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BİLDİRİ ÖZETLERİ KİTABI ABSTRACT BOOK

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O23 *Spirulina*'nın (*Arthrospira* sp.) Tatlı Su ve Deniz Balıklarının Et Kalitesi Üzerine Etkileri

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ÖZET

Balıklar zengin bir vitamin, mineral ve omega-3 kaynağı olması nedeniyle sağlıklı bir hayvansal gıda olarak kabul edilir. Balıkların lipid ve yağ asidi, kardiyovasküler ve koroner gibi insan hastalıklarına karşı koruyucu bir rol ile güçlü bir şekilde ilişkilidir. Balık, uygun şartlar altında saklanmadığında bozulması son derece kolaydır. Su ürünleri yetiştiriciliğinde, balıkların tazeliğini ve et kalitesini korumak için çok sayıda uygulamalar mevcuttur. Balıkların et kalitesi bazı iç ve dış faktörlere bağlı olarak değişir. Balıklar için en önemli iç faktörlerin başında ise yem ve yemleme gelmektedir. Antioksidan özelliklere sahip yem katkı maddeleri / hammaddeleri, balıkların kalitesini ve raf ömrünü korumak için destekleyebilir. Mikroalgler, en doğal antioksidan ve antimikrobiyal kaynaklardır. Doğal katkı maddesi / bileşen olarak kullanılan algler, esansiyel amino asitler, polisakkaritler, esansiyel yağ asitleri, biyoaktif maddeler, vitaminler ve eser elementler gibi yüksek değerli besinleri içeren sucul bitki kaynaklarıdır. *Spirulina*, su ürünleri yetiştiriciliğinde kolayca üretilebilen, %55-70 protein içeren dengeli bir amino asit içeriği olarak öne çıkan, balık yemindeki alternatif protein kaynakları arasında yer alan ekonomik bir mikroalgdir. *Spirulina*, farmasötik ve nutrasötik etkileri olan biyomoleküller açısından zengindir ve hücre duvarları selülozik yapıda olmadığından içeriğindeki proteinin %85'inden fazlasını kolayca sindirebilir. Yem içerisine ilave edilen *Spirulina*, balıkların fileto pigmentasyonu ve yağ asidi profilini olumlu etkilemektedir. Bu çalışmanın amacı, yeme ilave edilen *Spirulina*'nın bazı balıkların et kalitesi üzerindeki etkilerini incelemektir.

Anahtar Kelimeler: Balık, Et Kalitesi, Tazelik, Mikroalg, Balık Karkası

Effects of Dietary *Spirulina* (*Arthrospira* sp.) on Flesh Quality of Freshwater and Marine Fish

ABSTRACT

Fish is considered a healthy animal food due to it is rich source of vitamins, minerals and omega-3. Lipid and fatty acid of fish have been strongly associated with a protective role against of human diseases such as cardiovascular and coronary. Fish is extremely easy to spoil if it is not store under appropriate conditions. In aquaculture, there are numerous applications to protect the freshness and flesh quality of fish. The flesh quality of fish varies depending on some internal and external factors. The most important internal factors for fish are feed and feeding. Dietary additives/ingredients with antioxidant properties can support to protect the quality and shelf life of fish. Microalgae are one of the richest sources of natural antioxidants and antimicrobials. Algae used as a natural additive/ingredient are aquatic plant sources containing high-value nutrients such as essential amino acids, polysaccharides, essential fatty acids, bioactive substances, vitamins and trace elements. *Spirulina* is an economical microalga which is easily produced in aquaculture, stands out as a balanced amino acid content of 55-70% protein, and is among the alternative protein sources in fish feed. *Spirulina* is rich in biomolecules with pharmaceutical and nutraceutical effects and can easily digest more than 85% of the protein because of the cell walls are not in cellulosic structure. Dietary *Spirulina* positively affects filet pigmentation and fatty acid profile of fish. The objectives of this study were reviewed the effect of dietary *Spirulina* on the finfish flesh quality.

Keywords: *Finfish, Flesh Quality, Freshness, Microalgae, Fish Carcass*

INTRODUCTION

Seafood are not only valuable, but also very sensitive food groups which are rich source of vitamins (A, D, niacin, and B12), trace minerals (iodine, selenium) and n-3 PUFAs (Poly Unsaturated Fatty Acid) [1, 2]. So that, quality conditions and parameters of seafood are significant. Suitable preservation techniques could be enhanced the fish quality and extended their shelf life. The flesh freshness of fish differs depending on some factors, including condition at the capture time, capture methods, starvation-repletion conditions, gutting in processing technology, storage temperature and hygiene conditions [3, 4, 5]. Additionally, several techniques apply to preserve the flesh quality of fish in aquaculture operations. Feed ingredients and feeding are the most important factors affected to flesh freshness in fish [6]. Fish quality characters such as level of fatty acid composition and several macro and trace nutrients are known to be influenced by the formulation and composition of diet under aquaculture operations [7, 8, 9]. Also, feed additives have beneficial effects on coloration, texture, flavour and storage properties of fish flesh [10, 11, 12]. For this purpose, algae are effective feed additives on all these features [8]. Therefore, investigations are considered to enforce about the use of algal products in finfish feeds for flesh quality enhancements.

Spirulina (*Arthrospira* sp.) is one of the useful microalgae species which is widely using in aquaculture sector. The aim of this study is to reveal the beneficial properties of *Spirulina* and to review the effects of its use as an additive in aquafeeds on meat quality parameters.

ALGAE AS A DIETARY ADDITIVE IN AQUACULTURE

Micro and macro algae are used as a natural dietary feed additive / ingredient in fish production for their rich protein content and valuable nutritional compounds, including essential amino acids and fatty acids, polysaccharides, bioactive substances, vitamins and trace elements [6, 7, 13, 14]. Also, dietary algae meals and extracts could be helped against lipid oxidation in foods. Microalgae species such as *Chlorella* sp., *Haematococcus pluvialis*, *Scenedesmus* sp., *Chlamydomonas* sp., *Arthrospira* sp., *Schizochytrium* sp., *Nannochloropsis* sp., *Porphyridium aerugineum*, *Isochrysis galbana*, and *Tetraselmis* sp. and macroalgae species such as *Ulva* sp., *Gracilariaria* sp., and *Ascophyllum* sp. were tested in aquafeeds.

WHAT IS *SPIRULINA* (*Arthrospira* sp.)

Spirulina (Figure 1) is a filamentous, spiral-shaped, prokaryotic unicellular organism which belongs to *Cyanobacteria* phylum and formally classified as a blue-green microalgae [15, 16]. *Spirulina* was acknowledged as a “wonderful future food source” by the International Association of Applied Microbiology in 1967 [17]. This nutritional microalgae is now extensively cultivated throughout the world. *Spirulina* is an economic cyanobacteria species which contains 55-70% protein (Table 1) and a rich source of vitamins, (B12 and provitamin A), minerals (especially iron), colorants (β -carotene, chlorophyll-a, and C-phycoerythrin) and biomolecules with pharmaceutical and nutraceutical effects [12, 14, 18, 19]. Also, this species is one of the several sources of dietary γ -linolenic acid (GLA) [14]. More than 85% of the *Spirulina* protein can easily digest because of the cell walls are not in cellulosic structure [20].

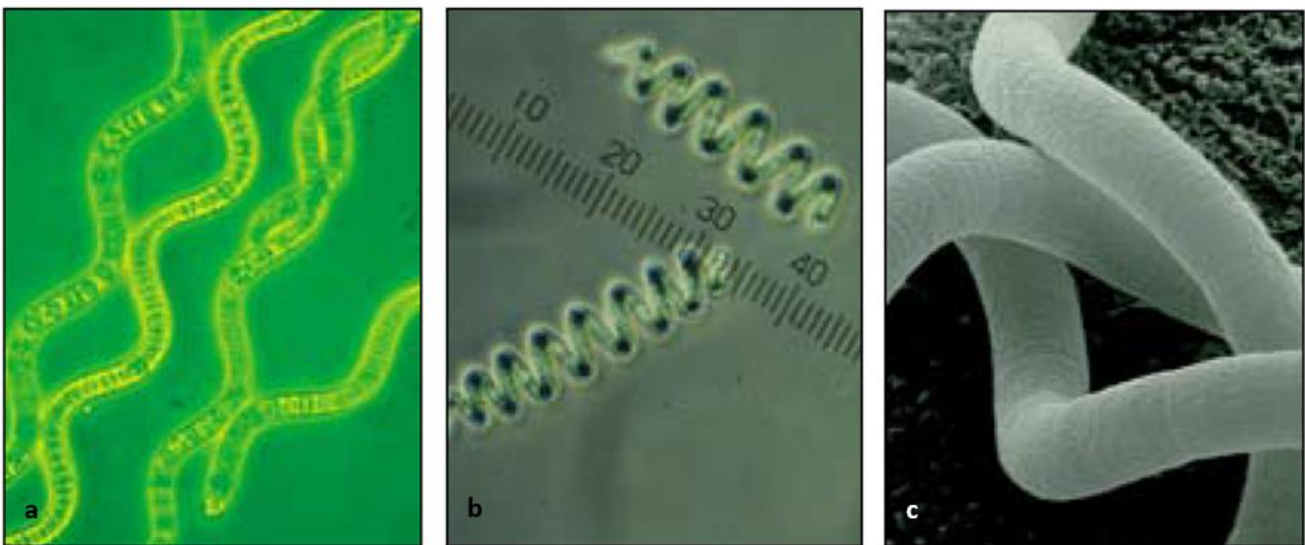


Figure 1. *Spirulina* (*Arthrospira platensis*) cells under different microscope types [15];

a. long filaments, **b.** perfect spiral coils, **c.** electron microscope

Spirulina has been assessed commonly as live food for fish and shellfish larvae [21, 22] or as dietary feed ingredient or additive for juveniles and adults [9, 23, 24, 25, 26, 27].

Table 1. Comparison of protein ratios between *Spirulina* and other important foods [15]

Food Type	Protein Ratio (%)	Usable Protein (%)
<i>Spirulina</i> powder	65	40
Dried chicken egg	47	44
Soybean meal	37	23
Milk powder	36	30
Chicken meat	24	16
Fish	22	18
Beef meat	22	15

EFFECTS OF *SPIRULINA* ON QUALITY PARAMETERS OF FISH

The positive effects of dietary *Spirulina* on carcass compositions of different cultured freshwater and marine fish species have been reported in previous studies. Abdulrahman [28] determined that the supplementation of *Spirulina* with 10 and 20% ratios improved the crude protein level in muscle of common carp (*Cyprinus carpio*). Mustafa et al. [29] noted that the *Spirulina* meal depressed the lipid deposition in the red sea bream (*Pagrus major*) muscle. Lu et al. [11] concluded the non-polar lipids in the carcass of tilapia (*Oreochromis niloticus*) dropped to lower levels, while polar lipids in higher levels. They suggested that the tilapia fed with *Spirulina* added diets had the qualified fillet. Jafari et al. [8] recommended that the *Spirulina* insertion up to 5% in rainbow trout (*Onchorynchus mykiss*) can be beneficial for fatty acids composition of the fish fillet. Liao et al. [10] and Watanabe et al. [30] declared that the inclusion of 5% dietary *Spirulina* decreased the crude fat, and enhanced the flavour and texture of the carcass of striped jack (*Pseudocaranx dentex*). Sirakov et al. [6] recorded that the fish fed with *Spirulina* included feed exhibited better consumable yield and fillet weight compared with the control diet. Teimouri et al. [12] presented that the loss of fillet carotenoid concentration during the cold storage (0, 7, and 14 days) slowed with the further levels of *Spirulina* supplemented diets in rainbow trout (*O. mykiss*). Rainbow trout (*Oncorhynchus mykiss*) fed with a low amount *Spirulina*-added feed during the feeding period has been found to be 50% less weight-loss after starvation and may have economic advantages [7]. Jafari et al. [8] declared that dietary *Spirulina* up to 5% in culture could be beneficial in terms of fatty acid profiles of the rainbow trout fillet.

Some researchers have been informed no significant differences on the carcass quality parameters of some finfish species. Ungsethaphand et al. [31] reported no difference in muscle composition between the groups of hybrid red tilapia (*Oreochromis mossambicus* × *O. niloticus*) fed with 0, 5, 10, and 20% *Spirulina* supplemented diets. Abdulrahman and Ameen [32] found no difference in freshness, juiciness, and taste between the groups of common carp (*C. carpio*) fed with 0, 5, 10, 15, and 20% *Spirulina* included diets.

A different effect of dietary *Spirulina* has been reported by Promya and Chitmanat [33] on African sharpnose catfish (*Clarias gariepinus*). The authors have stated that the protein level of carcass decreased with the inclusion level of 3% (31% protein), while no difference was found between the groups fed with 5% added *Spirulina* (33% protein) and the control diet (35.9% protein).

CONCLUSION

Spirulina (*Athrospira* sp.) is an extremely nutritious feed source in the aquaculture. Research outputs have related *Spirulina* to enhancements on nutritional product quality of important finfish species. Consumption of this microalga has also been associated to an improvement in fish welfare. Its nutritive and protein-rich composition leads to an extended commercial cultivation to meet consumer demand.

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