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Full length article

Biochemical assessment in the edible parts of *Tridacna maxima* Röding, 1798 collected from the Egyptian Red Sea

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ABSTRACT

The study assesses biochemical compositions in fresh and cooked flesh of *Tridacna maxima*. Carbohydrates formed the highest percentage (12.22 ± 2.0%) in cooked mantle, while protein recorded a very high ratio in the adductor muscles (72.14 ± 2.75% and 69.3 ± 0.83%) of both fresh and cooked flesh, respectively. Glycine formed the highest percentage of amino acids (24.44%) in fresh mantle. Hexadecanoic formed the highest percentage of fatty acids in mantle, in the adductor muscle of fresh and cooked samples (27.89%, 28.65%, 22.48%, and 21.68%), respectively. Polyunsaturated fatty acids (PUFA) recorded higher values than saturated acids (SFAs) and unsaturated acids (MUFAs) in fresh and cooked samples. Alpha-linolenic acid (ALA) recorded the highest PUFAs value (18:3n-3) with recordings of 17.38%, 17.95%, 18.35% and 19.85% in mantle and adductor muscles of fresh and cooked samples, respectively. The PUFAs recorded the highest values (50.83% and 52.25%) in the cooked mantle and adductor muscles, respectively. ω-3 PUFA recorded relatively higher values represented by EPA20:5(n-3), DPA22:5(n-3) and DHA22:6(n-3). This study concluded that *T. maxima* is considered a good source of nutrition as it is rich in protein and important amino and fatty acids. There weren't any significant differences in SFA, MUFA and PUFA between the fresh and cooked flesh.

Introduction

Giant clams are unique and important marine invertebrates that are used as food and dietary supplements (Dridi et al., 2017; FAO, 2018). Their meat has been traditionally used as a subsistence food source (Singh and Azam, 2013) especially in the tropical Indo-Pacific. Giant clams in coastal regions in Egypt are considered a main component of the famous soup "sea food soup". They have relatively large sizes, rapid growth rates and are characterized by the presence of photosynthetic symbiotic algae (zooxanthellae) or dinoflagellate symbiodinium, which engage in a mutual relationship with most tridacnids that were found in their mantle, and provide nutrients to the host (Klumpp et al., 1992; Toonen et al., 2012; DeBoer et al., 2012; Ullmann, 2013). However, only a few investigations on the distribution, abundance and ecology are listed by Ullmann (2013), as well as a few studies on the biochemical composition of the Egyptian Red Sea and other sites all over the world as listed by Hearty and Aharon (1988), Southgate (1996), Mohammed et al., (2014), Dubousquet et al, (2016) and Mies et al, (2017a). However, most bivalves, including Tridacnids, play an important role in providing metabolic energy. This is due to their high contents of amino acids and fatty acids needed for nutrition (Hoegh-Guldberg, 1999). These acids, especially the polyunsaturated and monounsaturated fatty acids, (PUFAs and MUFAs) are very important for human health as they reduce the risk of coronary heart disease (CHD) (Mostafa and Khalil, 2014). They illustrated also that *T. maxima* had the highest protein content (22.5%).

Bishop and Kenrick (1980) referred to the increase of FA in the tridacnid species due to the presence of symbiotic zooxanthella. However, *T. maxima* is one of the positive contributing organisms that serve as shelter for many life forms including zooxanthella and provide food to predators and scavengers, and supply a significant amount of O_2 to the environment (Neo et al., 2015). Moreover, this species is one of the marine organisms rich in a special class of PUFAs (Mostafa and Khalil, 2014). Southgate (1996) pointed out that both mantle and adductor muscle in *T. gigas* have high levels of PUFAs that reach about 45% or more. It was also mentioned that the fatty acids 20: 5n-3 and 22: 6n-3, are considered important for human nutrition. On the other hand, Mies et al., (2017a,b) pointed out the ω-3 PUFA (stearidonic acid, SDA,

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docosapentaenoic acid, DPA, and docosahexaenoic acid, DHA) are typically translocated from symbiodinium to its host and are produced by some zooxanthellate algae associated with *T. crocea* clam. Some other edible bivalves including tridacnids were characterized by high levels of PUFAs (ω-3 PUFA and ω-6 PUFA) which are of good nutritional quality to humans (Dridi et al., 2017). The present study aims to determine the chemical composition of *T. maxima* tissues as raw and cooked by boiling. It also aims to obtain the effects of cooking by boiling at >100 °C on the fatty acid composition in the edible parts, and the concentration of ω-3 PUFA and ω-6 PUFA as they serve as important components of human diet.

Material and methods

Raw materials and processing

Twenty individuals of giant clam *T. maxima* were collected from the inshore zone of Hurghada in front of NIOF Red Sea branch (27°17.5′N and 33°47.1′E) during May 2015. The investigated site is far from direct human impact as well as flash floods. Fresh clams were washed with distilled water several times to remove adhering sediments and organic particles. One hundred grams of each of the mantle and the adductor muscles of the collected specimens were separated from the animal tissues. These samples were divided into two groups, each group comprised of 10 samples of mantle and 10 samples of adductor muscles. The first group was dried directly at 70 °C for 48 h in the oven, and the second group was cooked by boiling using an automatic cooker (2,000 W, Tefal, Zahran) in 200 ml distilled water for each sample for about 60 min. The cooked mantle and adductor muscles were also dried at 70 °C for 48 h. All dried samples were weighed using a digital balance and homogenized using a kitchen blender for the next steps.

Sample analysis

Water content, total organic matter, ash, crude protein and crude fat contents were determined according to the methods described by AOAC (2000). Samples were prepared in NIOF lab. Samples of fatty acids and amino acids were detected by general analysis of the Faculty of Agriculture Research - Cairo University. The method described by Farag et al. (1986) was applied to estimate fatty acids by gas liquid chromatograph (GLC). The amino acids were isolated on Amino Acid Beckman Analyzer (Model: AAA 400). Acid hydrolysis was carried out according to Csomos and Simon-Sarkadi (2002).

Statistical analysis

Results of biochemical analysis and biological evaluation of each group were statistically analyzed using SPSS 18.0 for Windows as means and standard deviation. To test the influence of cooking by boiling on the main biochemical composition contents of T. maxima flesh, a one-way ANOVA and a student's *t*-test were used for pairs of data sets. Significance was assumed when $P < 0.05$.

Result

Biochemical composition

The main biochemical composition contents of the dried fresh raw flesh which included both mantle and adductor muscles and the cooked by boiling samples of *T. maxima,* are shown in Table 1. The water content was highest in the cooked samples (71.27 ± 3.88% and 73.27 ± 3.11%) in the mantle and adductor muscles, respectively. The maximum percentage of carbohydrates was 12.22 ± 2.0% in the cooked mantle, while the minimum percentage was 8.15 ± 2.0% in the fresh adductor muscle. The organic matter reached its maximum percentage (89.53 ± 2.13%) in the cooked adductor muscles as shown in Fig. 1. Moreover, the organic matter in the cooked flesh recorded a relatively higher percentage than that of fresh flesh. Lipid content in the fresh flesh was relatively low ranging between 4.6 ± 1.14% and 5.67 ± 1.03% in mantle of the fresh and cooked flesh, respectively. Protein as shown in Fig. 2 recorded a very high percentage of concentration, especially that of adductor muscles 72.14 ± 2.75% and 69.3 ± 0.83% in the both fresh and cooked flesh, respectively.

Amino acid contents

Generally, there weren't any significant differences between the amino acid content in fresh and boiled mantle ($t = 0.035$) or between fresh and boiled adductor muscles ($t = 0.019$) of *T. maxima* ($P > 0.05$).

The amino acid content in the fresh and boiled samples of *T. maxima* are listed in Table 2, where glycine recorded the highest amount of amino acids among the essential and non-essential acids. It recorded a maximum value (24.44%, 12.0%) in the mantle and adductor tissues of the fresh sample, and recorded values of 18.13%, 16.76) % in the mantle and adductor tissues of the cooked flesh, respectively. Those were followed by aspartic acid (13.67 and 10.45% in fresh mantle and adductor muscles, respectively, and 9.53 and 11.46% in cooked mantle and adductor muscles, respectively, followed by serine. Proline recorded the least amount (0.22%) in the cooked adductor muscle but was not recorded in the fresh one. Leucine and lysine were found to be the most essential amino acids, where leucine recorded the highest values (ranging between 7.03 and 9.49% in mantle and adductor of fresh samples and between 7.13 and 8.58% in adductor and mantle of the cooked flesh).

Fatty acid (FA) compositions

The fatty acid (FA) compositions of the fresh and cooked mantle and adductor muscles are listed in Tables 3 and 4. The levels of saturated fatty acids (SFA) are relatively high; their maximum values

Table 1
The percentage (%) of biochemical composition of dried fresh raw flesh and cooked by boiling *T. maxima* (±SD).

Type (%)	Dried fresh raw flesh		Cooked by boiling	
	Mantle	Adductor muscle	Mantle	Adductor muscle
Mean water contents	67.21 ± 4.33	69.67 ± 3.94	71.27 ± 3.88	73.27 ± 3.11
Means of tissue	32.79 ± 4.33	30.33 ± 3.94	28.73 ± 3.88	26.73 ± 3.11
Carbohydrates	10.03 ± 2.00	08.15 ± 2.00	12.22 ± 2.00	07.18 ± 2.01
Mean of organic matter	85.18 ± 4.80	87.23 ± 3.31	88.91 ± 2.16	89.53 ± 2.13
Mean of ash	18.97 ± 3.80	10.87 ± 3.35	11.09 ± 2.16	10.47 ± 2.13
Total lipid	04.60 ± 1.14	04.88 ± 2.09	05.67 ± 1.03	04.85 ± 0.66
Total protein	69.39 ± 1.53	72.14 ± 2.75	67.91 ± 2.91	69.30 ± 0.83