

Proximate, Nutrient and Mineral Composition of Cuttlefish (*Sepia recurvirostra*)

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Abstract: The proximate, nutrient and mineral analyses were conducted on the head and mantle of cuttlefish (*Sepia recurvirostra*). Proximate analysis showed both head and mantle of cuttlefish contained 13.16-13.51% protein, 0.7-0.9% ash, 0.8% fat and 1-1.4% carbohydrate. Amino acid analysis revealed cuttlefish contained essential and non essential amino acid with arginine (0.97%) and glutamate (0.81%) was the highest in the head, respectively, while lysine (0.7%) and glutamate (0.7%) was the highest in the mantle, respectively. Lipid of cuttlefish contained high Percentage of Polyunsaturated Fatty Acid (PUFA) with a high content of DHA (17.5–20.5%). The C16:0 and C18:0 were the most abundant saturated fatty acid in the head and mantle. Mineral analysis showed high contents of sodium, phosphorus, potassium and calcium, with sodium content being the highest (1532.7-1610.4 mg/kg). Zinc and copper were the dominant trace minerals in both portions. This study showed that cuttlefish contain essential nutrients for human good health with high in protein and mineral content.

Keywords: Amino acid, DHA, essential mineral, proximate, nutritional, *Sepia recurvirostra*

INTRODUCTION

Indonesian marine ecosystem is rich with natural resource and biodiversity and appears as “epicentre” of marine tropical biodiversity (Veron, 1995). Highly variation in type of island and archipelago is the reason for this large biodiversity (Gray, 1997). Cephalopods landings and consumption have been increasing worldwide during the past decades. Cuttlefish, which has recently been captured in various amounts ranging from 11,000 to 15,000 tons annually throughout the world, occupies an important place among cephalopoda (FIGIS, 2004).

Cephalopods including cuttlefish, squid and octopus are among an important marine resource since they are rich in taste and have few inedible parts. The connective tissue of cephalopods is highly developed compared to fish in general. Its body contain low level of lipid, however omega-3 polyunsaturated fatty acid presented the majority of the total lipid (Ozyurt *et al.*, 2006; Thanonkaew *et al.*, 2006; Phillips *et al.*, 2002). *Sepia recurvirostra* is demersal species that inhabits the continental shelf. It is widely distributed in Indo-West Pacific, from China to the Philippines, Indonesia and Pakistan. It is a commercial species in Gulf of Thailand, South and East China Seas and Japan (Jereb and Roper, 2005). The nutritional composition of cuttlefish has been reported by some researchers (Thanonkaew *et al.*, 2006; Villanueva *et al.*, 2004; Ozyurt *et al.*, 2006; Phillips *et al.*, 2002). However, this composition could

vary among species due to geographical differences of fishing grounds. In addition, compositions can vary with body part or organ. Therefore, this study was conducted to evaluate the chemical properties and nutritional composition of the cuttlefish head and mantle.

MATERIALS AND METHODS

Sample preparation: Samples of fresh cuttlefish (*S. recurvirostra*) were purchased from local fisherman in Muara Angke, Jakarta, Indonesia. The samples were placed in ice and transported to the Department of Aquatic Product Technology, Bogor Agricultural University. Length, width and height of 30 randomly selected mussels, was measured. After the biometric measurements were taken, the mussels were weighed, cut into mantle and head portions and were weighed. Each portion was powdered by blending the samples and kept in ice until analysis. The research was carried out between April and June, 2011 at the Department of Aquatic Product Technology, Faculty of Fisheries and Marine Science, Bogor Agricultural University.

Proximate analysis: Proximate analysis was carried out according standard procedure of the Association of Official Analytical Chemist (William, 2005). Moisture content was determined by drying the sample in an oven at 102-105°C and dried to constant weight. Ash content was determined by incineration of 5 g of the

sample at 600°C for 8 h. The determination of crude fat content was conducted by soxhlet extraction method using n-hexane as solvent. Nitrogen was determined using the Kjeldahl method and the quantity of protein was calculated by multiplying the percentage nitrogen content by the conversion factor 6.25. The content of total carbohydrates was determined by difference according to the formula 100 – [% water + % proteins + % lipids + % ashes].

Amino acid analysis: Amino acid analysis was carried out according to AOAC method using high performance liquid chromatography (William, 2005). Samples were hydrolyzed with 2 mL 6N HCl for 24 h and derivatized using Orthoptalaldehyde (OPA) prior to injected onto HPLC.

Fatty acid analysis: Fatty acid analysis were conducted according to method of William (2005). Lipid obtained from soxhlet destruction were trans methylated by refluxing the fractions in alkalized (sodium hydroxide) methanol for 20 min at 80°C. The internal standard was added to aid in the identification of the Fatty Acid Methyl Esters (FAME). Samples were cooled and converted to FAME using 20% boron trifluoride in methanol. The Fatty Acid Methyl Esters (FAMEs) of the tissues total lipids were extracted from the reaction with iso-octane. Fatty acid methyl esters were separated and quantified by a Shimadzu Gas Chromatograph (GC) 17A (Shimadzu Corporation, Kyoto, Japan) fitted with a Flame Ionisation Detector (FID).

Cholesterol content: Cholesterol content was estimated using Liebermann-Burchard reagent. Standard cholesterol solution used was 0.4 mg/mL. Liebermann-Burchard reagent was prepared with 0.2 mL concentrated sulfuric acid and 2 mL glacial acetic acid and was covered with aluminium foil and kept in dark place.

Mineral analysis: Minerals component were evaluated from solution obtained by first wet-ashing the samples and dissolving the ash with de-ionized water and concentrated hydrochloride acid in standard flask. The solution was analysed for minerals content using Atomic Absorption Spectrophotometer (Shimadzu type AA 7000). Phosphorus was determined colorimetrically using spectrophotometer as described by Reitz *et al.* (1987).

RESULTS AND DISCUSSION

Biometric parameters and meat yield: Table 1 shows the biometric measurements of the cuttlefish, as well as

Table 1: Biometric parameters and meat yield

Parameter	Value
Length (Cm)	12, 70 ±1, 30
Width (Cm)	5, 59 ±0, 53
Thickness (Cm)	1, 95 ±0, 40
Weight (gram)	59, 43 ±10, 91
Head (%)	32, 53
Mantle (%)	67, 47

Table 2: Proximate analysis of cuttlefish

Parameters	Head (%)	Mantle (&)
Moisture	84, 06±0, 08	83, 65±0, 43
Ash	0, 89±0, 14	0, 69±0, 14
Protein	13, 16±0, 10	13, 51±0, 68
Lipid	0, 77±0, 00	0, 79±0, 00
Carbohydrate	1, 12±0, 33	1, 36±0, 97

Table 3: Amino acids composition of cuttlefish

Amino acids	Head (g/100g of body weight)	Mantle (g/100g of body weight)
Aspartic acid	0, 62±0, 01	0, 52±0, 11
Glutamic acid	0, 81±0, 01	0, 69±0, 14
Serine	0, 53±0, 01	0, 43±0, 04
Histidine	0, 23±0, 01	0, 19±0, 01
Glycine	0, 65±0, 08	0, 47±0, 04
Treonine	0, 47±0, 01	0, 39±0, 02
Arginine	0, 97±0, 01	0, 69±0, 03
Alanine	0, 68±0, 02	0, 49±0, 06
Tyrosine	0, 49±0, 02	0, 33±0, 02
Metionine	0, 49±0, 01	0, 31±0, 01
Valine	0, 42±0, 01	0, 35±0, 01
Phenilalanine	0, 50±0, 02	0, 39±0, 01
Isoleusine	0, 46±0, 00	0, 38±0, 03
Leusine	0, 67±0, 01	0, 57±0, 09
Lysine	0, 78±0, 23	0, 71±0, 18

mantle yield and head percentage. The mantle, the main edible portion of cuttlefish and the head portion of *S. recurvirostra* was higher compared with *S. pharaonis* (Thanonkaew *et al.*, 2006). The mantle contained bulk of musculature where most somatic growth occurs (Semmens *et al.*, 2004). The size and weight of cephalopods are dependent on growth stage, temperature, salinity, oxygen, light, food, competition, social interaction and sex (Forsythe *et al.*, 2002; Okuzumi and Fujii, 2000).

Proximate analysis: The chemical compositions of both head and mantle of cuttlefish are shown in Table 2. The head portion contained more moisture and ash content, however contained less carbohydrate than the mantle portion. These result are similar with *S. pharaonis* which reported by Thanonkaew *et al.* (2006). Cuttlefish *S. recurvirostra* contained 13% of protein, similar with which reported Thanonkaew *et al.* (2006) on *S. pharaonis*, however it is still lower compared to *Sepia arabica* (Papan *et al.*, 2011). According to Lee (1994), cephalopods is composed of 18% protein and leaving only 3% of body mass for other biochemical compounds needed for life. Cephalopods have 20% more protein, 80% less ash, 50-100% less lipid and 50-

Table 4: Some fatty acid composition of cuttlefish

Fatty acid	Head	Mantle
Lauric Acid (C12:0)	0.03 ± 0.00	0.02 ± 0.00
Miristic acid (C14:0)	0.48 ± 0.04	0.30 ± 0.01
Pentadecanoic acid (C15:0)	0.18 ± 0.01	0.11 ± 0.00
Palmitic acid (C16:0)	7.34 ± 0.21	5.44 ± 0.39
Heptadecanoic acid (C17:0)	0.51 ± 0.02	0.44 ± 0.03
Stearic acid (18:0)	3.70 ± 0.01	3.58 ± 0.28
palmitooleic acid (C16:1)	0.40 ± 0.00	0.20 ± 0.04
oleic acid (C18:1 n9)	2.02 ± 0.04	1.24 ± 0.20
eicosenoic acid (C20:1)	0.38 ± 0.00	0.51 ± 0.06
linoleic acid (C18:2 n6)	0.30 ± 0.06	0.08 ± 0.02
linolenic acid (18:3 n6)	0.02 ± 0.00	0.02 ± 0.00
Arachidonic acid (C20:4 n6)	5.45 ± 0.03	4.14 ± 0.83
EPA (C20:5 n3)	6.28 ± 0.06	5.06 ± 0.21
DHA (C22:6 n3)	20.46 ± 0.23	17.55 ± 3.18

100% less carbohydrate when compared to fish. This author also stated that cephalopod mantle does not store lipid or its storage is below 1% of its wet weight.

Amino acid compositions: Amino acid compositions in both the head and mantle of cuttlefish are shown in Table 3. Arginine, leucine and lysine represented 48% and 49% of the essential amino acids (EAA) of the head and the mantle of *S. recurvirostra*, respectively. Glutamic acid, glycine and alanine represented 56% of the Non-Essential Amino Acids (NEAA) of both the head and the mantle. Arginine, leucine and lysine were among the highest component of essential amino acids in *S. officinalis*, *Loligo vulgaris* and *Octopus vulgaris* (Villanueva *et al.*, 2004), as well as in giant squid *Architeuthis* sp and *Rossia macrosoma* (Rosa *et al.*, 2005; 2006). The amino acids content could vary among organisms due to geographical differences, species, age and physiological condition (Capillas *et al.*, 2002).

Arginine and proline are served as the main substrates amino acid catabolism for energy in the cephalopods (Hochachka and Fields, 1983) as it derived carbon were found in CO₂, urea, ornithine, glutamate, citrulline, proline, alanine and octopine (Mommson *et al.*, 1982). The availability of arginine tend to increased during anaerobic work. Arginine phosphate is hydrolyzed and the arginine available is condensed with glucose-derived pyruvate to form octopine, the main anaerobic end product that accumulates in adult cephalopods during periods of exercise and stress (Hochachka *et al.*, 1977; Storey and Storey, 1978). In addition, arginine with glutamic acid, alanine and glycine are free amino acids responsible for the formation of flavour.

Fatty acid profile of cuttlefish: Some of fatty acids profile found in both head and mantle of cuttlefish are shown on Table 4. Palmitic acid (5.44-7.34%), oleic acid (1.24-2.02) and DHA (17.55-20.46) represented

the dominant fatty acid among saturated, monounsaturated and polyunsaturated fatty acid, respectively. These data is similar with others report. The variation of fatty acid composition depends on species, food availability, age, geographical area, season and salinity (Ozogul and Ozogul, 2005; Ozyurt *et al.*, 2006). Lipid content on cephalopods is lower compared with fish, with phospholipid presented the highest component. Adult cephalopods are rich in long Polyunsaturated Fatty Acid (PUFA) (Phillips *et al.*, 2002; Thanonkaew *et al.*, 2006; Ozyurt *et al.*, 2006) as well as the hatchlings and paralarvae cephalopods (Navarro and Villanueva, 2000). The lipid composition of cephalopods is influenced by the lipid composition of the food. Navarro and Villanueva (2000) found the cultured octopus paralarvae showed a lower content of PUFA as compared with the newly hatched individuals. Omega-3 PUFA, particularly DHA is major needed fatty acid in early developmental stages for membrane synthesis where the n-3 PUFA are incorporated (Henderson and Sargent, 1985), maintaining the structural and functional integrity of cell membranes in fish, be even more important for the correct development and survival of fast growing phospholipid-rich cephalopod paralarvae (Navarro and Villanueva, 2000).

Cholesterol content: The cholesterol content of cuttlefish was 74,64 mg/100 g in mantle and 108,90 mg/100 g in the head part. Several studies have shown that cephalopod lipid profiles display high concentration of phospholipids, cholesterol and Polyunsaturated Fatty Acids (PUFA). Okuzumi and Fujii (2000) reported a content of cholesterol in several cephalopods such as 123 mg/100 g in cuttlefish, 180 mg/100 g in squid and 139 mg/100 g in octopus. The level of cholesterol in the mantle of cuttlefish was increased with age (Almansa *et al.*, 2006). The high level of cholesterol in the body of cuttlefish was observed since in the early stages. Navarro and

Table 5: Mineral composition of cuttlefish (mg/kg body weight)

Mineral	Head	Mantel
Na	1610, 42 ±301, 47	1532, 69 ±366, 92
Mg	60, 02 ±2, 79	64, 87 ±9, 33
Ca	197, 86 ±8, 07	186, 23 ±8, 61
K	210, 72 ±2, 99	277, 48 ±1, 12
P	439, 26 ±16, 20	569, 67 ±37, 68
Fe	6, 77 ± 0, 22	4, 03 ±0, 53
Zn	21, 42 ± 0, 71	19, 62 ±1, 06
Cu	11, 82 ± 0, 06	5, 70 ±0, 15
Se	0, 06 ± 0, 01	0, 02 ±0, 01
Cd	0, 15 ± 0, 02	0, 04 ±0, 01
Pb	ND	ND
Hg	ND	ND

Villanueva (2000) reported a content of a cholesterol accounted for more than 20% of total lipid in the early stages of cuttlefish. Cuttlefish are known to change their diet in the wild, with the importance of fish increasing and crustacean decreasing, during growth (Castro and Guerra, 1990).

Mineral composition: The mineral content of *S. recurvirostra* is presented in Table 5. Sodium (1532-1610 mg/kg body weight) was found as the major component of mineral both in the head and mantle, followed by phosphorus and potassium. Lourenco *et al.* (2009) found that the main elements of common cephalopods were S, Cl, K, Na, P, Mg and Ca. Meanwhile, in hatchlings and juveniles of the cephalopod species showed a high content in S Villanueva and Bustamante (2006). Regarding the trace element, Zn and Cu were the dominant trace mineral in both head and mantle and this result is similar with Thanonkaew *et al.* (2006). Cephalopods are known as carnivorous and active predators. As they have very high feeding rates, most part of the elements can be assumed to be incorporated by the diet. The absorption of minerals from seawater also could take place by osmotic uptake through the gills and the body surface as the cephalopods live in hypoosmotic environment. Minerals also absorbed by digestive gland as they swallow massive quantities of sea water during and after feeding (Wells and Wells, 1989). Minerals are required for the maintenance of normal metabolic and physiological functions of living organisms. The main functions of essential elements in the body include the formation of skeletal structure, maintenance of colloidal systems, as well as regulation of acid base equilibrium. They are important components of hormones, enzymes and structural proteins (Lall, 2002; Villanueva and Bustamante, 2006). Sodium, potassium and chloride maintain homeostasis and the acid-base balance, while phosphorus and calcium are required for the formation of skeletal structure of the body (Lall, 2002). Copper and zinc are firmly associated with metal-dependent enzyme. Zn is involved in numerous protein functions such as the carbonic anhydrase and is efficiently absorbed and strongly retained in *S. officinalis* both

from the food and seawater pathways (Villanueva and Bustamante, 2006).

Level of cadmium of *S. recurvirostra* was low in both the head and the mantle, while lead and mercury were not detected. Cd, Pb and Hg were among element that could be harmful for organism (Nurjanah *et al.*, 1999). Cephalopods are considered to be a vector for the transfer of cadmium to top marine predators (Bustamante *et al.*, 1998; 2002). The digestive gland exhibited the highest cadmium accumulation compared with others organ, with food is likely the primary pathway bioaccumulation (Raimundo and Vale, 2008; Bustamante *et al.*, 2002).

CONCLUSION

This study revealed that cuttlefish contain essential nutrients for human good health with high in protein and mineral content, but low in lipid content. The body of cuttlefish contained high level of PUFA and various kinds of amino acid. Both head and mantle portions of cuttlefish comprised different trace minerals at varying concentrations.

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