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Proximate Chemical Composition, Fatty Acid Profile, and Amino Acid Content of *Tridacna maxima* (Röding, 1798) Inhabiting Egyptian Coast of the Red Sea

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ABSTRACT

Marine yield such as fishes, echinodermates, crustacean, oyster among others are a huge source of protein rich in essential amino acids (EAA). Additionally, a significant amount of monounsaturated and polyunsaturated fatty acids (MUFA and PUFA, respectively) are present in those yields, which may help enhance lipid profiles and reduce the risk of coronary heart disease (CHD). The present study determined the biochemical composition of *Tridacna maxima* collected from Hurghada site on the Egyptian coast of the Red Sea. Crude protein, fat, and ash contents in mantle and adductor muscles of the *T. maxima* ranged from 69.56 -72.65%, 4.12 - 4.95%, and 16.55 - 9.68% (% dry weight), respectively. Total phenolic content of *T. maxima* in aqueous, ethanol and methanol extracts were 40.11, 42.1, and 47.1mg GAE/ g, respectively. While, flavonoid total contents for *T. maxima* in water (70% ethanol, and 70% methanol extracts) were 4.9, 6.1, and 7.2 mg Qu/ g), respectively. Total saturated fatty acids (SFA) were higher than total MUFA and PUFA, accounting for 50.849 –33.91% and 15.24%, respectively. The non- essential amino acids were higher than EAA (59.25 and 35.98%, respectively). The major non-EAA and EAA in *T. maxima* were glutamic acid and leucine (18.57 and 6.76%, respectively). Therefore, *T.* maxima serves as a valuable source of multiple nutrients that have the potential to promote consumer health.

INTRODUCTION

Cardiidae is a family of giant clams that are dispersed over coral reefs in tropical oceans in the Indo-Pacific region **(Othman *et al.*, 2010)**. With their enormous size, distinctive shell forms, and vibrant mantles, giant clams are emblematic invertebrates of the coral reefs that serve crucial ecological roles as a source of food and a substrate for animals linked with the reef **(Mingoa-Licuanan & Gomez, 2002)**. The Tridacnidae large clam family currently has 13 recognized members, including 11 *Tridacna* species and 2 *Hippopus* species **(Othman *et al.*, 2010; Huelsken *et al.*, 2013; Su *et al.*, 2014; Borsa *et al.*, 2015)** (Tridacnidae: *Tridacna maxima*, *T. squamosa*, *T. costata*, *T. rosewateri*, *T. crocea*, *T. gigas*, *T. teveroa*, *T. derasa*, *Hippopus porcellanus* and *H. hippopus*).

According to **Mostafa *et al.* (2018)**, giant clams are a special and significant class of marine invertebrates that are consumed and added to diets. Traditionally, people have

used their flesh as a subsistence food source, particularly in the tropical Indo-Pacific region **(Singh & Azam, 2013)**. Large clams from Egypt's shore are regarded as a main component of the popular soup "sea food soup." The majority of the tridacnids found in their mantle form a mutual connection with photosynthetic symbiotic algae (zooxanthellae) or dinoflagellate symbiodinium, which provide nourishment to the host. This characteristic sets them apart **(DeBoer *et al.*, 2012; Ullmann, 2013)**. They also have relatively large sizes and rapid growth rates. Nonetheless, there have only been a small number of studies on the distribution, abundance, and ecology of tridacnids along the Red Sea coast of Egypt **(Ullmann, 2013)**, as well as a small number of studies on the biochemical makeup of *Tridacna* spp. and other sites worldwide **(Dubousquet *et al.*, 2016; Mies *et al.*, 2017)**. Furthermore, the majority of bivalves—including Tridacnids—contribute significantly to the supply of metabolic energy. This is due to their high concentration of essential fatty and amino acid content **(Hoegh-Guldberg, 1999)**.

Many nations view giant clams as lucrative fisheries; for example, their adductor, gonads, muscle, and mantle are edible; they are also common aquarium pets and rank among the top ten most traded ornamental invertebrates globally **(Wabbitz *et al.*, 2003)**. Clams, mussels, and oysters are examples of bivalve molluscs. They are very nutritious seafood, and their growing demand in global markets highlights their significance as a source of income **(Pogoda *et al.*, 2013; Rittenschober *et al.*, 2013; Irisarri *et al.*, 2015)**. Due to their abundance in premium proteins, bivalve molluscs are important providers of vital amino acids. These proteins are easily digestible and provide important building blocks for muscle growth and repair **(Wright *et al.* 2018; Song *et al.*, 2024)**.

Giant clams are an important fishery species that are utilized in many markets; for example, their shells are used as ornaments and their muscles are used as food and aquarium creatures **(Usher, 1984; Wabnitz *et al.*, 2003; Awaya & Lee, 2005)**.

Giant clams and other shellfish species are regarded as a rural diet in the Pacific Islands, where they provide people with animal protein and vitamin A **(Lucas, 1994)**. The two largest and fastest growing species are *Tridacna gigas* and *Tridacna derasa*, although other tiny species, such *Hippopus hippopus*, *Tridacna crocea*, and *Tridacna squamosa*, have higher natural abundances and are the most significant in traditional subsistence diets **(Munro, 1989)**. Due to habitat degradation and overfishing, the population of giant clams has drastically decreased **(Andrefou *et al.*, 2013; Neo *et al.*, 2015)**. Thankfully, numerous giant clam species have been successfully cultivated, reducing pressure on natural supplies. These species include *Tridacna maxima*, *T. squamosa*, *T. crocea*, *T. gigas*, *T. noae*, *T. derasa*, and *Hippopus hippopus* **(Ellis, 2000; Mies *et al.*, 2017; Braley *et al.*, 2018)**.

Tridacna maxima can be found in Egypt's Red Sea, Aqaba Gulf, and Suez Gulf. *Tridacna maxima* is a crucial ecological species that serves as a substrate for organisms linked with reefs and a source of seafood **(Singh & Azam, 2013)**. Tridacnids are known to have high economic values as food. Their flesh has always been a staple diet for sustenance. The giant clams of Red Sea areas are popular for food **(Tabugo *et al.*, 2013)**. A few studies were conducted on the different methods of giant clams cooking in

SouthEast Asia **(Cowan, 1988);** while in Egypt, the clams are not considered among the famous and common food, except in some coasted region south the Red Sea.

The sea food restaurants in the Red Sea depends on many marine organisms including giant clam *Tridacna* as a main source of protein and a delicacy flesh in different methods of cooking including seafood soup and increasing demand for them day by day. The present work aimed to determine the chemical composition, total flavonoids, amino acid content and fatty acid profile of *Tridacna maxima* in the Red Sea of Egypt.

MATERIALS AND METHODS

1- Sample collection and identification

Tridacna maxima specimens were collected carefully by using snorkeling and SCUBA diving equipment from Hurghada during spring 2020. Immediately upon collection, the samples were cleaned with sea water, and then washed with distilled water and preserved in -20°C in an ice box with ice cubes and a little amount of table salt until they were processed in a lab. The collected *Tridacna* specimens were identified according to its shell morphology depending on some key studies such as those of **Lucas (1994)**, **Knop (1996)**, **Poutiers (1998)**, **Su *et al*. (2014)** and **NEO *et al*. (2017)**.

2- Preparation of *Tridacna maxima* extracts

1) Water extraction

With minor adjustments, the extracts of the examined samples were made in accordance with the investigation of **Kim *et al*. (2013)**. Dried samples were ground in a mixer grinder, and 50g of each were separately soaked in one liter. The samples were centrifuged at 5000 rpm for 10min at 20°C after being boiled with distilled water (1:20 w/v) for 10min at 100°C. The samples were then filtered using Whatman No. 1 filter paper. According to **Vongsak *et al*. (2013)**, the extract was lyophilized using a vacuum freeze dryer (model: FDF 0350; Korea). After *T. maxima* extract was lyophilized, it was kept at -20º C until analysis.

2) Ethanol and methanol extraction

The process of alcoholic extraction was performed, as cited in **Vongsak *et al*. (2013)**. The samples were macerated for 48 hours at room temperature (28±2°C) with periodic shaking using a mixture of 70% ethanol and 70% methanol (1:20 w/v). After centrifuging the mixture for 10 minutes at 20°C at 5000 rpm, it was filtered through Whatman No. 1 filter paper. The extract was lyophilized using a vacuum freeze dryer (model: FDF 0350; Korea) after being filtered and concentrated under decreased pressure in a water bath that had been heated to 45º C using a rotary evaporator (IKA RV 05 basic Type HB 4 B, Germany).

3- Proximate chemical composition analysis

Water content, crude protein, crude fat contents, ash, and total organic matter, were determined according to the methods explained by **AOAC (2010)**.

4- Fatty acid analysis

Analysis of fatty acids was done by using the **Folch *et al.* (1957)** method, the fatty acids were extracted from freeze-dried tissues using a 2:1 V/V chloroform–methanol mixture. The next step was transesterification of 0.4 M KOH in methanol to create fatty acid methyl esters. Gas liquid chromatography was used to identify these methyl esters of fatty acids (GLC), utilizing **Liu *et al.* (2015)**'s methodology. The peak area ratio (% total fatty acids) was used to calculate the fatty acid content. Every sample underwent triplicate analysis.

5- Amino acid analysis

By using an Amino Acid Beckman Analyzer (Model: AAA 400), the amino acids were separated. The process of acid hydrolysis was followed by **Csomos and Simon-Sarkadi (2002)**.

6- Determination of total phenolic contents (TPC)

The content of total phenolic was measured spectrophotometrically using the Folin–Ciocalteu colorimetric method **(Dewanto *et al.*, 2002; Kim *et al.*, 2013)**. Total phenol contents (TPC) were expressed as gallic acid equivalent (GAE)/mg of dry weight.

7- Determination of total flavonoid contents (TFC)

Using a modified colorimetric approach as published by **Sakanaka *et al.* (2005)**, the total flavonoid content of the plant extracts was calculated and expressed as catechol equivalent (CE). Every determination was made three times.

8- DPPH radical scavenging activity

With a little modification, we examined the *T. maxima* extracts' capacity to scavenge free radicals by applying the DPPH technique as reported by **Brand-Williams *et al.* (1995)**. The DPPH radical scavenging activity was measured in milligrams of ascorbic acid equivalent (AAE)/g of dry material. The percentage of DPPH radical-scavenging activity was calculated using the formula below:

DPPH radical scavenging activity (% inhibition)

$$= \frac{(\mathrm{Abs}_{\mathrm{control}} - \mathrm{Abs}_{\mathrm{sample}})}{\mathrm{Abs}_{\mathrm{control}}} \times 100$$

All reagents were added except for *T. maxima* extract as a control, and all measurements were made in triplicate.

9- Statistical analysis

Data were represented as mean ± SD (standard deviation). Two sample independent t-test (t) was used for comparison between moisture, protein, fat, carbohydrate and ash in mantle and adductor muscle of *T. maxima*. All data were analyzed using IBM SPSS Statistics for Windows, Version 27, Graphpad Prism V. 8.3 and Microsoft Excel 365 (Microsoft Corporation, USA). For all statistical tests *P* value > 0.05 was considered not statistically significant, *P*< 0.05 was considered significant.

RESULTS

1- Chemical composition

Table (1) shows the averages (g) of moisture, protein, fat, carbohydrate, and ash per 100g of *Tridacna maxima*. Statistical analysis of data indicated that there weren't any significant differences between mantle and adductor regarded to their moisture, protein, fat, and carbohydrate contents, *P*-value > 0.05 (Table 1). On the other hand, the ash content was significantly higher in mantle than in adductor muscle (*P*= 0.012). The results of chemical compositions for *Tridacna maxima* revealed that protein recorded the highest average followed by ash, carbohydrates, and fat, respectively, in dry weight of *Tridacna maxima*. Additionally, Table (1) reveals that the water content of the adductor muscle was substantially higher than that of the mantle. The crude protein contents of the mantle were lower than that found in the adductor muscle (69.56 ± 3.44 and 72.65 ± 2.35, respectively). The mantle of *Tridacna maxima* had higher carbohydrates and ash content than the adductor muscle of *T. maxima*, while fat contents (% dry weight) in the adductor muscle were significantly higher than those recorded in the mantle.

Table 1. The averages of moisture, protein, fat, carbohydrate and ash (g/100g) in *T. maxima*. Data were represented as mean ± SD

Proximate composition(g/100g)	Mantle	Adductor muscle	Two-Sample T-Test	
			t-value	p-value
Moisture (WW)	72.02 ± 3.32	74.56 ± 3.21	0.95	0.395
Protein (DW)	69.56 ± 3.44	72.65 ± 2.35	1.28	0.269
Fat (DW)	4.12 ± 0.95	04.95 ± 0.93	1.08	0.340
Carbohydrates (DW)	9.55 ± 1.87	7.68 ± 1.22	1.45	0.221
Ash (DW)	16.55 ± 1.93	9.68 ± 1.96	4.33	**0.012**

WW, % wet weight; DW, % dry weight.

2- Free radical scavenging activity

The radical scavenging activity of water, methanol and ethanol extracts of *T. maxima* at one concentration (100µg/ml) tested using the 'stable' free radical (DPPH) is elucidated in Fig. (1). The results showed that free radical scavenging activity of *T. maxima* in methanol extract recorded the highest percentage (10.5%) followed by ethanol extract and water extract (6.7% and 3.5%, respectively). While, all extracts showed weakly free radical scavenging when compared with Vit. C (positive control, 99.7%).

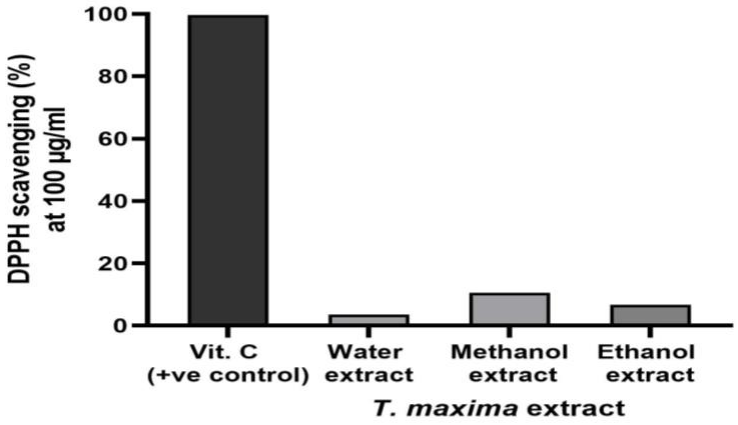

Fig. 1. Free radical scavenging activity of *T. maxima* extract, measured by using DPPH assay at concentration of 100µg/ ml

3- Total phenolic contents

For the water, methanol, and ethanol extracts of the internal sections of *T. maxima*, the total phenolic content was measured *in vitro*. Table (2) displays the findings of the analysis of the extracted samples' total phenolic content. When expressed as gallic acid equivalents (GAE)/g of dry extract, the total phenol concentration in the various extracts varied from 40.11 to 47.1mg GAE/g. Methanol extracts had the highest phenolic content (5mg/ ml extract concentration).

4- Flavonoid content

Results registered in Table (2) illustrate total flavonoid contents for *Tridacna maxima* in different solvent extracts (mg quercetin equivalents "Qu"/g). Total flavonoids *in vitro* were determined for water, methanol, and ethanol extracts of internal parts *T. maxima*. The content of total flavonoids in different extracts ranged between 4.9 ± 0.82 & 7.2 ± 1.07mg Qu/g. The highest flavonoids content was found in methanol extracts (with 5mg/ ml extract concentration).

Table 2. Total phenolic (mg GAE / g extract) and total flavonoid (mg Qu/g) contents of *T. maxima* in different solvent extracts

	Extra solvent		
	Water	**70% Ethanol**	**70% Methanol**
Total phenolic (mg GAE /g extract)	40.11 ± 2.42	42.1 ± 3.65	47.1 ± 3.21
Total flavonoid (mg Qu/g extract)	4.9 ± 0.7	6.1 ± 1.3	7.2 ± 1.7

5- GC-Gas for fatty acids

The fatty acid profiles of *Tridacna maxima* are illustrated in Table (3) and Figs. (2, 3). The saturated fatty acids (50.849% of total fatty acids) were the dominant type, followed by monounsaturated fatty acids (MUFA, 33.91% of total fatty acids) and polyunsaturated fatty acids (PUFA, 15.24% of total fatty acids). The high ratio in PUFA recorded for 6π followed by 3π were 5.753 and 4.182%, respectively. In addition, the

major fatty acids were palmitic acid "saturated fatty acid" and palmitoleic acid "unsaturated fatty acid" with percentages of 38.039 and 26.407%, respectively. However, the lowest fatty acids were linolenic acid [C9:12:15, 3 π] and undecylic acid (undecanoic acid, saturated) with 0.001 and 0.003, respectively.

Table 3. Fatty acids in *T. maxima* determined by GC- Gas analysis

P. No.	RT (Min)	Compound Name	M. F.	Area %	Class
1	10.33	Caproic acid (hexanoic acid)	$C_6H_{12}O_2$	0.010	Saturated
2	11.54	Caprylic acid (octanoic acid)	$C_8H_{16}O_2$	0.021	Saturated
3	12.77	Decanoic acid	$C_{10}H_{20}O_2$	0.010	Saturated
4	13.49	Undecylic acid (undecanoic acid)	$C_{11}H_{22}O_2$	0.003	Saturated
5	14.25	Lauric acid (dodecanoic acid)	$C_{12}H_{24}O_2$	0.138	Saturated
6	15.16	Tridecylic acid **(**tridecanoic acid**)**	$C_{13}H_{26}O_2$	0.017	Saturated
7	16.29	myristic acid (tetradecanoic acid)	$C_{14}H_{28}O_2$	4.483	Saturated
8	17.48	myristoleic acid (9-tetradecenoic acid)	$C_{14}H_{26}O_2$	0.950	Mono Unsaturated
9	17.65	Pentadecanic acid	$C_{15}H_{30}O_2$	0.451	Saturated
10	19.03	Pentadecanoic acid	$C_{15}H_{30}O_2$	0.041	Saturated
11	19.46	Palmitic acid (hexadecanoic acid)	$C_{16}H_{32}O_2$	38.039	Saturated
12	21.01	Palmitoleic acid (9Z)-hexadec-9-enoic acid)	$C_{16}H_{30}O_2$	26.407	Mono Unsaturated
13	21.58	Heptadecanic acid	$C_{17}H_{34}O_2$	0.868	Saturated
14	23.42	Margaric acid (heptadecanoic acid)	$C_{17}H_{34}O_2$	0.189	Saturated
15	24.44	Stearic acid (octadecanoic acid)	$C_{18}H_{36}O_2$	4.888	Saturated
16	25.88	Stearic acid (octadecanoic acid)	$C_{18}H_{36}O_2$	0.205	Saturated
17	26.62	Oleic acid (Z-octadec-9-enoic acid)	$C_{18}H_{34}O_2$	5.573	Mono Unsaturated
18	30.56	Linoleic acid ((9Z,12Z)-Octadeca-9,12-dienoic acid)	$C_{18}H_{32}O_2$	0.350	Polyunsaturated (2 π)
19	32.94	Arachidic acid (Icosanoic acid)	$C_{20}H_{40}O_2$	0.161	Saturated
20	34.12	Linolenic acid [C6:9:12]	$C_{18}H_{30}O_2$	2.341	Polyunsaturated (3 π)
21	36.34	Eicosenoic acid (gadoleic acid)	$C_{20}H_{38}O_2$	0.950	Mono Unsaturated
22	36.64	Linolenic acid [C9:12:15]	$C_{18}H_{30}O_2$	0.001	Polyunsaturated (3 π)
23	39.33	Heneicosanic acid	$C_{21}H_{42}O_2$	0.131	Saturated
24	42.82	Eicosadienoic acid	$C_{20}H_{36}O_2$	0.283	Polyunsaturated (2 π)
25	46.19	Behanic acid	$C_{22}H_{44}O_2$	0.325	Saturated
26	46.39	Eicosatrienoic acid [C8:11:14]	$C_{20}H_{34}O_2$	1.840	Polyunsaturated (3 π)
27	47.81	Erucic acid (docosenoic acid)	$C_{22}H_{42}O_2$	0.012	Mono Unsaturated
28	48.10	Arachidonic acid	$C_{20}H_{32}O_2$	2.918	Polyunsaturated (4 π)
29	49.72	Tricosanoic acid	$C_{23}H_{46}O_2$	0.697	Saturated
30	52.06	Eicosapentaenoic acid	$C_{20}H_{30}O_2$	1.754	Polyunsaturated (5 π)
31	53.29	Lignoceric acid (tetracosanoic acid)	$C_{24}H_{48}O_2$	0.172	Saturated
32	55.04	Nervonic acid (selacholeic acid or (*Z*)-Tetracos-15-enoic acid)	$C_{24}H_{46}O_2$	0.018	Mono Unsaturated
33	61.26	Docosahexaenoic acid	$C_{22}H_{32}O_2$	5.753	Polyunsaturated (6 π)

P. No.	RT (Min)	Compound Name	M. F.	Area %	Class
Saturated FA				**50.85**	
Mono unsaturated FA				**33.91**	
Poly unsaturated FA				**15.24**	
Total				**100**	

P. No.: Peak number, **RT**: retention time, **M.F**: molecular formula

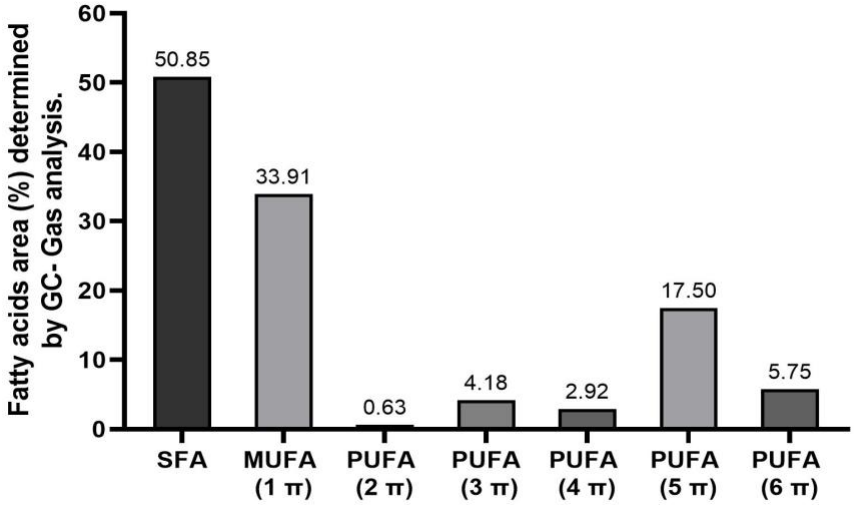

Fig. 2. Fatty acids in *T. maxima* determined by GC- Gas analysis. SFA ; Saturated fatty acids, MUFA; Mono unsaturated fatty acids and PUFA; Poly unsaturated fatty acids

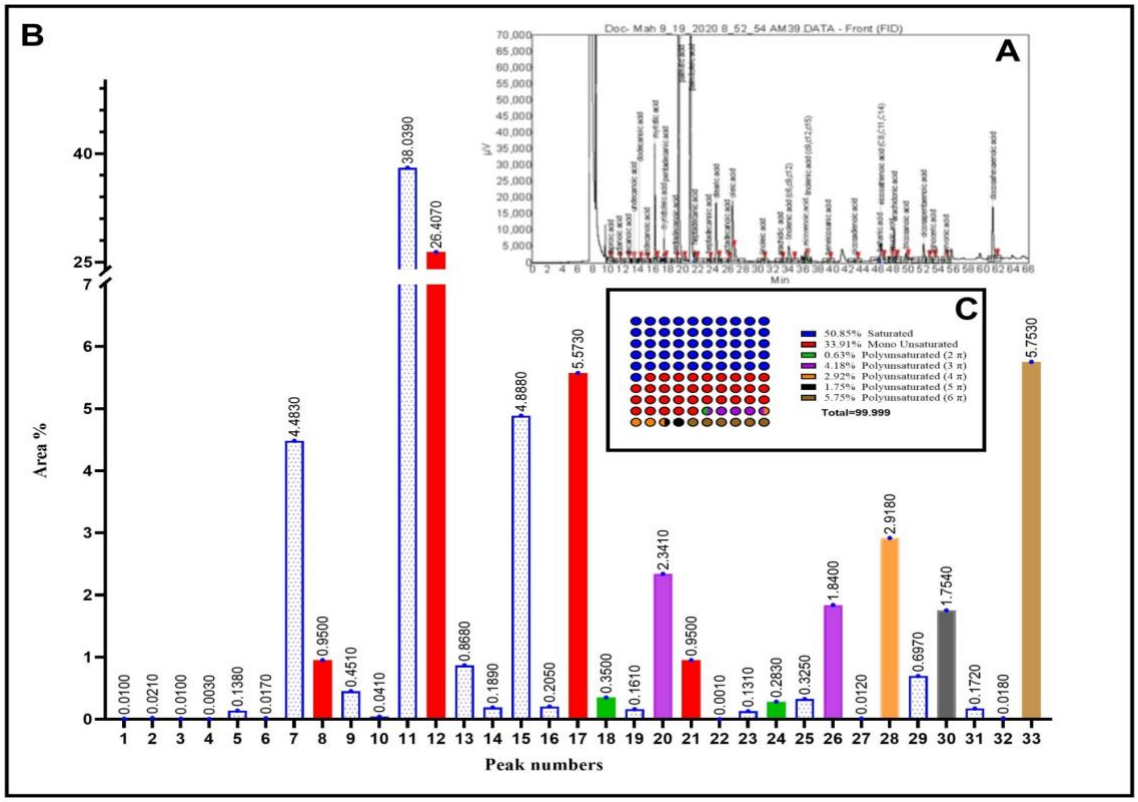

Fig. 3. A: GCMS chromatogram list of fatty acids, B: relative area % of identified fatty acids and C: histogram of the classification of the identified fatty acids

6- Amino acid determination by amino acid analyzer

Amino acids determination by amino acid analyzer in *T. maxima* are reported in Table (4) and Figs. (4, 5). The major non-EAA in tested samples were glutamic acid with 59.805mg/ g - 18.57% dry weight, followed by aspartic acid and alanine with 35.862mg/ g, 11.14% and 22.653mg/ g, 7.03% dry weight, respectively. While, leucine (21.762mg/ g, 6.76% dry weight) and lysine (21.052mg/ g, 6.54% dry weight) were the predominant EAA, followed by histidine and phenylalanine (18.518 and 16.166mg/ g dry weight, respectively). In addition, the minimum concentration of non-EAA was recorded for tyrosine 11.792mg/ g. However, methionine (8.290mg/ g) recorded the minimum concentration of EAA in tested sample.

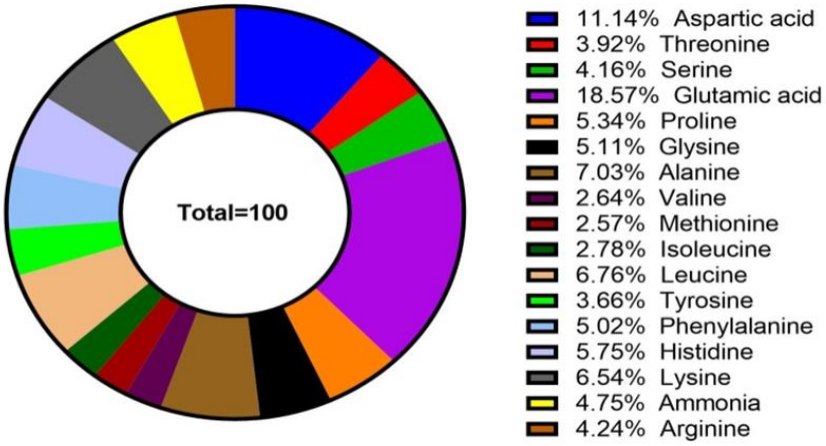

Fig. 4. The percentage of amino acids in one gram of tested sample

Table 6. Amino acids in *Tridacna maxima* determined by amino acid analyzer

No.	Amino acid	Concentration (mg/g)	%	Type
1	Aspartic acid	35.862	11.14	Non – essential amino acid
2	*Threonine*	12.626	3.92	Essential amino acid
3	Serine	13.399	4.16	Non – essential amino acid
4	Glutamic acid	59.809	18.57	Non – essential amino acid
5	Proline	17.209	5.34	Non – essential amino acid
6	Glycine	16.463	5.11	Non – essential amino acid
7	Alanine	22.653	7.03	Non – essential amino acid
8	Cysteine	0	0.00	Non – essential amino acid
9	Valine	8.505	2.64	Essential amino acid
10	Methionine	8.290	2.57	Essential amino acid
11	Isoleucine	8.959	2.78	Essential amino acid
12	Leucine	21.762	6.76	Essential amino acid
13	Tyrosine	11.792	3.66	Non – essential amino acid
14	Phenylalanine	16.166	5.02	Essential amino acid

No.	Amino acid	Concentration (mg/g)	%	Type
15	Histidine	18.518	5.75	Essential amino acid
16	Lysine	21.052	6.54	Essential amino acid
17	Ammonia	15.291	4.75	**Others**
18	Arginine	13.664	4.24	Non – essential amino acid
Total		322.02	100	
Essential amino acids		8	35.98	
Non-essential amino acids		9	59.25	
Others		1	4.75	

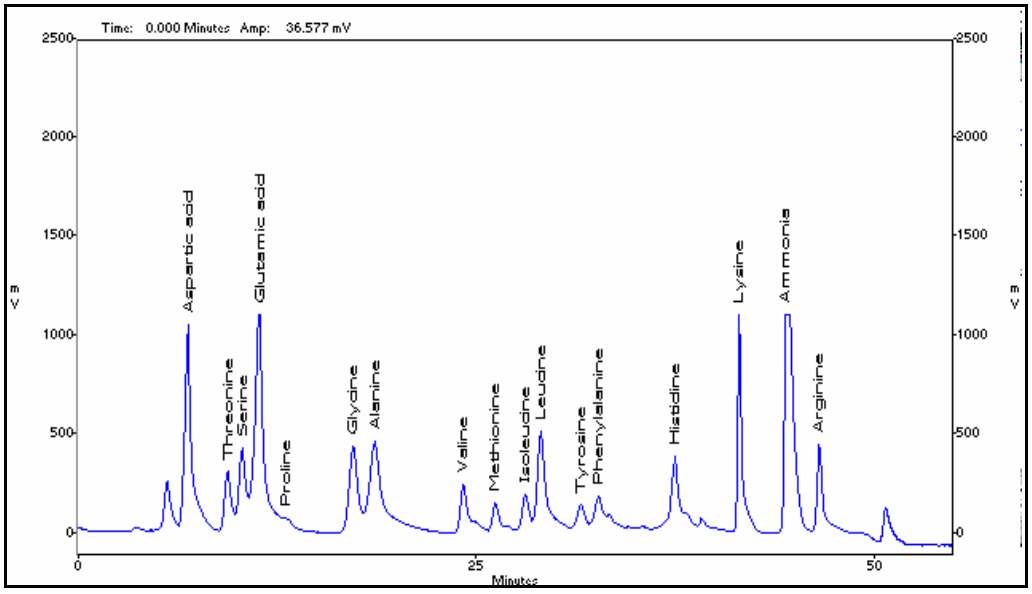

Fig. 5. Sequence of amino acids on the chromatogram collected by amino acid analyzer

DISCUSSION

Giant clams have traditionally been used as an important food source throughout the tropical Indo-Pacific region and Red Sea. This study showed protein recording the highest percent, followed by ash, carbohydrates and fat in dry weight of edible parts of *T. maxima*, which had the same favorable characteristics as many other seafood, such as fish, crustaceans, and molluscs **(Venugopal & Gopakumar, 2017; Wright *et al.*, 2018)**. Numerous bivalve molluscs' biochemical compositions have been recorded to date, and the reasons for the compositional difference are assorted and include species, tissues, maturity stages, and environmental conditions **(Mahmoud *et al.*, 2008)**. These results agree with those of **Mostafa and Khalil (2014)**, who showed that significantly higher protein content (72.33%) was recorded in boiled sample of *Tridacna* followed by (71.15%) cooked method, and grilled method (71.07%) when assaying chemical composition of *T. maxima*. **Mostafa *et al.* (2018)** illustrated that the *T. maxima* have high crude protein contents followed by ash, while crude carbohydrate and crude fat contents

were relatively low. The range for total protein, total lipids, and organic matter was established by **Dubousquet *et al.* (2016)**, who addressed *T. maxima*. The increased recycling activities seen in clams might be reflected in the high protein content **(Ungvari *et al.*, 2013)**.

The mantle tissue and adductor muscle of *T. maxima* were monitored with high protein, low fat, high levels of PUFA, and low cholesterol **(Toufektsian *et al.*, 2011)**. Conversely, it has been discovered that *T. maxima*'s predominant protein composition interacts with a variety of cell types, including red blood cells and tumor cells from diverse sources. It was recently shown that 24-methylenecholesterol, which was extracted from the Red Sea *T. maxima* mantle, has a mild cytotoxic effect **(Zamzamy, 2014)**.

According to **Wojdyło *et al.* (2007)**, since it is easy to assay and stable in radical state, DPPH is one of the most widely utilized substrates for quick assessments of antioxidant activity. Key antibacterial and antioxidant substances, phenolic compounds provide several advantages for human health and disease prevention. Natural compounds called flavonoids have a polyphenolic structure, which gives them antioxidant activity and the potential against diseases including atherosclerosis, cancer, and Alzheimer's **(Hamad *et al.*, 2015)**. The phenolic components of *T. maxima* methanol extracts may have a role in the extract's enhanced antioxidant capacity via donating hydrogen. The ability of phenoxide ions to donate hydrogen to free radicals like DPPH may be connected to the antioxidant properties of polyphenols, perhaps leading to the termination of a chain reaction **(Krishnamoorthy *et al.*, 2019)**. The hydroxyl groups in TFC's structures, which scavenge lipid peroxy-radicals and stabilize free radicals, singlet oxygen, and superoxide anion, are intimately linked to the compound's antioxidant effect **(Hamad *et al.*, 2020)**.

Among the most abundant and varied classes of natural substances are flavonoids. The natural phenols flavones, isoflavones, flavonoids, anthocyanins, and catechins are considered to be the most significant **(Sim & Young, 2008)**. The obtained results indicated that *Tridacna* appear as a good source for natural phenolic compounds and flavonoids which encourage their use in food, food processing and storage to get their health benefits. Due to their ability to promote health, polyphenols are important components of bivalve organisms. Moreover, because of their hydroxyl groups, they have the ability to scavenge free radicals, stabilizing the unpaired electron and preventing harmful oxidation. Therefore, bivalves' antibacterial and antioxidant properties may be directly attributed to their total phenol concentration. Being low in calories, abundant in nutrients, and simple to digest are the qualities of marine molluscs **(Hamad *et al.*, 2020)**. According to the Food and Agriculture Organization (FAO), molluscan edible tissue has exceptional nutritional value since the proteins and lipids have absorption coefficients greater than 0.9 **(Panayotova *et al.*, 2020)**.

In the current study, the saturated fatty acids (50.849% of total fatty acids) were the dominant type, followed by unsaturated fatty acids (49.15% of total). These results are in line with **Mostafa and Khalil (2014)**, who reported that both saturated and

unsaturated fatty acids make up the lipid content of *Tridacna*; however, the proportion of saturated fatty acids is comparatively higher than that of unsaturated fatty acids.

It is well recognized that healthy fatty acids like MUFA and PUFA may aid in maintaining normal blood cholesterol levels **(The European Commission, 2012)**. Because n-3 PUFA, such EPA and DHA, are scarce in plant and animal proteins, seafood is recognized for having a high concentration of them **(Larsen *et al.*, 2011)**. Some data suggest that n–3 fatty acids improve insulin sensitivity **(De Caterina.*et al.*, 2007)** and mildly inhibit platelet function **(Lev EI *et al.*, 2010)**. According to this study, Tridacna's comparatively high MUFA and PUFA levels were significant for platelet anti-aggregation and blood pressure-lowering effects in the human diet **(Orban *et al.*, 2006)**. According to **Dubousquet *et al.* (2016)**, the amounts of n-3 PUFA in the mantle and adductor muscle of *Tridacna squamosa* were comparable to those in the mantle of *T. maxima*.

For the saturated fatty acids, palmitic acid ($C_6H_3O_2$) is the dominant fatty acid in *T. maxim*. Their capacity to adapt their fatty acid composition to daily environmental fluctuations, which can differ from those of organisms acclimated to steady temperatures, may also be supported by this richness of fatty acids **(Van Dooremalen *et al.*, 2011)**. By altering the availability of lipid storage, this fatty acid pattern may also be significant for the cell. This may result in the varying utilization of specific fatty acids, particularly in cell signaling, energy metabolism, or metabolic activities like eicosanoid production **(Pernet *et al.*, 2007)**.

In the present study, *T. maxima* was shown to contain 16 amino acids. Amino acids are necessary for the synthesis of energy, osmoregulation, and the development of muscle **(Karanova & Andreev, 2010; Abu Zaid *et al.*, 2016)**. Furthermore, according to **Berra *et al.* (2006)**, phenylalanine plays a significant role in regulating the leucine transport pathway. The present work illustrates that the non-EAA recorded a high percentage compared to EAA (59.25% and 35.98%, respectively). The major non-EAA in *T. maxima* were glutamic acid and aspartic acid (18.57% and 11.14%, respectively). However, leucine (6.76%) and lysine (6.54%) were the predominant EAA; these results agree with the findings of **Southgate (1996)** and **Zamzamy (2014)**, who demonstrated how lysine and methionine, which are lacking in Egyptian diets, may be found in large amounts in the protein found in giant clams. Leucine, lysine, and threonine were also shown to be the most prevalent amino acids in both fresh and cooked tissues, as demonstrated by **Mostafa *et al.* (2018)**. *T. maxima* are regarded as high-protein, nutrient-dense food items **(El-Hendy & Kilada, 1997)**.

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