

PROCEEDINGS
of the Marine and Inland Waters Research Symposium 2022
former Panhellenic Symposium on Oceanography & Fisheries

AKS Porto Heli Conference Center, Porto Heli, Argolida, Greece
16-19 September 2022

HCMR Researchers Association & Panhellenic Union of HCMR Employees
Under the auspices of the Hellenic Centre for Marine Research
Anavyssos 2022

TECHNICAL QUALITY AND NUTRITIONAL VALUE OF FOUR INVASIVE FISH SPECIES

Grigorakis K.¹, Kotsiri M.¹, Kogiannou D.¹, Nikoloudaki C.¹, Dogramatzi A.² and Karachle P.K.²

¹ Institute of Marine Biology Biotechnology and Aquaculture (IMBBC), Hellenic Centre for Marine Research (HCMR), 46.7 km Athens-Sounion, kgrigo@hcmr.gr; mkotsiri@hcmr.gr; dkogiannou@hcmr.gr; cnikol@hcmr.gr,

² Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research (HCMR), dogramatzi@hcmr.gr; pkarachle@hcmr.gr

Abstract

The present research aimed at evaluating the technical quality and the nutritional value of four invasive to the Mediterranean fish species, which however, have a potential for commercial exploitation for human consumption in order to ease their pressure and to enrich the seafood market. In total 145 individuals of *Etrumeus golanii*, 26 of *Siganus rivulatus*, 26 of *Siganus luridus*, and 96 of *Pterois miles* were obtained, measured their somatometry, and analyzed for their proximate composition and fillet fatty acid contents. Among them, *S. rivulatus* was the one with higher fat contents. All species are rich in their total PUFA content. The ω 3 eicosapentaenoic (EPA) and docosahexaenoic (DHA) prevail. Both *Siganus* species were rich in total ω 6 PUFA and ARA in particular, thus exhibiting low ω 3/ ω 6 ratio (1.0), while on the contrary this ratio was extremely high for *P. miles* (4.0) and *E. golanii* (9.3). All species, based on their total ω 3, EPA and DHA contents can be characterized as exceptional sources for these PUFA that are essential for human nutrition. Their dressing and filleting yields and their proximate and fatty acid compositions indicate a very strong potential for their exploitation for human consumption.

Keywords: nutritional value, fatty acids, composition, invasive fish.

1. Introduction

The present research deals with four common invasive species with strong environmental and social impact in the Mediterranean, which however, have a potential for commercial exploitation for human consumption in order to ease their pressure and to enrich the seafood market. These four species, namely the Golani round herring *Etrumeus golanii* DiBattista, Randall & Bowen, 2012 (with potential impacts in purse seine fisheries and species competition with anchovies and sardines), the lionfish *Pterois miles* (Bennett, 1828), (which based the Caribbean example can have detrimental ecosystem effects), and the two spine-foot species, *S. luridus* (Rüppell, 1829) and *S. rivulatus* Forsskål & Niebuhr, 1775 (with proven ecological impacts by barrens' formation, and impacts to the artisanal fisheries). The aim of this study was to assess the technical quality and nutritional value of these four species, since no similar data occurs.

2. Material and Methods

The four species were collected from different locations in the Greek waters based on their availability, throughout the whole year. In total 145 individuals of *E. golanii*, 26 of *S. rivulatus*, 26 of *S. luridus*, and 96 of *P. miles* were obtained. They were transferred fresh, their somatometry took place and subsequently they were filleted and frozen until analysis. Proximate composition took place according to standard analysis (AOAC, 2005) and fatty acids were obtained after lipid extraction and direct methylesterification (Lepage & Roy, 1984). The statistical analysis was done by the GraphPad Prism v. 8.4.2. software. After normality check, one way ANOVA was applied with Tukey test used for comparing the means.

3. Results and Discussion

The somatic characteristics and technical yields of the four species appear in Table 1. It has been observed that *E. golanii* has a dressing yield and a filleting yield higher than the rest species. The lowest filleting yield was observed in the two *Siganus* species. The total composition of the four species fillets is presented in Table 2. The *S. rivulatus* was the species with the higher lipid content among all.

Table 1. Mean (\pm standard deviation) of total length (TL), weight (W), eviscerated weight (Wev), filleting yield (FY), condition index (CI) and dressing yield of the four species.

	<i>S. rivulatus</i>	<i>S. luridus</i>	<i>P. miles</i>	<i>E. golanii</i>
TL (mm)	2226 \pm 168.6	2058 \pm 112.4	2463 \pm 258.0	1992 \pm 379.4
W (g)	148.3 \pm 32.55	155.5 \pm 25.17	216.4 \pm 83.31	77.2 \pm 38.20
Wev (g)	120.9 \pm 25.23	123.8 \pm 20.41	188.8 \pm 71.68	70.7 \pm 35.36
FY (%)	35.01 \pm 2.56 a*	31.00 \pm 2.66 a	29.06 \pm 1.34 a	44.26 \pm 1.43 b
CI	1.3 \pm 0.08 b	1.8 \pm 0.18 c	1.4 \pm 0.19 b	0.9 \pm 0.04 a
DY (%)	81.8 \pm 3.26 a	79.7 \pm 4.74 a	87.4 \pm 3.86 b	91.2 \pm 2.91 b

*Different letters stand for statistically significant differences ($p < 0.05$)

Table 2. Mean (\pm standard deviation) of proximate composition (%) of the four species.

	<i>S. rivulatus</i>	<i>S. luridus</i>	<i>P. miles</i>	<i>E. golanii</i>
Protein	20.5 \pm 0.5 a	18.9 \pm 0.1 a	18.1 \pm 2.8 a	23.0 \pm 0.1 b
Fat	2.2 \pm 0.1 c	1.7 \pm 0.2 b	1.7 \pm 0.1 b	1.2 \pm 0.0 a
Moisture	75.6 \pm 0.3	77.6 \pm 0.2	76.8 \pm 0.4	73.8 \pm 0.8 a
Ash	1.5 \pm 0.0 a	1.5 \pm 0.0 a	1.4 \pm 0.0 a	1.7 \pm 0.1 b

*Different letters stand for statistically significant differences ($p < 0.05$)

The fatty acid composition, presented as main fatty acid group content and main polyunsaturated (PUFA) content in mg/100g fillet (Fig. 1) showed that all species are rich in their total PUFA content. The $\omega 3$ eicosapentaenoic (EPA) and docosahexaenoic (DHA) prevail as well as the essential $\omega 6$ arachidonic acid (ARA, 20:4 ω 6). Both *Siganus* species and *S. rivulatus* in particular were the species rich in total $\omega 6$ PUFA and ARA. The $\omega 3/\omega 6$ ratio was 1.0 for the two *Siganus*, 4.0 for *P. miles* and 9.3 for *E. golanii*.

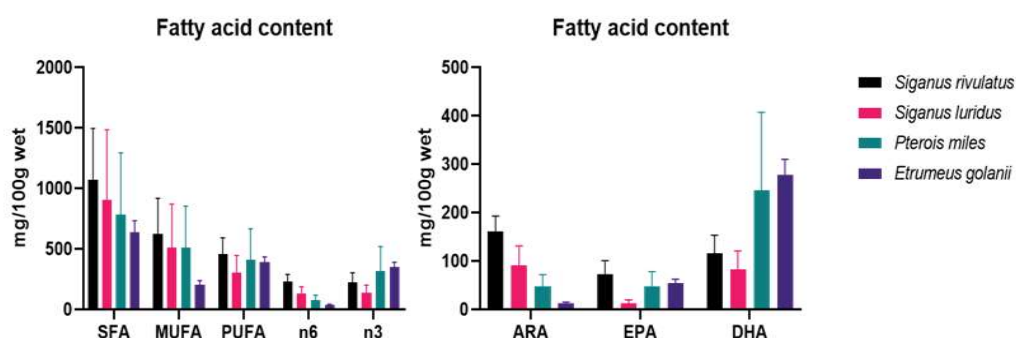


Fig. 1: Fatty acid composition (in mg / 100g fillet): Saturated (SFA), monounsaturated (MFA), total polyunsaturated (PUFA) fatty acids and arachidonic (ARA), 20:5 ω 3, 22:6 ω 3 (DHA) fatty acids. Bars represent standard deviations.

4. Discussion/Conclusion

The differences in dressing and filleting yields can be attributed to the morphometric characteristics of the fillets. Thus, the small size head and the plumpy body shape justify the particularly high DY and FY in *E. golanii*. In all cases the FY was satisfying and similar to those of many marine species that are commercialized as filleted (Borderías & Sánchez-Alonso, 2011).

The proximate composition of the four species has a typical protein content of around 20%, observed for most Mediterranean marine fish while they can all be characterized as low fat species (Grigorakis, 2017).

Out of the four species, the two *Siganus* ones exhibited a low ω_3/ω_6 ratio, almost half than the ideal for human that should be higher than 2. This is clearly due to their high ARA content, which, unlike the plant-derived ω_6 , mainly constituting of the low carbon-chain linoleic fatty acid (18:2 ω_6), is highly beneficial for the human health.

The nutritional importance of ARA for the growth and immune function of the herbivore species *S. rivulatus* has been previously shown (Nayak *et al.*, 2017) and this justifies the high concentration of this fatty acid in this species fillets. Besides the physiological importance of this fatty acid, the high concentration in *Siganus* spp. mirrors the natural dietary fatty acid profile for these two species deriving from the macroalgae that mainly constitute their diet (Grigorakis, 2011).

On the other side so *P. miles* as *E. golanii* -the latter in particular- have very high ω_3/ω_6 ratios, much higher than several wild and farmed Mediterranean species (Grigorakis, 2017), a fact that dignifies that they are exceptional sources of ω_3 PUFA. From the scarce available literature data, *E. golanii* show similar high ω_3 PUFA to those found in a previous study of the same species in the Mediterranean (Kucukguimez *et al.*, 2010). The sum of ω_3 PUFA and of EPA και DHA in *P. miles* and *E. golanii* are particularly high, comparing to those of species with much higher lipid contents like mackerels and the Australian amberjack *Seriola lalandi* (Chen & Liu, 2020).

Conclusively, the results of this study prove the excellent quality and high nutritional value of the four studied species, a fact that classifies them as very promising candidates for human consumption. Their technical yields are similar to those of many commercialized species, thus making their commercial exploitation and processing highly feasible in technical aspects. Since data of the present study derive from sporadic samplings throughout the year and seasonal sample collection is still undergoing, no seasonal effects in composition and fatty acids were evaluated herein.

The particularly high ω_3/ω_6 ratio of *E. golanii*, is an interesting observation and can be used as a strong point and advantage towards promoting the species in the food market.

A similarly important individuality, is the extremely high ARA content of both *Siganus* species, a fatty acid that is essential for human brain development and function. This can also serve as a strong feature for potential advertisement for human consumption of these two species. The potential commercialization of these species can largely facilitate the reduction of the ecological and social pressure applied by their presence in the Mediterranean.

5. Acknowledgements

This work has been conducted within the frame of the project “4ALIEN: Biology and the potential economic exploitation of four alien species in the Hellenic Seas”, funded by NRSF 2017-2020 (MIS (OPΣ): 5049511).

6. References

- AOAC, 2005. *Official methods of Analysis of AOAC international*. 18th edition.
- Borderías, A.J., Sánchez-Alonso, I., 2011. First processing steps and the quality of wild and farmed fish. *Journal of Food Science*, 76 (1), R1-R5.
- Chen, J., Liu, H., 2020. Nutritional Indices for Assessing Fatty Acids: A Mini-Review. *International Journal of*

Molecular Sciences, 21, 5695.

- Grigorakis, K., 2011. Tailorizing quality: effects of aquaculture handling techniques and nutrition on fish quality. p. 82- 95. In: *Seafood Quality, Safety and Health Effects*. Cesarettin, A., Shahidi, F., Miyashita, K., Wanasundara, U. (Eds) Wiley-Blackwell Publishing, London U.K.
- Grigorakis, K., 2017. Fillet Proximate Composition, Lipid Quality, Yields and Organoleptic Quality of Mediterranean Farmed Marine Fish: A Review with Emphasis on New Species. *Critical Reviews in Food Science and Nutrition*, 57, 2956-2969.
- Küçükgülmez, A., Celik, M., Ersoy, B., Yanar, Y., 2010. Effects of season on proximate and fatty acid compositions of two mediterranean fish - the round herring (*Etrumeus teres*) and tub gurnard (*Chelidonichthys lucernus*). *International Journal of Food Science & Technology*, 45, 1056-1060.
- Lepage, G., Roy, C.C., 1984. Improved recovery of fatty acid through direct transesterification without prior extraction or purification. *Journal of Lipid Research*, 25, 1391-1396.
- Nayak, S., Koven, W., Meiri, I., Khozin-Goldberg I., Isakov, N. *et al.*, 2017. Dietary arachidonic acid affects immune function and fatty acid composition in cultured rabbitfish *Siganus rivulatus*. *Fish and Shellfish Immunology*, 68, 46-53.