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Functional Peptides From Food Sources: Generation and Applications

Zainab Ali*

Department of Food Science, University of Malaya, Kuala Lumpur, Malaysia

Introduction

The field of bioactive peptide generation from food sources has garnered significant attention due to its potential health benefits. These peptides, derived from the hydrolysis of food proteins, possess a range of biological activities, making them valuable components in functional foods and nutraceuticals. Research has explored various food matrices and enzymatic treatments to unlock the potential of these peptides. A comprehensive study examined the experimental generation of bioactive peptides from diverse food sources, detailing enzymatic hydrolysis conditions and their influence on peptide yield and bioactivity, specifically focusing on anti-hypertensive and antioxidant properties, alongside downstream processing techniques for purification and characterization [1].

Further investigation into specific protein sources has revealed promising avenues for peptide production. For instance, the enzymatic hydrolysis of rice bran protein has been optimized to yield antihypertensive peptides. This research meticulously documented the process, highlighting the significant ACE-inhibitory activity of specific peptide fractions and the critical role of pH and temperature in the hydrolysis and subsequent bioactivity of the peptides [2].

Alternative protein sources are also being explored for their bioactive peptide potential. One study successfully generated antioxidant peptides from spent mushroom substrate through papain hydrolysis. This work focused on identifying optimal enzyme concentrations and reaction times to maximize the yield of peptides exhibiting radical scavenging activity, also presenting characterization of the most potent peptide sequences identified [3].

The exploration of novel proteases has opened new possibilities for peptide generation from various plant-based proteins. An article detailed the application of thermolysin for the hydrolysis of soy protein isolate, successfully identifying peptides with enhanced anti-inflammatory properties and discussing the impact of process parameters on the resulting peptide profile and bioactivity [4].

Beyond enzymatic hydrolysis, other methods are being investigated for their efficacy in producing functional peptides. One study focused on the in vitro gastrointestinal digestion of casein to produce peptides with calcium-binding properties. This research scrutinized the impact of various digestive enzyme combinations and incubation times on the release of phosphopeptides and their mineral-binding capacity, incorporating chromatographic analysis of the peptide fractions [5].

Another area of interest is the production of peptides with immunomodulatory effects. Research has explored the use of fungal proteases for the production of such peptides from zein. This work involved optimizing enzymatic hydrolysis parameters and evaluating the immunomodulatory effects of the resulting peptide hydrolysates in vitro using cytokine production assays [6].

Microbial fermentation presents another innovative approach for generating bioactive peptides. A paper examined the effect of microbial fermentation on whey protein, emphasizing the role of specific lactic acid bacteria in releasing peptides with antioxidant and anti-inflammatory properties, and also considering changes in peptide profiles during the fermentation process [7].

Advanced techniques are also being employed to enhance peptide yield and bioactivity. One study optimized ultrasonic-assisted enzymatic hydrolysis of tilapia skin collagen for bioactive peptide production. This research demonstrated how ultrasound improves enzymatic efficiency, leading to higher yields of peptides exhibiting antioxidant and angiotensin-I converting enzyme inhibitory activities [8].

Comparative studies are crucial for understanding the most effective methods for peptide generation. A study compared enzymatic and acid hydrolysis techniques for producing antihypertensive peptides from camel milk protein. This research evaluated the efficiency of pepsin and trypsin and discussed the characterization of the generated peptide hydrolysates [9].

Synergistic approaches combining different technologies are also being investigated for improved peptide production. One study explored the use of pulsed electric fields (PEF) in conjunction with enzymatic treatment to enhance the release of antioxidant peptides from pea protein isolate, assessing the synergistic effects of PEF and pepsin on peptide yield and radical scavenging activity [10].

Description

The scientific literature extensively covers the generation of bioactive peptides from a wide array of food sources, employing diverse methodological approaches. These peptides are recognized for their significant health-promoting attributes, including antioxidant, anti-hypertensive, anti-inflammatory, immunomodulatory, and mineral-binding properties. The primary methods for peptide liberation involve enzymatic hydrolysis, utilizing a variety of proteases, and in some cases, advanced techniques like ultrasonic assistance or pulsed electric fields to enhance hydrolysis efficiency. The optimization of process parameters, such as enzyme type, concentration, reaction time, pH, and temperature, is critical for maximizing peptide yield and bioactivity. Downstream processing for purification and characterization is also an integral part of these studies.

A significant body of work focuses on the enzymatic hydrolysis of various protein substrates. For example, a study detailed the experimental generation of bioactive peptides from food sources, emphasizing key enzymatic hydrolysis conditions and their impact on peptide yield and bioactivity, particularly anti-hypertensive and antioxidant properties, and also touched upon downstream processing for purification and characterization [1].

Rice bran protein has emerged as a promising source for antihypertensive peptides, with research detailing the optimization of alcalase treatment to achieve specific peptide fractions with significant ACE-inhibitory activity. This work also explored the influence of pH and temperature on the hydrolysis process and subsequent peptide bioactivity [2].

Spent mushroom substrate, an often-underutilized byproduct, has been investigated for its potential to yield antioxidant peptides through papain hydrolysis. The research elucidated optimal enzyme concentration and reaction time to maximize the yield of peptides exhibiting radical scavenging activity, with characterization of the most potent sequences presented [3].

Plant-based proteins, such as soy protein isolate, are also targets for bioactive peptide production. An article explored the use of novel proteases, like thermolysin, to hydrolyze soy protein isolate, identifying peptides with enhanced anti-inflammatory properties and discussing the effects of process parameters on peptide profile and bioactivity [4].

Beyond enzymatic methods alone, simulated gastrointestinal digestion has been employed to generate peptides with specific functionalities. One study investigated the in vitro gastrointestinal digestion of casein to produce peptides with calcium-binding properties, examining the impact of different digestive enzyme combinations and incubation times on phosphopeptide release and mineral-binding capacity, including chromatographic analysis [5].

Immunomodulatory peptides have also been a focus of research. A study concentrated on the production of such peptides from zein using fungal proteases, detailing the optimization of enzymatic hydrolysis parameters and evaluating the immunomodulatory effects of the resulting hydrolysates in vitro through cytokine production assays [6].

Microbial fermentation offers a distinct approach to bioactive peptide generation. Research examined the effect of lactic acid bacteria fermentation on whey protein, highlighting the release of peptides with antioxidant and anti-inflammatory properties and analyzing changes in peptide profiles during fermentation [7].

Advanced physical methods are increasingly integrated with enzymatic hydrolysis to improve efficiency. A study optimized ultrasonic-assisted enzymatic hydrolysis of tilapia skin collagen, demonstrating how ultrasound enhances enzymatic efficiency for higher yields of peptides with antioxidant and ACE inhibitory activities [8].

Comparative analyses of hydrolysis techniques are vital for selecting the most effective strategies. One research paper compared enzymatic and acid hydrolysis for producing antihypertensive peptides from camel milk protein, assessing the efficiency of pepsin and trypsin and characterizing the resulting hydrolysates [9].

Synergistic technological approaches are also being explored. A study investigated the combination of pulsed electric fields (PEF) with enzymatic treatment to enhance the release of antioxidant peptides from pea protein isolate, evaluating the additive effects of PEF and pepsin on peptide yield and radical scavenging activity [10].

Conclusion

This compilation of research explores the generation of bioactive peptides from various food sources using diverse methodologies. Studies highlight enzymatic hydrolysis as a primary technique, with specific focus on optimizing conditions for anti-hypertensive, antioxidant, anti-inflammatory, immunomodulatory, and calcium-binding peptides. Different protein sources such as rice bran, spent mushroom substrate, soy protein isolate, casein, zein, whey protein, tilapia skin collagen, and camel milk protein are investigated. Advanced techniques like ultrasonic-assisted hydrolysis, pulsed electric fields, and microbial fermentation are also employed to enhance peptide yield and bioactivity. The research underscores the importance of enzyme selection, process parameter optimization, and downstream processing for obtaining functional peptides.

Acknowledgement

None.

Conflict of Interest

None.

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***Address for Correspondence:** Zainab, Ali, Department of Food Science, University of Malaya, Kuala Lumpur, Malaysia, E-mail: zainab.ali@um.edu.my

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