International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Studies on the Availability of EPA and DHA of Different Cultured Carp Species during Different Seasons

Kaur M[1], Sehgal G.K[2]

M.sc, Department of Zoology, Punjab Agricultural University Ludhiana, Punjab

Abstract: ***The Polyunsaturated fatty acids (PUFAs), mainly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), prevent cardiovascular diseases. These fatty acids play an important role in reducing the risk of colon, breast and prostate cancer. It is important to maintain an appropriate balance of omega-3 fatty acids in the diet. Omega-3 fatty acids are very effective in the treatment of hyperlipidemia, hypertension and rheumatoid arthritis. Thus , present study was conducted to know the availability of EPA+DHA (g per 100 g of muscles) of carp species Labeo rohita (Ham) , Catla catla (Ham) , Cirrhinus mrigala (Ham), Cyprinus carpio (Linn) , Ctenopharyngodon idella (Steindachner) and Hypophthalmichthys molitrix (Richardson) . The highest EPA+DHA content was obtained from C. idella (0.56) in spring, C. mrigala (0.27) in summer, C.carpio (0.33) in autumn and L.rohita (0.22) in winter. Based on it, the cost of obtaining 1g of these fatty acids, C.idella and H.molitrix were the cheapest source of EPA+DHA in spring. In summer C. mrigala was the cheapest source while in autumn C.carpio and C.catla. In winter, L.rohita and H.molitrix were the cheapest source of obtaining EPA and DHA for healthy diet.***

Keyword: fatty acids, freshwater fishes, healthy diet, omega-3 fatty acids, Polyunsaturated fatty acids, prevention of disease

1. Introduction

Fishes are considered as high quality human food and a rich source of proteins (15-25%), minerals (Ca, P, Fe) and vitamins (A, D, E, K). Recently, interest has grown in fish and fish products as sources of polyunsaturated fatty acids (PUFAs), mainly of the n-3 family (also known as omega-3 fatty acids). Special attention is being paid to long chain omega-3 fatty acids (LC-PUFA) or highly unsaturated fatty acids (n-3 HUFA) i.e. eicosapentaenoic acid (EPA, C20:5 n-3) and docosahexaenoic acid (DHA, C22:6 n-3). This interest stems largely from those studies which have suggested that n-3 PUFAs may have an important role in prevention and management of cardiovascular diseases (Glomset, 1985; Goodnight *et al* 1982; Kromkout *et al* 1985; Norum and Drevon, 1986) and may even decrease the risk of cancer development at certain sites (Caroll and Bradon, 1984; Herold and Kinsella, 1986). It is important to maintain an appropriate balance of omega-3 and omega-6 fatty acid in the diet as these works together to promote health. (www. fsomega.com).

Several studies have found an inverse relationship between fish and omega-3 fatty acid consumption. Higher intake of DHA has been associated with decreased systolic and diastolic blood pressure (Rasmussen *et al* 2006). Mozafferian and Rimm (2006) reported that consumption of 1-2 serving/ week of fish, especially of species higher in omega-3 fatty acids (EPA and DHA), reduced coronary deaths by 36% and mortality by 17%. Omega-3 fatty acids are also reported to be effective in the treatment of hyperlipidemia, hypertension and rheumatoid arthritis (Berbert *et al* 2004 and Covington 2004).

Recommendations of the International Society for Study of Fatty Acids and Lipids (ISSFAL) suggest an adequate intake of omega-3 PUFAs to be 0.65 g of DHA plus EPA per day and 1.0 g of ALA per day. American Heart Association provided a list of 10 marine cold water fish/shell fish species with their omega-3s (g) per 3oz serving, ranging from 0.13 to 1.83 (www.aboutse a food.com/media/facts_statistics_detail). Since consuming fish is the only realistic way of increasing intake of EPA and DHA, it is essential that we look into the quality (fatty acid profiles) of the most commonly cultured fish species, the carps. Although carps (catla, rohu, mrigal, common carp, grass carp, silver carp, bighead carp, crucian carp) form the major chunk of harvested fish worldwide.

2. Materials and Methods

Comparative studies on the availability of EPA and DHA of six carp fish species cultured in Punjab belonging to order Cypriniformes, family Cyprinidae were made. The fish species were rohu *Labeo rohita* (Hamilton), catla, *Catla catla* (Homilton), mrigal, *Cirrhinus mrigala* (Hamilton), common carp, *Cyprinus carpio* (Linnaeus), grass carp, *Ctenopharyngodon idella* (Steindachner) and silver carp, *Hypophthalmichthys molitrix* (Richardson).

2.1 Collection of Samples

Table-sized (> 500 g) fresh specimens of each of the six fish species were obtained from the local fish market in Ludhiana during each season of the year. Each fish was wrapped individually in labelled clean air tight ziplock polythene bags and embedded in sufficient crushed ice in the ice box.

2.2 Sample Preparation

Each fish was scaled, finned, headed and gutted. The fish sample was then cleaned with tap water and 3 x 2.5 cm pieces of flesh were taken at random from three different parts of fish body *viz.* above lateral line from both the sides.

Bones were removed and the flesh was thoroughly mixed together to form a composite or representative sample of edible portion of the fish. The whole procedure, which was done on ice, took about 10 minutes. Composite sample was packed in clean labelled ziplock polythene bags and stored at -25^{0}C for future use.

2.3 Estimation Of Total Lipid Content and Fatty Acid Profiles

Total lipid (TL) content was determined by solvent extraction method as described by AOAC (2000), with little modification. Fatty acid composition was determined by Gas Liquid Chromatography (GLC) on M/s Nucon Engineers AIMIL Gas Chromatograph (solid state) model Nucon series 5700/5765 equipped with flame ionization detector fitted with SS column 1/8" outer diameter x 2M length, packed with 15% D.E.G.S on CHROMOSORB W.H.P, 80-100 mesh size.

2.4 Statistical Analysis

One way and Multifactor ANOVA was used to determine the inter-specific and inter-seasonal differences in the total lipids and fatty acid profiles of the six species of fish. The analyses were performed using Microsoft EXCEL and STATGRAPHICS statistical packages.

3. Result and Discussions

3.1 Availability of OMEGA-3 Fatty Acids In Edible Part Of Different Fish Species

The data on the availability of different n-3 fatty acids in edible part (muscles) of different fishes is given in Table 1.

H. molitrix had the highest availability of total n-3 fatty acids followed by *C. carpio.* The sequence of total n-3 availability was *H. molitrix*> *C. carpio*> *C. idella* and *C. catla*> *L. rohita*> *C. mrigala.* However the availability of EPA+DHA was maximum (0.19 g/100g) in *C. idella,* which was camparable with that of *H. molitrix* (0.18 g/100g). Thus, *C. idella* and *H. molitrix* may be considered as the best in their n-3 fatty acid quality.

Several health organizations have well recognized the importance of n-3 fatty acids, particularly the EPA and DHA required for different health benefits, which are shown in Table 2. Polat *et al* (2009) have suggested that red mullet (*Mullus barbatus*) is a good source of n-3 fatty acids and weekly consumption of 300g of this fish in autumn, winter and summer could meet EPA+DHA requirements of people. It is important, therefore, to know the amount of a particular fish species to be consumed to get the recommended amount of EPA+DHA. American Heart Association (AHA; Kris-Etherton *et al*, 2002) and Anonymous (2009) have reported the EPA+DHA content in g/3oz (ca 85.2g) serving and the amount of fish required to provide 1g of EPA+DHA. This information along with that calculated for the presently studied fishes is given in Table 3. Amongst the presently studied fishes, the cost of obtaining 1g of EPA+DHA from *C. idella* (177.5g) (Rs. 31.9) and *H. molitrix* (370.43g) (Rs. 59.3) has emerged to be the cheapest source in spring season. The cost of obtaining 1g of EPA+DHA from *C.idella* (177.5g) (Rs. 35.46) in spring, *C. mrigal* (568g) (Rs. 79.5) in summer, *C. carpio* (304.29g) (Rs.61.0) and *C. catla* (340.8g) (Rs.68.0) in autumn. *L. rohita* (448.42g) (Rs. 97.5) in winter season than the other studied fishes species is given in Table 4.

Fatty acid	Season	*Labeo rohita*	*Catla catla*	*Cirrhinus mrigala*	*Cyprinus carpio*	*Hypophthalmichthys molitrix*	*Ctenopharyngodon idella*
n-3 fatty acids							
Linolenic acid (C18:3 n-3)	Spring	__	__	0.04	0.01	0.19	__
	Summer	0.11	0.03	0.03	0.06	0.18	0.05
	Autumn	0.02	0.06	0.03	0.01	0.08	0.04
	Winter	0.01	0.01	0.02	0.03	0.06	0.02
	Mean	0.03	0.03	0.03	0.03	0.13	0.03
Eicosapentaenoic acid (C20:5 n-3)	Spring	0.08	0.04	__	0.01	0.02	0.50
	Summer	0.05	0.04	0.15	0.02	0.01	0.07
	Autumn	0.07	0.24	__	0.23	0.12	0.06
	Winter	0.14	0.04	0.01	0.01	0.08	__
	Mean	0.08	0.09	0.04	0.07	0.08	0.16
Docosapentaenoic acid (C22:5 n-3)	Spring	0.08	0.17	__	0.66	0.14	0.14
	Summer	0.06	0.08	0.06	0.04	0.01	0.06
	Autumn	0.12	0.06	__	0.15	0.02	0.03
	Winter	0.04	0.05	0.01	0.02	0.07	0.04
	Mean	0.07	0.09	0.02	0.22	0.06	0.09
Docosahexanoic acid (C22:6 n-3)	Spring	0.03	0.11	__	0.03	0.25	0.06
	Summer	__	__	0.02	0.01	0.01	0.03
	Autumn	0.08	0.05	__	0.10	0.03	0.02
	Winter	0.08	0.04	0.03	0.03	0.11	0.01
	Mean	0.05	0.05	0.04	0.04	0.10	0.03

Table 1: Availability of n-3 fatty acids (g per 100g of the muscles) of fishes during different seasons

Eicosapentaenoic acid +Docosahexanoic acid	Spring	0.10	0.15	__	0.03	0.37	0.56
	Summer	0.05	0.05	0.27	0.04	0.01	0.10
	Autumn	0.14	0.29	__	0.33	0.14	0.08
	Winter	0.22	0.08	0.04	0.04	0.19	0.01
	Mean	0.13	0.14	0.08	0.11	0.18	0.19
Total n-3	Spring	0.18	0.40	0.06	0.70	0.70	0.70
	Summer	0.22	0.16	0.36	0.14	0.20	0.20
	Autumn	0.28	0.41	0.04	0.48	0.24	0.14
	Winter	0.26	0.14	0.07	0.09	0.33	0.06
	Mean	0.24	0.28	0.13	0.35	0.37	0.28

Table 2: Amount of EPA+DHA in a serving of 3 oz (ca 85.2g) presently studied six fish species and the amount of fish meat providing 1g of EPA+DHA

Fish species	Season	EPA+ DHA (g)	Fish meat providing 1g EPA+DHA
Labeo rohita, freshly caught	Spring	0.11	946.67 g (ca 33.33 oz)
	Summer	0.05	2130 g (ca 75 oz)
	Autumn	0.15	655.38 g (ca 23.08 oz)
	Winter	0.22	448.42 g (15.79 oz)
	mean	0.13	774.55 g (27.27 oz)
Catla catla, freshly caught	Spring	0.15	655.38 g (ca 23.08 oz)
	Summer	0.04	2840 g (ca 100 oz)
	Autumn	0.29	340.8 g (ca 12 oz)
	Winter	0.08	1217.14 g (ca 42.8 oz)
	mean	0.14	710 g (ca 25 oz)
Cirrhinus mrigala, freshly caught	Spring	_	_
	Summer	0.27	568 g (ca 20 oz)
	Autumn	_	_
	Winter	0.04	2840 g (ca 100 oz)
	mean	0.08	1420 g (ca 50 oz)
Cyprinus carpio, freshly caught	Spring	0.04	2840 g (ca 100 oz)
	Summer	0.03	2840 g (ca 100 oz)
	Autumn	0.33	304.29 g (ca 10.71 oz)
	Winter	0.04	2840 g (ca 100 oz)
	mean	0.11	946.67 g (ca 33.33 oz)
Hypophthalmichthys molitrix, freshly caught	Spring	0.31	370.43 g (ca 13.04 oz)
	Summer	0.02	4260 g (ca 150 oz)
	Autumn	0.15	655.38 g (ca 23.08 oz)
	Winter	0.19	532.5 g (ca 18.75 oz)
	mean	0.18	532.5 g (ca 18.75 oz)
Ctenopharyngodon idella, freshly caught	Spring	0.56	177.5 g (ca 6.25 oz)
	Summer	0.10	946.67 g (ca 33.33 oz)
	Autumn	0.08	1217.14 g (ca 42.86 oz)
	Winter	0.01	8520 g (ca 300 oz)
	mean	0.19	501.18 g (ca 17.65 oz)

Table 3: Recommended amounts of EPA+DHA required for various health benefits.

Recommended by	Required amount	Required for
American Heart Association (AHA)	1g EPA+DHA per day	Reducing risk of coronary heart disease (CHD)
AHA	2-4g EPA+DHA per day	Lowering cholesterol levels
American Journal of Clinical Nutrition	0.25g EPA+DHA per day	Reducing risk of coronary heart disease (CHD) and Sudden cardiac death (SCD)
European Academy of Nutritional Sciences and Health Council of Netherlands	2g ALA and 0.2g EPA+DHA per day	General health
International Food Information Council	≥3g EPA+DHA per day	Reducing rheumatid arthritis
International Society for the study of Fatty Acids and Lipids (ISSFAL)	3.5g EPA+DHA per wk	Good cardiac health
ISSFAL	0.3g DHA per day	Pregnant and lactating women
The United Kingdom Department of Health	0.2g EPA+DHA per day	Health subjects
Lee *et al* (2008)	1g EPA+DHA per day	Reducing risk of coronary artery disease (CAD)
Lee *et al* (2008)	3-4g EPA+DHA per day	Lowering triglyceride levels, thus reducing hypertriglyceridemia

Table 4: Price of 1g of EPA+DHA available from the presently studied fish species

Fish Species	Season	Retail market price (Rs kg^{-1})	Approximate edible portion (g kg^{-1})	Fish meat providing 1g of EPA+DHA (g)*	Amount of EPA+DHA from 1kg of fish (g)	Cost of 1g of EPA+DHA (Rs)
		(a)	(b)	(c)	[d = (1/c)×b)	(e = a/d)
Labeo rohita	Spring	100	550	946.67 g	0.58	172.4
	Summer	85	550	2130 g	0.26	326.92
	Autumn	100	550	655.38 g	0.84	119.05
	Winter	120	550	448.42 g	1.23	97.56
Catla catla	Spring	100	500	655.38 g	0.76	131.58
	Summer	80	500	2840 g	0.18	444.44
	Autumn	100	500	340.8 g	1.47	68.03
	Winter	120	500	1217.14 g	0.41	292.68
	Spring	80	500	_	_	_

Cirrhinus mrigala	Summer	70	500	568 g	0.88	79.54
	Autumn	80	500	_	_	_
	Winter	100	500	2840 g	0.18	555.56
Cyprinus carpio	Spring	100	500	2840 g	0.18	555.56
	Summer	90	500	2840 g	0.18	500.00
	Autumn	100	500	304.29 g	1.64	60.98
	Winter	120	500	2840 g	0.18	666.67
Hypophthalmic-hthys molitrix	Spring	80	500	370.43 g	1.35	59.26
	Summer	75	500	4260 g	0.12	625.00
	Autumn	80	500	655.38 g	0.76	105.26
	Winter	90	500	532.5 g	0.94	95.75
Ctenopharyn-godon idella	Spring	90	500	177.5 g	2.82	31.9
	Summer	90	500	946.67 g	0.53	169.81
	Autumn	100	500	1217.14 g	0.41	249.5
	Winter	100	500	8520 g	0.06	1666.7

Table 5: Fish Species and the Season Providing 1g of EPA+DHA at Minimum Cost

Season	Fish Species providing EPA+DHA at minimum cost	Cost of 1g EPA+DHA (INR)	Cost of 1g EPA+DHA from other fishes (INR)
Spring	Grass carp	31.9	131.6 to 555.6
	Silver carp	59.3	
Summer	Mrigal	90.9	188.7 to 666.7
Autumn	Common carp	61.0	105.3 to 243.9
	Catla	68.0	
Winter	Silver carp Rohu	95.7 97.6	243.9 to 1666.7

4. Summary

The availability of EPA+DHA (g/100g of fish muscle), and the cost of obtaining 1g of EPA+DHA varied greatly during different seasons. It has been estimated that *C. idella* and *H. molitrix* were the cheapest source of obtaining EPA+DHA during spring (Rs.35.5 and 59.3 per g, respectively). *C. mrigala* was the cheapest source of these fatty acids during summer (Rs.90.9 per g). During autumn, however, *C. carpio* and *C. catla* were the cheapest sources (Rs.61 and 68 per g, respectively), while in winter, these were *H. molitrix* (Rs.95.7per g) and *L. rohita* (Rs. 97.6 per g). So the given content of EPA+DHA is very significant for health during different seasons.

References

[1] Anonymous (2009) Chinese Consumption will be unmatched. *Fishing Chimes* **27**: 134.
[2] AOAC (2000) Official Methods of Analysis (17th Edition). Meat and meat products Ch. 39, pp: 3. 481 North Frederick Avenue Gaithersburg, Maryland 20877-2417 USA..
[3] Berbert A A, Kondo C R, Almendra C L, Matsuo T and Dichi S (2005) Supplementation of fish oil and olive oil in patients with rheumatoid arthritis. *Nutr* **21**: 131-36.
[4] Carroll K K and Braden L M (1984) Dietary fat and mammary carcinogenesis. *Nutr Cancer* **6**: 254.
[5] Covington M B (2004) Omega-3 fatty acid. *Am Fam Physician* **70**: 133-40.
[6] Goodnight S H, Harris W S, Coonor W E *et al* (1982) Polyunsaturated fatty acids, Hyperlipidemia and thromboisis. *Arteriosclerosis* **2**: 87.
[7] Glomset J A (1985) Fish fatty acids and human health. *New England J Med* **312**: 1253.
[8] Herold P and Kinsella J E (1986) Fish oil consumption and decreased risk of cardiovascular disease: A comparison of findings from animal and human trials. *Am J Clin Nutr* **43**:566.
[9] Kris-Etherton P M, Harris W S and Appel L J (2002) Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. *Circulation* **106**: 2747-57.
[10] Kromkout D, Boschieter E B and Coulander C D (1985) The inverse relationship between fish consumption and 20-year mortality from coronary heart disease. *New Eng J Med* **312**: 1205.
[11] Lee J H, Keefe J H O, Lavie L J and Marchioli R (2008) Omega-3 fatty acids for cardioprotection. *Mato Clin Proc* **83** (3): 324-32.
[12] Mozafferian D and Rimm E B (2006) Fish intake, contaminants and human health- Evaluating the risks and the benefits.*JAMA* **296**: 1885-99.
[13] Nettleton J (1995) *Omega-3 fatty acids and Health*. pp. 359. Chapman and Hall, New York.
[14] Norum K R and Drevson C A (1986) Dietary n-3 fatty acids and cardiovascular diseases. *Arteriosclerosis* **6**: 352.
[15] Polat A, Kuzu S, Ozyurt G and Tokur B (2009) Fatty acid composition of red mullet (*Mullus Barbatus*): A seasonal differentiation. *J Musc Fds* **20**: 70-78.
[16] Rasmussen B, Vessby B, Uusitupa M, Berglund L, Pedersen E, Riccardi G, Rivellese A A, Tapsell L and Hermansen K (2006) Effects of dietary saturated, monounsaturated and n-3 fatty acids, on blood pressure in healthy subjects. *Am J Clin Nutr* **83**: 221-26.
[17] Simopoulos A P (1991) Omega-3 fatty acids in health and disease and in growth and development. *Am J Clin Nutr* **54**: 438-43.
[18] www.aboutse a food.com/media/facts_statistics_detail.
[19] www.fsomega.3.com.