PROTEIN EXTRACTS FROM FISH HEAD AS NATURAL FERTILIZER FOR CORN PLANTS

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The amino acid composition in the hydrolysates of fish proves to be a most promising source of protein. Two extracts from fish by-products (P1, from the head and fins of sturgeon and P2, from the cartilage of sturgeon head and fins) were obtained as liquids that were dried at 40°C. Liquid extracts were characterized physico-chemically (dry matter 3.86% and 4.25%, protein content 1.44% and 3.25%), and particle size (247nm, 94% and 4148nm, 65% majority populations for P1 and P2) and zeta potential (-27.4mV and -15.8mV) were measured. The smaller particle size for the P1 extract led to its choice for treatments applied in the growth of corn seeds. Four samples of concentrations of 0.5%, 1%, and 1.5% and control concentrations were experimented, each on 25 corn seeds, observing the growth of plants over a period of 13 days. A 13% higher increase of the corn plants was obtained in the case of the sample treated with 1.5% fish protein extract, P1. Throughout the experiments, the P1 sample with 1.5% fish protein extract had higher increases than the control sample. These results suggest that extracts from the head by-products of sturgeon fish could be used in agriculture as a nutrient in the growth of corn plants.

Keywords: protein extracts from fish head, majority populations of particle sizes, nutrients in the growth of corn seed

INTRODUCTION

The increase in the quantity of fish by-products not used worldwide, and in particular in countries engaged in large-scale fishing, has led to the investigation of their possible uses (Petrova *et al*., 2021). The amino acid composition in fish hydrolysates is a most promising source of protein for human consumption, for animal feed, for use in pharmaceuticals, cosmetics or in technologies of encapsulation of some compounds (Kumoro *et al*., 2022; Tørris *et al*., 2018). Depending on the species, gender, size, age, cultivation methods and the season of the year of harvest, fish meat contains between 15 and 24% protein (Karl *et al*., 2014). Fish proteins demonstrate unique functional characteristics that can become excellent vehicles for water retention, strong gel formation, stable foam formation, lipid binding and the formation of stable lipid emulsions (Kristinsson *et al*., 2007; Lee *et al*., 2016). Fish protein extract can be obtained from any kind of fish or fish residues. But in practice, it is usually produced from fish by separating the oil, removing bones and drying from which the final product can have a higher protein content (85% to 95%) and lower content of ash and water than fishmeal (Shaviklo, 2015). In addition to animal proteins, the protein extract from fish contains other important micronutrients, such as various vitamins, minerals and trace elements, which are beneficial during the child's growth period, maintaining well-being and accelerating recovery after malnutrition and various diseases, but also in animal nutrition. From a technological and economic point of view, the production of protein extract from fish is very effective because the protein loss is less than 4%, compared to other methods of processing fish (freezing, threading, canned food) in which it can reach from 40% to 60%. Characterized by high nutritional value, low caloric content, protein extract can be prepared from whole edible fish, can be used as food supplements, with high potential to

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reduce the state of malnutrition in a viable way economically worldwide, with a long shelf life, good storage stability and no need for refrigeration during transport and storage, all these being important advantages (Pires *et al*., 2012). Fish extract has a low level of antinutritional components, and can be used directly in the preparation of some food products (Lee *et al*., 2016). Fish extract typically possesses a smaller particle size than fishmeal and is of uniform color and texture (Shaviklo, 2015). The high content of amino acids in fish extract has encouraged its uses in human applications such as a milk substitute and treatments of patients with edema, hypoalbuminemia, malnutrition, patients in the post-surgical stage and in wound healing (Kumoro *et al*., 2022). In addition, peptides with various molecular weights contained in fish extract also demonstrate remarkable bioactivities such as anti-cancer, anti-inflammation, anti-microbial, antihypertensive, antioxidant, anti-aging, antidiabetic, antigermycide, anticoagulant and calcium binding activities, thus promoting human health and well-being (Hu *et al*., 2019; Khan *et al*., 2020; Shaviklo, 2015). The excellent functional characteristics of fish extract, such as solubility, viscosity, foaming properties, emulsifying properties, water retention capacity and oil absorption capacity suggest that fish extract could be used as an encapsulation or coating material in the field of nanotechnology (Khan *et al*., 2020; Kristinsson *et al*., 2007). Petrova *et al.* (2021) used protein hydrolysates from cod fish as peptones in microbiological culture media with good results in growing the strain of *Staphylococcus aureus* and *Salmonella enteriditis.*

This work aims to valorize the fish by-products by obtaining protein extracts from the head of sturgeon fish. They were characterized physico-chemically and the particle size and zeta potential were measured. Testing experiments were made in the growth of corn seeds by applying treatments with concentrations of 0.5%, 1% and 1.5% of fish extract obtained.

EXPERIMENTAL

Materials

The heads of sturgeon fish were bought from local fishermen (Figure 1). The chemical compounds used in the experiments were reagents for analysis.

Figure 1. Sturgeon head

Methods

Obtaining Protein Extracts from Fish Head

The protein extracts from the fish were obtained from the heads of sturgeon by boiling 4h, in distilled water, at a temperature of 90°C (Figure 2). Two types of fish head extracts were obtained: one from the fish head and fins (P1) and one from the

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cartilage extract from the fish head and fins (P2). After boiling the extracts were decanted and filtered through gauze and kept at 4°C (Figure 3). The fish extracts obtained were dried in the oven at 40°C.

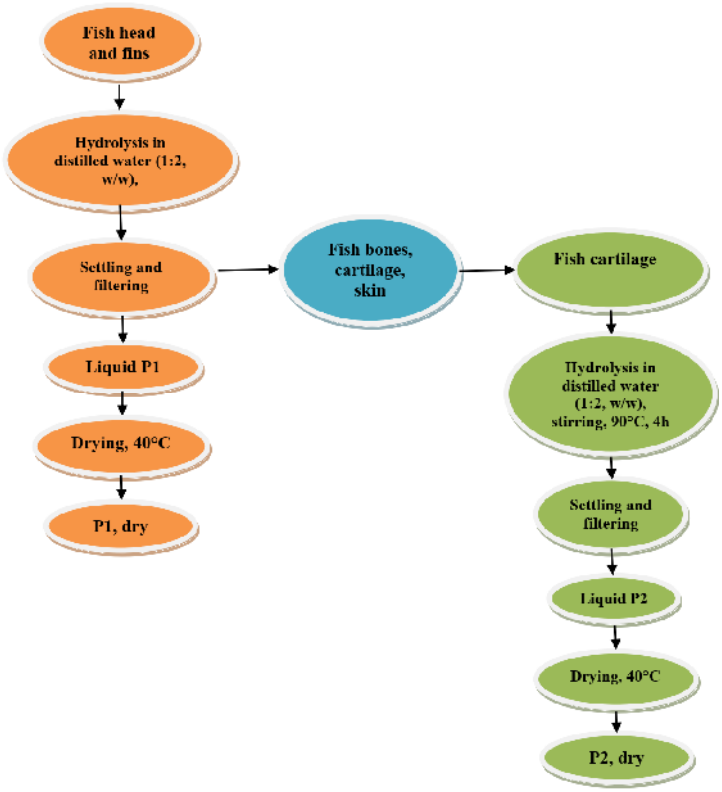
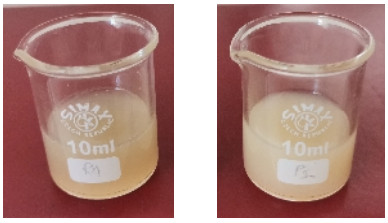


Figure 2. The scheme of obtaining protein extracts from fish head, P1 and P2



(P1) (P2)

Figure 3. Liquid protein extracts from fish head: P1 and P2

Physico-Chemical Characterization of Protein Extracts from Fish Head

The physico-chemical analyses of the obtained fish extracts were analyzed according to standardized and internal methods: SR EN ISO 4684:2006 (dry matter), SR EN ISO 4047:2008 (ash content), SR ISO 5397:1996 (total nitrogen and protein).

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DLS Analysis of Protein Extracts from Fish Head

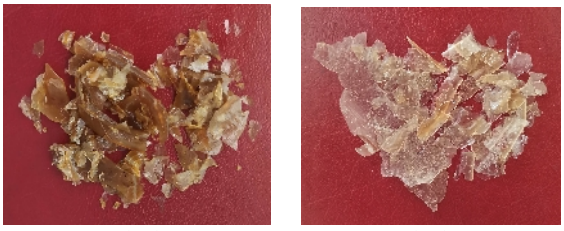
The particle size and Zeta potential of the fish head extracts was measured by the dynamic light scattering technique (DLS) with the Nano-ZS Zetasizer device from Malvern (Malvern Hills, UK).

The Use of Fish Head Extract as a Nutrient in the Growth of Corn Seeds

Experiments have been conducted to stimulate the growth of corn seeds by applying treatments with fish head protein extract, P1. Three extract concentrations of 0.5%, 1% and 1.5% were used and corn plants grown over a period of 13 days were measured. Four samples consisting of 25 corn seeds each were observed: a water-treated control sample without fish extract, a sample treated with 0.5% fish extract, a sample treated with 1% fish extract and a sample treated with 1.5% fish extract.

RESULT AND DISCUSSION

A head extract of sturgeon fish (P1) and a head and fins cartilage extract of sturgeon fish (P2) and dried at 40°C (Figure 4) were obtained.



(P1) (P2)

Figure 4. Dried protein extracts from fish head, P1 and P2

Liquid protein extracts from the obtained fish were characterized physico-chemically by dry matter, ash, total nitrogen, protein and pH content (Table 1). Close values for dry matter were obtained: 3.86% (P1) and 4.25% (P2), for total nitrogen: 0.48% (P1) and 0.52% (P2), and a pH of 6.8 for both samples, while the ashes and the content in the propane have higher values for the P2 sample obtained from cartilage.

Table 1. Physical-chemical characteristics of fish head extracts P1 and P2

Characteristics	P1	P2
Dry matter (%)	3.86	4.25
Ash (%)*	0.14	2.12
Total nitrogen (%)*	0.48	0.52
Protein content (%)*	3.00	3.25
pH (units of pH)	6.83	6.80

* Values reported at dry substance

The DLS analysis showed smaller particle sizes in the case of the P1 sample compared to the P2 sample (Table 2), with a particle average of 905 nm in the case of the P1 sample compared to 1549 nm for the P2 sample.

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Table 2. Particle sizes and zeta potential of P1 and P2 fish head protein extracts

Head fish protein extracts	Particle populations (%) and size (nm)						Average, d, nm	Pdl	Zeta potential, mV
	Majority population 1		Majority population 2		Majority population 3				
	Size	%	Size	%	Size	%			
P1	40	5	247	94	-	-	905	0.687	-27.4
P2	27.5	2	501.6	33	4148	65	1549	0.700	-15.8

The particle sizes of the majority populations of 40nm (5%) and 247nm (94%) for the P1 sample, smaller than 501.6nm (33%) and 4148nm (65%) for the P2 sample, have determined the choice of sample P1 to be used in treatments for growing corn seeds (Table 3).

Table 3. Average (cm) growing of corn seeds treated with protein extract, P1

Days	5	6	7	8	9	13
Control, average, CM	4.1	6	7.8	9.3	12.5	19.2
P1, 0.5%, average, CM	3.3	4.8	6.1	7.3	8	12.7
P1, 1%, average, CM	4.7	5.6	6.3	7.8	8.4	12.4
P1, 1.5%, average, CM	5.1	7	8.8	11	14.5	21.5

Corn seeds treated with 1.5% P1 protein extract have increased more than the control with better growth values throughout the experiments (Figure 3).

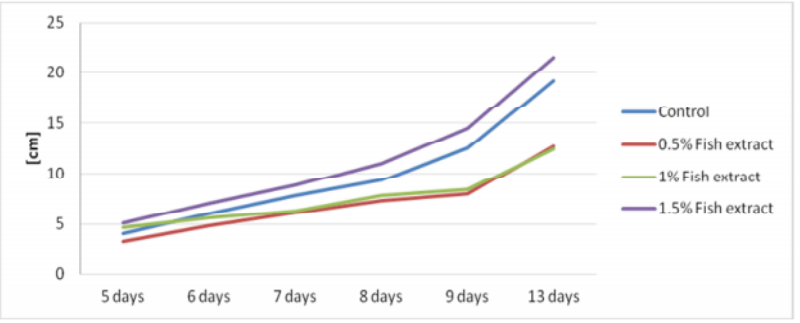

Figure 3. The increase in corn plants stem length, [cm]

Fish by-products can be capitalized and used in pharmaceuticals, cosmetics or natural fertilizers in agriculture.

CONCLUSION

Two protein extracts from the head of sturgeon fish, P1 and P2, were obtained and were characterized physico-chemically, also measuring the particle size. The P1 protein extract in a concentration of 1.5% applied as a treatment in the growth of corn seeds led to 13% higher results in the growth of corn plants compared to the control. These experiments suggest that protein extracts from fish by-products could be used as nutrients in agriculture.

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