ScienceDirect

International Journal of Gastronomy and Food Science

Volume 27, March 2022, 100455

From waste to a new sustainable ingredient in the kitchen: Red king crab abdominal flap (*Paralithodes camtschaticus*)

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https://doi.org/10.1016/j.ijgfs.2021.100455 ↗

Abstract

Paralithodes *camtschaticus* (red king crab) is an introduced species in the Barents Sea. Nowadays it is considered invasive, representing a potential threat to the ecosystems. In Norway, the red king crab catch has increased from 50 tons to 1906 tons from 2004 to 2011. As it is almost exclusively the legs of the red king crab that are commercially used, around 32% of the crab is discarded. This means 351 tons of waste during this eight-year period, an amount that will only increase in the next few years. Taking this environmental problem into consideration, the king crab abdominal flap, a common waste product in the king crab industry, has been used as an example to analyze the nutritional value and heavy metal content. The results show that the content of lead (<0.01 mg/kg), cadmium (0.0986 mg/kg) and mercury (0.0163 mg/kg) is below the concentrations established by EFSA (0.5 mg/kg). Also, the concentration of macronutrients was compared to standard king crab legs where the protein accounts for 14.6 g per 100 g, fat for 0.5 g and carbohydrates for 0.6 g. Mineral compounds such as potassium, phosphorus, and sodium have been found in high

concentrations in comparison to king crab leg samples. According to a sensory analysis, there are significant differences between the abdominal flap and leg, but the abdominal flap has been accepted by consumers averaging 6 points on the hedonic scale. In addition, male testers appreciated the flavor more than female testers in all the samples, but without any preferences between samples (variances were the same). Finally, when comparing cooking methods, pan searing has been concluded to be the best method to cook the abdominal flap, as it enhances the texture, aroma, and flavor, followed by cooking it sous-vide and pan seared and lastly just sous vide. The differences in flavor are due to the compounds generated during each process. Our culinary application study shows that this product is completely acceptable as a new ingredient, even for fine dining restaurants.

Introduction

One of the largest commercially caught arthropods in the world, the *Paralithodes camtschaticus* (red king crab), it's an invasive species in the Barents Sea and along the coast of Norway (Jørgensen, 2013), Alaska and Russia (Dvoretsky and Dvoretsky, 2015). In Russian waters, the red king crab commercial stock reached 21 million crabs in 2016 (Dvoretsky and Dvoretsky, 2018). The populations of red king crab in Norway have skyrocketed, with an estimated 12 million crabs living in the Barents Sea alone (WWF-Norge, 2002). Since it is an introduced species, the red king crab represents a potential threat to the ecosystems in the Barents Sea, due to their predatory behavior and ability to travel great distances with their long legs (Christiansen et al., 2015). Red king crabs are also a growing concern for fishermen, particularly in gillnet industries, as they destroy nets when they are by-caught (Jørgensen, 2013). Red king crab is a very expensive delicacy, above all, because of its legs. However, the rest of the animal is commonly not used in gastronomy. The by-product represents 32% of the crustacean. It is, therefore, highly relevant to reconsider this “waste” in order to use the whole product (Andreassen, 2014).

According to a report by the Nofima Laboratory about red king crab in Northern Europe, the catch of red king crab increased from 50 tons to 1906 tons from 2004 to 2011 (Stenberg et al., 2012). According to this study, 351 tons of waste was produced during this 8-year period. With this in mind, it is important to manage this waste in a sustainable way. It will become a major environmental issue due to the high concentration of different metabolites from proteins in landfills or ocean waters.

In addition, these wasted by-products contain a large amount of protein and essential amino acids, such as valine, leucin, arginine, lysin and threonine. The total amounts are 25% of free amino acids as well as 21% other proteins (Stenberg et al., 2012). Another finding in

the Nofima Lab study in Norway was that the content of heavy metals in the waste was below the maximum limits permitted in the Commissions Regulations (EU) Nº 1881/2006 of December 19, 2006, setting maximum levels for certain contaminants in food stuffs (Stenberg et al., 2012). The established limit is 0.5 mg/kg wet weight of mercury and lead (The Commision of the European Communities, 2006).

The adult male king crab abdominal flap (Fig. 1) as an interesting new part of the crab to use, due to around 50 tons are wasted per year by fishery producer (Stenberg et al., 2012). The king crab abdominal flaps used in this study were sourced from Norway, from the MS Donna company. MS Donna focuses on responsible fishing and has a zero-waste philosophy (rethink, reuse and reduce). MS Donna has highlighted some of the offcuts of the king crab, such as the abdominal flap and roe, by offering them to restaurants and challenging them to find ways to use them in their menus.

The king crab abdominal flap has been used in different traditional recipes, for example in Norway and Alaska, where they are pickled. More recently, king crab abdominal flap appeared on the menu of different fine dining restaurants in the Nordic region, where the goal is to turn food waste into a fine dining experience (MS Donna, 2010).

The objective of this research is highlighting the importance of the king crab abdominal flap as a new product and resource in gastronomy.

Section snippets

Materials and method

The nutritional value of flap was analysed to carry first part of this studio. To study the acceptance of the flap, a sensory analysis was performed by comparing of leg and flap samples. Additionally, three cooked methods were studied by another sensory analysis to analyze the appropriated cooked method for the flap.…

Nutritional analysis

Table 1 shows the obtained results for the nutritional composition and heavy metal content of King crab abdominal flaps. The values per 100 g of sample were found: 2.1 g ash, 82.2 g water, 14.6 g protein, 0.5 g fat, 0.6 g carbohydrate and 277 kcal. Per kilogram of sample, the king crab abdominal flap contained 3.67 mg of iron, 1470 mg of phosphorus, 4050 mg of sodium, and 2520 mg of potassium.

King crab abdominal flap showed a low concentration of heavy metals: <0.01 mg/kg of lead, 0.0986 mg/kg…

Discussion and conclusion

The flaps have similar nutritional qualities to leg meat and are well below the thresholds for nasty chemicals. The results of the study showed that the amount of heavy metals in king crab abdominal flap samples are below the maximum concentration established by the European Food Safety Authority (EFSA). The concentration must not be over 0.5 mg/kg (The Commision of the European Communities, 2006, 2016), thus the king crab abdominal flap sample did not exceed the maximum limit of lead, mercury…

Culinary application

According to the results from the sensory analysis, a king crab abdominal flap recipe was developed in the Alchemist restaurant test kitchen. The king crab abdominal flap was first brined in a seaweed brine (as explained in section two) for 24 h at 4 °C and then cooked at 52 °C for 15 min. Following the results obtained in the sensory analysis, the abdominal flap was brined, cooked sous vide and pan seared (3 min at 180 °C), a thin slice of bread was placed underneath the flap before it was pan …

Authors contributions

NR carried out all sensory analysis and drafted the manuscript. DP carried out all gastronomic applications and experiments and adapt the manuscript. RR carried out gastronomic applications test and sensory analysis samples. KO supplied all material samples and data on king crab and sustainability fishing inputs. RM founded and check all manuscript. All authors read and approved the final manuscript.…

Implications for gastronomy

The research article “From waste to a new sustainable ingredient in the kitchen: red king crab abdominal flap (*Paralithodes camtschaticus*)”, is relevant for gastronomy because it highlights an unused part of the king crab that has typically been disregarded and directly discarded for years. The research demonstrates the abdominal flap's gastronomical value through data analysis, including nutritional value, water content, ash, energy, fat, carbohydrates, and proteins. It also proves its safety…

Acknowledgment

Thanks to Copenhagen Hospitality College (HRS) for providing the space and the students to perform the sensory analysis.…

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