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The Biochemical Composition of the Eggs Blue Swimming Crab, *Portunus pelagicus* (Linnaeus, 1758) in the Persian Gulf Coasts, Iran

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Abstract: The present study gives an account on the nutritional value of eggs of blue swimming crab *P. pelagicus* from the Persian Gulf coasts in south Iran. Crabs with a carapace width of 120-140 mm yield an average of 25 to 30 g of eggs. Higher amount of protein was in yellow stage (38.68 %), amount of carbohydrate in orange stage (0.88 %) and amount of lipid was in brown stage (11.30 %). The total values of saturated fatty acids in crab eggs were calculated as (12.92 %). Among various saturated fatty acids recorded, the amount of Myristic acid (08.35 %) was predominant and minimum was Capric acid (0.10%). The total amount of monounsaturated fatty acids in the present study was found to be (04.70%). Higher amount of monounsaturated fatty acid was Myristoleic acid (03.20 %) and less amount of fatty acid was Nervonic acid (0.25 %). The total amount of polyunsaturated fatty acids was calculated as (15.39 %). Maximum amount of fatty acid was reported to be Arachidonic acid (06.99 %) and minimum was Linlelaidic acid (0.20 %). Results this study showed that percentage of protein is highest among the biochemical constituents.

Key words: Biochemical Composition · Egg · *Portunus pelagicus* · Nutritional · Persian Gulf

INTRODUCTION

The Persian Gulf is a body of water in the Middle East between the Arabian Peninsula and Iran. This inland sea is connected to the Gulf of Oman by the Strait of Hormuz. The Persian Gulf is one of the unique ecosystems due to its geographic distribution and its isolation from the international water and has unique specifications such as ecological, biological specifications and different varieties. It has a great biological diversity in the form of various marine flora and fauna. It includes marine sensitive ecological zones such as estuary, rivers, coral reef, mangrove forest, marsh and stone and mud coasts [1]. Crabs belong to a group of animals knows as decapods crustaceans. Most of the marine crabs occurring along the Persian Gulf coasts belong to the family Portunidae.

The blue swimming *P. pelagicus* is distributed from the eastern Mediterranean to east Africa in the Indian Ocean and to Japan and Tahiti in the western and south Pacific Ocean [2]. Crab *P.pelagicus* live in a wide range of inshore and continental shelf areas, including sandy, muddy or algal and sea grass habitats, from the intertidal zone to at least 50m depth [3, 4].They are usually found in large numbers in shallow bays with sandy bottom [5]. The blue swimming crab *P.pelagicus* supports substantial commercial fishery in the Persian Gulf and is an important component of many recreational fisheries in Iran and other parts of the world and the major species crab caught in trawl nets. Marine crabs belonging to the family Portunidae form by catch of shrimp trawlers in Iran. They are considered a secondary catch. Growth speed, high reproductive and strength against temperature, pH and salinity changes make the blue crab a proper species for aquaculture in the world. The post-monsoon conditions of high salinity and temperature make the backwaters an ideal nursery ground. The crab seed subsisting on the zooplankton grow very fast and remain in the backwaters until the first showers of the southwest monsoon in May-June. The abrupt fall in the temperature

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and salinity causes the crabs to migrate to inshore areas. By this time the individual crabs attain marketable size and have completed the pubertal moult stage. Subsequent broods are formed in the same breeding season.

Some information is available on the biochemical changes during larval development of crabs [6, 7]. As part of a continuing investigation of fish proteins being carried out at this laboratory, the comparative chemistry of the crude-protein fraction of the eggs of crab *P.pelagicus* has been studied. It was considered desirable to obtain such background information prior to investigating the specific technological problems which concern the industry. The eggs are attached to the pleopods and need to undergo a short period of incubation before hatching. Egg bearing females dominate in certain seasons. The consumers simply discard the eggs and use the meat. Studies on the biochemical composition of crab eggs are scanty. The principle components of most lipids are fatty acids [8]. Though the energy requirements is met from the oxidation of fat during embryonic development of crab the relative proportions of fatty acids accompanying embryogenesis is still unknown. The fact that the eggs are a good source of protein, carbohydrate and lipid is often ignored. The present study gives an account on the nutritional value of eggs of *P. pelagicus* from the Persian Gulf coasts in south Iran.

MATERIALS AND METHODS

Study Area: The study was carried out in the several adjoining coasts in the Persian Gulf such as Khuzestan province (including coasts Abadan and Bahrekan), Boushehr province (including coasts Boushehr and Khark) and Hormozgan province including coasts Bandar Abbas and Jask (Figure 1). The Persian Gulf lies on the South Iran, between longitudes 48°25' and 56°25" East and latitudes 24°30" and30°30' North. It has an estimated area of 260Km2 and extends 600Km offshore to a depth average of about 30-40 meter [1].

Sampling Stations: Six sampling stations were selected along a spatial grid of the Persian Gulf coasts covering a distance of about 909 kilometers. The sampling stations were selected based on ecological settings, vegetation and human activities in the area.

Sample Collection: The berried female crabs of *P. pelagicus* for study were collected in Summer season 2011. Sampling was performed with several methods such as trawl net and research ship. After sampling, samples were taken to the laboratory in a cooler and stored in a deep freezer for further analysis.

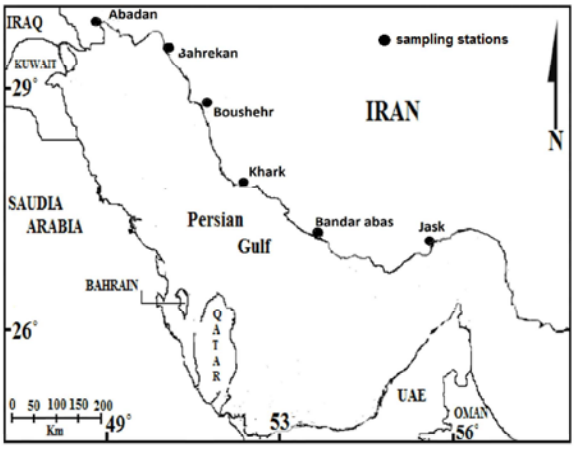

Fig. 1: Map of Persian Gulf coasts showing sampling stations and the study site

Demineralization: Then the crabs are washed for removing the mud and algae's and barnacles stuck to the external skeleton. Therefore each crab was sorted into species. The first sex and their morphological characteristics (Wet weight, carapace width and carapace length) were taken. The matured eggs were scrapped off from the brood with the help of scalpel. The eggs can be easily separated from the abdominal pleopods with a knife, stored in polythene bags and refrigerated or deep-frozen. Prolonged storage is not recommended as the lipids may become rancid. Besides direct consumption, the eggs are suitable for the preparation of sausages and protein concentrates. The eggs were then sun dried 3 days, properly ground using mortar and pestle and subsequently used for biochemical analysis. The protein, carbohydrate and lipid contents were estimated by adopting the standard methods respectively [9-11].

The fatty and methyl ester of the sample was injected into the gas chromatography (AP5890). Capillary column coated with 5% phenyl silicone at a temperature from 170 to 300 for 23min. Flame ionization detector was used for analysis. Based on the retention time, the different fatty acid samples were identified. Triplicate was maintained for each experiment.

Statistical Analysis: Statistical analyses were performed using SPSS 16.0 for Windows software. Differences in the means between groups were analyzed by one-way

analysis of variance (ANOVA) and post hoc multiple contrast (DUNCAN) and at P<0.05 was considered statistically significant.

RESULTS

The variation in the biochemical composition at different stages of eggs of *P. pelagicus* is presented in Table 1. Among various the protein recorded, the amount of yellow stage (38.68 %) was maximum, followed by orange stage (25.12 %) and brown stage (20.50 %). Among various the Carbohydrate recorded, the amount of orange stage (0.88 %) was maximum, followed by yellow stage (0.69 %) and minimum was brown stage (0.50 %). Among various the lipid recorded, the amount of brown stage (11.30 %) was maximum, followed by brown stage (08.50 %) and minimum was yellow stage (06.21 %). The eggs are classified into three stages based on yolk content and ova diameter [12]. Peak protein content with less fat is observed during the yellow and orange stages, while fat value increases and protein value drops during the advanced stages of development. This may be due to the storage of lipids for the early nutrition of the larvae. The eggs deteriorate if detached from the spawner in the early stages. The heavily yolked eggs, yellow and orange stages are recommended for consumption, while the spawners with subsequent brown and black eggs that are ready to hatch can be let out in the sea or used for crab culture. The total weight of the eggs depends on the carapace width of the crab. Usually crabs with a carapace width of 120-140 mm yield an average of 25 to 30 g of eggs. Although this is a small quantity per crab, the total number of crabs with brood that are being landed is huge and it is possible to extract several kilograms of eggs from a single landing station. The total values of saturated fatty acids in crab eggs were calculated as (12.92 %). Among various saturated fatty acids recorded, the amount of myristic acid (08.35 %) was maximum followed by Pentadecanoic acid (01.80 %), Heptadeeanoic acid (1.30 %) and minimum was Capric acid (0.10 %) (Table 2).

The total amount of monounsaturated fatty acids was found to be (04.70 %). Higher amount of monounsaturated fatty acid was Myristoleic acid (03.20 %) followed by Eicosenoic acid (0.85 %) and Palmitoleic acid (0.40 %). Less amount of fatty acid was Nervonic acid (0.25 %) (Table 3).

The total amount of polyunsaturated fatty acids was calculated as (15.39 %). Maximum amount of fatty acid was reported to be Arachidonic acid (06.99 %) followed by Ecosapentaenoic acid (04.55 %), Linoleum acid (01.35 %) and Linolenic acid (0.80 %). Minimum was Linlelaidic acid (0.20 %) (Table 4).

Table 1: The proximate biochemical composition at different stages of the matured eggs of *P. pelagicus*

Stage of Eggs	Protein	Carbohydrate	Lipid
Yellow	38.68±0.6	0.69±0.5	6.21±0.6
Orange	25.12±0.4	0.88±0.7	8.50±0.6
Brown	20.50±0.8	0.50±0.5	11.30±0.7

Table 2: Saturated fatty acids in the matured eggs of *P. pelagicus*

Fatty acids	Position of the carbon atom	Crab eggs %
Capric acid	C10:0	0.10
Luric acid	C12:0	0.55
Tridecanoic acid	C13:0	0.70
Myristic acid	C14:0	8.35
Pentadecanoic acid	C15:0	1.80
Palmitic acid	C16:0	0.40
Heptadeeanoic acid	C17:0	0.90
Henicosanoic acid	C20:0	0.65
Behenic acid	C22:0	0.50
Total		12.92

Table 3: Monounsaturated fatty acids in the matured eggs of *P. pelagicus*

Fatty acids	Position of the carbon atom	Crab eggs %
Myristoleic acid	C14:1	3.20
Palmitoleic acid	C15:1	0.40
Eicosenoic acid	C19:1	0.85
Nervonic acid	C20:1	0.25
Total		4.70

Table 4: Polyunsaturated fatty acids in the matured eggs of *P. pelagicus*

Fatty acids	Position of the carbon atom	Crab eggs %
Linlelaidic acid	C18:1	0.20
Linolenic acid	C14:2, 4	0.80
Linoleum acid	C18:1, 5, 8	1.35
Arachidonic acid	C20:3, 5, 10	6.99
Ecosapentaenoic acid	C22:1	4.55
Total		15.39

The more oceanic portunid crabs such as the *Portunus* species are not inferior to mud crabs in terms of nutrition. The comparatively larger size and higher meat content make the mud crab more attractive to the exporter. However, mud crabs have become less abundant while the *Portunus* species have an enormous potential that is as yet underexploited.

DISCUSSION

The proximate composition changes during embryogenesis of crustacean vary according to the yolk materials, ecological conditions in which animals live

initial egg size. During embryogenesis the crustacean eggs utilize preferentially either protein or fat to meet their energy requirements. Carbohydrate content of the egg is negligible as compared to that of either fat or protein [13]. Carbohydrate is typically a minor contributor to embryonic metabolism [14]. Some of scientist reported that which biochemical constituents are used during embryogenesis [15, 16]. So it is highly impossible to say which biochemical constituents is utilized for embryogenesis of *P. pelagicus*.

In the present study, the protein content of the *P. pelagicus* eggs was to be (38.68 %). The protein content of the yolk is important for the tissue differentiation and organization particularly for the cuticle layers, muscle, the digestive and nervous systems [17]. Barnes (1965) and Pandian (1972) reported that the protein developing eggs is progressively depleted and they also suggested the possible utilization of protein during embryogenesis to meet the metabolic demand [18, 19]. The protein content of the present study is comparable to other studies elsewhere [15, 20, 21].

Lipids are highly efficient source of energy in way that they contain more than twice the energy of carbohydrates and proteins. In the present study lipids content of the matured eggs of *P. pelagicus* was found to be (11.30 %). Needham (1950) classified the crustacean eggs Cleidoic and non- Cleidoic types eggs [22]. The Eleidoic eggs are not dependent on the environment for water and salt (ash); oxidation of protein is suppressed to considerable extent and fat oxidation is greatly enhanced, serving as main source for the embryonic metabolism. But the Cleidoic eggs protein is the main source energy for the metabolism. Pandian (1970) reclassified the crustacean eggs into terrestrial, marine and freshwater depending upon the habit [23]. In terrestrial eggs, the protein metabolism is greatly suppressed and the oxidation of fat is high; which in the marine and freshwater eggs, the protein metabolism prominent. In the crab *Callinectes sapidus,* the utilization of fat was higher than the protein. In rocky intertidal zone beach crabs *Xantho bidentatus* eggs; the utilization of fat was greater than that of protein. During egg development in ermasal marine crustacean eggs, lipid was found to be the main energy source [24, 25]. A similar pattern has been reported for *C. sapidus* [20] and *X. bidentatus* [17]. Kannupandi *et al.* (2003) also reported that the utilization of lipid was greater than protein in *S. brockii*.

Carbohydrates constitute only a minor percentage of total biochemical composition. In the present study, the carbohydrates content of the matured egg of *P. pelagicus* was (0.88%). The amount of carbohydrates in the present study is comparable with other crabs [15].

To fuel the major anatomical changes during embryogenesis of crustaceans, the stored energy reserves play a crucial role. These endogenous reserves from the eggs not only provide energy but also important for the biosynthetic precursors to meet the embryonic demands for growth and development [26]. Two long chain polyunsaturated fatty acids (PUFA), Eicossapentaenoic acid and Docosahexaenoc acid are nutritionally essential for the eggs and embryos [27-30] and for early larval stages [28, 31, 32] of fish and shell fish.

In the present study, the total values of saturated fatty acids in *P. pelagicus* eggs were calculated as (12.92 %). Among various saturated fatty acids recorded, the amount of Myristic acid (08.35 %) was predominant and minimum was Capric acid (0.10 %). Usually Palmitic acid was recorded most of the marine animal source. But in the present study this acid conspicuous absence.

The total amount of monounsaturated fatty acids in the present study was found to be (04.70 %). Higher amount of monounsaturated fatty acids was Myristoleic acid (03.20 %) and less amount of fatty acid was Nervonic (0.25 %). The monounsaturated fatty acids like Eicosenoic play an active role in water transport and osmoregulation [33].

The total amount of polyunsaturated fatty acids in the present observation was calculated as (15.39 %). Maximum amount of fatty acids was reported to be Arachidonic acid (06.99 %) followed by Ecosapentaenoic acid (04.55 %), Linoleum acid (01.35 %) and Linolenic acid (0.80 %). Minimum was Linlelaidic acid (0.20 %). In the present study, PUFA is higher side (15.39 %) than MUFA (04.70 %) probably is attributed to the fact that the developing eggs require enormous energy for cleavage, gastrulation and cellular differentiation in early stages and organogenesis in the later developmental stages. This finding agrees with Mathavan *et al*., (1986) and John Samuvel *et al*., [34]. According to Subramoniam (1991) the cellular differentiation in mole crab starts soon after gastrulation and requires enormous energy expenditure, which is supposed to be supplied with PUFA [35].

PUFA of both n-3 and n-6 types are important in biomembranes, particularly in the vascular and nervous systems [36]. Lands (1986) has shown that n-3 fatty acids

act as a suppressant to the biosynthetic pathway of prostaglandins, while n-6 fatty acids enhance the path way [37]. The high levels Linolelaidic acid, Arachidonic acid in the present study may also be due to the biosynthesis of prostaglandin since, Arachidonic acid is precursor for the biosynthesis of prostaglandins and they have structural roles in phospholipids and permeability [38].

From the present study it is confirmed that the percentage of protein is highest among the biochemical constituents. The percentage of saturated and polyunsaturated fatty acids are high when compared to monounsaturated fatty acids studied in the matured eggs of *P. pelagicus*. Further study is needed to know which biochemical constituents and fatty acids are fairly utilized during embryogenesis and larval development.

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