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The Effect Of Pretreatment On Sour Cherry Juice Filtration

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SUMMARY

In fruit juice production, pretreatment steps affect the filterability of juice. In this research, three different pretreatments were used to evaluate their effects during filtration which are raw juice, depectinized juice, depectinized plus clarified juice filtrations.

There was an inverse relation between the filtration rate and the resistance. It was observed that pretreatments decrease the resistance considerably.

ÖZET

VİŞNE SUYU ÜRETİMİNDE ÖN İŞLEMLERİN FİLTRASYONA ETKİSİ

Meyve suyu üretiminde, ön işlemler meyve suyunun filtre edilebilme özelliğini etkiler. Bu araştırmada, filtrasyona etkilerini incelemek amacıyla üç farklı ön işlem yapılmıştır. Bunlar; depektinizasyon, depektinizasyon ve durultmanın birlikte yapılması ve sadece preslenmiş vişne suyunun filtrasyonudur.

Filtrasyon hızı ile direnci arasında ters bir orantı vardır. Ön işlemlerin önemli ölçüde azalttığı gözlenmiştir.

INTRODUCTION

Solid-liquid filtration is a unit operation in which the insoluble solids are separated from the liquid by means of a porous medium which retains the solid particles on its upstream surface or within its structure or both but allows the fluid to pass.

Filtration phenomena started by Darcy's Law (1856) who studied the flow of liquids through the beds of sand and proposed an equation in the form;

$$v = K \frac{\Delta P}{L} \qquad (1)$$

where v is the fluid velocity, ΔP is the pressure drop, L is the length and K is a constant representing the chatecteristic of the fluid and bed.

Modeling of filtration in food industry is extremely limited (i.e. PELEG and BROWN, 1976; DE LA GARZA and BOULTON, 1984; BAYINDIRLI, ÖZİLGEN and UNGAN, 1989). Sperry's model (1917) is one of the most widely used model. According to this model, filtration rate is described as;

$$\frac{dV}{dt} = \frac{\Delta P\ A}{\mu} \frac{1}{(R_m + \alpha cV/A)} \qquad (2)$$

where ΔP is the pressure difference across the filter, A is the filtration area, μ is the viscosity of the filtrate, c is the concentration of the solids being collected, t is the time and V is the volume of the filtrate collected. R_m and α are the medium and specific cake resistances respectively.

Sperry's equation is useful for filtrations in which the solids being collected are rigid, or when the cake being formed with a filter aid is rigid.

However, generally this equation is not applicable in the food industry. Therefore, De La Garza and Boulton (1984) have developed two new mathematical models which are exponential and power models. These were described respectively as;

$$\frac{dV}{dt} = \frac{\Delta P\ A}{\mu} \frac{1}{(R_m \exp(kV/A))} \qquad (3)$$

and

$$\frac{dV}{dt} = \frac{\Delta P\ A}{\mu} \frac{1}{(R_m + \alpha cV/A)^n} \qquad (4)$$

where k and n were positive constants.

The exponential model begins to develop resistance as soon as the filtrate forms. However, power model permits an initial filtrate volume to pass before the rapid fouling begins DE LA GARZA and BOULTON, 1984).

Sour cherry juice production consists of several steps. Pressing, depectinization, clarification and filtration are the main units in fruit juice production. (CEMEROĞLU, 1982; TRESSLER and JOSLYN, 1971). Since the filtration is at the end of the fruit juice production line, some of the parameters of the previous units may affect the rate of filtration.

The purpose of this study was to observe the effects of these previous units on the filtration rate.

MATERIALS AND METHODS

MATERIALS

Sour cherries from a local variety (Afyon) having 22 % soluble solids were used in the experiments. Fabric filter medium and diatomaceous earth with 7 μm average particle size obtained from Turkish Sugar Factories Inc., ANKARA were used within the experiments.

METHODS

Sour cherry juice production was done in three different ways to see the effect of previous units on the rate of filtration.

In the first set, sour cherries were washed, sorted, seeds and stems were removed. Then, pressing was applied by hand. Finally, filtration was performed.

In the second set, all the stages before filtration were performed just the same as in the industry. First, sour cherries were washed and sorted to remove the spoiled and damaged fruits and leaves which cause off flavor and undesired color. Then these were elevated to the fruit mill that reduced them to a pulp suitable for juice extraction.

To increase the juice yield and extraction of other fruit components such as color and flavor ,mash was heated to 70 °C in a tubular heater. After that, juice extraction was done for 20 minutes by using hydraulic press (Bucher - Guyer AG). The yield was about 70 %.

Since the juice contatins some coarse particles as it comes from the press, it was screened before the enzyme treatment. For the enzyme treatment, pectinex is used, which is a highly purified pectolytic enzyme preparation containing mainly polygalacturonase, pectinesterase, pectintranseliminase and hemicellulases. Depectinization was done at about 50 °C for 2 hours. Next, clarification was done at about 6 °C overnight. For clarification, gelatin, kieselsol and bentonite were used. Finally, filtration was done.

In the last set, all the stages were the same as in the second set except clarification.

For all the three cases, the filtration procedure was the same. There was three major parts in the experimental set up: Pressure supply, reservoir and filtration unit. The pressure source was nitrogen gas. Constant pressure filtration was done. Filtration equipment was made of a 2,5 lt stainless steel storage vessel and a standard filtration cell holder (Spectra/Por, Spectrum Medical Ind. NY). Storage vessel had been placed on top of a magnetic stirrer to prevent settling. Filtration cell holder was originally manufactured for ultrafiltration studies. But instead of ultrafiltration membranes filter media was employed for this study.

Experiments were done at 21 °C under 0,65 atm. gauge pressure. Filtration area of the cell holder was 30,2 cm². Both for precoating and filter aid addition diatomaceous earth was used and fabric filter medium was employed in the experiments. Viscosity measurements were done by using Cannon - Fenske capillary viscometer.

To describe the filtration rates De La Garza and Boulton's «Exponential model» which described the cherry juice filtration succesfully was employed. According to this model;

$$R = \frac{dt}{dV} \frac{\Delta P A}{\mu} \quad (5)$$

and total resistance can be defined as;

$$R = Rm \exp (k V/A) \quad (6)$$

Then, quation (6) can be rewritten as;

$$\ln R = \ln R_m + K V/A \quad (7)$$

R values were calculated from Equation (5). Then, the parameters ln R_m and k were determined from the ln Rversus V data by using least squares analysis.

RESULTS AND DISCUSSION

De La Garza and Boulton's «Exponential model» was used in this study. The other filtration models were not appropriate.

The effect of certain parameters of the previous units on resistance is shown in Figs. 1, 2 and 3. And Table 1 summarizes the values of the model parameters which were obtained by using linear regression.

Table 1: Conditions of experiments and values of the model parameters.

Experimental Conditions	Model Parameters		
	Rm	k	r
Filtration of Raw Juice	4,5E + 9	0,30	0,94
Filtration of Depectinized Juice	1,5E + 9	0,30	0,99
Filtr. of Depect. Plus Clarified Juice	7,2E + 8	0,03	0,98

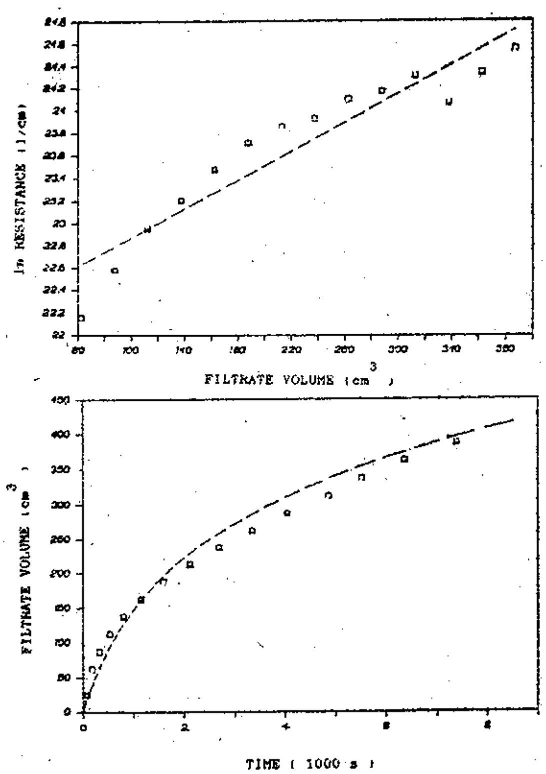

Fig. 1 — Filtration of raw juice directly.

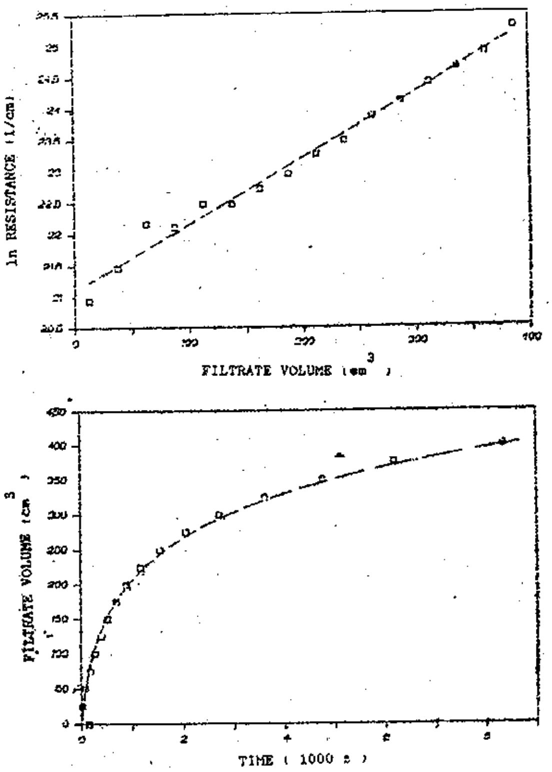

Fig. 2 Filtration of depectinized juice.

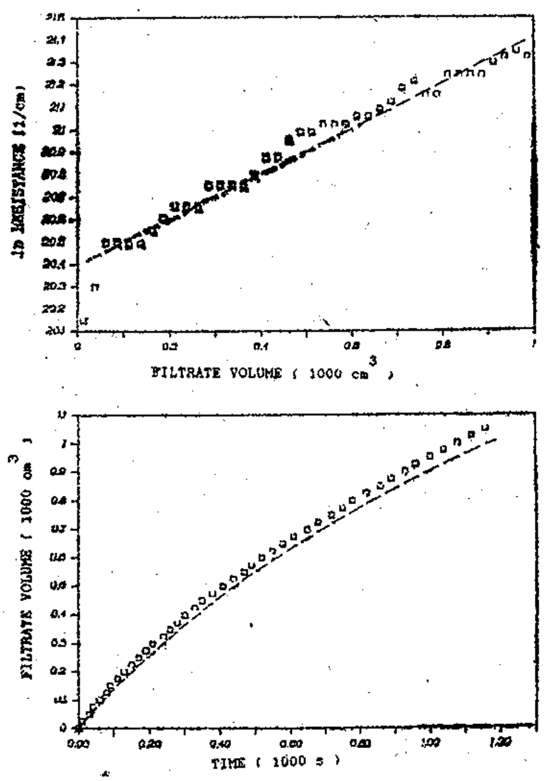

Fig. 3 — Filtration of depectinized plus clarified juice.

As can be seen from this table, the highest resistance was obtained in the case of direct filtration. Resistance decreased slightly when the cherry juice production was done just the same as the industrial operation except clarification. A further decrease was obtained when the clarification was also done.

The same result was expected for the parameter k. The minimum k value was in the case of industrial operation as expected. But the k values in the case of direct filtration and industrial operation without clarification were the same. Actually, there must have been a difference in k value but it was so small that it couldn't be detected due to the equipment limitations.

Equation (3) was solved for V at any time t with the previously determined values of R_m and k. Then, the calculated filtrate volumes were plotted against time in Figs. 1, 2 and 3. Experimental data points were also shown in the same figure to compare the simulations.

There was an inverse relation between the filtration rate and the resistance. Comparision of Figs. 1, 2 and 3 shows that higher filtrate volumes were achieved in a specific time interval in the experiments where resistance was lower.

The result of this study shows that the industrial operation is the best to have lower resistance and so higher filtration rate. Especially, clarification stage which causes settling of the colloidal particles, has very important effect on filtration rate.

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