

Optimization of pulse electric field-assisted protein extraction from lupine flour.

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Summary:

The use of pulse electric field (PEF) for protein extraction (Box-Behnken; 3x1x15- 3 central points) from lupin has been optimized to obtain high-purity protein isolates.

Introduction.

Present production abilities cannot meet the growing demands for proteins. Lupin is an interesting source with high protein content, but optimal protein extraction procedures are essential to obtain high-quality protein isolates. PEF-assisted is a prominent technology that produces membrane electroporation, increases permeability, and promotes mass transfer. Thus, this study optimized PEF parameters using a Box-Behnken experimental design to facilitate protein extraction from lupin flour.

Methods.

Lupin flour obtained from *Lupinus luteus* L. was used. The independent variables were the pulse width (x_1 ; 20-60-100 μ s), number of pulses (x_2 ; 100-150-200 pulses), and voltage (x_3 ; 5000-7500-10000 V), while the dependent variables were total yield (y_1) and protein purity (y_2). Response surface methodology (RSM) based on Box-Behnken design (3 factors and 3 levels; 3^K BBD) with 15 experimental runs and three center points (3x1x15) was used to obtain the optimal extraction conditions. For each run, 100 g of lupin flour was treated and the protein extraction was carried out using alkaline solubilization (pH 10.3), and isoelectric precipitation (pH 4.7). The lyophilized protein isolates were analyzed.

Results.

The experimental results showed that yield varied between 20.38% and 26.22%, while purity ranged from 87.14% to 89.28%. The regression model and ANOVA test were applied to determine the functional relationship for approximation and prediction of responses. The coefficients showed high model accuracy ($R^2=0.6688$ for yield and $R^2=0.7363$ for purity) and the lack of fit test was found to be non-significant, which corroborated the adequacy of the model in representing the experimental data outcomes for all variables.

The ANOVA results indicated that the number of pulses (linear and quadratic effects) had a significant effect on the yield extraction, while pulse width (linear and quadratic effects) and pulse width x number of pulses interaction influenced purity. The optimized extraction conditions were: pulse width = 24 μ s, number of pulses = 200, and voltage = 10,000V, obtaining 25.55% of total yield and 89.41% of purity (predicted values). The model was validated (predicted/experimental data-%RSD <10%)

Significance.

PEF-assisted extraction (under optimized conditions) of lupin proteins results in a high yield and a purity close to 90%, which allows obtaining high-quality protein isolates.

OPTIMIZATION OF PULSE ELECTRIC FIELD-ASSISTED PROTEIN EXTRACTION FROM LUPINE FLOUR

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INTRODUCTION

High demand for proteins → Search for alternative sources



Lupine: Underutilized source with high protein content

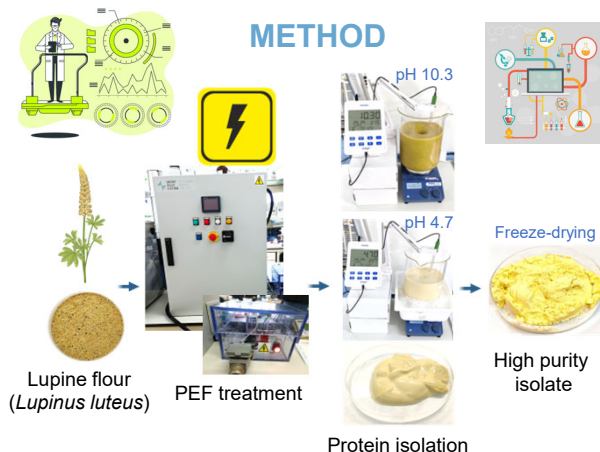


Obtaining high-quality lupine protein isolates

AIM

Optimization of pulsed electric field (PEF)-assisted extraction process for the production of a high-purity isolate from lupin

METHOD



Box-Behnken design
(3x1x15)
3 Central points

(3 factors and 3 levels; 3^K BBD)

Pulse width (x_1): 20-60-100 μ s
Pulse number(x_2): 100-150-200 pulses
Voltage (x_3): 5000-7500-10000 V

Total yield (y_1)
Protein purity (y_2)

PEF parameters (independent variables)

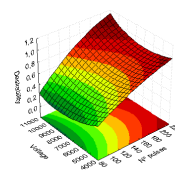
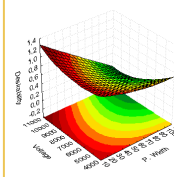
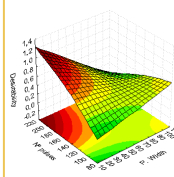
Response (dependent factors)

RESULTS

Regression model
&
Anova test

$R^2=0.6688$ for yield
 $R^2=0.7363$ for purity

Pulse width: Significant effect on Purity
Pulse number: Significant effect on Yield
 x_1 - x_2 interaction: Significant effect on Purity
Voltage: No significant effect



Optimal conditions

Pulse width (x_1): 24 μ s
Pulse number(x_2): 200 pulses
Voltage (x_3): 10000 V

Predicted data

Purity (% protein): 89.41%
Total yield (%): 25.55%

Experimental data

Purity (% protein): 87.59%
Total yield (%): 23.47. %

CONCLUSIONS

PEF technology (specifically, pulse width and number of pulses) notably enhanced protein extraction. PEF-assisted extraction (under optimized conditions) of lupin proteins results in a high extraction yield and a purity close to 90%, which allows obtaining high-quality protein isolates.

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