976). The low fat and high protein content of fresh milkfish provide an opportunity to process its meat into protein-rich premix flour.

Carbohydrate and total ash content were low compared to other nutrients. The chemical composition of each fish varies depending on the species of fish, between individual fish within the species, and between parts of the body of an individual fish. These differences can be caused by several factors, namely age, metabolic rate, movement of fish, feed, reproduction period, habitat and eating habits. The chemical composition varies greatly from one species and one individual to another depending on diet, sex, age, environment and season (Ondo-Azi *et al.*, 2013).

Mineral and vitamin content

The milkfish is rich in mineral content in the form of potassium, calcium, magnesium and sodium. Calcium and phosphorus are essential nutrients for growth and are the main elements of the structural components of human bone tissue (Murthy *et al.*, 2016). Low concentrations of sodium and high potassium were observed. It has been suggested that a sodium to potassium ratio in food of less than 1 acts to prevent cardiovascular disease (Perez, Ellen & Chang, 2014).

Microelements are essential for human nutrition (Francisca *et al.*, 2013). Among the most abundant microelements found in the edible parts were iron and zinc. Milkfish originating from Indonesian waters have a low iron and zinc content, unlike that which is cultivated in India. This is thought to be influenced by the nutrient content present at the location of the fish culture. Some microelements can be harmful when present in high concentration. However, the concentrations of copper, zinc, manganese and iron in the samples were lower than the toxic levels described by FAO/WHO (FAO, 2001).

Amino acid profile

The protein quality of any food is judged by the ratio of essential and non-essential amino acids that are present in it. High-quality protein contains dietary essential amino acids in quantities that correspond to human requirements (WHO, 2007). The amino acid profile of milkfish consists of approximately 17 types of amino acids (Table 3). Milkfish also contains the highest essential amino acids namely leucine. The difference of amino acid composition in milkfish meat is caused by several factors. These are internal factors including age, size, condition of fish, and the external factor that is the habitat. The red meat and white meat, liver, heart and other organs in milkfish have different amino acid compositions. The highest amino acid content for red meat and white meat in milkfish is histidine and taurine, while the highest amino acid for other organs (liver, intestine, and heart) is the amino acid taurine (Chyuan-Yuan *et al.*, 1996). Table 3 shows that the content of glutamic acid in milkfish meat is fairly high, giving the brackish water fish a more savoury taste. Seafood tastes are mostly influenced by the content of free amino acids (FAA). The FAA that is dominant in the white muscle of milkfish are histidine, taurine, and glycine (Shiau *et al.*, 2001).

It has been proposed that FAA regulates the main metabolic pathways to improve the health, survival, growth, development, lactation and reproduction of organisms. FAA also plays an important role in the prevention of metabolic diseases such as obesity, diabetes, and cardiovascular disorders, intrauterine growth restriction, infertility, intestinal and neural dysfunction and infectious diseases. Clandinin *et al.*, (1997) reported that arginine, cystine, leucine, methionine, tryptophan, tyrosine, aspartate, glutamic acid, glycine, proline, and taurine have been classified as important FAA in human nutrition.

Fatty acid profile

Fish lipids are known to be beneficial to human health because they are rich in eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). The fat content and fatty acid composition of fish varies according to species, season and environmental conditions (Moradi *et al.,* 2011). Six main types of fatty acids were identified in milkfish (Table 4). The saturated fatty acid that is present in highest concentration is palmitic acid, while the highest unsaturated fatty acid is oleic acid. The fatty acid content of palmitic and oleic acids in cultured milkfish from Indonesia is higher than that of cultured milkfish from India.

Fish have the ability to synthesise saturated fatty acids and monounsaturated fatty acids. It can also selectively absorb and metabolise fatty acids in their food intake including long chain polyunsaturated fatty acids (Bell *et al.*, 1997) to obtain optimum fatty acid compositions (Ackman, 1989). This optimum composition appears to be a characteristic specific to each species and even each strain (Pickova, Kiessling & Dutta, 1999).

CONCLUSION

Based on the results of proximate analysis, the profile of amino acids and fatty acids, and the content of minerals and vitamins, it can be concluded that milkfish is a highly nutritious source of animal food. Based on its protein content, milkfish has been classified as a source of high protein. Glutamic acid, which is the amino acid that is present in the highest concentration, makes milkfish very popular. In addition, the oleic acid content makes milkfish very good for health.

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Authors' contributions

MS, the principal investigator, conceptualised and designed the study, undertook the data analysis and interpretation of results, prepared the draft of the manuscript and reviewed it; TAB, provided advice on data analysis and interpretation and reviewed the manuscript; MMT and MB provided advice on the data analysis and interpretation and reviewed the manuscript.

Conflict of interest

The authors declare that they have no conflicts of interest in relation to this article

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