Optimization of ultrasound-assisted extraction of cold-pressed pistachio meal proteins

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COST Action Meeting
FoodWaStop
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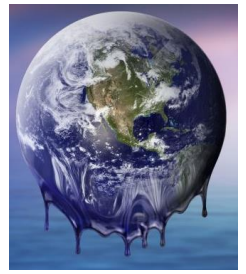
Motivation

- Environmental effects of food sector including livestock production
- Increasing world population
- Changes in dietary preferences
- Need of improving functional properties of proteins

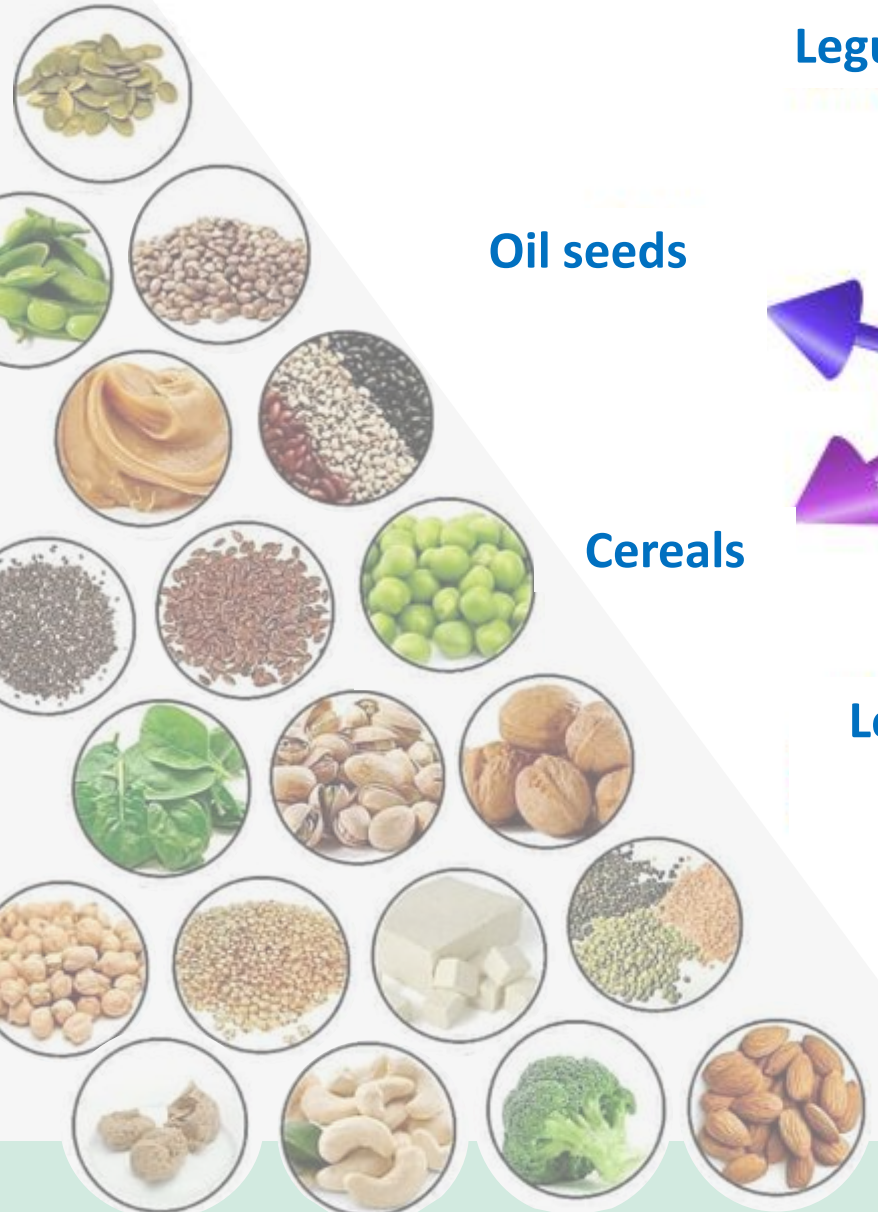


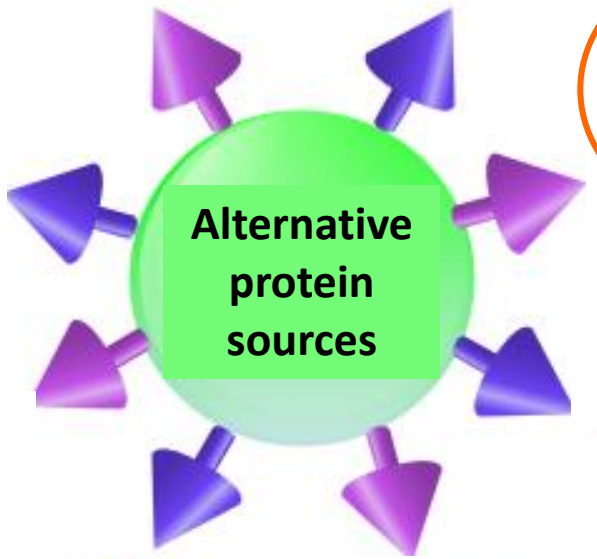



Alternative Protein Sources

Alternative Processing Technologies

Alternative Protein Sources





Legumes

Vegetables

Oil seeds

Cereals

Insects

Leaves

Micro and macro algae

Food waste and by-products

- Nutritional needs
- Efficient use of sources
- Development of new food ingredients
- Circular economy
- Sustainability

Residues from oil industry

Oil seeds and nuts

Cold pressing

Biomass/ meal

Oil

- Cosmetics
- Food
- Energy

- Utilization as an animal feed source
- Valorization in the concept of circular economy

Pistachio

Production

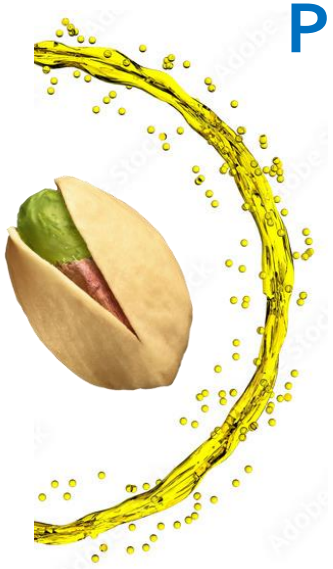
1- Iran (%53,2)
2- USA (%22,3)
3- Türkiye (12,7)

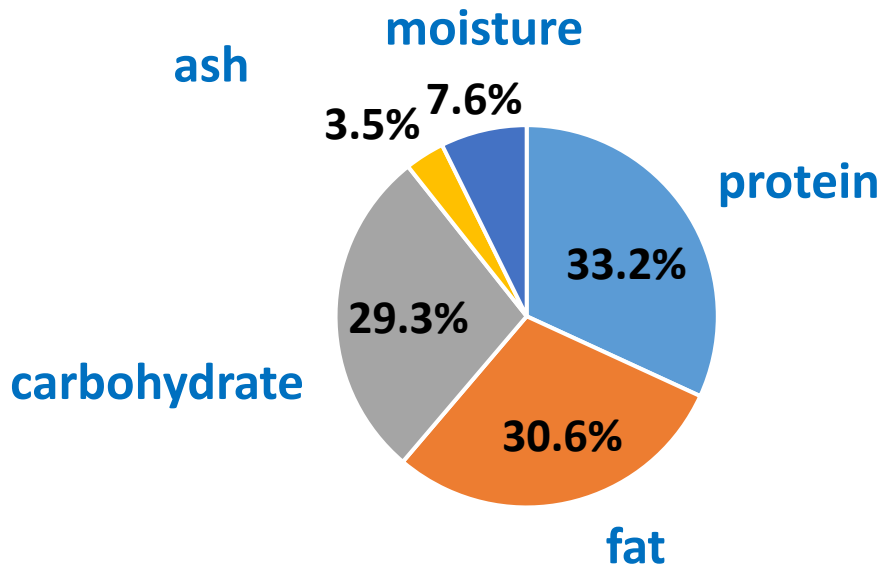
Ak vd. (2016)

Protein	**% 20.16**
Fat	**% 45.32**
Carbohydrate	**% 27.17**

USDA (2018)

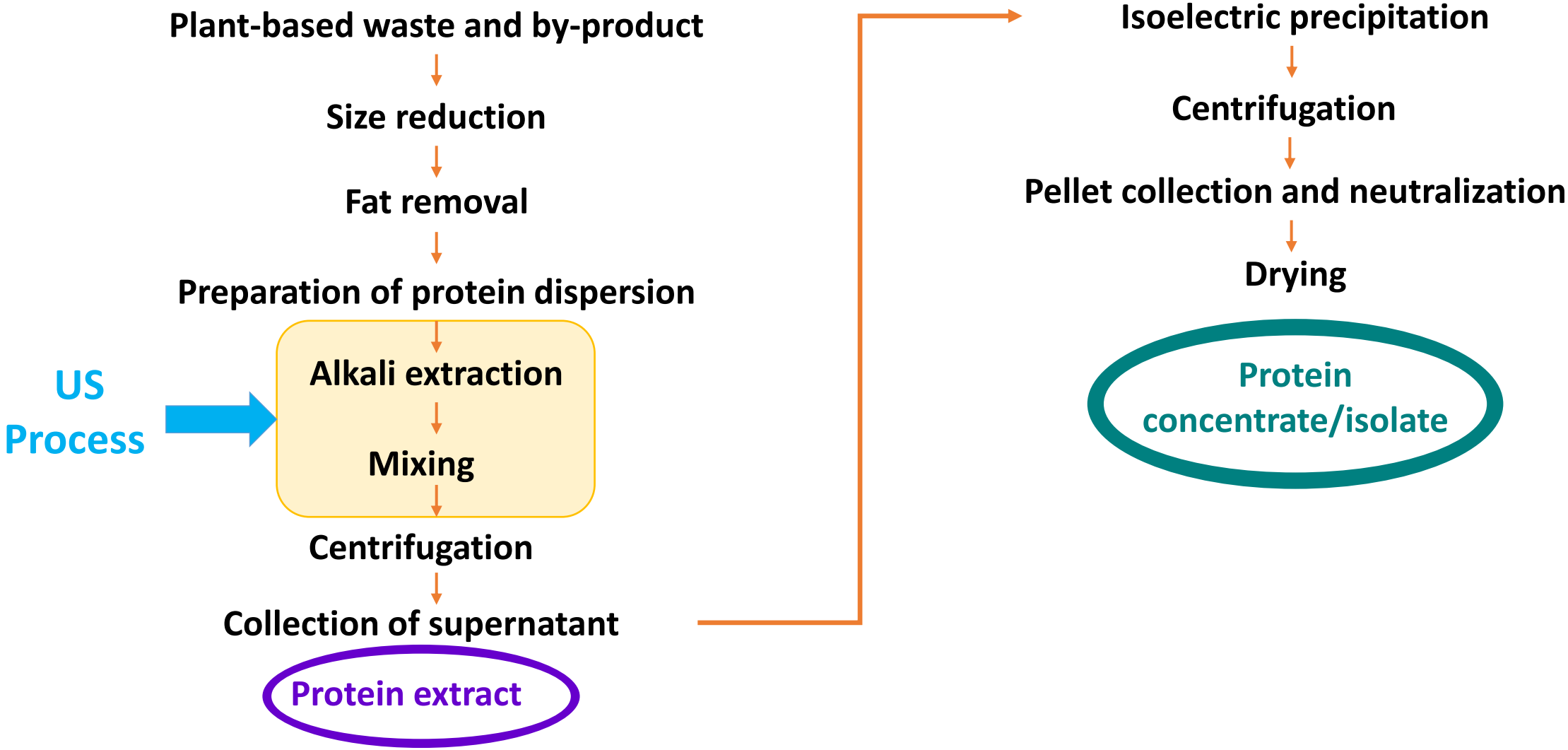
Pistachio meal



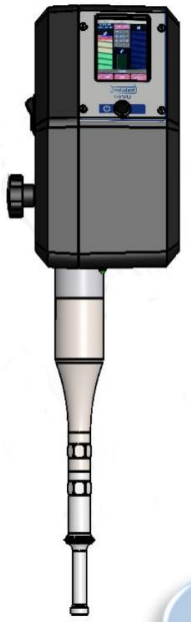


Salinas vd. (2021)

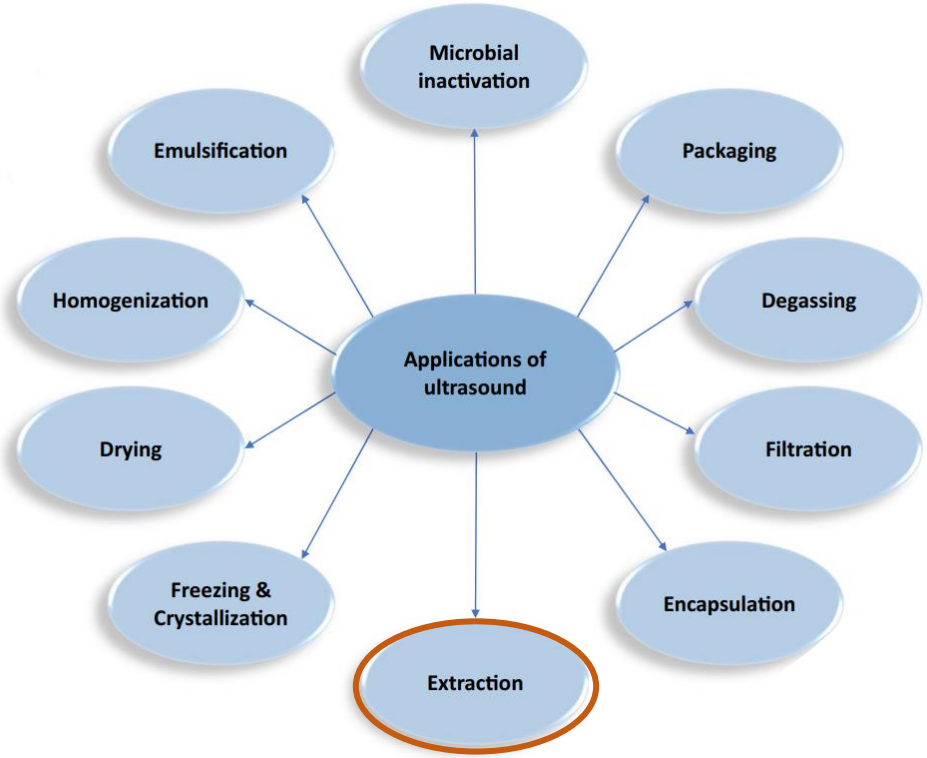
Protein extraction

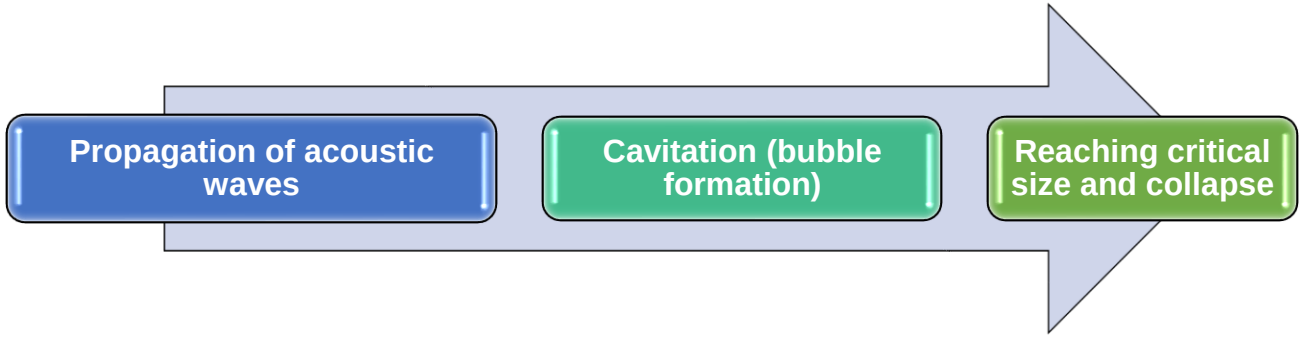


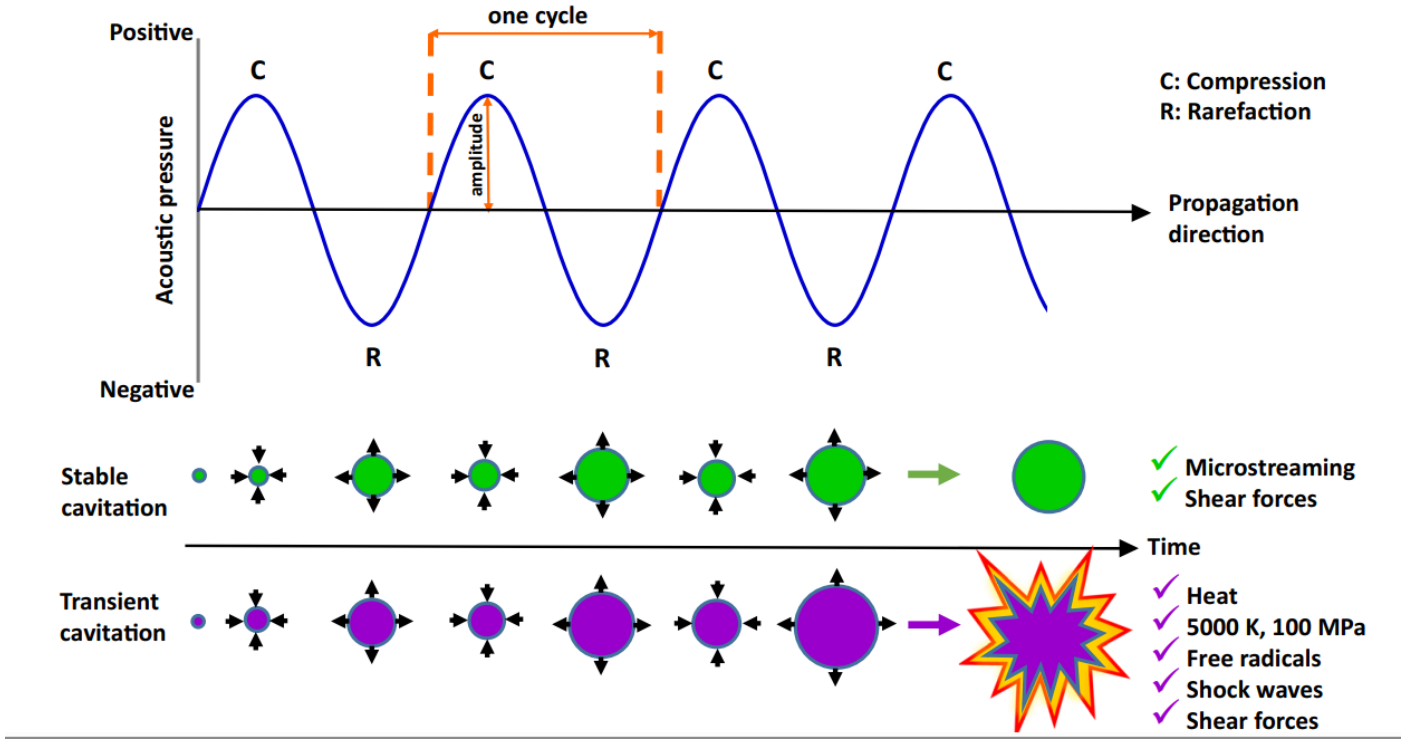
Ultrasound process



- ✓ Sound waves beyond human hearing (14 Hz – 18 kHz)
- ✓ **20-100 kHz**







Barbosa-Cánovas, G. V., Donsì, F., Yildiz, S., Candoğan, K., Pokhrel, P. R., & Guadarrama-Lezama, A. Y. (2021). Nonthermal processing technologies for stabilization and enhancement of bioactive compounds in foods. *Food Engineering Reviews*, 1-37.

Research Question

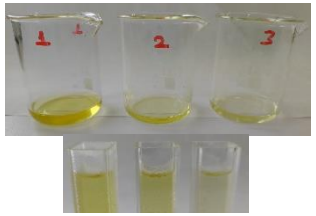
Can ultrasound-assisted alkaline extraction improve the protein extraction yield from cold-pressed pistachio meal?

Optimization of ultrasound-assisted protein extraction for maximum protein yield

Materials and Methods

Cold-pressed meal

Grounding

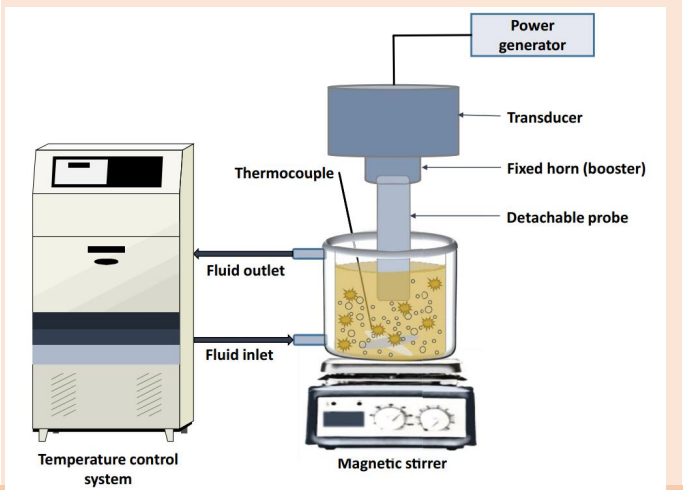


Defatting

Defatted powder

Rehydration
4 °C, 1 h

1 - Alkaline extraction



2 - Ultrasound-assisted extraction

Centrifuge (10000 rpm, 10 min, 4 °C)

Protein Extract (Alkaline pH)

Precipitation at isoelectric point (pH 4.5)

Centrifuge & Freeze-drying

Ultrasound

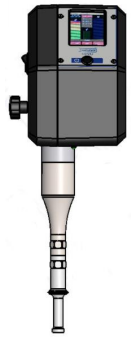
Alkaline

Optimization of extraction conditions

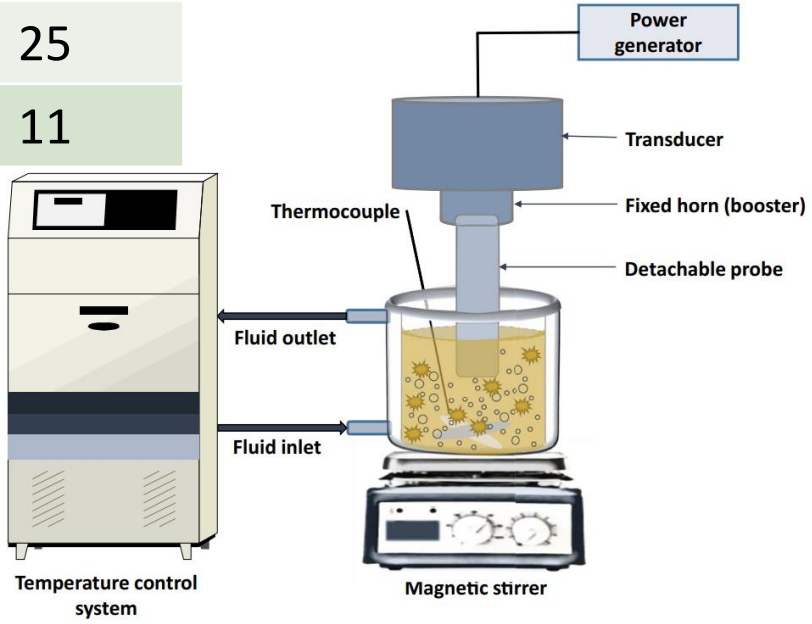
Ultrasound-assisted alkaline extraction (UDE)

Box-Behnken experimental design

Parameters	-1	0	+1
X_1 : Power (W)	200	400	600
X_2 : Time (min)	5	15	25
X_3 : pH	8	9,5	11



- Sonics, VCX750, Newtown, USA
- 13 mm probe
- Solid:liquid ratio: 1:10 (g/mL)
- Temperature control



Alkaline extraction (AE)

- Solid:liquid ratio: 1:10
- Power (optimal)
- pH (optimal)
- Time (optimal)

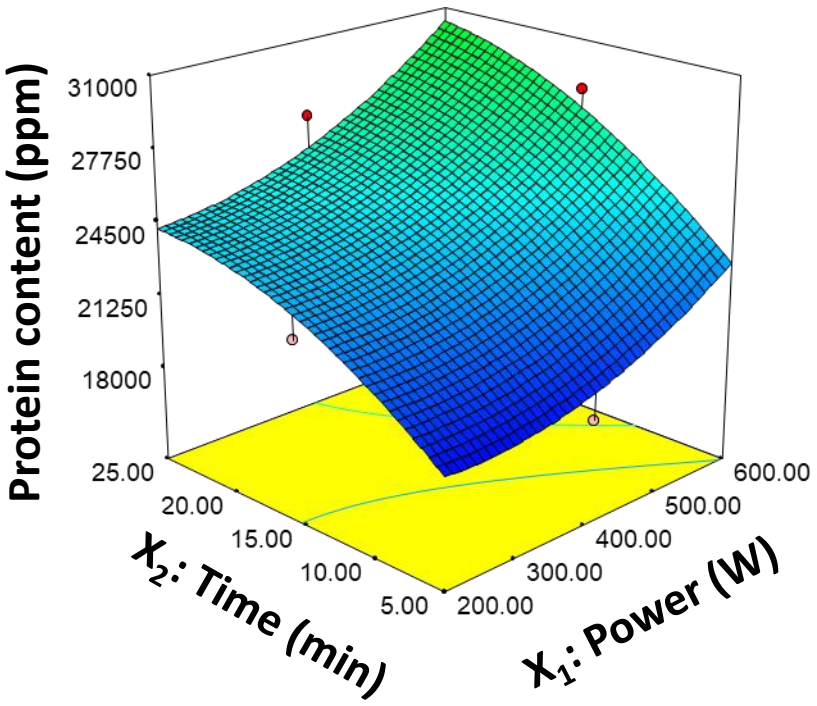
Optimization - ANOVA Table

Source	df	F value	p-value	
Model	9	15,60	0.0037	**significant**
X_1: Power	1	76,85	0.0003	
X_2: Time	1	20,72	0.0061	
X_3: pH	1	23,90	0.0045	
$X_1.X_2$	1	0,19	0.6831	
$X_1.X_3$	1	14,63	0.0123	
$X_2.X_3$	1	0,02	0.8981	
X_1^2	1	1,27	0.3103	
x_2^2	1	1,39	0.2919	
x_3^2	1	1,23	0.3181	
Residual	5			
Lack of Fit	3	7,86	0.1150	**not significant**
Pure Error	2			
Cor Total	14			

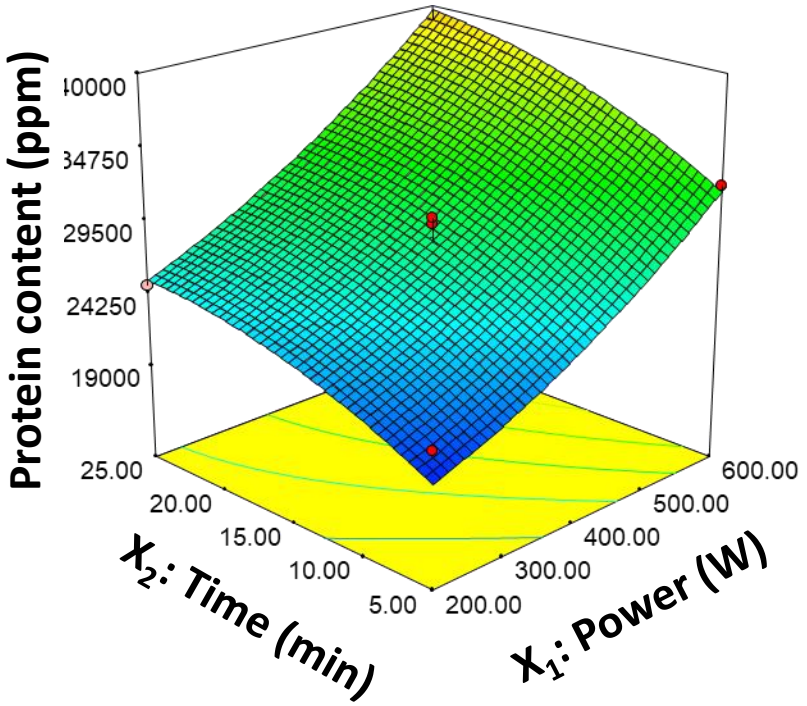
Std. Dev	2165.27
Ortalama	28347.22
C.V. %	7.63
R^2	**0.96**
R^2 (adjusted)	**0.90**
R^2 (predicted)	0.48

$$\text{Protein content (ppm)} = 28347,2 + 6710,9 * X_1 + 3484,4 * X_2 + 3742,2 * X_3 + 4140,6 * X_1X_3$$

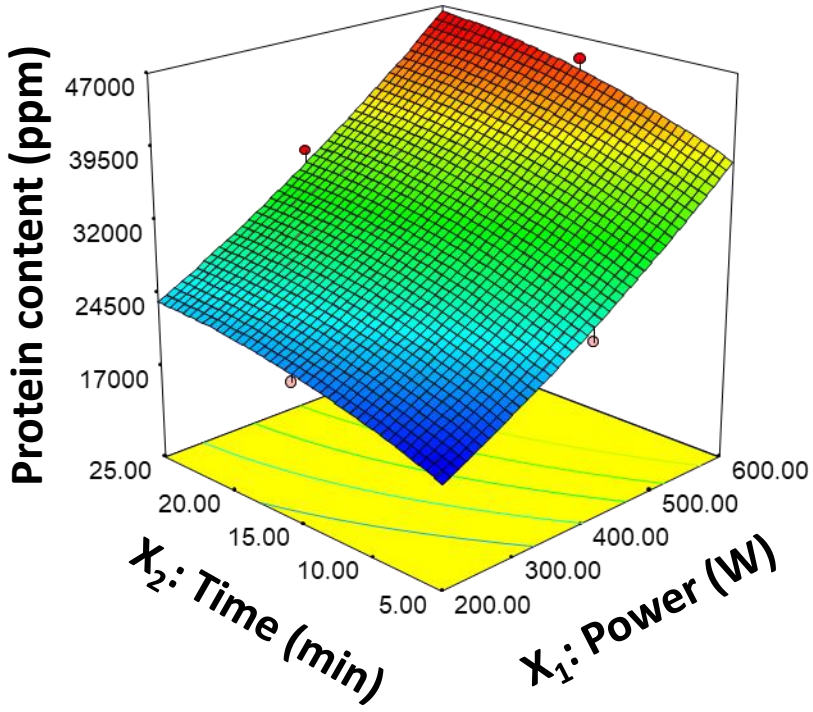
Optimization_pH



X_3 : pH 8

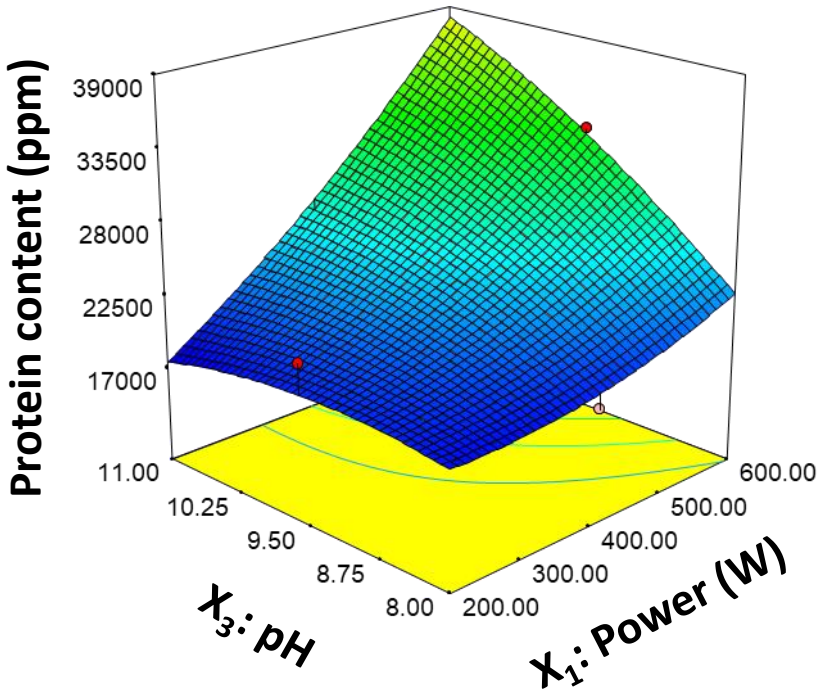


X_3 : pH 9.5

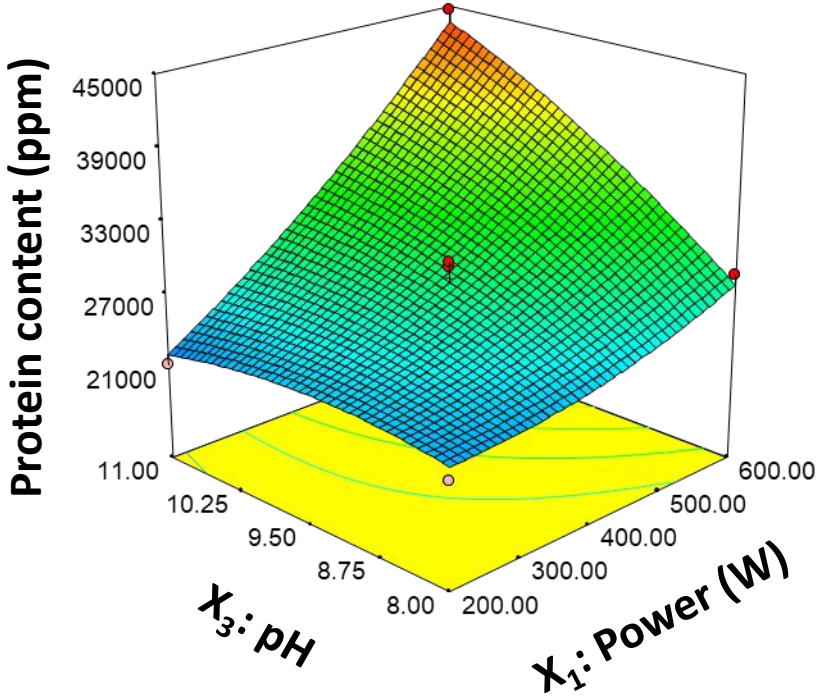


X_3 : pH 11

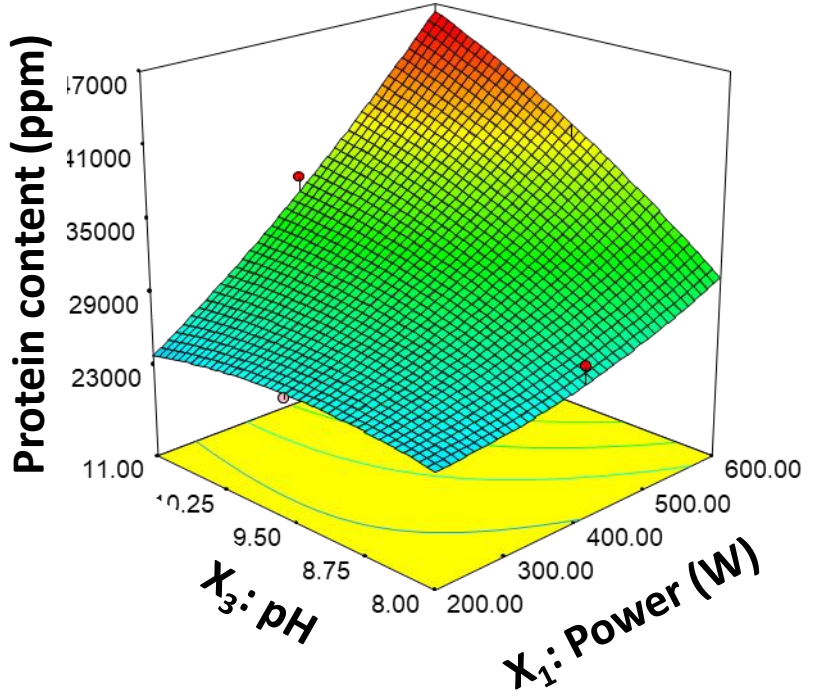
Optimization_Time



X_2 : 5 min

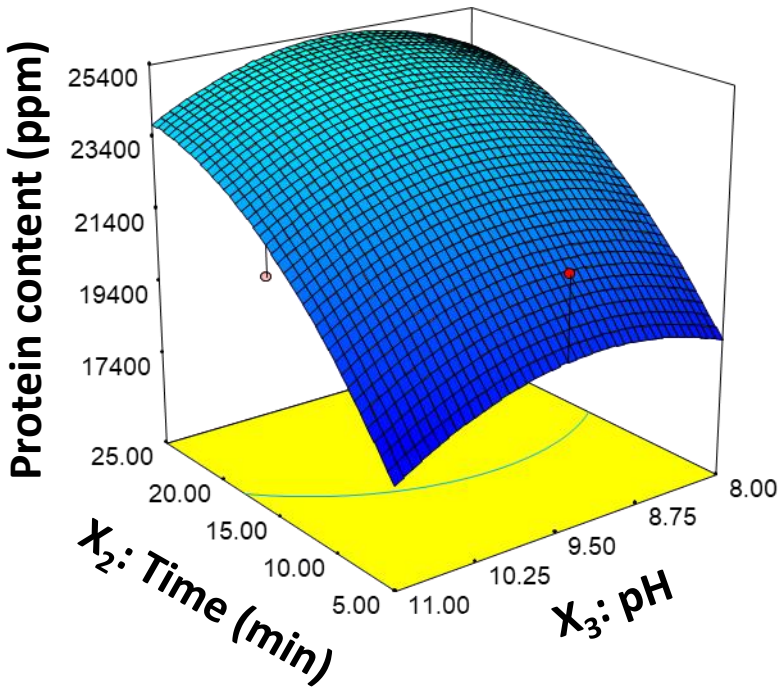


X_2 : 15 min

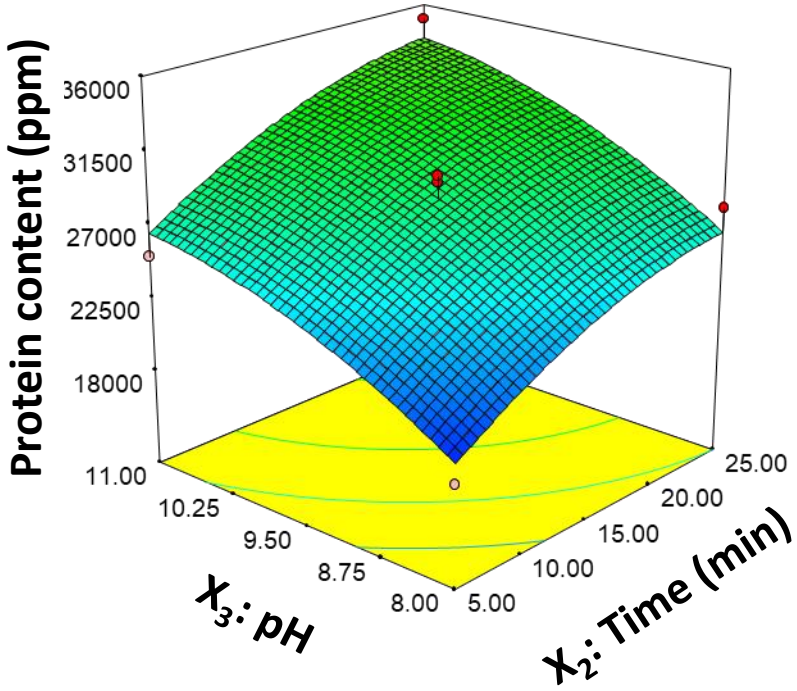


X_2 : 25 min

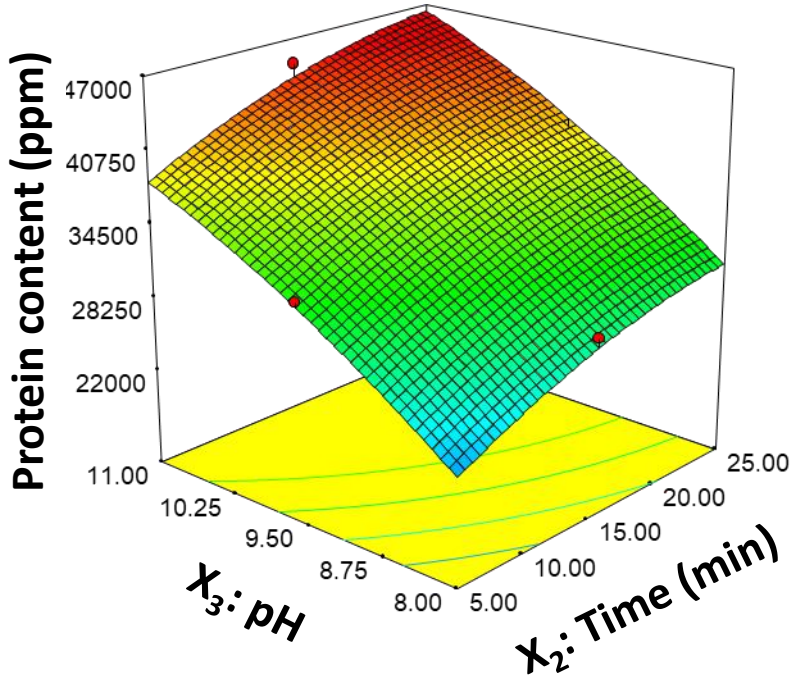
Optimization_Power



X_1 : 200 W



X_1 : 400 W



X_1 : 600 W

Optimization

Maximum protein yield

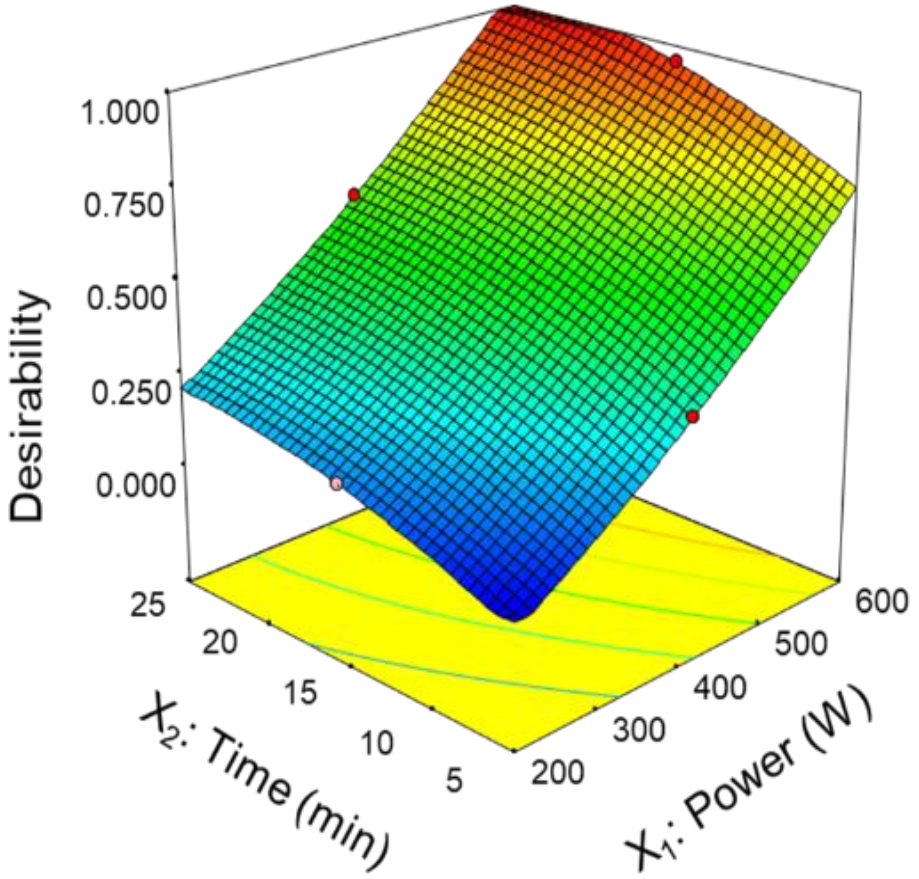
Optimal Conditions

Power: 595 W

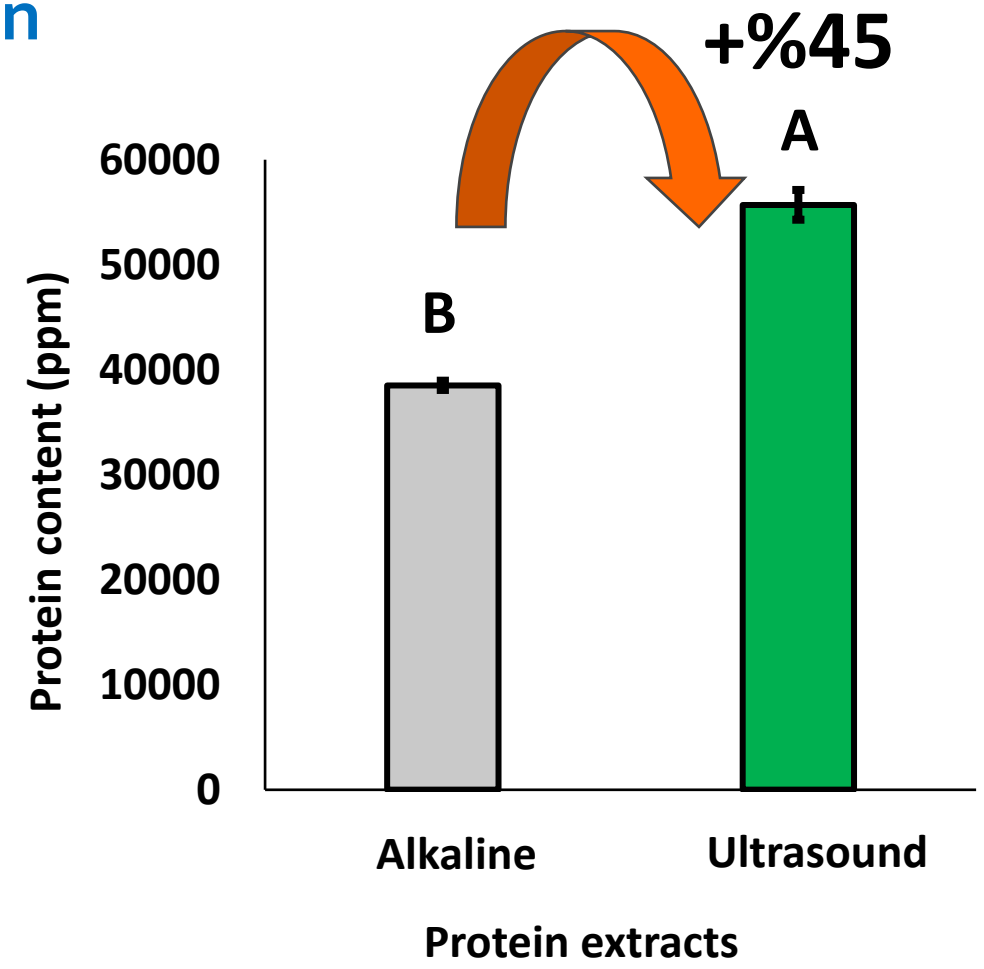
Time: 19 min

pH: 11

Desirability: 1.0



Validation



(Protein contents in the Protein Extracts by Bradford method)

✓ **45% increase** in protein yield with UDE compared to conventional alkaline extraction

Conclusions and Future Projection

✓**Optimum UAE conditions: 595 W, 19 min, pH 11.**

✓**Higher protein extraction yields in shorther time by UAE.**

✓**Contribution to circular economy by valorizating the by-products from food industry**

✓**Development of environmentally friendly and sustainable production strategies.**

✓**Investigation of functional and structural properties of proteins**

Possible Collaboration

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

Agri-Food Value Chain

European Commission

New healthy and sustainable food products and processes

TOPIC ID: HORIZON-CL6-2024-FARM2FORK-01-2

Impact of the development of novel foods based on alternative sources of proteins

TOPIC ID: HORIZON-CL6-2024-FARM2FORK-01-7

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