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Determination of proximate composition and sensory attributes of scallop (*Flexopecten glaber*) gonads.

Nermin Berik[1*] and Cem Cankiriligil[1]

[1]*Department of Fisheries and Processing Technology, Faculty of Marine Sciences and Technology, Çanakkale Onsekiz Mart University, Çanakkale, Turkey.*

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ABSTRACT

In this study, edible properties of gonads belonging to *Flexopecten glaber*, a particular Mediterranean species, were determined. The scallops used in the assay were purchased from Canakkale fish market, which were collected in Lapseki Bay in Canakkale. Sampling was done in February and April. The study was conducted in order to determinate proximate composition and sensory attributes of scallop gonads. Meat yield averages of scallop gonads were higher in April than in February ($P \leq 0.05$). Minerals that cause health risks such as Al, Pb, Cd were also determined and found below the legal limits in scallop gonads. Furthermore, results of microbiological analyses showed that values of microorganisms that cause health risks were also below the legal limits in scallop gonads. According to the sensory appreciation test in cooked gonads, fried gonads had the highest score. Eventually, it can be suggested that scallop gonads are appropriate food sources in terms of nutritional values and sensory attributes. This study will lead both sector employees and consumers about edible properties of *Flexopecten glaber*'s gonads and this will also increase the contribution of fishery products in sector and economy.

Introduction

Different scallop species are found almost all seas in the world (Pechenik 1996), and many high market valued scallop species have widely distributed all over including *Pecten jacobaeus*, *Mimachlamys varia*, and the *Flexopecten glaber* (Brand 2006). The amount of total scallop catch in the world was increased from 1713435 tons in 2000 to 2380100 tons in 2011 (FAO 2011). Scallops are preferred to be consumed generally as fried, boiled, roasted, smoked, sauteed or raw with gonads (Krzynowek and Murphy 1987).

Although seas in Turkey are rich in few scallop species including *Flexopecten glaber*, they are not assessable enough. In Turkey, bivalve processing sector is generally focused on scallop's adductor muscles. The main objective of this study is to determine the proximate composition and sensory characteristics of scallop gonads and to give them their deserved value.

*Corresponding author
E-mail address: nberik@yahoo.com (N. Berik)
Tel:+: +90 286 218 05 42 fax: +90 286 218 05 43

Material and methods

Scallops sampled for (30 kg, each months) our study, known to be catched in Lapseki Bay in Canakkale, were purchased from Canakkale fish market in February and April 2010. Scallops were brought to the laboratory in 18% salinity water within an hour. Since February samples (gonads) were too small, they were not used in this research. Instead only April samples were used as basic materials (Figure 1). The scallop gonads were separated off from all other tissues in the laboratory. Afterwards, different cooking techniques were applied to them.

Implementations of Different Cooking Techniques

The first technique was grilling technique which gonads were grilled for 10 minutes at 175° C. The second one was the boiling technique. Gonads were boiled in 18% salinity water at 104°C for 10 minutes. The third one is the deep-fried cooking technique that scallop gonads should have been breaded and fried in vegetable oil for 3 minutes at 150°C. Finally, in the butter-roasting technique, gonads

were roasted with spices such as savory, chili pepper and black pepper with butter for 3 minutes. For every cooking technique, 100 gram of scallop gonads were used.

Figure 1. Anatomy of *Flexopecten glaber*; ovary (A), testis (B), striped muscle (adductor muscle) (C), smooth muscle (D), mouth (E), digestive gland (F), intensine (G), foot (H), ligament (I), eyes (J), gills (K), tentacles (L), mantle (M).

Microbiological Analysis

In order to determine the microbiological quality, total mesophilic aerobic bacteria, total coliforms, total yeasts, total *Staphylococcus-Micrococcus* levels were determined (FDA 2000).

Physical Analysis

pH measurement and meat yield were carried according to Landvogt (1991) and Yıldırım et al. (1997), respectively.

Chemical Analysis

Water in Xm50 Precisa (Horwitz 2000), protein (AOAC 2000), fat (Folch 1957) ash (Horwitz 2000) and mineral analysis (EPA 2009) were carried out by considering the given methods.

Amounts of Aluminum (Al), Boron (B), Barium (Ba), Calcium (Ca), Cadmium (Cd), Cobalt (Co), Chromium (Cr), Copper (Cu), Iron (Fe), Potassium (K), Magnesium (Mg), Manganese (Mn), Sodium (Na), Nickel (Ni), Lead (Pb) and Zinc (Zn) were determined by mineral analysis.

Sensory Analysis

Flavor, aroma, texture, appearance and general approval parameters were evaluated according to the average assessments between 1 and 9 points in sensory appreciation test by expert panelists consisting of 12 people. Panelists rated, scallop flavor, scallop aroma, saltiness, tone, softness and cooking parameters in a scale of 1 to 9 points. Sensory appreciation test and sensory profile analyses were applied according to the hedonic scoring system which is stated by Mason and Nottingham 2008.

Statistical Analysis

Differences between groups were determined by one-way ANOVA method in SPSS 12 after testing the homogeneity of the data (Levene test). Kruskal-wallis method was used for sensory appreciation test data and chi-squared distribution test applied for sensory profile analysis.

Results and discussion

Microbial Content

Values of total mesophilic aerobic bacteria in scallop gonads were below the legal limits. Total coliform, *Staphylacoccus-Micrococcus* and total yeasts were not encountered.

pH

For Bivalves, pH should range in a scale of 5.6 to 8.3 (Kırkağaç and Köksal 2004). The pH results in our study showed similarities in every two months (6.20-6.60) although they were closer to each other in two months ($P \leq 0.05$).

Meat Yield

As in most bivalves, meat yields of scallops depend on its type, age, breeding season, nutrition features and water quality (Barnes 1987). As much as 10-16% of the weight of scallops with shells is edible meat portion and the maximum product is obtained just before ovulation (FAO 2011). In April, May and June, the reproductive period of scallops, meat yield rate don't change too much, but by the growth of the reproductive organ; ratio of the internal organs is increased (Mattei and Pellizzato 1999). In our study that held in April, it was observed that growth of the ovary and testicle exceeds the size of posterior adductor muscle (Figure 2).

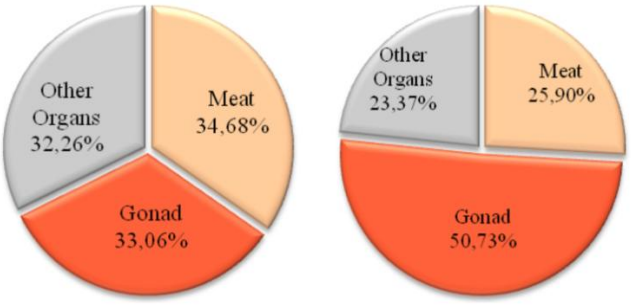

Figure 2. Meat yields of scallops in february (left); meat yields of scallops in april (right).

Proximate Composition

Protein, fat and ash contents in gonads were higher than itself in April. Fat and protein ratio showed an improvement before the ovulation (Pazos et al. 1997) and decreased following the ovulation by reason of utilising fatty acids and amino acids for the reproduction (Table 1).

Table 1. Proximate compositions of scallop meat and gonads in April.

	Adductor Muscle	Gonad
Water %	79.3 ± 0.14[a]	78.99 ± 0.06[b]
Protein %	12.39 ± 0.09[b]	13.35 ± 0.18[a]
Fat %	1.95 ± 0.02[b]	2.99 ± 0.01[a]
Ash %	1.30 ± 0.01[b]	1.80 ± 0.01[a]

*Means within the same line with different superscript letters are significantly different (P≤0.05).

Mineral Content

Scallops are rich in minerals. Scallop meats have 2.2% mineral such as sodium, potassium, calcium, magnesium and iron (Altun et al. 2004). Our mineral analysis results showed that Al, Ba, Ca, Cr, Cu, Fe, Mn, Na and Ni minerals are more in gonads than adductor muscle. However B was found more in adductor muscle than gonad. No statistical differences established in Cd, Mg, K and Pb (Table 2, Figure 3). Minerals mostly found in gonads and consumed as food are respectively K, Ca, Na, Mg and Fe (P≤0.05). Mineral contents that have potential risk for human health such as Al, Cd, Pb were also determined below the specified maximum values according to regulations about shellfish in the Food Law and Legislation (Table 2). The limit for Cd presence has been set as 1.00 mg/kg for shellfish and 0.05 mg/kg for fish meat. Limit for Pb presence has been set as 1.00 mg/kg for shellfish, 0.30 and 0.40 mg/kg for fish meat (EC 2001; Turkish Food Codex 2008).

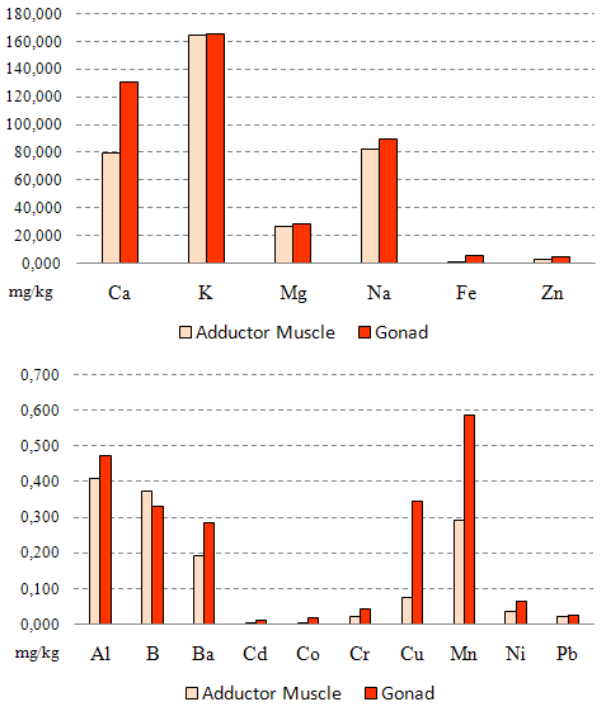

Figure 3. Mineral contents of scallop meat and gonads (mg/kg of wet weight).

Sensory Characteristics

In this research, the density parameters of scallop flavor and scallop aroma, saltiness, softness, tone, cooking rate had been located by the panelists in sensory profile analyses. According to frying rate sensory profile analysis; most intense scallop aroma and saltiness rates determined in deep-fried gonads, and the least intense scallop aroma and saltiness were detected in boiled gonads (P≤0.05) The highest softness ratio was found in grilled gonads, and the least density was detected in boiled gonads. The darkest color tone was discovered in grilled and deep-fried gonads, the lightest color tone was found in boiled gonads (P≤0.05).

Table 2. Mineral composition of gonad and adductor muscle (mg/kg of wet weight)

Minerals	Symbol	Adductor Muscle	Gonad
Aliminum	Al	0.409 ± 0.02[b]	0.472 ± 0.01[a]
Boron	B	0.373 ± 0.04[a]	0.330 ± 0.04[b]
Barium	Ba	0.193 ± 0.02[b]	0.285 ± 0.02[a]
Calsium	Ca	79.799 ± 1.21[b]	130.932 ± 1.22[a]
Cadmium	Cd	0.004 ± 0.01[a]	0.013 ± 0.01[a]
Cobalt	Co	0.005 ± 0.01[a]	0.016 ± 0.01[a]
Chromium	Cr	0.020 ± 0.01[b]	0.043 ± 0.01[a]
Copper	Cu	0.074 ± 0.01[b]	0.343 ± 0.01[a]
Iron	Fe	1.093 ± 0.09[b]	9.561 ± 0.07[a]
Potassium	K	164.436 ± 4.96[a]	165.424 ± 4.98[a]
Magnesium	Mg	26.689 ± 1.00[b]	28. 175 ± 1.19[a]
Manganese	Mn	0.292 ± 0.03[b]	0.886 ± 0.03[a]
Sodium	Na	82.150 ± 2.67[b]	89.245 ± 1.45[a]
Nickel	Ni	0.035 ± 0.01[b]	0.064 ± 0.01[a]
Lead	Pb	0.020 ± 0.01[a]	0.026 ± 0.02[a]
Zinc	Zn	2.980 ± 0.31[b]	4.743 ± 0.08[a]

*Means within the same line with different superscript letters are significantly different (P≤0.05).

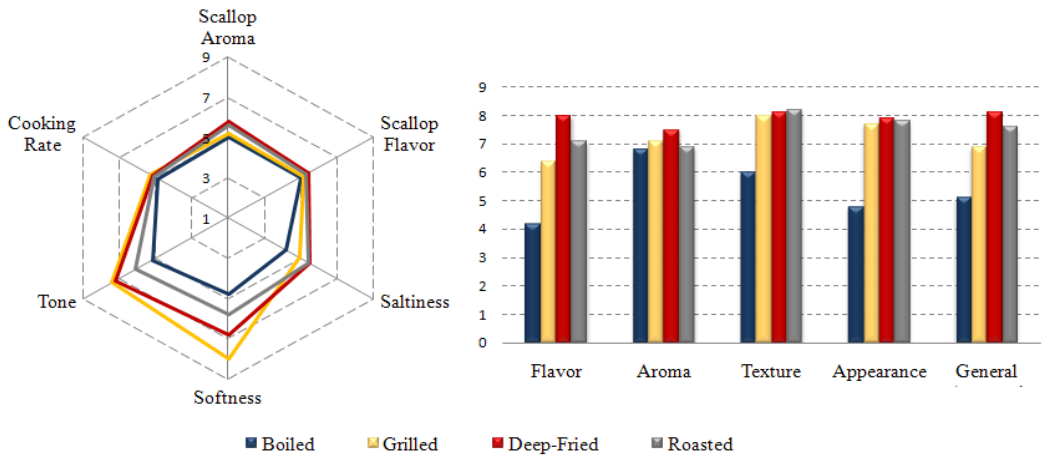

Figure 4. Sensory profil analyses results of gonads (left); sensory appreciation test results of gonads (right).

Tone rates did not show any statistically significant difference in deep-fried and grilled gonads (P≤0.05). Boiled gonads have shown the lightest cooking rates, yet, grilled, deep-fried and roasted gonads have shown no statistically significant alteration (P≥0.05). Furthermore, scallop flavor rates remained statistically stable in all cooked gonads (P≥0.05) (Figure 4).

When the sensory appreciation test is taken into account, it was determined that the most popular product was the deep-fried gonad. Fried gonads were followed by roasted, grilled and boiled ones. The highest value of the flavor and texture was found in roasted and fried scallops. The highest flavor, aroma, appearance, texture and general approval values were determined in the deep-fried scallops (Figure 4).

Conclusion

Proximate composition of scallop meat and gonads are very close. Consumption of shellfish may cause health risks related to toxic minerals. Therefore, scallop consumption is more secure in terms of food safety. It is because of the fact that the accumulation of toxic mineral Cd is large in the digestive gland, and very small amount is accumulated in adductor muscle and gonads. It is recommended that *Flexopecten glaber*'s gonads may also be an alternative and delicious choice if different cooking techniques are implemented constituting an important part of world consumption. Although Scallop gonads consumption can be encouraged, their inventory must be done and catching should be controlled for assuring the sustainability.

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