Green extraction of soluble matter from cabuya by pulsed electric fields

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ABSTRACT

The pulsed electric field-assisted extraction (PEF) of inulin from cabuya (Agave Americana) was studied. The agave was sliced into pieces of 1,5 x 1,5 x 2 mm. The effect of the electric field strength (1 000, 3 000 and 5 000 V/cm), pulse duration (0,1, 0,2 and 0,5 ms) and pulse number (10 000, 20 000 and 40 000) was evaluated on the disintegration index an energy consumption. The extract was purified and concentrated. Inulin was obtained by fractional precipitation and characterized. PEF was compared with conventional extraction. The results showed that the optimal conditions were 5 000 V/cm, 0,5 ms and 10 000 pulses. The disintegration index was 0,37 and the energy consumed was 15,2 kJ. The diffusion coefficient was 3,23E-5 m^2/s. The extraction yield obtained for conventional extraction was 44 % and for PEF extraction was 51 %. Finally, it was proved that isolated substance was inulin by means of Fourier-transform infrared spectroscopy analyses. The PEF process is shown in Figure 1.

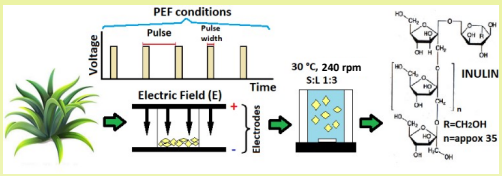


Figure 1. Inulin extraction process by pulsed electric fields

OBJECTIVES

1. Determine the electric field strength, number of pulses and pulse duration to obtain the highest cellular damage and less energy consumption in extraction assisted by pulsed electric fields.
2. Determine the work cycle to obtain the highest cellular damage and less energy consumption in extraction assisted by pulsed electric fields.
3. Compare conventional extraction and PEF assisted extraction by the normalized soluble matter yield obtained at the 60 minutes.

RESULTS and DISCUSSIONS

The best pretreatment conditions were 5 000 V/cm, 0,5 ms and 10 000 pulses, as it can be seen in Figure 2. These are the conditions, to which the highest disintegration index and the lowest energy consumption were obtained. According to Loginova, Shynkaryk, Lebovka, and Vorobiev (2010), the damage degree Z increased during the PEF treatment, and effect was more pronounced at higher electric field strengths (p. 1364). The pulse duration chosen is the highest, this is because an increase of disintegration efficiency was observed with increase of pulse duration (De Vito, Ferrari, Lebovka, Shynkaryk and Vorobiev, 2008, p. 309).

From it was concluded that the number of pulses is not a significant variable for the disintegration index. Therefore, this variable was chosen based on the less energy consumption over normalized soluble matter yield.

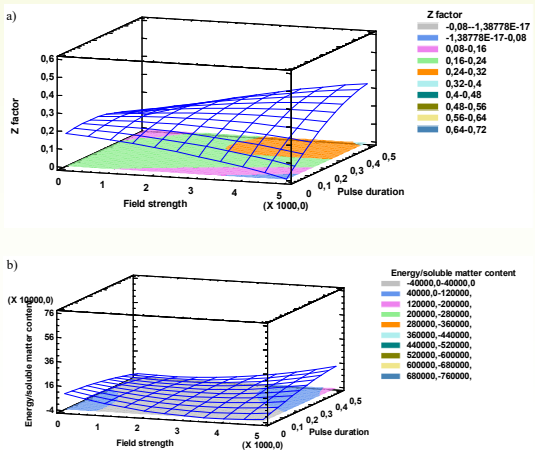


Figure 2. Statistical analysis of response surface at 10 000 pulses: a) Disintegration index as a function of voltage and pulse duration; and b) Energy over normalized soluble matter yield as a function of voltage and pulse duration

RESULTS and DISCUSSIONS (cont.)

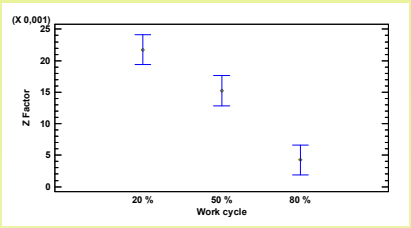


Figure 3. Fisher LSD stockings chart of duty cycle based on Z factor

The work cycle was obtained keeping constant the best conditions found in the first objective. Figure 3 shows the Fisher LSD stockings chart of duty cycle based on Z factor. There are significant differences between the levels of work cycle employed. The work cycle that generates de higher disintegration index is 20%. At this work cycle, the less energy consumption over normalized soluble matter yield is obtained.

Figure 4 shows the curves that relate the normalized soluble matter yield as a function of time for both assisted extraction with PEF and for conventional extraction; These curves were constructed under the same conditions of temperature and S: L ratio. It was observed that the maximum extraction yield for the non conventional method was 51 % and for the conventional one was 44 % at 60 minutes. It is because cells membranes are permeabilized when they are exposed to a given electric field, facilitating the releasing of the intracellular content (Zhu, et al., 2016, p. 16).

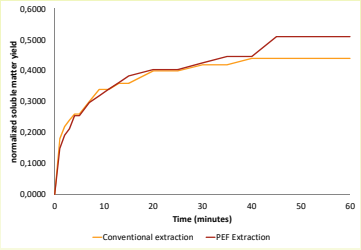


Figure 4. Performance as a function of time for PEF assisted extraction and conventional extraction (EC)

CONCLUSIONS

The pretreatment with pulsed electric fields permeabilize cell membranes, facilitating the releasing of intracellular content like inulin. In order to obtain the higher disintegration index the best pretreatment conditions are 5 000 V/cm and 0,5 ms. The number of pulses is not a significant variable for the disintegration index, but it was significant for the energy consumption over the normalized soluble matter yield, therefore the number of pulses of 10 000 was selected. Using the pulsed electric filed assisted extraction a higher normalized soluble matter yield can be obtained than the one obtained with a conventional extraction.

REFERENCES

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