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NUTRITIONAL VALUE OF CEPHALOPODS: A REVIEW

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NUTRITIONAL VALUE OF CEPHALOPODS: A REVIEW

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ABSTRACT

Recently there has been a growing demand for cephalopods (octopuses, squids, and cuttlefishes), as well as an increase in prices. Cephalopods consumption dates back to ancient times and still remained very popular in various regions of the world. However, lately cephalopods are often included on the menus of many restaurants and are used as ingredients in the preparation of many dishes. This worldwide demand for cephalopods and their high commercial value has led to the publication of an increasing number of studies on the chemical composition and nutritional value of these species. Thus, this report is a literature review of works published worldwide since 2010.

Keywords: octopuses, squids, cuttlefishes, proximate composition, fatty acids, elemental profile

Título: Valor nutricional de cefalópodes: uma revisão bibliográfica

RESUMO

Recentemente tem-se vindo a registar uma procura crescente de cefalópodes (polvos, lulas e chocos) bem como um aumento dos preços. O consumo de cefalópodes remonta à antiguidade e continuou a ser muito popular em várias regiões do mundo. Porém, ultimamente os cefalópodes estão presentes nos menus de muitos restaurantes e são utilizados como ingredientes na preparação de vários pratos. Esta procura mundial de cefalópodes e o seu elevado valor comercial tem levado à publicação de um número crescente de trabalhos sobre a composição química e o valor nutricional destas espécies. Assim, este relatório é uma revisão bibliográfica dos trabalhos publicados a nível mundial desde 2010.

Palavras chave: cefalópodes, polvos, lulas, chocos, valor nutricional

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Landings and prices

The worldwide landings and value of cephalopods (squids, octopus and cuttlefishes) during the period of 2013-2019 are shown in figure 1 (FAO, 2021). The maximum landings (4856 thousand tonnes) were recorded in 2014 which dropped to around 3736 thousand tonnes in 2019. However, despite this reduction in catches, the volume and monetary value in the international exports of cephalopods, reached 2.7 million tonnes and 11.36 billion US dollars, respectively in 2019 (FAO, 2021). The worldwide cephalopods catches are dominated by squids and the total landings of jumbo flying squid (*Dosidicus gigas*) and Argentine shortfin squid (*Illex argentinus*) represented about 32 % of total cephalopods in 2019. However, worldwide catches of shortfin squid (*Illex* spp.) fell from 850,000 tonnes in 2014 to 200,000 tonnes or less in recent years as reported by Ospina-Alvarez *et al.* (2022). Squids and cuttlefishes are primarily supplied by China, Viet Nam, Peru, and India while the Chinese and Moroccan fleets account for the majority of octopus catches worldwide. Per capita consumption of cephalopods has been increasing in recent years and in 2017 it was estimated at 0.5 kg. The worldwide demand for cephalopods has increased in recent years with the consequent rise in prices. In 2019, the average price was US$ 4.23/kg which is just below the prices of crustaceans (crabs, lobsters and king crabs) that were between US$7.82 and US$18.04/kg (FAO, 2021).

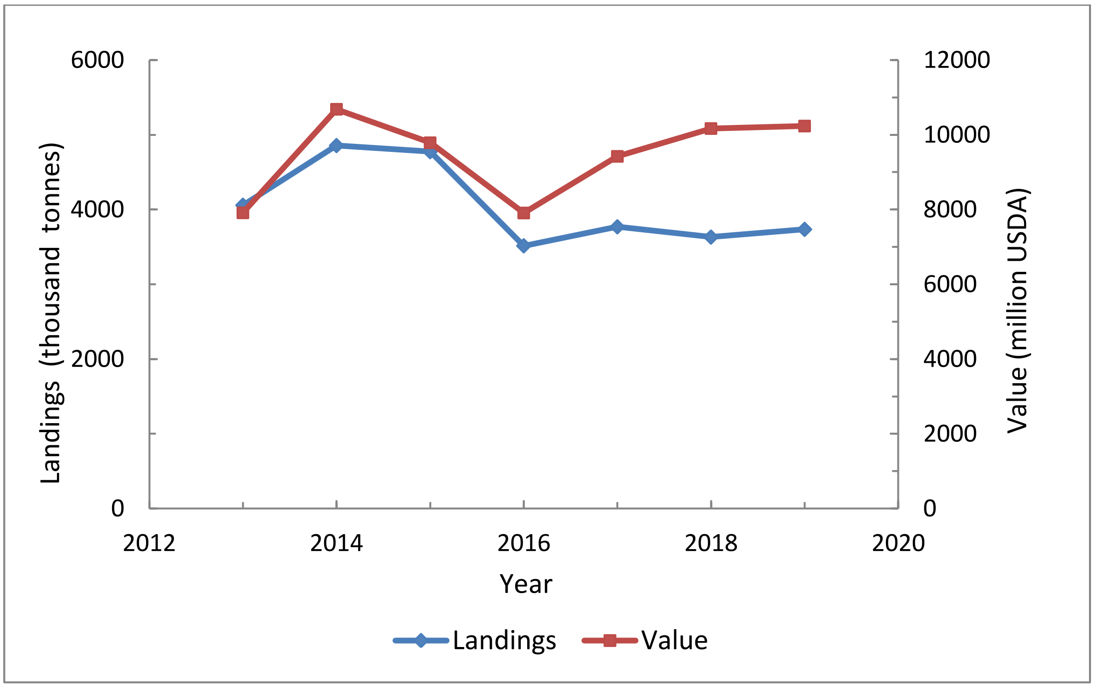

Figure 1 – Evolution of worldwide cephalopods landings (thousand tonnes) and monetary value (million USDA).

Figura 1 – Evolução dos desembarques de cefalópodes a nível mundial (milhares de toneladas) e valor comercial (milhões de dólares).

The landings of the three groups of cephalopods (octopuses, squids, and cuttlefishes) in the Portuguese auctions during 2010-2021 are shown in figure 2 (DGRM data, 2022).

Octopuses are the dominant group of cephalopods and their landings represent almost 80 % of the total cephalopods landed. The landings of octopuses are made up of horned octopus (*Eledone cirrhosa*) and mostly by common octopus (*Octopus vulgaris*) which represents 98 % of the total landed octopuses. As shown in figure 2, the landings of octopus show large annual differences, reaching a maximum of 9676 t in 2013 and a minimum of 3908 t in 2020.

Cuttlefishes are the second most important group of landed cephalopods and their landings were 1505 t in 2010 which decreased to 880 t in 2012. The amount of cuttlefish landed decreased to 764 t in the period up to 2018, but gradually increased to 1070 t in 2021. The landed cuttlefishes are basically the European common cuttlefish (*Sepia officinalis*).

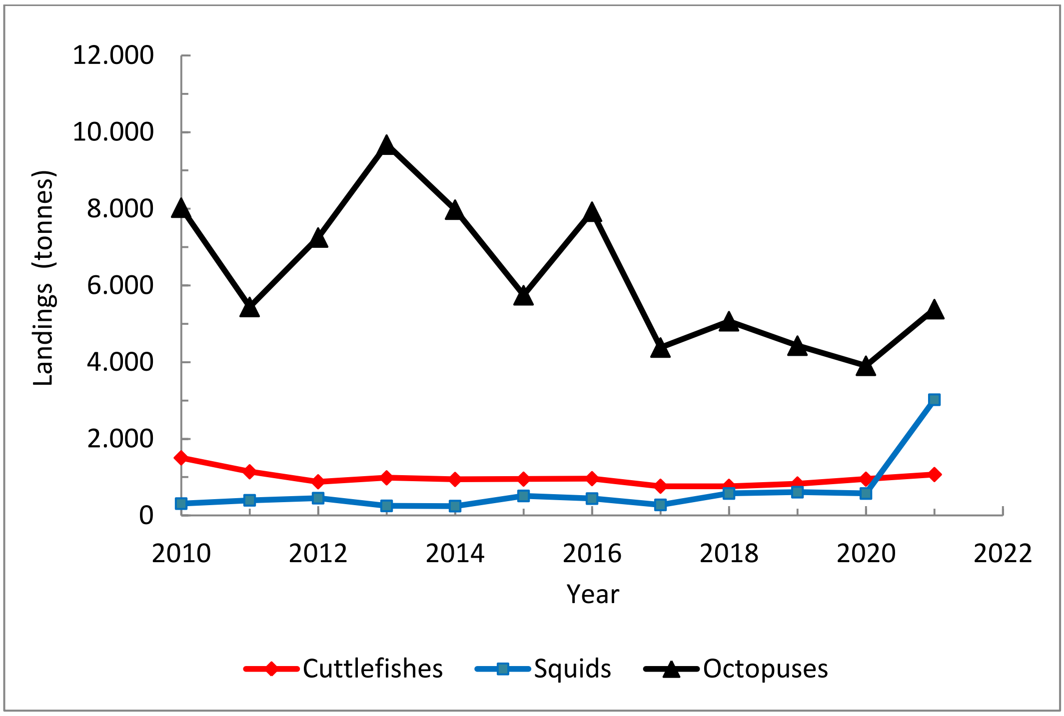

Figure 2 – Evolution of octopuses, squids, and cuttlefishes landings (tonnes) in Portuguese auctions.

Figura 2 – Evolução dos desembarques de polvos, lulas e chocos (toneladas) nas lotas portuguesas.

European squid (*Loligo vulgaris*) is the main landed squid and represented 60 % of total squids between 2010 and 2019. This percentage reached 85 % in 2020 mainly due to a decrease of shortfin squid landings (about 170 tonnes in 2019 and 60 tonnes in 2020), although the European squid landings had also increased from about 389 tonnes in 2019 to around 487 tonnes in 2020. European squid landings represented only 15 % of total squid landings in 2021 as a result of the very high level of shortfin squid landed (2517 t). Shortfin squid group includes three species belonging to the

Ommastrephidae family and their landings accounted for around 22 % of total landed squids in the period of 2010-2019 but in 2021 its percentage increased to 83 %.

Figure 3 shows the evolution of auction prices of the four main groups of cephalopods in the period 2010-2021. European squid had the highest prices ranging between 7.54 and 9.74 €/kg, while the lowest prices (1.19-2.95 €/kg) were recorded in shortfin squid during this period. An inverse relationship between price and the amount of landed common octopus or European common cuttlefish was observed. However, in the case of European and shortfin squids this relationship was not recorded.

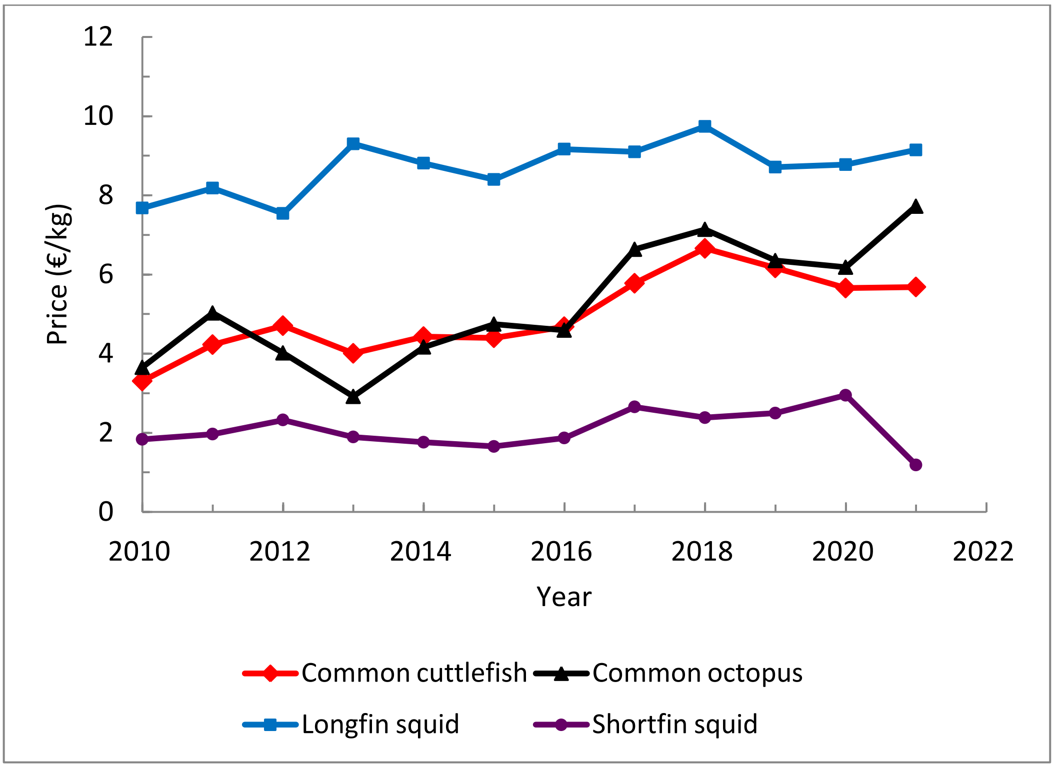

Figure 3 – Annual average prices (€ kg^{-1}) for octopuses, squids, and cuttlefishes in Portuguese auctions.

Figura 3 – Preços médios anuais (€ kg^{-1}) de polvos, lulas e chocos nas lotas portuguesas.

Nutritional value

Several databases with the chemical composition of fish are available in the literature, but that one from FAO (2016) is worth mentioning for presenting up-to-date, comprehensive and reliable data.

Octopuses

In the 2010s, several studies were published on the nutritional value of four species of octopus: common octopus, musky octopus (*Eledone moschata*), neglected ocellate octopus (*Amphioctopus neglectus*), and old woman octopus (*Cistopus indicus*).

In the work by Prato *et al.* (2010) the influence of five diets on the approximate chemical composition and fatty acid profile of the common octopus was studied. Wild octopus used in these experiments was caught in the Ionian Sea, Southern Italy. The proximate composition of cultured octopus shown in Table 1 is the average composition of octopus fed with the five different diets. Cultured octopuses had higher protein content and lower fat content than wild octopus. Saturated fatty acids (SFAs) were the major fatty acids group, followed by polyunsaturated fatty acids (PUFAs), and monounsaturated fatty acids (MUFAs) both in cultured and wild octopus (Table 2). However, fatty acid profiles among cultured octopuses presented significant differences reflecting their dietary fatty acids composition, but docosahexaenoic (DHA) and eicosapentaenoic (EPA) acids were predominant PUFAs both in wild and cultured octopuses.

Common octopus (*Octopus vulgaris*). (Photo kindly provided by Dr. João Pereira)
Polvo-comum (*Octopus vulgaris*). (Fotografia amavelmente cedida pelo Dr. João Pereira)

The study by Özden and Erkan (2011) on the nutritional value of various cephalopod species caught off in the Aegean Sea and purchased from an Istanbul fish market (Turkey) included the evaluation of the proximate composition and elemental profile (Tables 1 and 3) of common octopus. These authors also reported for this species an iodine content of 0.626 mg kg^{-1}. Oliveira *et al.* (2019) evaluated the effect of industrial water boiling on the nutritional value of common octopus purchased in Lisbon region, Portugal, by determining the proximate composition, fatty acid and elemental profiles of raw and cooked product (Tables 1, 2, and 3). The iodine content reported by these for raw and boiled common octopus was 0.08 and 0.12 mg kg^{-1}, respectively. Regarding the proximate composition of the octopus specimens reported in the three above mentioned studies, the biggest differences were registered in the protein content. These differences may be related to the physiological state of the specimens used in the these studies since, according to Rosa *et al.* (2003), nitrogen compounds appear to be closely related to sexual maturation, spawning and brooding. It is also noticeable the fatty acid differences between the results obtained by Prato *et al.* (2010) and Oliveira *et al.* (2019). For the latter authors, the order of the relative percentages of the three fatty acids groups was PUFAs>SFAs>MUFAs. Concerning boiled octopus, the true retention (TR) of macro nutrients was: 47.8 % water, 78.8 % protein, 89.5 % fat, and 49.2 % ash. In the case of fatty acids, TR was: 89.5 % SFAs, 92.1 % MUFAs, 89.0 % PUFAs, 90.8 % EPA, and 89.1 % DHA. For the mineral fraction, TR was 44.6 % Na, 48.6 % K, 66.8 % P, 51.8 % Mg, 69.8 % zinc, 80.5 % Cu, 53.5 % Se, and 86.8 % I (Oliveira et al., 2019). In terms of elemental composition, common octopus is a good source of P and Mg and excellent source of Se (Özden and Erkan, 2011; Oliveira et al., 2019), Fe (Özden and Erkan, 2011) and Cu and Zn (Oliveira et al., 2019) as shown in Table 3. The levels of total essential amino acids (EAA) and total non-essential amino acids (NEAA) in raw common octopus reported Özden and Erkan (2011) and Oliveira et al. (2019) were similar. The former authors obtained: 4.24 g 100 g-1 for EAA (tryptophan not determined) and 8.73 g 100 g-1 for NEAA and the latter authors referred: 4.10 and 8.18 g 100 g-1 for EAA and NEAA, respectively. In boiled octopus the EAA and NEAA were 7.43 and 12.49 g 100 g-1, respectively and the TRs were in the range of 65.7 % for glycine and 98.9 % for lysine (Oliveira et al., 2019).

The study by Ayas (2012) on the seasonal variations of fat and fatty acid composition of the arms and mantle of two Mediterranean octopuses species - common octopus and musky octopus - showed that the fat level in the mantle of common octopus ranged from 0.90 to 1.19 % and in musky octopus varied from 1.00 to 1.60 %. Fat content of arms ranged from 0.75 and 0.92 % in common octopus and between 0.89 and 1.07 % in musky octopus. These values were slightly lower than those recorded in the mantle which was in the range 0.75-0.92 % in common octopus and 0.89-1.07 % in musky octopus. In both species, the highest and lowest fat content was obtained in the summer and winter, respectively. PUFAs were the major fatty acids group in both octopus species (Table 2). The highest DHA level in the mantle (28.17 %) and arms (27.65 %) of common octopus was recorded in the summer, while the highest EPA content, 18.23 % both in the mantle and arms, was measured in the spring. In musky octopus, the highest DHA content of mantle (25.49 %) and arms (25.12 %) was recorded in the autumn and summer, respectively. However, the highest EPA level in mantle (12.90 %) and arms (12.67 %) was obtained in the autumn and summer respectively. In general, DHA content was similar in both species but common octopus was richer in EPA than musky octopus.

Chakraborty *et al.* (2016) evaluated the fat content and fatty acid profile of neglected ocellate octopus and old woman octopus collected from the south west coast of India. The former species had a fat content of 2.5 % and the latter a fat content of 1.75 %. PUFAs were the main group in both species as shown in Table 2. Palmitic acid (455.01 mg 100 g^{-1}) was the main SFA in neglected ocellate octopus but in old woman octopus it was stearic acid (253.92 mg 100 g^{-1}). In both species, erucic acid (22:1 n-9) was the dominant MUFA accounting for 228.04 and 322.34 mg 100 g^{-1} in neglected ocellate octopus and old woman octopus, respectively. DHA was also the main PUFA in both species. As shown in Table 3, both species are excellent sources of Mg, Fe, Cu, and Zn and good sources of Se.

The individual effects of sodium and potassium on blood pressure are well known. However, it has been reported that the sodium to potassium ratio (Na:K) is more important to predict the hypertension than either sodium or potassium intake alone (Stamler *et al.*, 1989; Tzoulaki *et al.*, 2012; Perez and Chang, 2014). The World Health Organization (WHO) recommend a sodium intake <2000 mg/day and a potassium intake >3510 mg/day, which would lead to a Na:K ratio ≤ 1.0 mmol $mmol^{-1}$ (WHO, 2012). However, recent studies have demonstrated that molar intake between 1.0 and 2.0 may lower cardiovascular disease risk in adults (Swanepoel *et al.*, 2016, Vasara *et al.*, 2017). Taking into consideration these reference values, only neglected ocellate and old woman octopuses had Na:K ratio ≤ 2.0 mmol $mmol^{-1}$.

In order to check the eventual addition of water to common octopus, Mendes *et al.* (2017) determined the water and protein content of 265 samples to establish the base line data for the composition of this species. Moisture and protein content were in the range of 76.2-85.4 % and 12.0-19.1 %, respectively. A significant inverse correlation (r=-0.75) between moisture and protein content was determined.

The levels (median in mg kg^{-1}) of Zn, Cu, Mn, and Se determined by Olmedo *et al.* (2013) in canned common octopus consumed in Andalusia, Spain, were the following: 6.431 Zn, 3.407 Cu, 0.224 Mn, and 0.09 Se.

Squids

Squids commercialized worldwide include several species whose chemical compositions are relatively similar, but they have very different sensory characteristics (mainly taste and texture) that determine, to a certain extent, their commercial value. In general, longfin squids, such as European squid, have a sweetish taste and are tender while some shortfin squids have a slightly bitter taste and are tougher.

In their study on the nutritional value of species consumed in Turkey, Özden and Erkan (2011) evaluated the proximate composition and elemental profile of European squid and broadtail shortfin squid (*Illex coindetii*) which are presented in Tables 1 and 3, respectively. The level of iodine reported for European squid and broadtail shortfin squid was 0.339 and 0.295 mg kg^{-1}, respectively.

Broadtail shortfin squid had the same content of total content of EAA and NEAA (5.13 g 100 g^{-1}) as reported by Özden and Erkan (2011) but tryptophan was not determined. European squid had the lowest total amino acid content of all the cephalopods studied by these authors and its EAA and NEAA contents were 2.98 and 6.93 (g 100 g^{-1}), respectively.

Indian squid (*Uroteuthis duvaucelii*).
(http://www.wildsingapore.com/wildfacts/mollusca/cephalopoda/sqindian.htm)
Lula indiana (Uroteuthis duvaucelii).

Atayeter and Ercoşkun (2011) studied the effect of frozen storage at three temperatures (-20 °C, -30 °C, and -40 °C) on the quality of European squid. This study provides information on the proximate composition and percentage of the three groups of fatty acids in squid mantle and tentacles (Tables 1 and 2). It is noteworthy the high percentages of PUFAs and DHA in both portions. An increase of SFAs content was observed but MUFAs and PUFAs contents decrease during frozen storage of mantle and tentacles. Moreover, an inverse relationship between the increase of SFA percentage and the reduction of frozen storage temperature was observed. It is worth mentioning the differences in moisture and protein contents obtained by Özden and Erkan (2011) and Atayeter and Ercoşkun (2011) in their studies on European squid. These differences may result from the growth stage, habitat and season as reported by several authors (Kreuzer, 1984; Ozogul *et al.*, 2008).

Chedoloh *et al.* (2011) determined the fat content (1.59 %) and fatty acid profile of Indian squid (*Uroteuthis duvauceli*) collected at the fishing port of Pattani, Thailand. As shown in Table 2, PUFAs were the major group followed by SFAs. The major SFA was palmitic acid (23.7 %) while oleic acid (11.7 %) was the predominant MUFA and DHA the most abundant within PUFAs.

Higher fat content (1.75 %) for Indian squid from the south west coast of India was obtained by Chakraborty *et al.* (2016). PUFA was also the major group of total fatty acids (Table 2), palmitic acid (408.83 mg 100 g^{-1}) the major SFA and oleic acid (83.43 mg 100 g^{-1}) the predominant MUFA.

Mehta and Nayak (2017) evaluated the biochemical composition (Tables 1 and 2) of Indian squid landed at Versova, India. In this study, the relatively low PUFA content and the high SFA content are noteworthy. Another study by Remyakumari *et al.* (2018) was designed to find out the biochemical composition and nutritional quality of Indian squid. The samples were collected at Fort Cochin (India) and the results of the proximate composition, fatty acids, and elemental profiles are shown in Tables 1, 2, and 3, respectively. The very low MUFAs content and high PUFAs, EPA, and DHA contents are the main features to be mentioned. It is also worth to stress the differences in the percentages of the three fatty acid groups reported in these four studies for Indian squid fatty acid composition. The highest PUFA/SFA ratio (2.3) was registered in the study by Remyakumari *et al.* (2018) followed by ratio values of 1.4 and 1.1 obtained by Chakraborty *et al.* (2016) and Chedoloh *et al.* (2011), respectively. However, a very low ratio (0.3) was reported by Mehta and Nayak (2017). These results put into evidence the effect of several factors on the chemical composition within the same species as mentioned above.

The levels of Zn, Cu, Mn, and Se were determined by Olmedo *et al.* (2013) in giant squid (*Dosidicus gigas*) and European squid (median in mg kg^{-1}) consumed in Andalusia. The level of these elements were the following: fresh giant squid - 1.651 Zn, 0.666 Cu, 0.076 Mn, and 0.093 Se; frozen European squid - 5.036 Zn, 2.959 Cu, 0.215 Mn, and 0.142 Se; and canned European squid - 4.504 Zn, 1.607 Cu, 1.527 Mn, and 0.113 Se.

Broadtail shortfin squid and European squid both stand out as excellent sources of Fe and Se and good sources of Mg. Indian squid is also remarkable as an excellent source of Mg, Fe, Cu, and Zn and a good source of Se (Chakraborty *et al.*, 2016).

Concerning the Na:K ratio, all squids comply with the reference values mentioned above.

Cuttlefishes

The proximate composition of common cuttlefish purchased from an Istanbul local market and collected from fish landing areas located along the West Coast of Peninsular Malaysia was determined by Özden and Erkan (2011) and Nurnadia *et al.* (2011), respectively (Table 1). Although these authors had analyzed specimens captured in very different locations, the similarity of the results obtained is noteworthy.

The elemental profile of common cuttlefish reported by Özden and Erkan (2011) is presented in Table 3. These authors also reported an iodine content of 0.228 mg 100 kg^{-1} for this species. As shown in this table, common cuttlefish is an excellent source of Fe and Se and a good source of P and

Mg. According to these authors, the levels of total EAA and NEAA (g 100 g^{-1}) in common cuttlefish were 6.77 and 8.28, respectively, but as mentioned above tryptophan was not determined.

The fat content and fatty acid profile of pharaoh cuttlefish (*Sepia pharaonis*) collected at the fishing port of Pattani, Thailand was determined by Chedoloh *et al.* (2011). The specimens analyzed had a fat content of 1.87 % and the percentages of SFAs, MUFAs, PUFAs, EPA, and DHA are shown in Table 2. The major SFA was palmitic acid (21.3 %), oleic acid (12.7 %) the predominant MUFA and EPA (10.6 %) the main PUFA.

Common cuttlefish (*Sepia officinalis*). (Photo kindly provided by Dr. João Pereira).

Choco-comum (*Sepia officinalis*). (Fotografia amavelmente cedida pelo Dr. João Pereira).

Chakraborty *et al.* (2016) also determined the fat content (2.56 %) and fatty acid profile (Table 2) of pharaoh cuttlefish from the south west coast of India. The order of abundance of the three fatty acids groups was also PUFAs>SFAs>MUFAs and palmitic acid (368.94 mg 100 g^{-1}) was the major SFA but erucic acid (268.31 mg 100 g^{-1}) was the major MUFA. A relatively higher PUFA/SFA ratio (1.7) was recorded in the fatty acid profile obtained by Chakraborty *et al.* (2016) than that reported by Chedoloh *et al.* (2011) (1.1).

Spineless cuttlefish (*Sepiella inermis*) analyzed by Chakraborty *et al.* (2016) had a fat content of 1.30 % and the fatty acid profile shown in Table 2. In this species, PUFA was the dominant group and palmitic (199.66 mg 100 g^{-1}) and erucic (199.66 mg 100 g^{-1}) acids were the major SFA and MUFA, respectively.

The elemental profile of these two cuttlefish species analyzed by Chakraborty *et al.* (2016) is presented in Table 3, being remarkable their high levels of Mg and Zn.

Cuttlefishes are generally excellent or good sources of Mg, Fe, Zn, Cu, and Se (Table 3). Only spineless cuttlefish have a Na:K ratio higher than 2.0.

The levels (median in mg kg^{-1}) of Zn, Cu, Mn, and Se in fresh giant cuttlefish marketed in Andalusia were 7.758, 3.148, 0.288, and 0.131, respectively as reported by Olmedo *et al.* (2013).

The majority of cephalopod species are extra lean (fat content lower than 2 %), have medium protein content (15 %), are good or excellent sources of Mg, Fe, Cu, and Se and have a relatively low caloric value (68 kcal $100g^{-1}$).

The effect of three cooking methods (oven and microwave cooking and frying) on the sterol content of three cephalopod species was evaluated by Ozogul *et al.* (2015). The level of cholesterol (mg 100 g^{-1}) in European squid, common octopus, and common cuttlefish was 18.92, 26.92, and 19.49, respectively. This sterol represented 60.9 % of total sterols in common octopus but 73.1 % and 71.9 % in squid and cuttlefish, respectively. Cholesterol level increased in microwave cooked cephalopods but a considerable reduction occurred in fried octopus. However, no significant changes of cholesterol content took place in oven cooked squid and octopus.

Factors used in this review

The caloric values shown in Table 1 were calculated based on the general Atwater factors, i. e., 4 kcal g^{-1} for protein and 9 kcal g^{-1} for fat (FAO, 2016).

In order to converting the percentage of fatty acid to fatty acid in mg 100 g^{-1} edible portion (EP) the following equation was used:

Total fatty acid (mg 100 g^{-1} EP) = % fatty acid x XFA x F x 10

where XFA is the conversion factor and F the total lipid content (g 100 g^{-1} EP).

XFA was calculated using the formula by Weihrauch *et al.* (1977) for molluscs:

XFA (g g^{-1}) = 0.956 - 0.296/total lipid content.

For molluscs with total lipid content lower than 0.55 g 100 g^{-1} EP, XFA = 0.417 was used according to Nowak *et al*. (2014).

Table 1 - Proximate composition of cephalopods (g 100 g^{-1}) and caloric value (kcal 100 g^{-1}).
Tabela 1 – Composição química aproximada de várias espécies de cefalópodes (g 100 g^{-1}) e valor calórico (kcal 100 g^{-1}).

Common name	Scientific name	Moisture	Protein	Fat	Carbohydrates	Ash	Caloric value	Source
Octopuses								
Common octopus (wild)	*Octopus vulgaris*	81.87	14.23	0.74	1.32	1.85	64	Prato *et al.* (2010)
Common octopus (cultured)	*O. vulgaris*	81.70	14.68	0.58	1.38	1.66	64	Prato *et al.* (2010)
Common octopus	*O. vulgaris*	81.99	13.09	0.76	1.95	2.21	59	Özden and Erkan (2011)
Common octopus (raw)	*O. vulgaris*	80.30	16.90	0.43	-	1.72	71	Oliveira *et al.* (2019)
Common octopus (boiled)	*O. vulgaris*	72.80	25.20	0.72	-	1.60	107	Oliveira *et al.* (2019)
Squids								
European squid (mantle)	*Loligo vulgaris*	78.54	18.52	1.37	-	1.45	86	Atayeter and Ercoşkun (2011)
European squid (tentacles)	*L. vulgaris*	80.72	16.16	1.44	-	1.63	78	Atayeter and Ercoşkun (2011)
European squid	*L. vulgaris*	83.90	11.38	2.63	1.32	0.77	69	Özden and Erkan (2011)
Broadtail shortfin squid	*Illex coindetii*	79.00	15.59	1.56	2.18	2.18	76	Özden and Erkan (2011)
Indian squid	*Uroteuthis duvaucelii*	84.60	14.20	0.70	-	0.90	63	Mehta and Nayak (2017)
Indian squid	*U. duvaucelii*	80.40	17.50	0.52	-	1.31	75	Remyakumari *et al.* (2018)
Cuttlefishes								
Common cuttlefish (edible muscle)	*Sepia officinalis*	82.61	14.59	0.28	1.26	1.26	61	Özden and Erkan (2011)
Common cuttlefish (mantle)	*S. officinalis*	83.68	13.94	1.35	0.87	0.90	68	Nurnadia *et al.* (2011)

Table 2 – Total content of SFAs, MUFAs, PUFAs, EPA, and DHA as percentage of total fatty acids and in mg 100 g^{-1} (in brackets) of several cephalopod species.

Tabela 2 – Teores de SFA, MUFA, PUFA, EPA e DHA em percentagem do total de ácidos gordos e em mg 100 g^{-1} (entre parêntesis) de várias espécies de cefalópodes.

Common name	SFA	MUFA	PUFA	EPA	DHA	n-3/n-6	Source
Octopuses							
Common octopus (wild)	56.22 (231.3)	12.27 (50.5)	31.51 (129.6)	6.29 (25.9)	10.57 (43.5)	1.78	Prato *et al.* (2010)
Common octopus (cultured)	48.78 (126.1)	18.25 (47.2)	31.91 (82.5)	6.48 (16.7)	9.67 (25.0)	2.81	Prato *et al.* (2010)
Common octopus (mantle)	30.05-34.07 (192.3-252.9)	7.10-10.71 (40.1-81.9)	51.25-53.59 (297.3-451.0)	15.98-18.23 (90.2-139.5)	25.17-28.17 (154.0-237.1)	-	Ayas (2012)
Common octopus (arms)	31.61-33.69 (141.8-192.0)	7.48-10.31 (31.5-55.0)	50.31-52.75 (221.2-294.1)	15.56-18.23 (67.7-101.5)	25.04-27.65 (113.1-161.3)		Ayas (2012)
Common octopus (raw)	- (125.74)	- (47.68)	- (252.18)	- (71.2)	- (92.6)	5.25	Oliveira *et al.* (2019)
Common octopus (boiled)	- (213,20)	- (83.24)	- (425.05)	- (131.89)	- (169.50)	5.17	Oliveira *et al.* (2019)
Musky octopus (mantle)	29.69-32.09 (196.0-364.6)	14.35-15.06 (97.0-179.1)	46.3-47.09 (310.8-571.2)	11.94-12.90 (85.1-154.3)	24.99-25.49 (168.2-312.2)	-	Ayas (2012)
Musky octopus (arms)	29.80-32.28 (165.3-226.0)	13.04-14.74 (81.8-97.1)	45.69-46.84 (256.6-337.1)	11.96-12.67 (66.9-92.1)	23.90-25.12 (132.9-182.6)		Ayas (2012)
Neglected ocellate octopus	- (879.25)	- (477.06)	- (1076.25)	- (238.84)	- (645.05)	6.35	Chakraborty *et al.* (2016)
Old woman octopus	- (461.62)	- (485.54)	- (660.86)	- (135.57)	- (374.68)	5.26	Chakraborty *et al.* (2016)
Squids							
European squid (mantle)	29.95 (303.6)	9.95 (100.9)	59.31 (601.2)	14.30 (145.0)	38.97 (395.0)	10.0	Atayeter and Ercoşkun (2011)
European squid (tentacles)	34.16 (431.2)	10.69 (134.9)	55.15 (696.1)	13.11 (165.5)	34.95 (441.2)	7.60	Atayeter and Ercoşkun (2011)
Indian squid	41.3 (505.5)	14.1 (172.6)	44.7 (547.1)	7.5 (91.8)	11.9 (145.7)	1.59	Chedoloh *et al.* (2011)
Indian squid	- (591.00)	- (180.95)	- (845.78)	- (213.54)	- (534.89)	10.64	Chakraborty *et al.* (2016)

Table 2 (cont.)

Indian squid	64.99 (242.5)	16.50 (61.6)	18.51 (69.1)	6.80 (25.4)	6.79 (25.3)	2.76	Mehta and Nayak (2017)
Indian squid	30.12 (65.3)	1.98 (4.3)	67.9 (147.2)	11.96 (25.9)	48.53 (105.2)	8.27	Remyakumari *et al.* (2018)
Cuttlefishes							
Pharaoh cuttlefish	39.4 (587.7)	17.2 (256.6)	43.5 (648.9)	10.6 (158.1)	8.9 (132.8)	1.30	Chedoloh *et al.* (2011)
Pharaoh cuttlefish	- (720.19)	- (515.28)	- (1211.27)	- (360.96)	- 599.90)	4.32	Chakraborty *et al.* (2016)
Spineless cuttlefish	- (398.26)	- (166.29)	- (594.90)	- (119.25)	- (267.63)	2.19	Chakraborty *et al.* (2016)

Table 3 - Elemental profile of cephalopods (mg 100 g^{-1}) except Se (μg 100 g^{-1}).
Tabela 3 – Perfil mineral de várias espécies de cefalópodes (mg 100 g^{-1}) exceto Se (μg 100 g^{-1}).

	Na	K	P	Mg	Ca	Fe	Cu	Zn	Se	Na:K molar ratio	Source
Octopuses											
Common octopus	609.60	330.72	*187.38*	**103.23**	44.23	**7.44**	-	-	**168.9**	3.1	Özden and Erkan (2011)
Common octopus (raw)	393.3	262.2	*162.2*	*57.4*	-	-	**0.18**	1.26	**35.0**	2.5	Oliveira *et al.* (2019)
Common octopus (boiled)	332.5	241.7	*205.2*	*56.1*	-	**-**	**0.27**	*1.66*	**35.0**	2.3	Oliveira *et al.* (2019)
Neglected ocellate octopus	172.45	144.56	86.07	**92.83**	73.72	**7.44**	**3.55**	**13.08**	*9.31*	2.0	Chakraborty *et al.* (2016)
Old woman octopus	170.14	184.83	66.33	**104.78**	54.04	**6.60**	**7.54**	**14.17**	*9.45*	1.6	Chakraborty *et al.* (2016)
Squids											
Broadtail short fin squid	231.60	417.05	**335.58**	*69.17*	54.64	**12.39**	-	-	**65.0**	0.9	Özden and Erkan (2011)
European squid	129.54	233.51	*230.36*	*52.70*	12.54	**10.73**	-	-	**26.3**	0.9	Özden and Erkan (2011)
Indian squid	171.98	176.13	85.63	**127.36**	72.82	**10.42**	**1.33**	**7.21**	*9.54*	1.7	Chakraborty *et al.* (2016)
Indian squid	102.0	189.0	-	**163.0**	15.0	*2.9*	*0.1*	1.0	-	0.9	Remyakumari *et al.* (2018
Cuttlefishes											
Common cuttlefish	204.43	333.98	*239.76*	*49.04*	36.05	**7.28**	-	-	**119.8**	1.0	Özden and Erkan (2011)
Pharaoh cuttlefish	170.18	201.2	80.40	**127.28**	108.41	**7.79**	**5.57**	**15.18**	*8.95*	1.4	Chakraborty *et al.* (2016)
Spineless cuttlefish	172.77	134.67	72.37	**109.76**	79.73	**8.45**	**5.33**	**8.34**	*9.34*	2.2	Chakraborty *et al.* (2016)
Recommended Daily Allowance	-	-	700	420	1000	8	0.9	11	55		USDA (2021)

Values in italics are “good sources” and values in bold are “excellent sources” based on RDA.

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