Bioscene

Bioscene
Volume- 21 Number- 02
ISSN: 1539-2422 (P) 2055-1583 (O)
www.explorebioscene.com

A Detailed Review on Role of Oil Seed Cake Hydrolysates in Food Preservation

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Abstract: Oilseed cakes are the byproducts of oil extraction which offers rich reserves of proteins, peptides, antioxidants, and phenolic compounds. Their hydrolysates are gaining prominence as natural meal preservatives due to their diverse bioactive factors. These hydrolysates play a multifaceted role in meal maintenance, exhibiting antioxidant and antimicrobial developments while fostering the creation of biodegradable coatings. Their potential spans, numerous components such as inhibiting lipid oxidation in foods, fighting spoilage microorganisms and lengthening shelf existence. Oilseed cake hydrolysates are prized for his or her antioxidative prowess, curbing loose radical harm and delaying meal spoilage. With their antimicrobial motion, they act as a natural defense against pathogens, lowering the reliance on artificial preservatives. These compounds additionally locate application in meat renovation, improving texture, moisture retention, and taste at the same time as ensuring protection by using hindering microbial growth at some point of storage. In packaging, these hydrolysates bolster biodegradable coatings, shielding meals and offering brought advantages like controlled release of antimicrobials or antioxidants, elongating product freshness. Explored in dairy upkeep, they could substitute artificial components, catering to the rising call for natural, sustainable options. This evaluation underscores the flexible function of oilseed cake hydrolysates in food preservation. Their integration signals a promising shift towards more healthy, green preservation strategies, emphasizing satisfactory, safety, and sustainability at the same time as lowering reliance on synthetics in food production and packaging.

Keywords: Oil seed cake hydrolysate, Oil seed cake preservatives,Antioxidant properties, antimicrobial activity, Biodegradable coatings, preservation.

1.Introduction:

Oilseed cakes left over following oil extraction have predominantly been utilized for animal feed, compost production, or as plant conditioners.These oilseed cakes, abundant in proteins, nitrogenous compounds, and minerals, represent a potential resource for human consumption alongside their existing uses.Considering the swiftly expanding human population and increasing food

costs, these protein-rich oilseed cakes could be investigated as a novel food commodity. Extracting and utilizing the high-quality proteins from these cakes not only supplements the current protein sources for human consumption but also addresses the issue of disposing of oilseed cake waste. (Singh et al., 2022).

Protein hydrolysates are produced through a two-step process involving enzymatic hydrolysis and post-processing. Firstly, whole protein sources are subjected to enzymatic hydrolysis using specific proteolytic enzymes under controlled conditions, breaking down the proteins results in a diverse combination of both active and inactive peptides. This controlled enzymatic treatment is preferred as it allows for precise manipulation of the hydrolysis process. Following hydrolysis, further processing is conducted to specifically extract the preferred and potent bioactive peptides from the resulting mixture. This facilitates the production of protein hydrolysates with heightened levels of beneficial compounds. This combination of controlled enzymatic hydrolysis and targeted post-processing culminates in the creation of protein hydrolysates that are valuable for food and health applications due to their enriched bioactive peptide content (Nasri, 2017). Protein hydrolysates are garnering attention in the food industry due to their beneficial effects on food products and human health. Enzymatic hydrolysis is the favored method for producing these hydrolysates, as it is a milder process compared to other techniques. The inherent specificity of different proteases provides enhanced control over the type and extent of the hydrolysis process. This controlled enzymatic approach enables the development of protein hydrolysates with desirable characteristics and functionalities that can be leveraged in food applications (Sandberg, 2011).

Protein hydrolysates obtained from oilseed cake demonstrate various beneficial effects on plant functions, encompassing nutrient uptake, root development, crop productivity, and quality enhancement, along with stress resilience and soil microbial activity. These hydrolysates are flexible in integrated crop management systems, as they can be used alongside fertilizers and pesticides. Utilizing hydrolysates from plant sources is especially appealing due to their enhanced sustainability, environmental safety, and compatibility with plant tolerance compared to those derived from animal sources (Ugolini et al., 2023).

Protein hydrolysates incorporated into edible films and preservatives prolong the shelf life of food items. The use of edible active packaging materials containing protein hydrolysates enhances food safety standards. Protein hydrolysates exhibit diverse functionalities. For example, a chickpea cake protein hydrolysate isolated using chymotrypsin has been discovered to possess antimicrobial properties against different foodborne pathogens, suggesting its potential as a natural food preservative. Similarly, a gram bean hydrolysate generated using Flavoenzyme for 2 hours displays unique structural characteristics and notable antioxidant properties (Sayed-Ahmed et al., 2022).By 2050, there's projected to be a doubling of global demand for animal protein, despite the detrimental environmental effects of its production. Simultaneously, there's a rising inclination

towards incorporating plant-based protein into diets. Utilizing these overlooked materials as potential ingredient sources can help meet the global demand for plant protein sustainably. Therefore, employing oilseed meals presents a sustainable approach to developing affordable, innovative, Nutrient-dense productswhile mitigatingexcess food. In the oilseed industry, there is now a greater demand for oilseed meals than for oilseed (Usman et al., 2023).This review includes the following areas such as antioxidant and antimicrobial properties, the use of biodegradable coating with incorporation of oil seed cakeprotein hydrolysates and biologically active peptides as packaging materials, as well
as the utilization of protein hydrolysates in meat and dairy preservation.

2. Role of Preservative Action in Food

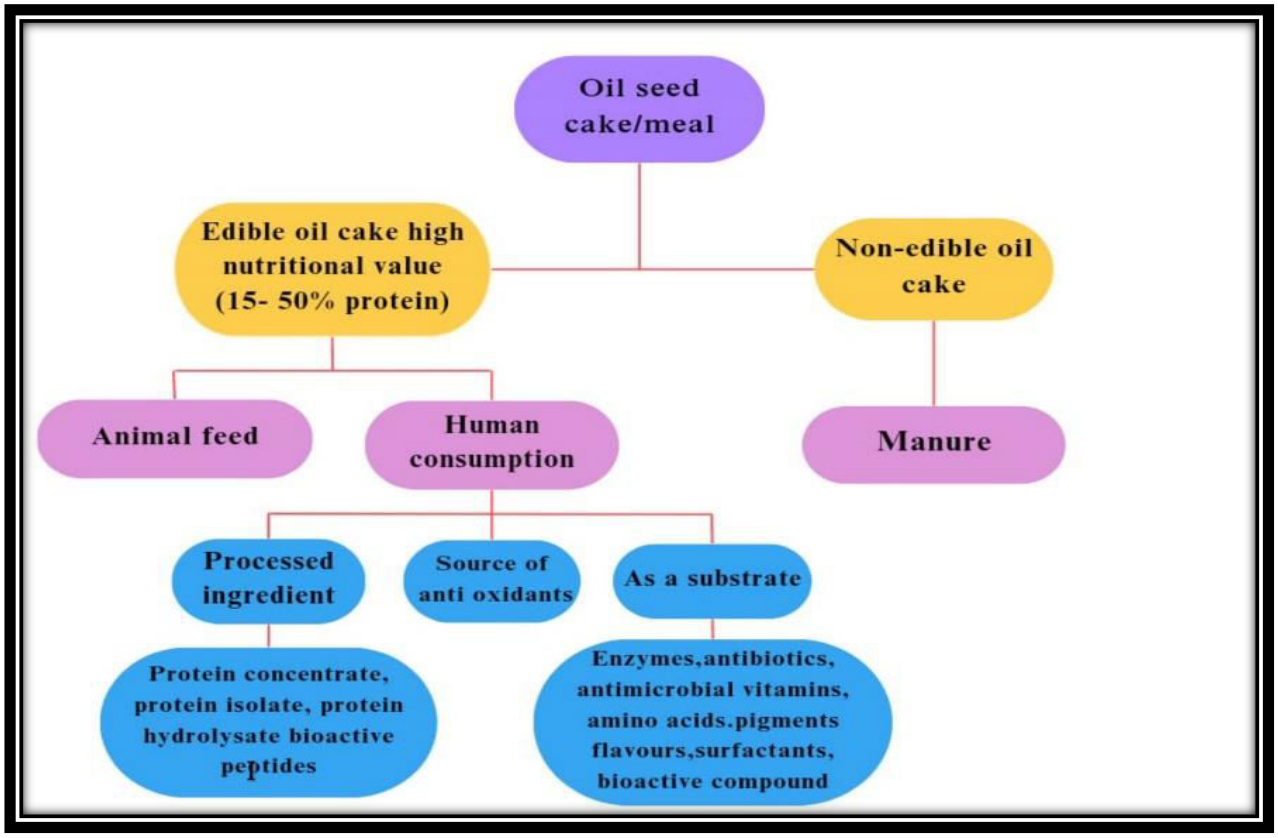

Figure 1. Oil seed cake and its byproducts

2.1. Anti-oxidant Activity:

The key signs of food spoilage are changes in how much bacteria are growing and the oxidation of fats. oxidative ranciditыis the main cause of food quality deterioration, leading to rancidity and shortened shelf-life. The use of antioxidants is a popular treatment to reduce rancidity processes. Antioxidants can work in various ways, such as acting as reducing agents, blocking free radicals, complexing with oxidation-catalyzing metals, preventing single oxygen

reactions, and inhibiting oxidative enzymes. While synthetic antioxidants like BHA and BHT have been used, there is increasing consumer interest in natural, health-promoting alternatives. In this context, protein hydrolysates and bioactive peptides possessing antioxidant properties have extensive potential applications in food items (Tkaczewska,2020). Protein hydrolysates derived from oilseed cakes exhibit antioxidant properties. These hydrolysates can neutralize free radicals and shield cells from oxidative stress-induced damage (L. Xu et al., 2015). The protein hydrolysates from oilseed cakes also demonstrate ACE (angiotensin-converting enzyme) inhibitory activity. ACE inhibitors are known to be beneficial for regulating blood pressure and promoting cardiovascular health (Karamać et al., 2014). The presence of phenolic compounds and antioxidants in oilseed cake hydrolysates contributes notably to their robust antioxidant hobby. Meal merchandise is more and more integrating protein hydrolysates and biopeptides from assets rich in antioxidants. These components exhibit diverse actions, such as reducing hydroperoxides, scavenging free radicals, neutralizing reactive oxygen species (ROS), chelating prooxidative transition metals, and altering the physical properties of products. Bioactive peptides and protein hydrolysates hold significant potential as antioxidants in food. (Usman et al., 2023). Protein hydrolysates and biologically lively peptides acquired from nutritional proteins, because of their antioxidant and antibacterial houses, can feature natural preservatives in food (Tkaczewska, 2020). Protein hydrolysates, formed by breaking down proteins into smaller fragments, possess enhanced functionality, solubility, and other characteristics in comparison to the original protein isolates. This is because the protein structure has been modified during the hydrolysis process. The hydrolysis process also creates bioactive peptides - smaller fragments of the original protein that have beneficial biological activities. These can include antioxidant, anti-clotting, cholesterol-lowering, bile acid-binding, and immune-modulating effects. The specific biological activities and properties of the hydrolysates depend on the enzymes used and the degree of hydrolysis. For example, hydrolysates from sesame, canola, and rapeseed have shown antioxidant, antihypertensive, and anti-clotting effects. Peanut peptides in particular have strong anti-clotting properties. Overall, protein hydrolysates and the bioactive peptides they contain can provide various health benefits beyond their nutritional value, depending on the starting material and processing conditions (Petraru & Amariei, 2020).The protein isolate extracted from pumpkin oil cake (POCPI) underwent hydrolysis using food-grade enzymes, specifically alcalase and trypsin. The protein hydrolysate produced using the alcalase enzyme (POCPH1) demonstrated promising antioxidant properties, such as the ability to scavenge DPPH radicals and chelate ferrous ions. These antioxidant activities exhibited by the alcalase-hydrolysed pumpkin oil cake protein isolate (POCPH1) make it an interesting and potentially useful candidate for food preservation applications. The antioxidant capabilities of this protein hydrolysate could help protect foods against oxidative deterioration and spoilage. Overall,

the study highlights the potential of utilizing enzymatically produced pumpkin oil cake protein hydrolysates as natural, food-grade antioxidants that can be utilized to enhance the shelf-life and quality of various food products (Nourmohammadi et al., 2017). Researchers have investigated using enzymes such as Protamex and neutrase to produce protein hydrolysates from hemp. These hemp protein hydrolysates exhibited significant DPPH radical scavenging activity, demonstrating their potential to serve as natural antioxidants. The enzymatic hydrolysis of hemp proteins using Protamex and neutrase-generated hydrolysates with potent free radical scavenging capabilities, as measured by the DPPH assay. This suggests the hemp protein hydrolysates could be valuable as natural antioxidant ingredients for diverse applications, for example food preservation or nutraceuticals (Teh & Bekhit2015).

Table 1
Examples of hydrolysates made from plant proteins and animal protein–derived hydrolysates

Source of plant protein	**The hydrolytic enzyme(s)**	**Antioxidant activity**		**References**
		Radical scavenging	**lipid peroxidation inhibition**	
Soybean oil seed cake	Flavoenzyme	✓	✓	(Moure et al., 2006**)**
Rapeseed oil seed cake	Pepsin	ND	✓	(Mamelona et al., 2009)
Hempseed oil seed cake	Alcalase	✓	ND	(Tang et al., 2009)
Mungbean oil seed cake	Proteinase	✓	ND	(Lapsongphon & Yongsawatdigul, 2013)

2.2 Antimicrobial activity

Antimicrobial peptides are essential parts of defense systems across life forms. These are small, hydrophobic peptides that have been widely studied for their potential in antibiotics and preserving food. Antimicrobial peptides can also be created in a laboratory by enzymatically breaking down food proteins. The effectiveness of these peptides against microbes, as well as the protein hydrolysates they originate from, relies heavily on factors such as their amino acid composition, structure, length, and sequence. Research on antimicrobial

peptides derived from food proteins is less extensive compared to studies focused on bacteriocins and antioxidant peptides.(Tkaczewska, 2020).Antimicrobial peptides typically consist of up to 50 amino acid residues. In their natural state, these peptides are often positively charged (cationic) and contain hydrophobic amino acids. They demonstrate a wide range of activity against bacteria, viruses, and fungi. Despite extensive research, the precise mechanism of action for these antimicrobial peptides remains incompletely understood. However, their key effects include altering the permeability of the cell membrane, destabilizing the lipid structure of the membrane, binding to lipopolysaccharides, inhibiting DNA replication, inhibiting protein expression, and triggering the release of ATP, ultimately resulting in cell lysis (bursting). In addition to these general antimicrobial properties, bioactive peptides derived from oilseeds have also been tested and shown to have antimicrobial activity (Garbacz et al., 2023). Protein hydrolysates from oilseed cakes, such as those obtained from sesame, canola, and rapeseed, have demonstrated antimicrobial properties. The antimicrobial activity of these hydrolysates is attributed to the bioactive peptides generated during the enzymatic hydrolysis process (Zhang et al., 2023). The antimicrobial effects of oilseed cake protein hydrolysates can inhibit a broad spectrum of microorganisms, including bacteria, viruses, and fungi. The specific antimicrobial mechanisms may involve disrupting cell membrane integrity, interfering with DNA/protein synthesis, and inhibiting enzyme activities in the target microbes (Kumar et al., 2022).Antimicrobial activity is an advantageous attribute in processed foods as it can prolong the product's shelf life. Antimicrobial peptides are categorized into three groups according to their size, charge, and amphipathic nature. These peptides frequently comprise significant proportions of hydrophobic amino acids such as leucine, isoleucine, valine, phenylalanine, and tryptophan. These antimicrobial peptides are naturally produced by multicellular organisms as a defense mechanism against pathogenic microbes. The antimicrobial activity in oilseed cake hydrolysates is vital for inhibiting the growth of harmful microorganisms in dairy products, thereby extending their shelf life and enhancing food safety. This property helps maintain product quality throughout storage and distribution, reducing food waste and ensuring consumer satisfaction. Additionally, it enables the development of antimicrobial packaging materials, further enhancing the safety and longevity of dairy products. Overall, antimicrobial activity in oilseed cake hydrolysates plays a critical function inmaintaining the integrityand safety of dairy items, supporting food sustainability and consumer health (Garbacz et al., 2023). Natural antimicrobial potential renders oilseed cake hydrolysates attractive for diverse applications. In food preservation, they can prolong shelf life by inhibiting spoilage

Table 2.
Antimicrobial activity of oilseed cake hydrolysates

Oilseed Cake	Antimicrobial Activity	Reference
Flaxseed oil cake	Significant antifungal and antibacterial activity at 1000 ppm; maximum zone of inhibition against Fusarium oxysporum	(Hassanin et al., 2017)
Pumpkin Seed Cake	Antioxidant properties; hydrolysate obtained by alcalase showed high DPPH radical scavenging activity	(Z. Wang, Liu, et al., 2021)
Hemp oil seed cake	Effects of subcritical water treatment on antioxidant, antiradical, and cytotoxic properties	(Švarc-Gajić et al., 2022)
Camellia Oil Seed Cake	Polysaccharides with potential natural antioxidant and antimicrobial properties	(Shen et al., 2014)

microorganisms and foodborne pathogens, offering a sustainable alternative to synthetic preservatives. Moreover, their biomedical applications extend to wound healing and topical treatments for skin infections, leveraging their antimicrobial properties for therapeutic purposes. In agriculture, they can combat plant pathogens and pests, contributing to sustainable pest management practices. Additionally, oilseed cake hydrolysates show promise in environmental remediation by inhibiting pathogenic microorganism growth in soil and water systems (P. Sharma et al., 2020). Flaxseed oil cake exhibited significant antifungal and antibacterial activity at 1000 ppm concentration, showcasing its potential as a natural antimicrobial agent. In particular, it demonstrated a maximum zone of inhibition against Fusarium oxysporum, a common fungal pathogen (Hassanin et al., 2017). Pumpkin Seed Cake, on the other hand, displayed notable antioxidant properties. Its hydrolysate, obtained through alcalase treatment, exhibited high DPPH radical scavenging activity, indicating its ability to neutralize free radicals and potentially mitigate oxidative stress. The Hemp Oil Seed Cake underwent subcritical water treatment, revealing alterations in its antioxidant, antiradical, and cytotoxic properties. This treatment

method holds promise for enhancing the beneficial attributes of hemp oil seed cake for various applications (Z. Wang, Liu, et al., 2021). Meanwhile, Camellia Oil Seed Cake contains polysaccharides that show potential as natural antioxidants and antimicrobial agents. These polysaccharides present opportunities for developing novel functional ingredients with applications in food, pharmaceuticals, and other industries (Švarc-Gajić et al., 2022). Below is a table 2 summarizing the antimicrobial activity of oilseed cake hydrolysates. These studies highlight the potential of oilseed cake hydrolysates in combating microbial growth and oxidative stress

2.3. Biodegradable coatings containing oilseed cake protein hydrolysates and biologically active peptides serve as packaging materials:

Plant-based proteins show great potential as eco-friendly polymers for packaging materials, but their widespread implementation in the packaging industry has not been realized (Senthilkumaran et al., 2022).Packaging plays a vital role in maintaining the quality of food, prolonging its shelf life, and offering nutritional details. While plastics are commonly used, their environmental impact is a concern. Oilcakes often overlooked by-products of oil extraction, are rich in valuable compounds and cost-effective, making them viable materials for food packaging (De Oliveira Filho & Egea, 2021). Enzymatic protein breakdown weakens intermolecular bonds and boosts chain end groups and free spaces, reducing the need for plasticizers and film permeability while keeping flexibility intact. These alterations impact mechanical traits and oxygen permeability of the protein coatings, improving them (Sothornvit & Krochta, 2000). Enzyme-assisted extraction serves as a sustainable alternative to harsh chemical methods, making it an environmentally friendly extraction approach. The effectiveness of these enzymes depends on factors such as pH and temperature. Nevertheless, in specific instances of protein extraction, the outcome remains consistent regardless of the enzyme type used (Senthilkumaran et al., 2022). Incorporating proteins into chitosan films reduces tensile strength and gas permeability (Bourbon et al., 2011). Higher levels of more highly hydrolyzed protein hydrolysates can enhance tensile strength in coatings. Protein hydrolysates serve as dynamic supplements in biopolymer films, extending the shelf life of packaged goods and enhancing mechanical attributes(Zhang et al., 2019). Protein hydrolysate films possess remarkable versatility, presenting a broad spectrum of uses. They serve as efficient vehicles for antimicrobial and antioxidant substances, prolonging the shelf life of meat products such as sausages, fillets, or beef patties by averting oxidation and restraining microbial growth. Moreover, they find application in supplementing a variety of food items through coating techniques. Additionally, they improve resistance to moisture and oxygen, thereby extending the shelf life of fruits and vegetables. The mechanical properties of crosslinked films resemble those of synthetic films and can substitute lightweight materials such as pouches and bags, acting as primary

packaging films. (Sandhu et al., 2017).

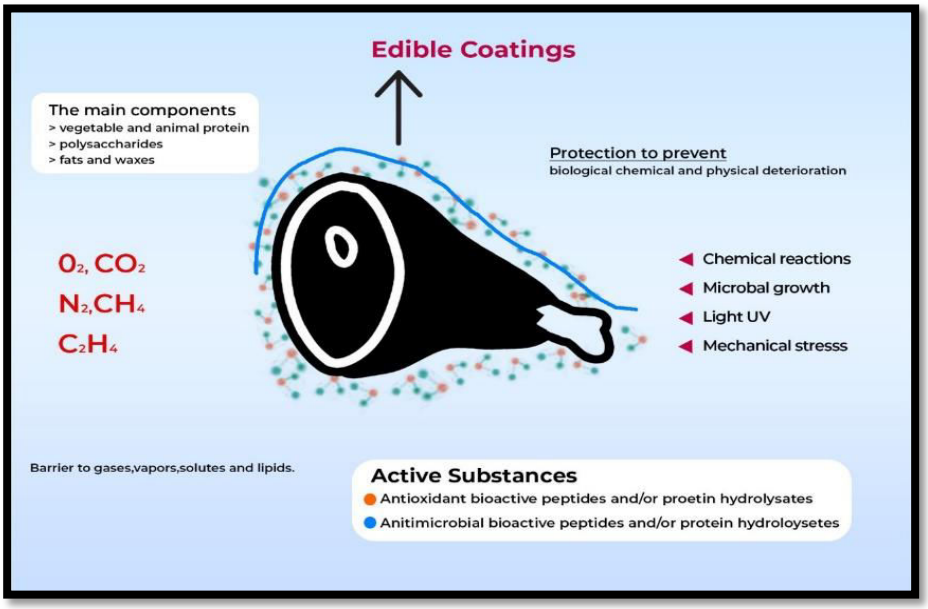

Figure 2. Main functions of coatings with protein hydrolysates and bioactive peptides.

2.4. Protein Hydrolysates in Meat Preservation:

Oil seed cake protein hydrolysates play a significant role in meat preservation by leveraging their bioactive properties to enhance meat quality and shelf life. Derived from oil seed cakes, which are the byproducts left after extracting oil from seeds such as soybeans, sunflower, or canola, these hydrolysates are rich in protein and offer multiple benefits in meat preservation. The use of oilseed cake protein hydrolysates and fibershas been investigated as a means to replace meat with plant-based components for nutritional enrichment. Researchers have expressed curiosity in enhancing burgers by incorporating chia seed meal, while a blend of porcine fat and beef in hamburgers could be substituted in part with textured soy proteins (TSP) and partially defatted chia flour (PDCF). Chia and poppy seeds have been successfully added to burgers, producing low-calorie, high-carbohydrate products.The study proposes that seed oils and flours are viable ingredients for crafting burgers that provide notable health advantages while retaining comparable physical attributes and flavor to conventional burgers (Usman et al., 2023). Researchers have explored utilizing protein hydrolysates derived from legume seed waste to extend the shelf life of meat fillets when stored under refrigeration. (Golpaigani et al., 2023). The antimicrobial qualities of oil seed cake protein hydrolysates prevent the proliferation of spoilage bacteria and pathogens in meat products, thereby prolonging their shelf life and lowering the likelihood of foodborne illnesses. Additionally, these hydrolysates possess antioxidant properties that prevent lipid oxidation in meat, a process that leads to off-flavors and spoilage. By acting as natural preservatives, the hydrolysates maintainthe integrity and safety of meat products(Czelej et al.,

2022). Apart from their preservation benefits, oil seed cake protein hydrolysates also serve as flavor enhancers, improving the taste of preserved meat products and making them more appealing to consumers. These hydrolysates can also aid in water retention and emulsification within meat products, contributing to improved texture and juiciness (Asaithambi et al., 2022).As a sustainable source, using oil seed cake protein hydrolysates for meat preservation is environmentally friendly, as it utilizes a byproduct of oil extraction and reduces waste. Oilseed cake proteins are being employed as substitutes for meat, incorporating plant-based ingredients to enhance nutritional content. Researchers have shown interest in enhancing burgers by experimenting with chia seed meal hydrolysate enrichment. A study by A. H. P. De Souza et al. (2014) showcased that a combination of porcine fat and beef in hamburgers can be substituted to some extent with textured soy proteins (TSP). Likewise, research conducted by Rabadán et al. (2021) effectively integrated chia and poppy seed cake hydrolysate into burgers, yielding low-calorie, high-carbohydrate products. The research proposes that seed oils and flours are viable for creating burgers that offer enhanced health advantages, while still maintaining similar physical attributes and taste to conventional burgers. (Usman et al., 2023).The incorporation of flaxseed oil cake hydrolysate into meat products has shown multifaceted benefits. It demonstrates a significant reduction in lipid oxidation, ranging from approximately 130% to 153% compared to control samples, highlighting its powerful antioxidative properties. (Singh et al., 2022). Moreover, it contributes to microbial load reduction, eliminating 31–55% of bacterial load in meat products, thus enhancing food safety (He et al., 2013). Beyond preservation, the addition of flaxseed oil cake hydrolysate enhances the texture of meat products by improving water-holding capacity, resulting in juicier meat (Garbacz et al., 2023). Importantly, it also aids in flavor retention during storage, maintaining the characteristic taste of the meat. Beyond its functional attributes, flaxseed oil cake hydrolysate offers a sustainable alternative to synthetic additives, aligning with the growing demand for natural and environmentally friendly food ingredients (Teh & Bekhit, 2015).

Table 3
Use of oilseed protein hydrolysate in meat preservation.

Aspect	Effect	Reference
Lipid Oxidation Inhibition	Reduces lipid oxidation by approximately 130–153% compared to control samples.	(Singh et al., 2022)
Microbial Load Reduction	Eliminates 31–55% of bacterial load in meat products.	(He et al., 2013)

Texture Enhancement	Improves water-holding capacity, resulting in juicier meat.	(Garbacz et al., 2023)
Flavor Retention	Maintains meat flavor during storage.	
Sustainability	Natural and sustainable alternative to synthetic additives.	(Teh & Bekhit, 2015)

2.5. Protein hydrolysates in diary Preservation:

Oil seed cake protein hydrolysates can significantly enhance dairy preservation by leveraging their natural antimicrobial and antioxidant properties. These hydrolysates inhibit the growth of spoilage-causing microorganisms such as bacteria, yeast, and moldsthus prolonging the shelf life and preserving the freshness and safety of dairy products. They prevent lipid oxidation, thereby preserving the flavor and overall quality of dairy items. (Sharma et al., 2023).Oil seed cake protein hydrolysates can improve the texture and consistency of dairy products, providing a creamier mouthfeel. By repurposing a byproduct from oil extraction, using these hydrolysates aligns with sustainable practices. Additionally, they offer nutritional benefits, such as essential amino acids, that can boost the nutritional profile of dairy products. (N. Nourmohammadi et al., 2023).A study published in a reputable food science journal may discuss the antimicrobial properties of oil seed cake protein hydrolysates and their ability to hinder the growth of spoilage-causing microorganisms in dairy products. Another research paper might explore the antioxidant effects of these hydrolysates in preventing lipid oxidation, which can preserve the flavor and quality of dairy items(Pua et al., 2022).Oilseed cake protein hydrolysates are essential in the dairy industry for several reasons. They enhance the functionality of dairy products by providing emulsification and gelation properties, improving texture and stability. Additionally, they enrich the nutritional profile of dairy items with essential amino acids and bioactive peptides. These hydrolysates offer a potential alternative to dairy proteins for individuals with allergies, reduce manufacturing expenses, and aid in creating healthier, more sustainable dairy goods (Abedini et al., 2022).One of the oilseed cake hydrolysates commonly used for dairy preservation is soybean cake hydrolysate. It contains bioactive peptides with antimicrobial properties capable of inhibiting the growth of spoilage microorganisms in dairy products, thus extending their shelf life. Additionally, soybean cake hydrolysate offers functional properties that improve the texture and stability of dairy items, making it a popular choice for preservation and quality enhancement in the dairy industry(Garbacz et al., 2023).Figure 4 demonstrates the efficacy of oilseed cake protein hydrolysate in preserving dairy products.

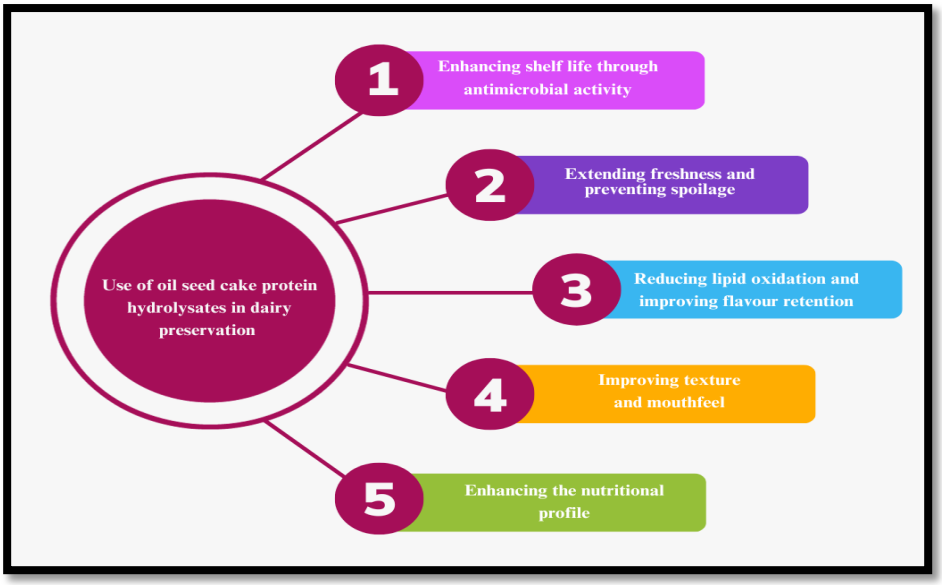

Figure 3. Use of oil seed cake protein hydrolysates in diary preservation

Future aspects or trends:

Within the destiny of meal protection, oilseed cake hydrolysates are expected to be very important. Those hydrolysates, which are crafted from the waste substances produced all through the processing of oilseeds, offer a healthy and sustainable manner to grow the shelf lifestyles of meal items. They possess antibacterial qualities that could prevent the formation of infections and spoilage microorganisms in meals because they're excessive in bioactive substances like peptides and antioxidants. Oilseed cake hydrolysates properly healthy the trend in the direction of easy label and environmentally friendly food maintenance techniques. They may be a promising development in the look for environmentally pleasant techniques of meals protection due to the fact they now not simplest enhance meal safety however additionally assist to save you meals waste through preventing rotting.

Conclusion:

The usage of oil seed cake hydrolysates in diverse aspects of meal protection represents a promising and sustainable method inside the cutting-edge food industry. This complete review has shed light on their pivotal role in enhancing food nice, protection, and sustainability throughout more than one domain, along with antioxidant and antimicrobial activities, biodegradable and fit-to-be-eaten coatings, and meat renovation. Oil seed cake hydrolysates have emerged as herbal and powerful antioxidants, combatting the unfavorable results of oxidation on meal merchandise. Their ability to mitigate oxidative techniques now not most effective extends shelf existence however additionally continues the sensory attributes and nutritional cost of meals. In the context of antimicrobial hobby, these hydrolysates have established their prowess in

inhibiting the proliferation of spoilage microorganisms and pathogenic bacteria. By presenting a natural defense mechanism against microbial infection, they lessen the dependence on artificial preservatives whilst ensuring the protection and toughness of meal gadgets. The improvement of biodegradable and edible coatings enriched with protein hydrolysates and biologically energetic peptides presents a sustainable packaging answer. These coatings now not handiest defend products from environmental factors but additionally impart useful benefits, which include the controlled release of antimicrobial dealers and antioxidants, thereby improving food renovation even as minimizing environmental effects. Inside the realm of meat preservation, oil seed cake hydrolysates have demonstrated value. They beautify the texture, moisture retention, and flavor of meat merchandise, in the long run enhancing the overall consuming revel. Concurrently, their antimicrobial houses shield meat against microbial spoilage, making sure of its safety and shelf existence. As a natural and long-lasting solution, using oilseed cake protein hydrolysates in dairy maintenance shows promise. These hydrolysates have bioactive peptides with antibacterial characteristics that help extend the lifestyles of dairy products by stopping the boom of microorganisms that motivate spoiling. Additionally, their use may also lessen the requirement for artificial preservatives, and assembly purchaser choice for products with smooth labels. In the end, oil seed cake hydrolysates represent a multifaceted and green tool in the realm of food maintenance. Their numerous packages, ranging from antioxidant and antimicrobial sports to biodegradable coatings and meat protection, underscore their importance in addressing the demanding situations of meals fine, protection, and sustainability. As client options shift in the direction of herbal and sustainable alternatives, those hydrolysates are poised to play an more and more essential role in shaping the future of meals protection practices. The combination of oil seed cake hydrolysates indicates a dynamic and ahead-thinking technique that aligns with both industry demands and client expectancies for more healthy and greater environmentally responsible meals preservation-strategies.

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