Tropical Technology Journal ISSN: 1656-0264
Volume 17, January – December 2014

NUTRITIONAL QUALITY OF THE EGG MASS AS "LUKOT" OF THE WEDGE SEAHARE *Dolabella auricularia* (Lightfoot, 1786)

Pepito AR[*1, 2],Delan GG[1], Asakawa M[3], Ami LJ[2], Yap EES[2],
Olympia MSD[2], Yasui K[3], Maningo AG[1], Rica RLV[4], Lamayo RC[1],
Babaran MC[1] and Abdon HC[1]
[1]Cebu Technological University-Carmen Campus
[2]Institute of Fish Processing Technology, College of Fisheries and Ocean Sciences,
University of the Philippines Visayas, Miag-ao, Iloilo
[3]Department of Bioresource Science and Technology, Graduate School of Biosphere Science, Hiroshima University
[4]Cebu Technological University-Main Campus
[*]Corresponding author/[*]Telephone Number: (032) 429-9898
[*]Mobile Number: 09162918523/[*]email address: ador_riverapepito@yahoo.com

ABSTRACT

The egg mass of the wedge seahare *Dolabella auricularia* has been gathered as human food for quite a long time without knowing its nutritional composition. Thus, this study was conducted in order to determine some nutritional aspects of the egg mass as basis of its utilization as human food. Important composition of the egg mass that were determined were its proximate composition, mineral contents and amino acid profile. In terms of proximate composition, the egg mass has a moisture content of 91.10 percent, fat of 0.85 percent, protein of 2.85 percent, ash of 3.43 percent and 1.77 percent for carbohydrates. The mineral content such as: calcium, iron, potassium, sodium and zinc contains 1040 mg/kg, 25.3 mg/kg, 599 mg/kg, 9803 mg/kg and 41.6 mg/kg, respectively. The amino acid profile, has six (6) essential amino acids such as: threonine, valine, isoleucine, leucine, phenylalanine and hstidine while it has nine (9) non-essential amino acid like: taurine, aspartic acid, serine, glutamic acid, glumatimine, glycine, alanine, tyrosine, proline. It has also eight (8) other amino acids components such as: Phospo-serine, urea, aromatic amino acid, citrulline, beta-alanine, gamma-aminobutyric acid, ammonia, ornithine. Results show that the egg mass of the wedge seahare contains some nutritional components that are very essential in maintaining a healthy and balanced life, thus making it as another food commodity from the marine environment.

Keywords: opisthobranch – mollusks, proximate composition, mineral content, amino acids

INTRODUCTION

Seafoods are very important in the diet of every Filipino which can be served either as fresh and/or cooked. They are of high demand because of their considerable health benefits and for being nutritious (Skonberg and Perkins, 2002). Seafood products are being considered potential and the cheapest source of animal protein due to their amino acid composition and digestibility (Louka *et al,* 2004). The vitamins and minerals of the seafoods are sufficient to warrant healthy living (Murray and Burt, 2001). On the other hand, measurement of fish constituents is sometimes necessary to meet the requirements of food regulation or commercial purposes (Osibona, 2011). The proximate composition of fish serves as an index for fish quality (Hernandez *et al.,* 2001) and provide information in terms of the nutritive value of a fish (Steffens, 2006). The diet conscious consumers preferred fish as a potential source of animal protein and essential nutrients (Fawole *et al,* 2007). Protein has been recognized as essential for the

sustenance of life. Fish can be an excellent source of protein because of its amino acid components and the degree of its digestibility (Louka *et al,* 2004). Fishery products have been found to be rich in protein needed by human in terms of nutritional nourishment.

The wedge Seahare, *Dolabella auricularia* belongs to the *Opisthobranch* molluscs (*Aplyssidae)*. It is mostly found in shallow tropical shoreline and was observed to feed on algae or seagrasses (Calumpong, 1979).The organism lays a gelatinous string like egg mass usually cemented to eel grass or seaweed. Spawning and recruitment period of the wedge sea hare has been observed to occur throughout the year, with peaks in May and July and September to October making its egg mass available the whole year round (Calumpong and Pauly, 1984). Utilization of the egg mass of the wedge seahare are not only popular in the Philippines but in other parts of the world like Samoa, Kiribati and Fiji Islands (Singh and Vuki, 2009). In the aforementioned places both the organism and the egg mass are collected for food, and are eaten either raw or half-cooked, or marinated with lemon juice (Fay-Sauna, 2001).

In the Philippines, egg mass are either eaten raw in a form of a salad or added as one of the ingredients in cooking "*Tinolang Isda"* (a staple soup in Visayas region) and shellfishes. The egg mass has been traditionally consumed as human food for quite a long time and there have been no reported incidents/cases of food poisoning due to ingestion of the egg masses. Further, anecdotal information claims that eating the egg mass could bring many health benefits to its consumer. However, these claims were not scientifically and empirically proven. Thus, this study was conceptualized in order to determine the nutritional composition of the egg mass in relation to its utilization as human food.

MATERIALS AND METHODS

Sample Collection and Preparation

Egg masses of *D. auricularia* were collected from the coastal areas of Danao City and Carmen, Cebu during the lowest tide in the morning. They were harvested fresh from the sources and were cleaned of debris and placed in a tray lined with paper cloth to remove the excess moisture before being placed in ziplock cellophane bag. Packed samples were then placed in a styrofoam box lined with crushed ice and transported to the laboratory for the proximate and mineral content analysis while for the amino acid analysis, the sample was transported frozen to Hiroshima University.

Proximate Composition

Egg mass samples were analyzed for moisture and ash content following the procedures by AOAC (1995), Total Fat by Bligh and Dyer Method (1996) and crude protein using the Modified Kjeldahl Method (AOAC, 1980). Carbohydrates were calculated by the difference between 100 percent and the sum of the other components. Triplicate determinations were carried in each analysis.

 ISSN: 1656-0264

Mineral Content Determination

The mineral content of the egg mass in terms of calcium (Ca), iron (Fe), Potassium (k), sodium (Na), and zinc (Zn) were analyzed at the laboratory of the Department of Science and Technology Region VII. Samples were digested with nitric acid, added with potassium chloride and diluted to known volumes. The test solutions were aspirated through the Atomic Absorption Spectrometer (AAS) set in flame emission mode for measurement.

Amino Acid Profile

Analysis of the amino acid composition of the egg mass of *Dolabella aurecularia* was done at the Hiroshima University, Japan, using an Amino Acid Analyzer (Automatic Amino Acid Analyzer 400).

RESULTS AND DISCUSSION

Proximate Composition

The chemical characteristics of the egg masses of *Dolabella auricularia* were determined through its proximate composition. Percentage composition of moisture, protein, total fat, ash and carbohydrates is shown in Table 1. The egg mass of the wedge seahare is a high moisture product whose percent composition is even higher than that of the sea urchin roe which is 78.97 percent (Mol, et al, 2008) and quail egg which is 74.54 percent (Dudusola, 2010). Results show that since the egg mass is high in moisture content, it will have better digestibility and help supplement the water requirements of its consumer.

The total fat composition of the egg mass (Table 1) was very much low compared to the fat contents of sea urchin roe which is 3.05 percent (Mol, et al, 2008) and quail egg which is 10.83 percent (Dudusola, 2010). The low percent composition of the crude fat of the egg mass could be attributed to its high moisture content. The low percentage of lipid in the egg mass is an index that it is a low oil foodstuff and can be recommended as egg substitute for those who are observing low fat diet. In the case of the egg mass it is a low fat food since its proximate composition is less than 5 percent (Stansby, 1982).

Table 1. Proximate Composition of *Dolabella auricularia* Egg Masses

Proximate Composition	Percentage
Moisture	91.10
Total Fat	0.85
Protein	2.85
Ash	3.43
Carbohydrates	1.77*

-*calculated by difference
- Values are mean of 3 replicates

 ISSN: 1656-0264

The percent composition of protein (Table 1) in the egg mass of the wedge seahare was found higher compared to the other components because it forms the largest quantity in fish (Steffens, 2006). High protein supply in the body aids in the regulations of blood sugar and facilitate in losing weight (Sutharshiny and Sivashanthini, 2011). The high percentage of protein and low in fat content are the advantages of seafood (Pigott and Tucker, 1990). Based from the results, the egg mass of the wedge seahare is a potent source of high protein and low fat food commodity from the marine environment.

High levels of ash content (Table 1) were found in the egg mass sample of seahare. According to Hanan *et al.* (2009) high level of ash content in the food is of significance in measuring the mineral. Ash content is oftentimes associated to its relatively high mineral content (Ratana-Arpon, 2006). Bolawa *et al.* (2011) reported that high ash content of the products can be a good source for minerals such as calcium, potassium, zinc iron and magnesium. These minerals are important for human nutrition (Sikorski *et al.,* 1990). The egg mass of the wedge seahare can be a rich source of minerals as indicated with high ash content as shown in the results (Table 1).

The carbohydrate content obtained from the egg mass was 1.77 percent. Results suggest that the egg mass of the wedge seahare can be recommended as part of the diet for those who are observing their sugar levels since most of the carbohydrates found in fishery products contains glucides (Sudhakar *et al,* 2011) in which there were some traces of glucose, fructose, sucrose and other mono and disaccharides (Okuzumi and Fujii, 2000).

Mineral Content

The result shows (Table 8) that the egg mass of *D. auricularia* is rich in calcium (Ca), iron (Fe), potassium (K), sodium (Na) and zinc (Zn). Ca and K are necessary to maintain an optimal bone development with more of both mineral being required during childhood and growing stages to prevent rickets and osteomalacia. Literature shows that daily calcium requirements of individuals vary in gender and age level.

FAO/WHO (Food and Agriculture Organization/ World Health Organization) recommend that men aged between 19 to 65 years and women aged over 19 years, and up until the menopausal stage, consume 1000 mg calcium/day and that postmenopausal women and men aged over 65 years consume 1300 mg calcium/day (FAO/WHO 2002). This simply shows that the egg mass of the wedge seahare can still be consumed daily by individuals belonging to the age ranged previously mention and can help supplement the calcium requirement of individual. However, conscious consumption of egg mass should be observed if the age range of the consuming public is below than what is stipulated earlier.

 ISSN: 1656-0264

Table 2. Mineral Content (mg/kg) of *Dolabella auricularia* Egg masses

Mineral	**Content**
Calcium	1049
Iron	25.3
Potassium	599
Sodium	9803
Zinc	41.6

- Values are mean of 3 replicates

Iron (Fe) performed several vital functions in the body. It serves as carriers of oxygen to the tissues from the lungs by red blood hemoglobin (Sudhakar *et al.,*2011). The iron requirements of individuals varies in terms of gender and age. According to FAO (2002), the recommended daily intake of iron for male ranges from 27.4 to 37.6 while for women ranges from 28-65.4. The iron content in the egg mass (Table 2) was higher than that of what is required by FAO, therefore careful consumption of the egg mass should be observed since too much iron accumulation in the body can cause organ dysfunction through the production of reactive oxygen species which may led to liver and heart failures (Kohgo *et al.,*2008).

In terms of potassium according to the Food and Nutrition Board (2005) there is a varied dietary intake which is 4.5g to 4.7 g for men and 4.7 g for women. Results show (Table 2) that the potassium content in the egg mass is a little bit higher than that of the allowable daily intake per day. However, it is still safe for the consumer to eat the egg mass since there was no tolerable upper limit for potassium intake because toxicity is rare to healthy individuals (Bellows and Moore, 2013).

In terms of sodium content (Table 2), results show that the egg mass of the wedge seahare has been found to contain sodium than that of what is required by the Food and Nutrition Board (2005) which is 1500 mg/day. The higher sodium content in the egg mass could be possible reasons for its distinct taste since sodium improves the sensory properties of foods, by increasing saltiness, decreasing bitterness, and increasing sweetness and other congruent flavor effects (Liwm, Miremali and Keast, 2011).

Hambidge (2000) reported that zinc (Zn) is known to be involved in most of the metabolic pathways in plants, animals and humans since it performed varied biological and physiological role in the body. It is then imperative that it must be incorporated in the diet of every individuals. It is noteworthy to mention that in a developing country like the Philippines one of the health issues for children is zinc deficiency which resulted in retardation of children's growth and impairment of their cognitive functions (Salgueiro *et al,*2002).

 ISSN: 1656-0264

Amino Acid Profile

The amino acid profile of the egg mass of the wedge seahare is classified based from the study of Sudhakar *et al.* (2011). Results show that the egg mass of the wedge sea hare contains six (6) Essential Amino Acid (Table 3). The essential amino acids valine, leucine and isoleucine are known to perform the important functions of increasing the protein which serves as a source of energy during exercise. The three previously mentioned essential amino acids comprised 35 to 40 percent of the dietary essential amino acids found in the body of protein and 14 percent of the total amino acids in skeletal muscle (Vlaardingerbroek *et al.,* 2011). Therefore, incorporating it in the diet can help balance the nutritional requirements of every individual. Threonine is essential amino acids which is an important constituent of collagen, elastin and tooth enamel protein. It also helps prevents the building of fat in the liver. However, threonine deficiency, may result to diarrhea.

Table 3. Essential Amino Acid of the Egg Mass

Amino Acid	**Egg Mass**	**µg/ml**
Threonine	Thr	2.664
Valine	Val	5.643
Isoleucine	Ile	5.253
Leucine	Leu	0.761
Phenylalanine	Phe	0.535
Histidine	His	0.230

Phenylalanine is essential amino acids known to be used by the brain in making morepinephrine, a chemical important in arousal that keeps one awake and alert. However, hydroxylation of phenylalanine to tyrosine disposes excess phenylalanine, which prevents the accumulation of toxin (Vlaardingerbroek *et al.,* 2011). Histidine is essential for growth and removes heavy metals from the body. It will be converted into our body as histamine which plays a role in smooth muscle function and the dilation and contraction of blood vessels. The Essential amino acids in an appropriate amount are required for the maintenance of life, growth, synthesis of vitamins and reproduction (Sudhakar *et al,* 2011). Balance nutritional components in the body system must be of paramount importance to every individual to warrant healthy living. Lowest level in any of the essential amino acids in a protein source limits the utilization of the protein, thus making it as a first limiting amino acid (Paulraj and Sridhar, 2001) while high levels of amino acids can trigger the occurrence of inflammatory diseases (Shoda *et al,*1996 and Gil, 2002).

Chukwuemeka (2008) reported that in order for an adult to remain healthy, essential amino acids like: lysine. methionine, phenyalanine, threonine, tryptophan and valine must be incorporated in the diet. Based from the unique functions of essential amino acids into the body

and the fact that it cannot be synthesized by the body system, it is imperative that it must be included in the diet of every individual to compensate the amino acid requirements.

Results show (Table 3) that three (3) of the previously mentioned amino acids are present in the egg mass, making it as one of the good sources of essential amino acids and are highly recommended to be always incorporated in the diet to help supplement the amino acid requirements of human.

The egg mass of the wedge seahare has nine (9) non-essential amino acids (Table 3). Taurine, intracellular sulphur-containing amino acid (Boucknooghe *et al,* 2006) is not part of the human body's structural proteins. It simply remain free in the tissues and bloodstream which are abundant in the heart, the skeletal muscles and nervous system. Taurine has been recognized for its diverse biological function into the body and have even demonstrated potent antioxidants and showed effectiveness against diabetes mellitus by decreasing the concentration of glocuse and fructosamine and increased the contents of insulin, c-peptide and glycogen in the liver (Gavrovskaya *et al*, 2008). Another study revealed that supplementing taurine in the diet of an infant can help aid in the bile acid secretion, fat absorption and proper liver function (Hayes *et al*, 1980). Taurine has been proven by Matsuyama *et al* (1981) to decrease the level of bilirubin and bile acids in a double-blind, randomized study of an acute hepatitis patients in the amount of four (4) grams three (3) times daily after meal.

Aspartic Acid helps in removing harmful ammonia from the body and increases endurance and resistance to fatigue. Serine plays an important role in the biosynthesis of purines and pyrimidines. It is also the storage of glucose that helps strengthen the immune system. Glumatic Acid is known as nature's brain food and will be converted into glutamine in the body which detoxifies ammonia in the brain. Glutamine helps sustain mental ability, regulates brain metabolism and is being used in the treatment of alcoholism and can protect against alcoholism. Glycine is required in the conjugation of bile acids and plays a role in cell signaling. It also serves as an ammonia donor and is essential for the synthesis of glutathione. Alanine is an important source of energy for muscle tissue and also strengthen the immune system by producing antibodies. It is the second most important amino acid involved in interorgan nitrogen transport, particularly from muscles to liver (Vlaardingerbroek *et al.,* 2011).

Tyrosine is used by the body in the production of various amines while serine has essential role in the functioning of the Central Nervous System (CNS) by providing precursors for amino acids, protein and nucleotide synthesis, neurotransmitter synthesis and L-serine derived lipids (Tabatabaie *et al*, 2010). Proline is vital for the proper functioning of joints and tendon and helps strengthen heart muscles. It is also known as the key regulator of multiple biochemical and physiologic processes in cells, such as cell differentiation and free radical scavenging (Vlaardingerbroek *et al.,* 2011).

 ISSN: 1656-0264

Table 4. Non-Essential Amino Acid of the Egg Mass

Amino Acid	Egg Mass	µg/ml
Taurine	Tau	19.373
Aspartic Acid	Asp	4.299
Serine	Ser	2.707
Glutamic Acid	Glu	23.842
Glutamine	Gln	0.501
Glycine	Gly	7.670
Alanine	Ala	7.562
Tyrosine	Tyr	3.367
Proline	Pro	4.525

Based from the results, the egg mass which contains eight (8) non essentials amino acids can be a very good food source that would aid/supplement for proper nourishment. It has even higher amino acid content than that of salmon roe (Seagran *et al,* 1953).

In terms of the other components of the egg mass, eight (8) other components (Table 5) were determined. Gamma-aminobutyric acid is a dietary supplement that works as primary inhibitory neurotransmitter in the central nervous system in adults. I is further claimed either to increase or decrease human growth hormone levels and may increase the level of the hormones insulin and glucagon. However, these claims are not yet proven empirically and scientifically. Citrulline an amino acid which serves as an important constituent of the liver, acts as detoxifying agent by removing the toxic compounds like ammonia in the system.

Orthinine an amino acid derived from the breakdown of arginine during the citric cycle helps build muscles and reduced body fat. Urea, not as waste product due to the end of protein metabolism, is used by the body as a raw material to synthesize amino acid and protein. Ammonia has been known to be essential in the body as building block for making protein and other complex molecules. In terms of beta-alanine, a naturally occurring beta-amino acid and is classified as non-proteinogenic amino acid, are claims to be used by the body in the building of proteins.

Table 5. Other Amino Acids of the Egg Mass

Amino Acid	Egg Mass	µg/ml
Phospho-serine	P-ser	2.574
Urea	Urea	7.6555
Aromatic Amino Acid	AAA	0.595
Citrulline	Cit	0.254
Beta-alanine	b-ala	1.214
Gamma-aminobutyric acid	GABA	0.239

 ISSN: 1656-0264

Ammonia	NH_3	3.874
Ornithine	Orn	0.240

Based from the results of the study, the egg mass of the wedge seahare contains amino acids that can help supplement the amino acid requirements for healthy body. As shown in Table 5 upon eating the egg mass, a couple of essential and non-essential amino acids are introduced into the body that can help balance the nutritional requirement. Eating the egg mass is far more better than taking a synthetic dietary supplement because, in dietary only a target amino acids are present while in the egg mass a couple of amino acids can be assimilated by the body making it as a potent source of amino acid requirements and another ideal food commodity from marine environment.

CONCLUSION AND RECOMMENDATION

Based from the results of the study, it was found out that the egg mass of the wedge sea hare *Dolabella auricularia* was found as an ideal food for human consumption.Further studies are suggested to determine the profile of the fatty acid component, its vitamins and minerals content and to screen the egg mass for any possible biologically active compounds to maximize its utilization and consumption.

ACKNOWLEDGMENT

The authors wish to extend their sincere thanks to DOST – PCAARD (formerly PCAMRD) for the scholarship of Mr. Pepito, DOST–RO VII for the Laboratory Analysis, CTU–Carmen Campus and Department of Bioresource Science and Technology, Graduate School of Biosphere Science, Hiroshima University, Japan for the amino acid analysis.

LITERATURE CITED

Bolawa, O. E., Gbenle. G. O., Ayodele, S.O., Adewusi, O. R., Mosuro, A. O. and Apata, O.S. 2011. Proximate composition properties of different fish species o/btained from Lagos, Nigeria. Internet J. of Food Safety.13:342-344

Boucknooghe T, Remacle C, Reusens B. 2006. Is taurine a functional nutrient? Curr Opin Clin Nutr Metab Care. 9:728–33

Calumpong, H. P.1979. Some aspects of ecology of sea hare *Dolabella auricularia* (lightfoot), in Central Philippines. Siliman J. 26: 134-146

Calumpong, H. P. and Pauly, D.1984. Growth, reproduction and mortality of the sea hare *Dolabella auricularia* (Gastropoda: Aplysiidae) in the Central Visayas. Marine Biology. 79(3): 289-293

Chukwuemeka, U.2008. The fatty and amino acids profiles of Cichlidae and Claridae finfish species. Internet J. of Food Safety. 10: 18-25

Fay-Sauna, L. 2001. A comparative study if women's involvement and the management of the arkshell (*Anadara sp.)* Kiribate and Fiji. MSc Thesis. University of the South Pacific. Fiji (Unpublished)

Fawole, O.O., Ogundiran, M.A., Ayandiran, T.A., and Olagunju, O.F. 2007. Proximate composition in some selected fresh water fishes in Nigeria, Internet J. of Food Safety.13 (9): 52-55

Gavrovskaya, L.K., Ryzhova, O.V., Safonova, A.F., Mstveev, A.K., Sapronov, N.S. 2008. Protective effect of taurine on rats with experimental insulin-dependent diabetes mellitus. Bull. Exp. Biol. Med. 146: 226-228

Hayes, K.C., Pronczuk,A., Addesa, A.E. and Stephan ,Z.F. 1989. Taurine modulates platelet aggregation in cats and humans. *Am J Clin Nutr.* 49:1211-1216.

Hernandez, M.D., Martinez, F.J., and Garcia, B. 2001. Sensory evaluation of farmed sharpsnout seabream (*Dipludos puntazzo)*. Aquacult. Int. 9:519-529

Ikeda H.1977. Effects of taurine on alcohol withdrawal. *Lancet*. 2(8036):509.

Kreider, R.B. 1999. Dietary supplements and the promotion of muscle growth with resistance training. Sports Medicine. 27:97-110

Louka, N., Juhel, F., Fazilleau, V. and Loonis, P. 2004. A Novel Colorimetry Analysis used to Compare Different Drying Fish Processes. J. Food Control. 15:327-334

Mc Ardle, W. 2000. Essentials of exercise physiology, 2nd Ed. Philadelphia: Lippincott William and wilkins

Mac Genitie, G. E. 1934. The egg laying activities of the sea hare, *Tethys californicus*. Biol. Bull.67:300-303

Matsuyama, Y. , Morita, T. , Higuchi, M. and Tsujii T. 1983. The effect of taurine administration on patients with acute hepatitis. *Prog Clin Biol Res*. 125:461-468

Mol, S., Baygar, T., Varlik, C. and Tosun, S.Y. 2008. Seasonal variations in yield, fatty acids, amino acids and proximate composition of sea urchin *(Paracentrotus lividus)* Roe. J. of Food and Drug Analysis. 16 (2):68-74

Moran, A. L. and Woods, H. 2007. Oxygen in egg masses: interactive effects of temperature, age and egg mass morphology on oxygen supply to embryos. J. of Exp. Bio. 210 :722 -731

Murray, J. and Burt J.R. 2001. The composition of fish. Torry Advisory Note No. 38, Ministry of Technology. Torry Research Station, U.K. 14

Okuzumi, M. and Fujii, T.2000. Nutritional and Functional Properties of Squid and Cuttlefish. National Cooperative Association of Squid Processors, California. 223

Osibona, A.O., 2011. Comparative study of proximate composition, amino and fatty acids of some economically important fish species in Lagos, Nigeria. African J. of Food Science. 5 (10):581-588

Paulraj, R. and Sridhar, S.M. 2001. Essentials amino acid and fatty acids requirements of fish and crustaceans. Course Manual on Advance in Fish and Crustaceans and Aquatic Feed Biotechnology, CMFRI, Kodie

Pigott, G. M. and Tucker, B.W. 1990. Extracting and processing marine lipids. In. Pigott and Tucker, editors, Seafoods: Effects of technology on nutrition. N.Y. Marcel Dekker, Inc. 294-314

Seagran, H., Morey, D., Dassow, J. 1953. The amino acid content of roe at different stages of maturity from five species of pacific salmon. The Journal of Nutrition: 139-149

Shakuntala, K. and Pandian, T.J. 1972. On the hatching mechanism of a freshwater prawn *Macrobrachium idae.* Hydrobiologia. 40:381-384

Shoda, R., Matsueda, K., Yamato, S., and Umeda, N. 1996. Epidemiologic Analysis of Crohn Diseases in Japan: Increased Dietary intake of n-6 polyunsaturated fatty acids and animal protein relates to the increased incidence of Crohn disease in Japan. Am. J. Clin. Nut. 63:741-745

Singh, S. and Vuki, V. 2009. The sea hare fishing in Fiji Islands. SPC Women in Fisheries Bulletin, 19:17-18 Sikorski, Z. E., Kolakowska, A. and Pan, B.S. 1990. The Nutritive Composition of the Major Groups of Marine Food Organism In: “Seafood: Resources Nutritional Composition and Preservation”. Ed. Z.E. Sikorski. Gdansk, Poland, 25-29

Skonberg, D.I. and Perkins,B.L. 2002. Nutrients composition of green crab *(Carcinus meanus)* leg meat and claw meat. Food Chem. 77:401-404

Soundarapandian, P. and Singh R. K. 2008. Biochemical composition of the eggs of commercially important crab *Purtunus pelagicus* (Linnaeus). Inter. J. of Zoological Research. 4(1):53-58

Stansby. M. E. 1982. Properties of fish oils and their application to handling of fish and to nutritional and industrial use. In: Chemistry and Biochemistry of Marine Food Products, Martin, R. E., Flick, G.J., Hebard, C.E., and Ward, D. R. (Eds). Avi Publishing Co., Westport, CT. 75-92

 ISSN: 1656-0264

Steffens, W. 2006. Freshwater fish-wholesome foodstuff. Bulg. J. Agric. Sci. 12:320-328

Sudhakar, M., Raja, K., Anathan, G., and Sampathkaumar, P. 2011. Compositional characteristics and nutritional quality of *Podopthalmus vigil(Fabricius).* Asian J. of Biol. Sci. 1-9

Sutharshiny, S. and Sivashanthini, K. 2011. Proximate composition of three species of *Scomberiodes* fish from Sri-Lankan waters. Asian J. of Clinicl Nut.3: 103-111

Tabatabaie L, Klomp LW, Berger R, de Koning T. J. 2010. L-serine synthesis in the central nervous system: a review on serine deficiency disorders. Mol Genet Metab. 99(3):256-62.

Van Horn, J. 2005. Sea hares in the aquarium. SeaScope. 22:1-4.

Wilde, C. J. , Addey, C. V. P. , Li, P. & Fernig, D. G. 1997. Programmed cell death in bovine mammary tissue during lactation and involution. Experimental Physiology 82:943-953.

Waterman, J.J. 2000. Composition and Quality of Fish. Torry Research Station, Edinburg.

WHO/FAO/UNU Expert Consultation, 2002