Pectinases are a complex group of heterogeneous enzymes that catalyses the degradation of pectic compounds by depolymerizing or de-esterifying reactions Shrestha *et al* (2021). They are extensively distributed in higher plants, which help modify pectinaceous components during the natural ripening of various fruits. Various plants, fungi, yeasts, insects, bacteria, and microorganisms naturally manufacture pectinase enzymes. Pectinases are categorized into three categories based on their mechanism of action: pectin esterase, hydrolases, and lyases Garg *et al.* (2016).

The production of Pectinases from fungi, such as *Aspergillus niger*, generates these enzymes to break down the middle lamella in plants to absorb nutrients and introduce fungal hyphae. The production of Pectinases by filamentous fungi of the genus *Aspergillus is* carried out in solid-state or submerged culture John *et al* (2020), Samreen *et al* (2019). When pectinase is cooked, the enzyme becomes denatured, making it more difficult to bind with pectin at the active site and create as much juice as possible.

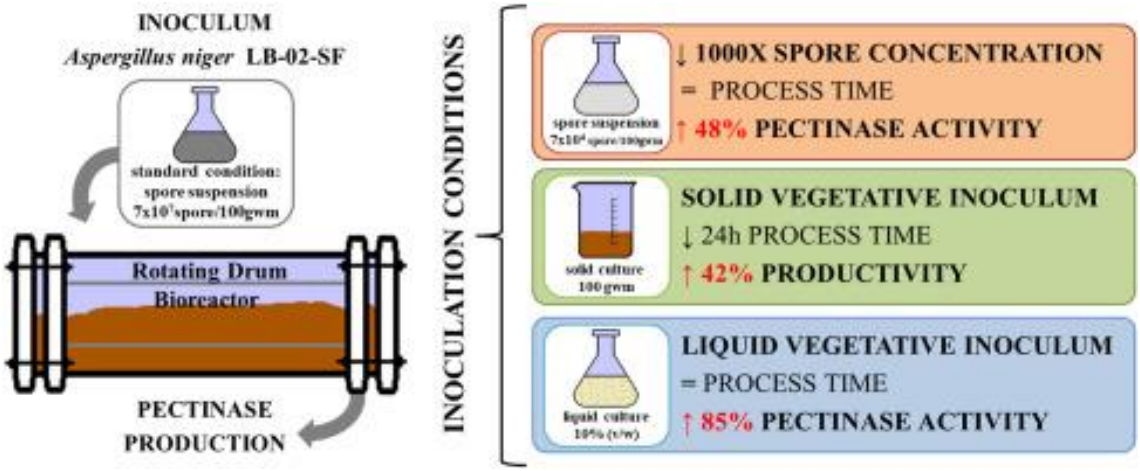

Figure 1. The production of pectinase

Pectinase's commercial applicability was first detected in 1930 Kertesz (1930). The biotechnology industry has frequently exploited pectinases to degrade plant cell walls. They are recognized as environmentally benign biocatalysts, with a 25% share of the worldwide food and beverage enzyme industry Amin *et al* (2019).

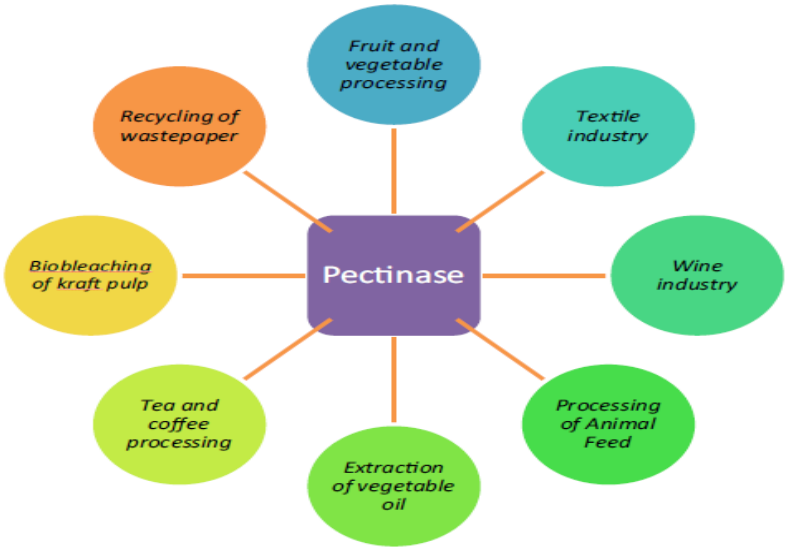

Figure 2. Industrial applications of pectinase in various biotechnological and industrial sectors.

Global research domains are doing applications investigations using pectinases to get maximal enzyme activity. The rising worldwide demand for pectinase has led to its widespread use. The use of pectinolytic enzyme varies depending on the availability of physical circumstances.

Oil extraction

Pectinase and other cell wall degrading enzymes (CWDE) have been extensively studied for oil extraction from a variety of sources, including flaxseed, olives, dates and so on. Citrus oils, such as lemon oil, can be extracted using pectinases because these enzymes impair the emulsifying characteristics of pectin, which prohibits oils from being extracted from citrus peel extracts**.** Haile and Ayele (2022)

Jams and jellies preparation

Excess sugar is added during the manufacture of jams and jellies for gelation. Because pectin esterase converts high-methoxylated pectin into low-methoxylated pectin, it ultimately increases calcium gelation properties and reduces sugar requirements Kubra *et al* (2018).

Fermentation of coffee and tea

Alkaline pectinases have been employed in tea fermentation to minimize the foaming of instant tea powders by degrading the pectin and removing the mucilaginous layer from coffee beans Carr, (1985). In tea leaf fermentation, commercially available pectinase may enhance theaflavin (TF) by 5.8%, thearubigin (TR) by 5.72%, high polymerized substances (HPS) by 4.96%, and total soluble solids (TSS) by 9.29% Marimuthu *et al* (2000). Pectinase crude preparations outperform refined enzymes in increasing tea leaf fermentation (Amin *et al.*, 2019); Angayarkanni *et al.* (2002); (Samanta, 2021)

Finally, due to their unique ability to break down complex pectin structures, pectinase enzymes have been proven versatile in various biotechnological industries. Their uses range from juice and wine production to textile and paper production, waste management, and biofuel production. The future of pectinase enzymes in biotechnology is bright, as advances in genetic engineering and enzyme optimization methods enable the development of new and better variations with increased activity and selectivity. Furthermore, the growing demand for environmentally friendly and sustainable products is likely to drive the adoption of pectinases as an alternative to traditional chemical treatments in a variety of industries.

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