Production of protein-fibre hybrid-ingredients from rice bran by dry fractionation

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Background
Tackling the protein challenge by using side-streams

Challenges?
- How to feed the protein demand of 9 billion people
- Restricted availability of animal proteins

Solutions?
- Increasing use of plant proteins
- New sustainable ways to produce proteins
- Improved resource sufficiency and more efficient use of side-streams

Plant proteins are a megatrend – the number of flexitarians and vegetarians is on the rise
Background

Cereal side streams are a significant protein source

Wheat bran and rice bran production is in total around 250 million tons per year → Bran protein could feed a billion people

* Calculated with 15% raw material protein content and with 50% yield from side streams, and with 50 g daily protein need

→ Use of plant proteins requires protein fractionation and concentration from the plant matrices and functionalization of the protein ingredients

→ Instead of aiming at pure isolates, the studies should be focusing on the complex food systems and hybrid-ingredients enriched in desirable components

→ Dry fractionation including for example milling and air classification provides a useful tool for production of such hybrid-ingredients.

- No addition and removal of water, no use of chemicals, native functionality of proteins and other components are better retained
Aim

- To develop dry fractionation concepts for protein enrichment and pericarp removal from non-heat-treated and fat-extracted rice bran

- To assess the techno-functional properties of the air classified fractions in comparison to their raw material rice bran
Materials and methods (1/2)

**Dry raw material**
- Rice bran, non-heated

**Lipid removal**
- Supercritical CO$_2$-extraction

**Disintegration and particle size reduction**
- Pin disc milling (Hosokawa Alpine 100UZP, 2x17800 rpm)

**Dry fractionation**
- Air classification (Hosokawa Alpine 50ATP)
- Sequences of air classifications and millings
Materials and methods (2/2)

Biochemical composition
- Protein (Kjeldahl N x 5.95)
- Dietary fibre (AOAC 991.43)
- Starch (AACC 76–13.01)
- Ash (combustion at 550°C)
- Phytic acid (colorimetric determination, Wade-reagent)

Functional and protein properties
- Protein solubility (Kjeldahl, pH 5, 6.8 and 8)
- Colloidal stability (visual observation of the dispersion sedimentation)
- Foaming capacity and stability (visual observation of the foam stability)
- SDS-PAGE (reducing)

Dry raw material
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Dry fractionation
- Air classification (Hosokawa Alpine 50ATP)
- Sequences of air classifications and millings
Results
One-step air classification allowed protein-enrichment from 18.5 to 25.7%

- Fresh rice bran
  - Fat extraction by supercritical carbon dioxide
    - Defatted fresh rice bran
      - Dry milling
        - Air-classification
          - FINE fraction Protein-enriched
          - COARSE fraction

Protein: 18.5%
Starch: 23.5%
Soluble dietary fibre: 6.5%
Insoluble dietary fibre: 30.5%
Ash: 10.5%
Phytic acid: 8.7%

Mass yield: 27.2%
Protein: 25.7%
Protein yield: 38.0%
Starch: 7.9%
Soluble dietary fibre: 7.1%
Insoluble dietary fibre: 14.2%
Ash: 25.5%
Phytic acid: 21.6%
Air classification of the non-milled rice bran allowed removal of pericarp structures.

**Fresh rice bran**

**Fat extraction by supercritical carbon dioxide**

**Defatted fresh rice bran**

**Air-classification**

**COARSE fraction**

**FINE fraction Pericarp-free**

- **Mass yield:** 18.5%
- **Protein:** 19.7%
- **Protein yield:** 19.7%
- **Starch:** 12.9%
- **Soluble dietary fibre:** 7.7%
- **Insoluble dietary fibre:** 13.2%
- **Ash:** 25.9%, Phytic acid: 24.5%

- **Mass yield:** 77.8%
- **Protein:** 18.5%
- **Protein yield:** 76.7%
- **Starch:** 23.4%
- **Soluble dietary fibre:** 6.5%
- **Insoluble dietary fibre:** 30.5%
- **Ash:** 10.5%, Phytic acid: 8.7%
Further milling and air classification of the non-milled coarse fraction allowed protein-enrichment to 27.4%.

Mass yield: 13.9%
Protein: 27.4%
Protein yield: 20.2%
Starch: 6.8%
Soluble dietary fibre: 6.8%
Insoluble dietary fibre: 20.5%
Ash: 21.1%
Phytic acid: 16.5%

Protein: 18.5%
Starch: 23.5%
Soluble dietary fibre: 6.5%
Insoluble dietary fibre: 30.5%
Ash: 10.5%
Phytic acid: 8.7%
Protein composition and functional properties of the fractions were altered as a result of air classification.

**Foaming**
- Defatted rice bran
- Fine fraction from milled bran
- Fine fraction from non-milled bran
- Fine fraction from milled and air classified coarse fraction

**Protein solubility (%)**

- pH 5
- pH 6.8
- pH 8

Defatted and milled rice bran

Fine fraction (25.7% protein) from air classification

RB: Defatted rice bran
1sF: Fine fraction from milled bran
1sC: Coarse fraction from milled bran
2sF: Fine fraction from non-milled bran
2sC: Coarse fraction from non-milled bran
2sCF: Fine fraction from milled and air classified coarse fraction
Conclusions & future prospects

- In conclusion, dry fractionation enabled production of protein- and fibre-enriched ingredients from rice bran
  - Fractions were free of pericarp structures
  - Soluble dietary fibre and phytic acid fractionated together with protein whereas starch was separated
  - High phytic acid content in the protein-enriched fractions should be considered in the further experiments due to binding of proteins and minerals

- Interest in producing hybrid-ingredients
  - Air classification does not allow production of pure fractions, but fractions with varying composition and enriched in desired components like protein and fibre
  - Possibility to exploit the properties of different components present in the fractions
  - Nutritional benefits from all the components
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