Multifunctionality of rapeseed meal protein isolates prepared by sequential isoelectric precipitation

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Background and objectives: Rapeseed oil is a valuable commodity that is widely used in the food industry or other industrial sectors for the production of biofuel, paper, textile, plastics, lubricants, and surfactants. The enhanced demand for this vegetable oil world-wide results in the generation of high amounts of rapeseed meal as a byproduct which reached 38.8 million tons in 2018. In addition to being used as an inexpensive protein-rich ingredient in feed formulation, the rapeseed meal is an appropriate source for preparation of protein isolates for the food industry. **THE AIM OF THE STUDY** was to generate rapeseed meal protein isolates with enhanced solubility and evaluate their functional properties.

METHODS

Preparation of protein isolates

Wash with 75% ethanol aqueous solution 4 times

Ethanol-treated rapeseed meal

Protein extraction
(pH 12, 40° C, 60 min)

Sequential precipitation of proteins starting at pH 10.5 to 2.5 by lowering pH with 1 unit.

Sequential precipitation of proteins starting at pH 2.5 to 8.5 by increasing pH with 1 unit.

Centrifugation of protein precipitate at each pH value

The sediments, obtained at each pH value, were collected, lyophilized, and mixed

Protein isolate
($PI_{10.5-2.5}$)

Protein isolate
($PI_{2.5-8.5}$)

Antioxidant properties of $PI_{2.5-8.5}$ and $PI_{10.5-2.5}$·

- **DPPH method**
- **FRAP method**
- **Hydroxyl radical scavenging assay** (2-deoxy-D-ribose method)

Emulsifying properties of $PI_{2.5-8.5}$ and $PI_{10.5-2.5}$·

- **Emulsifying activity**
- **Emulsion stability**

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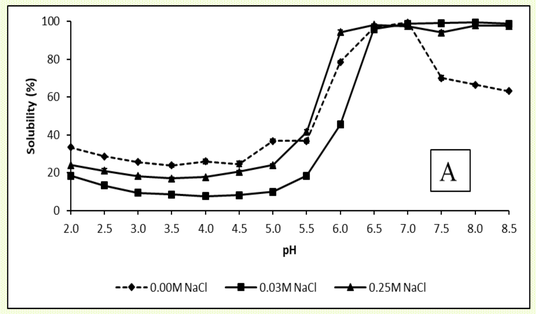
RESULTS



Solubility

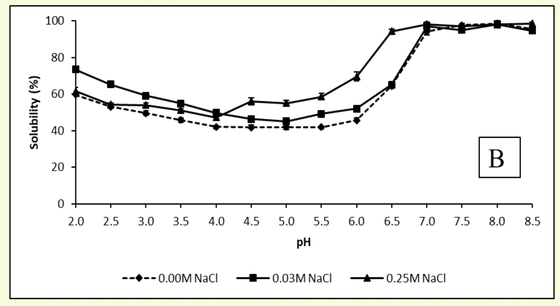


Figure 1. Solubility of protein isolates $PI_{2.5-8.5}$ (A) and $PI_{10.5-2.5}$ (B) at different pH values and NaCl concentrations.

Antioxidant properties

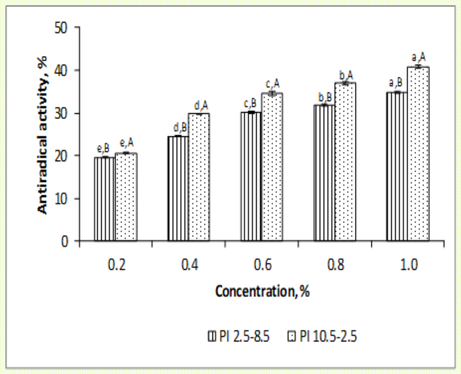


Figure 2. Scavenging effect of ethanol-treated rapeseed meal protein isolates, $PI_{2.5-8.5}$ and $PI_{10.5-2.5}$, on 2,2-diphenyl-1-picryl hydrazyl (DPPH) radical. [a-e] Means of one sample with different concentrations without a common letter differ significantly ($p < 0.05$). [A-B] Means of the samples with one and the same concentration without a common letter differ significantly ($p < 0.05$).

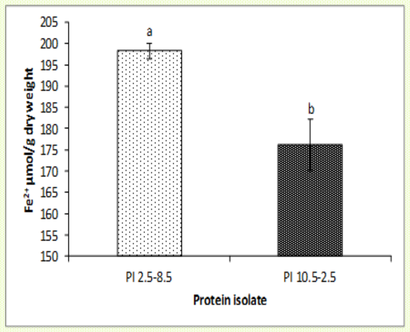


Figure 3. Ferric reducing antioxidant power (FRAP) of ethanol-treated rapeseed meal protein isolates, $PI_{2.5-8.5}$ and $PI_{10.5-2.5}$. [a-b] Means with different superscripts differ significantly ($p < 0.05$).

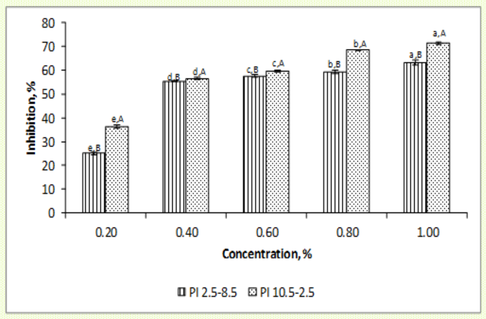
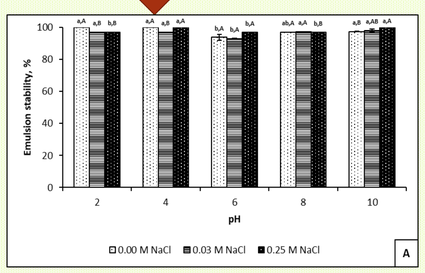


Figure 4. Hydroxyl radical scavenging activity of ethanol-treated rapeseed meal protein isolates, $PI_{2.5-8.5}$ and $PI_{10.5-2.5}$. [a-e] Means of one sample with different concentrations without a common letter differ significantly ($p < 0.05$). [A-B] Means of the samples with one and the same concentration without a common letter differ significantly ($p < 0.05$).

Emulsifying properties

Table 1. Emulsifying activity of $PI_{2.5-8.5}$ and $PI_{10.5-2.5}$ at different pH and NaCl concentrations.

Sample	NaCl concentration	Emulsifying activity, % pH 2	pH 4	pH 6	pH 8	pH 10
$PI_{2.5-8.5}$	0.00M	53.85±0.00^{b,A}	51.17±0.50^{bb,A}	55.03±1.37^{b,A}	46.36±0.44^{ab,B}	52.00±1.88^{a,A}
	0.03M	50.38±0.53^{ab,B}	52.37±1.07^{a,B}	59.18±0.40^{a,A}	49.68±1.41^{a,B}	51.34±0.02^{a,B}
	0.25M	47.53±1.48^{b,A}	48.53±0.06^{b,A}	45.78±1.00^{c,A}	45.07±0.00^{b,A}	46.54±2.07^{b,A}
$PI_{10.5-2.5}$	0.00M	48.92±1.53^{a,AB}	46.51±1.67^{a,B}	45.85±0.90^{b,B}	46.67±0.00^{b,AB}	50.96±0.41^{a,A}
	0.03M	49.28±0.00^{a,AB}	48.09±0.56^{a,AB}	50.70±0.98^{b,A}	46.95±1.41^{b,B}	46.25±0.59^{b,B}
	0.25M	44.68±0.55^{b,D}	46.77±1.50^{a,CD}	48.29±0.40^{ab,BC}	51.02±0.47^{a,AB}	53.44±1.04^{a,A}



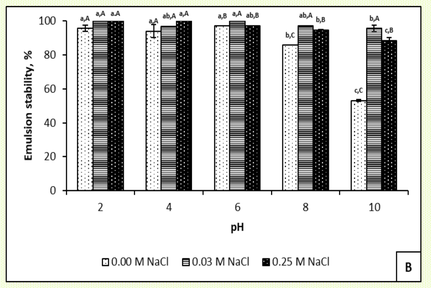


Figure 5. Emulsion stability of $PI_{2.5-8.5}$ (A) and $PI_{10.5-2.5}$ (B) at different pH and NaCl concentrations. [a-b] Means without the same lowercase letter for a particular NaCl concentration differ significantly ($p < 0.05$). [A-B] Means without the same capital letter for a particular pH differ significantly ($p < 0.05$)

Conclusions

- **$PI_{10.5-2.5}$** is more soluble than **$PI_{2.5-8.5}$**.
- **$PI_{10.5-2.5}$ has higher** scavenging capacity on DPPH and hydroxyl radicals than **$PI_{2.5-8.5}$**.
- **$PI_{2.5-8.5}$** exhibits high emulsion stability which is weakly responsive to pH changes from 2 to 10.