Enhancing the nutritional quality of plant proteins by blending different protein sources and extrusion processing

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1. Background

The challenge of plant protein sources

Imbalanced profile of essential amino acids.

Presence of compounds that hinder protein digestibility: antinutritional factors.

Low protein nutritional quality

?

How to tackle this challenge?

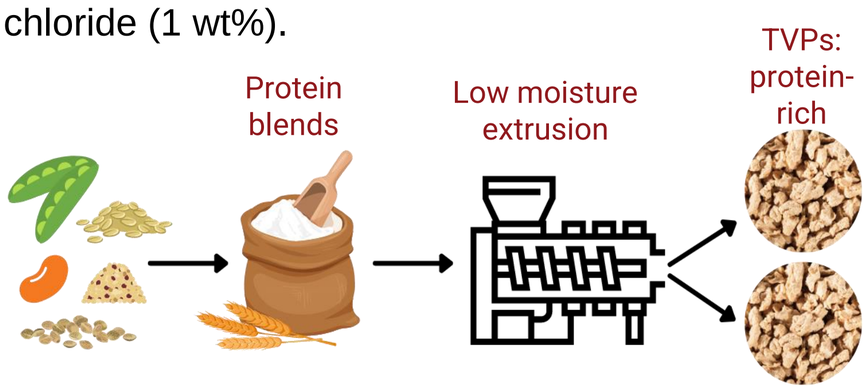
Protein blends + Extrusion

2. Aim

To enhance the nutritional quality of plant protein ingredients by blending different protein sources and using low moisture extrusion process.

3. Material & Methods

Six extrudates were prepared with protein blends of concentrates or flours (99 wt%) and sodium chloride (1 wt%).



Composition of protein blends:
Texturized vegetable proteins (TVP) 1: 89% pea, 10% faba beans; TVP 2: 49% faba beans, 40% pea, 10% quinoa; TVP 3: 79% pea, 10% faba beans, 10% hemp
Snack 1: 60% oat, 39% pea; Snack 2: 50% quinoa, 39% pea, 10% oat; Snack 3: 59% oat, 20% pea, 20% hemp.

Evaluation of protein nutritional quality:

Protein blends & TVPs/Snacks

- Static *in vitro* protein digestibility
- Trypsin inhibitor activity
- Essential amino acid profile and score

One-way ANOVA followed by Tukey's post hoc test was used to compare the results of trypsin inhibitor activity and protein digestibility among different samples. The significance level was set at $p < 0.05$.

4. Results

Reduction in trypsin inhibitor activity (TIA)

Extrudates	TIU per mg protein (dry basis)	TIA Reduction (%)
TVP blend 1	15.11 ± 0.47^{bc}	
TVP 1	3.78 ± 0.26^{g}	74
TVP blend 2	16.33 ± 0.09^{b}	
TVP 2	3.37 ± 0.48^{g}	78
TVP blend 3	15.15 ± 0.30^{bc}	
TVP 3	3.03 ± 0.21^{g}	79
Snack blend 1	14.05 ± 0.23^{cd}	
Snack 1	3.40 ± 0.31^{g}	74
Snack blend 2	13.11 ± 0.22^{d}	
Snack 2	3.42 ± 0.11^{g}	71
Snack blend 3	13.57 ± 0.22^{d}	
Snack 3	3.68 ± 0.16^{g}	71

Results are shown as mean ± standard deviation (n = 3). Values within the same column with different letter superscripts are significantly different ($p < 0.05$). TIU: trypsin inhibited units.

In vitro protein digestibility of TVPs before and after extrusion

Extrudates	Pepsin digestibility (%) (1h)	Pancreatin digestibility(%) (1h)	Total digestibility (%) (2h)
TVP blend 1	4.17 ± 0.15 ^{bc}	13.41 ± 0.19 ^{d}	17.58 ± 0.32 ^{c}
TVP 1	3.88 ± 0.06 ^{c}	17.07 ± 0.34 ^{ab}	20.94 ± 0.30 ^{b}
TVP blend 2	4.54 ± 0.16 ^{b}	16.14 ± 0.78 ^{bc}	20.68 ± 0.90 ^{b}
TVP 2	3.80 ± 0.18 ^{c}	17.64 ± 1.01 ^{ab}	21.44 ± 1.09 ^{b}
TVP blend 3	3.91 ± 0.18 ^{c}	14.34 ± 1.34 ^{cd}	18.25 ± 1.51 ^{c}
TVP 3	3.85 ± 0.22 ^{c}	18.67 ± 0.61 ^{a}	22.52 ± 0.58 ^{b}
BSA Reference	6.44 ± 0.09 ^{a}	18.77 ± 0.19 ^{a}	25.21 ± 0.22 ^{a}

The results are shown as mean ± standard deviation (n = 3). Values within the same column with different letter superscripts are significantly different ($p < 0.05$). BSA: bovine serum albumin. TVP: texturized vegetable proteins.

In vitro protein digestibility of snacks before and after extrusion

Extrudates	Pepsin digestibility (%) (1h)	Pancreatin digestibility (%) (1h)	Total digestibility (%) (2h)
Snack blend 1	3.66 ± 0.09 ^{b}	13.58 ± 0.33 ^{bc}	17.24 ± 0.40 ^{b}
Snack 1	2.55 ± 0.08 ^{c}	15.63 ± 1.10 ^{b}	18.19 ± 1.05 ^{b}
Snack blend 2	4.02 ± 0.35 ^{b}	14.92 ± 0.44 ^{b}	18.94 ± 0.18 ^{b}
Snack 2	2.40 ± 0.04 ^{c}	15.14 ± 0.69 ^{b}	17.54 ± 0.70 ^{b}
Snack blend 3	2.77 ± 0.04 ^{c}	10.64 ± 0.50 ^{d}	13.41 ± 0.47 ^{c}
Snack 3	1.56 ± 0.36 ^{d}	12.36 ± 1.31 ^{cd}	13.93 ± 1.67 ^{c}
BSA Reference	6.79 ± 0.09 ^{a}	20.50 ± 0.19 ^{a}	27.28 ± 0.17 ^{a}

The results are shown as mean ± standard deviation (n = 3). Values within the same column with different letter superscripts are significantly different ($p < 0.05$). BSA: bovine serum albumin.

Essential amino acids

- Snacks maintained a balanced amino acid score.
- TVPs showed a reduction between 3-10% in the amino acid score.
- The loss of Met+Cys in TVPs was more pronounced than other amino acids.

5. Conclusions

- Extrusion effectively reduced trypsin inhibitors > 70%.
- The *in vitro* protein digestibility was improved only in TVPs.
- Extrusion caused a small loss of certain essential amino acids, especially Met+Cys.

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