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DISCOVERY SCIENTIFIC SOCIETY

Determining the fat content and its changes in males and females of the Blue Swimmer Crab *Portunus pelagicus* (Linnaeus, 1758) from Syria

Izdihar Ali Ammar[1*], Hussam Alddin Laika[2], Sara Adnan Fadel[3]

ABSTRACT

This research focused on determining the fat content in samples of the invasive blue swimmer crab, *Portunus pelagicus*, collected quarterly from the coast of Latakia during the year 2020. Fat percentages ranged between 3.1-5.5%, with an average of (4.59±0.77) in males, and 2.9-3.9%, with an average value of (3.28±0.36) in females. in the summer, and between 1.7-2.9% and an average value (2.29±0.46) in males and 1.1-3.5% and an average value (1.56±0.70) in females during the Autumn. In the winter, 0.7-1.9%, an average value (1.29±0.48) in males, and 0.2-1.5%, an average value (1.13±0.53) in females, and between 3.7-6.9% and a value Average (5.22±0.86) in males and 3-4.2% and a medium value (3.44±0.44) in females in the spring. The current study showed that the invasive crab *P. pelagicus* can be considered a good source of healthy fats, and that the lowest percentage of fats was in the spring and summer seasons, and the percentage is related to sex and season, and it can be recommended to catch it and consume its meat as a food item rich in important fatty acids and not expensive compared to Fish in Syrian local markets and thus contributing to solving the problem of its negative impact on the Syrian coast.

Keywords: blue swimmer crab, crustacea, fatty acids, Syrian coast

1. INTRODUCTION

The Blue Swimmer Crab (BSC) is Portunus pelagicus (Linnaeus, 1758) and its modern name in the Mediterranean Sea, Portunus segnis (Forskål, 1775), is a species of commercially important marine crab that is widely distributed in coastal and estuarine areas, especially in tropical and subtropical regions (Romano and Zeng, 2008). It has economic importance in many countries of the world. This species is native to the western Indian Ocean, including the Red Sea and the Persian Gulf (Galil et al., 2002). It is a nocturnal inshore species, and lives in several types of documents

(rocky, muddy and sandy) in shallow waters (tidal to 55m), sometimes in estuaries and in a wide range of coastal areas and continental shelves including algal or seagrass habitats.

The BSC is one of the most important elements of the marine food chain and can be considered an opportunistic predator. Its diet is primarily carnivorous (Tureli and Yesilyurt, 2017). It feeds on detritus, fish, algae, cephalopods, decapods, and annelids, and is prey for mammals, birds, and fish (Hall et al., 2006). The breeding season extends throughout the year except winter, and spawning is linked to seasonal changes in sea surface temperature and can occur at different periods of the year (Giraldes et al., 2016). Originally native to the western Indian Ocean, the BSC has been expanding its range into new areas, including the Mediterranean Sea via the Suez Canal, and was recorded in Port Said, Egypt, in 1898. The invasion pathways of P. segnis in the Mediterranean have been studied from the moment of its entry from the Red Sea via the Suez Canal to the present Fox, (1924), Zenetos et al., (2022), Castriota et al., (2022), focusing on its negative effects and procedures and measures to manage this species (Galanidi et al., 2023).

Its spread has recently expanded to reach the Adriatic, Gabes, and the western Mediterranean (Shakman et al., 2017; Shaiek et al., 2021, DeCarvalho-Souza et al., 2023; Grati et al., 2023). P. pelagicus is considered one of the invasive alien species in the Mediterranean that is exciting and drawing the attention of researchers and decision makers in two ways: Firstly, it has a potential impact on biodiversity, being a large predator Giraldes et al., (2016), Lai et al., (2010), and in addition, and secondly, because it can represent a valuable fish resource due to its palatable and delicious meat. Seafood products, including crabs, may enhance human health. Its nutritional value depends on its biochemical composition, such as protein, amino acids, fats, fatty acids, carbohydrates, vitamins, and minerals Abdel-Salam, (2014), as marine crabs and other types of crustaceans such as prawns and lobsters are rich sources of essential fatty acids that are not synthesized in the body.

In humans, it can help prevent and treat heart disease, cancer, arthritis, high blood pressure, and diabetes Valfre et al., (2003), and it is also an important source of omega-3 acids (Shibana et al., 2018). The composition of fatty acids varies in different types in different regions of the world (Latyshev et al., 2009; Ayas and Ozogul, 2011). Crabs constitute a large proportion of aquatic invertebrates, and are one of the most valuable products of commercial fisheries (Latyshev et al., 2009). They are approved as food, and their meat is also exported. Blue crabs in particular are considered one of the aquatic commodities that contribute significantly to fisheries in many countries of the world, such as Indonesia, India, and the United States of America. They are often marketed in the form of canned and pasteurized meat, which competes with other marine products (Fahmi et al., 2015). It is of great value for human consumption in its areas of distribution.

Many therapeutic properties are attributed to crab meat and it is used to treat asthma and chronic fever. This species contributes 0.04% of the total global catch, and represents 5% of the world's crustacean fisheries, according to data from the Food and Agriculture Organization (FAO, 2020). Commercial investment in this invasive species is one of the recently proposed solutions is to address its invasion of the Mediterranean and the resulting negative effects, especially in the Western Basin in Italy, France, and Tunisia Marchessaux et al., (2023) where blue crabs are widespread during the peak season and represent more than 70 percent of the catch (Bejaoui et al., 2017).

The purpose of this study was to determine the fat content of the claws and breast of male and female P. pelagicus, caught from the northern part of the Syrian coast. This is the first time that the nutritional value and biochemical composition of an invasive species, specifically crustaceans, have been evaluated in Syria to be used for human consumption as a basic and important step before recommending it as an edible food. The importance of the research comes from the necessity of studying the chemical composition of any edible living organism to know its nutritional value, which is reflected in its biochemical contents, as the newer species should be recommended for human consumption only after evaluating their nutritional value.

2. MATERIALS AND METHODS

Sampling sites

Blue crab samples were caught from locations distributed along the coast of Latakia Governorate, extending from Burj Islam in the north to the mouth of the Northern Kabir River in the south (Figure 1), during the year 2020, at a rate of one sortie per season. Gillnets with a mesh diameter of 32 mm were used to collect samples, and they were kept in refrigerated boxes until they were transported to the Marine Biology Laboratory at the Higher Institute for Marine Research - Tishreen University.

Figure 1 Survey area from the Syrian coast

Discrimination between males and females

Males and females are easily distinguished by their dorsal color patterns, with males being larger and more colorful, with a dark blue carapace and a pale belly, while the claws and legs are richly blue (hence the name blue swimmer crab). Female crabs are pale brown in color and are small in size. There are irregular white spots on the carapace and limbs. The claws and walking legs are dark brown. Males also have longer claws in proportion to their claws than females. However, the easiest way to check if a blue swimmer crab is male or female is to turn it upside down and look at the shape of the ventral ring region.

The male's flap is narrow and angular (shaped like an inverted "T"), while the female's flap is wide. Conical/oval to round depending on its shape. The sex of each individual (male - female) was determined according to the shape of the abdomen and telson (end of the abdomen), where the abdominal rings are wide in females, while they are narrow and triangular in shape in males (Figure 2). Weight measurements were taken for each individual, and the number of individuals worked on reached 80 individuals (40 males and 40 females).

Figure 2 Male and female blue swimmer crab P. pelagicus

To determine the percentage of fat in male and female blue swimmer crabs P. pelagicus

Muscle tissue was manually removed from the chest area and tweezers for each individual and stored at a temperature of -18°C until the analysis was performed, taking into account that the analyzes were performed quickly due to the time effect on the general content, and on the fat content in particular. P. pelagicus Muscle tissue was manually removed from the chest area and tweezers for each individual and stored at a temperature of -18°C until the analysis was performed, taking into account that the analyzes were performed quickly due to the time effect on the general content, and on the fat content in particular.

Chemical analysis of fat according to (AOAC, 2000)

About 3-5 grams were taken from each sample, weighed after drying to calculate the moisture percentage in each sample. The samples were placed in the dryer at a temperature of 105°C to ensure complete evaporation of moisture for 3 hours. 25ml of hexane was added to each sample, the samples were placed in an ultrasonic water bath for an hour at normal temperature, the samples were filtered, and the bottles were incubated in a water bath at a temperature of 80-90°C until the solvent completely evaporated, and the bottle became completely dry. The samples were transferred to the dryer to ensure that the moisture had disappeared, and then they were re-weighed dry. Finally, according to the weight of fat, the percentage was determined according to the following relationship:

$$Fat\% = (\text{weight of fat} \times 100) \div \text{weight of sample}$$

3. RESULTS AND DISCUSSION

The percentage of fat in male and female blue swimmer crabs P. pelagicus was determined for twenty quarterly samples (ten males and ten females) in the two edible parts (edible viscera and muscles) to reveal their nutritional value. This is the first time that the nutritional value of a species has been studied. Crustaceans in Syria for use as human food. The total weight of male individuals of the studied species P. pelagicus during the summer ranged between 55.71-104.41g, while the weights of females ranged between 60-159.46g. The percentage of fat ranged between 3.1-5.5%, with an average value of (4.59±0.77) in males, and 3.9-2.9%, with an average value of (3.28±0.36) in females (Figure 3).

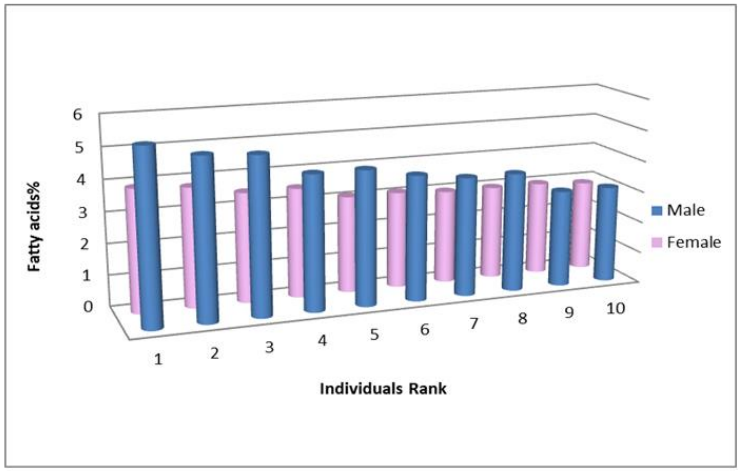

Figure 3 Percentage of fat for samples of male and female *P. pelagicus*

The total weight of male individuals of the studied species P. pelagicus during the Autumn season ranged between 120.15-196.21 grams, while the weights of females ranged between 87.69-141.18 grams, and the percentage of fat ranged between 1.7-2.9% and a medium value (2. 29±0.46) in males and 1.1-3.5% and an average value of (1.56±0.70) in females, (Figure 4). Seasonal values and averages show a clear decrease in fat ratio during Autumn compared to the values recorded in the Summer.

The total weight of male individuals of the studied species P. pelagicus during the winter ranged between 57.01-104.01g, while the weights of females ranged between 83.65-140.8g, and the percentage of fat ranged between 0.7-1.9% and a medium value (1.29±0.48) In males, it was 0.2-1.5%, and the average value was (1.13±0.53) in females (Figure 5). A clear decrease in fat percentage is observed in males and females during the winter.

It appears from the figure that the percentage of fat in the spring is the highest, with an average value of 5.06 for males and 3.55 for females, and it was slightly less than that in the summer, when it reached 4.95 and 3.23 for males and females, respectively. The total weight of male individuals of the studied species P. pelagicus during the spring ranged between 55.7-104.55 grams, while the weights of females ranged between 55.75-114 grams, and the percentage of fat ranged between 3.7-6.9% and a medium value (5.22±0.86) In males, it was 3-4.2%, and the average value was (3.44±0.44) in females (Figure 6).

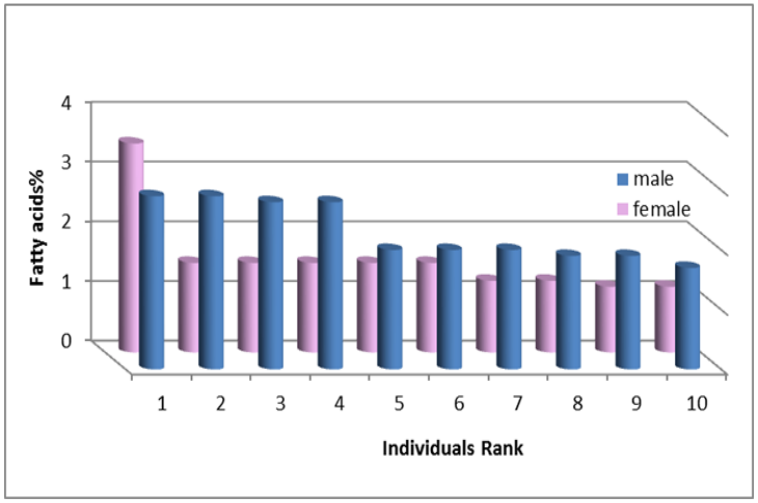

Figure 4 Percentage of fat for samples of male and female *P. pelagicus* in Autumn 2020

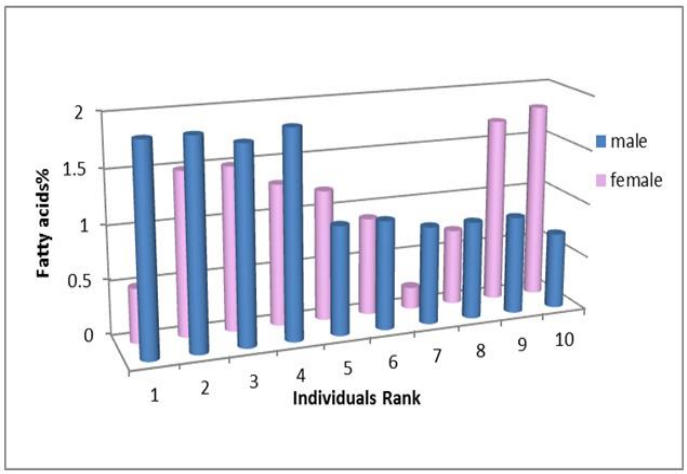

Figure 5 Percentage of fat for samples of male and female *P. pelagicus* in Winter 2020

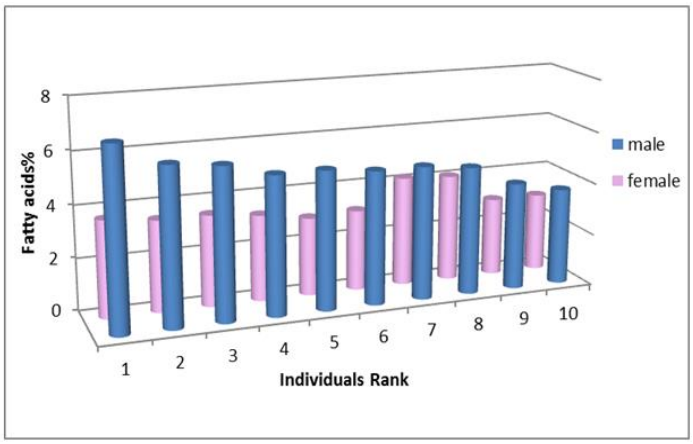

Figure 6 Percentage of fat for samples of male and female *P. pelagicus* in spring 2020

The percentage of fat also decreased during the Autumn and reached (2.29) in males and (1.56) in females. The lowest fat values were recorded in the winter season and reached (1.29) in males and (1.13) in females (Figure 7).

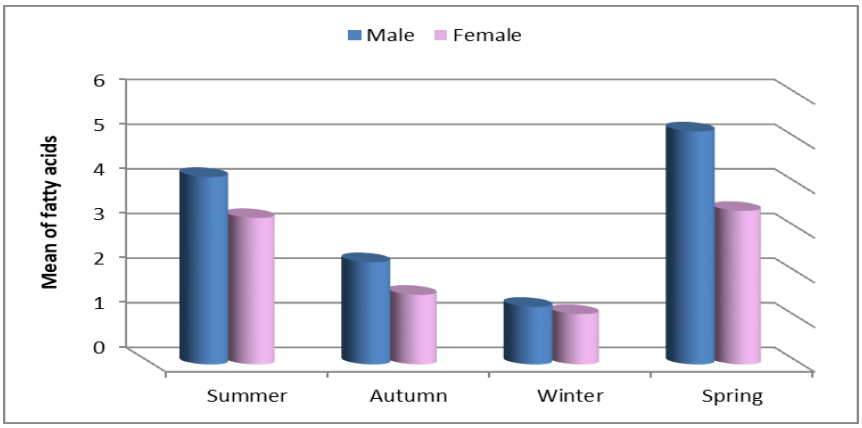

Figure 7 The average value of fat percentage in male and female P. pelagicus

In general, the results showed a clear increase in the weight of male blue swimmer crabs P. pelagicus compared to females in the Autumn of 2020, in addition to an increase in the weight of females in the Autumn of 2020 compared to the summer of 2020. In comparison, it was observed that the percentage of fat differed according to the seasons and sex, and this was due to the difference in the reproductive stage and feeding periods, as it differed according to the season, sex, reproductive stage, temperature, and food availability. The study shows the existence of strong correlations between the percentage of fat and body weight for samples of male and female blue swimmer crabs P. pelagicus in the summer, as shown in (Figure 8), where the value of the correlation coefficient for males was r = 0.935, and for females r = 0.852.

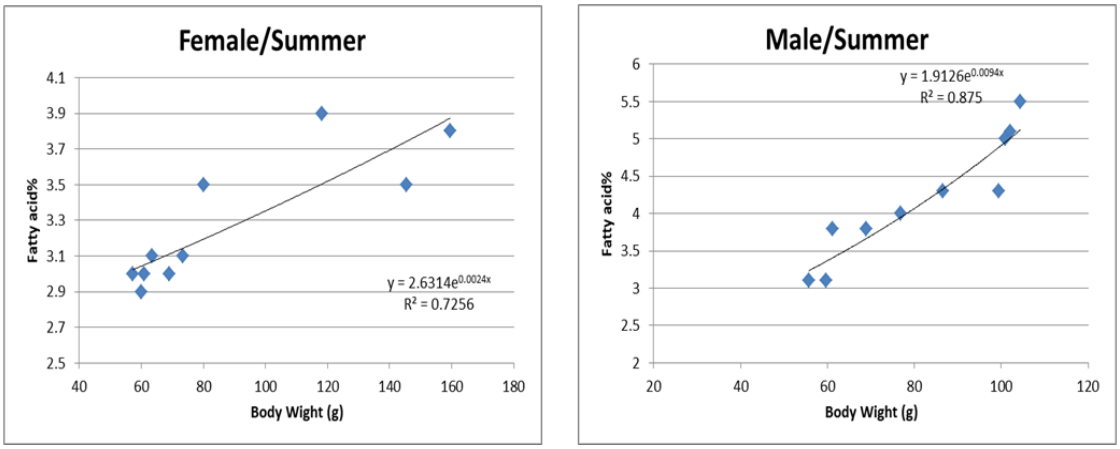

Figure 8 Linear correlation curve between total body weight and percentage of fat in males and females of *P. Pelagicus* during the summer 2020

In addition to the presence of moderate correlations between the percentage of fat and body weight for samples of male and female blue swimmer crab *P. pelagicus* in the Autumn season, as shown in (Figure 9), where the value of the correlation coefficient for males was r = 0.774, and weak for females, r= 0.048.

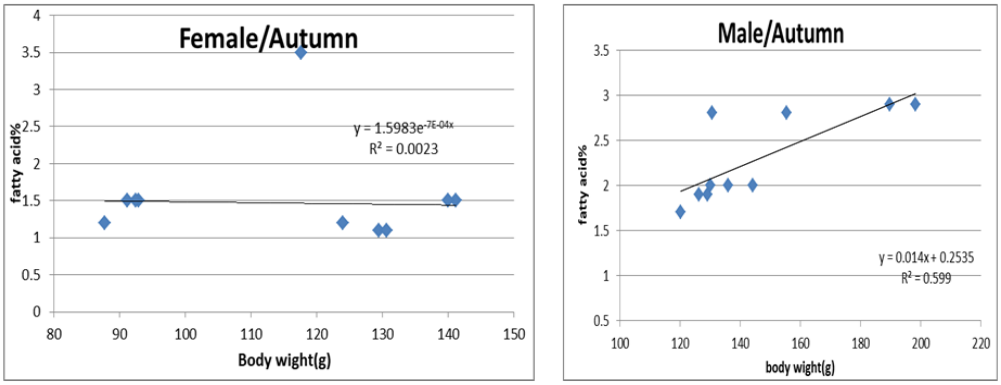

Figure 9 Linear correlation curve between total body weight and percentage of fat in males and females of P. Pelagicus during the Autumn semester 2020

In addition to the presence of strong correlations between the percentage of fat and body weight for samples of male and female blue swimmer crab in the winter, as shown in (Figure 10), where the value of the correlation coefficient in males was (r= 0.928) and weak in females (r= 0.572).

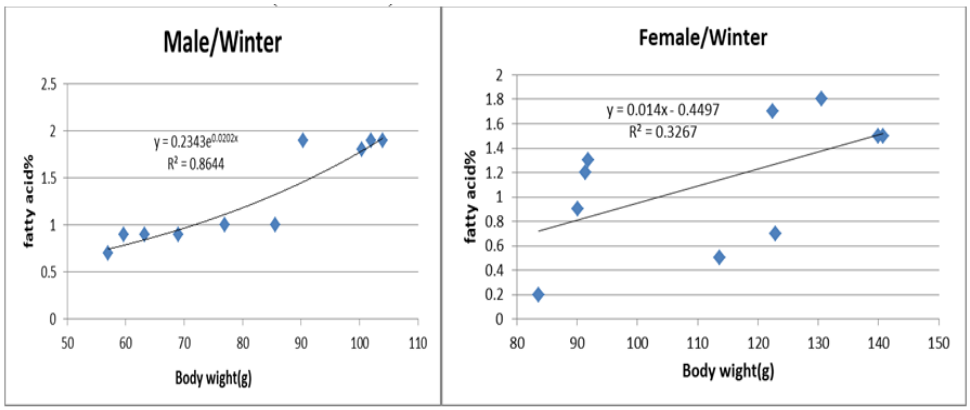

Figure 10 Linear correlation curve between total body weight and percentage of fat in males and females of *P. Pelagicus* during the winter of 2020

The study also showed that there are strong correlations between the percentage of fat and body weight for samples of male and female blue swimmer crabs P. pelagicus in the spring, as shown in (Figure 11), where the value of the correlation coefficient for males was (r = 0.888) and weak for females (r= 0.105).

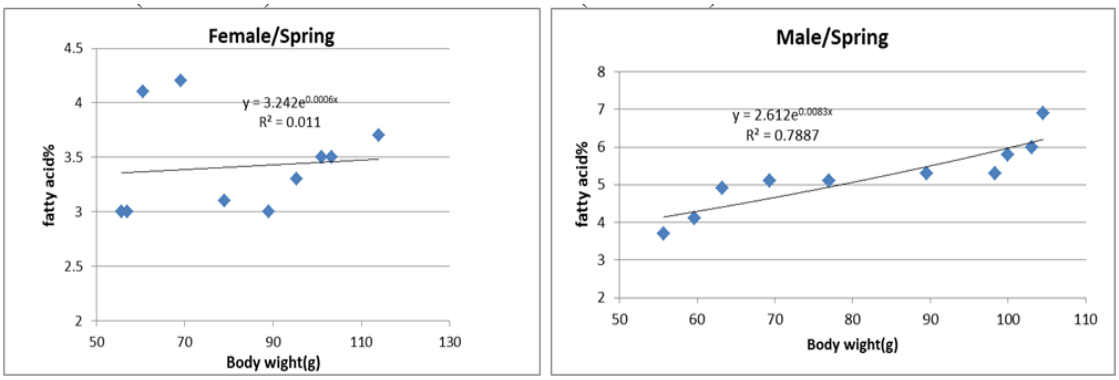

Figure 11 Linear correlation curve between total body weight and percentage of fat in males and females of P. Pelagicus during the spring 2020.

Blue crab is a fast-growing species. It can live up to 2.5-3 years, weighs up to 1kg and is up to 20cm wide depending on gender and region. A study of the relationship between height and weight in P. pelagicus shows that in juvenile individuals and prepubertal crabs, weight gain is almost uniform in males and females; Females are slightly heavier than males until the carpel width reaches 120-125m.m. Males are then heavier than females at all lengths (Josileen, 2011). In Syria, *P. Pelagicus* lives in sandy beds and bottoms covered with algae and seaweed. Starting from the intertidal zone to a depth of 55m. Its presence in Syria was recorded for the first time in Latakia in 1930. This invasive species spreads abundantly in soft bottoms at depths ranging between (5-70 m) in all regions (Ammar, 2002; Hassan et al., 2008; Ammar, 2019).

It continues to appear in large numbers throughout most months of the year and reaches its peak in the Autumn months. Currently, it is spread abundantly along the Egyptian Mediterranean coast and in the Levantine Sea up to the Gulf of Iskenderun. It is a benthic, predatory animal that feeds on hermit crabs, gastropods, bivalves, and serpentine sea stars. It grows to large sizes that may reach 185 m.m., and is caught in several areas. It has been hunted for commercial purposes in the Mediterranean. Its appearance in large numbers made it appear in fish markets and is sold in constant quantities in Egypt and Haifa, and is also sold in large quantities in Turkey and Sicily Crocetta, (2006) and the Aegean Sea (Yokes et al., 2007). Despite its negative role from an environmental and socio-economic perspective, it today constitutes an important fishing and food security resource in some Mediterranean countries such as Tunisia Ennouri et al., (2021), Tsirintanis et al., (2022), and Egypt.

It is popular in Lebanon Zibrowius and Bitar, (2003), and is served in upscale restaurants in southern Turkey (Özcan et al., 2005). In Syria, this species of marine crab is the only one that is consumed and sold in fish markets. Local residents in the main coastal cities and towns have been eating it for decades. The meat found in the breast and legs is eaten, and soup is also made from it. The presence of swimmer blue crabs in the local markets in Baniyas and Latakia is almost constant, in different quantities, and is sold at high prices. As for the rest of the types of marine crabs that are caught by accident, they are not desirable for consumption and are used as bait. The chemical composition and nutritional value of blue crab meat have been studied in different parts of the world (Nalan et al., 2003).

However, there are still few studies related to the biochemical analyzes of the blue crab in the Mediterranean. In Tunisia, where this invasive species recently arrived, a study was conducted to evaluate the fatty acids and lipid classes (polar and nonpolar) and the nutritional value of the crab breast. It has been found to be rich in protein and oil, with clear differences between the sexes (Bejaoui et al., 2017). Differences were also observed in their content of saturated, monounsaturated and polyunsaturated fatty acids. The fatty acid content of males was higher than that of females. Cancer breast can be considered rich in it, as saturated fatty acids were significantly higher in males compared to females. Therefore, the breast of P. pelagicus is an important source of high-quality oil, as it is rich in essential fatty acids in both males and females. Results of analyzes of amino acids and fatty acids have been revealed on blue crab products frozen at (-30°C) and those cooked in different ways, such as smoking and boiling.

On the effect of cooking method on sensory and chemical properties of the product Pathak et al., (2019), Fahmi et al., (2023), in addition to a significant decline (deterioration) in lipids with increasing storage time and changes in the composition of fatty acids and lipid components (Ghribi et al., 2023). Therefore, from a nutritional standpoint, it is preferable for human consumption to eat frozen crab for no more than 30 days because it retains a higher nutritional value (Ting et al., 2020). Seasonal differences in the percentage of fats from one season to another in the studied samples are explained by temporal changes in water temperature, which has been proven to affect the physiological processes of marine organisms in general and the formation of fatty acids (FA) and the histological development of the gills in the blue swimmer crab *P. pelagicus* (Abol-Munafi et al., 2020). It was found that temperature affects the concentrations of omega-3 and omega-6 and the histological condition of the gill structure of this species.

The study showed that the analysis of FA in crabs in water at a temperature of 28°C showed the content of greater FA in whole body structures compared to crabs found at 32°C, which clearly explains the higher content of total fat during the spring, when the temperature ranged between (19.2-24°C), and decreased in the summer, when the average water temperature reached (30.2°C) and decreased. Its fat content is less than that during the Autumn season, which may be subject to the breeding period that extends from September until the beginning of November. In winter, the temperature dropped and reached an average value of (17 C). Therefore, the percentage of fat is higher in crabs in water located within a temperature range of 19.2-24 C. Knowing that the composition of fatty acids in the edible parts of P. pelagicus varies depending on gender and tissue, studies have confirmed that forceps and brisket meat contain the highest amount of saturated and unsaturated fatty acids and are very rich in omegas (Mehran et al., 2016).

It is the richest in fats, the composition of which differs between males and females. The results of the current study showed that the percentage of fat in males is higher than in females in all samples analyzed. In other studies, analyzes showed clear differences

between the sexes, as the content of fatty acids in males was higher than in females (Bejaoui et al., 2017). Taking into account that crab breast is rich in saturated fatty acids and is significantly higher in males compared to females. In comparison with the results of similar studies, the percentage of fat in the current Syrian samples of male meat was BSC is higher than the percentages found in samples from other regions, which amounted to 0.047±2.02% (Premarathna et al., 2015). Since the nutritional value of any edible living organism is reflected in its biochemical contents, the high fat content proven by this study in addition to the good protein content in the meat of Syrian portunus of both sexes makes it suitable for human consumption, even.

It supports the belief that eating blue crab meat would help address the problem of food shortages in the future and contribute to controlling it as an invasive species and managing it properly. Temperatures in the studied location changed according to the season, with the lowest value recorded in the winter at 18°C, and the highest value in the summer at 32.2°C. A high concentration of fat is obtained in the summer and the lowest in the winter. The percentage of fat decreases in the breeding season because these organisms depend on the fat stored in their bodies for vital processes. In this study, the highest percentage of fat was obtained in the spring, when sexual maturity was completed, to be used during the breeding months, then it gradually decreased to reach its lowest values in the winter.

4. CONCLUSIONS AND RECOMMENDATIONS

Portunus pelagicus can be considered a good source of fat and can be recommended as an ideal food item and can also be used as a food supplement in order to balance human nutrition to prevent nutritional deficiencies in the future. This research is an introduction to a study related to culturing crabs in artificial farms, especially the *P.pelagicus*, because of its great economic benefit in providing food and increasing development. The results provide direction towards investing in this invasive species by targeting it with fishing and reducing its negative effects on the Syrian marine environment. Fat percentage is related to gender and is higher in males than in females, As related to weight (direct relationship). The effect of seasonal changes seemed clear in the fat percentages of males and females of the species studied, and it is believed that the issue is largely related to the sexual activity of the species and the reproductive period in addition to the availability of food.

Conflicts of interests:
The authors declare that there are no conflicts of interests.

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Ethical approval
The Animal ethical guidelines are followed in the study for species observation & identification.

Data and materials availability
All data associated with this study are present in the paper.

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