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CONCENTRATING OF ENZYME PRETREATED BLACKCURRANT JUICE BY REVERSE OSMISIS

Key words:
reverse osmosis, concentration, blackcurrant juice, depectinization, enzyme pretreatment

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SUMMARY

The aim of this study was to examine the effect of the different enzyme pretreatment and to examine the applicability of the reverse osmosis for the concentration of blackcurrant juice.

Paterson Candy International (PCI) apparatus was used for the concentration equipped with tubular B1 module., i.e. RO membrane was applied, the salt retention of the membrane was 99%, and active membrane area was 0,9 m^2. The concentration of the juice was carried out on 20 °C, on 60 bar. The applied low temperature (26-30 °C) preserved the valuable components *(anthocyanins, phenols,* C-vitamin) and the antioxidant capacity during the process.
The fresh juice had total soluble solids (TSS) content about 17 °Brix. The effects of enzymatic pretreatment on the permeate flux have been evaluated by two enzymes (Pectinase from Aspergillius Aculeatus, Cellobiase from Aspergillius niger).It was concluded that the applied RO membrane was suitable for concentration of blackcurrant juice up to 29.5 °Brix. This was achieved concentrating juice treated withpectinase enzym.

INTRODUCTION

Blackcurrant juice is very popular among consumers due to its pleasant taste, as well as its numerous beneficial health effects. It contains in great amounts mineral salts and vitamins, which have beneficial effects to human health. Its C-vitamin concentration is 4–5 times higher than that of lemon. It is also rich in P -, B1 -, B2 - vitamin, in provitamin A, in pigment and anthocyanins (Bánvölgyi *et al.*, 2006). After harvesting the berries, blackcurrants are usually processed into juices. One of the basic unit operations of fruit juice technology is the concentration process to reduce liquid volume and, therefore, storage and transportation costs. Concentration is expected to increase the total soluble solids content (TSS) of the juice from 10% up to 75% by weight.

To provide consumers with all beneficial properties of the fresh berry in the products, it is necessary to apply gentle processing method that promotes the preservation of the original characteristics of berries. In recent years, membrane processes such as nanofiltration (NF), reverse osmosis (RO) and alternative membrane based separation: membrane distillation (MD) and osmotic distillation (OD) have been evaluated as fruit juice concentration processes (Girard & Fukumoto, 2000). RO has achieved some commercial success in the fruit juice concentration: it presents the advantages of a lower thermal damage to the product, reduction in energy consumption and lower capital equipment costs. However, the final concentration of juices is limited to about 25–30 °Brix, due to the high osmotic pressure of the retentate at those levels the possibility to avoid enzyme treatment is significant from economical point of view. There is also an indication that clarification by UF results in the loss of health promoting compound content of blackcurrant juices. During UF, about 36% of the anthocyains and 40% of flavonols have been released to the permeate, and most of them concentrated in the by-product stream (Pap *et al.*, 2006).

The aim of the research was to concentrate blackcurrant juice at a pilot scale by reverse osmosis without prefiltration by micro- or ultrafiltration. The effect of clarification by centrifugation, and enzymatic depectinization was evaluated by comparing the achieved final TSS content and permeate flux during concentration of treated juice to the juice without any pretreatment.

MATERIALS AND METHODS

Paterson Candy International (PCI) apparatus was used for the concentration equipped with tubular B1 module., i.e. RO membrane was applied, the salt retention of the membrane was 99%, and active membrane area was 0,9 m^2. The module contained AFC 80 polyamide tubular membrane, which had 80 % salt rejection. This compact tubular module has been developed to ease the concentration of highly viscous fluids. Temperature is controlled by means of a heat exchanger. After passing through the heat exchanger, the feed temperature was set to 25 °C. The transmembrane pressure was fixed at 60 bar, and 60 liter of the juices were concentrated in each batches. Cleaning of the membranes was carried out after every test run as follows. The membrane was first rinsed with tap water at a recirculation rate of 1500 L/h and transmembrane pressure of 60 bar for 30 min. This was followed by circulating 0.1 w/w% NaOH solution at same conditions for 30 min and rinsed with tap water. Finally, a 0.5% citric acid solution has been used and circulated for 30 min, followed by rinsing with tap water. Before and after each cleaning procedure the pure water flux was measured.

Total soluble solid (TSS) content was measured using an Atago PR-101 α digital refractometer. Measurements were made at ambient temperature. TSS data were expressed as °Brix. Prior to each set of measurements, the instrument was calibrated at 0 °Brix using deionised water.

The concentration of the juice was carried out on 20 °C, on 60 bar. The applied low temperature (26-30 °C) preserved the valuable components (anthocyanins, phenols, C-vitamin) and the antioxidant capacity during the process.

The blackcurrant juices were pretreating by two enzyme (Pectinase from Aspergillius Aculeatus, Cellobiase from Aspergillius niger). The enzymes hydrolyse the methyl ester groups of pectin and reduce the viscosity of the blackcurrant juices. This, in turn, can ease the filtration of the juices. A small amount of enzymes (8 ml / 20 l) were used and the treatment time was 24 hours at 25°C.

RESULTS AND DISCUSSION

The permeate fluxes decreased during the concentration procedure in all runs. The initial fluxes and slope of this changes was different and depended on the applied pre-treatment (Fig. 1).

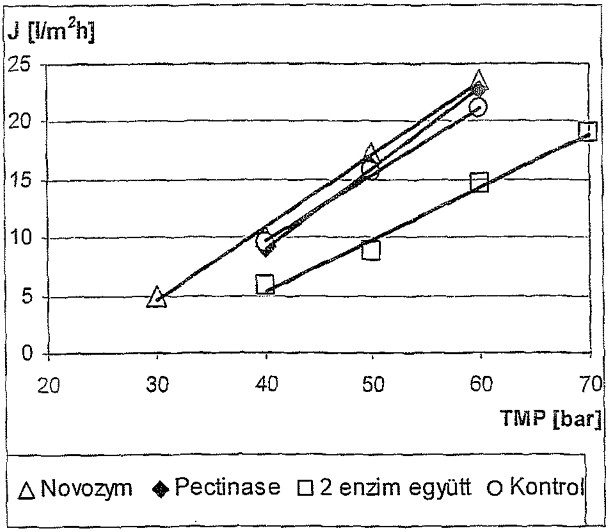

Figure 1. The fluxes of the different pretreated blackcurrant on different pressure

Permeate flux increased with increase of TMP. As the experiment progressed the °Brix increased and the most abatement of flux was observed in the case of the Novozyme enzyme.. The data was illustrated in Figure 2 for the pretreating juices (Novozyme, Pectinase enzyme and together with two enzymes), and the control juice. The highest permeate flux was achieved in the concentration of juice previously pretreated by Cellobiase from Aspergillius niger (Novozyme). It can be noted that the lowest permeate flux was achieved with the control sample to which no enzymatic treatment had been applied, and the achieved max. TSS % was also the lowest in control case; 22.5 °Brix as compared to 28.5-29.5 achieved with treated samples.

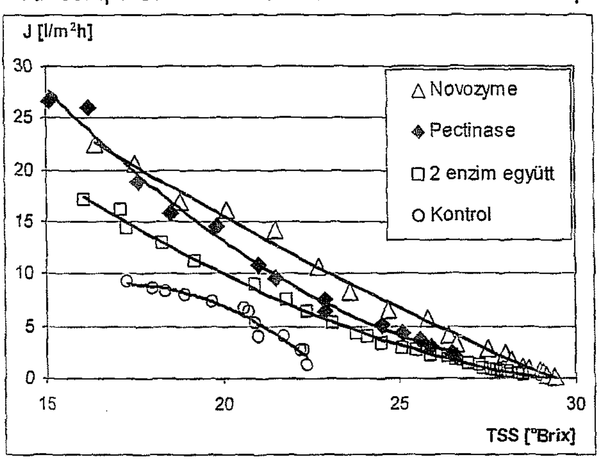

Figure 2. The effect of TSS on the fluxes

The initial total soluble solid content of the feed varied between 15-17 and reached 26,5 °Brix for Pectinase, 29,5 °Brix for Novozyme enzyme after, 28,5 °Brix for together with two enzymes and 22°Brix for the control juice. At the same time, the Novozyme enzyme pretreated all samples. The contentration of the control sample ended under 130 minutes. The contentration of the enzyme treated samples ended 200 minutes for Novosyme, 160 minutes for Pectinase and 270 minutes for together with two enzymes However the concentration time of together with two enzymes treated juices was longer than that of the Novozyme. The TSS increase was sharper for the Novozyme treated sample. The highest TSS value achieved with Novozyme treated sample (29.5 °Brix).

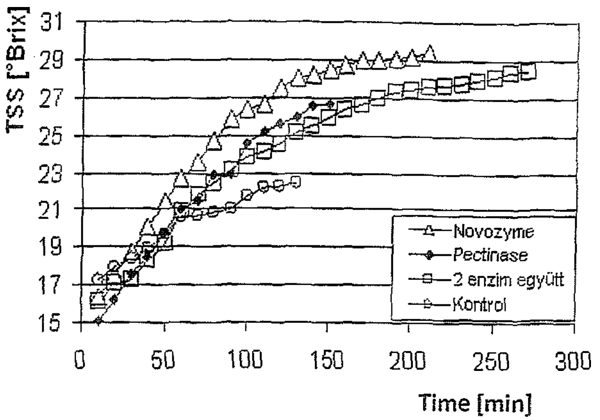

Figure 3. Comparison of TSS values during concentration of blackcurrant juice.

CONCLUSIONS

The aim of this study was to examine the applicability of reverse osmosis for the concentration of blackcurrant juice by AFC - 80 polyamide tubular membrane. The effects of pretreatment with different enzymes were also investigated. Two commercially available enzyme preparations (Pectinase from Aspergillius Aculeatus, Cellobiase from Aspergillius niger) were used for enzymatic depectinization. The results were compared to a control sample, clarified only by centrifugation.

For the control sample, the permeate flux was the lowest, the flux decline rate the highest and the maximum TSS of the concentrate reached was the lowest at 22 °Brix. The highest permeate flux of 20 $l/(m^2h)$ was achieved during the concentration of juice that has been previously depectinized by Panzym Super E, and the flux decline rate was the smallest for this sample as well. In the terms of permeate flux, or TSS content of the concentrate, there has been no significant differences between the two samples treated with Trenolin at different conditions. The highest concentration ratio was observed in case of Novozyme pretreatment. The total soluble solid content of the concentrates rose to 26,5; 29,5; 28,5 and 22 for Pectinase, Novozyme, together with two enzymes and control, respectively.

It can be concluded that reverse osmosis is a viable method for concentration of blackcurrant juices with the applied membrane at 60 bar transmembrane pressure and 25 °C operating temperature, when an enzymatic pretreatment is applied before the processing. It was found that, of those tested, Novozyme was the most effective in aiding concentration by reverse osmosis.

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