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Research / Araştırma

MINERAL ELEMENT and NUTRIENT COMPOSITION of TWO NEWLY-INTRODUCED FISH SPECIES (*Dentex dentex* and *Seriola dumerili*) in RECIRCULATING AQUACULTURE SYSTEM (RAS)

İlknur Meriç*

Ankara University Faculty of Agriculture
Department of Fisheries and Aquaculture Engineering, Diskapi, Ankara

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Abstract

As the world's fastest ongrowing sector in food production, aquaculture has remarkable priority and needs technological improvements and new candidate fish species to overcome some limitation factors. Considering these issues, this study based on determining the flesh quality in terms of nutrient and mineral element composition of two potential fish species, common dentex (*Dentex dentex*) and greater amberjack (*Seriola dumerili*), in recirculation aquaculture system (RAS). On the nutrient basis, the dry matter content of 28.82% and fillet yield with a value of 53.28% of *Dentex dentex* were found significantly higher than (P<0.05) *Seriola dumerili*. Crude protein and lipid values demonstrated slight but insignificant differences between the species. Among the macro elements of K and Mg and micro elements of Cr, Mn and Ni were noticeably higher in common dentex than greater amberjack, but Zn level was present almost double amount in amberjack (P<0.05).

Keywords: *Dentex dentex, Seriola dumerili,* minerals, Recirculating aquaculture systems (RAS), ICP-AES

KAPALI DEVRE SU ÜRÜNLERİ SİSTEMİNDE (RAS) YETİŞTİRİLEN İKİ YENİ BALIK TÜRÜNE (*Dentex dentex* ve *Seriola dumerili*) AİT MİNERAL MADDE ve BESİN KOMPOZİSYONU

Özet

Dünya gıda üretimi içinde en hızlı büyüyen sektör olan su ürünleri yetiştiriciliği, dikkate değer bir önceliğe sahiptir. Yetiştiriciliği etkileyen bazı kısıtlayıcı faktörlerin aşılabilmesi için sektörün teknolojik gelişmelere ve yeni aday türlere ihtiyacı vardır. Bunlar gözönünde bulundurulduğunda, bu çalışmanın temelini kapalı devre su ürünleri sisteminde (RAS) yetiştirilen ve iki potansiyel tür olan sinagrit (*Dentex dentex*) ve sarıkuyruk (*Seriola dumerili*) balığına ait et kalitesinin, besin ve mineral madde kompozisyonu yönünden incelenmesi oluşturmaktadır. Besin kompozisyonuna göre, *Dentex dentex* türüne ait kuru madde içeriği %28.82, fileto verimi ise %53.28'dir, *Seriola dumerili* ile karşılaştırıldığında bu değerler önemli ölçüde yüksek (P<0.05) bulunmuştur. Ham protein ve lipit değerleri, türler arasında önemsiz küçük değişimler göstermiştir. Macro elementlerden K ve Mg, mikro elementlerden ise Cr, Mn ve Ni, sinagrit balığında yüksek iken, sarıkuyruk balığında iz elementlerden Zn seviyesinin yüksek olduğu (P<0.05) görülmüştür.

Anahtar kelimeler: *Dentex dentex, Seriola dumerili*, mineraller, kapalı devre yetiştiricilik sistemleri (RAS), ICP-AES

* Yazışmalardan sorumlu yazar / *Corresponding author;*
meric@agri.ankara.edu.tr, (+90) 312 596 1505, (+90) 312 318 5298

INTRODUCTION

Due to the rapid expansion of the aquaculture industry in an effort to meet seafood consumption, the use of more improved aquaculture systems is a dictate of environmental sustainability, when we consider the declining water resources in east Mediterranean region. In this frame, recirculating aquaculture systems (RASs), is a land based systems having biological and mechanical treatments (1, 2), tenders the advantages of reduced water demands (3), improved oppurtunities for waste management and nutrient recycling by reconditioning of water (4), better food conversions (5), disease management (6, 7) and biological pollution control (8).

In view of depleting wild stocks and for the diversification of aquaculture as alternatives to sea bream, *Sparus aurata* and sea bass, *Dicentrarchus labrax*, which are the dominant farmed fish species, common dentex (*Dentex dentex*) and greater amberjack (*Seriola dumerili*) could be a suitable candidate species for RASs. The newly introduced fish species as common sea bream (*Pagrus pagrus*), shi drum (*Umbrina cirrosa*), sharpsnout sea bream (*Puntazzo puntazzo*) and blue spatled bream (*Dentex gibbosus*) with total production of 228 tons have been gained in place of annual aquaculture production of Turkey which was about 235.133 tons in 2014 reported by TUIK (9) and as well 113 tons of this production were obtained from common dentex. This species has been cultured in Greece, Italy, Spain and Turkey and has the same market price with sea bass and sea bream (10).

Notwithstanding, through these potential species, the adaption to culture environment of greater amberjack has not been actualised yet in a commercial scale, it is based on capture of wild juveniles that are fattened to marketable size (11). A few attempts were carried out in private hatcheries and some institutes as stated in Öksüz (12), however, Greece, Malta and Japan reared larvae since 1987 (13). The culture of new finfish species like *Seriola lalandi*, a Carangid like amberjack, in RASs has been investigated and satisfactory growth performance and acceptable feed conversion were procured (14). Researchs asserted that this species has excellent potential for RASs even in fluctuating water temperature (15).

In this sense, the aim of this research was, considering the limited researches which comprised notably one fish species, to reveal the flesh quality in terms of nutrient and mineral composition of two candidate fish species focusing on RAS.

MATERIALS AND METHODS

Fish material and sampling procedure

As a fish material, the common dentex and greater amberjack were obtained from a commercial aquaculture firm, İzmir, Turkey. Fish samples were transferred to the laboratory in polystyrene boxes filled with crushed ice and ice batteries, immediately. Fish samples were gutted, washed under running tap water, filleted manually with skin-on and homogenized. The total number of 20 fish (10 for each species) were used in the research and the whole body weights of dentex and amberjack were 148.10±5.55 g, 231.90±5.88 g and the total lengths were 19.24±1.73 cm and 29.01±2.25 cm, respectively.

Rercirculating aquaculture system (RAS)

Fish were held in RAS for a period of one year and RAS comprised 13 tanks with a volume of 130 tons for each tank, a drum filter of 100 µ and equipped with ozone sterilization and a protein skimmer system. The mean values of water temperature, pH and dissolved oxygen in the RAS were 26°C, 7 and 11.5 mg/kg, respectively. Fish were fed with commercial diet (AquaK) to ad libitium twice a day. The nutrient composition of the commercial diet was as follows; 46% protein, 18% lipid, 10% moisture, 9.3% ash and 2.5% fiber, and data were obtained from the R&D department of the feed producer company.

Fillet yield

Ten biological replicates representing of each fish species were filleted with skin-on and fillet yield was computed as a percentage of the edible flesh weight to the whole body weight (16).

Nutrient composition analysis

The pooled triplicate samples of dentex and amberjack fillets were analysed for dry matter, crude ash, crude protein and crude lipid according to the standard procedures following AOAC (17).

Briefly, dry matter was computed after drying the samples at 105°C for 24 h, crude ash after combustion at 550°C for 4 h in a muffle furnace (Nüve MF110, Turkey), crude protein (N x 6.25) by Kjeldahl distillation (Kjeltec System, Tecator, Hoganas, Sweden) and crude lipid after extraction with petroleum ether by Bligh and Dyer method (18).

Determination of macro and micro elements

The mineral element composition of edible tissues in dentex and amberjack were analysed by the method of Skujins (19) from ten biological replicates for each species. Approximately 1 g of sample was subjected to wet mineralisation using HCl, H_2SO_4, HNO_3 and the macro and micro element contents were determined by inductively coupled plasma atomic emission spectroscopy (ICP-AES; Varian-Vista). The working conditions of ICP-AES were as follows: RF power, 0.7-1.5 kW (1.2-1.3 kW for axial); plasma gas flow rate (argon), 10.5-15 l/min (radial) and 15 l/min (axial); auxiliary gas flow rate (argon), 1.5 l/min; viewing height, 5-12 mm; copy and reading time, 1-5 s (Max. 60 s); and copy time, 3 s (max. 100 s).

Statistics

Data presented here are means±standard deviation (SD) of three pooled replicates for nutrient analysis and ten biological replicates for fillet yield and mineral element analysis. Independent samples T-Test, a confidence level of 95%, was applied using statistical software SPSS 11.5 (20) to verify the presence of significant differences among the groups.

RESULTS AND DISCUSSION

The nutrient composition was not significantly differed ($P>0.05$) between the species (Table 1), except dentex had higher dry matter content with a value of 28.82%, whereas amberjack had 21.60% ($P<0.05$), meanwhile crude protein and crude lipid contents tended to be high in dentex compared with amberjack, however these differences were found insignificant ($P>0.05$). Taking into account the previous studies that compared the wild and cultured dentex and amberjack (11, 12, 21, 22), it is possible to remark that cultured fish always have more lipid and less moisture content than the wild ones and the variations in the nutrient composition can be interpreted with the influencing factors; dietary regime, age, size or even sex also stated by Fagbenro *et al.* (23)

On the basis of these nutrient data, we can conclude that dentex can exploit the feed more efficiently compare to amberjack in a RAS. This view was also confirmed by Perez-Jimenez et al (24) in a feeding trial of dentex with different macronutrient combinations.

The fillet yield values of dentex and amberjack were 53.28% and 48.56%, respectively. The results regarding to fillet yield were presented in Table 1. The remarkable difference regarding to fillet yield between two species was found statistically significant ($P<0.05$). According to Öksüz (12), due to the over feeding or feeding the fish with lipid-rich diets lead to fat deposit in peritoneal cavity, meanwhile they have reduced locomotor activity in a culture condition comparison to wild (25), probably, the low fillet yield values of two species can be clarified as these opinions.

The role of minerals in human metabolism notably, essential ones have a indispensable role in human body. The main functions of minerals are being part of skeletal structure, maintenance of colloidal system and regulation of acid-base equilibrium (21). In the case of deficiency inclined to improper enzyme-mediated metabolic functions and results in organ malfunctions; as it reduces

Table 1. The nutrient composition and fillet yield of common dentex (*Dentex dentex*) and greater amberjack (*Seriola dumerili*) (Mean ± SD) (n=3)*

Nutrient composition (%)	Species	
	Dentex dentex	*Seriola dumerili*
Dry matter	28.82±0.69^{a}	21.60±0.92^{b}
Crude ash	2.07±0.70	2.13±0.16
Crude protein	13.88±2.74	10.85±1.80
Crude lipid	5.78±3.85	3.84±0.37
Fillet yield	53.28±6.79^{a}	48.56±9.40^{b}

*Means in the same row with different bold superscripts significantly differ ($P\leq0.05$)

productivity and causes chronic diseases, such as inability of blood to clot, osteoporosis, anemia and ultimately to death (26, 27).

The macro and micro element contents were presented in Table 2 for dentex and amberjack. The lowest and the highest range of Recommended Dietary Allowances (RDAs) or Adequate Intakes (AIs) of these elements in human nutrition (28) were also given in the same table in terms of both males and females. As macro elements, Ca, K, Mg and P levels were noticed to be higher for dentex following the same trend in nutrient levels and fillet yield. Nevertheless, the differences found in terms of Ca and P levels were not significant (P>0.05), while K and Mg levels were differed significantly (P<0.05) between the species. Öksüz (12) reported that macro element values of amberjack were much greater in captured wild fish compare to those that cultured and as a macro element, Ca was the most ample one for this study in both species and followed by phosphorous. According to the literature, the recommended daily intake of Ca is about 1000-1300 mg per day (Table 2). Our findings demonstrated that like P and K, which present remarkable amounts in seafood, Ca, those found in fish can be underscored as essential for human nutrition after dairy products. Depending on the seasonal and biological differences as sex, age and species and other environmental conditions, some variations could be reveal in the mineral contents even in the same species of fish (10) as corroborating this research findings.

Likewise in macro elements, the micro elements such as Cu, Mn, Zn and Se are involved in several metabolic or immunological processes in organisms by activating or inhibiting enzymatic reactions, by competing for binding sites with other elements and metalloproteins, by affecting the permeability of cell membranes or by several other mechanisms (29, 30) in order to maintain the homeostasis (31, 32). So, they have to be taken from several resources as fish in daily diet. Nevertheless, they incline to become detrimental if their concentrations are above the metabolic demand in the tissue (27).

Here, in this study, the levels of micro elements, Cr, Mn, Ni and Zn demonstrated significant differences (P<0.05) between dentex and amberjack. Dentex had much more higher values than amberjack. On the other hand, no significant differences were observed for Cd, Cu, Fe and Pb levels. Amberjack had the highest Cu and Pb contents, though those levels were found insignificant (P>0.05). Zn is an important trace mineral and this element is second only to iron in its concentration in the body. It is found in cells throughout the body and needed for the body's defensive (immune) system to properly work. It plays a role in cell division, growth, wound

Table 2. The mineral (macro and micro) composition of common dentex (*Dentex dentex*) and greater amberjack (*Seriola dumerili*) (mg/kg wet weight basis) (Mean ± SD) (n=10)* and RDA or AIs levels in nutrition

Macro elements	Species		RDAs or AIs (Male and female)
	Dentex dentex	*Seriola dumerili*	
Ca	3915.96±282.14	2464.95±104.36	1000-1300 (mg/day)***
K	3289.56±679.68[a]	2464.93±733.90[b]	4.5-4.7 (g/day)***
Mg	317.38±74.93[a]	233.25±40.50[b]	240-420 (mg/day)**
Na	1158.28±367.31	1235.98±278.71	1.2-1.5 (g/day)***
P	3548.19±592.54	2481.45±521.83	700-1250 (mg/day)**
Micro elements			
Cd	0.04±0.02	0.03±0.02	0.07 (mg/day)****
Cu	0.57±0.47	1.43±2.78	700-900 (µg/day)**
Cr	0.30±0.17[a]	0.14±0.12[b]	20-35 (µg/day)***
Fe	12.14±5.40	10.35±3.53	8-18 (mg/day)**
Mn	1.52±0.58[a]	0.93±0.13[b]	1.6-2.3 (mg/day)***
Ni	0.74±0.47[a]	0.39±0.17[b]	-
Pb	0.55±0.19	0.72±0.37	0.24 (mg/day)****
Zn	3.84±1.23[b]	7.69±3.65[a]	8-11 (mg/day)**

*Means in the same row with different bold superscripts significantly differ (P≤0.05)
**RDAs: Recommended Dietary Allowances (28)
***AIs: Adequate Intakes (28)
****Daily intake levels (12)

healing and the breakdown of carbohydrates (33). The Zn levels of 3.84 and 7.69 mg/kg were much more higher comparison to other trace elements in dentex and amberjack respectively, but still in the acceptable limits of 8-11 mg per day (28). However, the Pb contents were over the legislative limits for both dentex and amberjack.

CONCLUSION

As a consequence, comparison of two fish species that have commercial importance for sustainable aquaculture, in terms of nutrients, macro and micro element compositions, dentex has much more higher flesh quality. On the other hand, considering the limited researchs concerning amberjack, it can be needed more comprehensive further works to reach certain decisions.

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