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Nutritional component of *Barbonymus balleroides*: A wild fresh water fish from Indonesia

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Abstract. *Anita S, Haryono, Wahyudewantoro G. 2019. Nutritional component of Barbonymus balleroides: A wild fresh water fish from Indonesia. Biodiversitas 20: 581-588.* *Barbonymus balleroides* is a native species of fish from Indonesia that threatens by overfishing activity and habitat damage whereas little is known about its nutritional information. This study aimed to evaluate the nutritional content of wild barb fish that was collected from two different sites in Indonesia. Fishes were collected from Serayu and Cipunagara River. The body part of fishes was grouped and weighted to identify the ratio. Proximate composition was determined for flesh and byproduct parts. Flesh parts of fish were then examined for mineral content, fatty acid, and amino acid profile. Barb fish samples mainly form Cipunagara River contain high protein compare to several Indonesian freshwater fishes that commonly consumed. Flesh samples from both fish group were the heaviest part followed by its edible byproduct that often wasted. The amount of moisture and protein were higher in the flesh parts while byproduct showed higher content of fat and ash. Both samples contained a dominant amount of macro elements K and P. Fatty acid profile of flesh samples showed essential fatty acid that is good for human health. Amino acid profile showed the most dominant amino acid found in both samples was glutamic acid.

Keywords: Amino acid, *Barbonymus balleroides*, fatty acid, mineral content, protein, proximate

INTRODUCTION

World demand for fish is growing as human population increase over time. According to Food and Agriculture Organization, world fish food supply has grown significantly in the last five decades, with an average growth rate of 3.2%/year from 1961 to 2009, higher than world's population growth rate (FAO 2012). Fish is known as a major source of animal protein, essential fatty acid, and other essential micronutrients. Studies on freshwater fish have shown that this fish could serve as good sources of protein, mineral and fatty acid which comparable to marine fish (Ahlgren et al. 1994; Steffens 1997; Ozogul et al. 2007; Zuraini et al. 2006).

Barbonymus balleroides is a freshwater fish and native species of Indonesia that spread widely in Borneo, Java, Malaya, Cambodia, Thailand, and Vietnam (Kottelat et al. 1993). Barb is an omnivore fish that consume phytoplankton, aquatic plants, detritus, insects, pieces of fish, gastropods, and crustaceans (Rumondang 2013). This fish is usually consumed by catching it directly from its habitat. The previous study has shown that there is an indication of overexploitation and overfishing activity in Serayu River (Rumondang 2016). In some area of Java, this fish is already difficult to find possibly due to overfishing activity and also environmental damage (Haryono 2015). This pressure could threaten barb's population sustainability in their natural habitat. On the other hand, overfishing activity indicates high consumer preference and showed potency for developing this fish as aquaculture commodity. Therefore study on understanding its growth pattern and producing its culture are still made (Haryono et al. 2016; Prakoso et al. 2017).

Fish quality commonly evaluated using various parameters, for example, texture, color and also its chemical composition. Study has shown that wild and farmed fish or another aquaculture commodity could contain different characteristics that determined its nutritional quality (González et al. 2006; Fuentes et al. 2010; Fallah et al. 2011; Li et al. 2011; He et al. 2017). The same species of wild fish could also have a different nutritional composition that influenced by factors like origin, habitat characteristics and season (Lloret et al. 2005). Even more, the same species of fish that come from different geographical sites and season could contain peculiar lipid profile (O'Neill et al. 2015). Therefore fish quality assessments are important in order to inform consumer on nutritional variation that could help in making an informed decision rather than belief based choices when consuming a particular food.

Little is known about nutritional information of barb fish even though it is commonly consumed. Therefore this study was conducted to evaluate the nutritional content of wild barb fish (*Barbonymus balleroides*) that was collected from two different locations. Knowledge from this research is important for supporting the domestication plan that further could help in reducing overfishing activity in their natural habitat. Information on nutrition such as protein, fat, amino acid, fatty acid and mineral content of the fish are important for knowing fish quality as a food source and a guide in meeting specific nutritional needs. Since only meat part that mainly consumed, another part of the fish that possibly still contain nutrition is often wasted. Therefore nutritional content of the byproduct parts (head, bone, fin, tail) was also evaluated to see the further potential application.

MATERIALS AND METHODS

Procedures

Fish collection

Fishes were collected from two different locations. First fishing location conducted at its original habitat which is Serayu River, Banjarnegara, Central Java, Indonesia. Second fishing location was in River around Cipunagara, Sumedang city, West Java, Indonesia. Both habitats characterize by flowing stream, rocky bottom bed, composed of sand and gravel substrate. Fishing sites were also characterized by pH 7-8, temperature 24-31ºC and the concentration of dissolved oxygen around 4.1-8.3 ppm. Fishes were catch using cast and gill net, a traditional fishing instrument that commonly used by local people around the habitat. Fishes were kept in a plastic bag filled with oxygen. After collecting a sufficient amount, fishes were transferred to the pond near the River and maintained there for about 2-3 days then transported to our fish pond laboratory facility. Fishes were transported in a plastic bag filled with water and oxygen with 1:3 ratios. A plastic bag containing fishes were placed in a styrofoam box with several ice cube to stabilize the temperature during the trip. After arrival, fishes were maintained at the pond with tarpaulin based for about 1 to 2 weeks before the experiment. Fishes were feed with commercial pellet (ad libitum) during maintenance in the pond.

Sample preparation

Towards the test, fish were caught, dissected and then cleaned with running water. Body parts of fishes were divided into scales, offal, flesh (with skin attached) and the byproduct (head, fin, bones, and tail). All these groups were weighted in a wet condition to know its ratio compare to the whole body weight. Scales and offal were discarded. The edible part of the flesh and skin that represent the part consumed by local people was collected. In addition, head, bones, fins and tails part of fish that rarely consumed and often wasted were also collected and referred as fish byproducts. All these parts were cut into small pieces, oven dried at 65°C overnight, homogenized using food blender and then stored in 4°C before further testing. All samples were analyzed for proximate and only flesh sample was further analyzed for fatty acid, amino acid, and mineral component. Flesh sample from Serayu River and Cipunagara River was labeled as FSS and FSC respectively. The fish byproduct from Serayu River was labeled as FBS and from Cipunagara River as FBC.

Proximate analysis

Crude protein, moisture and ash content were determined according to the Association of Official Analytical Chemists (1990). The protein content of the sample was estimated by determining nitrogen contents of the sample based on standard Kjeldahl procedure. Crude protein content was estimated by multiplying the total nitrogen (TN) with a conversion factor. In this study, we used a conversion factor of 4.94 for fish and fish product (Salo-Vaananen and Koivistoinen 1996). Total crude fat was determined by fat extraction method using soxtec system instrument and petroleum benzene as the non-polar solvent. The following formula determined the lipid content: % crude lipid = (wt of residue/original wt of the sample) x 100. Moisture content was determined by oven drying of 2.5 g of sample at 105°C until a constant weight was reached. Ash content was determined after combustion for eight hours in 550 °C.

Fatty acid determination

To determine the fatty acid composition, fat extraction was conducted using soxhlet extraction with hexane as solvent. The sample was then converted into methyl esters by reaction with methanol and KOH as a base catalyst. The second methylation was conducted using BF3 as an acid catalyst. The resulted of methyl esters was then analyzed with GC FID Clarus 580 Perkin Elmer. Samples were analyzed using nitrogen as the carrier gas and Supelco SPTM 2560 column. The initial temperature of the column was set and held at 100°C for 3 min. The temperature was then raised at 2.5 °C/minute to 240°C which was held for 23 min. The fatty acid component was quantified by comparing each peak area with total peak areas and then expressed as a percentage of total fatty acid quantified.

Amino acid determination

The amino acid composition was determined using high-performance liquid chromatography (HPLC). Samples were hydrolyzed using hydrochloric acid under anaerobic condition for 24 h. The hydrolyzed samples were neutralized with NaOH and were derivatized. The derivatized samples were injected in HPLC (Waters) equipped with a C18RP column and a fluorescence detector. The amino acids were identified and quantified by comparing with the retention times and peak areas of standards.

Mineral content determination

Preparation of samples for mineral elements analysis followed method described by the Association of Official Analytical Chemists (1990). The sample was weighed into an acid-washed crucible and dried in oven 105˚C for 24 hours. Dried samples were then digested in a furnace oven at 550˚C overnight. The ash was digested in nitric acid, cooled and filtered through Whatman filter paper. Samples were then analyzed for its minerals content with atomic absorption spectrophotometer except for Phosphorus (P). Colorimetric method was used to measure Phosphorus (P) content. The vanadate-molybdate reagent was added to samples, homogenized and the absorbance was measured using UV spectrophotometer.

Data analysis

All results expressed are the mean of three or two measurements. Data were presented as mean (standard deviation). To test the differences between fish from different locations and nutrient components, two sample t-Test was performed using Minitab software (Version 16). Significance was established at P < 0.05 and highly significant at P < 0.01.

RESULTS AND DISCUSSION

Fish quality for a human food source is determined based on intrinsic or extrinsic factors. Color, texture and chemical composition of the flesh are among the most critical factor that defines the intrinsic quality of fish (Johnston et al. 2006). Data on fish body composition were also could be used for aquaculture because it influences fish appetite, growth and the efficiency of food utilization (Breck 2014). In this study, the basic chemical composition of barb fish was investigated and evaluated to identify its value as nutritional sources and commodity. Essential nutrition components described here were proximate content, mineral content, fatty acid, and amino acid profile. Factor that is also significant to be considered when assessing fish quality is the ratio of its body parts. This relative amount can be used to assess meat size and other edible parts of fish. In this study, different collecting time between both fishing sites may account for some variation between samples.

Table 1. Body part weight ratio (%) of Barb fish from Serayu River and Cipunagara River, Indonesia

Fish group	Average weight (%)			
	Flesh	Head, fin, bones, tail (edible byproduct)	Offal	Scales
Serayu	44.12	37.63	6.73	4.65
Cipunagara	42.49	38.95	5.72	5.73

Table 2. Summary of the proximate composition, statistical analysis, and results of Barb Fish from two different locations

	Flesh*		By-product*	
	FSS (SD)	FSC (SD)	FBS (SD)	FBC (SD)
Moisture (%) (n=3)	6.35 (0.05)**	7.21 (0.02)**	4.19 (0.07)**	5.31 (0.09)**
Ash (%)(n=3)	4.63 (0.04)**	5.19 (0.05)**	20.16 (0.02)**	14.91 (0.06)**
Fat (%)(n=3)	9.67 (0.18)**	6.02 (0.12)**	25.55 (2.62)**	39.09 (3.55)**
Protein (%)	64.17 (0.16)	66.23 (0.41)	40.66 (0.02)	31.20 (0.74)

Note: *Results were significantly different at p<0.05 for each paired group. **Results were highly significant at p<0.01 for each paired group. FSS: Flesh sample of barb fish from serayu, FSC: Flesh sample of barb fish from cipunagara, FBS: Byproduct of barb fish from serayu, FBS: Byproduct of barb fish from cipunagara. Data were presented as mean (standard deviation)

Body part ratio

Fish collected from both locations were varied in weight and length. The size range of fishes collected was also varied between 9.1 cm to 25.8 cm. These variations were unavoidable since it strongly depends on wild reserve. Therefore we weighted all fishes and each of its body part to measure the average ratio. The value was calculated as the average weight and presented in Table 1 as percentages in comparison to the total weight. Both group showed that flesh was the main component of barb fish followed by the edible byproduct (head, fin, bones, and tail). Offal and scales part comprise a small portion of total body weight. Flesh part ratio of both group was low compared to other wild freshwater fish like brown trout (Salmo Trutta Forma Fario) that contain about 67.59% fillet part (Kaya et al 2014). Barb's head, fin bone and tail which often wasted during consumption compose a significant part of the fish body. Thus this part is interesting to be investigated further to know its chemical properties.

Proximate analyzes

Table 2 gives the moisture, ash, fat, protein contents of the edible parts of barb fish from both locations. Data shows that the chemical composition of fish varies between fish locations and body parts. Overall, the amount of moisture and protein were higher in the flesh parts rather than in the byproducts. In opposite, byproducts showed higher content of fat and ash compare to flesh samples. Statistical test showed highly significant differences for each paired group except for protein content of the flesh.

The moisture content of all samples was lower than several freshwater fishes that have been studied which usually in the range of 60-80% (Teame et al. 2016; Fallah et al. 2011; Gul et al. 2017). This difference probably caused by sample preparation method. In this study, samples were prepared using oven dried that could contribute to a significant loss of water. The moisture content of flesh and byproduct part of fish from Cipunagara River was higher than Serayu River. There was a significant difference found in moisture content for each group of samples. The moisture content of fish varies greatly within species, sex, and age and it could depend on species, season, nutritional regime, size, spawning season, sex and catching area (Doğan and Ertan 2017). Since habitat character and fishing season between both samples group were relatively similar, it was speculated that difference moisture content could be related to size, sex and spawning time. However, more information and measurement needed to confirm significant factors which affect the difference in the nutritional content of both samples origin.

Ash content of Barb flesh sample from Serayu and Cipunagara were 4.63% and 5.19% respectively. These amounts were still in the range of ash content from several freshwater fish that have been studied. For instance, ash levels of wild rainbow trout (*Oncorhynchus mykiss*) from Iran were 1.30% (Fallah et al. 2011). Study on important food fishes from India showed that *Ailia coila*, *Amblypharyngodon mola*, *Anabas testudineus*, *Catla catla*, *Cirrhinus mrigala*, *Chitala chitala*, *Clarius batrachus* contained ash around 2.0, 4.0, 5.3, 2.5, 2.5, 1.7, 2.3 % respectively (Mohanty et al. 2017). Another study on wild freshwater fish from Pakistan such as *Barilius pakistanicus*, *Garrago tyla*, *Carassius auratus*, *Schizothorax plagiostomus*, *Schizothorax labiatus* showed ash content of 4.33, 8.00, 3.33, 4.66, 6.33% respectively (Gul et al. 2017).

Table 1 also showed that the ash content of fish byproduct was higher than flesh sample. This could be related with byproduct component that mainly composed of bones. Bones is regarded rich in minerals and important for storing calcium and phosphates. Fish bone is potential to be used as ingredients for health products, and aquaculture feeds. Study on dried fish bones that were used for cod feed showed a positive effect on the fish growth compared to traditional diets (Toppe et al. 2006). The edible fish byproduct is also potential to be converted into fish powder with accepted nutrient content and more affordable that could be used to answer human malnutrition (Abbey et al. 2017). Another study on using catfish's byproduct particularly by producing catfish's head flour showed that it could serve as raw material to increase the calcium content of crackers (Ferazuma et al. 2011). These shows that barb byproduct potentially could be served as raw material for various applications for animal or human.

Fat content in the flesh part of fishes groups were 9.67% and 6.02% respectively for fish from Serayu and Cipunagara. The fat content of flesh sample that was in the range 5-10% shows that barb fish could be categorized as fish with medium fat (Bennion 1980). Both flesh and byproducts of Barb fish contain higher fat compare to other common edible freshwater fish from Indonesia such as *Chanos chanos* and *Oreochromis niloticus* which contained 0.72% and 0.10% of fat respectively (Hafiludin 2015; Ramlah et al. 2016). This fat content was considered higher than several freshwater fishes that have been studied. For example, a study on fishes from lake and river in Ethiophia showed fat content of *B. docmak*, *C. carpio*, *C. gariepinus*, *L. intermidus*, *L. nedgia* were 4.32, 1.26, 5.74, 2.32, 2.28% respectively (Teame et al. 2016). Study on wild freshwater fish from Pakistan such as *Barilius pakistanicus*, *Garrag otyla*, *Carassius auratus*, *Schizothorax plagiostomus*, *Schizothorax labiatus* showed fat content of 1.00, 6.00, 4.33, 2.50, 4.33% respectively (Gul et al. 2017). However, the fat content of Barb's flesh samples was considered lower compare to several known freshwater fish in Asia like weel (*Anguilla mauritiana*), catfish (*Mystus nemurus*), African catfish (*Clarias grapienus*) and red pomfret (*Piaractus brachyponus*) (Rahman et al. 1995). Fish byproducts of both samples contain more fat than its flesh which is 25.55% and 39.09% respectively. The amount of fat content in the byproducts could be related to a lipid storage type of fish. For example, fatty fish (salmon, trout, herring, and mackerel) that store lipid in muscle has higher content lipids in bones compare to lean fish (cod, saithe and blue whiting) (Toppe et al. 2007).

Protein contents in the flesh part were 64.17% and 66.23% respectively for Serayu and Cipunagara locations. Barb fish contain high protein than other freshwater fishes that commonly consumed. Indonesia freshwater fish such as *Chanos chanos* and *Oreochromis niloticus* contained relatively low protein which is 20.49% and 12.94% (Hafiludin 2015; Ramlah et al. 2016). A wild freshwater rainbow trout (*Oncorhynchus mykiss*) from Iran also contained lower protein which is about 19.2% (Fallah et al. 2011). Food fishes from India which is *Ailia coila*, *Amblypharyngodon mola*, *Anabas testudineus*, *Catla catla*, *Cirrhinus mrigala*, *Chitala chitala*, *Clarius batrachus* contained crude protein around 12.9, 16.3, 16.9, 16.2, 15.5, 22.2, 16.4% respectively (Mohanty et al. 2017). Fishes from lake and river in Ethiophia showed lower protein content of *B. docmak*, *C. carpio*, *C. gariepinus*, *L. intermidus*, *L. nedgia* were 15.35, 17.25, 15.44, 14.98, 15.09% respectively (Teame et al. 2016). However, higher protein content was showed by wild yellow perch (*Perca flavescens*) which is 94.3% (González et al. 2006).

Mineral content

Mineral is important for healthy life process, and all animals need these inorganic elements. In fish, minerals are responsible for skeletal formation, maintenance of colloidal systems, regulation of acid-base equilibrium and for biologically important compounds such as hormones and enzymes. Table 3 shows the mineral content (main and trace elements) in the flesh sample of *B. balleroides*. Both barb fish from Serayu and Cipunagara contained a high amount of calcium, phosphorus, and potassium. Among the main elements, the most abundant in both samples were potassium, which is 1.485% and 1.270% in fish samples from Serayu and Cipunagara respectively. Overall, the mineral content of both samples groups was still higher than several freshwater fishes that have been studied (Fawole et al. 2007). A study that had been done on commercial Nile fishes showed lower content of potassium, phosphorous and calcium compare to Barb samples (Mohamed et al. 2010). Flesh sample from both fishes also showed a low level of Na and low-level Na/K ratio. This ratio shows that barb flesh could be categorized as a good food source for human health, particularly in the case of cardiovascular disease prevention (Bu et al. 2012; Perez and Chang 2014). Barb fish samples also showed the dominant content of Phosphor. This content could be related to fish feeding habit that consumes phytoplankton. Phosphor knew as one of mineral needed for phytoplankton growth (Ivančič et al. 2012). A study conducted by Rumondang (2013) showed the content of orthophosphate in the Serayu River. Relatively high Ca/P ratio was observed in both samples, which is 0.438 and 0.608 respectively for fish from Serayu and Cipunagara. The study showed that low intake of Ca/P and high Na/K ratio might have a negative impact on lipid metabolism (Bu et al. 2012).

Table 3. Main and trace elements contents in the flesh sample of the Barb fish from two different locations. Data presented as mean (standard deviation)

Minerals	Barb Fish of Serayu		Barb Fish of Cipunagara	
	FSS	SD	FSC	SD
Ca (%)	0.425*	0.007	0.590*	0.000
P (%)	0.970	0.000	0.970	0.000
Mg (%)	0.155	0.007	0.150	0.000
K (%)	1.485*	0.007	1.270*	0.028
Na (%)	0.300	0.000	0.230	0.000
Na/K ratio	0.202	0.000	0.181	0.000
Ca/P ratio	0.438	0.000	0.608	0.000
Fe (μg/g)	0.465	0.092	0.105	0.001
Mn (μg/g)	0.004	0.000	0.005	0.001
Zn (μg/g)	0.027	0.000	0.033	0.001
Cu (μg/g)	0.002	0.000	0.003	0.001

Note: *Results were significantly different at $p<0.05$ for each paired group

Table 4. Fatty acid profiles of barb fish flesh sample from two different locations

Fatty acid	FSS (%)	FSC (%)
C 10:0 (capric acid)	0.0034	0.0059
C 12:0 (lauric acid)	0.1297	0.1584
C 14:0 (myristic acid)	0.2313	0.4393
C 15:0 (pentadecyclic acid)	0.0225	0.038
C 16:0 (palmitic acid)	3.0918	5.7463
C 17:0 (margaric acid)	0.0323	0.0576
C 18:0 (stearic acid)	0.7551	1.6937
C 20:0 (arachidic acid)	0.0285	0.0447
C 21:0 (heneicosanoic acid)	0.0043	0.0057
C 23:0 (tricosylic acid)	0.0027	0.005
Σ Saturated fatty acid (SFA)	4.3041	8.1999
C 14:1 (myristoleic acid)	0.0047	0.0076
C 16:1 (palmitoleic acid)	0.2292	0.3149
C 17:1 (heptadecenoic acid)	0.0219	0.0311
C 18:1 ω9 (oleic acid)	3.3204	6.7995
C 20:1 (eicosenoic acid)	0.0266	0.0408
C 22:1 (erucic acid)	0.0052	0.0218
C 24:1 ω9 (nervonic acid)	0.0038	0.0077
Σ Monounsaturated fatty acid (MUFA)	3.6146	7.2232
C 18:2 ω6 (linolenic acid)	1.9496	3.2200
C 18:3 ω3 (linolenic acid/ALA)	0.1001	0.1872
C 18:3 ω6 (linolenic acid)	0.0646	0.0651
C 20:2 (eicosadienoic acid)	0.0072	0.0089
C 20:3 ω3 (eicosatrienoic acid)	ND	0.0069
C 20:3 ω6 (eicosatrienoic acid)	0.0880	0.1349
C 20:4 ω6 (arachidonic acid/AA)	0.2853	0.2097
C 20:5 ω3 (eicosapentaenoic acid/EPA)	0.0255	0.0696
C 22:2 (docosadienoic acid)	0.0049	0.0128
C 22:6 ω3 (docosahexaenoic acid/DHA)	0.2294	0.2689
Σ Polyunsaturated fatty acid (PUFA)	2.7546	4.1840
Σ Unsaturated fatty acid	6.3710	11.4072
PUFA/SFA ratio	0.6399	0.5103
Total Omega 3	0.3567	0.5327
Total Omega 6	2.3876	3.6296
ω6/ ω3 ratio	6.6936	6.8135
Total Omega 9	3.3257	6.8212
EPA + DHA	0.2549	0.3385

Note: . Data presented as mean. FSS: Flesh sample of Barb fish from Serayu. FSC: Flesh sample of barb fish from Cipunagara

Microelements are essential for human nutrition, however at specific concentrations could be harmful and toxic. The level of Cu, Zn, Mn, and Fe in Barb fish from both locations was lower than the toxic levels (FAO 2001). Among the microelements in both samples, the most abundant was Iron. This is due to the important role of iron in fish respiration (Watanabe et al. 1997). The high content of iron was found in flesh sample of Barb fish from Serayu. However, this iron level was low compared to other fishes particularly from marine fishes, commercial Nile fishes and wild yellow perch (González et al. 2006; Mohamed et al. 2010; Nurnadia et al. 2013).

Differences between the mineral content of Barb fishes from two locations could be related to several factors. Minerals accumulate in the fish body through the food chain and water. The concentration of minerals in fish tissue was also influenced by nourishment sources, biological differences seasonal factors and environmental conditions. These factors could related with the differences amount of mineral content between samples from two fishing site. However, more investigation is needed to find the most related factor.

Fatty acid

The fatty acid is one of the nutrient component that most sought from fish. Overall, Barb fish from Cipunagara contained more fatty acids (Table 4). Barb fish from Serayu were composed of, 4.3041% of total saturated fatty acids (SFA), 3.6146% monounsaturated fatty acids (MUFA) and 2.7546% polyunsaturated fatty acids (PUFA). Barb fish from Cipunagara contained 8.1999% SFA, 7.2232% MUFA and 4.1840% PUFA. Total unsaturated fatty acids were higher than saturated fatty acids in both samples, particularly for MUFA. Among saturated fatty acid, palmitic acid (C16:0) was the most dominant in both samples, this finding was in line with a study about freshwater fish from Greece and south Brazil that found palmitic acid as one of the dominant fatty acids in the sample (Aggelousis and Lazos 1991; Andrade et al. 1995). The most dominant MUFA found in both samples were oleic acid (C18:1). This fatty acid was also found abundant after palmitic acid in freshwater fishes of Indus River (Jabeen and Chaudhry 2011). Both fishes contained arachidonic acid (C20:4) which known as an important component in the wound healing process for facilitating blood clotting and attachment to endothelial cell (Rahman et al. 1995). Fatty acid profiles also showed a comparable ratio in both fishes for PUFA/SFA at 0.6399% and 0.5103% for Serayu and Cipunagara fishes respectively. The fatty acid composition of freshwater fish was influenced by lipid pattern of their natural food and environmental temperatures. For example, carp fish on a diet with essential fatty acid accumulated long-chain polyunsaturated fatty acids such as docosahexenoic acid in response to cold temperature (Farkas et al. 1980).

Both flesh sample of fish contained essential fatty acid (omega 3 and 6). Total Omega 3 found was 0.3567% and 0.5327% for flesh sample of fish from Serayu and Cipunagara respectively. The most abundant omega 3 in Barb fish from both locations was DHA, 0.2294% and

0.2689% for fish from Serayu and Cipunagara respectively. Omega 6 was found higher than omega 3 in both samples, whereas 3.3876% in fish from Serayu and 3.6296% in fish from Cipunagara. Omega 6 was found abundant as AA (0.2853%) in Serayu's fishes and as linolenic acid (3.2200%) in Cipunagara's fishes.

The omega-6/omega-3 ratio is known as important nutrition index for assessing the balanced synthesis of eicosanoids in the body (Steffens 1997). ω6/ ω3 ratio of Barb fish from both locations was relatively similar around 6. This ratio was considered high due to the high amount of omega-6 in the flesh sample from both locations which was very different with marine fish (Fernandes et al. 2014). A high proportion of n-6 PUFA, mainly linoleic acid and arachidonic acid, is known as a characterization of freshwater fish that could be attributed to the type of diet in the wild environment (Steffens 1997). Study on lipid and fatty acid comparison of marine and freshwater fish showed that the n-6 content of freshwater fish was higher than marine fish (Ozogul et al. 2007). However, the omega-6/omega-3 content of Barb fish still indicated that this fish is good for nutrition source since the ratio was low compared to other food that could affect diseases such as cardiovascular or breast cancer (Simopoulos 2002). Omegas 3, particularly in the form of DHA and EPA, have been shown to play a vital role in human health. This fatty acid has been demonstrated as essential for the growth and functional development of the infant's brain and also required for normal brain function maintenance in adults (Horrocks and Yeo 1999). DHA and EPA also have been reported to have preventive effects on cardiovascular diseases (Raatz et al. 2013). Overall, Barb fish contained PUFA that could be an indication of a good source for human nutrition. Fish is known as the primary source of a long chain of PUFAs as this type of fatty acid plays an essential role in immune system regulation, blood clots, neurotransmitters, cholesterol metabolism, and structure of membrane phospholipids in the brain and the retina (Abedi and Sahari 2014). Beside an indication for nutrition source, rich content of fatty acid could also be related with the feeding habit of this wild fish that consumes phytoplankton, an organism that rich essential fatty acid. A study conducted by Rumondang (2013) in Serayu river found 101 species of phytoplankton.

Amino acid

The composition of amino acid in both fish samples was varied as shown in Table 5. Fish, are known to have a high protein content, and the most abundant in the form of non-protein nitrogenous compounds are amino acids. Overall barb fish from Serayu contain more amino acid than fish from Cipunagara except for leucine, arginine, glycine, alanine, and cysteine. The abundant amino acids found in samples were glutamic acid, lycine, and aspartic acid. This was relevant to study that showed the most abundant amino acids found in aquatic organisms are glutamic acid, aspartic acid, and lysine (Ozden and Erkan 2008). Various species of fish contain the different dominant amino acid, for example, glutamate that was found dominant in this study was also found dominant in *Cirrhinus mrigala*, *Catla catla*, *Labeo rohita* (Mohanty et al. 2014). Differences between these fish group were shown by histidine that was found in fish from Serayu but was not detected in Cipunagara barb fish. However, the undetected result could also due to the value below the detection limit of the instrument. Fish from Cipunagara also contain high glycine compare to fish from Serayu River. Differences in total amino acid values in fish could be influenced by various factors such as species, spawning season, feeding conditions and the living area (Kaya et al. 2014; Ozden and Erkan 2011). However, amino acid composition found in fishes group from Serayu and Cipunagara was lower than another freshwater such as *Channa* spp. fish (Zuraini et al. 2006).

Fish is an important source of animal proteins, and it has been showed that fish protein could cause greater satiety than other sources of animal protein like beef and chicken (Uhe et al. 1992). Amino acids that were found abundant in samples were glutamic acid, aspartic acid, lysine, and histidine. These amino acids have important function related to human health. For example, glutamic acid has a role in amino acid metabolism because of its role in transamination reactions and necessary for the synthesis of key molecules like glutathione which are required for removal of highly toxic peroxides and the polyglutamate folate cofactors (Mohanty et al. 2014). Muscle of fish is the most consumed part that tastes delicious which was influenced by amino acid content. Glutamic acid and aspartic acid that were found abundant in both samples are known as an amino acid that related with the characteristics flavor of fish (Fuentes et al. 2010). Aspartic acid is important for hormone regulation and also as an amino acid precursor (Mohanty et al. 2014). Lysine is an amino acid that required for optimal growth, and its deficiency leads to immunodeficiency (Chen et al. 2003). Histidine has been shown playing an important role in protein interaction (Liao et al. 2013).

Table 5. Amino acid profile of barb fish flesh sample from two different locations

Amino acid	**Barb fish of Serayu**		**Barb fish of Cipunagara**	
(%)	**FSS**	**SD**	**FSC**	**SD**
GLU	9.20	0.00	6.50	0.00
LYS	8.47	1.22	5.62	0.31
HIS	8.01	2.19	-	-
THR	6.93	0.00	3.06	0.35
ASP	6.73	0.32	5.78	0.04
PRO	5.83	0.26	4.44	0.00
MET	3.90	0.32	3.86	0.00
ILE	3.64	0.39	3.53	0.47
SER	3.26	0.33	3.12	0.53
VAL	3.08	0.23	2.74	0.20
LEU	2.96	2.02	4.23	0.14
ARG	2.83	0.04	3.91	0.30
GLY	2.64	0.21	5.67	0.09
PHE	2.55	0.54	1.76	0.00
TYR	1.60	0.13	1.26	0.04
ALA	1.31	0.24	1.80	0.11
CYS	0.78	0.03	0.86	0.18

Note: SD: standard deviation

Overall, there are differences in some nutritional components between fish groups based on their fishing sites. Physical properties of both fishing sites such as habitat characteristic, pH, temperature and dissolved oxygen were almost similar. Therefore it was suspected that differences in nutritional components observed between the fish group were mostly resulted from feeding type or another intrinsic factor. The chemical composition of the flesh from the different fish group could be expected to reflect the diet or factors influencing metabolisms such as growth rate, spawning time or other growth activity. Future work could be continued by assessing intrinsic factor with control to extrinsic factor that could contribute to barb fish metabolism particularly about its nutritional component of Barb fish from different locations.

In conclusion, the present study showed basic nutrition components, mineral contents, fatty acid and amino acid profile of wild barb fishes that were collected from two different rivers in Java. Overall, flesh and byproduct samples from two locations showed different nutritional content. Flesh samples of Barb fish, particularly from Cipunagara River, contain higher protein than several known freshwater species. Both flesh samples contained a mineral that was good for health such as the low ratio of Na/K. Flesh samples of both fishes also contained essential fatty acids such as omega 6 and omega 3 that is good for human health. Amino acid profile showed that flesh sample contained good amino acid for human nutrition. Overall this study showed that *Barbonymus balleroides* could serve as a good source of nutrition and recommended to be a candidate for aquaculture commodity.

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