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PHARMACEUTICAL APPLICATIONS OF MARINE-DERIVED PROTEINS

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Abstract
In the biotechnological sector, pectin and pectinase are both vital macromolecules. Both compounds are effective, non-toxic natural devices with a wide range of applications. Pectic materials' structure, unique depolymerization, and biochemical characteristics, such as a catalytic mechanism and the close bonds between these molecules, can significantly expand their industrial applicability. For instance, learning about the modular molecular heterogeneity of the compounds can be viewed as the focal point for addressing industrial issues from a variety of perspectives. The basic information about structure, depolymerization properties, pectin classification, pectinase kinds, and biochemical nature has been attempted to be coordinated in this review. Additionally, this page explains many production techniques that entail product optimization and its significant contribution to the pharmaceutical industry (either pectinase or derived pectic products).
Keywords: biomolecules, molecular heterogeneity, depolymerization characteristics

1. INTRODUCTION

This is due to the fact that the enzymes were capable of replacing certain poisonous chemicals that had been used earlier in food processing. A major obstacle for the researchers, nevertheless, is the biotechnological approaches that include the identification of microbial enzymes, mechanisms of action, and large-scale production [1]. In addition to recombinant techniques, protein engineering offers a feasible way to create recombinant enzymes that boost activity in various ways. Pectinase is an enzyme that has garnered attention worldwide as a biological catalyst in several industrial processes[2]. Because it hydrolyzes the pectin that is normally found in plant cell walls, this enzyme is well-known for its use in the industrial production of transparent fruit juice, the liquefaction and saccharification of plant material, the manufacturing of paper, and the fermentation of coffee and tea. With a high galacturonic acid concentration and carboxyl groups esterified with methanol, pectin is an acidic heteropolysaccharide structural component. One important component of fruits, vegetables, and cereals is the acidic heteropolysaccharide. High molecular weight, biocompatible, non-toxic, anionic natural polysaccharides, pectic compounds are essential parts of plants' primary cell wall and middle lamella. Pectic compounds, including pectic acids, are broken down by the complicated enzyme system of pectinase. Pectinase hydrolyzes the pectin polymer more efficiently than other pectinase classes of enzymes, according to the enzymatic nomenclature system. It is well known that the pectinase enzyme is mostly produced by microorganisms and plants [9].
However, pectinase generation from microbial sources is becoming a significant topic of study interest due to its technological and financial viability. Naturally, the enzyme plays a significant part in the metabolic activities of

almost every living thing, including bacteria, viruses, fungi, plants, and mammals. However, academics are now interested in how various biotechnological tools might be used to improve its performance in various aspects. Furthermore, researchers are focusing on modifying or enabling pectinase to make it useful in many industrial bioprocessing areas. Although pectinolytic enzymes have a wide range of commercial uses, they are mostly employed in the food industry for specific processes such as the extraction of vegetable oils and the clarifying of fruit juices and wines [3]. Additionally, it is widely used in the extraction and processing of pectin, which is essential for the production of coffee and tea, the maceration of plant and vegetable tissue, the defumming of plant fibers, wastewater treatment, paper bleaching, and as an addition in textiles and poultry feed. By improving nutritional prebiotic qualities through the digesting of plant food, pectinase also contributes to the maintenance of intestinal microbiota homeostatic balance. Many pharmaceutical industries also employ enzymatic pectin preparations to produce low-methoxy pectin, which is appropriate for diabetes patients[13]. In plant protoplast culture work, purified pectinase forms which are commercially obtained from a variety of fungal organisms are crucial because they help produce high quantities of viable protoplasts when treated with cellulose. As a result, the current review provides comprehensive information on the structure, depolymerization behaviour, and classification of pectic substances as well as the type and biochemical behaviour of pectinase, all of which are gathered through a literature search for economic and market needs[10]. Additionally, the study gives a summary of the several methods used to produce pectinase as well as the medicinal uses of pectin and the pectinolytic enzyme [10]. Thus, it is intended that this review article will help develop conceptual understanding of the protease enzyme and its substrate.

2. REVIEW OF LITERATURE

Because of the amazing function these enzymes play, biotechnologists from all over the world are very interested in enhancing their potential through the use of diverse recombinant techniques. Both submerged fermentation and solid-state fermentation (SSF), which use different fungi or bacteria, are used to produce the commercially available pectinase enzymes. The process has been in use since the 1940s, when bacteria were cultivated on liquid broth while being constantly stirred to produce large quantities of antibiotics. Later, it was widely employed in other industries to produce a wide variety of microbial metabolites [5].

The choice or development of a particular technique and an appropriate medium is based on chosen microorganisms, along with some environmental conditions surrounding them for optimizing the production of pectinase. Some notable contributions concerning selectable substrate-containing media and production techniques. The increasing demand of pectin in the field of pharmaceuticals has hastened the need for efficient extraction processes. At the commercial level, naturally occurring biomolecules can be recovered from citrus fruit peels using alcohol precipitation. During extraction, recovery of pectens at the industrial level is critical in order to provide with acceptable supply for the growing demand. Commercial pectin is often produced by hydrolysing proto pectin with acid at a high temperature, followed by ethanol precipitation. Microwave-enhanced extraction, enzymatic extraction (hemicellulose, protease, cellulose, α-amylase, microbial mixed enzymes, etc.), supercritical water extraction, ultra-high-pressure treatment, ultra-high electric field treatment, and ultrasound extraction are some of the new methods that are needed because of constraints like decreased yield, heterogenic macromolecular and gelling property changes, etc [11].

These new techniques demonstrate a high handling capacity, a shorter processing time, enhanced purity, a soft condition, and an environmentally responsible and energy-efficient mode of operation. However, proper precipitation is necessary for effective purification, and this was achieved by alcohol precipitation along with washing[6]. Through cultivation and study, it was shown that innovative methods including metal precipitation, ethanol precipitation, ultrafiltration paired with diafiltration, and ultrafiltration may successfully purify pectins.

3. MATERIALS AND METHOD

Different enzymes generated from microbes have found extensive use in various industries that are utilized directly or indirectly in daily life in this modern day. Because of their increased application in other biotechnological processes, enzymes have particular and tunable catalytic capabilities, making them the highest level of biological instruments. Among the most significant industrial enzymes are pectinases, whose significant contributions to the pharmaceutical industry are discussed here. Because humans are omnivores and often consume a variety of foods, their digestive systems need to be able to properly digest them. Friendly bacteria that live inside the gastrointestinal system know how to use convolution to break down foreign complicated substances because they enter regularly. For this reason, pectinase-fermented dietary fibers may help to improve the immune system by acting as natural prebiotics and to regulate the internal enzymatic system for effective digestion [7]. Depolymerized pectins can be used directly in certain pharmaceutical products to increase the quantity and viscoelasticity of stool. They can also be used to treat acute and chronic constipation. Furthermore, fermented pectic chemicals are utilized in throat lozenges as a demulcent decongestant and in conjunction with other products to aid in the healing process of wounds. In order to prevent colostomy treatment, the pectic components are

applied as medicated adhesives. When combined with sulfate, pectins reduce clotting time and can be used in place of heparin. Iron deficiency anomia can be effectively treated with a mixture of iron and broken-down pectin. Due to their effective medicinal potential in treating a variety of illnesses, including microbial infectious diseases, depression, anxiety, cancer, and wound healing with minimal or no side effects, medicinal plant essential oils are currently widely used in both developed and developing countries. They are also playing a major part in perfumes and cosmetics. However, the solvent extraction procedure may eliminate some crucial functional groups that cause negative health effects. To avoid this, pectinase enzymes are used in the extraction process in most oil processing, pharmaceutical, and cosmetic industries. This stops pectin's emulsifying effect and makes it easier for cell wall material to liquefy, which results in a higher volume of products. The high concentration of phytocompounds, including polyphenols, essential proteins, antioxidants, lipophilic bioactive compounds, and vitamin E, is also maintained in the oils extracted by enzymatic techniques, which further improves their storage stability [15].

Pectin hydrogels are currently widely employed in tablet manufacture as a binding agent that acts as a controlled release agent; these are mostly used in the treatment of colon cancer. A sustained-release drug delivery method, hydrolyzed pectin beads are made using the ionotropic gelation procedure[8]. Drug distribution is also improved by low-methoxy pectin modification by esterification or the inclusion of calcium pectinate gel beads in the formulation[12]. Calcium pectinate is typically used because it forms hydrophilic coatings that are insoluble, interact with one another within the host cell, and facilitate the uniform release of the desired drug[14]. Additionally, a study showed that oral formulations containing pectic chemicals that were compacted from orange and mango peels were effective and had a regulated release. These are showing a great effect with functional polymers and possess exceptional binding properties during the formation of different tablets.

4. RESULT AND DISCUSSION

Because of the growing demand from young people, the pharmaceutical industry now concentrates on a variety of cosmetic-related beauty goods. Serious health repercussions, like a detrimental impact on skin health, have increased due to bad lifestyle choices and rising environmental pollution. In cosmetics and other personal care products, pectic compounds are successfully combined with other chemicals that have been shown to be useful against a variety of skin conditions. It is known for its complex polysaccharide structure, which contains particular anti-oxidative and anti-aging components that can prevent skin damage, in addition to its efficacy as an emulsifier in thickening and gelling face cream. However, depending on the source from which it is extracted or fermented by the appropriate pectinase enzymes, the efficacy rate may vary.

Marine ecosystems, being a major reservoir of biodiversity, have been widely recognized across the world for their immense value as a source of food and bioactive molecules. The discovery of novel proteins and peptides from marine creatures has been documented in an increasing number of studies in recent years, suggesting that these resources have untapped potential. These proteins and peptides from seafood have been identified as a possible future source of nutraceuticals and functional foods due to their unique amino acid composition, bioavailability, and bioactivity.

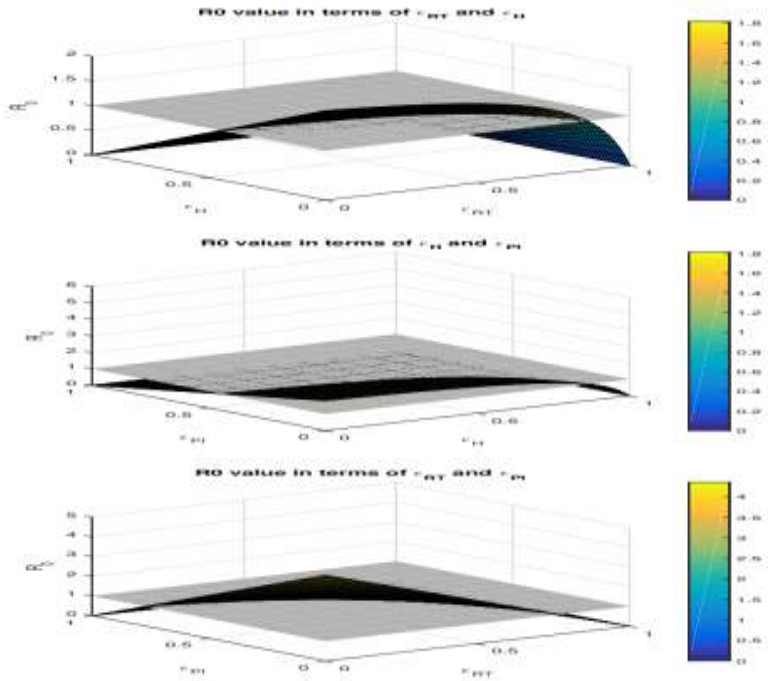

Figure 1: stochastic 2-LTR HIV model

The increased, burgeoning interest in functional foods is also reflected in the sport nutrition community, as strategies for nutrition aimed at enhancing performance and recovery have become increasingly more sophisticated and specialized. Athletes continually seek out new, cutting-edge nutritional strategies that will enhance performance safely, enhance recovery, and keep the athlete in a state of general good health.

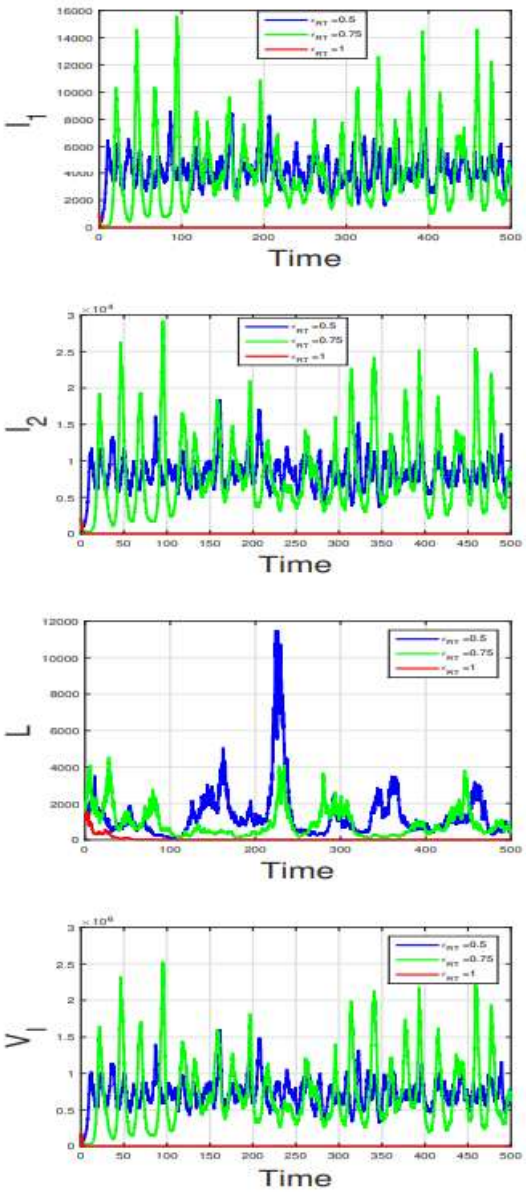

Figure 2: extinction time

The creation of functional foods for athletes, therefore, is an important potential growth and research area. Recent trends involve the utilization of natural and renewable sources of peptides and proteins, personalized nutrition approach, and increasing emphasis on improvement in physical as well as mental performance.

5. CONCLUSION

In the current era of innovations and cutting-edge research for the discovery of the new utility of microorganisms and their products, microbial studies have formed an irreversible rebirth. The use of pectinases and/or pectins is found to be intriguingly recognized in a variety of industrial processes, with encouraging results, it is concluded. It is clear from the extensive research that pectinolytic enzymes are now the most important factor in developing novel approaches for the significant creation or improvement of enzymes related to industrial products. However, the cost-effectiveness of producing these enzymes from certain microorganisms and applied environmental conditions is one of the most important considerations. It is clear that the application of pectinase and its derivative pectic compounds in medicinal formulations is mostly unexplored. Enhancing and expanding the use of these valuable enzymes in the pharmaceutical industry is therefore imperative. Furthermore, the development of a wide-spectrum pectinase with improved catalytic affinities urgently requires the input of biotechnological considerations. Therefore, it is crucial to have a thorough understanding of the biochemical and molecular

mechanisms of expression. Functional foods, also known as nutraceuticals, are food components with added nutrients that have health-promoting effects in addition to basic nutrition. Functional foods are used to enhance overall well-being, stimulate the immune system, decrease the risk of illness, and control health disorders. Of the range of possible functional food ingredients, peptides have been the subject of much interest. Peptides are short chains of amino acids, and they can be developed to have the desired physiological effects depending on their structure and composition. They have been found to exhibit different bioactive properties, including antioxidant, antimicrobial, and anti-inflammatory activities, which are possibly beneficial to human health and wellbeing.

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