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Bacterial Pectinases and their Potent Biotechnological Application in Fruit Processing/Juice Production Industry: A Review

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Summary

Pectinases from food and food Bio products processed waste alone account to a total of one-third quarter of world's food enzyme production. The uninterrupted search, which is being undergone for pectin hydrolyzing enzymes from biomass of fruit industry waste rich in lingo cellulosic material, is deriving straightaway immenseness in production of bacterial Pectinases .By products or waste obtained from orange, apple, grapes, pine apple, papaya, lemon juice manufacturing industries are used as source of the enzyme production .Scrutinized samples of soil obtained from fruit processed area are found to an appreciable reservoir for Pectinolytic Bacteria. The central theme of the review concentrates around the brief introduction to classified Pectinases, Pectinolytic Bacteria and different Pectinases employed at different stages of fruit juice processing. It also adds note on currently available commercial Pectinases.

Key Words: Bacterial Pectinases, Fruit juice processing, Agricultural and food industrial waste, Clarification, Cloud removal

Introduction

Enzymes are the Bio-active compounds that regulate many chemical changes in living tissues. Pectin's are the versatile, structural polysaccharides of higher plants containing long Galacturonic acid chains with residues of carboxyl groups and with varying degree of methyl esters[2]. They are prominently seen in middle lamella and primary cell wall occupying one-third of the dry weight of plant tissue [24].

The first commercial application of Pectinases was observed in 1930[11]. Pectin's are the major polysaccharide compounds present in fruits [32].Pectinases in spite of their usage in other industries are endowed with promising applications in fruit processing industry as juice clarifies, colour and yield enhancers and in fruit mash treatment [3]. Abundant waste from agri and fruit processing industrial waste becomes an appreciable section for biological utilization of fruit processing waste in juice industry. Pectinases play a crucial role in clarification [8], extraction, in reduction of viscosity, to remove off the peels and to increase the yield [14]. In apple, pear and grape Pectinases are used during pressing and straining stages. In Orange, Mango, Guava, Pineapple and Papaya Pectinases are employed to remove the cloudiness. Pectinases are of prompt application in maceration, liquefaction, extraction and clarification processes [4].

In spite of the wide range commercial application of Pectinases in the market, enhancement of production technology in Bio-chemical aspects, detailed understanding of the fermentation processes and various recovery methods made the microbial production of enzymes affordable [6,22].

Decreasing the capital investment by using low cost agricultural and fruit processing industrial waste as raw materials not only booms up the commercialization of the product but also aids in recycling [19]. A multi-step process involving screening of soil samples from agro-industrial wastes for native novel [12,15] Bacteria(organism), organised fermentation processes (up streaming and down streaming), implementation of techniques like strain improvement or any modern techniques to boost up the yield of isolated bacteria is to be employed in a co-ordinated way for successful large scale production of Pectinases .Thus the enzyme technology is more focussed on research on Pectinolytic bacteria and on genetic modifications for production of high yielding strains of Pectinolytic bacteria[27]. The pH of Bacterial alkaline Pectinases usually ranges from 10 to 11[7, 9]. Bacillus strains are inferred to be the potent sources of Exo-polygalacturonases [26]. Glucose analogues are used in isolation of over producing mutants to increase the yield [23]. Bacteria offer an additional advantage of not being influenced by climatic and seasonal factors. Some of the Pectinolytic Bacteria include *Bacillus spp., clostridium spp., and pseudomonas spp.* [30].Bio-informatics plays a major role in recent advent of research. It paves a simple way for structural analysis [29].

Pectinases and their action

Pectinases are a complex heterogeneous group of different enzymes that act specifically on Pectic substances. Pectinases act on and decrease the intracellular adhesivity and tissue rigidity [25].

The activity of Pectinases is also influenced by the physical and chemical parameters that are vital for increase in the yield [21]. Pectinases are the acidic polysaccharides consisting of 3 main classes. They include polymethylesterase's (PME), Polygalacturonase's (PG), and Pectate lyase's (PAL) [16, 5]. Polygalacturonases causes the breakdown of α (1-4) -glycoscidic linkage between the Galacturonic acid residues. Pectate lyase [20] acts on pectin eliminating oligosaccharides of α (1-4) linked galacturonic acid residues. Poly methyl esterases act on pectin methyl esters releasing methanol [10]. Microbes are prominent in

their ability to produce Pectinases provided with specific substrate [28].

Applications in different phases of fruit juice manufacturing

Pectinases are endowed with potent biotechnological applications in fruit juice manufacturing industry. Using by-products for pectinase extraction is still more profitable [1]. During extraction pectin passes into juice and makes the juice cloudy. Cloudiness in pulp can be removed by enzymatic hydrolysis. Practically different steps notably; washing, sorting and crushing followed by pressing and maceration are utilized in fruit juice processing for production of fruit juices [4].

Literature emphasizes that application of mixture of commercial Cellulases and Pectinases solubilises almost 90% of orange peel solids [18]. Pectinases find their way in extraction and clarification processes. Pectinases are the one among the group of macerating enzymes used in extraction, clarification and stabilization phases in the industry [13]. They are also applicable in increasing the volume of the juice and to soften the peels for their easy removal [4].

Pectinases in citrus juice manufacturing:

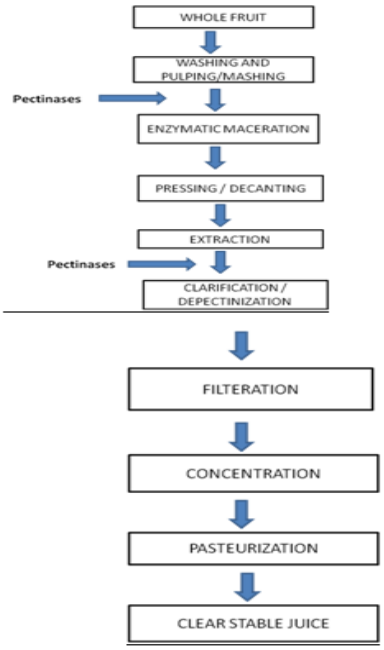

Fig.1. Pectinases at different phases of fruit juice manufacturing

India is the major citrus fruits producer particularly in states of Maharashtra, Tamilnadu, Andhra Pradesh, Himachal Pradesh, Punjab and Haryana. In citrus juice processing Pectic enzymes contribute to remove the cloudiness and for juice stabilization [17].

Orange juice

The pectin particulates make the Orange juice cloudy in appearance. Clarification using Pectinases is to be done to make it marketable. In classical processing of Orange juice, heating spoils the flavour and freezing is expensive. Hence enzymatic treatment of Pectinases clarifies the juice cloud, while maintaining its stability [17].

In Orange juice processing the skin is peeled off and added to the mixer. Fruits are washed and mechanically crushed. The prepared juice is strained. After the pulp is washed macerating enzymes are added during crushing and clarification processes [31]. Addition of Pectinases is done for enzymatic maceration. The sediment particles of the pectin are acted on by this Pectinases to reduce the cloud [10]. The clarified juice is less viscous. Liquefication occurs and the increase in yield is contributed by the Pectinases in this step. Solids are allowed to separate by secondary extraction using a mixture of different commercial Pectinases. Decanting and clarification of extract occurs yielding clear, stable juice [4]. Pectinases offers an extensive way to peel off the citrus peels making the production process easy [14].

Lemon

In processing of Lemon juice Pectinases are added during the clarification process. The obtained extract can be then easily concentrated and marketed. Whole fruits are crushed and mashed. Macerating enzymes are added assisting in liquefaction thus increasing the yield. This also helps in reduction of processing time. Clarification is also aided by Pectinases in commercial large scale production, making the produce marketable. Literature evidences suggest that Pectinases hold important criteria in imparting flavour enhancement to the processed juice.

Guava processing

Pectinases also helps for cloud removal in guava juice production process.

Apple juice:

In apple juice processing Pectinases are used in extraction and clarification processes thus removing the cloud. These enzymes remove the suspended particles, thus removing the 'After Haze' effect. Despite of traditional processes, Pectinases help in removing the cloudiness to obtain clear juice. Pectinases also tend to contribute to high quality produce with enhanced flavour along with the increase in the yield after pressing from apples.

Grape juice processing:

In grape juice processing Pectinases are used during crushing, to reduce the pressing time and to clarify the juice [14].

Commercial pectinases

Supplier	Location Brand	Name
C.H. Boehringer Sohn	Ingelheim, West Germany	Panzym
Ciba-Geigy, A.G.	Basel, Switzerland	Ultrazyme
Grinsteelvaeket	Aarthus, Denmark	Pectolase
Kikkoman Shoyu, Co.	Tokyo, Japan	Sclase
Schweizerische Ferment, A.G.	Basel, Switzerland	Pectinex
Societe Rapidase, S.A.	Seclin, France	Rapidase,
Clarizyme Wallerstein, Co.	Des Plaines, USA	Klerzyme
Rohm, GmbH	Darmstadt, West Germany	Pectinol, Rohament
Biocon Pvt Ltd	Bangalore, India	Pectinase

Note: This data is collected from PECTINASES database 2011.

Conclusion

Hence Pectinases contribute largely to the fruit juice manufacturing industry at varying stages. Weighing all its potent applications, more emphasis is to be laid not only on screening the novel Pectinolytic bacteria, but also on production of high yielding strains. Utilization of fruit processed industrial by-products and waste as substrates acts to recycle the waste and to decrease the production cost making it economical. Hence furious work in this area is found to be an adept opportune both to the researches and to be industry.

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