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Assessment of Omega-3 Fatty Acids (EPA& DHA) in the Liver and Muscle Tissues of Red Mullet (*Mullus Barbatus Barbatus*) from the Market of Al-Bayda City: Comparative Study with Regional References

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Abstract

Omega-3 poly unsaturated fatty acids, particularly eicosapentaenoic acid (EPA) & Docosahexanoic acid (DHA), are essential nutrients for a human health, playing critical role in cardiovascular and cognitive functions, The red Mullet (*Mullus barbatus barbatus*) is important a commercially fish species in Mediterranean, but it's nutritional profile can vary significantly od to Environmentally an dietary factors. This study aimed to quantify and compare of the concentration of EPA and DHA in the liver and muscle Tissues of red mullet obtained from the local market of Al-bayda City, Libya. Lipids were extract using a modified Folch method, and fatty acids Methyl Esters (FAMEs) were analyzed using gas chromatography-mass spectrometry (GC-MS). The results showed that the DHA was the dominated fatty acid in both tissues, with concentrations approximately double those of EPA. The Liver tissue Exhibited significantly higher combined concentrations of EPA and DHA (7.79% of total fatty Acids) compared to the muscle tissue (3.09%). When compared to reference study from eastern Mediterranean (Iskenderun Bay) [4], our findings revealed a substantially lower content of both EPA (0.89% vs 4.59%) and DHA (2.01 vs 8.25%) in the muscle tissue in the Libyan red mullet. This disparity is likely to this attributable to local environmental conditions, dietary deficiencies and seasonal variations, which may affect the nutritional quality of the fish. This study provides baseline data of fatty acid profile of red mullet were study highlighting the need for further seasonal and ecological research to understand the factor influencing its nutritional value.

Keywords: Omega-3, EPA, DHA, GC-MS Spectrophotometry, Red Mullet, Al Bayda's Market

Introduction

Poly unsaturated acids (PUFAs), especially Omega-3 long chain fatty acids like EPA and DHA, are vital for human health contributing to prevention of cardiovascular diseases and supported of neurological development [1]. The primary dietary source of these fatty acids is marine fish, which obtain them from the food chain from microalga However, the concentrations of EPA and DHA in fish is highly variable, influenced by species, diet, season and geographic location [2]. The red mullet (*mullet barbatus barbatus*) is benthic fish species widely distributed in Mediterranean Sea and is a significant component of the Libyan fisheries sector. Its nutritional value, particularly its lipid profile, is of considerable interest to consumers and researchers, However there is a notable important fish species, Lack of scientific data on the nutritional composition of fish from the Libyan coast, Which impedes informed dietary choices and development of local aquaculture. This study aims to fill this gap by quantifying and comparing the EPA and DHA content in the liver and muscle of red mullet from the fishes market of Al-bayda, then compare results with data from other regions of the Mediterranean. This comparison well help to evaluate the potential Impact of local environmental factors in the nutritional quality of this important fish species.

Materials and Methods

Sample Collection and Preparation

Fresh samples of red mullet these fishes were common for local consumption in al-jabal al-Akhder region, there buy from the local fish market in Al-bayda city, the fishes were transporting in the icebox with layers of crushed ice to the laboratory. Three individual fishes were using as biological replicates. For each fish the liver and a sample the dorsal muscle (fillet) were excises, using cleaned equipment, and stored separately at (-20 C°) until analysis.

Lipid Extraction and Fatty Acid Methyl Ester (FAME) Preparation

Total lipids were extract from approximately 20g of homogenized liver and muscle tissue using modified Folch method with a chloroform-methanol mixture (2:1v/v) [3]. The extracted lipids were then subjected to base catalyzed transesterification using methanolic potassium hydroxide to convert the fatty acids into their corresponding fatty methyl esters (FAMEs), following standard protocol [3]. The resulting FAMEs were extracted with n-hexane, and then dried over anhydrous sodium sulfate, before GC-MS analysis.

Gas Chromatograph-mass Spectrometry (GC-MS) Analysis

FAME analysis was performed using an Agilent 7890gas chromatograph coupled with a 5975 mas selective detector. Separation was achieve on an HP-5MS capillary column (30m × 0.25 mm ×0.025µm). The oven temperature was programming from 80°C (held for 2min) to 250°C at a rate of 10°C/min. Helium have been used as the carrier at flow rate of 2 ml/min. the injector and detector temperatures were set at 250°C and 280°C, respectively. Fatty acids were identified by comparing their mass spectra and retention times with those in the NIST 2008 mass spectral library. Quantification was based on the percentage of the total peak area for each identified fatty acid.

Results

The fatty acid composition analysis focused on the concentration EPA and DHA in the liver and muscle tissues the data were present as mean percentage of total fatty acids with standard deviation (SD).

EPA and DHA Content in Liver and Muscle

Table 1 summarize the EPA and DHA content in the liver and muscle tissues. The liver contained significantly higher concentration of both EPA and DHA (2.01±0.15%) and DHA (4.49±0.37%). In both tissues, the concentration of DHA was approximately twice that of EPA.

Table 1: EPA and DHA content (percentage of total fatty acids) in liver and muscle tissues of Mullus barbatus

Tissue	EPA (%)	DHA (%)
Liver	2.01 ± 0.15	4.49 ± 0.37
Muscle	0.89 ± 0.05	2.01 ± 0.07

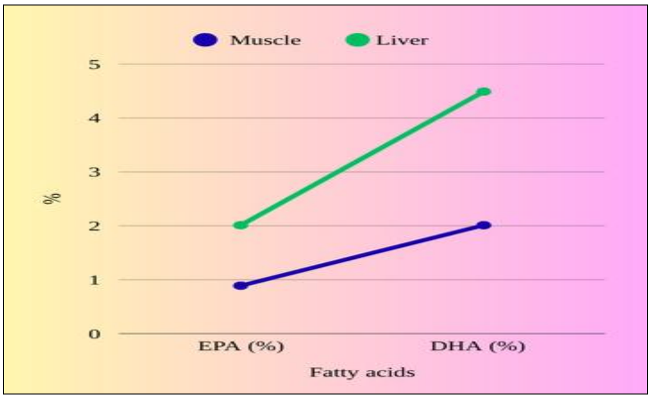

Fig 1: Provides a visual comparison of the EPA and DHA content between the two tissues (liver & muscle)

Distribution of Total Omega-3 (EPA+DHA) Between Liver and Muscle Tissues

The liver was the primary site of omega-3 fatty acid accumulation containing 71.60% of the total EPA+DHA found in the whole fish (liver +muscle combined), as shown in Table 2.

Table 2: Distribution of total omega-3 (EPA+DHA) between liver and muscle tissues

Tissue	Omega-3 Content	Percentage of Total
Liver	7.79	71.6%
Muscle	3.09	28.4%
Total	10.88	100

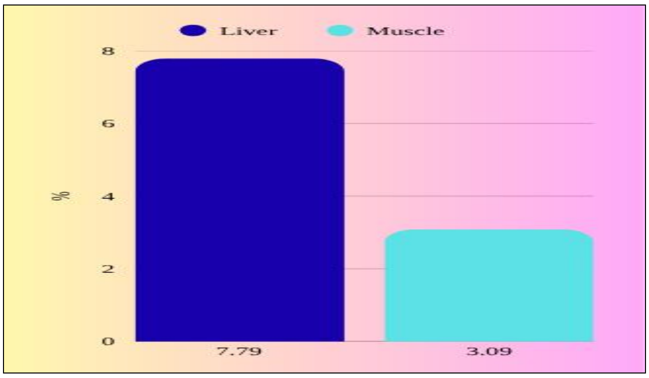

Fig 2: Distribution of Total Omega-3 (EPA+DHA) Between Liver and Muscle Tissues

Comparison Reference Value

When compared to reference study on *Mullus barbatus* from Iskenderun Bay in the Eastern Mediterranean [4]. Our findings show a markedly lower content of both EPA and DHA in the muscle tissue (Table 3).

Table 3: Comparison of EPA and DHA Content in the muscle of *Mullus barbatus* from the Libyan Coast and Iskenderun Bay Coast turkey (East Mediterranean)in winter season

Location	EPA (%)	DHA (%)
Libyan (This study)	0.89±0.05	2.01±0.07
Iskenderun Bay (Ref)	4.59	8.25

Discussion

The current study successfully employed GC-MS to quantify EPA and DHA in the liver and muscle of *red mullet.* The dominance of DHA over EPA in both tissues (approximately 2:1) is consistent with previous studies for same marine (values in Table 3) [5], reflecting its critical role in cell membrane structure, particularly in neural and retinal tissues. The significantly higher concentration of omega-3 fatty acids in the liver compared to the muscle (Table 1) is a common finding in fish physiology and is attributed to the liver's central role in lipid metabolism, biosynthesis and storage of long chain PUFAs [6]. The liver is the primary site for the elongation and desaturation of fatty acid precursors to produce EPA and DHA, explaining the higher concentration found there. This also suggests that the liver is an excellent indicator of a fish's recent dietary fatty acid intake. The most striking finding of this study is the substantial difference in the fatty acid profile of *Mullus barbatus* from the Libyan coast compared to the reference data from Iskenderun bay coast [5]. The much lower concentration of EPA (0.89% vs4.59 %) and DHA (2.01% vs 8.25%) in the muscle tissue strongly suggest that the Libyan fish are poorer in nutritional quality in terms of omega-3 content. Several factors could contribute to this disparity: Nutritional Factors: the primary driver of fatty acid composition in fish is their diet [7]. The significantly lower omega-3 levels in the Libyan fish likely indicate a dietary deficiency, possibly due to scarcity of omega-3 rich prey such as specific copepods or other lipid-riche zooplankton in the local environment. The red mullet (*M.barbatus*) is a benthic feeder, so the quality and composition of the benthic community are critical. This suggests that the foraging areas of the Libyan fish may be less productive or less rich in the specific lipid sources required for EPA and DHA biosynthesis. Environmental Factors: Variations of water temperature, salinity, and nutrient availability are knew to influence the lipid metabolism and fatty acid composition of fish [9]. While the reference data is from the same season, different years and specific locations can have distinct oceanographic conditions that affect the base of the food web, which ultimately affects the fish's fatty acid profile. The environmental conditions of the Libyan coast, such as the strength of upwelling events, may be less favorable for the production of lipid rich phytoplankton and zooplankton compared to the eastern Mediterranean locations. Seasonal Factors: fatty acids profile particularly in species like *M.barbatus,* were knew to fluctuate with the reproductive cycle [4]. While our study was conduct in a specific season, the reference data might had been collect at a different reproductive stage, which could explain some of the variation. However, the magnitude of deference observed (over 5-fold For EPA and over 4-fold for DHA) suggests that seasonal variation alone is unlikely to account for the entire discrepancy. The higher levels of omega-3 found in the liver compared to the muscle underscores the importance of considering different tissues when assessing the nutritional value of fish. Furthermore. The results highlight the vulnerability of the nutritional quality of wild-caught fish to local environmental conditions and emphasize the need for robust, region-specific nutritional database.

Conclusion

This study provides the first quantitative on the EPA and DHA content in Mullus barbatus from the Libyan coast. The result demonstrate that DHA is the predominant omega-3 fatty acid and that the liver is the primary organ for its storage. The substantial difference between the fatty acid profile of Libyan fish and that of fish from a reference region in the eastern Mediterranean is likely attributable to a combination of dietary deficiencies and local environmental factors. This finding underscores the necessity for further research, including comprehensive seasonal monitoring, dietary analysis, and ecological studies of the Libyan coastal zone. Such studies are crucial for understanding the determinants of fish nutritional quality, which is vital for public health management and development of local fisheries and aquaculture.

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