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Investigation of functional properties of cereal germ- and amaranth proteins in model and complex systems

Summary of PhD thesis

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1. Introduction

New approaches in food science are to recover new protein sources and to find out their economic utilization in food industry and human nutrition. Technological processes in food industry produce several valuable by-products that are rich in proteins and other nutritional components. The utilization of these plants worths better aims. Wheat germ, corn germ and rice germ used to be utilized as animal feed. Diversification of agriculture, cultivation of more and more industrial plants are important from the view point of economic, ecology and society. Pseudocereals are such a potential plants. Amaranth is well-known due to its unique small starch granules, but its proteins were poorly investigated.

The new food safety requirements also need the investigation of new protein sources. To find out the optimal use of proteins, functional, physico-chemical and other specific properties need to be studied.

The aim of this work is to isolate proteins from wheat-, corn-, rice germ and amaranth and to investigate their functional properties in model and complex systems.

- One step alkaline extraction of plant proteins and their fractionation by modified Osborne method
- Quantitative analysis and chemical compositional characterization of proteins
- Investigation of subunit structure of proteins
- Investigation of surface and functional properties of proteins in model and complex systems using micro-scale methods.

2. Methods

One step alkaline extraction was used for protein isolation from cereal germ and amaranth. Fractionation was carried out by modified Osborne fractionation.

Gross chemical composition of meals and proteins were investigated using AOAC methods. Subunit composition (SDS-PAGE, chemical modification), hydrophobicity (RP-HPLC) and functional properties in model systems (solubility, emulsifying and foam properties, surface aromatic hydrophobicity) were studied. In complex system such as wheat dough, proteins were added into the flour and rheological properties were measured with the application of smale-scale equipment (2g-Mixograph, micro Z-arm mixer and micro extension tester).

Development in the methodology was necessary in some cases (emulsion properties and RP-HPLC). Statistical analysis on the results was done using STATISTICA software (version 5.5).

3. New scientific results

Protein composition:

- ❖ The amino acid pattern of protein fractions are more valuable than meals (eg. higher lysin concentration), but tendency of changes in amino acid composition is different in the same fractionation steps.
- ❖ The SDS-PAGE composition of wheat- and rice germ proteins are very similar, the corngerm proteins differ from that, the latter contains less characteristic subunits and high mol. weight fractions (>100kDa).

❖ The SDS-PAGE composition of corn germ proteins didn't change for the effect of chemical modification in LMW range. The hydrogen bonds of wheat- and rice germ proteins can be influenced by carbamide treatment. The so created big aggregates are stabilized by disulphide bonds. The hydrogen bond system of amaranth proteins can not be changed by carbamide treatment, the bigger than 100kDa subunits are connected with disulphide bonds.

❖ By the results of RP-HPLC, the monomers of wheat- and rice germ proteins can be categorized into more hydrophobicity group, while corn germ proteins consist of monomers that are similar by hydrophobicity. The changes in disulphide bonds can be indicated using DTT.

Method developments:

❖ New RP-HPLC method was developed that are suitable to investigate cereal germ proteins.

❖ A new evaluation method: Emulsion stability is characterized with ESV (emulsion stability value) on the basis of integration of the conductivity curve.

Investigation of functional properties of proteins in model systems:

❖ Solubility of the appropriate cereal germ proteins are similar to each other, but amaranth proteins differ, have weak solubility.

❖ Regarding emulsion and foam properties, corn germ alkaline isolate and glutelin show high values as the reference proteins. Functional properties of wheat- and rice germ and amaranth proteins are far low from the references.

❖ Corn germ alkaline isolate and glutelin and rice germ protein fractions show high values in surface aromatic hydrophobicity as the reference proteins, the rest of the proteins have low values.

❖ Significant relationships were found among functional properties measured in model systems (unless: S_0 -ESV, S_0 -FPI, S_0 -FSI).

The effect of protein addition in complex system:

❖ The effects caused by addition of cereal germ and amaranth proteins to wheat flour can be controlled with micro-scale equipment such as the 2g-Mixograph and Micro Z-arm Mixer.

❖ The addition of wheat- and corn germ meal using both mixers decreased (positive effect) on mixing time of wheat flour. Unless albumins, all of the protein fractions increased (positive effect) water absorption of flour. Resistance breakdown of dough was decreased (positive effect) by addition of albumins and amaranth alkaline isolate.

❖ Changes in stretching properties are independent from mixing action and this is due to the rest period before stretching the dough in the method.

Relationships between functional properties measured in model systems and rheological parameters of wheat dough

❖ Significant correlations were found between these properties in several cases

❖ The surface properties of proteins and stretching properties of dough were not significantly in relation (only two cases), which indicates that stretching properties are not influenced by surface properties of proteins.

❖ In case of weaker flour there were more times significant correlation between surface and rheological properties than in case of hard flour. The effects of surface properties of added proteins vary as the function of flour quality.

4. Publication list

PAPERS

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9. Tömösközi S., Haraszi R., Gaugecz J., Varga J., Lásztity R.: New types of isolates from cereal germs, in: Proceedings of Functional Foods-EURO FOOD CHEM X. CONFERENCE, Budapest, **1999**.
10. J. Varga; D. Fodor; J. Nánási; F. Békés; M. Southan; P. Gras; C. Rath; R. Haraszi; A. Salgó; S. Tömösközi: A novel sample preparation method for small-scale testing, in Proceeding of 6th International Wheat Conference, June **2000**, Budapest, Hungary
11. Butow; B.J., Gras; P.W., Haraszi, R. and Békés, F.: A rheological evaluation of the effect of salt on wheat varieties of different X-type/Y-type; in Proceeding of 11th Cereal and Bread Congress, 195-199. old., **2000**, Gold Coast, Australia

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