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# Utilisation of enzymes in fruits and vegetable processing

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**ARTICLE ID: 015**

## Introduction

Fruits and vegetables are an important source of dietary fibers, various vitamins and minerals, and phytochemicals. These are highly perishable due to the higher content of moisture. Hence, they have a very limited shelf life. In India, more than 20-25% of fruits and vegetables go to waste before utilization. Fruits and vegetable cell walls consist of polysaccharides such as cellulose, hemicelluloses, pectin, and starch. Fruits and vegetables are converted to various value-added products to avoid glut and wastage during the season. Fruits and vegetable juices have nutritional potential. Fruit and vegetable juice production requires extraction, filtration, and clarification. Direct extraction by pressing is difficult and this mechanical pressing gives juice highly viscous and bound with cellular debris with lesser yield. There is a need to get clarified and less viscous juice. Hence the application of enzyme is one such pre-treatment that can be used to obtain highly clarified juices with higher yield and quality. These enzymes soften the cell wall and increase the yield of juice extract.

Enzymatic extraction is one of the recent approaches for extracting bioingredients from plant materials. This method is gaining more attention due to the demand for eco-friendly extraction methods and technologies. They are responsible for many essential biochemical reactions in microorganisms, plants, animals, and human beings.

## Characteristics of enzymes

Enzymes are proteinaceous and made up of amino acids. They are highly specific biological catalysts produced by all living organisms. Only a small part of the enzyme participates in the catalysis of biochemical reactions; this is called the active site. This active site accommodates the shape of the substrate that requires transformation. Enzyme fits like a

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key in a lock. The specificity of the action of an enzyme on a specific substrate is determined by the structure and conformation of the active site.

Enzymes are classified based on the compound they act. Some of the common types are proteases which break down proteins, cellulases which break down cellulose, lipases that split fats into glycerol and fatty acids, amylases which break down starch into simple sugars, and pectinases which break down pectin. Enzymes are highly specific; it means the enzymes protease do not act on the starch substrate and amylases do not act on the proteinaceous substrate. Based on their property of catalyzing definite reactions, a particular enzyme acts on a specific substrate.

**Factors affecting enzymatic extraction of fruits and vegetables**

Enzymes are highly sensitive to pH, high temperature, and inhibitory compounds such as polyphenols hence while processing, careful handling of enzymes is important. The enzyme concentration, incubation time, and temperature are the speed governing factors in all enzymatic processes. Incubation temperature is an important parameter. At higher temperatures, the enzyme becomes less effective facilitated by the thermal inactivation process. The optimum temperatures for pectinase and cellulase activity are 50 °C and 45 °C respectively.

Enzymes are expensive and there is a need to minimize the operational cost in the food industry. Therefore, in enzyme application, one has to standardize the operational conditions such as type of enzyme, enzyme concentration, incubation time, incubation temperature, use of a different combination of enzymes, and optimum pH for the maximum activity of the enzymes with less use of enzymes.

**Advantage of enzymatic extraction**

Enzymes are biodegradable. They work efficiently and rapidly. Enzymatic assisted extraction enhances the end product quality as it uses milder processing conditions. It is a solvent-free process as it does not use any organic solvent it just uses the water for extraction

and it extracts the natural ingredients from different raw materials. It is an environment-friendly method of extraction.

Enzymatically clarified juice resulted in viscosity reduction and cluster formation, which facilitates separation through centrifugation or filtration. As a result, the juice presents higher clarity and improved stability, as well as more concentrated flavor and color. Enzymatic hydrolysis of the cell walls increases the extraction yield, reducing sugars, soluble dry matter content, galacturonic acid content, and titratable acidity of the products. A further quantity of waste pomace is reduced.

**Process of enzyme extraction**

The enzymatic extraction process largely consists of three steps grinding or crushing the raw material, enzymatic hydrolysis, and separation or fractionation. Fruit is first washed, cut into small pieces, and then pre-treatments like steaming, cooling, or heating before enzymatic extraction increase juice recovery. The enzyme extraction process involves crushing, pulping, blanching, enzyme hydrolyses followed by filtration and clarification.

**Effect of enzymes on fruits and vegetable juice yield and clarification**

Enzymes have been used as pre-treatment for the natural raw material before the mechanical extraction to get better yield and good quality of extracted bioingredients. Enzymatic pre-treatment has become an integral part of the modern fruits and vegetables processing industry for easy pressing by softening the raw materials, for increased release of cell content, higher yield, and for a higher quality of end products. Enzymes improve production efficiency.

**Macerating enzymes use for fruits and vegetables**

Cellulases, hemicellulases, and pectinases, collectively called macerating enzymes generally used as pre-treatment for extraction of bioactive compounds and facilitate pressing and clarification of juice from fruits and vegetables. These enzymes have been an integral part of modern fruit processing industries. The use of these enzymes alone or in combination can

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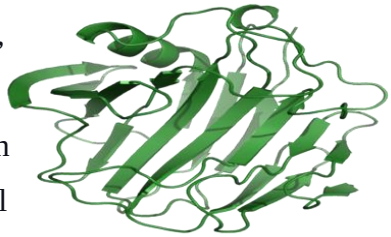
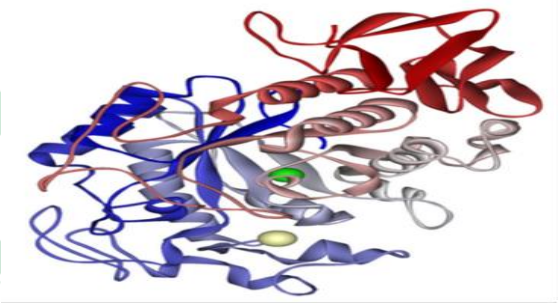
give a better yield and the best quality. Cellulose is a crystalline polymer. Most of the time cellulose fibers are present with other structural biopolymers, primarily hemicelluloses, and lignin. Cellulases are defined as a family of enzymes that perform the process of degradation of cellulose into glucose. This hydrolyses cell wall polysaccharides. These enzymes act on cell walls and cell wall components of fruits and vegetables, hydrolyze them and increase the permeability of the cell wall, thus resulting in increased yield of the metabolites. Moreover, the extraction of flavors, pigments, and essential oils is achieved using these enzymes from plant residues. Cellulases are also used in carotenoid extraction to liberate aroma-rich compounds, as well as in the extraction of phenolic compounds. *Aspergillus niger, Aspergillus nidulans, Aspergillus oryzae* fungi are generally used for the production of microbial cellulases.



Pectin are composed of galacturonic acid units glycosidically linked to form polygalacturonic acid that is partially esterified. Pectin is generally associated with cells and plant polymers and they provide a fibrous-like structure hence during the processing of fruits and vegetables these fibers make the clarification process harder. Pectinase enzymes are the most widely used enzymes for the extraction, clarification, and concentration of fruit and vegetables. Pectinases are high molecular weight, negatively charged, acidic glycosidic macromolecules. Pectinase enzymes act on pectic substances and lead to degradation of pectin and cause the pectin protein complex to flocculate. This flocculates removed by filtration and removes the pectineus material. This further reduces juice viscosity. Pectinase enzymes increase yields, improve liquefaction, clarification, and filterability of juices, maceration, and extraction of plant tissues. *Aspergillus niger* or *Aspergillus aculeatus* is used for the industrial production of pectolytic enzymes. The pectinase obtained from the different organisms can act differently in biological systems. Cellulytic and pectolytic enzyme mixtures have wide applications to enhance pulp liquefaction and provide a higher yield of juice with high soluble solids content.



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## Conclusion

Enzymatic treatment alone or in combination with others has been recognized as a novel and useful way to retrieve bound compounds. Enzymes work efficiently and rapidly; they are also biodegradable and highly efficient in increasing the reaction rate of biochemical processes that otherwise proceed very slowly or in some cases, not at all. Pectinase and cellulase enzymes are mostly used enzymes for the processing of fruits and vegetables in food industries to increase the recovery of juice, decrease viscosity and turbidity, and with the best quality.