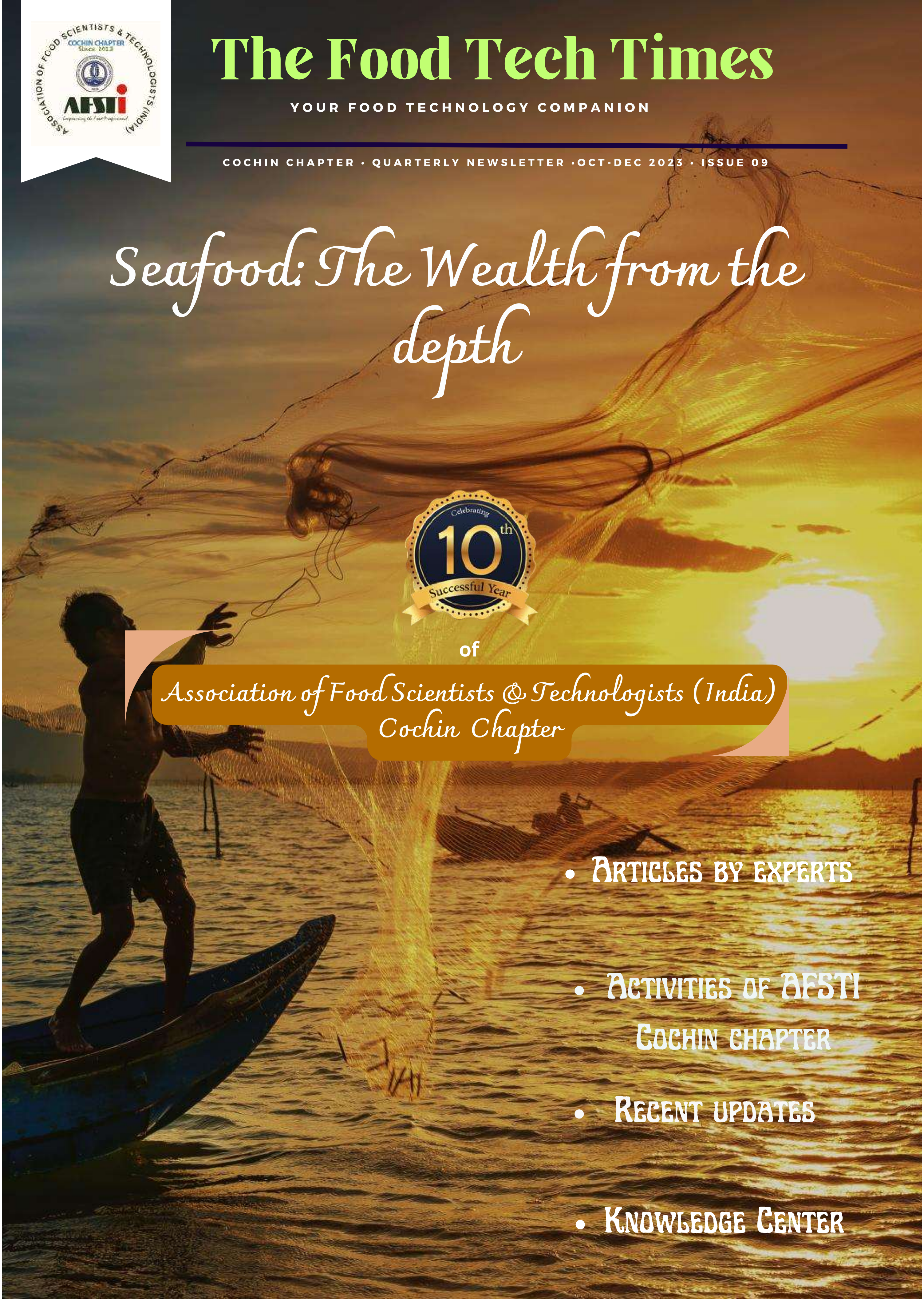

The Food Tech Times

YOUR FOOD TECHNOLOGY COMPANION

COCHIN CHAPTER • QUARTERLY NEWSLETTER •OCT-DEC 2023 • ISSUE 09

Seafood: The Wealth from the depth

Celebrating 10th Successful Year

of

Association of Food Scientists & Technologists (India) Cochin Chapter

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FOOD ENTREPRENEURS CONCLAVE (FECO 2.0)

FECO

by

Association of Food Scientists & Technologists (India), Cochin Chapter

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Department of Food Science & Technology, KUFOS

On 30/11/2023 @ Kerala University of Fisheries & Ocean Studies, Kochi

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From Editor's desk

Dr. Abhilash Sasidharan

Editor, The Food Tech Times

Seafood, including fish and shellfish, plays a significant role in our diets and ecosystems, holding immense importance for human health, the environment, and the global economy. Seafood is a rich source of essential nutrients such as high-quality protein, omega-3 fatty acids, vitamins (like B12, D), and minerals (such as iodine, selenium, and zinc). These nutrients are crucial for maintaining good health, aiding in the development of the brain, heart, and immune system, and reducing the risk of chronic diseases. Regular consumption of seafood is associated with reduced risk factors for heart disease. Omega-3 fatty acids in fish can lower triglycerides, reduce blood pressure, and decrease the likelihood of blood clot formation, thus promoting cardiovascular health. Omega-3s, particularly DHA (docosahexaenoic acid), are essential for brain development in infants and cognitive function in adults. Including seafood in the diet during pregnancy and early childhood is recommended to support optimal brain growth and function. The seafood industry is a significant contributor to the global economy, providing livelihoods for millions of people, including fishermen, processors, and restaurant workers. It represents a major export and trade commodity in many countries, contributing to economic growth and stability. Sustainable fishing and aquaculture practices are vital to maintaining seafood stocks for future generations. Overfishing and destructive fishing methods can deplete fish populations and harm ocean ecosystems. By promoting sustainable practices, we can ensure a continued supply of seafood. Seafood consumption helps maintain the balance of marine ecosystems. Predatory fish control the populations of smaller species, preventing overpopulation and promoting biodiversity. A healthy marine ecosystem benefits not only seafood production but also the entire environment. Seafood is an integral part of the culinary traditions of many cultures around the world. It often represents cultural identity and heritage, with various recipes and preparation methods passed down through generations. Seafood offers a wide variety of options, from white fish like cod and haddock to oily fish like salmon and mackerel, as well as shellfish such as shrimp, crab, and oysters. This diversity allows for a range of flavors and cooking methods, catering to different preferences and dietary needs. Seafood can be a reliable source of food, especially in coastal regions where it may be more accessible than other forms of protein. It can help address food security issues by providing a consistent source of nutrition. Fish and shellfish are often more efficient at converting feed into protein compared to land animals, reducing greenhouse gas emissions associated with meat production. Sustainable aquaculture practices can have a smaller environmental footprint compared to traditional livestock farming. Seafood is celebrated for its unique flavors and textures, making it a versatile ingredient in various cuisines. It can be grilled, baked, fried, steamed, or served raw in dishes like sushi and sashimi. In conclusion, seafood is more than just a delicious addition to our diets. It is a vital source of nutrition, a driver of economic growth, and a cornerstone of cultural and culinary traditions. To ensure its continued importance, it is crucial that we promote sustainable practices in harvesting and consuming seafood, safeguarding both our health and the health of the oceans on which we depend. This edition of The Food Tech Times brings you the significance of seafood under the theme Seafood: The wealth from the depth.

"If we wipe out the fish, the oceans are going to die. If the oceans die, we die."

– Paul Watson

The Food Tech Times
AFST(I) Cochin Chapter

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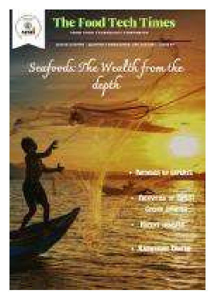

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APPLICATION OF CHITOOLIGOSACCHARIDE CONJUGATES

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Introduction

Chitin, a naturally occurring polymer, is synthesized by a vast array of organisms and is recognized as the second most found biopolymer in nature, following cellulose (Kaczmarek, M. B., et al., 2019). Chitin is a linear polysaccharide composed of N-acetyl-D-glucosamine (GlcNAc) residues linked together by β (1-4) bonds and is frequently regarded as the second most prevalent polysaccharide in the natural world, following cellulose. Its primary role is as a structural element in the cell walls of yeast and fungi, as well as in the exoskeletons of insects and arthropods, such as, lobsters, crabs and shrimps. Numerous studies have demonstrated its useful properties, leading to its wide-ranging applications in the fields of food industry, agriculture, wastewater treatment, textile industry, microbiology, nanotechnology, chemistry, material science, tissue engineering, and drug delivery. Its application in the food and pharmaceutical sectors is restricted due to its limited solubility. Chitosan can be obtained through the partial deacetylation of chitin and is a heteropolymer consisting of GlcNAc and D-glucosamine (GlcN) residues. In contrast to chitin, chitosan exhibits solubility in weakly acidic aqueous solutions.

Chitooligosaccharides

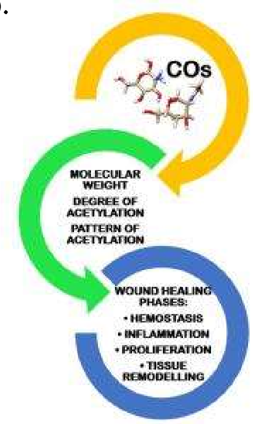
Chitooligosaccharides (COS), are degradation products of chitosan with a degree of polymerization (DP) less than 20 and an average molecular weight of less than 3900 Da (Li et al., 2016). COS are generally soluble in water and partially soluble in methanol and dimethyl sulfoxide, making them more accessible for various applications in agriculture, food, cosmetics, and the pharmaceutical industry. They possess distinct properties such as antibacterial, antifungal, anti-inflammatory, and antioxidant activities. To overcome the solubility issue associated with chitin and chitosan, Chitooligosaccharides have been employed in many of the applications. Chitooligosaccharide (COS) conjugates refer to molecules or compounds in which chitooligosaccharides are chemically attached or combined with other substances, such as drugs, polymers, proteins, or nanoparticles. These conjugates are created to harness the unique properties of chitooligosaccharides, which include biocompatibility, biodegradability, and bioactivity, for various applications in fields like medicine, agriculture, and biotechnology. COS conjugates can be designed to improve drug delivery, enhance the solubility of certain compounds, or offer targeted delivery of bioactive substances, among other purposes.

COS blends can be generated from chitosan through various physical techniques, such as hydrothermal processing (Sato et al.,2003), microwave treatment, ultrasonication (Wu et al.,2008) and exposure to gamma-rays (Yoksan et al., 2004). Alternatively, chemical processes involving acids [Domard et al.,1992; Einbu et al.,1992) hydrogen peroxide (Lin et al., 2009) or sodium nitrate (Morris et al., 2007) can also produce COS. Among the chemical methods for breaking down chitosan (Mittal et al., 2022; Vo et al., 2017; Atasoy et al., 2019; Quideau et al., 2011), acid hydrolysis is likely the most widely recognized.

In this review, we offer an outline of several of the most encouraging applications of COS conjugates. Additionally, we present an account of the current understanding of COS conjugates, their characteristics, and their utilization across diverse domains.

Potential applications of COS-PPN conjugates

A research study was aimed to synthesise and evaluate conjugates of chitosan oligosaccharides (COS) with a range of naturally occurring phenolic antioxidants, which are frequently found in plants, including catechin (CAT), epigallocatechin gallate (EGCG), gallic acid (GAL), caffeine (CAF), and ferulic acid (FER), was investigated. Using the ascorbate (AsA) and hydrogen peroxide (H_2O_2) redox pair system, the researchers were able to create an effective synthesis strategy for these COS-phenolic conjugates. They next used Fourier- transform infrared (FTIR), nuclear magnetic resonance (NMR) and UV-visible spectroscopy to thoroughly characterize the synthesized COS-phenolic conjugates in order to verify the conjugation. They also evaluated the COS conjugate antibacterial and antioxidant qualities. Finally, the study looked at the inhibitory effects of COS and its polyphenol conjugates on pancreatic lipase, α-amylase, and α-glucosidase (Mittal et al., 2022).



Chitooligosaccharides in wound healing process (Matica et al., 2023)

Antioxidant activity of COS-PPN conjugates

COS-PPN Conjugates have been extensively used in many foods and pharma applications because of their antioxidant properties. It retards the oxidation of protein, lipids, DNA etc. by interrupting the oxidative propagation chain reaction (Atasoy et al., 2019).

Some antioxidants namely secondary antioxidants scavenge some metal peroxidants thus lower oxidation in lipids. When COS is conjugated with PPNS it causes increment in antioxidant activity of biomolecule in process system thus shows an improved efficiency of radical scavenging activity (Quideau et al.,2011). Pasanphan and Chirachanchai (2008) utilized the carbodiimide method to create a conjugate of chitosan and gallic acid, resulting in an enhanced ability to scavenge free radicals and -OH radicals. Likewise, Cho et al. (2011) documented an elevation in the DPPH-radical scavenging capabilities of the CS-gallic acid conjugate. The antioxidant impact of gallate chitooligosaccharides was assessed in mouse macrophage RAW264.7 cells by Ngo et al. (2011). They found that gallic acid (G-COS) could scavenge cellular radicals in RAW264.7 cells and inhibit oxidative damage to lipids, proteins, and DNA. They also inferred that G-COS could reduce the expression and activation of NF-B and raise intracellular antioxidant enzyme levels (SOD and GSH) in RAW264.7 cells that had been exposed to oxidative stress.

Antimicrobial activity of COS-PPN conjugates

Although Chitosan has a variety of functions, its antimicrobial activities have garnered significant attention in recent years. Since CS's weak antimicrobial properties are most likely caused by its low solubility, CS has been combined with a number of phenolic compounds to increase its antimicrobial activity. Chitooligosaccharides could be conjugated with biomolecules in order to improve antimicrobial properties. The antioxidant activity of many COS derivatives was investigated by Eom et al. (2012) their research revealed that protocatechuic acid conjugated COSs and caffeic acid conjugated COSs exhibited the greatest antioxidant activity out of all the PA-c-COSs synthesised.

Pharmaceutical application of COS-PPN conjugates

The antioxidant and anti-inflammatory activities of gallic acid-conjugated COS were evaluated in human lung epithelial A549 cells. The conjugate COS and Gallate were found to have an exceptionally high capacity to scavenge DPPH radicals and to provide protection against H 2 O 2 -induced damage to DNA. This study found that the addition of gallic acid to COS improved its antioxidant and anti-inflammatory properties. Results suggested that gallate-COS could be a useful prophylactic against inflammation of the lungs and lung cancer caused by free radicals. The capacity of Chitooligosaccharide to scavenge free radicals was investigated both in vitro and in vivo using a high-fat diet mice model. Strong antioxidant qualities of COS were found to be able to protect animals from oxidative stress (Vo et al., 2017). In a study Salicylic acid and COS conjugates improved the oxidized alginate-gelatin hydrogel's capacity to heal wounds. The COS conjugate enhanced collagen proliferation at the wound sites, resulting in faster healing (Oh et al., 2021).

COS have the capacity to effectively manage hypertension by suppressing the activity of renin and angiotensin-converting enzyme (ACE). COS acts as an ACE inhibitor by specifically targeting the positively charged active site of ACE, which contains hydrogen-bond acceptors and relies on zinc as a cofactor. A study conducted by Hong et al. (2005) revealed that among various COS derivatives with different degrees of polymerization, the chitotriose derivative with a degree of polymerization (DP) equal to 3 exhibited the most potent ACE inhibitory activity. Furthermore, research has indicated an inverse relationship between the degree of deacetylation (DD) and the ACE inhibitory activity of COS and its derivatives (Huang et al., 2005; Hong et al., 1998). Because hydrogen bonds develop to facilitate COS binding, the aminoethyl-conjugated COS showed improved ACE inhibitory activity (Ngo et al., 2008).

Application as Edible coatings of COS-PPN conjugates

The use of CS-PPN conjugate edible coatings for the preservation of different food items has drawn a lot of attention nowadays. The goal of edible coatings is to create natural layers on product surfaces that increase shelf life by preventing weight loss, slowing respiration, halting microbial development, and oxidizing lipids. Fruit preservation has been achieved with the application of CS-PPN coating (Liu et al., 2017; Dehghani et al., 2016), on a variety of fruits, including, peach fruit (Jiao et al., 2019) pineapple (Jing et al., 2019), and king oyster mushroom (Liu et al.,2016).

Wu et al. (2016) CS-gallic acid conjugate to coat silver pomfret (Pampus argentus) and quality parameters were observed for 15 days at 4°C. The CS-gallic acid conjugate coating significantly decreased the production of volatile bases, lipid oxidation products, and microbiological spoilage across all coated samples. Additionally, the fish freshness was preserved, by its increased water-holding capacity and decreased ATP decomposition (K value). As a result, silver pomfret sensory qualities and shelf life were extended by 3 to 6 days. In another study, the pork meat had a shelf life of six days, but the CS-gallic acid conjugate, which was made with recombinant laccase isolated from B. vallismortis fmb-103, increased it to 18 days at 4°C (Zheng et al., 2018).

Application as Bioactive films of COS-PPN conjugates

Due to their numerous advantages, including non-toxicity, antimicrobial, antioxidant, biodegradability, biocompatibility, and the capacity to form films, CS-PPN conjugates are frequently used in the production of bioactive edible films (Kerch., (2015) which enhance the quality and prolong the shelf life of most of the perishable food products. Concurrently, the issues related to the application of chemical preservatives can be mitigated. When peanut powder was packaged in CS-gallic acid conjugate bags as opposed to polyethylene and CS bags, Schreiber et al. (2013) found reductions in TBARS, PV, and conjugated trienes.

β-secretase (BACE) inhibitory activity of COS-PPN conjugates

BACE - β-site amyloid precursor protein (APP)-cleaving enzyme is a crucial component in reducing Aβ amyloid peptide levels in Alzheimer's disease (AD) as it initiates the initial step in Aβ production. Eom et al. (2013) synthesized eight different types of chitooligosaccharides (COS) linked to phenolic acids, using hydroxyl benzoic acid and hydroxyl cinnamic acid. These COS variations contained different types of substitution groups, including p-hydroxyl, 3,4-dihydroxyl, 3-methoxyl-4-hydroxyl, and 3,5-dimethoxyl-4-hydroxy groups. The study examined the inhibitory effects of these COS derivatives on β-site amyloid precursor protein (APP)-cleaving enzyme (BACE). The study found that these derivatives demonstrated significant inhibitory activity against BACE. Among these derivatives, Caffeic acid- conjugated COS (CFA-COS) was further analyzed to determine its mode of BACE inhibition, which was found to be non-competitive. The findings of this study suggested that CFA-COS derivatives hold promise as innovative BACE inhibitors for reducing the risk of Alzheimer's disease (Eom et al., 2021).

Anti-inflammatory effect of COS-PPN conjugates

To enhance the combined benefits of unripe apple polyphenols (APP) and chitooligosaccharides (COS), scientists used a spray-drying method to create microcapsules called apple polyphenols-chitooligosaccharides (APCM). They examined how APCM influenced the release of polyphenols in a simulated gastrointestinal digestion model and assessed its anti-inflammatory properties against LPS-induced RAW264.7 cells. APCM notably suppressed the production of nitric oxide (NO) and TNF-α, while simultaneously increasing the production of the cytokine IL-10 as the concentration rose. These findings suggest that APCM can mitigate inflammation by reducing the production of pro- inflammatory cytokines like TNF-α and by promoting the production of anti-inflammatory cytokines such as IL-10. These findings support the application of conventional medicine to treat inflammatory disorders with scientific validity (Rana et al., 2021).

Propionibacterium acnes plays a significant role in the development of acne-related inflammation and can compromise the body ability to defend against oxidative stress. To tackle this issue, antibiotics such as tetracyclines, azelaic acid, macrolides, and erythromycin are commonly used to manage microbial proliferation and mitigate inflammation. However, these antibiotic treatments often entail adverse effects like cytotoxicity, allergies, and gastrointestinal disturbances. Consequently, recent research has shifted its focus towards the development of alternative antimicrobial materials. In this particular study, researchers chemically linked chitooligosaccharide (COS) with gallic acid (GA) using a hydrogen peroxide-mediated approach, and they assessed the resulting compounds antioxidant and antimicrobial properties. Subsequently, they developed a polyvinyl alcohol hydrogel containing GA-conjugated COS (GA-COS) for the treatment of acne. GA-COS, particularly when within the molecular weight range of 5-10 kDa, exhibited outstanding antioxidant capabilities and demonstrated more potent antimicrobial effects against P. acnes in comparison to COS alone. Furthermore, the polyvinyl alcohol hydrogel containing GA-COS not only inhibited the generation of reactive oxygen species within cells but also exhibited superior antimicrobial properties when compared to control treatments (Park et al., 2018).

Conclusion

In both medicine and food, COS biomolecule conjugates have the potential to provide sustainable and innovative solutions that address various health and safety concerns. Their versatility and biocompatibility make them a promising candidate for a wide range of applications, contributing to advancements in healthcare and food technology. However, further research and development are needed to optimize their efficacy and safety for specific applications.

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