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Comparative study on nutrient contents of native and hybrid Koi (*Anabas testudineus*) and Pangas (*Pangasius pangasius*, *Pangasius hypophthalmus*) fish in Bangladesh

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Abstract

The proximate composition, heavy metals, minerals and amino acid profile were determined for the two species of native and hybrid fishes (*Anabas testudineus*, *Pangasius pangasius*, *Pangasius hypophthalmus*) from different local market of Dhaka city of Bangladesh. In the proximate composition, higher amount of protein 20.22±1.94% and fat 11.28±1.35% found in hybrid Koi in contrast of protein 18.05±1.06% and fat 8.64±0.56% of native Koi, whereas native Pangas showed higher protein 26.06±1.27% and fat 14.79±2.47 % than protein 23.18±2.11% and fat 11.11±1.75% of hybrid Pangas. Minerals included Zn, Na, Ca, K, Fe, Cu, Mg and Al was higher in native species. The distribution of heavy metal: Pb, Hg, Cd and As were not significantly differed at $p<0.05$ in native and hybrid fishes; except Cr in Pangas. The concentrations of all heavy metals were below toxic levels. A total of fourteen amino acids were identified and mean value of lysine, leucine, valine, methionine, threonine, serine, glutamic acid, glycine and arginine in native and hybrid Koi showed the significant differences ($p<0.05$). In case of Pangas fish lysine, isoleucine, valine, threonine, histidine, aspartic acid, glutamic acid, glycine, alanine and tyrosine in native and hybrid Panagas significantly differed ($p<0.05$). The overall results indicated that hybrid Koi is better than native Koi; whereas native Pangas is well again than hybrid Pangas in addition to good dietetic fish food.

Introduction

Fish is a high protein food consumed by a large percentage of populace because of its high palatability, low cholesterol and tender flesh (Eyo, 2001). It is the cheapest source of animal protein and other essential nutrients required in human diet particularly of the low and middle income groups. The nature and quality of nutrients in most animals depend largely on their food type. Moreover, the feeding habit of an individual fish species greatly affects the nutritional composition its flesh. About 85 to 90% fish protein is digestible and all the dietary essential amino acid is in fish flesh (Cappell *et al*., 2007). The measurement of some proximate composition including protein, fat, moisture, ash and carbohydrate contents is often necessary to ensure the food regulatory requirements. Fish is also an important source of mineral elements required in human diets. The mineral elements take part in some metabolic processes and are also components of many enzyme systems that are known to be indispensible to all living things (Shul'man, 1974). Their deficiency induces a lot of body malfunctioning such as, reduces productivity and causes diseases e.g. the inability of blood to clot, osteoporosis, anemia etc. (Shul'man, 1974). The measurement of these micro-nutrients in fish will reveal their availability to fish consumers and thus give a room to prevent the resultant effects of their deficiencies.

On the other hand, the heavy metal in fish flesh causes a serious health risk to the fish consumers (Onyia *et al*., 2010). The heavy metals gain access into the aquatic environment from natural and anthropogenic sources and bio-accumulate in fish and other aquatic animals and rather than sedimentations in water (Luinnik and Zubenko, 2000). Toxic heavy metals in the aquatic environment get to man either

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directly from drinking water or indirectly through the food chain and have been implicated in many human health problems such as cancer, brain damage and various behavioral problems (Forstner and Wittmann, 1981).

The present rate of fish production in Bangladesh is lesser than that of population boom. To meet up scarcity of food protein hybrid Pangas and hybrid Koi along with native Koi and Pangas is cultured for nutritional significance and various economic advantages. Higher growth rate and bigger size encourage the fish farmers to pursue its artificial breeding and culture in Bangladesh. Therefore, analysis of proximate composition such as protein, carbohydrates, lipids, moisture as well as the amino acid profile in protein and micronutrients associated with table-sized hybrid and native fish species before consumption is required to ensure how well they meet up the dietary requirements. Therefore, the present study was undertaken to find out the nutritional qualities of native and hybrid Koi and Pangas for the preference of the consumers of this fish.

Materials and Methods

Fish collection and sampling

The fish samples used for this study include native Koi (*Anabas testudineus*), native Pangas (*Pangasius pangasius*), hybrid Koi (*Anabas testudineus*), hybrid Pangas (*Pangasius hypophthalmus*) were collected from different local market of Dhaka city of Bangladesh. In early morning, the collecting fish samples were stored in ice box, and brought to the Institute of Food Science & Technology laboratory, BCSIR, Dhaka for analyses. After washing with tap water and taking length and weight of the fishes, the sample fishes were frozen at –18ºC until laboratory analysis. Initial weigh of the sample fish were taken. Then the fish samples were filleted and dried in an oven (Memmet 854 Schwabach) at about 105ºC for 8 to 10 hours. At two hours interval the fish samples were reweighed after cooling in a desiccators until a constant weight was achieved. The dried samples were then minced and powdered in an electric grinder.

Chemical analysis

Chemical analyses for moisture, ash, protein etc. of the concerned dried fish were done following the standard methods described in the AOAC manual (AOAC, 2005). Protein content of the experimental fish was calculated by multiplying total nitrogen content of fish by 6.25 conversion factor. Total lipids were determined following the method of Folch (1959). The concentration of mineral and heavy metal elements were determined using Atomic Absorption Spectrophotometer (Thermo-scientific iCE 3000) and the calorific value of each species of fish was calculated. Amino acids composition was determined with an automatic amino acid analyser (LKB 4151 plus, Biochrom Ltd., Cambridge, UK) according to Bidlingmeyer *et al*. (1987).

Statistical Analysis

The statistical analyses were performed using Student's t-test and one way ANOVA. Multiple comparisons of means were done by least significant difference (LSD) test. A probability value of $p<0.05$ was considered to be significant. All data were analyzed by the statistical software SPSS (version 11.0). The data were presented as mean ± SD of three determinations.

Results and discussion

Proximate analysis

Native and hybrid Koi

As observed in Table 1, hybrid Koi contained higher amount of protein and fat than protein and fat in native Koi. Higher amount of moisture ash and carbohydrate found in native Koi correspond to moisture ash and carbohydrate in hybrid Koi. Protein in native Koi also coincides with preceding studies (Kamal *et al*., 2007). The moisture, fat, ash and carbohydrate are more or less similar to the data reported by Ali *et al*. (1992). The little differences observed in fish flesh may be attributed to consumption or absorption system of food taken by the fish species (Adewoye, 2010). Moisture, fat and ash content of native and hybrid Koi differed significantly from each other ($p<0.05$) except protein and carbohydrate. The calorific value of fishes was not significantly differed ($p>0.05$). Ali *et al*. (1992) also found similar calorific value in native Koi (*Anabas testudineus*).

Native and hybrid Pangas

Table 1 showed higher amount of protein, fat and ash in native Pangas than protein, fat and ash in hybrid Pangas. Higher amount of moisture and carbohydrate was found in hybrid Pangas than that of moisture and carbohydrate content in native Pangas. This may be due to feeding pattern, metabolism and absorption system of fishes. Native Pangas contained more fat and showed an inverse relationship between fat and moisture content of fish. Fat and carbohydrate contents of hybrid Pangas is in line as shown by Ali *et al*. (1992) in their previous study. Fat and ash content of native and hybrid Pangas differed significantly from each other ($p<0.05$) but moisture, protein, fat and calorific value were not significantly differed.

Table 1. Proximate composition and energy values

	Parameters					
Fish name	Moisture	Protein	Fat	Ash	Carbohydrate	Energy(k Cal)
Native koi	70.26±1.31[a]	18.05±1.06[a]	8.64±0.56[b]	1.30±0.09[a]	1.74±0.93[a]	156.92±6.89[a]
Hybrid koi	65.82±1.25[b]	20.22±1.94[a]	11.28±1.35[a]	0.98±0.04[b]	1.59±1.33[a]	189.16±3.28[a]
Native pangas	56.11±4.01[a]	26.06±1.27[a]	14.79±2.47[a]	1.11±0.19[a]	1.80±0.68[a]	244.67±28.58[a]
Hybrid pangas	62.71±2.69[a]	23.18±2.11[a]	11.11±1.75[b]	0.86±0.14[b]	2.13±0.83[a]	201.23±17.52[a]

Triplicate analyses were performed and the results were expressed in gm% as mean values ± standard deviation and same superscripts among row indicates insignificant difference at p<0.05

Table 2. Mineral content (mg per 100 g)

Parameter	Native koi	Hybrid koi	Native pangas	Hybrid pangas
Zinc (Zn)	1.07±0.37[a]	0.57±0.05[a]	0.88±0.003[a]	0.75±0.005[b]
Sodium (Na)	125.44±2.98[a]	85.13±3.472[b]	210.26±4.670[a]	99.68±3.132[b]
Calcium (Ca)	367.80±8.2009[a]	310.16±5.9803[b]	90.71±2[a]	56.36±3.09[b]
Potassium (K)	161.26±2.7034[a]	129.35±3.2111[b]	311.71±3.009[a]	214.06±4.465[b]
Iron (Fe)	2.10±0.03[a]	1.91±0.07[b]	4.58±0.7601[a]	1.51±0.009[b]
Copper (Cu)	0.47±0.0556[s]	0.32±0.0532[b]	0.36±0.045[a]	0.20±0.0231[b]
Magnesium (Mg)	26.32±0.1987[a]	18.84±0.961[b]	48.94±2.87[a]	21.03±2.122[b]
Aluminum (Al)	5.95±0.0308[a]	3.29±0.8974[a]	0.71±0.01[a]	0.89±0.02[b]

Triplicate analyses were performed and the results were expressed in mg % as mean values ± standard deviation and same superscripts among row indicates insignificant difference at p<0.05.

Mineral content

Native and hybrid Koi

The mineral content of native and hybrid Koi compiled in Table 2. Native Koi contained higher amount of zinc, sodium, calcium, potassium, iron, copper, magnesium and aluminum than that of zinc, sodium, calcium, potassium, iron, copper, magnesium and aluminum per 100 g edible flesh in hybrid Koi. It was observed that both varieties are ample source of calcium as well as contain the appreciable amount of sodium and potassium. Calcium and iron content of native Koi was found less than that reported by Ali *et al*. (1992). Sodium, calcium, potassium, iron, copper and magnesium in native and hybrid Koi differed significantly ($p<0.05$) except zinc and aluminum. The study therefore, showed that native Koi are good sources of minerals. It could be inferred that the elemental mineral level of this species is a function of the availability of preferential accumulation.

Native and hybrid Pangas

Table 2 demonstrated that native Pangas contained higher amount of zinc, sodium, calcium, potassium, iron, copper, magnesium and aluminum than hybrid Pangas per 100 g edible flesh. The study indicated that native Pangas is good sources of minerals than hybrid Pangas. This may be due to feeding habit, size, age and habitat etc. In native and hybrid Pangas zinc, sodium, calcium, potassium, iron, copper, magnesium and aluminum were significantly differed ($p<0.05$).

Heavy metal

Native and hybrid Koi

Heavy metal contents obtained in fish species are summarized in Table 3. The study explored that concentrations of lead (Pb) and chromium (Cr) in hybrid Koi are higher than lead and chromium in native Koi but these are in permissible limit (WHO, 1996). Cadmium was not detected in both hybrid and native Koi. This may be due to their feed habit and habitat etc. Chromium content in both native and hybrid Koi was found within the recommended value 0.05-0.2 mg/day for adult (USDA, 2005). Heavy metal contents of native and hybrid Koi were not differed significantly ($p<0.05$). Mercury (Hg) was not detected in native and hybrid Koi.

Native and hybrid Pangas

Native Pangas contained more mercury and chromium in contrast of mercury and chromium of hybrid Pangas (Table 3). This may be due to habitats, feed habit and capability of accumulation as well as absorption etc. Mercury content in hybrid Pangas is similar to the mercury content reported by Elnimr (2011). Chromium in native and hybrid Pangas differed significantly ($p<0.05$). Safe value of lead, cadmium, chromium and arsenic are 0.3, 0.2, 2.3 and 0.05 mg/kg fish flesh respectively for adult per day (FAO, 2007). However, permissible safe value of mercury recommended by EU is 0.5 mg/kg diet (EC, 2011).

Table 3. Heavy metal content (mg per 100 g)

Parameter	Native koi	Hybrid koi	Native pangas	Hybrid pangas
Lead (Pb)	ND	0.0369±0.001^a	ND	ND
Mercury (Hg)	ND	ND	0.004±0.0604^a	0.0009±0.0001^b
Cadmium (Cd)	ND	ND	ND	ND
Chromium (Cr)	0.1103±0.046^b	0.1622±0.0031^a	0.3248±0.067^a	0.1464±0.0103^b
Arsenic (As)	0.0023±0.0002^a	ND	0.0012±0.0001^a	ND

Triplicate analyses were performed and the results were expressed in mg % as mean values ± standard deviation and same superscripts among row indicates insignificant difference at p<0.05. ND = Not Detected

Table 4. Essential amino acid content (g per 100 g)

Essential amino acids	Fish name			
	Native koi	Hybrid koi	Native pangas	Hybrid pangas
Lysine	2.57±0.001^a	2.40±0.02^b	3.24±0.056^a	2.61±0.312^b
Leucine	0.08±0.003^b	0.11±0.007^a	0.21±0.09^a	0.16±0.5001^a
Isoleucine	0.52±0.03^b	0.58±0.03^a	1.10±0.05^a	0.81±0.001^b
Valine	0.12±0.03^a	0.11±0.00^b	0.17±0.03^a	0.09±0.0091^b
Methionine	0.17±0.007^b	0.21±0.007^a	0.40±0.036^a	0.32±0.05^a
Threonine	0.22±0.003^b	0.27±0.01^a	0.86±0.021^a	0.77±0.0265^b
Histidine	0.99±0.053^a	1.12±0.090^a	1.06±0.07^a	0.86±0.01^b

Triplicate analyses were performed and the results were expressed in gm % as mean values ± standard deviation and same superscripts among row indicates insignificant difference at p<0.05

Table 5. Non-essential amino acid content (g per 100 g)

Essential amino acids	Fish name			
	Native koi	Hybrid koi	Native pangas	Hybrid pangas
Aspartic acid	0.58±0.004^b	0.64±0.05^a	0.37±0.06^a	0.26±0.00^b
Serine	0.74±0.0210^b	0.86±0.05^a	0.70±0.04^a	0.64±0.01^a
Glutamic acid	0.39±0.001^b	0.42±0.007^a	0.72±0.04^a	0.55±0.03^b
Glycine	2.16±0.005^b	2.70±0.09^a	3.12±0.09^a	2.24±0.09^b
Alanine	0.84±0.005^a	0.82±0.006^a	0.81±0.05^a	0.56±0.06^b
Tyrosine	0.19±0.0001^b	0.26±0.05^a	0.42±0.002^a	0.28±0.032^b
Arginine	1.48±0.0300^b	1.68±0.03^a	0.98±0.01^a	0.84±0.03^a

Triplicate analyses were performed and the results were expressed in gm % as mean values ± standard deviation and same superscripts among row indicates insignificant difference at p<0.05.

Amino acid profile

Essential amino acid

Table 4 illustrating higher amount of leucine, isoleucine, metheonine, threonine in hybrid Koi than leucine, isoleucine, metheonine, threonine in native Koi. Where as native Koi contained more lysine, valine, histidine than that of lysine, valine, histidine. There were significant differences between lysine, leucine, isoleucine, valine, methionine and threonine in native and hybrid Koi ($p<0.05$) but histidine were not significantly differed ($p>0.05$). The results showed that the calculated amount of isoleucine, leucine, lysine, threonine and valine are more or less similar to the recommended daily allowance of isoleucine, leucine, lysine, threonine and valine for adult per day (FAO, 1996). In Table 4 it is observed that hybrid Pangas contain higher amount of all the essential amino acids lysine, leucine, isoleucine, valine, methionine, threonine and histidine compared to native Pangas. Native Pangas is the good source of lysine. Statistical analysis showed significant differences in lysine, isoleucine, valine, threonine and histidine contents between native and hybrid Pangas ($p<0.05$) except leucine and methionine.

Non-essential amino acid

The non-essential amino acid contents are listed in Table 5. Except alanine all non-essential amino acid such as aspartic acid, serine, glutamic acid, glycine, tyrosine and arginine in hybrid Koi are higher than those are present in native Koi. Native Koi contained higher amount of alanine compare to that in hybrid

Koi. Serine, glutamic acid, glycine and arginine content differed significantly between native and hybrid Koi ($p<0.05$) but aspartic acid and tyrosine are not differed significantly. In case of Pangas; native one contain higher amount of aspartic acid, serine, glutamic acid, glycine, tyrosine and arginine compared to hybrid one. Notable amount of glycine found in native Pangas. Statistical analysis showed that the amino acid content in natitive and hybrid pangas differ significantly at 5% level of significance except serine and arginine.

Conclusion

In spite of being exotic species hybrid fishes are now prominent in rural and urban areas, and economical to the different traditional grades according to the consumers and fisherman preference in Bangladesh. Protein, lipid and moisture contents as well as calorific values were the major constituents which had been considered in comparing the nutritional value of the species studied. The examined native fishes contained appreciable concentrations of Zn, Na, K, Fe, Cu, Mg and Al compared to hybrid fishes. Native Pangas were higher both in essential and non-essential amino acid than hybrid one. Hybrid Koi contained more essential amino acids than native one. Few heavy metals were found but these are within the tolerable limits. The present study has elucidated the importance of hybrid Koi as a good source of proximate composition and lower in mineral content compare to native one, and native Pangas is better in terms of proximate, mineral and amino acid profile and contain higher heavy metals than native one, and has also focused on the nutritional value of studied fish. Likewise, since the interest in commercial culture of fish has increased to fill up the gaps between demand and supply, therefore, this study may be useful in developing nutrient-balanced and cost-effective diets for consumers.

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