Foaming properties of whey and soy protein isolates in mixed systems before and after heat treatment

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INTRODUCTION AND OBJECTIVE

- Whey protein isolate (WPI):
  - β – lactoglobulin (β-Lg) – 18.3 kDa.
  - α - lactalbumin (α-La) – 14.2 kDa.
  - Major proteins
- Soy protein isolate (SPI):
  - β – conglycinin – 150-200 kDa.
  - Glycinin – 300-380 kDa.
  - Major proteins
- Heat treatment:
  - Changes on protein structure and on their techno-functional properties.

Do WPI and SPI mixed systems have synergic foaming properties?

METHODOLOGY

WPI:SPI → rehydration → Untreated / 91.5 °C/ 5 min

Characterization of protein structure

Foaming properties

RESULTS AND DISCUSSION

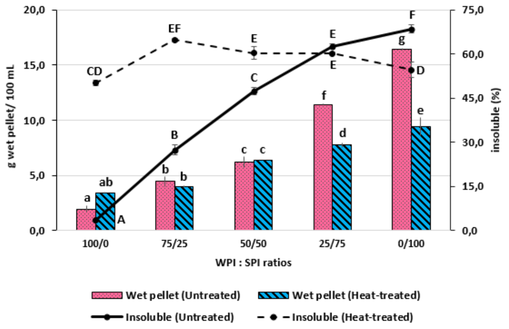

Fig. 1 Solubility of the samples. Different letters mean a significant difference ($p < 0.05$). Lower-case letters were used for wet pellet data and upper-case letters were used for dry-basis insoluble material data.

Solubility

✓ **WP proteins** – decrease Thermo-induced protein aggregation;

✓ **SP proteins** – increase Thermo-induced dissociation of insoluble hydrophobic aggregates.

Total free sulfhydryl groups (SH)

- **WPI:SPI (100:0)** → disulfide bonds on stabilizing the thermo-induced WP aggregates;
- **WPI:SPI (25:75)** → formation or interexchange of disulfide bonds promoted by highly reactive basic chain of Glycinin, in presence of β-LG.

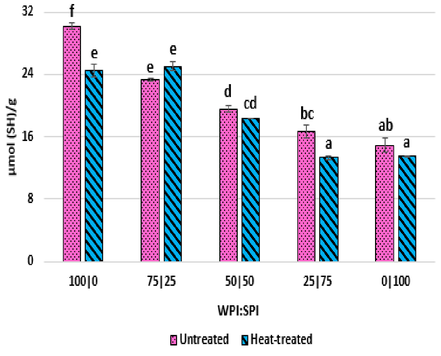

Fig. 2 Total free -SH groups of untreated and heat-treated samples containing different WPI:SPI ratios. Different letters mean significant difference ($p < 0.05$) by One-way ANOVA with Tukey's post –test.

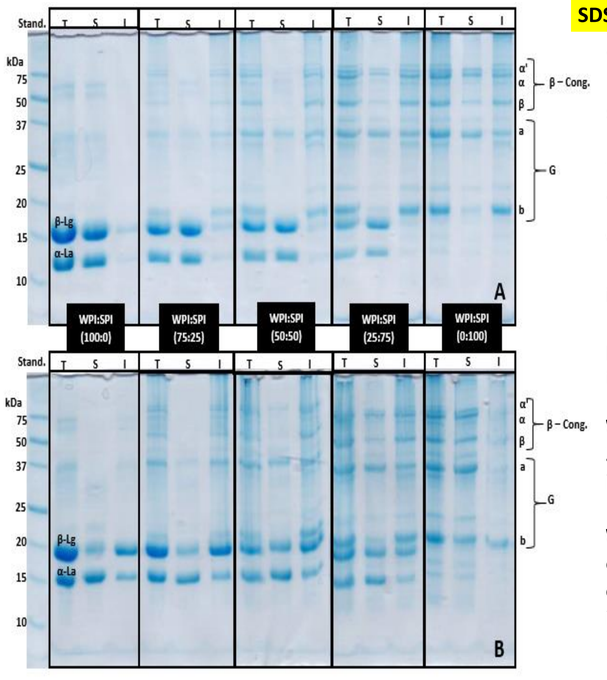

Fig. 3 SDS-PAGE in reduced condition of total, soluble and insoluble fractions of samples containing WPI:SPI mass ratios before (A) and after (B) heat treatment.

SDS-PAGE

WPI:SPI (100:0)
- Untreated → complete soluble;
- Heat-treated → insoluble fraction: protein aggregation.

WPI:SPI (0:100)
- Untreated → Soluble and insoluble fractions;
- Heat-treated → predominance of soluble fraction;

WPI:SPI (75:25 and 50:50) → bands of SP were in the insoluble fractions;

WPI:SPI (25:75) → more equilibrated distribution of SP in the soluble and insoluble fractions.

Accessible hydrophobic patches of proteins in soluble fractions

Heat treatment: increase of the intensity of fluorescence: increase of the concentration of soluble SP → dissociation of SP hydrophobic aggregates

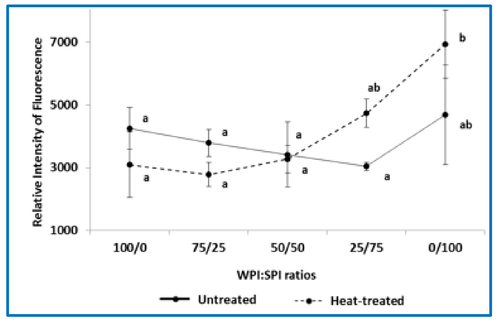

Fig. 4 Relative intensity of fluorescence of ANS (excitation: 365 nm and emission: 484 nm) added to the soluble fraction of samples containing different WPI:SPI ratios before and after heat treatment. Different letters mean significant difference ($p < 0.05$) by One-way ANOVA with Tukey post –test.

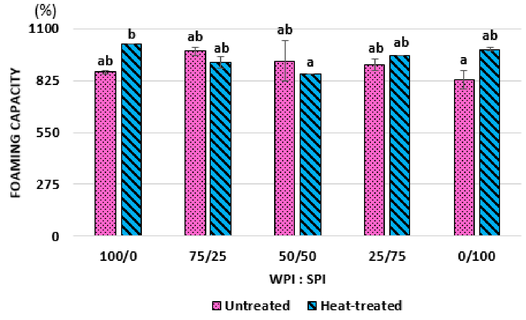

Fig. 5 Foaming capacity of untreated and heat-treated samples. Different letters mean significant difference ($p < 0.05$) by One-way ANOVA with Tukey`s post –test.

Foaming Capacity

- No significant differences of foaming capacity before and after heat treatment.
- All samples were able to entrap air in the same magnitude to produce foams.

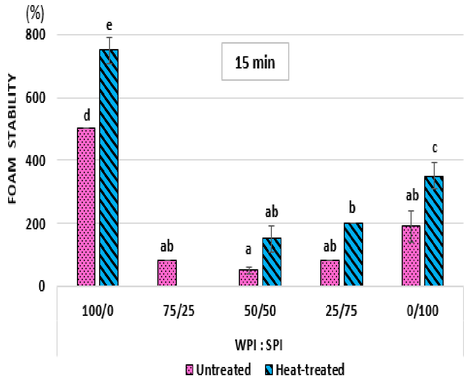

Fig. 6 Foam stability after 15 min on untreated and heat-treated samples. Different letters mean significant difference ($p < 0.05$) by One-way ANOVA with Tukey`s post –test.

Hypothesis

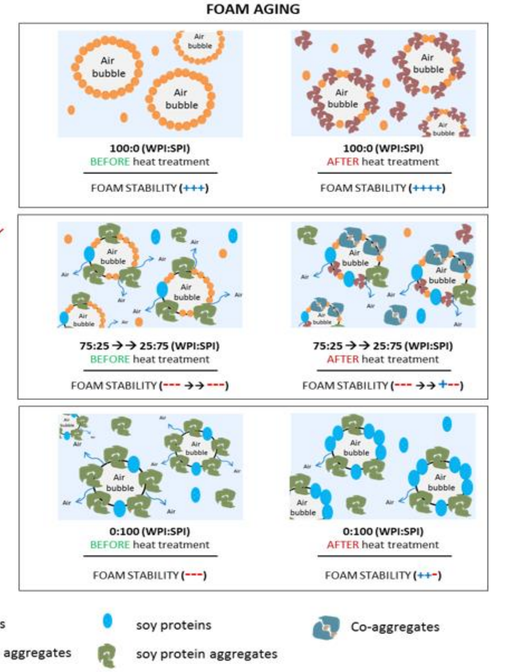

Fig. 7 Schematic representation of the foam stability of the different samples.

Foam Stability

- **WPI:SPI (100:0):** improved foam stability after heat treatment → WP aggregates;
- Increase of the foam stability by increasing the SPI concentration → accessible hydrophobic patches on the soluble proteins;
- **WPI:SPI (75:25):** antagonistic effect.

- **Before heat treatment:** small amount the SP aggregates may sterically prevent the fixation of WP at the air-water interface, resulting in a less cohesive interfacial film.
- **After heat treatment:** intense co-aggregation between WP and SP by hydrophobic interactions may reduce the susceptibility of such aggregates to act at the air-water interface.

CONCLUSION

• Mixing WPI and SPI had a negligible effect on the FC of the mixtures, but it had an antagonistic effect on the FS of the samples;
•Before heat treatment SP insoluble aggregates negatively impacted the FS of samples containing SPI;
•After heat treatment, the formation of insoluble WP and SP co-aggregates, contributed to reduce the flexibility of the proteins and their susceptibility to act for reinforcing the interfacial film.

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