Comparative study on biochemical composition of some edible marine molluscs at Canakkale coasts, Turkey

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Present study was carried out, at Dardanelles and the Marmara Sea coasts during March 2011 to February 2012. Ostrea edulis, Mytilus galloprovincialis, Ruditapes decussatus, Ruditapes philippinarum and Rapona venosa were collected seasonally along with temperature and salinity. Biochemical composition of molluscs (protein, lipid, carbohydrate, moisture and ash) was examined from the samples. Seasonal values of protein, lipid, carbohydrate, ash and moisture were mean 64.71±1.31%, 1.86±0.10%, 24.09±1.33%, 9.35±0.26% and 67.51±1.47% in R. venosa; 55.88±2.04%, 5.60±0.19%, 23.43±1.59%, 15.10±0.67% and 83.28±0.86% in R. philippinarum; 56.27±1.98%, 5.82±0.34%, 23.39±1.62%, 14.53±0.66% and 83.58±0.59% in R. decussatus; 54.03±2.82%, 10.52±1.22%, 22.84±4.33%, 12.61±2.54% and 82.45±1.70% in M. galloprovincialis; 48.11±3.04%, 8.81±0.65%, 29.16±4.62%, 13.92±1.89% and 82.25±2.66% in O. edulis, respectively. Consequently, the sampled mollusc species has high protein (40.19 - 67.38 %) and low lipid (1.65 – 12.86 %). Overall, R. venosa appears to be best as diet with relatively high protein and low lipid among other examined molluscs.

[Keywords: Mollusc, Biochemical composition, Dardanelles and Marmara Sea coasts]

Introduction

Protein deficiency will continue to increase sharply in the coming decades1. For the present time and near future, one of the most promising way to close the gap can be overcome by effective utilization of protein rich molluscs2. Molluscs are the largest invertebrate animals living marine species and represent 12% of the total production in the World3. These include animals such as snails, clams, mussels, and oysters that constitute popular protein rich foods and can be used by all cultures as an important part of the diet.

Several studies reported that marine mollusc reserve biochemical energy in the reproductive and/or somatic tissue for use when needed4,5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15. The biochemical energy is stored in response to the varying environmental food supply, the ability of the animal to convert environmental energy in to biologically usable units and for the periods of increased synthetic activity such as reproduction and growth16. The growth and reproductive activity affected to seasonal fluctuations of biochemical composition17. In general, energy is stored prior to gametogenesis when food is abundant in the form of glycogen, lipid, and protein6,18.

Mussel, clam, oyster and sea snail have a high export value in Turkey. The production based on fishing and remains significantly below that of 39.000 tonnes in 2011 due to overfishing19. Aquaculture offers one way to supplement the production and will continue to increase in the future.

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In this sense, we consider that knowledge on biochemical composition of higher economic value species may support future aquaculture expansion in the country. To date, many studies on biochemical content of mussel M. galloprovincialis and oyster O. edulis have been carried out, but no scientist has ever studied on biochemical status on clams, R. decussatus, R. philippinarum and sea snail R. venosa in the Marmara sea\textsuperscript{20, 21}. This experiment is also first known study on R. philippinarum for Turkey. The aim of study determines protein, lipid, carbohydrate, moisture and ash content of these molluscs in the Marmara Sea. In addition, the experiment is preliminary study and more detailed investigation on biochemical composition, gametogenic cycle, meat yield and growth pattern are needed from the area.

Material and Method

The study was carried out in North East coasts of Dardanelles at the Marmara sea (west of Bandýrma: 40°21′33″N, 27°51′13″E) from March 2011 to February 2012 (Fig. 1). Samples were seasonally (May, August, November and February) collected from depths approximately 3 m to 15 m by divers in the study area.

![Study area](image)

Fig. 1–Study area In Balikesir Coast, Turkey

Seasonally sampling was carried out for environmental and biochemical composition of molluscs. On each sampling date, temperature and salinity were determined by using multiparameter (WTW Multi 340i/SET type) at 3m depth.

The experiment was performed on Ostrea edulis, Mytilus galloprovincialis, Ruditapes decussatus, Ruditapes philippinarum and Rapana venosa. All species were conspicuously identified\textsuperscript{22, 23, 24, 25, 26}.

Biochemical Analyses

Samples were transferred to the laboratory in a cool box (6–9°C). All molluscs were scrubbed for encrusting organism (e.g. barnacles, epifauna and seaweeds). Thirty individuals of mussels (M. galloprovincialis) and clams (R. decussatus, R. philippinarum) and fifteen individuals of sea snail (R. venosa) and oysters (O. edulis) were randomly selected from each species group and used as three replicates at every sampling date. Tissues from all molluscs were dissected from shells. Moisture of triplicate samples was determined by drying in an oven at 105°C for 20 h for each seasonally sample date. Dried tissues of molluscs were kept in a deep-freezer for biochemical analyses. Protein, lipid and ash contents were quantified in each tissue sample. Triplicate dry meat samples were analyzed for lipid, protein and ash\textsuperscript{27}. Total nitrogen content was determined by the Kjeldahl method and was converted to crude protein content by multiplying by 6.25\textsuperscript{27}. Ash weight was determined by combusting a known dry weight of tissue at 500°C for 15 h in a muffle furnace and reweighing the tissue. Carbohydrate content was calculated by the difference of the sum of moisture, fat, protein and ash contents from 100%. The following formula was used for determining carbohydrate content:

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\text{Carbohydrate} \text{ (%) } = 100 - [\text{lipid} \text{ (%) } + \text{protein} \text{ (%) } + \text{ash} \text{ (%)}]
\]

Statistical Analyses

Statistical analysis was evaluated by Microsoft Excel (Microsoft Corp., Redmond, WA) and Minitab Release 13.20 (Minitab Inc., State College, PA, USA). All percentages of the data were transformed by arcsin transformation prior to the ANOVA and reversed afterwards\textsuperscript{28}. A correlation matrix was used to determine the relationships between all measured parameters.

Results

The temperature ranged from 9.3°C (February) to 18°C (August) with a mean of 15.28 ± 2.01 °C. Salinity varied between 21.8 psu (August) and 23.40 psu (February) with a mean of 22.50 ± 0.34 psu (Fig. 2).
Temperature was significantly negatively related with lipid of clams and also carbohydrate of sea snail (p<0.01). Salinity has also strong negative correlation with lipid of mussels while strong positive correlation with protein of oysters (p <0.01).

The mean of protein, lipid, carbohydrate, ash and moisture were 64.71±1.31%, 1.86±0.10%, 24.09±1.33%, 9.35±0.26% and 67.51±1.47% for R. venosa; 55.88±2.04%, 5.60±0.19%, 23.43±1.59%, 15.10±0.67% and 83.28±0.86% for R. philipinarium; 56.27±1.98%, 5.82±0.34%, 23.39±1.62%, 14.53±0.66% and 83.58±0.59% for R. decussatus; 54.03±2.82%, 10.52±1.22%, 22.84±4.33%, 12.61±2.54% and mean of 82.45±1.70% for M. galloprovincialis; 48.11±3.04%, 8.81±0.65%, 29.16±4.62%, 13.92±1.89% and 82.25±2.66% for O. edulis, respectively (Fig. 3.).

Discussion

The seasonal changes in dry weight of molluscs largely reflect the stage of the reproduction cycle which indirectly affects seasonal chemical content\(^5\). Therefore we have taken advantages of seasonal dry matter fluctuations to evaluate the chemical content changing of all mollusc species.

Gonadal development was almost same in R. decussatus and R. philipinarium\(^29, 30\). Our results similarly demonstrated, the biochemical composition of carpet shell clam (R. decussatus) and manila clam (R. philipinarium) were found in parallel seasonal pattern. When the experiment was initiated (May), dry weight was maximum and decreased till its minimum level in August which evinced the situation of spawning of clams. However, it was possible to begin the spawning activity earlier months (March or April) and might be missed as a result of experiment start time. So our data did not directly show a first spawning period. The spawning event of T. decussates occurred in March and continued to July in Dardanelle Strait (Çanakkale coast)\(^29\). In the present study, dry matter increased from August to November and decreased again until February. This situation showed that gamete ripening and spawning activity
continued most probably through the year because temperature varied between 9°C and 18°C. Gonadal development constitutes between 8°C and 12°C and egg release occurred in 14°C\textsuperscript{18,30}. Our data also indicate that carbohydrate reserves of clams started decreased with spawning and minimum level was obtained in November and again start to increase towards to February which showed that clams accumulated carbohydrate before gametogenesis for use in egg maturation and spawning activity. Our results were similar with many studies\textsuperscript{31,32}. Protein content of clams was lower in May, spawning time, and gradually increased towards to November when calculated highest protein and high dry meat rate. Protein is major source of bivalve eggs and use as energy source during egg development\textsuperscript{32}. Protein was lowest in February which could show that partial spawning occurrence and also use an alternative energy source under food scarcity conditions\textsuperscript{33}. Lipid value of clams was significantly strong negative relationship with temperature (p<0.01). Lipid was lower in May and August during spawning activity and was highest in February because of gonad maturation. Lipids are the biomolecules that are more influenced by gametogenesis\textsuperscript{34}. 

The present study demonstrated that protein, lipid, carbohydrate, ash and moisture values of mussels and oysters displayed similar and depending on reproduction period. Lipid and carbohydrate values were at their highest level in August. Lipid and carbohydrate of bivalves were peak when organic matter in the seawater was higher, in the spring and summer months\textsuperscript{35}. Dry meat of mussels and oysters was determined peak in August and decreased in November that could also show second spawning time (the first breeding season was probably missed due the same reason of clams, sampling time). In addition the highest level of lipid and carbohydrate were in August and lipid gradually decreased to February while carbohydrate showed their minimum level in November. It is clearly demonstrated that protein and lipid decreased due to ovulation and lipids were an energy source used for egg proliferation. However, protein and carbohydrate values showed marked seasonal variation and there is a clear inverse relationship between these two components (p<0.05). These results indicate that protein and carbohydrate reserves were not used for the same purpose. Many studies have also reported parallel results. The biochemical composition cycles of mussels and oysters indicated annual patterns of accumulation and the use of reserves due to a complex interaction between food availability, growth and reproduction\textsuperscript{36,37,38}. During the reproduction phase, bivalves heavily utilise their reserves in order to meet the energetic requirements of gametogenesis and spawning\textsuperscript{6,32}.

As in many other marine molluscs, the gonadal maturation of R. venosa had an annual periodicity during the reproductive season, with a sharp decrease in the gonad index of female whelks between July and late August\textsuperscript{16,18,39}. According to the sea snail data of sampled months, dry weight and ash content dropped their lowest level in August that clearly showed spawning period; mating occurred during winter and spring and egg cases were laid in May to August. Similar results were obtained that ash rate was obtained lower in August and September than other months\textsuperscript{40}. In addition, several studies reported similar period that R. venosa spawns between June and August and similar periods, May to September\textsuperscript{41,42}. Protein level was determined highest (67.38%) in August, whereas lipid content gradually decreased from May to February through spawning activity. The protein values of 64.71% of the present study were more with the protein values of 53.7% and 12.53 % in flesh meat and 16% in flesh meat\textsuperscript{40,43,44}. Thus R. venosa would be better alternative sources since it contains the highest protein among other sampled molluscs in the region.

Conclusion

Present study reveals that the molluse species are one of the best protein source with high level (40.19 - 67.38 %) and low lipid (1.65 – 12.86 %). Overall, R. venosa appears to be best as diet with relatively high protein and low lipid. However, seasonal sampling appears to be insufficient for clearly understanding reproduction properties and chemical composition due to excessively lengthy sampling interval. Thus, monthly sampling should be advisable in the future studies.
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Reference


