THEORETICAL ASPECTS OF PRESSING IN ORDER TO OBTAIN APPLE JUICES

ASPECTE TEORETICE ALE PRESĂRII ÎN OBŢINEREA SUCURILOR DE MERE

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Abstract. *One of the most important stages of the technological process for the obtaining of apple juices is pressing. Certain empirical observations could lead to the establishing of some rules and the output of the pressing operation is influenced by factors such as: succulence of the raw matter, thickness of the material subject to pressing, consistence and structure of the pressing layer, time variation of pressure, auxiliary pressing substances added and the enzymatic maceration of pulp. The pulp obtained by crushing/grinding is made, in case of apples, of a liquid and viscous phase – juice and a solid – semi-jellified phase. The adding of pectolitic enzymes leads to the increase of juice quantity and triggers a superior content in compounds determining its flavour, taste and smell. The modern pressing techniques rely on the sequential control principle according to which preliminary data in terms of the raw matter used and characteristic qualitative parameters (breed, phytosanitary state, crunchiness, acidity, succulence etc) shall be memorized and subsequently processed by means of a computer being thus defined as "ideal" parameters of the pressing process.*

Key words: pressing, juice production, quality

Rezumat. *Una din cele mai importante etape ale procesului tehnologic de obtinere a sucurilor de mere o constituie presarea. Anumite observaţii empirice au putut conduce la stabilirea anumitor reguli, randamentul operaţiei de presare fiind influenţat de factori ca: suculenţa materiei prime, grosimea stratului de material supus presării, consistenţa şi structura stratului de presare, variaţia în timp a presiunii ce se exercită, substanţe auxiliare de presare adăugate, macerarea enzimatică a pulpei. Pulpa obţinută prin zdrobire/mărunţire este formată, în cazul merelor, dintr-o fază lichidă şi vâscoasă – suc şi o fază solidă - semigelificată. Adăugarea de enzime pectolitice duce la mărirea randamentului în suc şi determină un conţinut superior în compuşi ce determină aroma, gustul şi mirosul acestuia. Tehnicile moderne de presare se bazează pe principiul controlului secvenţial, potrivit căruia date preliminare cu privire la materia primă utilizată şi parametrii calitativi caracteristici (soi, stare fitosanitară, crocanţă, aciditate, suculenţă etc) vor fi memorate şi procesate ulterior cu ajutorul unui computer, fiind astfel definiţi parametri "ideali" ai procesului de presare.*

Cuvinte cheie*:* presare, obţinere sucuri, calitate

INTRODUCTION

The pressing itself may be achieved classically by continuous and discontinuous acting presses that may be, from the structural viewpoint, basket

presses, screw presses, roll presses or pneumatic presses (Arthey D., Ashurst Ph. R., 2001).

The discontinuous acting presses (with galley or basket) are used for the artisanal production of the fruit juice. To obtain juices in an industrial system, they prefer the continuous belt presses (Beceanu D., 1994).

MATERIAL AND METHOD

Besides the study of specialized literature in the field, books, treaties and scientific articles published at international symposia or specialized magazines and doctoral theses, we also read different internet pages of some foreign non-governmental agencies having as object of activity the research in the field of public alimentation (Cockram S., Seneca, 1993; Beceanu D., Chira A. 2003; Ducastaing A., Adrian J. 1990; Espiard E. 2002).

We studied the ways to increase output when pressing apple pulp to obtain apple juice. A team of specialists of Bucher's R & D, USA have elaborated a technique for the optimization of pressing designing a computer-assisted system (Espiard E. 2002).

RESULTS AND DISCUSSIONS

Even since 1943 (Terzaghi), they have made numerous studies trying to determine the bond between the speed of juice discharge, the pressing time and the juice quantity, on one hand, and the characteristics of pulp and presses, on the other hand. Numerous parameters, steady or variable in time, were taken into account: pulp thickness, its porosity, mechanical resistance, juice viscosity and density, inflicted pressure. In 1964, Kormendy proposed a differential equation to describe the pouring down of juice fractions depending on the thickness of the material layer subject to pressing in conditions of given temperature and pressure.

Certain observations and empirical data regarding pressure could lead to the setting of some rules:

- the thinner the pulp layer, the easier the juice discharge;
- output is improved if pressure is inflicted progressively;
- the alternation of the rest phases with the pressing ones favors the progressive destruction of the cellular walls and the elimination of juice.

In the same pressing conditions, using Bucher HPX 5005 press (9 t/h capacity) for a pulp with component particles having size between 2-4 mm, we obtained an output of 85.3% by 1.3% more than in the case of coarse particle pulp. Pectic enzymes (pectinases, pectolitic enzymes) from the hydrolase class catalyze the scission of pectic substances. Depending on the specific substratum and they way of action, we have: protopectinases, pectin demetoxylases, pectin depolymerases etc. Protopectinase catalyzes the scission of bonds from protopectin macromolecule leading to its degrading into calculosis, hemicellulose and pectin. Pectin demetoxylases PME or PE (saponifiable enzymes) produce demetoxylation of pectic substances with methanol release. In case of apples, they are active at pH-6.6 being activated by some salts.

Pectin depolymerases divide the bonds of polygalacturonic chain in the presence of water and may be classified in:

- Endo/Exo polymethyl galacturonases = PMG de-polymerize pectinic acids in the presence of water

- Endo/Exo poly-galacturonases = PG act on pectic acids.

The activity of these enzymes intensifies once with the decrease of structural-textural firmness when the fruits mature and in case of apples this treatment lasts for 20 minutes at temperatures of 15-30 ^{0}C.

Amylases catalyze enzymatic hydrolysis of starch. The most important are:

- Alpha-amylase is an endoenzyme that hydrolyzes at random the glycosidic bonds from the starch macromolecule leading to dextrins of different sizes.

- Beta –amylase is an exoenzyme hydrolyzing the glycosidic bonds at the non-reducing ends of polyglucidic chains of starch releasing maltose and "limit dextrins". It acts at a weak acid pH and an optimal temperature of 55-63^{0}C.

During maturation, the activity of amylases increases once with the decrease of the starch content.

Cellulases (beta-glucanases) catalyze cellulose hydrolysis from the cellular membrane contributing to its getting thinner. The glycosidic bonds from cellulosic chains are gradually divided. Cellulases have an optimal weakly acid pH 4.5-6.5 being thermally stable in the range 30 – 60 ^{0} C. The pulp obtained by crushing/grinding is made of a liquid and viscous phase – juice and a solid- semi-jellified phase. The adding of pectolitic enzymes leads to the increase of juice quantity and a superior content of compounds determining its flavor, taste and smell. The optimal way of their administration is the following:

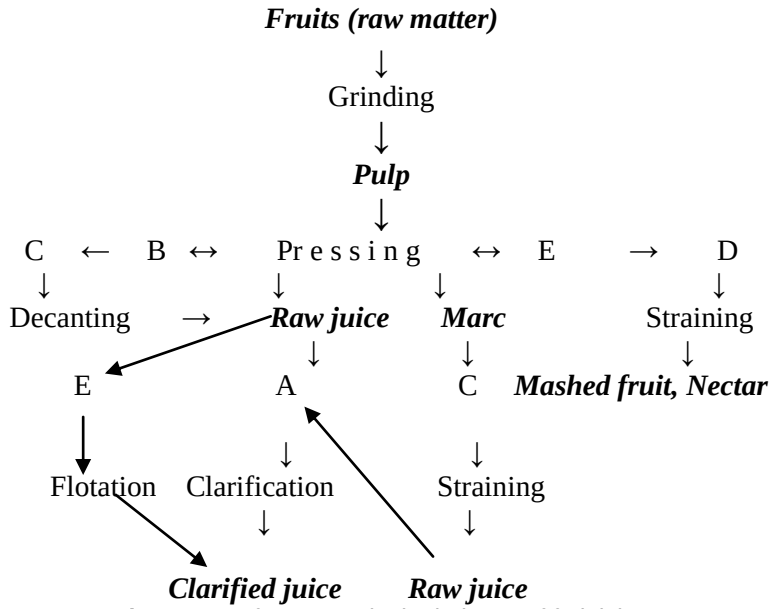


Fig. 1. Use of enzymes in the industry of fruit juice (European method)

where:

A: pectolitic enzymes – clarification
B: pectolitic enzymes – auxiliary maters for pressing
C: pectolitic and amylolytic enzymes – liquefaction
D: poly-galacturonases (PG) - maceration
E: pectolitic enzymes and calcium salts – pectin jellification

In recent years, they use a wide range of enzymes in the obtaining of fruit juices for their synergic effect, namely:

a) Increase of the pressing output: the pulp is usually treated with pectolitic enzymes at the temperature of 15-30^0 C for 30-60 minutes. The quantity of enzymes used varies depending on the pH, the activity of enzymes, the type of fruits as raw matter, the contact time and temperature. The enzymatic treatment may lead to the increase of pressing output by up to 10% in case of apples harvested at optimal maturity and kept in frigorific storehouses.

b) Juice clarification and improvement of filtration: the raw juice is generally turbid, with a high viscosity due to the presence of the pectic substances. The pectolitic enzyme treatment leads to the clarification of these juices. The used quantity shall be calculated depending on the content in pectins of the raw juice, its pH, and temperature. The enzymatic treatment usually takes place at 54^{0}C for 1 hour or at 16^{0}C for 6-8 hours.

Pectinase
↓
Raw juice ← Clarification ← o→ Filtration → Clarified juice

c) The flavour enrichment of the final product: certain volatile substances are lost during the clarification and concentration processes of juices. One of the methods for the increase of the juice quality in terms of flavours is the fortification of the final product by enzymatic treatment with glycosidases, glucosides being flavour precursors for apples (Enzymes in Juice processing - Y. D. Hang). Flavours also appear naturally: beta-glucosidase (endogenous) from fruits catalyzes the hydrolysis beta D glucosides up to geraniol, nerol and citronellol.

Beta - glucosidase
↓
Glucosidic monoterpene → Monoterpene + Glucose
(Inactive flavour) (Active flavour)

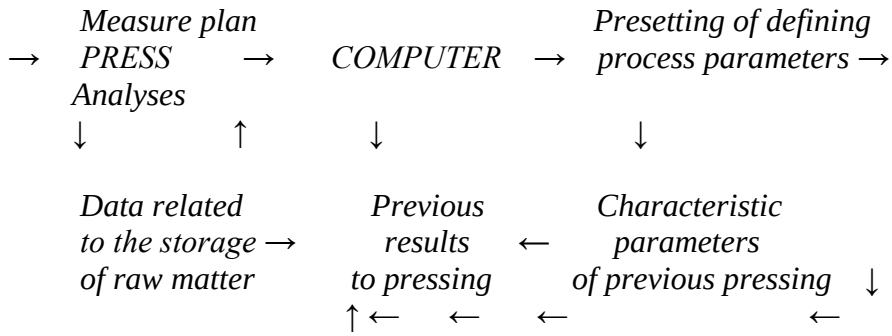
In recent years, in the food industry, NOVO Laboratories, Inc; Gist-brocades Food Ingredients, Inc; Genecor International, Inc; Rohm Tech, Inc; Solvay Enzimes, Inc, AB Enzymes GERMANIA a.o. have become conspicuous as main manufacturers and suppliers of pectolitic enzymes.

The modern pressing techniques rely on the sequential control principle according to which preliminary data in terms of the raw matter used and characteristic qualitative parameters (breed, phytosanitary state, crunchiness, acidity, succulence etc) shall be memorized and subsequently processed by means of a computer being thus defined as "ideal" parameters of the pressing process.

The objectives attained by the use of this optimization technique are:

1. optimization is achieved by self regulation;
2. the press operation takes place depending on the characteristics of the raw matter, the press must "feel" the pressability degree of the material subject to pressing;
3. for each parameter in evolution they try to define a physical model based on the laws of physics that might allow the obtaining of an optimal output.

SEQUENTIAL CONTROL PRINCIPLE



This technique was successfully put into practice by the team of specialists of the company Bucher's R & D, USA, that has designed such a computer-assisted system, Bucher HPX 5005, being considered at present the most effective system for this purpose.

The press used to obtain juices must give a product where the insoluble solid substances may be easily eliminated by decanting. This exigency is satisfied by the vertical or horizontal presses that do not turn round or turn round very little during pressing.

The discontinuous acting presses (with galley or basket) are used for the artisanal production of the fruit juice. To obtain juices in an industrial system, they prefer the continuous belt presses.

Belt press

When designing this type of press they started from the operation principle of the galley discontinuous press or the pressing filters. The pulp, stored on the belt (cloth) is pressed in a thin layer to favor the discharge of juice. The first belt presses, such as Shenk, operated in fact semi-continuously, the loading, emptying and pressing phases being successive. At present, numerous types of presses - Bellmer, Flotweg, and Klein – with double belt allow the continuous processing

of the raw matter. The pulp bed is carried forward between two belts whose movement is owed to the movement of some parallel adjustable drums (rolls). By reducing the distance between them, they inflict a higher and higher pressure over the pulp, the juice extracted being collected in a collecting tank and the waste go though an evacuation strainer. A beater and aspersion jet device ensures the cleaning of the pressing belts. After pressing, the raw juice is vulnerable to oxidization and the spontaneous starting of fermentation depending on the raw mater and the technological line; thus they must prevent the enzymatic brownness and ensure the microbiological stability.

CONCLUSIONS

The pressing time necessary for the obtaining of a steady output is proportional to the square of initial thickness of the pulp layer.

The output of the pressing operation is influenced by factors such as: succulence of raw matter, thickness of the material subject to pressing, consistence and structure of pressing layer, time variation of the inflicted pressure, auxiliary pressing substances added for the enzymatic maceration of pulp.

At present, one of the modern pressing techniques relies on the sequential control principle, the computer-assisted system designed and put into practice by specialists of Bucher's R & D, USA, the use of Bucher HPX 5005 press being the most effective system for this purpose.

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