Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 28(4): 335– 347 (2024)
www.ejabf.journals.ekb.eg

Characteristics and Nutrition of Fat-Soluble Vitamins from the Patin Fish Oil (*Pangasius hypothalmus*) and Their Potential in Dental Health

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ARTICLE INFO
Article History:
Received: April 30, 2024
Accepted: June 13, 2024
Online: July 19, 2024

Keywords:
Patin fish oil,
Fatty acid profile,
Physical and chemical properties,
Vitamins,
Dental health

ABSTRACT
Fish oil in general has benefits for heart and blood vessel health, brain or neurological development and function, mental health, vision, immune system balance, weight control, joint function, and strength. Periodontal disease, dental caries, and post teeth extraction can be prevented by improving nutritional intake by consuming fish oil. The characteristics of the patin fish oil were analyzed using the wet rendering methods. Analysis of fatty acid composition with gas chromatography (GC) and vitamins A, D, E, and K were determined using the method of high-performance liquid chromatography (HPLC). The patin fish oil showed a percentage of omega-9 of 37.5%, followed by omega-6 and omega-3 fatty acids of 14.54% and 1.5%, respectively. The chemical properties of the patin fish oil found a peroxide number of 4.2 mEq, a free fatty acid of 0.098%, an anisidin number of 3.47 AV, and an iodine number of 69.41 Wijs. The physical properties of the patin fish oil include yellow color and normal smell. The vitamin content is as follows: Vitamin A is 62.4 mcg, vitamin D is 6.20 mcg, vitamin E is 15.83 mg, and vitamin K is 21.91 mg. The good characteristics of the patin fish oil are its fatty acid profile, vitamins, as well as physical and chemical properties and their potential in dental health.

INTRODUCTION

The relationship between health and the food consumed, especially foods that contain bioactive compounds as active components, is called nutraceuticals. The nutritional requirements of humans are divided into two categories, macronutrients (carbohydrates, fats, proteins, and water) and micronutrients (minerals and vitamins). Nutrition and dental health are linked in two directions. Optimal nutrition can positively affect the bone, helping to prevent periodontal disease, dental caries in addition to healing post teeth extraction. Periodontal disease is a condition in which the adhesion between the periodontal tissue and the tooth is damaged by alveolar bone resorption and is the leading cause of tooth loss. This disease can be prevented by improving one's nutritional intake through consuming fish oil. Fish oil is one of the natural remedies derived from the marine biota having high health benefits. The content of omega-3 fatty acids, PUFA (polyunsaturated fatty acids), consisting of EPA (eicosapentaenoic acids) and DHA (docohexaenoic acids) are capable of reducing the production of inflammation mediators and cytokines so that alveolar bone resorption decreases due to a decrease in the number of osteoclasts. Caries caused by calcium demineralization processes and dental caries prevention can be helped by consuming fish oils that contain fatty acids omega-3, omega-6, and vitamins that are good for the body and can improve enamel denticity. Tooth extraction can cause damage to periodontal tissue and alveolar bone and cause the inflammation of tissue. The bone healing process in the post-dental socket can be accelerated by a supporting therapy. In this respect, fish oil can be used as a supportive therapy. It contains EPA and DHA, which play an essential role in reducing pro-inflammatory mediators. Fish oil has become one of the nutrients that are widely used by the good society in Indonesia. The active contents of fish oil are long-chain fatty acids PUFA omega-3: EPA (eicosapentaenoic acids) and DHA (docosahexaenoic acids), long-chain fatty acids PUFA Omega-6: arachidonic acids (AA) and monounsaturated fatty acids MUFA omega-9 **(Abedi, 2014)**.

Omega 3 fatty acids are non-saturated fatty acids that have many bonds; the first bond is located on the third carbon atom of the omega methyl group. The next bond is located on the carbon atom number of the third bond of the previous bond. The omega methyl group is the last group of the fatty acids chain. Examples of omega-3 fatty acids are linolenic fatty acids (C18:3, n-3), EPA eicosapentaenoic fatty acids (C20:5, n-3), and DHA decosahexaenoate fatty acids (C22:6, n-3). Omega-6 fatty acids (PUFA) represent an essential fatty oxide with 18 carbon atoms (C) and a number of 2 bonds (multiple unsaturated fatty acids). Another name is linoleic fatty acids. Omega-9 fatty acids are also called monounsaturated fatty ácids (MUFA) since they consist of 9 carbon atoms and their bonds are located at the ninth C atom. One type of MUFA is omega 9 (oleic fatty acids), which has protective powers that can lower LDL cholesterol in the blood and boost HDL cholesterol greater than omega 3 and omega 6, which is more stable than PUFA **(Ayadi & Alba, 2021; Pateiro *et al*., 2021)**.

Fish oil in general has benefits for heart and blood vessel health, brain or neurological development and function, mental health, vision, immune system balance, weight control, joint function, and strength. The world's fish oil needs are increasing over time for a variety of purposes, namely human or edible consumption (14%), industrial (5%), and aquaculture (81%) **(Febrianto & Sudarno, 2020; Sarker, 2020)**. Sumatera Utara Province is one of the provinces in Indonesia that has an excellent potential in the fisheries subsector, both catch and cultivation, and it is the second largest contributor area after Maluku Province, Indonesia. According to data from the Central Statistical Authority of Sumatera Utara, the patin fish (*Pangasius Hypothalmus*) is the fish species with the most significant value of cultivated fisheries production in Sumatera Utara **(Hastarini *et al*., 2012)**. The patin fish has more oil than any fish **(Haas, 2005; Ayu *et al*., 2019)**. Production of fish oil from the patin fish waste can be obtained from different parts of the fish's body, such as the head, tail, stomach content, bones, skin, belly flap, and scales. The percentage of waste produced from the processing of the patin fillets includes head (23,05%), bones (15,06%), skin (6,14%), stomach contents (10,8%), trimmed meat residues (5,28%) and belly flap meat (6,98%) **(Kamini *et al*., 2016)**.

This study aimed to find out the characteristics of the patin fish oil based on its physical and chemical properties, and the content of vitamins A, D, E, and K in fish oil, and its potential dental health.

MATERIALS AND METHODS

This type of research is descriptive, and the ethics committee has approved it under the number 145/KEH/SKE/XII/2023 Veterinary Ethics Commission of the School of Veterinarian Medicine and Biomedical Institute Pertanian Bogor.

1. Tools and materials

The tools used in the current study were: Erlenmeyer flask, chemical glasses, measuring cylinder, büchner funnel, dropping pipette, separatory funnel, volumetric flask, buret spatula, analytical balances, hot plates, cylinder paper, casserole fabric, magnetic mixers, stainless steel pots, nitrogen gas tubes, refrigerator, stations and clems, vertical coolers, as well as a set of gas chromatography devices. The raw material used in this study was 50kg of patin fish, each weighing 750 grams, sourced from freshwater fish cultivation in the district of Serdang Bedagai, Sumatera Utara, Indonesia. N-hexane, Aquades, NaCl, NaOH 0.5 N, ethanol, methanol, bentonite, HCl, urea, EDTA, nitrogen gas, alcohol, chloroform, glacial acetic acid, KI, sodium thiosulfate, Na_2SO_4.

The fish specimens cultivated in freshwater were received alive, and were then slaughtered. Afterward, head and bones of each fish sample were separated, and the fish body was cut into small pieces weighing approximately 280 grams, with the aim of facilitating the process of extracting fish oil.

2. Fish oil extraction by wet rendering methods

The fish oil was extracted using a modified wet rendering method, which employs heat and water. The body of the prepared patin fish, weighing 280 grams, was placed in a pot. The patin fish fillet was steamed using a steamer via maintaining a temperature of no more than 90^0C for 30 minutes. Then, the temperature of the pressing machine was set in the range of 60-70^0C, and a container was provided to collect the pressing outcomes (oil and water mixture) and residue (dried fish meat). The patin fillet meat was inserted slowly into the pressing machine, which was run, and the pressed results were collected into a container. The water phase and oil phase obtained from the pressing were separated by centrifugation at a speed of 4000rpm and a temperature of 25- 28°C for 10 minutes.

The oil phase at the top of the centrifuge bottle was collected using a drop pipette, producing 3-5mL of patin oil, which was then transferred into a plastic bottle.

3. Vitamin A, D, E analysis (AOAC 2001. 13. 2011)

Standard solutions of vitamins A, D, and E were prepared with at least 6 concentration points in 10mL volumetric flasks. Test portions weighing 2-3 grams were placed in 100mL beakers and mixed with 95% ethanol, antioxidant, and 50% KOH. The mixture was homogenized and heated in a water bath at 80°C for 45 minutes. After cooling to room temperature, the solution was transferred to a 100mL volumetric flask, and a glacial acetic acid was added. The solution was diluted with a 95% THF: ethanol (1:1) solution, homogenized, and filtered through a 0.45μm syringe filter into 2mL amber vials for injection into the HPLC system.

4. Vitamin K analysis (LC-MS)

A standard solution of vitamin K1 with at least 6 concentration points was prepared. Test portions weighing 1 gram were placed in 60mL amber reaction tubes, mixed with aqua and vortexed. Lipase was used in an enzymatic process, followed by extraction using hexane performed three times. The extracted solution was evaporated to dryness with a nitrogen evaporator, reconstituted with a motion phase solution, and vortexed. After adding internal standard 13C6-Vitamin K1, the solution was filtered through a 0.2μm syringe filter into 2mL amber vials for injection into the LC-MS system.

5. Analysis of physicochemical properties of patin fish oil

First, free fatty acids (FFA) were determined according to AOCS Ca 5a-40 **(AOCS, 1998)**. Next, the peroxide value (PV) was assessed following AOAC 965.33 **(AOAC, 2012)**. Subsequently, the p-anisidine value (AnV) was measured based on Watson's method **(Watson, 1994)**. Total oxidation (TOTOX) was then calculated according to Perrin's approach **(Perrin, 1996)**. The iodine value was determined according to AOAC 993.20 **(AOAC, 1996)**. Additionally, the fatty acid profiles were analyzed using gas chromatography with a flame ionization detector (FID), following the AOAC method 969.33 **(AOAC, 2005)**. Finally, the analysis included an assessment of the color and odor of the fish oil.

6. Fish oil fatty acids profile analysis

The fatty acid profiles of omega-3s, omega-6s, and omega-9s were analyzed using gas chromatography (GC). Sample preparation involved placing 30- 40mg of sample oil in Teflon-sealed tubes, adding 1mL of 0.5 N NaOH in methanol, and heating in a water bath for 20 minutes. Subsequently, 2mL of 20% BF3 was added and heated for another 20 minutes. After cooling, 2mL of saturated NaCl and 1mL of isooctane were added, mixed, and left to separate. The isooctane layer was collected with a drop pipette into a tube containing 0.1g of Na2SO4, allowed to stand for 15 minutes, and then separated. The liquid phase was injected into the gas chromatography system.

RESULTS

The analysis of fatty acid type and quantity in the fish oil extract was conducted using gas chromatography (GC) in two stages. First, the fatty acids were esterified into methyl esters to lower their vaporization point for an easier gas chromatographic separation. Once separated in the GC, a chromatogram was generated, showing the compounds present in the oil and their abundance represented by a peak area. Fig. (1) displays the chromatogram of patin fish oil, while Table (1) details the composition of fatty acids found in the patin fish oil.

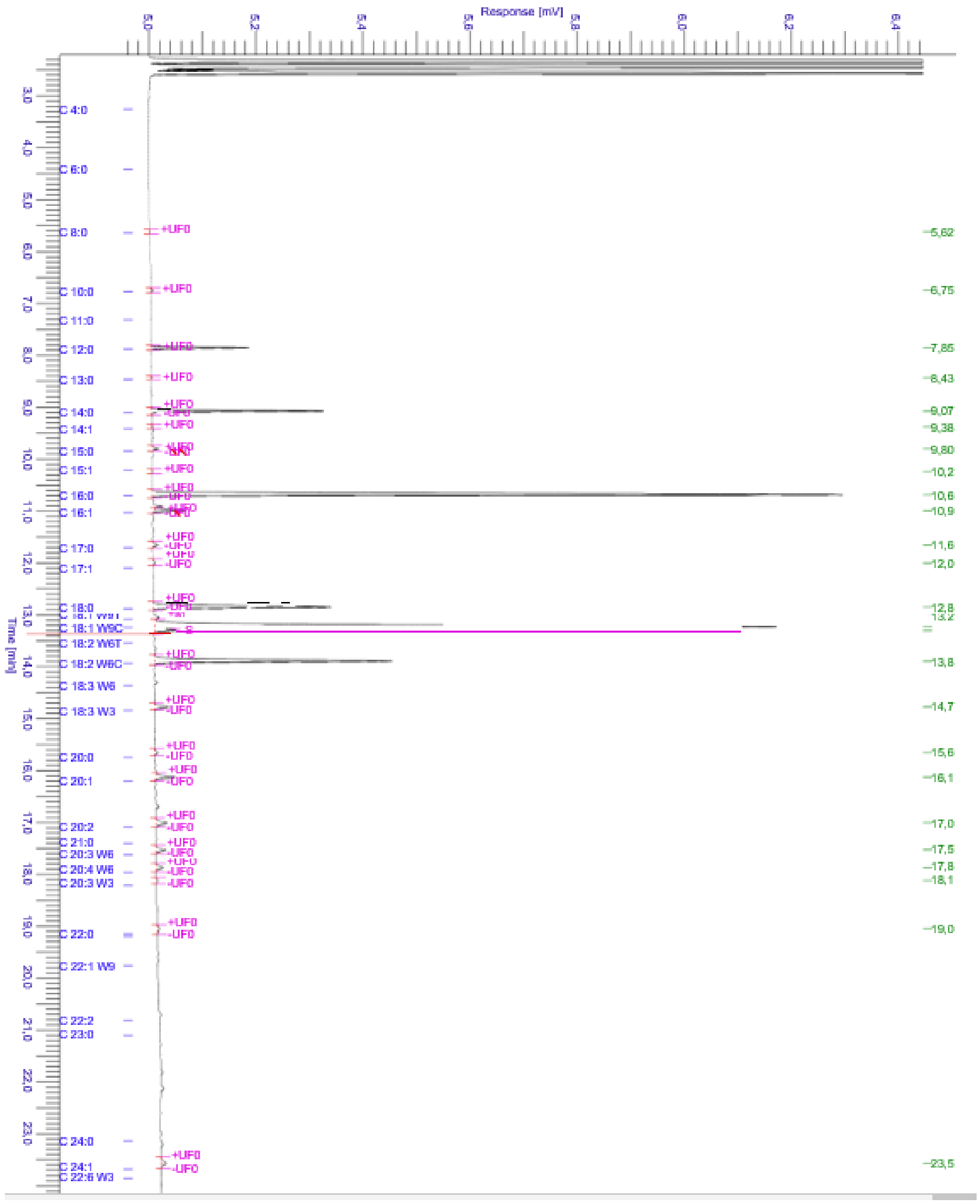

Fig. 1. The patin fish oil chromatogram

Based on Fig. (1) as well as Table (1), data obtained from the analysis of GC showed that omega-9 value was 36.36%, followed by omega-6 at 12.19%, and omega -3 at 0.68%.

Table 1. Composition of fatty acids contained in the patin fish oil with gas chromatography

Name of fatty acids	Structure	Amount (%)
Caprylic acid	C 8:0	0,01
Capric acid	C 10:0	0,06
Lauric acid	C 12:0	2,63
Tridecanoate acid	C 13:0	0,02
Myristic acid	C 14:0	5,37
Pentadecanoic acid	C 15:0	0,20
Palmitat acid	C 16:0	28,67
Heptadecanoic acid	C 17:0	0,24
Stearat acid	C 18:0	8,74
Archidat acid	C 20:0	0,16
Total SFA		
Myristoleic acid	C 14:1	0,03
Pentadecenoic acid	C 15:1	0,03
Palmitoleic acid	C 16:1	1,11
Heptadecanoic acid	C 17:1	0,14
Oleic acid	C 18:1	36,36
Eicosenoic acid	C 20:1	1,01
Total MUFA		
Linoleic acid	C 18:2	12,19
Eicosadienoic acid	C 20:2	0,74
Linolenic acid	C 18:3	0,68
Eicosatrienoic acid	C 20:3	0,07
Arachidonic acid (AA)	C 20:4	0,41
Eicosapentaenoic (EPA) acid	C 20:5	0,20
Docosahexaenoic (DHA) acid	C 22:6	0,41
Total PUFA		
Total Omega-3 fatty acids		0,68
Total Omega-6 fatty acids		12,19
Total Omega-9 fatty acids		36,36

Table 2. Physical and chemical properties and vitamins of the patin fish oil

Characteristic	Unit	Total
Physical properties	-	
Color	-	Yellow
Smell		Normal
Chemical properties		
Number of peroxide	meq/kg	4,21meq/ kg
Number of anisidine	meq/kg	3.47meq/ kg
Total of oxidation	meq/kg	11.89meq/ kg
Free fatty acids level	**%**	0.098 %
Number of iodine	ml/g	69.41ml/ g
Vitamin		
A	mg/g	62.4mcg/ g
D	mg/g	6.20mcg/ g
E	mg/g	15.8mg/ g
K	mg/g	21.9mcg/ g

1. The number of peroxide

Tests were performed to determine the quality of fish oil extracts, and the number of peroxides showed the tiredness that occured. The value obtained from this study with the wet rendering methods was 4.21meq/ kg; this value meets the standard of a good fish oil peroxide according to the International Fish Oil Standard **(IFOS, 2014)** (≤ 5.0meq/ kg).

2. Free fatty acids levels (FFA)

The content of free fatty acids in fish oils was higher by 0.098%, and the value of those free fatty acids was lower than the standard of the good quality of fish oil. Free fatty acids are one of the indicators that determine the quality of oil. The worse the quality of fish oil, the higher the value of free fatty acids. The level of free fatty acids in fish oil in this study was determined in accordance with the IFOMA (International Fish Meal and Oil Manufactured Association) standards; the quality of fish oil is good if it contains free fatty acids according to International Fish Oil Standard **(IFOS, 2014)**, with a value ≤ 1.5meq/ kg .

3. The number of anisidine

According to the International Fish Oil Standard **(IFOS, 2014)**, the maximum acceptable level of anisidine in fish oil is 20mEq/ kg. In this study, the anisidine value was measured at 3.47mEq/ kg.

4. Total of oxidation

The total oxidation value (TOC) is the sum of the primary and secondary oxidation results, which is 2 times the number of peroxides plus the count of anisidine.

The number of peroxides and the number of anisidine determine the total oxidations found in this fish oil, obtained at 11.89mEq/ kg, according to International Fish Oil Standard **(IFOS, 2014)**, with a value < 26.00meq/ kg.

5. The number of iodine

The amount of iodine is the amount (grams) of iodine that can be absorbed by 100 grams of oil. The number of iodine can indicate the degree of saturation of oil or fat. The larger the number of iodine, the higher the degree; in this study, it was 69.41ml/g. These results recorded higher values than the standard number of iodine according to SNI 04-7182-2006, which is 45- 46mg/ g. It was concluded that the high number of iodium indicates that the oil contains high unsaturated fatty acids.

6. Organoleptic value

Fish oils are physically yellow because of the high content of carotene, which is a natural colourant that can occur as a result of the absorption process in fatty or unsaturated oils. Fish oil has a characteristic taste and smell of fish oil.

7. Vitamins in fish oil

In general, fish oils contain vitamin A, and vitamin D. The patin fish oil contains vitamin A at 62.4mcg/ g fish oil, vitamin D at 6.20mcg/ g, vitamin E at 15.83mg/ g, and vitamin K at 21.91mcg/ g.

DISCUSSION

Fish is one of the foods that has a sufficiently complete nutritional composition. Freshwater fish are rich in carbohydrates and proteins, while seafood is rich in fat, vitamins, and minerals **(Haas, 2005; Ayu *et al.*, 2019; Sarker, 2020)**. The nutritional content of freshwater fish is relatively high and almost the same as seawater fish. The meat of fish that contains vitamins such as vitamin A is very beneficial for eye health and acts as an antioxidant **(Haas, 2005; Hastarini *et al.*, 2012)**. Based on Fig. (1) as well as Table (1), the results of this study are consistent with those of a previous study on the characteristics of the patin fish oil, stating that the patin fish has high levels of omega-9 fatty acids, followed by omega-6 and omega-3 fatty acids, with percentages of 40.14, 21.78, and 0.37%, respectively **(Panagan, 2012; Ayu *et al.*, 2019)**. The stability of fatty acids oxidation depends heavily on the number of bonds it has. It is also influenced by temperature, oxygen concentration, metals, water activity, peroxide, antioxidants, and catalysts—oil in direct contact with air and high temperatures result in disintegrating unsaturated fatty acids. The carbon chain in the bond is broken, and subsequently the free fatty acids increase. The broken carbon chains are bound with oxygen, and hence the oil peroxide increases **(Dari *et al.*, 2017; Nazir *et al.*, 2017; Husnah, 2020; Putri *et al.*, 2021)**. The low level of fish oil-free fatty acids is due to the nature of most significant fatty acids composition of the patin fish oil being oleic acid, i.e., unsaturated fatty acids that have single bonds (MUFAs) so that the oil is more stable than other unsaturated fatty acids with more bonds, (PUFA) **(Dari *et al.*, 2017; Nazir *et al.*, 2017; Husnah, 2020;**

Putri *et al*., 2021). The number of anisidine in research is the same as the Suseno study of 3.74± 2.15mEqu/ kg in the sardine fish oil **(Suseno *et al*., 2017; Husnah, 2020; Putri *et al*., 2021)**. The amount of iodine in each fatty acids is different; for example, in the large linoleic type of unsaturate fatty acids, the number of iodine can reach 273.7mg/ g; for linoleic, the amount of iodine can reach 181.1mg/ g, and for oleic acid, the number is 89.9mg/g **(Dari *et al*., 2017; Nazir *et al*., 2017; Husnah, 2020; Putri *et al*., 2021)**.

Vitamin D has a significant role in calcium metabolism and bone growth. Vitamin B6 impacts the metabolism of amino acid and fats and prevents anemia and nerve damage. Vitamin B12 has a potential in the red blood cell formation and fat metabolism and protects the heart. In addition to proteins, fats, and vitamins, fish also contains some minerals, including iron, which functions in the formation of red blood cells; iodine, which functions in the health of the thyroid gland and prevents the swelling of the gout glands; selenium that acts as an antioxidant, and zinc that helps in the work of enzymes and hormones. Additionally, fluorine contributes to nutritional health. Vitamins are vital organic compounds that affect metabolic processes. They are organic nutrients that primarily act as coenzymes in a number of biochemical functions, such as carbohydrate metabolism, fat, protein, and DNA production, as well as new cells in the body. Given their soluble properties, vitamins are divided into fat-soluble vitamins and water-solute vitamins. Some compounds are classified in the group of vitamins A, including retinol, retinal, retinoic acid, and retinyl esters. The term vitamin A often refers to a compound of retinol compared to other compounds since it is the most active in the body and is most commonly found in freshwater fish. The sources of vitamin A in most human foods are originated from vegetable and animal food sources, with extensive variations to meet human daily needs. In industrialized countries, more than two-thirds of the vitamin A intake comes from preformed animal foods such as vitamin A. The preformed source of vitamin A in food includes milk, liver, and dairy products, eggs, as well as fish. The richest source of vitamin A is the liver oil, for example, in freshwater fish. It is worthy to mention that, higher vitamin A supplementation induces an increased risk of fractures in older people. While, some studies postulated that vitamin A intake is linked to an improved bone health **(Shi *et al*., 2024)**.

Vitamin D is an essential nutrient that enhances the assimilation of minerals such as calcium, magnesium, iron, phosphates, and zinc in the intestinal tract. Vitamin D helps metabolize calcium and phosphorus, which are essential minerals for the growth of the jaw and teeth. Vitamin D deficiency is rakhitis and maxillary dysplasia and causes periodontal inflammation. Orthodontic movement can be accelerated with intraperitoneal vitamin D3 injections. Gratton, the administration of vitamin D systematically slows the movement of orthodontic teeth and causes relapses. Khalaf, who conducted a study using mice induced by vitamin D deficiency, found that it did not significantly inhibit the movement of orthodontic teeth **(Gratton *et al*., 2022)**.

On the other hand, vitamin E is an extracellular antioxidant that can affect the movement of orthodontic teeth by protecting ischemic tissue and hypoxia. Vitamin E has been shown to be beneficial in suppressing the damaging effects of oxygen-free radicals in cells during bone formation. It was reported that vitamin E has a significant impact on the osteoblastic cells that play a role in the bone remodeling process; reserchers detected no statistically significant difference in the average number of osteoclastic cells between the control group and vitamin E at each observation time on days 0, 1, 3 and 7 **(Sufarnap *et al*., 2020)**.

Vitamin K is a group of fat-soluble vitamins that are necessary for blood clotting, regulating blood calcium levels, and forming proteins necessary for bone metabolism, such as osteocalcin and periostin **(Rahman & Walls, 2020)**.

Fish oil, rich in omega-3s, has become one of the most widely used nutraceuticals in both Indonesia and the world. Fish oil can be obtained from a variety of species depending on the type of fish used. In this study, it was found that omega-9 fatty acids are the most dominant in both the patin and massif fish compared to the reverse with low omega-3 fatty acid levels in both types of fish. In this research, the levels of omega-3, 6, and 9 fatty acids were higher compared to previous studies; the difference in the level of these fatty acids was influenced by the given feed, the type, season, habitat, and several other factors **(Ayu *et al*., 2019)**.

The key to tooth movement is the changes taking place in the arachidonic acid levels that affect bone resorption. Omega-6 is a precursor of arachidonic acid (AA), which produces eicosanoids that have a role in inflammatory processes. Eicosanoids are involved in modulating the intensity and duration of the inflammatory response. Omega-3s show anti-inflammatory effects by lowering the levels of pro-infectious cytokines and pro-inflammatory mediators. Moreover, EPAs contained in omega-3s produce eicosanoids with distinct properties compared to the eicosanoids derived from arachidonic acid. EPA can also act as a substrate for both cyclooxygenase (COX) and 5-lipoxygenase (5-LOX), producing eicosanoids with a slightly different structure than those formed from arachidonic acid. EPA and DHA also stimulate the formation of resolvins that have anti-inflammatory properties and have an effect on bone remodeling processes **(Pateiro *et al*., 2021)**. Iwami-Morimoto, who used a four-week-old male Wistar rat, showed that the amount of tooth movement in the group given fish oil containing 10% omega-3 was 80% slower than in the control group **(Morimoto *et al*., 1999)**. It was reported that, upon using the male albino wistar mice of 12 weeks old that were given omega-3 supplements in a study to detect the impact of the supplemented diet, it was observed that, omega-3 fatty acids decreased the number of osteoclasts and caused a slowdown in the movement of orthodontic teeth. Omega-3s cause changes in arachidonic acid levels and affect bone resorption, which is a crucial factor in tooth movement **(Ogrenim *et al*., 2019)**.

On the other hand, DHA supplements were given to male New Zealand rabbits aged 12 – 16 weeks for 14 days in a previous research. The authors suggested that the administration of DHA may lead to a decrease in the number of osteoclases responsible for alveolar bone resorption on the side of compression, thereby slowing the movement of the tooth. Supplementation with DHA for 14 days in the experimental group (doses of DHA-750 mg and DHA 1500 mg) showed lower tooth movement compared to the control group. Microalgae DHA is an important factor in inhibiting the movement of dental orthodontics. From the perspective of a clinical study, this study provides insight into modulation to enhance tooth movement in orthodontic care where osteoclastic formation occurs through the process of osteoclastogenesis; the administration of DHA inhibits osteoclastogenesis **(Karunia *et al*., 2019)**.

Gad said that giving omega-3 supplements to male New Zealand albino rabbits systematically reduced the movement of orthodontic teeth, owing to the effect of omega-3 on the inhibition of osteoclasts **(Gad & Soliman, 2022)**.

The administration of omega-3 fatty acids induces changes in the levels of arachidonic acid in the alveolar bone, accompanied by changes in prostaglandin levels so that alveolar bone resorption is inhibited on the side of pressure, causing a decrease in tooth movement **(Shi *et al*., 2024)**. Diaz noted that the administration of omega-6s can induce osteoclastic activity by reducing the expression of the gene osteoprotegerin in the osteoblast and promoting differentiation of MSC stem cells into adipocytes, thereby reducing osteoblast production **(Diaz *et al*., 2013)**. Increased osteoclast activity can increase the degree of movement of the teeth in the case of orthodontics. Omega-3s have been shown to increase bone density compared to the reverse omega-6s that enhance bone resorption. Notably, the patin and the goldfish are rich in omega-9 and omega-6 but low in omega-3 **(Innes & Calder, 2018)**.

In this case, further research is needed to investigate the effects of omega-3, omega-6, and omega-9 on accelerating orthodontic tooth movement in an *in vivo* experimental model.

CONCLUSION

The patin is one of the fish that is quickly bred in Indonesia. The patin fish contains 68.6% protein, 5.8% fat, 3.5% ash, and 59.3% water. Moreover, it has quite a lot of oil content when compared to other freshwater fish species, such as the cork fish and the goldfish, which are 4.0 and 2.9%, so the patin fish has the potential to be extracted as a source of fatty acids that are rich in benefits. The patin fish has the potential to use its oil as a source of unsaturated fatty acids increasing the fulfillment of food and nutritional needs of the community. Fish oil is a nutrient that contains beneficial fatty acids since it contains many unsaturated fatty acids. The content of fatty acids and vitamins in the oil affects bone remodeling, and further research is needed on the effect of the administration of oil on the acceleration of tooth movement in orthodontic treatment.

ACKNOWLEDGEMENTS

This research was funded by PUTI Grant-Universitas Indonesia, Number: NKB-177/UN2.RST/HKP.05.00/2023.

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