
Nutritional Composition of Fatty Acids and Amino Acids of the Fermented *Scomberomorus tritor* in Benin

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Abstract: In Benin fermented fish (lanhouin) are often considered as food reserved for poor people, so these are commodities considered as by-products of fishing. To get the population to consider fermented fish as first choice food products, we decided to determine the fatty acid and amino acid composition of fermented *Scomberomorus tritor*. For this, after fermentation and drying of *Scomberomorus tritor*, gas chromatography coupled with mass spectrometry (GC / MS) and high performance liquid chromatography (HPLC) were used as methods of analysis. The results of these analyzes revealed thirty-five (35) fatty acids, including fifteen (15) saturated fatty acids (SFA), nine (09) monounsaturated fatty acids (MUFA) and eleven (11) polyunsaturated fatty acids (PUFA), and seventeen (17) amino acids including nine (09) non-essential amino acids and eight (08) essential amino acids counted in fermented *Scomberomorus tritor*. Therefore, these results show a very large richness in nutrients (fatty acids and amino acids) of the fermented *Scomberomorus tritor*.

Keywords: Fatty Acids, Amino Acids, *Scomberomorus tritor*, Fermentation

1. Introduction

Fish represents the major source of food for humans. It provides a significant amount of unsaturated fatty acids for the major population of developing countries. The good taste of fish meat comes from their fat content. The importance of this flavor comes from the highly unsaturated fats they contain [1-3]. The nutritional value of fish consumption is increasingly attributed to the content of ω -3 fatty acids and ω -6 fatty acids [4].

Fish lipids have been intensively studied since their protective effect against cardiovascular disease was first studied. Fish oils are rich in long-chain polyunsaturated fatty acids (LC-PUFA), mainly eicosapentaenoic (EPA) and docosahexaenoic (DHA), which reduce the risk of arteriosclerosis [5]. The beneficial effects of ω -3 polyunsaturated fatty acids (PUFA) on health are well-

defined: they are essential for the normal growth and development of the brain and nervous system and would also have beneficial effects in the treatment of coronary heart disease, hypertension, arthritis and clinical depression, anxiety, inflammatory and autoimmune diseases, and cancer [6-14]. In addition, ω -3 and ω -6 polyunsaturated fatty acids are considered essential but since they can not be synthesized in the human body, they must be obtained through diet [15].

Amino acids are mainly obtained from proteins in the diet. However, the quality of dietary protein is evaluated from the ratio of essential and non-essential amino acids. High-quality proteins are easily digestible and contain the essential amino acids (EFA) in amounts corresponding to human needs [16]. Proteins, the most abundant macromolecules found in biological systems, are present in various forms such as structural elements, enzymes, hormones, receptors, signaling molecules, etc., with biological functions specific. Proteins

are necessary for essential bodily functions, mainly the supply of essential amino acids and the development and maintenance of muscles [17].

Fermentation is an established technique for preserving food and adding value. This is the case of drinks, cheeses and fermented milks, meat products and fermented fish, etc. Moreover, it is presented by Romain Jeantet and *al* [18] in "Food Sciences, vol 1, TEC and DOC editions, 2008", as "a method of biological stabilization used for more than 600 years". Fermentation enhances the nutrient content of foods through the biosynthesis of vitamins, essential amino acids and proteins, improving the digestibility of proteins and fibers, enhancing the bioavailability of micronutrients and reducing anti-nutritional factors [18]. It can be seen that during fermentation, degradation of the organic molecules (lipids and protein) occurs.

The objective of this work is to determine the fatty acids and amino acids obtained after the fermentation of *Scomberomorus tritor* in Benin.

2. Material and Methods

2.1. Biological Material

For the current study, we used fermented *Scomberomorus tritor*. *Scomberomorus tritor* is known for its good nutrient composition and adaptation to processing for preservation. It is a fat species and its fat content is well distributed throughout the body [19]. It also contains significant amounts of protein, essential amino acids, lipids and many other biologically active compounds.

2.2. Method for Obtaining the Fermented *Scomberomorus tritor*

A quantity of fish is put into the fermentor which is hermetically sealed. The fermentation process according to the method described by Dossou-Yovo, 2002 [20] is launched. The diagram in Figure 1 shows the method of obtaining *Scomberomorus tritor* fermented used for our study.

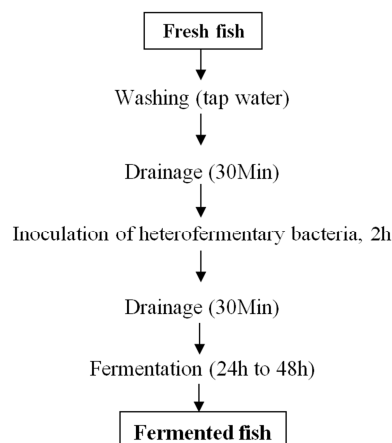


Figure 1. Schematic diagram for obtaining fermented *Scomberomorus tritor*.

2.3. Fatty Acid Analysis Methods

After extraction of the oil by the Soxhlet method, the fatty acids contained in the oil were determined by gas chromatography together with mass spectrometry (GC / MS).

Gas chromatography together with mass spectrometry (GC / MS) is an analytical technique that combines the performance of gas chromatography, for the separation of compounds from a sample and mass spectrometry, for the detection and identification of compounds based on their mass / charge ratio. This technique makes it possible to precisely identify and / or quantify numerous substances present in very small quantities, even in traces.

2.4. Amino Acid Analysis Methods

High performance liquid chromatography (HPLC) was used to identify the amino acids obtained after fermentation of *Scomberomorus tritor*. HPLC is one of the most widely used techniques in chemical analysis laboratories. It allows the identification, separation and dosing of chemical compounds in a mixture.

3. Results and Discussion

Table 1 shows the fatty acids contained in the fermented *Scomberomorus tritor*.

Table 1. Fatty acids obtained after fermentation of *Scomberomorus tritor*.

Symbol (standard nomenclature)	Symbol (omega nomenclature)	Common name (systematic name)
C8:0		Caprylic acid (octanoic acid)
C10:0		Capric acid (decanoic acid)
C11:0		(undecanoic acid)
C12:0		Lauric acid (dodecanoic acid)
C13:0		(tridecanoic acid)
C14:0		Myristic acid (tetradecanoic acid)
C14:1	ω -5	Myristoleic acid (cis-9-tetradecenoic acid)
C15:0		Pentadecyl acid (pentadecanoic acid)
C15:1		6 - (Cis-8-pentadecenyl) salicylic acid
C16:0		Palmitic acid (hexadecanoic acid)
C16:1	ω -7	Palmitoleic acid (9-hexadecanoic acid)
C17:0		Margaric acid (heptadecanoic acid)
C17:1		6 - (Cis-10-heptadecenyl) salicylic acid
C18:0		Stearic acid (octadecanoic acid)
C18:1N9C	ω -9	Oleic acid (9-octadecenoic acid)

Symbol (standard nomenclature)	Symbol (omega nomenclature)	Common name (systematic name)
C18:1N9T	ω -9	Elaidic acid (9-octadecenoic acid trans)
C18:2N6C	ω -6	Linoleic acid (cis, cis-9, 12-octadecadienoic acid)
C18:2N6T	ω -6	Trans Conjugated Linoleic Acid (trans, cis-10,12-octadecadienoic acid)
C18:3N3	ω -3	α -linolenic acid (cis, cis, cis-9,12, 15-octadecatrienoic acid)
C18:3N6	ω -6	γ -linolenic acid (cis, cis, cis-6, 9, 12-octadecatrienoic acid)
C20:0		Arachidic acid (icosanoic acid)
C20:1	ω -11	Gadoleic acid (cis-9-icosenoic acid)
C20:2	ω -6	Eicosadienoic acid
C20:3N3	ω -3	Cis-11,14,17-eicosatrienic acid
C20:3N6	ω -6	Dihomo- γ -linolenic acid
C20:4N6	ω -6	Arachidonic acid (cis, cis, cis, cis-5, 8, 11, 14-icosatetraenoic acid)
C20:5N3	ω -3	(cis, cis, cis, cis, cis, cis-5, 8, 11, 14, 17-eicosapentaenoic acid)
C21:0		Henicosylic acid
C22:0		Behenic acid (docosanoic acid)
C22:1N9	ω -9	Erucic acid (cis-13-docosenoic acid)
C22:2		Docosadienoic acid
C22:6N3	ω -3	Docosahexaenoic acid
C23:0		(Tricosanoic acid)
C24:0		Lignoceric acid (Tetracosanoic acid)
C24:1	ω -9	Selacholeic acid (cis-15-tetracosenoic acid)

We find that the fermented *Scomberomorus tritor* is very rich in fatty acids. It therefore contains thirty-five (35) fatty acids including 42.86% saturated fatty acids (or fifteen SFA) and 57.14% unsaturated fatty acids (or twenty USFA). Of the unsaturated fatty acids, there are nine (09) monounsaturated fatty acids and eleven (11) polyunsaturated fatty acids. The oil of the fermented *Scomberomorus tritor* is therefore rich in polyunsaturated fatty acids (PUFA) or 31.42%. This confirms the high polyunsaturated fatty acid content of marine fish oils [21, 22].

Fish is also a commodity rich in essential fatty acids. Essential fatty acids (EFA) are fatty acids that the body can not produce but are very important for the proper functioning of the body. These essential fatty acids are found in some food products. They belong to two groups of fatty acids namely: ω -3 fatty acids and ω -6 fatty acids. The fermented *Scomberomorus tritor* oil analyzed, contains ten (10) essential fatty acids (28.57%). This amount of essential fatty acids is slightly higher than that found by Guizani S. and *al* in 2015 [23]. Let's also note that the total number of fatty acids found in the oil of fermented *Scomberomorus tritor* is much higher than that found by Guizani S and *al.*, (2015) [23]. This difference in composition of fatty acids can be explained, in addition to the factors related to the species (size, age, environment, period...), by the transformation method used (fermentation, drying, roasting...), the method of analysis and the standards available to the analytical laboratory.

The ratio ω -3 / ω -6 has been suggested as a useful indicator for comparing the relative nutritional values of fish oils. It has been suggested that a ratio of 1: 1 to 1: 5 would be a healthy diet for humans [24, 25]. The ω -3 fatty acid / ω -6 fatty acid ratio of the fermented *Scomberomorus tritor* oil is 0.67 (between 1: 1 and 1: 2). This shows that the fermented *Scomberomorus tritor* is a healthy diet for humans.

Fatty acids in general and essential fatty acids in particular are very important to the body and are involved in the prevention of certain diseases. Epidemiological studies have demonstrated the importance of ω -3 fatty acids in human

health and have shown the relationship between a ω -3 enriched diet and the prevention of certain diseases such as cardiovascular disease and myocardial infarction [26-28], intestinal disease [29], treatment and prevention of mental illness [30], prevention of several types of cancer [24, 31] or bronchial asthma [32]. Subsequently, numerous epidemiological and clinical studies have focused on the effect of ω -3 PUFAs, in particular EPA and DHA, on human health and the mechanism by which this effect occurs. PUFAs have been reported to act as nutraceuticals [33].

The US Food and Drug Administration has already assigned the health claim status to eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), arguing that conclusive and inconclusive research shows that consumption of EPA and DHA may reduce the risk of coronary heart disease. ω -3 fatty acids are more effective at increasing energy levels, endurance and performance, improving concentration, reducing cardiovascular risk factors, inhibiting cancer growth and metastasis, increasing susceptibility to insulin, accelerate the healing of wounds due to an accidental injury, decrease inflammation and joint pain, alleviate the symptoms of autoimmune diseases, improve bone mineral metabolism, improve weight management and increase burning and reduction fat production [34].

A major benefit of highly unsaturated fatty acids (HUFA) is the reduction of the risk of sudden death [35, 36]. It is recognized that these HUFA reduce arrhythmic events by altering the lipid microdomains of plasma membranes, thereby affecting ion channel conductance [37]. PUFA from fish oil reduce the expression of matrix metalloproteinases (a family of collagenases involved in extracellular matrix degradation), which increases the stability of the plaque and potentially reduces sudden coronary events [38, 39]. The proposed mechanisms for ω -3 fatty acids involve a reduction in circulating triacylglycerol levels, platelet activation and the expression of vascular adhesion molecules [40, 41]. ω -3 triacylglycerol-enriched particles are eliminated more rapidly from human and animal blood and are much less dependent on

the activities of lipoprotein lipase, LDL receptor and apolipoprotein E for blood collection tissue targeting [42, 43].

In addition, DHA is recognized as a physiologically essential nutrient in the brain and retina of the eye, where it is needed at high concentrations to provide optimal mental performance (neural function) and respectively visual activity. The six double bonds allow the folding of the fatty acid structure [44]. This unique structure associated with a melting point of about 50°C contributes to the maintenance of an extremely fluid microenvironment within phospholipidic components of gray matter in mammalian brain and other cellular membranes of the nervous system [45]. Its modulatory effect on ion channel activity emphasizes its role in supporting electrical signaling [46] and, ultimately, brain function, such as learning ability, memory, etc. The high level of DHA in the brain and nerve system is particularly prevalent during the last trimester of pregnancy and the first two months of a child's life [47]. A source of DHA in the brain and nerve tissue is needed to restore and maintain optimal levels of DHA in order to function for the duration of life [48].

Despite the benefits associated with the consumption of fatty acids, they also present risks under certain conditions. The suspected risks of high EPA and DHA levels may include increased bleeding potential for overuse (usually more than 3 g daily) by a patient also taking aspirin or warfarin, a hemorrhagic stroke (only in very high doses), reduced glycemic control in diabetics and cardiac risk in people with congestive heart failure, recurrent chronic angina pectoris, or with signs of poor blood circulation [34]. It would therefore be necessary for a patient taking aspirin or warfarin, to avoid overuse and for people with diabetes or congestive heart failure, chronic angina pectoris to notify a physician before taking any foods rich in PUFA.

Amino acids were counted in fermented *Scomberomorus tritor*. Amino acids are mainly obtained from proteins in a diet and the quality of dietary protein is assessed from the ratio of essential and non-essential amino acids. Table 2 shows the amino acids contained in the fermented *Scomberomorus tritor*.

Table 2. Amino acids obtained after fermentation of *Scomberomorus tritor*.

Non-essential amino acids	Aspartic acid
	Glutamic acid
	cystine
	serine
	wistaria
	arginine
	alanine
	proline
	tyrosine
	histidine
	threonine
	valine
Essential amino acids	methionine
	isoleucine
	leucine
	phenylamine
	lysine

The analyzes reveal seventeen (17) amino acids including nine (09) non-essential amino acids and eight (08) essential amino acids in fermented *Scomberomorus tritor*. These results show the richness in amino acids and especially in essential amino acids of the fermented *Scomberomorus tritor*.

Amino acids are important biomolecules that serve as both building blocks of proteins and intermediates in various metabolic pathways. They serve as precursors for the synthesis of a wide range of biologically important substances, including nucleotides, peptide hormones and neurotransmitters [17]. In addition, amino acids play an important role in cell signaling and act as regulators of gene expression and protein phosphorylation cascade [49], nutrient transport, and metabolism in humans animal cells [50], as well as innate and cell-mediated immune responses.

Amino acids are essential for the growth and maintenance of the body. Thus, each amino acid plays well-defined roles for the proper functioning of the body. Leucine is the only dietary amino acid that can stimulate muscle protein synthesis [51]. It plays an important therapeutic role in stress states such as burns and trauma [52]. As an essential amino acid, leucine has been shown to slow the breakdown of muscle tissue by increasing the synthesis of muscle proteins. Methionine is used to treat liver disorders, improve wound healing and treat depression, alcoholism, allergies, asthma, copper intoxication, side effects of radiation, schizophrenia, weaning medications and Parkinson's disease [53]. Glutamic acid plays an important role in amino acid metabolism due to its role in transamination reactions, and is necessary for the synthesis of key molecules, such as glutathione, necessary for the removal of highly toxic peroxides and folate polyglutamate cofactors. This amino acid is considered to be one of the most abundant amino acids in fish species such as mackerel [54], sockeye [55]. Glycine plays an important role in metabolic regulation, preventing tissue damage, enhancing anti-antioxidant activity, promoting protein synthesis and wound healing, and improving immunity and treatment of metabolic disorders related to obesity, diabetes, cardiovascular disease, ischemia-reperfusion injury, cancer and various inflammatory diseases [50]. Tryptophan is a precursor of serotonin, the brain-suppressive neurotransmitter pain suppressant. Free tryptophan enters brain cells to form serotonin. Thus, tryptophan supplementation has been used to increase serotonin production to increase pain tolerance [56]. Tryptophan is also the precursor of melatonin, tryptamine and kynurenine and plays an important role in the functioning of neurotransmitters such as dopamine. The tryptophan supplement is used in the treatment of pain, insomnia, depression, seasonal affective disorder, bulimia nervosa, premenstrual dysphoric disorder, attention deficit disorder, hyperactivity disorder and chronicle fatigue [57]. Histidine plays several roles in the interaction of proteins [58] and is also a precursor of histamine. It is also needed for tissue growth and repair, for the maintenance of myelin sheaths and for the removal of heavy metals from the body [59]. Lysine is an EAA that is widely needed to optimize growth and its deficiency leads to immunodeficiency [60].

Lysine is used to prevent and treat cold sores. It is taken by mouth or applied directly to the skin for this purpose. Threonine is used to treat various nerve systems disorders including spinal spasticity, multiple sclerosis, familial spastic paraparesis and amyotrophic lateral sclerosis [61]. Isoleucine is a branched-chain amino acid that is necessary for muscle formation and proper growth [62]. All of the above really shows the nutritional importance of the different amino acids in human nutrition.

4. Conclusion

In short, we can say that the fermented *Scomberomorus tritor* is very rich in fatty acids (SFA, MUFA, PUFA and EFA) and in amino acids (non-essential amino acids and essential amino acids). Based on the composition and nutritional importance of certain fatty acids and amino acids contained in fermented *Scomberomorus tritor*, *Scomberomorus tritor* can therefore be recommended in clinical nutrition for appropriate therapeutic uses.

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