LIPID COMPOSITION OF TWO MARINE FISHES – *Scomber scombrus* AND *Trachurus trachurus*

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ABSTRACT

Lipids from two species of marine fish – Scomber scombrus and Trachurus trachurus were investigated. Fish oil from Trachurus trachurus had higher oil yield than that of Scomber scombrus. The lipids contain high levels of triacylglycerol 228 – 250 mg%, cholesterol 160 – 235 mg%, and phospholipid 2.2 – 2.4 mg%. Saponification of the different oils yielded saturated and unsaturated fatty acids, such as palmltic, oleic linoleic acids. Hexane and methanol were found effective solvents for separation of fatty acids from the fish oil.

Keywords: Fish oil, Nutrition, Industrial applications

INTRODUCTION

Fish oils have long been a natural constituent of human diet, and have been reported to be hypocholesterolemic (Bang, 1990). They contain essential fatty acids especially oleic and linoleic acids as well as other polyunsaturated fatty acids (Sztem and Harris, 1991). The unique unsaturated fatty acids of marine oil particularly their long chain fatty acids C_{20} – C_{22} unsaturates make them desirable for a number of industrial and food applications (Visser and Meijer, 1990; and Wright, 1990). In the present study the composition of lipids obtained from two common marine fishes sold in a tropical Nigerian market, as well as fractionation of the constituent fatty acids was investigated to complement existing knowledge on their nutritional uses.

MATERIALS AND METHODS

Fresh fishes were collected from the Nsukka market, Enugu State, Nigeria and their identity authenticated by the taxonomical section of the Department of Zoology, University of Nigeria, Nsukka. The fishes were dissected to remove the visceral content, and were oven dried at 55 ± 1 °C for 25 minutes to prepare them for milling. Total lipids for each fish species were extracted from the dried mill (100 g) using the method of Folch *et al.,* (1957). Triacylglycerol was estimated by the method of Gottferied and Rosenberg (1973), Cholesterol by the method of Stadam (1975) and phospholipid by the method of Stewart (1980). Saponification of the oil and fractionation of fatty acids were performed by solvent crystallization method of El-Zanati and Khedr (1991). All the analysis were carried out in triplicates.

The oil (100 g) was saponified with alcoholic potassium hydroxide and the resulting soap hydrolysed with 1% dilute sulphuric acid to liberate the free fatty acids, which were then washed with warm water until free from mineral acids. Solvent crystallization was carried out to separate the fatty acids into fraction El-Zanati and Khedri (1991).

Several organic solvents (hexane, methanol, acetone and ethanol) were tried in order to determine the most suitable solvent for winterization and separation of fatty acids. A sample (50 g) of each fish was dissolved in the organic solvents at different oil to solvent ratio ranging from 1:1 to 1:5 (w/v). The solution formed were cooled at 56 ± 1 °C for 24 hours to complete the crystallization of the fatty acids. The crystals were recovered by filtration. Further fatty acids were obtained from mother liquor by distillation and chilling of the concentrates. The degree of unsaturation and saturation of the fatty acids were determined by evaluation of the iodine values using (AOAC, 1984).

Statistical Analysis: Mean values were compared using student T-test.

RESULTS

The lipid constituent of the oils is presented in Table 1. From the table, the total oil yield of *Trachurus trachurus* was 17.10 % while that of *scomber scombrus* was 10.11 %. The Triacylglycerol levels ranged between 228 mg% in *scomber scombrus* and 250 mg% for *Trachurus trachurus*. The cholesterol levels found in the study was 168 mg% for *scomber scombrus* and 235 mg% for *trachurus trachurus*. The lecithin levels (phospholipids was found to be between 2.2 mg% and 2.4 mg% for both species. The saturated and unsaturated fatty acids are presented on table 2.

Table 1: Lipid composition of *Trachurus trachurus* and *Scomber scombrus*

Lipids	*Trachurus trachurus*
% yield	17.10 ± 0.14
Triacylgylcerol mg%	250.0 ± 0.36
Cholesterol mg%	235.0 ± .46
Phospholipid mg%	2.4 ± 0.2
	Scomber scombrus
% yield	10.11 ± 0.15
Triacylgylcerol mg%	228.0 ± 0.24
Cholesterol mg%	168.0 ± 0.34
Phospholipid mg%	2.2 ± 0.18

Table 2: Percentage yield of saturated and unsaturated fatty acids using hexane and methanol as solvents

Fish Species	Hexane	
	SFA	USFA
Trachurus trachurus	44.75	55.23
Scomber scombrus	47.14	52.85
	Methanol	
	SFA	USFA
Trachurus trachurus	40.67	59.38
Scomber scombrus	43.64	55.85

DISCUSSION

The result of this study shows that marine fishes are good sources of oil. The oil yield from the two species averaged 13.9 %. The total lipid from these species differ from those found in some other marine fishes especially mackerel 5.23 % and those from fresh water fishes (5.8 %) (Viswanatha and Gopakomar, 1978). The actual reason for this variation in the total lipid content of different species is not clearly understood, but possibly the long spawning migration as well as size of the edible portion might be plausible reason (Stansby, 1972). The triacylglycerol and cholesterol contents of the marine fishes were high and are consistent with earlier reports (Ackman and Eaton, 1972 and Stansby, 1972). The high levels of the triacylglycerol may be important in the physiology as well as energy needs of the fishes, as they are readily used during long spawning migrations (Stansby, 1991). Similarly, the cholesterol may be utilized for biosynthetic processes, especially in the synthesis of steroids and bile acids (Voet and Voet, 1990). In nutrition and health, fish oil has found tremendous use in the treatment of arthritis, multiple sclerosis, cancer, malaria, non-insulin dependent diabetes, renal diseases, and chronic liver diseases (Orvilla and Arba, 1992; Wright, 1990; Visser and Meijer, 1990). Although the fraction of the fish oil that achieve these therapeutic functions are the omega 3-fatty acids (Bang, 1990). In the present study we did not determine the omega 3-fatty acids rather we fractionated the oil into its saturated and unsaturated fractions. The results obtained show that hexane rather than methanol, ethanol and acetone could be used satisfactorily in separating fish oil into its constituent fatty acids. The percentage saturated fatty acids when compared to the unsaturated fractions were high and compares well with results obtained from another study (Stansby, 1972). Apart from vegetable oils, fish oils contain primarily polyunsaturated fatty acids which vary in the location of the double bonds within the molecules. Polyunsaturated fatty acids have long been reported to be protective against cardiovascular diseases (Engerberg, 1959). It therefore means that diet rich in fish oil will be protective against cardiovascular diseases, and possibly other diseases like cancer, arthritis (Stansby, 1991). Although fats rich in unsaturated fatty acids are prone to oxidation which may trigger off free radicals, the results obtained from this study as well as earlier results from other studies, shows that fish oil contains a lot of antioxidant vitamins, A & E as well as phospholipids (Aruoma, 1993). These vitamins and phospholipids protect the oil from oxidative reactions and hence prevent the production of the free radicals, which could lead to tissue damage. Similarly, the phospholipids extracted could be emulsified and used in drug formulation as an emulsifier (Ononogbu, 1988). From an industrial view point, the saturated fatty acid produced may have immediate applications, especially as fat blends in the confectionery industries or used in the formulation of fat emulsions for parenteral nutrition (Akoh, 1995; Bimbo and Gowther, 1992). This may well substitute coconut oil or be used as blends with coconut oil, a common oil used in parenteral nutrition.

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REFERENCES

ACKMAN, R. G. and EATON, C. A. (1971). Some commercial Atlantic herring oils: Fatty acid composition. *Journal of Fish Research, 28*: 601 – 606.

AKOH, C. C. (1995). Structured lipids – enzymatic approach. *Inform, 6(9):* 1055 – 1061.

AOAC (1984). Official methods of analysis 14th ed. AOAC (Association of Official Analytical Chemists), Washington D. C.

ARUOMA, O. I. (1993). Free radicals and foods. *Chemistry in Britain.* pp. 210 – 214.

BANG H. O. (1990). Dietary fish oil in the prevention and management of cardiovascular and other disease. *Comparative Therapeutics and Therapy, 16(5):* 31 – 35.

BIMBO, A. P. and CROWTHER, J. B. (1992). Marine oil: fishing for industrial uses. *Inform, 3(9):* 98 - 1001.

EL-ZANATI, E. M. and KHEDRI, M. A. (1991). Separation of saturated and unsaturated acids from rice bran oil. *Journal of American Oil Chemists Society, 68(6):* 436 - 437.

ENGERBERG, H. (1959). Hypocholesterolic effects of vegetable fats. *Circulation, 19:* 884.

FOLCH, J. M., LEES, M., and STONE-STANLEY, G. H. (1957). A simple method for the isolation and purification of total lipids from animal tissues. *Journal of Biological Chemistry, 226:* 497 – 451.

GOTTFERIED, S. and ROSENBERG, B. (1973). Improved manual spectrophotometric procedure for determination of serum triglyceride. *Clinical Chemistry, 19:* 1077 – 1078.

ONONOGBU, I. C. (1988). Lipids & Lipoprotein, New African Publishing Limited, Owerri, Nigeria, pp. 45 - 58.

ORVILLA, A. L. and ARBA, K. A. (1992). Omega 3 fatty acid, oxidative stress and malaria. *Omega 3 News, VII (2):* 2 – 4.

STADAM, T. C. (1975). Preparation and assay of cholesterol and ergosterol. Pages 392 – 394. *In:* Clowick, S. P. and Kaplan, N. (Eds.). Methods in enzymology, Volume 3, Academic Press, New York.

STANSBY, M. E. (1972). Proximate composition of fish. Pages 5 – 10. *In:* Heen E. and Kreyzer, R. (Eds.). *Fish in Nutrition,* Fishing News, London.

STANSBY, M. E. (1991). *Fish and fish oil in the diet and its effects on certain medical conditions.* National Marine Fisheries, Washington D.C. pp. 1 – 40.

STEWART, J. C. M. (1980). Colorimetric determination of phospholipids with ammonium ferrothiocyanate. *Analytical Biochemistry, 104:* 10 – 14.

SZTEM M. I. and HARRIS, W. S. (1991). Short term effects of fish oil on human plasma lipid levels. *Journal of Nutritional Biochemistry, 2(5):* 255 – 259.

VISSER, J. J. and MEIJER, S. (1990). Dietary supplementation with omega 3 polyunsaturated fatty acids from fish oil in chronic liver disease. *Hepatology, 11(6):* 1096 – 1098.

VISWANATHA, N. P. G. and GOPAKOMAR, K. (1978). Fatty acid composition of 15 species of fish from tropical waters. *Journal of Food Science, 43:* 1162 – 1164.

VOET, O. and VOET, J. (1990). *Biochemistry.* John Wiley, New York. pp. 304 – 315.

WRIGHT, S. (1990). Essential fatty acid in clinical dermatology. *Journal of Nutrition and Medicine, 1(4):* 301 – 314.