STUDY ON NUTRITIONAL QUALITY OF THE REFRIGERATED GILTHEAD SEA BREAM *(SPARUS AURATA)*

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The study aimed an analysis of the nutritional quality of refrigerated gilthead sea bream (Sparus aurata), based on the gross chemical composition and its energy value, respectively. Were analyzed 28 gilthead sea bream samples, size 300/600g (average weight 420g), purchased in July 2019 from four supermarkets (coded M1, M2, M3, M4, seven fish per store). The content in water, proteins, lipids and collagen was determined using the Food Check automatic analyzer (infrared spectrophotometer); the mineral substances were determined by calcination at 550 °C, and the carbohydrate content and energy value were established by calculation, using conventional formulas. The analyzes performed revealed an average content of 66.26% water, 12.33% lipids, 18.41% proteins, 1.04% carbohydrates and an energy value of 193.68 kcal/100g gilthead sea bream, with higher variability for water (5.71 percentage points) and lipids (4.2 percentage points) and lower for proteins (2.38 percentage points) and mineral substances (1.47 percentage points). The data obtained were statistically processed using classical methods and through the ANOVA variance analysis test (GraphPad Prism 8.1 software), not being highlighted significant statistical differences (p>0.05) between the mean of the chemical determinations performed for M1-M4.

Keywords: gilthead sea bream, chemical composition, energy value

INTRODUCTION

Fish are considered nutritionally valuable part of the human diet and consumption two times a week is recommended, mostly due to the content of long chain polyunsaturated n-3 fatty acids (n-3 LC-PUFA), such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), that are essential in human nutrition and involved in many metabolic functions. They have anti-inflammatory effects, decrease platelet aggregation and are essential parts in the cell membranes, cardiovascular system, brain and nervous tissue of children in prenatal development, and to prevent the metabolic syndrome or obesity [1, 7, 20, 21, 24, 26, 36, 40, 41].

The nutritional quality is an inducement for fish consumption due to the high content of fish in n-3 LC-PUFA which have been associated with beneficial properties for human health [30, 36, 26, 33]. More recently fish proteins, peptides and amino acids have also gained increased attention with similar positive health effects as the n-3 LC-PUFA [21, 32, 34, 40]. Aquatic protein is highly digestible and rich in several peptides and essential amino acids that are limited in terrestrial meat proteins, as for example methionine and lysine [40]. Studies related to inflammation, metabolic syndrome, osteoporosis, insulin resistance, obesity-related comorbidity and development of cancer have been executed and fish protein, peptides or hydrolysates have shown of importance in nearly as many areas as fish lipids [21, 22]. A sardine protein diet showed to lower insulin resistance, leptin and tumor necrosis factor (TNFa), improved hyperglycemia and decreased adipose tissue, oxidative stress in rats with induced metabolic syndrome [27]. Fish protein hydrolysates are considered superior from a nutritional point of view due to the excellent amino acid composition and easily digestible proteins, being mostly used in animal nutrition [21, 22]. It has been shown in

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human macrophages that fish protein hydrolysates decreased TNFa compared to casein hydrolysates. The combination of n-3 PUFA with fish protein hydrolysates synergistically decreased expression levels of TNFa compared to fish protein hydrolysates or n-3 treatment only [34]. Furthermore, fish is also a rich source of certain vitamins and minerals as vitamin D3 (cholecalciferol), B1 (thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pridoxine, pridoxamine and pyridoxal), B12 (cynocobalamin) selenium, phosphorus and calcium. Riboflavin converts the amino acids into niacin, which is also responsible for energy production, neural and enzymatic functions in the body. In addition to niacin, vitamin B6 has an important functionality on amino acid metabolism, glycogen and different kinds of enzymatic reactions [9, 13, 37]. Another important aspect of fish quality is the sensory characteristics of a fish product, since they greatly determine consumer acceptance, and therefore the consumption [3, 29]. The sensory and nutritional quality of fish can vary depending on numerous endogenous and exogenous factors, including the type of fish species under investigation and the post-harvest handling of fish, such as processing and culinary preparation [3, 8, 25, 36]. Examining the effects of various culinary preparation methods on fish fatty acid profiles or other aspects of their nutritional quality, has been the subject of several studies [4, 28, 36]. The nutritional and sensory quality, are related to the choice of culinary preparation method [21, 22, 36, 40].

The gilthead sea bream (*Sparus aurata)* is one of the most cultivated species in the Mediterranean area, the leading producers being Turkey, Greece and Spain, that covered 87.2% of the European production in 2015 [5, 6]. The demand for fresh gilthead sea bream has increased significantly over the past decade in Europe due to its desirable aroma and quality, and consequently, its high value has made the farming of the fish a profitable business [2, 16]. Total increase in gilthead sea bream production in 2019 is expected to be higher with 4% compared with 2017. These figures have also been reflected in the export statistics of both Greece and Turkey, the two most significant producers, which showed substantial gains in 2017 [14].

The study aimed an analysis of the nutritional quality of refrigerated gilthead sea bream (*Sparus aurata*), based on the gross chemical composition and respectively its energy value.

MATERIALS AND METHODS

Were analyzed 28 gilthead sea bream samples, size 300/600g (average weight 420g), purchased in July 2019 from four supermarkets (coded M1, M2, M3, M4, seven fish per store). The samples were chopped and homogenized with an electric shredder. The water, proteins and lipids content were determined using the Food Check Near Infrared Spectrophotometer (NIRS technology); the energy value was determined by calculation, using conventional formulas and gross ash content was assessed by calcinations (after a preliminary carbonization at 550°C for 16 h). The energy conversion factors were: 3.87 for carbohydrates, 4.27 for proteins and 9.02 for lipids (according to Atwater system) [15].

The achieved results were statistically processed through the main descriptors computation (arithmetic mean, $\overline{x}$, standard deviation, s, and coefficient of variation, V%, and by analysis of variance test (ANOVA multiple comparisons), using the GraphPad Prism 8.1 software.

RESULTS AND DISCUSSIONS

Analyzing the average values obtained for the gilthead sea bream M1, M2, M3 and M4 (Tables 1-4), the highest differences between them (2.17 percentage points), were observed at the level of water (67.13% for M3 and 64.99% for M1).

The highest average amount of dry matter was observed for gilthead sea bream M1 (35.02%), followed by M2 (34.01%), M4 (33.39%) and M3 (32.8%) whit differences between them of 2.15 percentage points; also lower values are observed, but similar in representation for the samples analyzed for organic matter.

A relatively small variation of the average lipid content of the gilthead sea bream studied was observed, with differences of 1.07 percentage points (12.90% for M1 and 11.83% for M3), thus obtaining a higher energy value for M1 (200.48 kcal/100g) compared to M3 (188.56 kcal/100g).

Table 1 Chemical composition and energy value of gilthead sea bream *(Sparus aurata)* from M1

Chemical components	$\overline{X} \pm s_{\overline{X}}$	s	V%	Min.	Max.
Water %	64.95±25.29	67.44	18.90	64.09	65.57
Dry matter %	35.05±13.08	64.66	13.60	34.43	35.91
Organic matter %	32.76±12.15	64.24	12.82	31.94	33.82
Lipids %	12.90±4.04	54.27	19.01	11.90	13.90
Proteins %	18.17±6.19	59.03	15.01	17.80	18.80
Collagen %	3.22±0.09	4.75	0.02	2.97	3.35
Carbohydrates %	1.09±0.53	54.58	0.85	0.74	1.22
Ash %	2.29±0.29	21.92	0.25	2.09	2.49
Salt %	1.08±0.79	26.32	1.85	0.82	1.31
Energy kcal/100g	200.48±80.62	69.65	19.62	199.29	202.35
Energy kJ /100g	838.82±341.22	70.46	15.64	833.82	846.64

s= standard deviation; V%=coefficient of variation.

The average amount of proteins it varied less, with differences of 0.46 percentage points (18.63% for gilthead sea bream M4 and 18.17% for M1 and M2). The higher collagen content was observed for gilthead sea bream M2 (3.24%) followed very close to the sea bream M1 and M3 (3.22% and 3.31%) and the lowest was determined for M4 (2.98%); the differences between averages were 0.26 percentage points.

Table 2 Chemical composition and energy value of gilthead sea bream *(Sparus aurata)* from M2

Chemical components	$\overline{X} \pm s_{\overline{X}}$	s	V%	Min.	Max.
Water %	65.99±25.71	67.50	13.66	64.53	67.30
Dry matter %	34.01±12.66	64.47	20.91	32.70	35.47
Organic matter %	31.73±11.73	64.03	12.79	30.82	33.49
Lipids %	12.40±3.84	53.60	14.18	11.40	13.40
Proteins %	18.17±6.19	59.03	15.01	17.70	18.90
Collagen %	3.23±0.10	5.10	0.03	3.19	3.33
Carbohydrates %	1.17±0.75	11.20	1.68	0.82	1.39
Ash %	2.28±0.29	22.31	0.26	1.88	2.98
Salt %	1.33±0.68	88.39	1.39	1.10	1.70
Energy kcal/100g	193.93±77.95	69.62	17.63	185.81	205.69
Energy kJ /100g	811.41±30.03	70.45	16.54	777.44	860.62

s= standard deviation; V%=coefficient of variation.

The average amount of salt determined for gilthead sea bream was close to the all samples taken in the study (1.17% for M3 and 1.22% for M4), higher values being observed for M2 (1.33%) and lower for M1 (1.08%), with differences of 0.25 percentage points.

Table 3 Chemical composition and energy value of gilthead sea bream *(Sparus aurata)* from M3

Chemical components	$\overline{X} \pm s_{\overline{X}}$	s	V%	Min.	Max.
Water %	67.13±26.18	7.55	16.54	65.80	69.80
Dry matter %	32.87±12.19	64.26	18.01	30.20	34.20
Organic matter %	31.05±11.45	63.88	13.43	28.26	32.57
Lipids %	11.83±3.61	52.78	19.01	9.70	13.90
Proteins %	18.63±6.38	59.33	12.20	17.90	19.80
Collagen %	3.20±0.08	4.52	0.02	3.08	3.41
Carbohydrates %	0.81±0.99	92.37	2.92	0.76	0.98
Ash %	1.82±0.48	46.12	0.70	1.63	1.94
Salt %	1.17±0.75	10.60	1.67	1.01	1.31
Energy kcal/100g	188.56±75.76	69.59	16.64	166.61	204.80
Energy kJ /100g	788.94±320.86	70.44	18.76	697.08	856.88

s= standard deviation; V%=coefficient of variation.

The average amount of carbohydrates was higher for M2 (1.17%), followed by M1 (1.09%) and lower for M3 (0.81%) and M4 (0.89%), with differences of 0.36 percentage points between the average values determined.

Table 4 Chemical composition and energy value of gilthead sea bream *(Sparus aurata)* from M4

Chemical components	$\bar{X} \pm s_{\bar{x}}$	s	V%	Min.	Max.
Water %	66.61±25.97	67.53	12.90	65.81	67.91
Dry matter %	33.39±12.41	64.36	11.88	32.09	34.19
Organic matter %	31.58±11.67	63.99	18.41	30.14	32.68
Lipids %	12.57±3.91	53.83	15.76	10.40	13.90
Proteins %	18.27±6.24	59.10	16.64	17.42	19.20
Collagen %	2.98±0.01	0.51	0.00	2.84	3.13
Carbohydrates %	0.89±0.92	15.93	2.55	0.75	1.26
Ash %	1.81±0.48	46.28	0.70	1.51	1.98
Salt %	1.22±0.73	13.17	1.58	1.05	1.41
Energy kcal/100g	194.24±78.07	69.62	18.85	177.87	205.04
Energy kJ /100g	812.71±330.56	70.45	15.75	744.19	857.90

s= standard deviation; V%=coefficient of variation.

For ash, differences of 0.48 percentage points were observed, with higher values for M1 (2.29%) and lower for M4 (1.81%).

The average energy value was the highest for M1 (200.48 kcal/100g) and the lowest for M3 (188.56 kcal/100g), them presenting low differences of 11.92 kcal/100 g.

After statistical processing (tab. 5) through the ANOVA variance analysis test (GraphPad Prism 8.1 program), the statistical differences between the means of chemical determinations performed for M1-M4 were not significant ($p > 0.05$).

Table 5 The statistical significance of the differences on chemical composition and energy value of the gilthead sea bream *(Sparus aurata)* from M1- M4

ANOVA	Lipids		Proteins		Collagen		Water		Ash		Salt		Sen		D.M.		O.S.		E kcal/100g	
	S	P value	S	P value	S	P value	S	P value	S	P value	S	P value	S	P value	S	P value	S	P value	S	P value
M1-M2	ns	0.9789	ns	>0.9999	ns	0.9987	ns	0.8481	ns	>0.9999	ns	0.5642	ns	0.9579	ns	0.8484	ns	0.8767	ns	0.9283
M1-M3	ns	0.8407	ns	0.8694	ns	0.9998	ns	0.3643	ns	0.4157	ns	0.9596	ns	0.7054	ns	0.3661	ns	0.6123	ns	0.7011
M1-M4	ns	0.9935	ns	0.9963	ns	0.3443	ns	0.5800	ns	0.4103	ns	0.8743	ns	0.7905	ns	0.5805	ns	0.8254	ns	0.9370
M2-M3	ns	0.9699	ns	0.8901	ns	0.9956	ns	0.7893	ns	0.4323	ns	0.8275	ns	0.9312	ns	0.7910	ns	0.9539	ns	0.9583
M2-M4	ns	0.9992	ns	0.9983	ns	0.2851	ns	0.9559	ns	0.4268	ns	0.9314	ns	0.9708	ns	0.9560	ns	0.9994	ns	>0.9999
M3-M4	ns	0.9388	ns	0.9444	ns	0.3770	ns	0.9720	ns	>0.9999	ns	0.9932	ns	0.9984	ns	0.9725	ns	0.9774	ns	0.9512

ANOVA =Multiple Comparison's test Graph prism; n.s. (not significant) = $p > 0.05$;

Following the analyzes performed (for all the samples taken in the study), the highest variation was observed, at the level of water 5.71 percentage points, with a maximum of 69.80% and a minimum of 64.09%, with a total average of 66.26% (Fig. 1). The same 5.71 percentage point variation (Fig. 2), applies and for the amount of dry matter (D.M).

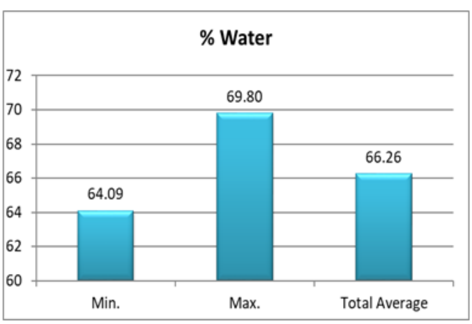

Fig. 1. The water content of the *Sparus aurata*

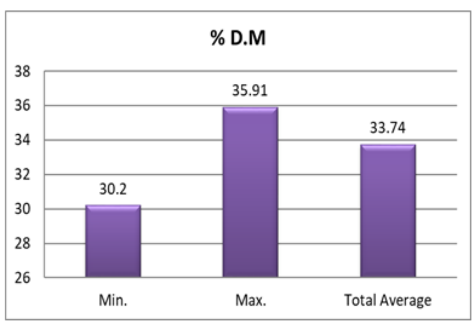

Fig. 2. The D.M. content of the *Sparus aurata*

For organic matter (O.S.) a variation of 5.56 percentage points was observed, with averages of 31.75% for all analyzed samples, with a minimum of 28.26% and a maximum of 33.82% (Fig. 3).

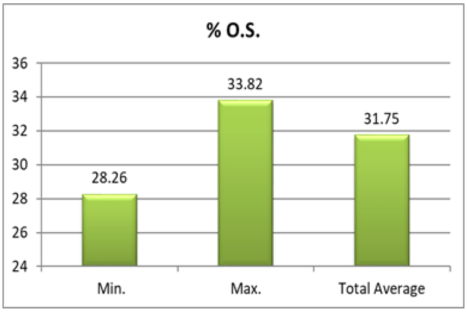

Fig. 3. The O.S. content of the *Sparus aurata*

Also, there was a variation of 4.2 percentage points for the amount of lipids, with a minimum of 9.7% and a maximum of 13.90%, presenting a total average of 12.33% (Fig. 4).

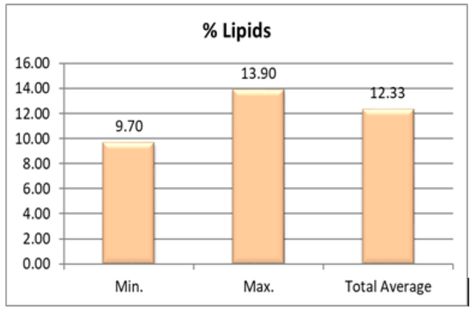

Fig. 4. The lipids content of the *Sparus aurata*

It is notable and a relatively low variation in protein content, 2.38 percentage points, presenting minimum values of 17.42% and maximum of 19.80%, with total averages of 18.41% (Fig. 5).

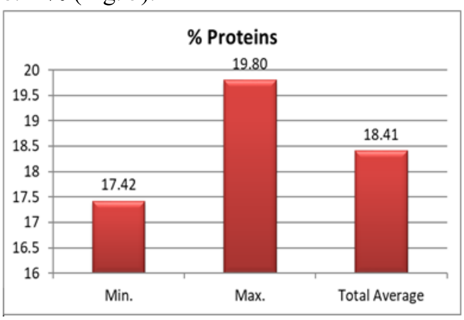

Fig. 5. The proteins content of the *Sparus aurata*

The collagen varied only by 0.57 percentage points (Fig. 6), being observed average values of 3.18%, minimums of 2.84 and maximums of 3.41%.

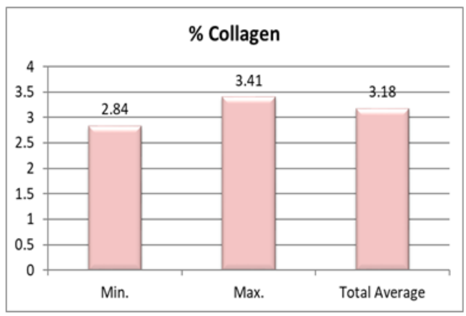

Fig. 6. The collagen content of the *Sparus aurata*

The average amount of carbohydrates was 1.04% for all samples analized, with a variation of 0.65 percentage points, being noticed minimum values of 0.74% and maximum of 1.39% (Fig. 7).

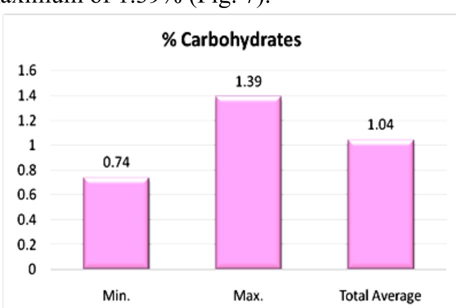

Fig. 7. The carbohydrates content of the *Sparus aurata*

For ash, the average values determined was 2.08%, with a variation of 1.47 percentage points between the samples taken in the study, being noticed maximum values of 2.98% and minimum of 1.51% (Fig. 8).

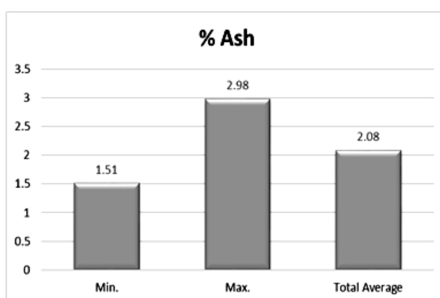

Fig. 8. The ash content of the *Sparus aurata*

The average amount of salt was 1.21%, with a maximum of 1.70% and a minimum of 0.82%, with a variations of 0.88 percentage points (Fig. 9).

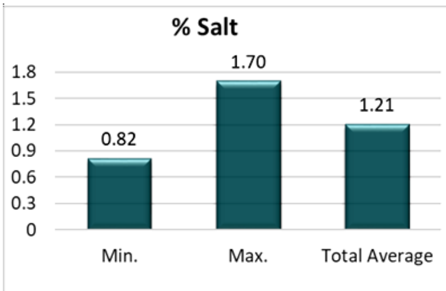

Fig. 9. The salt content of the *Sparus aurata*

The energy value had a variation of 39.08 kcal/100 g gilthead sea bream, with a maximum value of 205.69 kcal/100g and a minimum of 166.61 kcal/100g (Fig. 10).

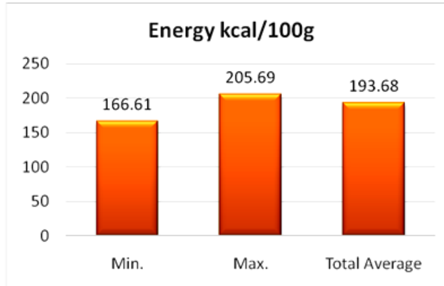

Fig. 10. Energy content (kcal/100g) of the *Sparus aurata*

The average values and the limits of variation observed in the present study are in agreement with other determinations made in other works from Greece, Turkey, Spain, UK, Portugal and Italy.

After Grigorakis and Alexis, 2005 [18], there were obvious fluctuations of the different quality parameters among three dietary groups of gilthead sea bream *(Sparus aurata)* and no statistically significant differences between them after a different feeding period (p>0.05). They found the following limits of variation at the level of chemical composition: 68.80-71.50% water, 18.80-20.90% proteins, 6.73-10.10% lipids and ash 1.28-1.47%.

After Grigorakis et al., 2002, muscle fat content and total fat depot indicated a seasonal variation, with minimum values observed in late spring and maximum in late summer for gilthead sea bream; they found in May 6.53% lipids, and in August 10.37% lipids [19].

Alasalvar et al., 2001, found 18.0% proteins, 6.53% lipids, 74.4% water and 1.53% ash for cultured gilthead sea bream [2].

Cardinal et al., 2011, found a quantity of proteins between 18.5-20.6% and of dry matter between 27.9-32.0% for gilthead sea bream reared under intensive conditions [8]

Kouroupakis et al., 2019 found 19.1% proteins in wild-caught white sea bream fillet, 1.09 % lipds, 78.2 % water and 1.46% ash [23].

The popularity of fish is mainly due to the overall high quality and the positive effects on human health [22].

Fatty acids contained in fish, in particular EPA, have important health functions for the body and are different from those of beef and pork, the latter being rich in cholesterol [12]. Fish and seafood fatty acids have the ability to a decrease cholesterol blood level and are therefore very useful for the prevention of cardiovascular diseases [26, 3 0, 32, 34, 41]. There is a clear link to health and life expectance in correlation with the consumption of fish and seafood. A clear correlation between health and life expectancy and fish intake was shown in Japan, with a high per capita fish intake [36, 39] being noticed the highest life expectancy and the lowest incidence of obesity and cardiovascular diseases, while in the US obesity and cardiovascular diseases are a major problem, the fish intake being significantly lower [21, 36, 39].

Unfortunately, the presence of polyunsaturated fatty acids from fish lipids are extremely susceptible to oxidative deterioration during storage. As a result, lipid oxidation is one of the most important factors responsible for quality deterioration of fish, both refrigerated and frozen. Changes occurring during the oxidation of lipids affect sensory quality (colour, flavour and texture) negatively, and are related to loss of functional properties, nutritive value and safety of fish meat [11, 17, 31]. For this reason fresh fish is stored frozen at -18°C or in ice with a temperature close to 0°C for commercial purposes, which has proven to be an effective strategy to delay fish spoilage [6, 10]. Global consumption of fresh and minimally processed fish has grown rapidly in recent decades, which denotes consumer nutrition education. In this regard, aquaculture has been responsible for the extraordinary growth in the supply of fish for human consumption, which resulted in a high-record per capita consumption of 20.3 kg in 2016 [11, 14].

CONCLUSIONS

The analyzes performed revealed an average content of 66.26% water, 12.33% lipids, 18.41% proteins, 1.04% carbohydrates and an energy value of 193.68 kcal/100g gilthead sea bream, with higher variability for water (5.71 percentage points) and lipids (4.2 percentage points) and lower for proteins (2.38 percentage points) and mineral substances (1.47 percentage points). After statistically processing of the data obtained through the ANOVA variance analysis test (GraphPad Prism 8.1 software), no significant statistical differences ($p>0.05$) between the mean of the chemical determinations performed for M1-M4 have been observed.

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