Amino and fatty acids composition and the effect of selected marine yield available in Egyptian markets on serum lipid profile

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Abstract: Marine yield such as oyster, crustacean and fishes are known to be a source of protein rich in essential amino acids. Moreover, those yields contain high in monounsaturated and polyunsaturated fatty acids that might favorably improve lipid profiles and reduce risk of coronary heart disease (CHD). Thus this study was carried out to determine fatty and amino acids compositions and determine the effect of feeding with different amount of different common marine fishes on serum lipid profile. The results indicated that, Marine crustacean (Shrimp) tended to have the highest moisture content (76.3%). Marine yield with the least moisture content was freshly *Mugil Cephalus* (Bore) (63.6%). *Tridacna maxima* (Boser) had the highest protein content (22.5%). While, Shrimp and *Mugil Cephalus* (Bore) samples collected from Egyptian markets had approximately similar protein content (19.4% and 19.7%, respectively). Crude fat was lowest in Shrimp (1.15%) and highest in *Mugil Cephalus* (Bore) (8.6%). The predominant amino acids amongst the non-essential amino acids were aspartic acid and glycine, and those amongst the essential amino acids were lysine and leucine. The sum of essential amino acids ranged between 25.52% in *Mugil Cephalus* (Bore) to 38.79% in *Pandalus borealis* (Shrimp). Leucine, isoleucine plus valine account for 13.01%, 14.7% and 17.45% of total amino acids for *Mugil Cephalus, Tridacna maxima*, and *Pandalus borealis,* respectively. The PUFA contents were much higher (26-47 %) than the saturated fatty acid (24-40%). All investigated fish, oyster and crustacean are rich sources of a special class of polyunsaturated fatty acids known as the omega-3 or n-3 fatty acids (DHA, EPA and ALA). Investigated samples were richer in omega-3 PUFAs (15-27%) than omega-6 PUFAs (5-9%). Treating hyperlipidemic groups fed on basal diet with different kinds and levels of investigated marine yields to significant decrease in the mean value of serum cholesterol, triglyceride, LDL-c and VLDL-c as compared to the positive control group. In conclusion, inclusion of marine sources of the n-3 PUFA in the diet seems reasonable because they are good sources of protein without the accompanying high saturated fat seen in fatty meat products. Therefore, to benefit from vital nutrients like ω-3 HUFA, protein, essential amino acids, a moderate quantity of marine yields should be consumed by people.

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1- Introduction

Food helps human beings maintain good health by providing all essential nutrients. Consuming a variety of foods in balanced proportions will prevent deficiency diseases and chronic diet-related disorders.

Fish is known to be a source of protein rich in essential amino acids (lysine, methionine, cystine, threonine and tryptophan) (Zygmunt *et al.,* 2009). The essential amino acids are lysine, methionine, threonine, tryptophan, isoleucine, leucine, phenylalanine and valine. Failure to obtain enough of even one of the essential amino acids results in the degradation of the muscle proteins in the body. Recent evidence shows that some amino acids and their metabolites are important regulators of key metabolic pathways that are necessary for maintenance, growth, feed intake, nutrient utilization, immunity, behavior, larval metamorphosis, reproduction, as well as resistance to environmental stressors and pathogenic organisms in various fishes. Therefore, conventional definitions on essential and nonessential amino acids for fish are challenged by numerous discoveries that taurine, glutamine, glycine, proline and hydroxyproline promote growth, development, and health of aquatic animals (Li *et al.,* 2008).

Fish meal has been the most important feedstuff used as a source of protein in aquaculture feeds because of its essential amino acid composition and palatability (Davis *et al.,* 2004). Demand for protein ingredients in aquaculture is expected to exceed supply in the next decade. The growth of the aquaculture industry will also raise the price of feedstuffs (New and Wijkstom, 2002).

Fish oil can be obtained from eating fish or by taking supplements. Oily fishes provide about 1 gram of omega-3 fatty acids in about 3.5 ounces of fish. During the past 20 years, however, there has been renewed interest in other dietary components that might favorably improve lipid profiles and reduce risk of coronary heart disease (CHD). Fish and fish oil, rich sources of omega-3 fatty acids, have sparked intense interest in both epidemiological studies, which suggest a favorable effect on CHD, and metabolic ward studies, which show a striking improvement in lipid profiles in hyperlipidemic patients (Eritsland *et al.,* 1995).

Pandalus borealis (Shrimp), *Mugil Cephalus* (Bore) and *Tridacna maxima* (Boser) are the most delicious seafoods and is part of Egyptian's traditional meal. Its popularity has created a demand for its produce around the world. To data, a limited number of investigations have been performed on the lipid composition, amino acid composition and the affect of fish consumption on the serum lipid profile of fresh *Pandalus borealis* (Shrimp), *Mugil Cephalus* (Bore) and *Tridacna maxima* (Boser) obtained from Egyptian markets. Thus this study was carried out to determine fatty acid composition, amino acid compositions and determine the effect of feeding with different amount of different common marine fishes on serum lipid profile.

2- Material and Methods

Material

Marine yield such as marine crustacean *Pandalus borealis* (Shrimp), *Mugil Cephalus* (Bore) and *Tridacna maxima* (Boser) were purchased from Hurghada, local market. Chemicals were purchased from Sigma-Aldrich (St. Louis, MO). Kits for biochemical analysis of serum glucose, cholesterol, triglyceride, HDL-c, AST, ALT, were obtained from the Gamma Trade Company for Pharmaceutical and Chemicals, Dokki, Egypt.

Determination of Moisture, crude protein and crude fat:

Moisture, crude protein and crude fat contents were determined according to the methods described by AOAC (2000). Carbohydrates were calculated by differences.

Determination of fatty acids and amino acids:

The method described by Farag *et al.* (1986) was applied for determination of fatty acids by gas liquid chromatograph (GLC).

Determination of amino acids:

The amino acids were separated on Amino Acid Analyzer (Model: AAA 400).Acid hydrolysis was carried out according to Csomos and Simon-Sarkadi (2002).

Samples of fatty acids and amino acids were determination on General analysis from Faculty of Agriculture Research Faculty of Agriculture – Cairo University.

Animal care

The present study was approved by the local Animal Ethics Committee. The investigation conformed to the National Institutes of Health (NIH) Guide for the Care and Use of Laboratory Animals [DHHS Publication No. (NIH) 85-23, Revised 1985, Office of Science and Health Reports, Bethesda, MD 20892]. All animals were maintained on a 12 h lights and 12 h dark cycle and a temperature of 23 ± 1°C. All animals received modified basal diets (Reeves, 2004) and water *ad libitum*. Male Sprague-Dawley rats with average weights of about 200 g (10 wk old) were purchased from Laboratory Animal Colony, Ministry of Health and Population, Helwan, Cairo, Egypt. They were housed 5 rats/cage. All rats' except rats in group 1 were fed on hypercholesterolemic diet to induce hypercholesterolemia. Rats were divided into the following experimental groups (n = 10 rats in each group):

- Group I: Negative control, normal healthy rats, receiving regular diet with no treatment.
- Group II: positive control, hypercholesterolemic rats receiving hypercholesterolemic diet with no treatment.
- Group III: hypercholesterolemic rats receiving hypercholesterolemic diet and receiving powdered *Mugil Cephalus* (Bore) 5% of the total diet.
- Group IV: hypercholesterolemic rats receiving hypercholesterolemic diet and receiving powdered *Mugil Cephalus* (Bore) 15% of the total diet..
- Group V: hypercholesterolemic rats receiving hypercholesterolemic diet and receiving powdered *Tridacna maxima* (Boser, muscle) 5% of the total diet.
- Group VI. hypercholesterolemic rats receiving hypercholesterolemic diet and receiving powdered *Tridacna maxima* (Boser, muscle) 15% of the total diet.
- Group VII. hypercholesterolemic rats receiving hypercholesterolemic diet and receiving powdered *Pandalus borealis* (shrimp) 5% of the total diet.
- Group VIII. hypercholesterolemic rats receiving hypercholesterolemic diet and receiving powdered *shrimp* (shrimp) 15% of the total diet.

After 4 weeks the blood was extracted from the tail vein and estimated some serum lipid profile.

Estimation of serum lipid profile

Total serum cholesterol (Cohn *et al.,* 1988), triglycerides (Foster and Dumns, 1973), HDL-c (Young, 2001), LDL-c and VLDL-c calculated by the methods described by (FriedWald *et al.,* 1972).

Statistical analyses

The results are expressed as mean ±SEM. The SPSS (release10.0) software package (SPSS Inc., Chicago, IL) was used for the statistical analyses. For comparisons of more than two groups, significance was tested using an analysis of variance (one way-ANOVA). Differences between groups were considered significant when $P<0.05$.

3- Results and Discussion

Table 1 summarizes the major findings from this study. In general, different marine yield such as fish (Bore), marine crustacean (shrimp) and marine oyster (Boser) types assessed had high levels of investigated macronutrients.

Table 1. Average analysed nutrient profile of 100 g edible, *Mugil Cephalus* (Bore), *Tridacna maxima* (Boser) and *Pandalus borealis* (Shrimp) meat (moisture/dry weight)

Fish types	weight	Protein (g)	Carbohydrate	Fat	Moisture
Mugil Cephalus (Bore)	MW	$19.7^{b} \pm 1.2$	$8.7^{a} \pm 1.1$	$8.6^{a} \pm 2.2$	$63.6^{b} \pm 10.6$
	DW	$53^{c} \pm 4.6$	$24^{a} \pm 4.3$	$23^{a} \pm 5.4$	
Tridacna maxima (Boser)	MW	$22.5^{a} \pm 3.8$	$8.6^{a} \pm 1.2$	$1.7^{b} \pm 0.3$	$67.6^{b} \pm 11.2$
	DW	$68.5^{b} \pm 6.7$	$26.3^{a} \pm 3.3$	$5.3^{b} \pm 1.0$	
Pandalus borealis(Shrimp)	MW	$19.4^{b} \pm 2.9$	$3.2^{b} \pm 0.6$	$1.15^{b} \pm 0.3$	$76.3^{a} \pm 13.4$
	DW	$82^{a} \pm 8.7$	$13.2^{b} \pm 3.0$	$4.6^{b} \pm 0.7$	

Significance at $p<0.05$

MW: moisture weight DW: dry weight

[a, b, c, d,] means that values which don't share the same letter in each column are significantly different at $p<0.05$.

[a] is the best result followed by [b] and [c] and so on

Moisture Content:

As shown in Table 1, moisture content of different edible marine yield assessed varied based on types of marine yields. Moisture content of fresh marine yields ranged from 63.6% to 76.3%. Marine crustacean (Shrimp) tended to have the highest moisture content (76.3%). Marine yield with the least moisture content was freshly *Mugil Cephalus* (Bore) (63.6%). Both of *Mugil Cephalus* (Bore) and *Tridacna maxima* (Boser) have the approximately similar total moisture content. Even no statistical significant were observed between them.

Crude Protein: Fresh

Tridacna maxima (Boser) had the highest protein content (22.5%). While, Shrimp and *Mugil Cephalus* (Bore) samples collected from Egyptian markets had the least protein (19.4% and 19.7%, respectively). Even no statistical significant were observed between them.

Fat Content:

Fat Content of the marine yields assessed in this study, crude fat was lowest in Shrimp (1.15%) and highest in *Mugil Cephalus* (Bore) (8.6%). *Mugil Cephalus* tended to have fat content 7-fold higher than *Tridacna maxima* (Boser) *and Pandalus borealis* (shrimp). Even highly statistical significant were observed between *Mugil Cephalus and Tridacna maxima or shrimp*. It may be to Bore fish is classified as fatty fish, while both shrimp and Boser are classified as low fatty fishes (Ryan *et al.,* 2010)

Carbohydrate contents:

Carbohydrate contents of edible marine yields assessed varied based on types of fish. Carbohydrates content of fresh fishes ranged from 3.2% to 8.7%. Shrimp tended to have the lowest carbohydrate contents (3.2%). Marine yield with the highest carbohydrates content were freshly *Mugil Cephalus* and *Tridacna maxima*. Both of *Mugil Cephalus* and *Tridacna maxima* have the approximately similar total carbohydrates content. Even no statistical significant were observed between them.

Amino acids composition

To further investigate the quality of proteins in the tested samples, the amino acid composition was determined. The amino acid compositions of proteins in selected marine yields are shown in table 2. When the results were expressed per 100 g of dry product, the sum of essential amino acids ranged between 25.52% in *Mugil Cephalus* (Bore) to 38.79% in *Pandalus borealis* (Shrimp). The differences in the essential amino acid contents between selected marine yields were statistically significant. *Pandalus borealis* (Shrimp) was characterized by greater contents of essential amino acids in comparison to other tested types. It should be noted that, the essential amino acid requirement for an adult man weighing 70 kg is about 5.6 g per day (Gawedzki, 1997). As calculated essential amino acids from tables 1 and 2, the results indicated that 58, 62, and 75 grams of Bore, Shrimp and Boser, respectively met the daily requirement for essential amino acids (data not present in tables).

The predominant amino acids amongst the nonessential amino acids were aspartic acid and glycine, and those amongst the essential amino acids were lysine and leucine. This result in general was agreed with previous study (Zygmunt *et al.,* 2009).

Table 2. Amino acid composition of selected marine yields g/100 g dry weight

	Essential amino acids		
Item	*Mugil Cephalus* (Bore)	*Tridacna maxima* (Boser)	*Pandalus borealis* (Shrimp)
Lysine	5.53	5.32	10.12
Threonine	2.87	2.47	5.07
Valine	2.19	3.56	5.34
Methionine	2.57	1.55	1.58
Leucine	2.91	5.25	5.82
Phenyl-lanine	2.49	1.75	4.54
Isoleucine	1.80	1.28	3.18
Histidine	5.46	1.71	3.144
Sum.	25.82	22.89	38.79
	Non-essential amino acids		
Item	*Mugil Cephalus* (Bore)	*Tridacna maxima* (Boser)	*Pandalus borealis* (Shrimp)
Serine	2.05	15.12	2.80
Glycine	6.82	5.65	6.64
Proline	2.49	0.17	4.95
Alanine	10.55	6.19	6.78
Aspartic acid	2.28	9.19	10.01
Arginine		2.23	7.86
Ammonia		6.31	
Tyrosine	2.98	1.22	3.26
Cysteine			0.91
Sum.	27.17	46.08	43.21

Statistical significance of the differences in lysine and sum of essential amino acids were observed amongst tested marine yield. *Pandalus borealis* (Shrimp) tended to have the highest content of lysine and leucine amino acid among all tested marine yields. Moreover the sum of essential amino acid in shrimp is higher than those in Bore and Boser. Even statistical significant were observed between them. Fortunately, lysine is one of the predominant essential amino acid because Lysine is a substrate for the synthesis of carnitine, which is required for the transport of long chain fatty acids from the cytosol into mitochondria for oxidation. Potential benefits of dietary carnitine supplementation include growth promotion, protection against the toxicity of ammonia and xenobiotics, improved acclimation to extreme temperature changes and associated stress, and enhanced reproduction performance (Harpaz, 2005). Moreover leucine is considered as a functional AA to stimulate muscle protein synthesis and inhibit proteolysis in mammals (Nakashima *et al.,* 2007). It should be noted that Leucine, isoleucine plus valine account for 13.01%, 14.7% and 17.45% of total amino acids for *Mugil Cephalus, Tridacna maxima*, and *Pandalus borealis,* respectively (data not present in table). This result is partly agreed with the previous study that reported that Leucine, isoleucine plus valine account for 18–20% AA in animal proteins. Leucine, isoleucine plus valine are called Branched-chain AA (BCAA) and play important function as an activator of the target of rapamycin (a protein kinase) (Li *et al.,* 2008).

Selected marine yield are good sources of essential amino acids, it was found that the giant clams protein is of good quality especially in lysine and methionine which are apt to be deficient in the Egyptian diets (El-Hendy and Kilada, 1997).

Fatty acids composition

The fatty acid contents are shown in table (3). The PUFA contents were much higher (26-47 %) than the saturated fatty acid (24-40%). While monounsaturated fatty acids ranged from 27-33% of the total fatty acids. This result was completely agreed with Osman *et al.* (2001). The trend is different when compared to an earlier study on fresh water fish where the concentrations of MUFA were higher than saturated fatty acids and PUFA (Suriah *et al.,* 1995). The difference can be attributed to the fact that freshwater fish feed largely on vegetation and plant materials, whereas marine fish stable are mainly zooplanktons rich in PUFA (Osman *et al.,* 2001).

The results illustrated that investigated fish, oyster and crustacean are rich sources of a special class of polyunsaturated fatty acids known as the omega-3 or n-3 fatty acids (DHA, EPA and ALA). This results in general agreed with other studies (Harris, 1989 and Nettleton, 1995). Moreover, EPA and DHA are very long–chain fatty acids obtained from marine sources (Neil and Stone, 1996). Fortunately, linoleic acid, are considered essential fatty acids that must be consumed in the diet. Arachidonic acid is a long-chain n-6 PUFA that is found in all investigated marine yields is synthesized from linoleic acid.

This study shown that investigated samples were richer in omega-3 PUFAs (15-27%) than omega-6 PUFAs (5-9%). Earlier study published by Osman *et al.*(2001) results was within with the current study results. Moreover, Wang *et al.,* study reported similar finding in that marine fish were rich in omega-3 PUFAs than omega-6 PUFAs (Wang *et al.,* 1990).

Table 3. Fatty acids composition of selected marine yields g/100 g fat

	Lipid name		*Mugil Cephalus* (Bore)	*Tridacna maxima* (Boser)	*Pandalus borealis* (Shrimp)
12.0			0.11± 0.001	-	2.0± 0.24
14:0	Tetradecanoic Acid (Myristic)	saturated	8.00± 0.12	6.92± 0.65	6.3± 0.34
15:0	Pentadecanoic	saturated	-	10.70± 1.22	0.9 ± 0.05
16:0	Hexadecanoic	saturated	25.45 ± 0.2	1.91± 0.07	22.1 ± 1.65
18:0	Octadecanoic	saturated	6.68 ± 0.15	4.87± 0.51	8.01 ± 0.75
16:1n-7	Palmitoleic acid	monounsaturated	20.73 ± 0.21	-	9.1± 0.35
18:1n-9	Oleic acid	monounsaturated	10.77 ± 0.25	25.74± 1.61	15.7± 2.10
18:3n-6	Linoleic acid	polyunsaturated	3.93 ± 0.19	-	2.9 ± 0.10
20:4n-6	Eicosatetraenoic acid	Poly unsaturated	3.53 ± 0.09	9.65 ± 0.43	-
18:3n-3	Alpha-linolenic acid (ALA)	Poly unsaturated	2.23 ± 0.16	19.66 ± 1.27	2.5 ± 0.6
C20:1	Eicosenoic acid	monounsaturated	1.14 ± 0.21	-	0.9±0.01
C20:2			-	-	0.8 ± 0.01
20:3n-6	Dihomo-gamma-linolenic acid (DGLA)	Poly unsaturated	-	9.14 ± 1.11	5.8± 1.01
20:5n-3	Eicosapentaenoic acid (EPA)	Poly unsaturated	6.98±0.17	3.35 ± 0.12	11.1 ± 2.35
22:1(n-9)	Erucic acid	Monounsaturated	0.85±0.05	2.10± 0.06	2.9±0.01
22:6n-3	Docosahexaenoic acid (DHA)	Poly Unsaturated	9.61±0.45	3.67 ± 0.07	2.09 ± 0.11
24:6(n-3)	Nisinic acid	Poly Unsaturated	-	2.29 ± 0.18	7.7 ± 0.31
total SFA			40.24±0.22	24.4	39.31
total MUFA			33.48±0.34	27.84	28.6
total PUFA			26.28±0.30	47.76	32.09

The contents of ALA was much higher in *Tridacna maxima* than other investigated fishes. Whereas, EPA was much higher in *shrimp* than in *Tridacna maxima* and *Mugil Cephalus. Mugil Cephalus* tended to have DHA more than 3-folds than in other investigated samples. Elena *et al.,* study reported similar results (Elena *et al.,* 2004).

It should be noted that fishes are rich sources of EPA and DHA omega-3 fatty acids. It may be due to Fish are much more efficient than mammals at converting the ALA to the EPA and DHA omega-3 fatty acids (Gao *et al.,* 2012).

Polyunsaturated fatty acids (PUFA), especially n-3 and n-6 PUFA has been considered essential fatty acids and have been shown to have curative and preventive effect of cardiovascular diseases and neurodevelopment in infant and fat glycemic control (Conner, 1997). Moreover,. Research has shown that omega-3 fatty acids decrease risk of arrhythmias (abnormal heartbeats), which can lead to sudden death. Omega-3 fatty acids also decrease triglyceride levels, slow growth rate of atherosclerotic plaque, and lower blood pressure. Accordingly, The American Heart Association recommends eating fish (particularly fatty fish) at least two times (two servings) a week. Each serving is 3.5 ounce cooked (Sala and Calder, 2011).

The results indicated that, positive control group that fed on hyperlipidemic diet without any treating had the highest level of TG, CHOL, LDL-C, ratios. This results are in agreement with those observed by (Beyegue *et al.,* 2012) who found that, in high fat diets induced the infected hyperlipidemic rats model, feeding with the atherogenic diet for 30 days were significantly increased the plasma levels of TG, TC, LDL-C, ratios.

Effect of different marine yield on hypercholesterolemic rats lipid profile

Treating hyperlipidemic groups fed on basal diet with different kinds and levels of investigated marine yields to significant decrease in the mean value of serum cholesterol and triglyceride as compared to the positive control group. Data in table (4) revealed that, the mean value of total serum cholesterol and triglyceride in rats suffering from hyperlipidemic decreased gradually with increasing the level of dried fishes. Statistical analysis in this table showed that, significant change in serum cholesterol and triglycerides were observed between the groups treated with low and doses of selected dried marine yields. The best results in serum cholesterol observed for hyperlipidemia group fed on basal diet and treated with 15% of *Tridacna maxima* muscles, because this treatment showed no significant differences in serum cholesterol and triglyceride as compared to the negative control group. The current results completely agreed with Mahmud *et al.*(2004) who reported that after 3 weeks of oily fish feeding, plasma total cholesterol decreased in both the non-diabetic and diabetic rats by 35 and approximately 10%, respectively, and triglyceride fell by 69 and 20%, respectively, compared with control rats. The reduction of serum cholesterol may be inhibition of intestinal absorption of cholesterol by dried fishes therefore, reduce serum cholesterol concentrations (Tehrany *et al.,* 2013). In additional the reduction on total cholesterol, TG and LDL after consumption of fish was in accordance with Panagiotakos *et al.,* (2007) study, which reported that, fish intake was inversely associated with total serum cholesterol (p=0.012), and triglyceride levels (p=0.024) (Tehrany *et al.,* 2013).

Table (4): Effect of supplementation powder *Mugil Cephalus* (Bore), *Tridacna maxima* (Boser) and *Pandalus borealis* (Shrimp) meat on Lipid profile of hypercholesterolemic rats.

Groups	CHOL(m/dl) .	T.G. (m/dl)	HDL(m/dl)	LDL(m/dl)	VLDL(m/dl)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Negative control	91.16 ± 1.49	62.82± 2.20^{c}	60.20± 3.04 ^{d}	18.56 ± 0.09 ^{c}	12.40 ± 0.44 ^{c}
Positive control	162.72 ±9.32 ^{a}	141.29 ± 12.13 ^{a}	42.08 ± 5.19 ^{d}	92.04 ± 4.19^{e}	28.25± 2.43 ^{a}
Mugil Cephalus 5%	112.38±7.06^{cd}	73.50 ± 3.46 ^{cd}	55.50 ± 11.67 ^{ab}	42.22 ± 2.90 ^{d}	14.71 ± 0.69 ^{cd}
Mugil Cephalus 15%	90.44 ± 5.13 ^{b}	67.51^{b} ± 5.80	62.53 ± 5.88 ^{a}	14.48 ± 5.71 ^{b}	13.50^{b} ± 1.16
Tridacna maxima (Muscle)5%	105.62 ± 2.73 ^{c}	69.64 ± 2.22 ^{d}	59.85 ± 3.90 ^{bc}	31.38 ± 4.42^{d}	13.89^{d} ± 0.44
Tridacna maxima (Muscle)15%	88.33 ^{cd} ± 3.12	60.47 ± 6.34 ^{e}	69.62 ± 2.88 ^{bc}	6.63 ± 1.62^{a}	12.09^{e} ± 1.27
Pandalus borealis 5%	103.12 ± 3.68 ^{c}	75.60 ± 3.33 ^{e}	53.43 ± 4.06 ^{bc}	34.62 ± 4.44^{d}	15.12^{e} ± 0.67
Pandalus borealis 15%	91.62 ± 3.68 ^{d}	65.20 ± 3.84 ^{e}	66.50 ± 2.05 ^{c}	12.01 ± 3.09 ^{b}	13.04^{e} ± 0.77
F	188.905	844.475	104.745	1381.356	117.764
Sig	0.00	0.00	0.00	0.00	0.00
	* *	* *	* *	* *	* *

Values are presented as means ± standard deviation. ** Highly significant difference at($p < 0.01$) probability level

The reduction in triglyceride occurred in the current study is agreed with a now researchers believe that fish oil, can reduce triglyceride levels by 20% to 50% (Khawaja *et al.,* 2012). A significant reduction in risk of various forms of cardiac disease, including arrhythmias, angina, myocardial infarction and heart failure, is achieved at least in part by lowering blood total and LDL cholesterol levels, lowering TG and increasing HDL-C (Harris, 1999). Moreover, Fatty fish is the major dietary sources of (n-3) long chain polyunsaturated fatty acids (LCPUFA). Fatty fish has been associated with beneficial effects on a number of risk factors in adults such as reductions in blood pressure and blood triacylglycerol (TAG) concentrations and a possible lowering of cardiovascular disease (CVD) mortality (Hooper *et al.,* 2004). The results indicate that long-term fish intake is associated with reduced levels of the most common cardiovascular disease risk markers in a cohort of elderly people (Panagiotakos *et al.,* 2007). In those patients with hyperlipidemia, the use of fish is an important therapeutic option (Phillipson *et al.,* 1985). Connor (1994) listed the following putative mechanisms of dietary n-3 PUFA on lipoprotein metabolism in humans: (1) inhibition of VLDL triglyceride synthesis, (2) decreased apoprotein B synthesis, (3) enhancement of VLDL turnover with an increased fractional catabolic rate of VLDL, (4) depression of LDL synthesis, and (5) reduction of postprandial lipemia.

Conclusion

Marine yields are particularly good sources of many essential amino acids such as lysine, which is severely restricted in cereals, the most important staple food in the world. Furthermore, the sulphur-containing essential amino acids in marine yields can supplement the corresponding deficiency in plant proteins. Thus, the mixing between selected marine yields with cereal and vegetables can be utilised optimally for a healthy body constitution. On the other hand, inclusion of marine sources of the n-3 PUFA in the diet seems reasonable because they are good sources of protein without the accompanying high saturated fat seen in fatty meat products. Moreover, marine yields can be recommended for the patients with severe, treatment-resistant hyperlipidemia. Based on the above-mentioned evidences on health-related outcomes, the nutrient profiles analysed in this study and a detailed appraisal of the RDA of national and international agencies, it can be concluded that selected marine yields investigated in the current study can be considered as healthy food for humans. The health benefits of eating marine yields go beyond ω-3 fatty acids and other individual nutrients, including proteins and essential amino acids. Therefore, to benefit from vital nutrients like ω-3 HUFA, protein, essential amino acids, a moderate quantity of marine yields should be consumed by people.

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