ScienceDirect

Journal of Food Composition and Analysis

Volume 98, May 2021, 103826

Short communication

Fatty acid composition of the Barents Sea red king crab (*Paralithodes camtschaticus*) leg meat

Alexander G. Dvoretsky [a], Fatima A. Bichkaeva [b], Nina F. Baranova [b], Vladimir G. Dvoretsky [a]

https://doi.org/10.1016/j.jfca.2021.103826

Highlights

- PUFAs dominated (55.2 %) among FAs assayed in muscle of adult red king crabs.
- Concentrations of FAs do not depend on size, shell condition, limb injury or sex.
- The levels of FAs in muscle were 7–15 times lower than in the hepatopancreas.
- The Barents Sea crabs are richer in SFA and PUFA than their native conspecifics.
- The omega-3/omega-6 ratio is 3.7:1 and close to the recommended value.

Abstract

The information on fatty acid profiles in different tissues of the Barents Sea red king crab (*Paralithodes camtschaticus)* is scarce and fragmentary. For this reason, leg meat of red king crabs collected at a coastal site of the Barents Sea in summer was analyzed for fatty acid composition by gas chromatography. Polyunsaturated fatty acids (PUFA) dominated among fatty acids assayed (1623 $\mu g \cdot g^{-1}$, 55.2 %), saturated fatty acids (SFA) accounted for 790 $\mu g \cdot g^{-1}$ or 27.6 % and monounsaturated fatty acids (MUFA) – 519 $\mu g \cdot g^{-1}$ or 17.28 %. Concentrations of fatty acids were similar in red king crabs regardless of size group, shell condition, limb injury status or sex (with some exceptions). The meat of red king crabs from the Barents Sea contains higher percentages of SFA and PUFA and lower percentages of MUFA than the meat of the crabs from native regions and the percent value of arachidonic acid was 14 times higher than in Alaskan red king crabs. High concentrations of essential eicosapentaenoic and docosahexaenoic acids in the Barents Sea red king crab meat and an n-3/n-6 ratio close to the recommended value characterize this product as important for human food.

Introduction

Aquatic invertebrates both marine and freshwater are used as high-quality food and feed supplements throughout the world (Śmietana et al., 2020; Tinker-Kulberg et al., 2020; Wang et al., 2020; Nędzarek and Czerniejewski, 2021). Among many other invertebrates, marine crabs are also considered as important shell fishery products (Rosa and Nunes, 2004;

Mandume et al., 2019). The red king crab, *Paralithodes camtschaticus* (Tilesius, 1815), is a large commercially important crustacean native to the North Pacific. To establish a new fishery resource in a region where no native commercial crab species occur, the red king crab was intentionally introduced into the Barents Sea in the 1960s (Kuzmin and Gudimova, 2002). Further acclimation and range expansion of this species was registered in the next three decades and, by mid-1990s, the invader had formed a self-sustaining population. To study this new red king crab population and prepare advice for its sustainable exploitation, the Joint Fisheries Commission initiated an experimental red king crab fishery. This fishery was undertaken annually in September–December 1994–2003 with the same permitted catch rates for Norway and Russia. In 1995, the total number of *P. camtschaticus* and their commercial stock in the Barents Sea were 456,000 and 225,000 crabs, respectively. By 2003 these parameters have increased considerably to 19,995,000 and 13,370,000 individuals, respectively (Dvoretsky and Dvoretsky, 2018). Today, the population of *P. camtschaticus* in Russian waters of the Barents Sea supports a relatively large-scale commercial fishery. The total catches of red king crab that were taken during 2017, 2018, and 2019 amounted to 9285 t, 9187 t, and 9836 t respectively (Bakanev and Stesko, 2020).

The rapid growth and continuous spread of red king crabs to new areas prompted scientists to start full-scale studies on the effects of this species on the native ecosystem (Britayev et al., 2010; Malovic et al., 2010; Pedersen et al., 2018). Long-term data have shown that the proposed impact of the red king crab on bottom communities of the Barents Sea is not as dramatic as has been expected from its high feeding activity and wide diet (Pavlova, 2008). In addition, cross-correlation analysis suggests that *P. camtschaticus* has no negative effects on the stocks of important fish (Dvoretsky and Dvoretsky, 2015a) but some bycatch problems (gear damage, detrimental catch and loss of fishing) associated with the high abundance of the crab were registered in the first years of its commercial fishery. The biology of *P. camtschaticus* has been extensively studied in recent years providing information about its molting, growth, feeding, behavior, reproduction and symbiotic relationships in the Barents Sea (Kuzmin and Gudimova, 2002, Pavlova, 2008, 2014; Dvoretsky and Dvoretsky, 2009, 2014a, b, 2015b, 2016).

The meat from red king crabs obtains high prices on the market due to its attractive properties. This product has high quality due to a low proportion of cholesterol and muscle protein of red king crabs contains higher proportions of tyrosine, histidine, arginine, tryptophan and cysteine in comparison to fish species. The energy value of cooked red king crab meat is 96 kcal per 100 g (Kizevetter, 1962). Yet despite the long history of study in the Barents Sea there are no complete reports (available for a wide international audience) providing data on the fatty acid composition of red king crab meat. For this reason, this

study was undertaken to measure concentrations of fatty acids in leg meat of red king crab, test relationships between fatty acid profiles and crab size, sex, shell condition and limb injury status, and compare fatty acid concentrations between red king crabs living in the Barents Sea and in their native areas.

Section snippets

Materials and methods

Red king crabs were caught by divers at 5–30 m depth during a coastal expedition in Dalnezelenetskaya Bay (a small gulf situated to the east of Kola Bay, 69°07'N, 36°05'E, see Dvoretsky and Dvoretsky, 2020a, b for detailed description) in July 2016. Each crab was individually weighed, and measured for carapace length (the distance from the posterior margin of the right eye orbit to the medial-posterior margin of the carapace) using a vernier caliper (Donaldson and Byersdorfer, 2005). Limb…

Results

A total of 45 red king crabs (37 females and 7 males) were used for biochemical assays. Among them, 40 crabs (37 females and 3 males) had new shells (2–12 months post ecdysis) while the other 5 male crabs had old shells (13–24 months post ecdysis). Variations in crab sizes and weights are presented in Table 1. Males were larger (df = 1, H = 6.07, p = 0.014) and heavier (df = 1, H = 9.35, p = 0.002) than females. A total of 43 fatty acids were routinely identified and quantified in the red king…

Discussion

The unbalanced sex ratio of large *P. camtschaticus* in shallow waters of Dalnezelenetskaya Bay is associated with differences in the behavior of male and female crabs: in spring, after mating, most of the mature males (carapace length > 110 mm) migrate to deeper water, whereas the females tend to not move as far offshore because higher water temperatures at

coastal sites are required for egg development (Dvoretsky and Dvoretsky, 2013, 2018). Males had larger sizes and were heavier than females.…

Conclusions

An n-3/n-6 ratio of 4:1 is established as optimal for the human diet. However, today this ratio is biased to n-6 fatty acids in the proportions of 10:1–20:1, indicating that Western rations cannot be considered as adequate and well-balanced diets. Because n-3 fatty acids are essential in growth and development throughout the life cycle, they should be included in the diets of all humans. Low cholesterol content of red king crab meat, the presence of all essential amino acids, high…

Declaration of Competing Interest

The authors report no declarations of interest.…

CRediT authorship contribution statement

Alexander G. Dvoretsky: Conceptualization, Investigation, Writing - original draft, Project administration. **Fatima A. Bichkaeva:** Validation, Methodology, Investigation, Formal analysis, Writing - review & editing. **Nina F. Baranova:** Validation, Methodology, Formal analysis, Writing - review & editing. **Vladimir G. Dvoretsky:** Data curation, Investigation, Visualization, Writing - original draft.…

Acknowledgements

This work was supported by the Ministry of Science and Higher Education of the Russian Federation. The English text of the paper and its readability was greatly improved thanks to careful editing and valuable remarks of Dr. Jeffrey Muehlbauer.…

Recommended articles

References (52)

A.G. Dvoretsky *et al.*

Inter-annual dynamics of the Barents Sea red king crab (*Paralithodes camtschaticus*) stock indices in relation to environmental factors
Polar Sci. (2016)

J. Folch *et al.*
A simple method for the isolation and purification of total lipids from animal tissues
J. Biol. Chem. (1957)

N.A. Latyshev *et al.*
Lipids and of fatty acids of edible crabs of the north-western Pacific
Food Chem. (2009)

I. Malovic *et al.*
Trypanosome infections of marine fish in the southern Barents Sea and the invasive red king crab *Paralithodes camtschaticus*
Mar. Pollut. Bull. (2010)

A. Marques *et al.*
Chemical composition of Atlantic spider crab *Maja brachydactyla*: human health implications
J. Food Anal. (2010)

A. Nędzarek *et al.*
The edible tissues of the major European population of the invasive Chinese mitten crab (*Eriocheir sinensis*) in the Elbe River, Germany, as a valuable and safe complement in essential elements to the human diet
J. Food Anal. (2021)

C.D. O'Leary *et al.*
Lipid class distribution and fatty acid composition of wild and farmed prawn, *Penaeus monodon* (Fabricius)
Aquaculture (1990)

D.I. Skonberg *et al.*
Nutrient composition of green crab (*Carcinus maenus*) leg meat and claw meat
Food Chem. (2002)

N. Śmietana *et al.*

Variability of elements and nutritional value of spiny-cheek crayfish (*Faxonius limosus*, Rafinesque, 1817): Variability of elements and nutritional value of *F. limosus*

J. Food Anal. (2020)

X. Wang *et al.*

Characterizing the phospholipid composition of six edible sea cucumbers by NPLC-Triple TOF-MS/MS

J. Food Anal. (2020)

X. Wu *et al.*

Comparison of gender differences in biochemical composition and nutritional value of various edible parts of the blue swimmer crab

J. Food Anal. (2010)

D. Ayas *et al.*

The chemical composition of carapace meat of sexually mature blue crab (*Callinectes sapidus*, Rathbun 1896) in the Mersin Bay

J. FisheriesSciences.com (2011)

S.V. Bakanev *et al.*

Northern Fishing Basin. Red king crab

S. Barrento *et al.*

Nutritional quality of the edible tissues of European lobster *Homarus gammarus* and American lobster *Homarus americanus*

J. Agric. Food Chem. (2009)

S. Barrento *et al.*

Effect of season on the chemical composition and nutritional quality of the edible crab *Cancer pagurus*

J. Agric. Food Chem. (2009)

T.A. Britayev *et al.*

Studies on impact of the alien red king crab (*Paralithodes camtschaticus*) on the shallow water benthic communities of the Barents Sea

J. Appl. Ichthyol. (2010)

K. Chen *et al.*

Biochemical composition and nutritional value analysis of Chinese mitten crab, *Eriocheir sinensis*, grown in pond
Glob. Adv. Res. J. Agric. Sci. (2013)

V.I. Chuchukalo *et al.*
Feeding and some ecological features of mass commercial crab species from the northwestern Japan Sea in early spring
Izv. TINRO (2011)

W.E. Donaldson *et al.*
Biological Field Techniques for Lithodid Crabs
(2005)

A.G. Dvoretsky *et al.*
Fouling community of the red king crab, *Paralithodes camtschaticus* (Tilesius 1815), in a subarctic fjord of the Barents Sea
Polar Biol. (2009)

A.G. Dvoretsky *et al.*
Hemolymph molting hormone concentrations in red king crabs from the Barents Sea
Polar Biol. (2010)

A.G. Dvoretsky *et al.*
Population dynamics of the invasive lithodid crab, *Paralithodes camtschaticus*, in a typical bay of the Barents Sea
ICES J. Mar. Sci. (2013)

A.G. Dvoretsky *et al.*
Red king crab in russia: populations, fisheries, and symbionts

A.G. Dvoretsky *et al.*
Size-at-age of juvenile red king crab (*Paralithodes camtschaticus*) in the coastal Barents Sea
Cah. Biol. Mar. (2014)

A.G. Dvoretsky *et al.*
Commercial fish and shellfish in the Barents Sea: have introduced crab species affected the population trajectories of commercial fish?
Rev. Fish Biol. Fisheries (2015)

A.G. Dvoretsky *et al.*

Size at maturity of female red king crab, *Paralithodes camtschaticus*, from the costal zone of Kola Peninsula (southern Barents Sea)

Cah. Biol. Mar. (2015)

There are more references available in the full text version of this article.

Cited by (30)

Fatty acid composition of two small fish in the Gyda River (Kara Sea Basin, Northwestern Siberia, Russia)

2024, Journal of Food Composition and Analysis

Show abstract

Dietary arachidonic acid supplementation promotes the growth, steroidogenesis and ovarian development in mud crab Scylla paramamosain

2023, Aquaculture Reports

Show abstract

Fatty acids in the circulatory system of an invasive king crab from the Barents Sea

2022, Journal of Food Composition and Analysis

> *Citation Excerpt :*
>
> …Over the last two decades, the red king crab in the Barents Sea has been intensively studied and new data were obtained for population dynamics and distribution patterns (Dvoretsky and Dvoretsky, 2013a, 2016, 2022a; Matishov et al., 2012; Spiridonov et al., 2020; Strelkova et al., 2021), reproduction and growth (Dvoretsky and Dvoretsky, 2012, 2013a, 2014b, 2015b), feeding and behavior (Sundet and Berenboim, 2008; Pavlova, 2015), symbiotic relationships (Dvoretsky and Dvoretsky, 2011, 2013a, b, 2021a, 2022b), and fishery aspects (Dvoretsky and Dvoretsky, 2015a, 2018, 2022a). Although recent studies have provided information on the fatty acid composition of some red king crab tissues and organs such as hepatopancreas and leg muscles (Dvoretsky et al., 2020, 2021a; Lian et al., 2022), biochemical investigations of the red king crab circulatory system are still nascent not only in the Barents Sea but also in the native area of this crustacean. There is no distinction between interstitial fluids and blood within crabs, therefore, they possess a semi-closed or semi-open circulatory system.…

Show abstract

Compositions, nutritional and texture quality of wild-caught andcage-cultured small yellow croaker

2022, Journal of Food Composition and Analysis

> *Citation Excerpt :*
>
> ...The total fatty acids content in CYC muscle was higher than that in the edible part of European seabass (Dicentrarchus labrax), while the total fatty acids content in WYC muscle was lower than that in the edible part of European seabass (Dicentrarchus labrax) (Marques et al., 2019). Compared with crabs, the total fatty acid contents both in CYC and WYC muscles were higher than that in Cooked Female Chaceon Maritae from Namibe (Dvoretsky et al., 2021). The total fatty acids content in CYC muscle was higher than that in the Barents Sea red king crab (Paralithodes camtschaticus) leg meat, while the total fatty acids content in WYC muscle was slightly lower than that in the mean and maximum samples of Barents Sea red king crab (Mandume et al., 2019)....

Show abstract

Renewal of the amateur red king crab fishery in Russian waters of the Barents Sea: Potential benefits and costs

2022, Marine Policy

Show abstract

Fatty acids in microalgae and cyanobacteria in a changing world: Contrasting temperate and cold environments

2022, Biocell

Show abstract

View all citing articles on Scopus ↗

View full text