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FISH HYDROLYSATE

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ABSTRACT

Fish protein hydrolysate (FPH) is resulting product of fish hydrolysate. FPHs are considered the most important source of protein and bioactive peptides and also possess excellent nutritional value since they have a balanced amino acid composition and a high digestibility. FPHs also possess bioactive properties such as anti-hypertension and anti-cancer activity. FPHs obtain through chemical hydrolysis, enzymatic hydrolysis or by fermented hydrolysis.

KEYWORDS: Fish protein hydrolysate, Hydrolysis, Enzymatic, Bioactive.

INTRODUCTION

There is a rapid increase in the commercial seafood industry in the world in recent decades and fish processing units generating large quantities of solid waste and wastewater (Muzaddadi et al. 2016). According to Awarenet (2004), solid waste represents 20–60% of the initial raw material which consists of various kinds of residues, including whole waste fish, fish heads, viscera, skin, bones, blood, frame liver, gonads, guts, and some muscle tissue, etc. The by-products, which are discarded, are used for plant fertilizer, livestock feed, and value-added specialty foods such as fish oil,which could be isolated efficiently and used as a dietary supplement (Ananey-Obiri et al. 2019). By-products are a significant source of protein, phospholipids, soluble vitamins, and bioactive compounds (Villamil et al. 2017). Fish peptides are shown anti oxidative, antihypertensive, and antithrombotic effects (Hamed et al. 2015).

Hydrolysates are the resulting products of hydrolysis (Ananey-Obiri et al. 2019). Schaafsma (2009) defined protein hydrolysates as a blend of short- and long-chain peptides and amino acids that result from partial hydrolysis. Hydrolysates are considered the most important source of protein and bioactive peptides (Ananey-Obiri et al. 2019). FPH can be obtained by controlled enzymatic hydrolysis (Wang, 2021). FPHs possess excellent nutritional value since they have a balanced amino acid composition and a high digestibility (Wang, 2021). Fish protein hydrolysate (FPH) is a breakdown product of fish proteins that containing smaller peptides and amino acids (Venugopal, 2016).

SOURCES OF FISH PROTEIN HYDROLYSATE

FPH sources derive from three major fish components: muscle, skin, and waste (Wang, 2021). Fish muscles are rich sources of protein and account for 65%-75% (w/w) of the total protein which is used for extraction of FPH (Harnedy & Fitzgerald, 2013). Lean fish species or their processing wastes are the ideal raw material for FPH, which also can be used as food binders, emulsifiers, gelling agents, and nutritional supplements (Venugopal, 2016). Seafood proteases from

Atlantic salmon and trypsin from fish pyloric ceca have been used for FPH (Kristinsson & Rasco, 2000; Zamani & Benjakul, 2016).

STRUCTURAL AND FUNCTIONAL PROPERTIES OF FISH PROTEIN HYDROLYSATE

Functional properties are defined as overall physiochemical properties of proteins in food systems during processing, storage, and consumption (Ananey-Obiri et al. 2019). Many functional properties of hydrolysates have been mentioned, such as solubility, emulsifying properties, foaming properties, water holding capacity, and fat binding capacity (Ananey-Obiri et al. 2019).

Solubility is the property that measuring how well the solute can dissolve in a solvent. A decrease in hydrogen bonds due to larger molecular weight causes reduced solubility. The hydrolysis process generates more carboxylic and amine groups, which provide more exposed groups to surrounding water (Ananey-Obiri et al. 2019).

The emulsifying properties of the hydrolysate are determined by the reduced tension of hydrophobic and hydrophilic components and a greater exposure to interaction at the oil-water interface. Hydroxylated amino acids contributed to the emulsion of hydrolysate from rainbow trout viscera (Taheri et al. 2013).

Foaming properties are governed by penetration and rearrangement at the air-water interface (Halim et al. 2016). Hydrophobic regions of the molecules determine the adsorption at the air-water interface (Ananey-Obiri et al. 2019).

Water holding capacity is the ability of the protein to capture water in the food matrix. Low molecular weight peptides are more hydrophilic and can affect water holding capacity more (Ananey-Obiri et al. 2019).

BIOACTIVE PROPERTIES OF FISH PROTEIN HYDROLYSATE

Bioactive or biologically active peptides are beneficial for human health due to their positive effects on physiological activity such as that of anti-hypertension and anti-cancer activity (Wu et al. 2015). Marine-derived peptides with strong antioxidant activity are able to scavenge free radicals and prevent lipid oxidation (Shavandi et al. 2019). During hydrolysis process, it generate peptides that exhibiting bioactivities such as anti-inflammation, antibacterial, or antioxidant activity (Chakrabarti et al. 2014). Other bioactive properties exist via hydrolysis and exhibit anti-oxidation, anti-proliferation, cyto-immunomodulation, anti-hypertension, and anti-diabetic activities (Ananey-Obiri et al. 2019).

PRODUCTION OF FISH PROTEIN HYDROLYSATE

Fish protein hydrolysates (FPH) are a product made from fish or fish material by the method of protein hydrolysation (Petrova et al. 2018). FPH is produced in two forms: liquid and dried. Liquid FPH is a watering mixture of hydrolyzed proteins, which consist up to 90% of moisture (Petrova et al. 2018). FPH in a liquid form is highly unstable for a long-term storage and, it is also difficult to be transported. Thus, dried FPH is preferable due to a longer shelf-life, easier storage and transportation (Petrova et al. 2018).

The hydrolysis of protein achieves through acids, alkalis or enzymes mediated breakdown of proteins in the waste into smaller protein fractions, peptides and free amino acids (Kim & Dewapriya, 2015). Acid hydrolysis makes the product unpalatable because of tryptophan destruction and the formation of sodium chloride after the neutralization (Kim & Dewapriya, 2015). Alkaline hydrolysis produces some toxic compounds which are undesirable for human consumption (Kim & Dewapriya, 2015). Among protein hydrolyzing methods, enzymatic hydrolysis offers several advantages over others (Kristinsson & Rasco, 2000).

Chemical hydrolysis

Chemical hydrolysis is provided by either acid or alkali. It is achieved by cleaving the bonds between different peptide groups in the protein sequence by chemical agents (Petrova et al. 2018).

1. Acid hydrolysis

In acid hydrolysis, either hydrochloric acid or sulfuric acid is used to completely hydrolyze the fish proteins at high temperatures, and most times under high pressure (Kristinsson & Rasco, 2000). High temperature and pressure of solution (121–138 °C and 220–310 mPa correspondingly) are held during several hours (typically 2–8) so because of that achieve a certain degree of hydrolysis (DH) (Pasupuleti & Braun, 2008). Then the mixture is neutralized to pH 6.0–7.0 and delivered for further dehydration (Kristinsson & Rasco, 2000). Hydrolysates recovered by using this method have high solubility, but they are bitter and have reduced nutritional qualities and poor functionality (Chobert et al. 1996). It is a low-cost, easy and simple process so because of that makes it important at the industrial level (Das et al. 2021). However during acid hydrolysis, important amino acids, such as tryptophan, methionine, & cystine are lost. In addition, asparagine and glutamine are converted into aspartic acid and glutamic acid respectively (Das et al. 2021).

2. Alkaline hydrolysis

In alkaline hydrolysis, sodium hydroxide is mainly used (Das et al. 2021). Alkali hydrolysis is held at less elevated temperatures (typically 27–54 °C) in the presence of such alkaline agents as calcium, sodium or potassium hydroxide during several hours until the desired degree of hydrolysis is reached (Pasupuleti & Braun, 2008). A number of amino acids as serine and threonine are destroyed during alkaline hydrolysis (Pasupuleti & Braun, 2008). Alkaline hydrolysis is limitedly used in the fish processing industry to recover a range of proteins from fish material and fish protein concentrates (Kristinsson & Rasco, 2000).

Enzymatic hydrolysis

Enzymatic hydrolysis also known as proteolytic hydrolysis, which is the most common method of protein hydrolysate recovery from fish processing by-products (Ananey-Obiri et al. 2019). This process is carried out by using endogenous enzymes or is an accelerated and controlled process using exogenously sourced enzymes (Ananey-Obiri et al. 2019). Enzymatic hydrolysis is a partial hydrolysis, and by this method the functionalities of native proteins are improved (Althouse et al. 1995).

Enzymatic hydrolysis is carried out from one to several hours at mild conditions: slightly elevated temperatures (generally around 35–65 °C) and a certain pH according to the optimal requirements of the used enzymatic systems: alkali, neutral or acid (Petrova et al. 2018). For FPH production, the used enzymes are of animal (pepsins), plant (papain, bromelain) or microbial origin (alcalase, neutrase, flavourzyme) (Petrova et al. 2018). The inactivation of enzymatic hydrolysis is typically accomplished by the elevated temperatures of around 75–100 °C applied for 5–30 min (Kristinsson & Rasco, 2000). This process involves a high production cost due to the long reaction time (Ananey-Obiri et al. 2019). However, the resulting FPHs are more marketable and valuable (Shahidi et al. 1995).

Fermented hydrolysis

Fermentation biochemically uses microorganisms to break down fish proteins into peptides and amino acids (Ananey-Obiri et al. 2019). Different microorganisms have been identified and used to produce hydrolysates from fish protein (Ananey-Obiri et al. 2019). Due to the differences in microorganisms used in the culture for fermentation, the functionality of FPHs recovered by this method may vary (Daliri et al. 2017). Protein hydrolysates have been produced through fermentations using bacteria such as *Enterococcus faecium* NCIM5335 (Balakrishnan et al. 2011), and lactic acid bacteria (LAB) *Pediococcus acidilactici* NCIM5368 (Chakka et al. 2015). It is also interesting to note that fermentation of fish protein can help remove hyper-allergic or anti-nutritional components that are found in the ingredients (e.g., trypsin inhibitors, glycinin, β-conglycinin, phytate) (Hou et al. 2017). This offers an advantage that is not obtained from other FPH recovery methods (Ananey-Obiri et al. 2019).

APPLICATION OF FISH HYDROLYSATE

FPH is used in dietetic foods, such as soufflés, meringues, macaroni, or bread, and for the preparation of fish soup, fish paste, and shellfish analogues as flavoring compounds as a source of small peptides and amino acids (Muzaddadi et al. 2016). The major feed applications of FPH are as milk replacers for calves and weaning pigs and as proteins and attractants in fish feed (Gildberg, 1993). Chemical composition of fish protein hydrolysates is important in nutrition perspective of human health (Elavarasan, 2019). In general, required essential amino acids are abundant in FPH with richness in glutamic and aspartic acid content (Elavarasan, 2019). Fish protein hydrolysates are soluble in wide range of pH which is an ideal characteristic helps to use in wide range of products (Elavarasan, 2019).

Fish protein hydrolysates (FPHs) have been used in aquaculture feeds in order to enhance the growth and survival of fish (Elavarasan, 2019). The amino acid composition and the peptides present in hydrolysate are responsible for the improved growth and immunological status (Elavarasan, 2019). FPH is also being used as a source of protein in poultry feed formulation and in pet animal foods (Elavarasan, 2019). Other applications include FPH as a plant booster, ingredient in microbiological media and as a cryo-protectant in fish mince/surimi (Elavarasan, 2019).

CONCLUSION

FPH offers many useful capabilities, which makes its applicability in food processing and even outside food processing desirable. The functionality, bioactivity, and nutritional value of FPH widen its scope of use. The choice of method used in the hydrolysis process prodigiously impacts the physicochemical, functional, and bioactive characteristics of the FPH, and consequently its use as a food ingredient.

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