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Comparative Characteristics of Percentage Edibility, Condition Index, Biochemical Constituents and Lipids Nutritional Quality Indices of Wild and Farmed Scallops (*Flexopecten glaber*)

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Abstract: The consumption of seafood has considerably increased over recent decades; however, as wild seafood stocks are limited, the cultured ones represent a possible valuable alternative. The purpose of this study was to compare wild and cultured scallops, *Flexopecten glaber*, on the basis of their marketability indices and biochemical characteristics. Wild and cultured specimens were harvested from the Ionian Sea (the Central Mediterranean Sea). Protein and lipid were significantly different between scallops, with the values of protein of 8.50 and 11.6 g/100 g and lipid of 1.45 and 1.70 g/100 g for wild and cultured scallops, respectively. Regarding fatty acids (FAs), statistical differences were also detected. The cultured species showed significantly ($p < 0.05$) higher polyunsaturated fatty acids (PUFAs) than its wild counterpart. Eicosapentaenoic (EPA, 20:5 n3) and docosahexaenoic acid (DHA, 22:6:3) were the major polyunsaturated fatty acids, although only DHA showed significant differences between wild and culture scallops ($p < 0.05$). The ratio of n3/n6 PUFA showed high values, with 2.7 and 3.1 for wild and cultured scallops, respectively. The atherogenic and thrombogenic indices and hypocholesterolemic/hypercholesterolemic fatty acid ratio indicated an import role in human diet. The appreciated nutritional properties of this species could support the interest to promote its cultivation, ensuring high food nutritive value for the purchasers.

Keywords: *Flexopecten glaber*; proximate composition; fatty acids; mariculture; lipid nutritional quality indices

1. Introduction

The commercial exploitation of shellfish (mainly mollusk bivalves) represents a very important resource worldwide, with species of high economic value, such as oysters, mussels, scallops and clams, that account for about 1.8 million tons from marine and freshwater capture fisheries [1]. However, the constant request for seafood leads to the overexploitation of wild stocks beyond biological sustainability, reducing these resources to critical levels. The attention on these products is growing at a time when global demography show us that world population is growing and will continue to grow in the future, which means that there is a need to produce more protein foods [2]. Aquaculture holds the key to mitigating the growing request that must focus on forms of marine aquaculture that generate high quality products on a solid base of environment sustainability [3].

The lack of diversification in shellfish culture in European aquaculture is a serious weakness that could prevent the expansion of this sector in Europe [3]. To overcome such problems, there is great interest in developing a sustainable bivalve culture, adding value to production with high-value species that could contribute to a new source of protein for consumers [4]. The diversification of aquaculture through the introduction of new bivalve species can contribute to meet the demand in seafood production, reducing pressure on wild stocks [5].

Bivalve aquaculture is considered a "sustainable and green" aquaculture industry [3]. Indeed, bivalves feed on phyto- and micro-zooplankton, on various organic detritus, and bacteria, present naturally in the water column and they do not need prepared feeds [6].

Bivalves products represent a very valuable source of essential nutrients for much of the world's population, although there are considerable variations of consumption between countries and regions in terms of the overall amount, which reflects differences in eating habits, availability, and socioeconomic levels [7,8]. Some of the benefits attributed to the bivalves are the incorporation of components of significant nutritional value, such as high quality proteins, vitamins, essential amino acids, minerals, and low lipid contents, besides being a source of n3 series polyunsaturated fatty acids (PUFAs), especially eicosapentaenoic (EPA) and docosahexaenoic (DHA) acid, which bring several benefits to human organisms [9–12].

Among bivalves, scallops represent a valued delicacy that is particularly appreciated in European countries. They represent an important part of the global seafood market and are obtained from fishery or aquaculture activities [13]. The development of scallop culture has been promoted in the United Kingdom, France, Spain, Norway, and Ireland, and, to a lesser extent, in Italy and Croatia; however, despite the attempts, a successful, large-scale scallop aquaculture industry has not yet developed in Europe [14]. However, the commercial aquaculture activities for *Pecten maximus* have been developed in France, Spain, Scotland, and Norway, and for *Aequipecten opercularis* in Spain (both on the Atlantic and Mediterranean coasts) and Scotland. In relation to the Mediterranean regions, there are some promising candidate species for aquaculture, including *Pecten jacobaeus*, *Mimachlamys varia* and the *Flexopecten glaber* [15].

Flexopecten glaber (Linnaeus, 1758) is a commercially important species belonging to the Pectinidae family and is widely distributed in the Mediterranean Sea, including the Black Sea coast [15,16]. They are harvested via artisanal fisheries, even though this is insufficient to fulfil the market demands [17]. Previous studies reported that *F. glaber* could be a promising candidate for an emerging Mediterranean aquaculture on artificial substrates of wild spat because of its wide availability and ease of collection; moreover, they grow fast and do not seem to be threatened by severe pathogens. For these reasons, the smooth scallops show the potential to diversify bivalve cultures, stimulating the perspective of the meat market and consumer demands [5,18].

Generally, the quality of the biochemical composition of any edible organisms is an important indication of flesh quality and permits determining its nutritional value in comparison to other organisms. This is a valuable tool to assess the source of nutritive constituents for human consumption [11,12,19]. Information on the quality differences between wild and cultured bivalves is central to better ensuring that products from aquaculture meet the beneficial requirements. However, to our knowledge there is no literature data that reports the comparison of the nutritional composition of wild and farmed Pectinidae.

Through a comparative analysis between wild and cultured *Flexopecten glaber*, the objectives of this paper were to investigate: their marketability indices (Percentage Edibility and Condition Index), biochemical composition (proximate and fatty acid composition) and Lipids Nutritional Quality indices. This information could be useful to consider *F. glaber* as an emerging species in European aquaculture.

2. Materials and Methods

2.1. Collection, Samples Preparation, Percentage Edibility and Condition Index of Bivalves

Scallops were cultivated in suspended cages at a depth of 6–9 m in an experimental long-line plant located in an area of the Ionian Sea (the Central Mediterranean Sea, 40°25′54″ N, 17°14′22″ E). The suspended cages consisted of round plastic crates, generally used to on-grow shellfish. The crates are made up of shallow cylindrical baskets (height 11 cm, 60 cm in diameter and 1 cm mesh size, with an available surface of about 0.25 m^2), which stack together and are suspended by a single rope running vertically through the center of the stack. In the same area, samples of wild specimens were collected by scuba diving during April and May 2016.

Dissolved oxygen was measured by means of a Niskin bottle, while water temperature and salinity were measured using a probe (IDROMAR IM 52). The values of the water temperature registered were 18 ± 2 °C, the salinity was about 38 ± 1 psu, and the dissolved oxygen, 105–107%.

All samples were immediately iced and transported to the laboratory within 1 h to be brushed, washed, and processed. To avoid analytical differences that were size dependent, adult samples with similar shell length were chosen (n = 30; 45.2 ± 3.2 mm and 45.3 ± 5.0 mm shell length for wild and cultured scallops, respectively; n = 30; 11.9 ± 2.2 g and 12.3 ± 3.5 g total weight for wild and cultured specimens, respectively). Three subsamples of ten individuals each were rinsed with deionized water and opened by cutting the adductor muscle with a scalpel. The meat was pressed with blotting paper to remove excess moisture before weighting, homogenized and stored at −20 °C until use for biochemical analysis.

Percentage Edibility (PE) was calculated as: PE = (wet meat weight/total weight) × 100 [20].

Condition Index (CI) was determined as: CI = (wet meat weight/shell weight) × 100 [21].

2.2. Proximate Composition

The edible portion of cultured and wild *Flexopecten glaber* was analyzed for proximate composition. Moisture and ash content were determined according to the standard methods [22]. For moisture, samples were dried at 105 °C overnight until reaching constant weight. The ash content was determined in the furnace oven at 550 °C overnight.

The total proteins were determined using the protein dye binding method [23], with blue brilliant of Coomassie (G 250, Merck, Milan, Italy) as the reagent and bovine serum albumin (Sigma, Milan, Italy) as standard.

The carbohydrate content was quantified according to the phenol-sulfuric acid method [24], using glucose as the standard.

The chloroform-methanol (2:1, *v*/*v*) lipid extraction and gravimetric determination of total lipid (TL) were performed following the method of Folch et al. [25].

The contents were expressed on wet weight of sample since the main purpose of this work was to evaluate the quality of a product as purchased by consumers.

2.3. Fatty Acids

The fatty acids (FAs) in the total lipid were esterified into methyl esters by saponification with 0.5 N methanolic NaOH and trans-esterified with 14% boron trifluoride (*v*/*v*) in methanol.

Fatty acid methyl esters (FAMEs) were analyzed on a Hewlett Packard (HP) Agilent 6890 N model gas chromatograph (GC) equipped with a flame ionization detector (FID) and fitted with a capillary column (Omegawax; 30 m × 0.32 mm, i.d., film thickness 0.25 μm; Supelco, Bellefonte, PA, USA). Helium was used as the carrier gas (1 mL/min). The column temperature program was as follows: 150 to 250 °C at 4 °C/min and held at 250 °C.

The fatty acid peaks were identified by comparing their retention times to a mixture of fatty acid methyl ester standards (Supelco 37 Component FAME Mix; Supelco Inc., Bellefonte, PA, USA).

Quantification was made using the technique of internal standardization with triheptadecanoin serving as standard (Sigma, St. Louis, MO, USA).

Relative quantities were expressed as weight % of total fatty acids. Percent of total fatty acids data were converted to amounts per 100 g wet fillet according to Greenfield and Southgate [26].

2.4. Lipid Nutritional Quality Indices (LNQI)

The data from the fatty acid composition analysis were used to determine the nutritional quality of the lipid fraction by means of three indices using the following formulas:

1. The atherogenicity index [27]:

$$AI = \frac{(C12:0 + 4\ x\ C14:0 + C16:0)}{\sum MUFAs + \sum PUFAs} \quad (1)$$

2. The thrombogenicity index [27]:

$$TI = \frac{(C14:0 + C16:0 + C18:0)}{\left[\left(0.5\ x\ \sum MUFAs + 0.5\ x\ \sum n6\ PUFAs + 3\ x\ \sum n3\ PUFAs + \frac{n3}{n6}\right)\right]} \quad (2)$$

3. The fatty acids hypocholesterolemic/hypercholesterolemic ratios [28]:

$$HH = \frac{(C18:1\ cis\ 9 + C18:2n6 + C20:4n6 * C18:3n3 + C20:5n3 + C22:5n3 + C22:6n3)}{(C14:0 + C16:0)} \quad (3)$$

2.5. Statistical Analysis

All data were expressed as mean values ±SD (standard deviation). Analyses were performed in three replicates. The normality and homogeneity of the data was evaluated by Kolmogorov–Smirnov and Levene tests. The differences between scallop product types (wild and cultured products) were compared using independent sample t test. A significance level of 0.05 was used.

3. Results and Discussion

As the edibility percentage and condition index reflect the eco-physiological status of the individuals (gametogenesis and nutrient reserve storage consumption), they are parameters of economic importance because they detect the commercial quality of bivalve species, especially of those exploited [7,29]. These, together with proximate composition, are probably the simplest and most useful criteria adopted as standard in international trade [30].

In this work, the percentage of edibility and the condition index were highest in farmed scallops, with values of 45.2 and 95.3, respectively ($p < 0.05$) (Figure 1), in agreement to those reported by Prato et al. [12] for other bivalve species from the same area and same period.

The knowledge of proximate composition of food is necessary to ensure the requirements of food regulations and at the same time to provide the commercial specifications. Moreover, the awareness of the chemical composition of any edible organism is enormously significant because it gives an idea about the nutritive value of that organism.

The moisture content of food material affects the physical and chemical aspects and it is considered a good indicator of freshness and quality of seafood [31]. Its content depends on the flesh physical structure since the water is a fundamental medium for chemical reactions involved in many physiological processes, such as nutrient transport, the removal of waste products, nerve impulse transmission, and muscle contractions [31].

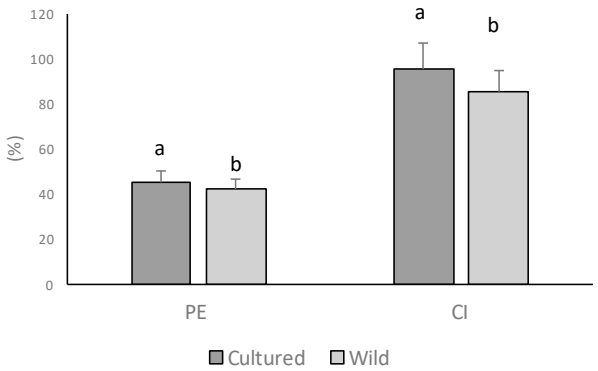

Figure 1. Mean values of three replicates ±standard deviation. Percentage of edibility (PE) and condition index (CI) of cultured and wild *Flexopecten glaber*. Different letters indicate significant differences ($p < 0.05$).

The results of this study indicated the moisture as the main component is >83% of *F. glaber* and similar values are typical of other bivalve mollusks [32]. However, between wild and cultivated scallops, no significant differences were found ($p > 0.05$) (Table 1).

Table 1. Proximate composition of wild and cultivated *Flexopecten glaber*. Values are average ± SD ($N = 20$, $n = 3$). Means followed by different letters are significantly different ($p < 0.05$).

	Wild	**Cultivated**
Moisture (g/100 g)	84.53 ± 1.5	83.17 ± 0.8
Ash (g/100 g)	3.51 ± 1.7	3.78 ± 0.8
Protein (g/100 g)	8.50 ± 1.2 [a]	11.62 ± 1.1 [b]
Lipid (g/100 g)	1.45 ± 0.3 [a]	1.70 ± 0.2 [b]
Carbohydrate (g/100 g)	0.03 ± 0.1	0.03 ± 0.1

Wild and cultured scallops showed a comparable ash content ($p > 0.05$), with values of 3.51 and 3.78 g/100 g, respectively.

According to the literature data and the results of this study, the carbohydrates in tissues of scallops examined in this study (0.03 g/100g) are less compared with other nutrients [33,34].

It is generally accepted that seafood is a high-quality source of protein and that its consumption provides health benefits to growing children, adolescents, and the aged. [12,35,36]. The farmed *F. glaber* had a significant higher protein content with 11.62 g/100 g than the wild (8.50 g/100 g) ($p < 0.05$).

The cultured scallops showed a lipid content higher than that of the wild specimens ($p < 0.05$) (Table 1).

The main biological functions of lipids comprise signaling and storing energy and are important in the structural organization of cell membranes [37]. Moreover, they represent a storage material utilized during stressful conditions [38], and they are an efficient energy source and essential component for the formation of tissue membranes [34,39].

Several previous studies reported similar values, for protein and lipid content to those found in the present study. Berik et al., [15] reported values of 12.0–13.7 g/100 g for protein and 1.12–1.95 g/100 g for lipid in wild samples from Lapseki Bay in Canakkale (Turkey). Prato et al. [12] found similar protein content in cultivated *F. glaber*.

In general, *F. glaber* from Mar Grande exhibited a proximate composition comparable to that of the specimens from the north east of Tunisia (Bizerte lagoon) [40].

Limited studies exist on the fatty acid composition of scallops from different areas of the Mediterranean Sea, including Italian waters, and therefore the comparison with other scallop species, harvested in the same period.

The importance of fatty acids in seafood commonly focus on polyunsaturated fatty acids, which are important to human health. As well as other marine invertebrates, bivalves are not able to synthesize n-3 and n-6 PUFAs de novo to satisfy physiological needs, so PUFAs are derived exclusively from their diet (phyto- and zooplankton, bacteria and detritus) [41].

Moreover, FAs are considered as biochemical markers, since the potential food sources of seafood (diatoms, dinoflagellates, zooplankton, bacteria) have a distinctive FA composition with unique FAs; therefore, they can be considered an efficient tool to provide information on a bivalve's diet [42].

The fatty acid profile of the *F. glaber*, wild and cultured, with their absolute amounts (mg/100 dw) and relative proportions (% of total FAs) are summarized in Table 2.

Table 2. Values reported are means ± standard deviations. Fatty acids (FAs) composition (mg/100 g) in the brackets (% of total FAs) of wild and cultured *F. glaber*. Means followed by * in the same line are significantly different ($p < 0.05$).

	Wild	**Cultured**
C14:0	56.25 ± 43.13 (5.54)	44.42 ± 8.93 (3.73)
C15:0	18.26 ± 30.85 (1.80)	1.35 ± 0.56 (0.11)
C16:0	253.32 ± 21.96 * (24.96)	319.32 ± 29.78 * (26.83)
C17:0	18.54 ± 2.89 (1.83)	18.64 ± 1.81 (1.57)
C18:0	39.57 ± 19.91 * (3.90)	77.35 ± 11.72 * (6.50)
C20:0	2.92 ± 2.27 (0.29)	1.98 ± 0.72 (0.17)
C21:0	3.09 ± 0.33 (0.30)	4.01 ± 1.22 (0.34)
∑SAFA	398.19 ± 55.08 (39.22)	467.07 ± 25.66 (39.25)
C14:1	1.3 ± 0.49 (0.13)	1.54 ± 0.47 (0.13)
C16:1	82.67 ± 9.10 * (8.14)	45.62 ± 7.74 * (3.83)
C17:1	8.67 ± 0.89 (0.89)	9.72 ± 2.93 (0.82)
C18:1n9t	10.21 ± 2.21 (1.00)	11.98 ± 2.75 (1.01)
C18:1n9c	6.43 ± 0.64 (0.63)	3.23 ± 1.89 (0.27)
C18:1n7	55.61 ± 45.94 (7.84)	54.62 ± 11.40 (4.59)
C20:1n9	3.07 ± 0.62 (0.27)	2.97 ± 1.19 (0.25)
C22:1n9	3.71 ± 0.13 (0.36)	4.88 ± 0.74 (0.41)
∑MUFA	195.65 ± 16.03 (19.27)	134.57 ± 7.11 (11.31)
C18:2n6t	12.65 ± 1.49 (1.24)	14.75 ± 9.86 (2.56)
C18:2n6c	30.09 ± 1.05 (2.96)	36.25 ± 9.80 (3.05)
C18:3n6	3.75 ± 0.18 * (0.37)	1.58 ± 0.29 * (0.13)
C18:3n3	38.66 ± 4.94 (3.81)	40.62 ± 2.85 (3.41)
C18:4n3	62.91 ± 1.92 (6.20)	52.95 ± 17.65 (4.45)
C20:2	1.71 ± 0.38 * (0.17)	7.14 ± 3.14 * (0.6)
C22:0 + 20:3n6	32.02 ± 6.51 * (3.15)	65.65 ± 17.65 * (5.52)
C20:3n3 + 22:1	9.89 ± 0.32 * (0.97)	44.23 ± 20.02 * (1.40)
C20:4n6	39.44 ± 2.95 * (3.88)	16.66 ± 4.76 * (3.43)
C22:2	0.89 ± 0.16 * (0.09)	40.86 ± 11.74 * (0.06)
C20:5n3	101.11 ± 2.25 (9.96)	105.91 ± 4.12 (8.90)
C22:5n3	23.81 ± 5.19 (2.34)	7.21± 1.07 (0.61)
C22:6n3	81.06 ± 10.25 * (7.98)	163.43 ± 4.95 * (13.73)
∑ PUFA	403.02 ± 49.24 * (39.70)	553.79 ± 13.78 * (46.54)

PUFAs represented the highest proportion of total FAs, contributing to 39.70% of the total FAs in wild scallops and to 46.54% of the total FAs in those cultured. Saturated fatty acids (SAFAs) were the second group with proportions that did not show significant differences between scallops, as well as the monounsaturated fatty acids (MUFAs) that accounting for 19.27 and 11.31% of the total FAs in wild and cultured, respectively ($p > 0.05$).

The most abundant SAFAs in all samples of both scallops were: myristic (C14:0), palmitic (C16:0) and stearic acid (C18:0). The significant higher content of palmitic and stearic in cultured scallops compared to the wild specimens ($p < 0.05$) suggests the importance of detritus in the scallop's diet

when cultured in suspended cages. The amounts of odd-branched carbon SAFA 15:0 + 17:0 in both species reached 3.63% of total FAs in wild scallops and 1.68 in cultured samples, evidencing a moderate presence of bacteria in the diet of both scallops [42] (Table 2).

It is known that the high SAFA consumption represents a risk factor to develop coronary heart disease or cardiovascular disease [43] since it increases the blood total cholesterol and Low Density Lipoprotein (LDL) [44]. Lauric (12:0), myristic (14:0), and palmitic acids (16:0) are the SAFAs that contribute to increase total and LDL-cholesterol [44], because these fatty acids reduce the activity of the LDL receptors and thereby decrease the cellular LDL uptake [27]. On the contrary, stearic acid (18:0) does not cause a significant increase of cholesterol levels, but rather a High Density Lipoprotein (HDL)-cholesterol-level-lowering effect [45].

MUFAs are often referred to as "beneficial to human health" because they help in reducing both total and low density lipoprotein-LDL blood cholesterol levels and protect against cardiovascular disease [46].

In this study, palmitoleic (16:1), vaccenic (18:1 n7) and oleic (18:1 n9) acids were the major MUFAs detected in both wild and cultured scallops. Significantly higher amounts of 16:1 (82.67 mg/100 g dw; corresponding to a percentage of 8.14% of total FAs) in wild scallops than cultured (45.62 mg/100 g dw; corresponding to a percentage of 3.83% of total FAs) were found, while wild and cultured scallops did not differ for 18:1 n7 as well as 18:1 n9 contents ($p > 0.05$). A high concentration of 16:1n-7 indicates an important contribution of diatoms in the diets of bivalves [42].

Cultured scallops exhibited higher PUFA content than wild ones, with 553.8 and 403.0 mg/100 g dw for cultured and wild, respectively ($p < 0.05$). PUFAs are very important biochemical components of bivalves, contributing to their high nutritional quality and making them an ideal food for the human diet. The major contributors to n3 PUFA were eicosapentaenoic (EPA 20:5 n3), docosahexaenoic acid (DHA, 22:6 n3), stearidonic acid (STD, 18:4 n3), and α-linolenic acid (ALA, 18:3 n3), although only DHA was significantly higher in cultured scallops than wild scallops ($p < 0.05$). DHA predominated over EPA in cultured samples, and this could reflect an ingestion of Dinophyceae while the ratio DHA/EPA was reversed in favor of EPA in wild scallops indicating a diatom- or flagellate-based diet.

Chakraborty et al., [47] in a study on the nutritional composition of wild and cultured oyster *Crassostrea madrasensis* from the southwest coast of India, reported a higher EPA and DHA content in wild oysters. Stancheva et al. [48] reported for Black Mussel (*Mytilus galloprovincialis*) from the Bulgarian Black Sea values of EPA + DHA from 0.252 g (wild) to 0.425 g/100 g (cultured).

Despite the essential role that n3 PUFA play in the normal growth and development along the lifespan, they are not adequately consumed, especially in Western countries where a relative imbalance in the consumption of n6 and n3 PUFA is observed due to a high consumption of food of animal origin [49].

Large amounts of n6 PUFA and low amounts of n3 PUFA, with the consequent high n6/n3 ratio, contribute to increased cardiovascular risk, cancer, inflammatory and autoimmune diseases.

However, there is a growing public interest in the benefits of dietary n3 FA on the human health, as several studies state that a diet rich in marine origin food prevents chronic diseases such as coronary heart disease (CHD) [50].

It is widely recognized that a high dietary intake of n6 PUFA promotes a proinflammatory response in the consumers; however, recent evidence has also shown the opposite [51,52], suggesting some anti-inflammatory actions such as those of the n3 PUFA [53]. For example, mean serum C-reactive protein concentrations showed a decrease with increased n6 PUFA ingestion, in both Japanese men and women [51,52].

Among n6 PUFAs, arachidonic acid (ARA C20: n6) plays an important role for the synthesis of eicosanoids, for cognitive functions, in the development of skeletal muscle, central nervous system.

In this study the ARA content showed significantly higher values in wild (39.4 mg/100 g dw) than cultured scallop (16.66 mg/100 g dw) (Table 2) indicating a major contribution of micro-heterotrophs (flagellates and ciliates) in the wild scallops' diet [42].

The health benefits of seafood may be related to n3 PUFAs that in this study were significantly higher ($p < 0.05$) in cultured scallop (414 mg/100 g dw) than wild (317.44 mg/100 g dw), while the n6 PUFAs content did not show significant differences between wild and cultured scallops (Figure 2A).

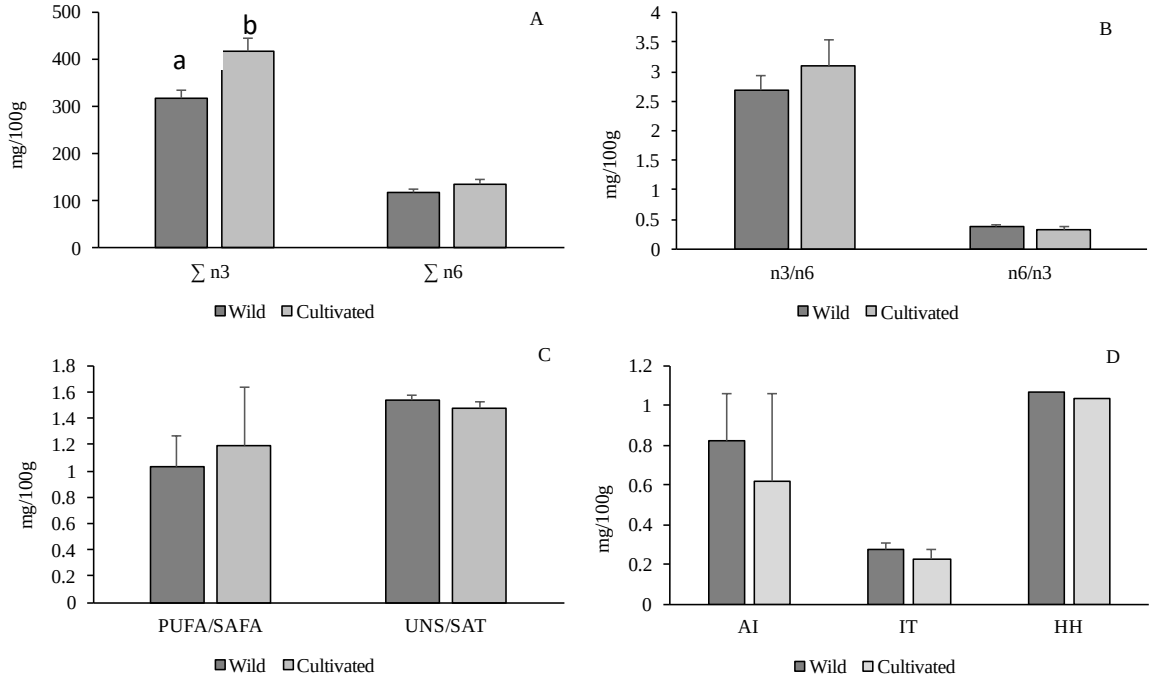

Figure 2. Nutritional quality indexes of wild and cultures scallops. Values are mean (± SD). (**A**) ∑n3 and ∑n6 = sum of omega 3 and omega6 fatty acids; (**B**) n3/n6 and n6/n3 ratios; (**C**) SAFA/PUFA = saturated and polyunsaturated fatty acids ratio and UNS/SAT = unsaturated and saturated fatty acids ratio; (**D**) AI = Atherogenic Index; TI = Thrombogenicity Index; and HH = hypocholesterolemic/hypercholesterolemic fatty acid ratio. Different letters indicate significant differences ($p < 0.05$).

Chakraborty et al. [47], on the contrary, for the edible oyster *C. madrasensis*, reported a total content of n3 significantly higher ($p < 0.05$) in the wild than in the cultured.

In general, the n3/n6 ratio is higher for many marine organisms than terrestrial food—this is consistent with previous studies [54–58]. This ratio is very useful index for assessing the nutritional quality of fish lipids, due to their human health effects in coronary heart diseases, chronic inflammatory conditions, autoimmune diseases [59–61]. An appropriate n3/n6 ratio is fundamental to the balanced production of eicosanoids and allows a major conversion of α-linolenic acid into DHA [60,62]. In the present work, the n3/n6 ratio was 2.70 for wild and 3.1 for culture scallops. Chakraborty et al. [47] reported higher n3/n6 ratio in both wild and cultured *C. madrasensis*, with 5.1–6.7 in the wild and 4.4–5.7 in the cultured samples. n6/n3 ratios of *F. glaber* wild and culture were 0.37 and 0.32, respectively (Figure 2B). The UK Department of Health recommends an ideal ratio of n6/n3 of 4.0 at maximum [63], and values above 4.0 are considered harmful to human health. Therefore, the consumption of food rich in n3 PUFA is an important approach to balance the high n6/n3 ratios.

Another important nutritional indicator is the PUFA/SAFA ratio. Many studies report that both reduced SAFA and increased PUFA dietary intakes were very important in regulating blood cholesterol level [64,65]. According to some nutritional guidelines, the PUFA/SAFA ratio should be above 0.45 [66]. In this study, the PUFA/SAFA exhibited good values with 1.03 in wild and 1.20 in cultured scallops (Figure 2C). Also, the ratio unsaturated (UNS)/SAFA is largely used to evaluate the nutritional quality of lipid [11]. Wild and cultured scallops showed a ratio in favor of UNS with values of 1.53 (wild) and 1.48 (cultivated).

AI, TI, and HH are widely used to assess the nutritional quality of the lipid fraction and its potential effect on the appearance of cardiovascular disease (Figure 2D) [27]. High AI and TI values indicate

high fatty acids content involved in atherogenic and thrombogenic processes and are considered to be important factors underlying CHD risk increase. Therefore, the smaller the AI and TI index values, the healthier the food. The higher n3 fatty acid content, and consequently the higher n3/n6 fatty acid ratio, in all samples in this study contributed to lower atherogenic and thrombogenic indices. AI was slightly lower in cultivate scallops (0.61) than wild (0.81); as well as IT, with values of 0.22 in cultivated scallops and 0.27 in those wild.

As regard hypocholesterolemic/hypercholesterolemic fatty acid ratio, lower values of HH are deleterious to human health. The HH ratio take into account specific effects that single fatty acids might have on cholesterol metabolism, and high HH values are desirable for human benefit. The scallops studied herein showed values of 1.07 (in wild) and 1.03 (farmed), indicating that edible tissues are beneficial to human health.

The dietary guidelines from international agencies recommend a regular seafood consumption (one to two servings per week with each serving to provide the equivalent of 250–500 mg of EPA + DHA) [67]. The results of this study showed that, in order to obtain the recommended daily portion (RPD) of EPA + DHA, people need to eat a smaller portion of farmed scallops (93.0 ± 3.1 g) than wild ones (of about 137.5 ± 7.0g ($p < 0.05$).

4. Conclusions

The approach of this study aimed to examine if suspended farmed scallops of *Flexopecten glaber* in the sea could compete with the wild ones currently offered on the market. The results demonstrated that the scallops as a new product cultured in the Ionian Sea at the experimental site could compete positively with current wild products.

The proximate composition and fatty acids profile of cultured and wild scallop products were similar, in line with a previous study on mussels from Ionian waters by Prato et al. [58]. The comparison between the two scallop products showed that the cultured ones had higher n3 fatty acids, n3/n6 ratio, EPA, DHA, than their wild counterparts, so it is possible to say that commonly cultured scallops are products with slightly higher nutritive value, especially in term of the prevention of cardiovascular diseases.

The present study provides baseline information to assess the nutritional value of scallops (*F. glaber*) in the Ionian Sea (Mediterranean Sea) that could be useful for eliminating the prejudice toward their production through the cultivation of sea products. In conclusion, *F. glaber* can be worthily considered as a potential sustainable candidate in Mediterranean aquaculture.

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