Marine Peptides: Application Potentials in Food and Nutraceutical Sector

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INTRODUCTION

The abundance of bioactive substances in marine resources can be widely explored for its potential application in food and nutraceutical industry. Seafood proteins, on account of its structural diversification as well as nutritional, functional and biological properties can be effectively exploited for their recovery to different bioactive forms of which protein hydrolysate is a better option. In this regard, not only the meat protein but also the protein rich fish processing discards could also be chemically/ enzymatically converted into its hydrolysates, facilitating its effective utilization. Protein hydrolysates being the breakdown products of proteins viz., smaller peptide chains with amino acids, are obtained by chemical or biological hydrolysis which facilitates effective recovery of essential nutrients viz., amino acids as well as has vast possibility in food, nutraceutical and pharmaceutical industry on account of the tremendous properties viz., physicochemical, functional as well as bioactivity they possess.

One of the major characteristics of protein hydrolysates is the functional properties, which are those physicochemical properties that affect the behaviour of proteins in food systems during storage, processing, preparation and consumption (Phillips et al., 1994). These attributes affect the quality as well as sensory characteristics of the product and hence have an influential role when used as additive in food systems. These characteristic properties include water absorption capacity, oil absorption capacity, protein solubility, jellification, foaming and emulsification properties.

Marine peptides are proven to exhibit various bioactive properties, promising to be potential additive in the development of functional foods. Functional foods are those which contain one or more bioactive substances that go far beyond the nutritional functions, in concentrations suitable to support additively and/or synergistically to human health, well-being, and longevity. Functional foods are regarded to act in two complementary ways; one by means of participating in the general metabolism in a much more interactive manner and other by reducing the risks of chronic diseases. Food proteins as a source of bioactive peptides contained in their primary structure sequences in inactive forms, can be released and activated by enzymatic action in vitro or digestive system. Further these peptides are absorbed more rapidly than free amino acids or the intact protein. Once absorbed in the active form they can perform various biochemical and biological functions to improve human metabolism and health. Peptides isolated from various fish proteins exhibit different biological activities such as antihypertensive, antioxidative, anti-proliferative, anti-microbial, opoid agonistic, immune-modulatory, pre-biotic, mineral binding, antithrombotic and hypo-cholesterolemic effects (Ryan *et al.,* 2011; Suleria *et al.,* 2015; Halim et al., 2016).

SOURCES OF PEPTIDES

In addition to utilization of fish meat for extraction of proteins to derive bioactive peptides, other body parts can also be effectively converted as they are equally loaded with proteins (Chalamiah *et al.,* 2012). About 36 million tons of leftover is estimated globally from the seafood processing plants of which only 5.7 million tons is currently reprocessed (Seafoodsource, 2016). Further the increasing demand of utilization of limited natural resources and escalating environmental pollution has emphasized the need for better utilization of these fish processing by products. Almost all parts of fish can be efficiently recovered to derive bioactive peptides for exploring its immense application potentials. There exist some fluctuations and differences in the chemical composition of raw matter being used as well as intra-variations which can be on account of intrinsic well as extrinsic factors. Hence effective recovery of protein fraction from the source can be ensured by critical evaluation at the technological line.

Fish dark muscle

In addition to utilization of the white meat of fish, the dark meat can also be effectively recovered for deriving hydrolysates. Protein rich dark muscles from fishes like tuna, mackerel, black tilapia etc have currently limited use on account of their accessibility to oxidation and off-flavour and are mostly processed into low market value products. Effective pre-treatments and hydrolysis process can facilitate conversion of these protein rich materials into its hydrolysate form for exploring its applicability (Parvathy et al., 2019).

Fish skin

Fish skin, a major processing by product from seafood industry, is a rich source of compounds like collagen and gelatin which are abundant source of protein. Collagen has been extensively utilized for various applications, including functional foods, nutraceuticals, cosmeceuticals etc. Several studies have demonstrated the potential of converting fish skin processing by product waste to fish protein hydrolysates (Hema et al., 2017).

Fish head

Among the byproducts generated in the seafood processing industries, fish head waste has a major share. Being a rich source of nutrients like proteins, these wastes can be effectively utilized by converting to protein hydrolysates.

Fish viscera

Fish viscera generated during processing account to about 20% of the biomass and are potential source of protein that can be used as a raw material for the production of protein hydrolysates with excellent properties for various food and nutraceutical applications.

Fish liver

Fish liver, a by-product which is currently used to produce fish meal and animal feed or is discarded as processing

waste. This protein rich by-product can be converted to peptides to improve and upgrade the functional and nutritional properties.

Fish roe or egg

Fish roes are considered as nutritionally valuable for their high content of nutrients like fat and proteins. However currently the eggs of several fish species are underutilized. Effective utilization and recovery of protein from these sources can be made by converting it to protein hydrolysates using appropriate proteolytic enzymes (Binsi *et al.,* 2016).

Fish bone and frame

Fish backbone is one of the important parts of fish processing waste, and they contains around 30% protein. Similarly frame proteins are also normally discarded as industrial by-products in the fish processing plants. Various attempts are being made to extract the commercially valuable products from various fish bone and frame by-products of which protein hydrolysate is a very promising option which assures enhanced market demand.

FOOD & NUTRACEUTICAL APPLICATIONS

Currently, there is an increased interest in the use of natural bioactive products as ingredients in foods. Hydrolysates or bioactive peptides can be suggested as a potential source of natural ingredient and in this context more focus is given by researchers on improving the bioavailability and bioaccessibility of these marine protein hydrolysates for validating as functional ingredients for healthy foods. Further they are well established for the numerous significant and unique properties that they possess, finding their suitability in different food systems (Chalamaiah *et al.,* 2012). Functional properties of these marine peptides give desirable characteristics to the end products in which they are incorporated. These include improved solubility, emulsifying, foaming or dispersion activities in sausages, mayonnaise, salad dressings, spreads, beverages, etc. within a wide range of pH (Halim *et al.,* 2016). Further on account of the antioxidative property that these peptides possess, they assist in stabilization of food system against oxidative deteriorations (Parvathy *et al.,* 2018). The high protein content in these peptides addresses fortification of foods that are low in nutritional value. Various studies have been carried out at ICAR-Central Institute of Fisheries Technology on the application of fish protein hydrolysates in various food products viz., oil encapsulate, mayonnaise, health mix etc.

In addition to the nutritional properties of food proteins, their role as a valuable source of peptides with multifunctional activities is well demonstrated and hence finds application as nutraceuticals. Nutraceuticals are considered as foods that can provide both health as well as medical benefits for the prevention and treatment of diseases. Nutraceuticals from peptides are considered to be the most versatile with numerous bioactivities viz., antioxidative, antihypertensive, antiproliferative, antimicrobial, antiinflammatory, etc. This nutritional richness of peptides is basically linked with their essential amino acid content while the nature of bioactive peptides determines their bioactive properties (Saadi et al., 2015).

Compared to the parent protein from which they are derived, these biopeptides offer a lot of advantages viz., relatively superior bioaccessibility, enhanced bioactivity and a wide spectrum of therapeutic action. Further they are considered to be milder and safer for the consumers, with protein hydrolysates and peptides of low molecular weights to be less allergenic than their parent proteins.

They are used for maintaining the nutritional status of individuals with nutritional or physiological needs that are not provided by conventional foods. These include application in the diets of patients with specific disorders of digestion, absorption and metabolism. All these advantages make them suitable in various specialized dietic formulations viz., sports nutrition, geriatric diets, infant formulas etc (Clemente, 2000).

TABLE 1 : *Applications of Fish Protein Hydrolysates*

Properties	Applications
Nutritional	Beverages, bakery and confectionery products, high energy food supplements, specialized diets
Solubility	Beverages, bakery products etc.
Water absorption	Meats, bakery products viz., breads and cakes, boiled foods
Fat absorption	Meats, sausages, doughnuts, spreads, crackers, deep fried products
Viscosity	Soups, gravies
Foaming	Breads, cakes, beverages
Emulsification	Sausages, soups, cakes, protein spreads, mayonnaise
Antioxidant	Meats, seafood products,fish oil
Cryoprotection	Meat/Fish mince and surimi
Calcium binding property	Infant formulas Geriatric products
Antiinflammatory	Sports nutrition Geriatric products
Antioxidative	Sports nutrition Geriatric products
Antihypertensive	Geriatric products
Antiproliferative Antithrombotic Antiarthritic	Specialized diets for health disorders

Peptides derived from marine sources offer numerous application potential in food and nutraceutical sector. Appropriate optimisation designs facilitating effective hydrolytic conditions are to be opted for extracting bioactive hydrolysates with intended end applications. This can facilitate economic and viable production of protein hydrolysates in a commercial mode.

REFERENCES

Binsi, P. K., Viji, P., Panda, S. K., Mathew, S., Zynudheen, A. A., & Ravishankar, C. N. (2016). Characterisation of hydrolysates prepared from engraved catfish (Nemapteryx caelata) roe by serial hydrolysis. Journal of Food Science and Technology, 53(1), 158-170.

Chalamaiah, M., Hemalatha, R., & Jyothirmayi, T. (2012). Fish protein hydrolysates: proximate composition, amino acid composition, antioxidant activities and applications: a review. Food Chemistry, 135(4), 3020-3038.

Clemente, A. (2000). Enzymatic protein hydrolysates in human nutrition. Trends in Food Science & Technology, 11(7), 254-262.

Halim, N. R. A., Yusof, H. M., & Sarbon, N. M. (2016). Functional and bioactive properties of fish protein hydolysates and peptides: a comprehensive review. Trends in Food Science & Technology, 51, 24-33.

Hema, G. S., Joshy, C. G., Shyni, K., Chatterjee, N. S., Ninan, G., & Mathew, S. (2017). Optimization of process parameters for the production of collagen peptides from fish skin (Epinephelus malabaricus) using response surface methodology and its characterization. Journal of food science and technology, 54(2), 488-496.

Parvathy, U., Nizam, K. M., Zynudheen, A. A., Ninan, G., Panda, S. K., & Ravishankar, C. N. (2018). Characterization of Fish Protein Hydrolysate from Red Meat of Euthynnus affinis and its Application as an Antioxidant in Iced Sardine. Journal of Scientific and Industrial Research, 77, 111-119.

Parvathy, U., Binsi, P. K., Joshy, C. G., Jeyakumari, A., Zynudheen, A. A., George Ninan, & Ravishankar, C. N. (2019). Selective extraction of surface-active and antioxidant hydrolysates from yellowfin tuna red meat protein using papain by response surface methodology. The Indian Journal of Nutrition and Dietetics, [S.l.], 10-25.

Phillips, L. G., Whitehead, D. M., & Kinsella, J. E. (1994). Protein stabilized foams. In: Structure-function of food proteins. (Phillips, L. G., Whitehead, D. M., & Kinsella, J. E. Eds.) New York: Academic Press, pp. 131-152.

Ryan, J. T., Ross, R. P., Bolton, D., Fitzgerald, G. F., & Stanton, C. (2011). Bioactive peptides from muscle sources: meat and fish. Nutrients, 3(9), 765-791.

Saadi, S., Saari, N., Anwar, F., Hamid, A. A., & Mohd Ghazali, H. (2015). Recent advances in food biopeptides: Production, biological functionalities and therapeutic applications. Biotechnology Advances, 33, 80–116.

SeaFoodSource (2016) https://www.seafoodsource.com/news/supply-trade/entrepreneurs-getting-creative-with-seafood-byproducts

Suleria, H., Osborne, S., Masci, P., & Gobe, G. (2015). Marine-based nutraceuticals: An innovative trend in the food and supplement industries. Marine drugs, 13(10), 6336-6351.