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Original Research Article

The evaluation of selected shellfish as a source of niacin in nutrition and therapy of modern human

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ABSTRACT

Introduction: The presence of fish and seafood in the diet of people at high risk of heart disease, pregnant women and the elderly is conducive to the preservation of health. Food originating from the sea is a good source of niacin and should be consumed by all, regardless of age and/or physiological state. Therefore, it is recommended by physicians and nutritionists.

Aim: The aim of this study was to determine the content of niacin in selected seafood and to evaluate these products as a potential source of niacin.

Material and methods: The content of niacin was determined by the microbial method. The vitamin was extracted from the analyzed samples using enzymatic hydrolysis.

Results: A portion of 100 g seafood implements the standard daily requirement in range of 4.43%–8.21% for women and 3.88%–7.19% for men, respectively.

Discussion: Fish and seafood consumption has a tendency to increase all over the world, whereas in some countries (Poland) it persists insufficient with a declining tendency. Considering high nutritive value, the analyzed shellfish are recommended as valuable ingredient of diet. Increased consumption of seafood might contribute to reduce the risk of civilization diseases morbidity.

Conclusions: The niacin analysis that was conducted showed differences between the various types of seafood. Among the analyzed seafood, the best source of niacin came from the meat of clams.

1. Introduction

1.1. Nutrition

Nutrition is one of the major factors affecting human development, health and well-being. The presence of seafood in the diet of people at high risk of heart disease, pregnant women and the elderly is conducive to the preservation of health. Food originating from the sea is a good source of vitamins A, D, B group (niacin, B_6, B_{12}), long-chain n-3 polyunsaturated fatty acids (PUFAs), and rare microelements (iodine, selenium, fluorine), and should be consumed by all, regardless of age and/or physiological state.[1–4] Its protein is

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highly digestible due to low connective tissue content.[5] Therefore, it is recommended for children, pregnant women and the elderly. The lack (or excess) of B group vitamins contributes to developing specific diseases, which are related to modern lifestyle, such as hyperlipidemia, hypertension, obesity or cardiovascular disorders which are so common in these days among industrialized countries. Making healthy food choices is an integral part of cardiovascular risk management.[6,7]

Recent studies have shown that most species of shellfish are a good source of PUFAs. In particular, crab, oysters and mussels contain as much n-3 as some oil-rich fish.

PUFAs reduce plasma triglyceride concentrations and have been postulated to reduce type 2 diabetes.[8,9] Eating seafood products regularly reduces ischemic heart disease, and dietary supplementation of n-3 marine triglycerides improves survival in patients who have recently had a myocardial infarction. PUFAs, including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), inhibit platelet function, prolong bleeding time, have an anti-inflammatory effect and reduce plasma fibrinogen. EPA and DHA have been shown to have cardioprotective effect.[6] EPA substitutes for arachidonic acid in cell membranes and gives rise to 3-series prostaglandins and thromboxanes and 5-series leukotrienes. A preparation of n-3-acid ethyl esters is licensed in the United Kingdom for the prevention of recurrent events after myocardial infarction in addition to the treatment of hypertriglyceridemia; it causes less of an increase in low-density lipoprotein (LDL) and fewer problems with fishy odor, weight gain and dyspepsia than the older fish oil preparations that were popular in the past.

Specific dietary pattern that includes seafood may be associated with lower risk of metabolic syndrome in adults.[10] High consumption of fish and n-3 fatty acids was significantly associated with a lower risk of metabolic syndrome among men.[11]

1.2. *Niacin*

Niacin (vitamin B_3), the common name for both nicotinic acid and nicotinamide, is a vitamin, and as such is essential for many important metabolic processes. The main coenzymes derived from nicotinic acid are nicotinamide adenine dinucleotide (NAD^+) and nicotinamide adenine dinucleotide phosphate ($NADP^+$). Nicotinamide nucleotide coenzymes catalyze many chemical reactions within the glycolytic pathway/tricarboxylic acid cycle and pentose phosphate pathway of glucose metabolism. Niacin can be synthesized in the human body from the essential amino acid L-tryptophan. Approximately 60 mg of L-tryptophan yields 1 mg of niacin, so foods containing a balanced amount of protein, as fish and shellfish, are important contributors to the total niacin equivalent intake.

1.3. *Niacin in therapy*

Niacin is a broad spectrum lipid regulating agent, in pharmacological doses, and was proven to exert many favorable effects on cholesterol metabolism, including reduction in total cholesterol, decreases very-low-density lipoprotein (VLDL), triglycerides secretion, LDL cholesterol (LDL-C), lipoprotein(a), and augmentation of high-density lipoprotein cholesterol (HDL-C).[12–14] LDL-C is the primary goal of therapy, although there is considerable evidence that the triglyceride-rich VLDL and the remnant lipoproteins are also atherogenic.[15]

Niacin is known to suppress adipose tissue lipolysis in individuals with atherogenic dyslipidemia, improving hypertriglyceridemia and elevated plasma free fatty acid (FFA) concentrations.[16] Treatment with niacin (nicotinic acid) and its analogs has been shown to reduce FFA concentrations, and flux and improve insulin sensitivity.[17]

Long-term administration to survivors of myocardial infarction reduced mortality in the Coronary Drug Project (CDP) trial, but unintended effects limit its clinical use.[18] New analogs of nicotinic acid can be available during the onset of an acute coronary syndrome to maintenance heart contraction and to counter ventricular arrhythmias.[19]

Niacin reduces cardiovascular disease events and the progression of atherosclerosis, in patients with established vascular disease. It can occur through a mechanism not reflected by changes in HDL-C concentration.[20,21]

Nicotinic acid has been used in gram quantities as a lipid-lowering agent, as an adjunct to statin in dyslipidemia, or used alone.[13,14,22] Current treatment guidelines recommend lowering elevated LDL-C levels with a statin as the primary lipid-modifying intervention to reduce cardiovascular risk in patients with type 2 diabetes mellitus, or metabolic syndrome.[23] Niacin therapy for three years in subjects with normal baseline glucose levels is associated with an increase in blood glucose levels and the risk of the development of impaired fasting glucose, with a significant reduction in coronary stenosis progression and clinical cardiac events.[24]

Niacin administration significantly reduces oxidative stress in patients with hypercholesterolemia and low levels of HDL-C and inhibits vascular inflammation.[25,26]

Infusion of intravenous niacin provides a model for acutely improving dietary fat storage, perhaps by suppressing of lipolysis in visceral adipose tissue and a reduction in fractional spillover.[27]

The current review advocates an initially slow niacin dose escalation from 0.5 g to 1.0 g daily during eight weeks and then from 1.0 g to 2.0 g in a single titration step (if tolerated).[28] A maximum daily dose of niacin at 2.0 g can be given once daily at night in rising doses.

A modified-release preparation is better tolerated. Adverse effects include flushing, palpitations and gastrointestinal disturbance. Flushing may be minimized by taking niacin with meals (or at bedtime with a low-fat snack), avoiding exacerbating factors (alcohol or hot beverages), and taking 325 mg of aspirin 30 min before niacin dosing or with laropiprant.

Another noted side effect of niacin therapy is an observed increase in serum glucose levels. High doses can disturb liver function, impair glucose tolerance, and precipitate gout by increasing the circulating urate concentration.

2. Aim

The aim of this study was to determine the niacin content in shellfish and assess the analyzed products as a source of niacin in the human diet.

Table 1 – Accuracy and precision obtained during niacin determination.

Content in shellfish (mg/100 g)	N	Enrichment (mg/100 g)	Recycle (%)	SD (%)	Relative error (%)
7.89 ± 0.15	10	3	97.87	2.89	−2.13
		6	103.04	3.13	+3.04

Comment: N –number of sample.

Table 2 – Niacin content in examined shellfish and realization of RDA for Polish population (according to Jarosz et al.[32]).

Type of product	Niacin content[a] (mg)	RDA[a] (%)						
		Children	Men		Women			
		1–9 years	10–18 years	≥19 years	10–18 years	≥19 years	During pregnancy	Breast feeding
European oyster	1.15 ± 0.06	13.26	7.19	7.19	8.21	8.21	6.39	6.76
Pacific oyster	1.04 ± 0.07	12.00	6.50	6.50	7.43	7.43	5.78	6.12
Bivalve molluscs	0.75 ± 0.03	8.65	4.69	4.69	5.36	5.36	4.17	4.41
St Jacob's molluscs	0.62 ± 0.03	7.15	3.88	3.88	4.43	4.43	3.44	3.65

[a] Amounts per 100 g of product.

3. Material and methods

The experimental material were oysters and mussels obtained from the Gdańsk trade market. Different varieties of clams and oysters were examined. After grinding and mixing, the meat was weighed and three samples of each product were taken.

In order to isolate the analyzed samples, enzymatic extraction was carried out using the enzymes: papain and diastase in amounts of 40 mg per 2 g of sample.[29,30] The concentration of niacin was determined by the microbiological method,[29,31] using bacteria strain – *Lactobacillus plantarum* ATCC No. 8014.

In order to verify the accuracy and precision of the applied method, the content of the vitamin in shellfish samples was analyzed by the addition of a known amount of vitamin. We obtained highly satisfactory accuracy and precision in the analytical method (Table 1).

4. Results and discussion

The results of studies on the content of niacin in seafood are presented in Fig. 1 and Table 2.

Niacin content ranged from 0.62 mg to 1.15 mg (per 100 g of product). Among the analyzed seafood, the highest content of niacin was measured in oysters: with the European oyster and the Pacific oyster containing 1.15 mg and 1.04 mg (per 100 g of flesh), respectively. The lowest content of niacin was measured in clams and in the great scallop – 0.75 mg and 0.62 mg (per 100 g of flash), respectively.

Table 2 presents data on the extent of the recommended daily allowance (RDA) for niacin per 100 g of seafood with

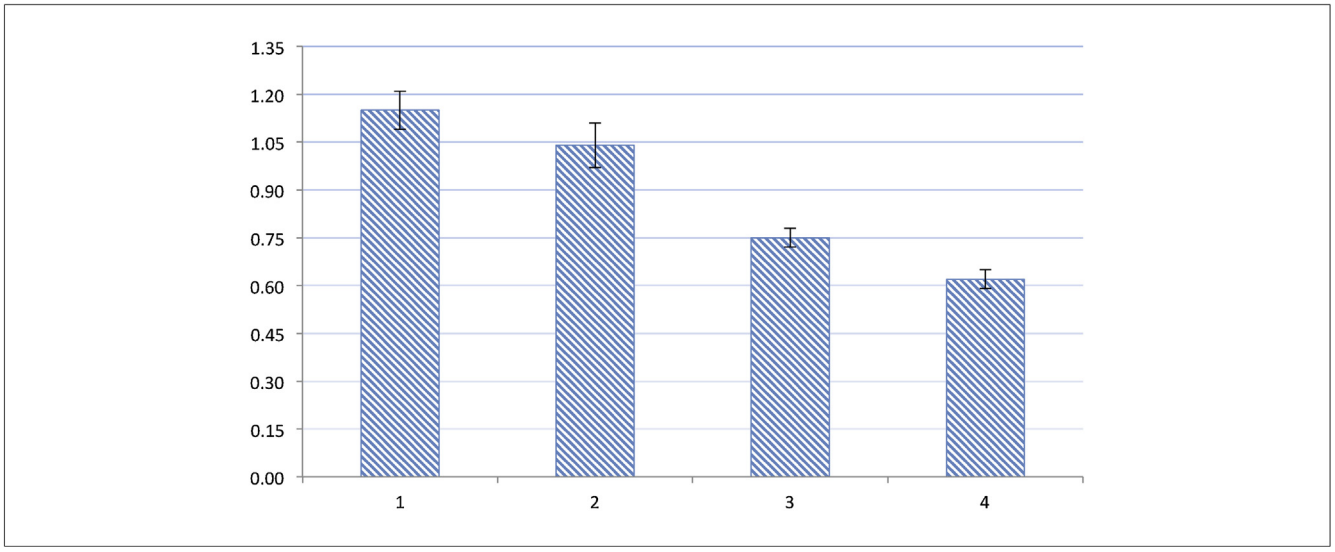

Fig. 1 – Niacin content in analyzed shellfish (mg per 100 g). *Comments*: 1 – European flat oysters (*Ostrea edulis*), 2 – Pacific oysters, fresh (*Crassostrea gigas*), 3 – clams, and 4 – great scallop (*Pecten maximus*).

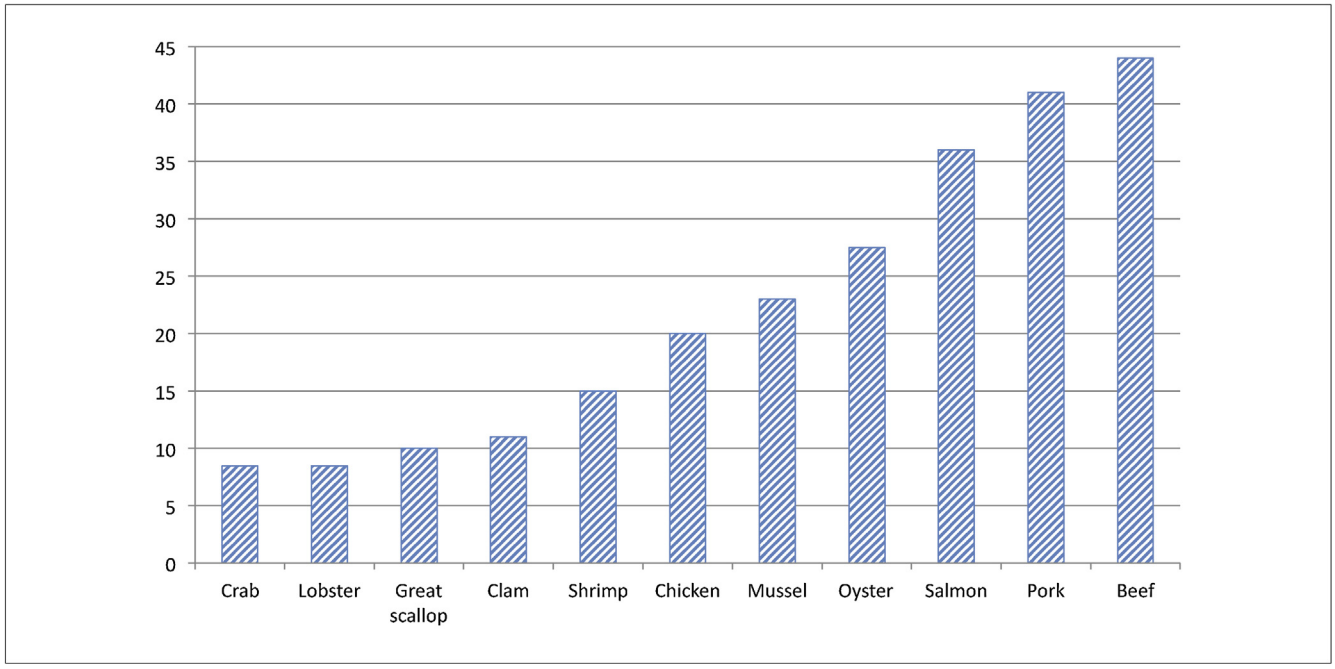

Fig. 2 – Percent calories from fat.[8]

regard to age, sex and physiological state of the body.[32] It has been shown that a 100 g portion of the oyster richest in niacin (the European oyster) covers the RDA in 13.26% of cases in children. For adults, the RDA for niacin is attained in 7.19% and 8.21% of cases for men and women, respectively.

Making healthy food choices is an integral part of total health management.[6,7] The seafood consumption scheme in many countries is changing with declining tendency in Poland.[33] An increased consumption of seafood might contribute to a risk-reduction toward variety of diseases, which include hyperlipidemia, hypertension, cancer, diabetes obesity, and coronary artery disease.[3–6,9–11,18]

Considering the high nutritive value of analyzed seafood products, they can be recommended as a valuable ingredient of a human diet.[34] Shellfish can play an important role in a healthy balanced diet and are naturally low in fat and calories (Fig. 2).

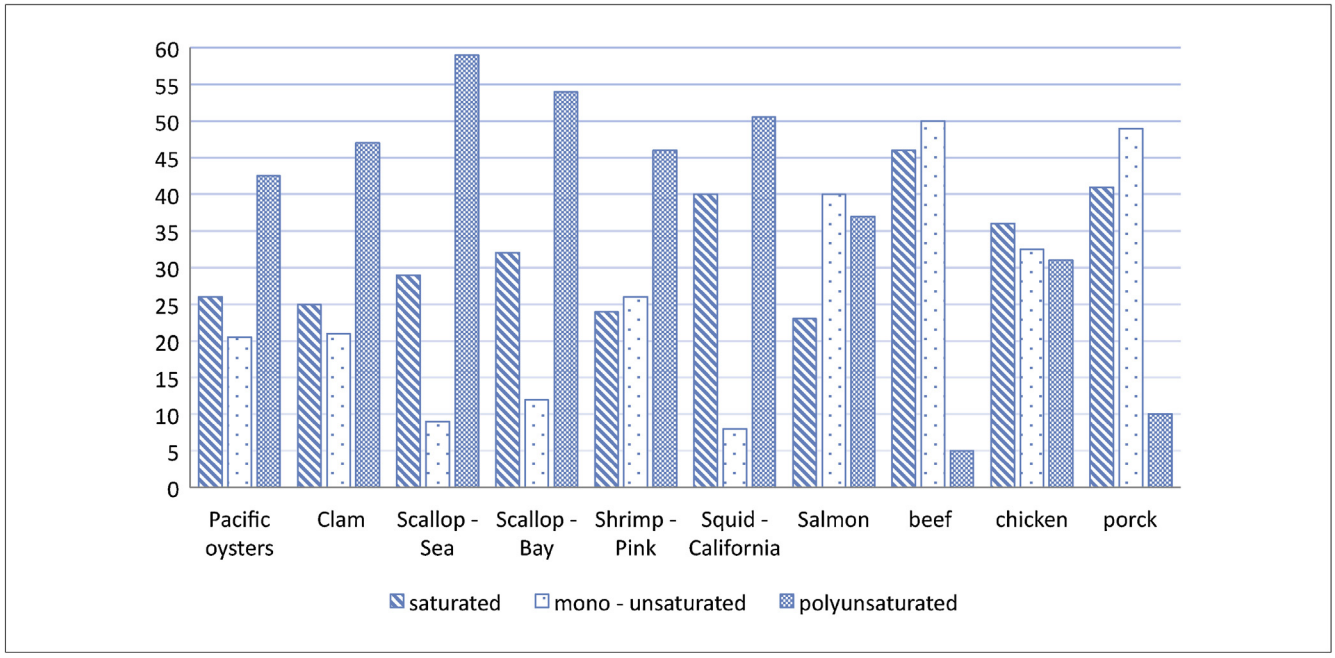

Fig. 3 – Fatty acid composition (g per 100 g lipids).[8]

Potential benefit of shellfish consumption could in addition to long-chain n-3 fatty acids be attributed to a wider array of nutrients (and their interaction) that are abundant in shellfish. They are a good source of vitamins D and B group (niacin, B_6 and B_{12}), which have been linked to inverse cerebrovascular risk.[1,2,35,36] In addition, essential amino acids and trace elements may have potentially favorable vascular effects. They are also a rich source of many key nutrients which are not readily available from many other food products. Current cardiovascular guidelines for healthy individuals encourage consumption of a variety of seafood, preferably oily types, at least twice a week.[7] Moreover, the positive impact of sea product could be explained by a concomitant reduction in intake of foods detrimental to vascular health, such as land animal meat rich in saturated fatty acids (Fig. 3). Higher shellfish consumption may simply be an indicator of a human awareness of healthier dietary pattern or higher socioeconomic status, which themselves are associated with conventional vascular determinants and outcomes.

People who have immunodeficiency should only eat cooked shellfish due to the risk of severe infections from ingesting raw shellfish contaminated with infectious organisms. In allergic patients the primary management of shellfish allergy is to avoid them.[37]

The suitability assessment of the analyzed foods of marine origin in the implementation of the daily requirement for niacin was carried on, taking as reference, standards proposed by Jarosz et al., for men and women in all age groups and physiological states. Comparing the RDA for niacin by the analyzed fish products (100 g) can be concluded that the likely degree of implementation is for women from 3% to 8%, and for men from 4% to 7%. In children, RDA is higher ranging from 7% to 13%.

Eating seafood products should not stand alone but should make a composition of a sensible balanced diet with other foods. Shellfish grown in clean water and harvested using recommended procedures should have a place in a healthy diet as part of the ''Meat and Beans'' group of the My Plate recommendations.

5. Conclusions

Maintaining good health and a sense of well-being are top priorities for many people today. Both health and well-being are strongly related to diet.

The niacin analysis that was conducted showed differences between the various types of seafood. Among the analyzed seafood, the best source of niacin came from the meat of clams. The beneficial effect of shellfish intake on health might be mediated through a complex interplay among a wide range of nutrients commonly found in seafood. Further research is needed to identify other benefits of shellfish consumption.

Conflict of interest

None declared.

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