HIGH QUALITY NOODLE PRODUCTS AND THEIR TRADITIONAL AND NON-TRADITIONAL PROCESSING
VISOKOKVALITETNI TESTIČARSKI PROIZVODI I NJIHOVA TRADICIONALNA I NETRADICIONALNA PROIZVODNJA

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SUMMARY

Traditional pasta is produced only from different qualities of wheat flour (T. durum, T. aestivum) and water, but the use of leguminous flour (like yellow pea flour), pseudocereals (like amaranth) or maize starch as well etc. for producing noodle products is unconventional. There are several possibilities for improving the quality of the products: to change the technology (drying on low or high temperature) or to use additives such as emulsifiers and/or enzymes. For developing an improved pasta structure the enzyme transglutaminase can be used as well.

In the presence of emulsifier an emulsifier-carbohydrate-protein-lipid complex can be expected. The rate of the individual interactions depends on the components of the sample and on the type of applied emulsifiers. Transglutaminase enzyme, a protein-glutamine γ-glutamyl-transferase (EC.2.3.2.13), catalysis acyl-transfer reactions, and introduces covalent cross-links between proteins. The application of transglutaminase has great importance for the development of pasta products: from pseudocereals, or wheat flours (T. durum, T. aestivum). Pasta products with good quality like T. durum-based pastas can be produced from T. aestivum flour. By using transglutaminase the quality of T. durum flour can also be improved, so the pastas will show higher cooking quality. The enzyme ensures cholesterol free products. Pasta and noodle products were produced according a modelling system. The effect of the enzyme treatment on cooking properties, sensory assessment and protein distribution was analyzed. The change of the protein structure depends on the type of systems, the amount and the type of additives.

Key words: emulsifiers, transglutaminase enzyme, pasta properties, SDS-PAGE.

INTRODUCTION

According to nutritionists and consumers, pasta from wheat flour is a valuable nutritional and long-lasting energy source, which made this product increasingly popular in the human diet. The popularity of dried pasta may be also attributed to its sensory appearance, quality, low cost, easy preparation and excellent storage stability. In addition, fresh (non-dried) pasta products appear on the market as a new type of “fresh product” with high consumer acceptance, therefore a growth of pasta consumption is expected. In Hungary pasta is very popular, one of the most preferably eaten product. So far the production of pastas was mainly made with egg. There are several possibilities for improving the quality of the products: to change the technology (drying on low or high temperature) or to use additives such as emulsifiers, enzymes.

Use of emulsifiers. Emulsifiers activity is based on its molecular structure, namely the hydrophilic (“head”) and the hydrophobic (“tail”) part. The foods are very complex hydrocolloidal systems. If we use emulsifiers in this system, different kind of interactions should occur between the components of food and emulsifiers. The most important interactions can be the following: protein-emulsifier, carbohydrate-emulsifier and lipid-emulsifier [1].

Protein-emulsifier interactions can be: hydrophobic bonds, hydrogen bridges and electrostatic interactions. The interactions depend on the amino acid components of the protein. The possible interactions are listed in Table 1.

<table>
<thead>
<tr>
<th>Type of interaction</th>
<th>Amino acid components</th>
<th>Energy of bond kJ/mol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrophobic bonds</td>
<td>Ala, Val, Leu, I-Leu Pro, Phe-Ala, Tryp, Met</td>
<td>3-19</td>
</tr>
<tr>
<td>Electrostatic bonds</td>
<td>Lys, Arg, His, Asp, Glu</td>
<td>21</td>
</tr>
<tr>
<td>Hydrogen bridge</td>
<td>G1y, Ser, Cys, Tyr, Asp, Glu</td>
<td>12-16</td>
</tr>
</tbody>
</table>

The protein-emulsifier interactions help to develop a better structure in food systems. We can see these interactions in the change of molecular weight distribution of the protein fraction (salt soluble, gliadin and glutenin fractions).

Emulsifier-carbohydrate interactions. Starch consists of two types of carbohydrate, amylose and amylopectin, both built up from glucose units. From the two fractions of carbohydrate the amylose is in the position to form a starch inclusion compounds, so called complex with suitable ligands. The other possibility of interaction with the ligands is to form a hydrogen-bridge with the amylopectin.

From the point of complex forming ability the emulsifiers are ideal ligands. In the case of the emulsifier-amylose inclusion compounds only the hydrophobic residues of the molecules will be built into the helical configuration and the hydrophilic head is outside of the helical structure. The emulsifiers glycerol-monostearate, lysolecithin are good complex forming agents, where as lecithin is not able to form a complex.
Emulsifiers-lipids interactions. This interaction can be mainly hydrophobic.

Use of enzyme transglutaminase (TG). For developing a pasta structure the enzyme transglutaminase can also be used. Transglutaminase is a protein-glutamine γ-glutamyl-transferase, (EC.2.3.2.13) catalyses acyl-transfer reactions, introducing covalent crosslinks in proteins. Crosslinks are formed between lysine residues and glutamine residues producing an ε-(γ-Glu)-Lys bond, without reducing the nutritional value of the lysine residue.

\[
\begin{align*}
\text{H}_2\text{N} &- (\text{CH}_2)_4 - \text{CH} - \text{COOH} + \text{O} = \text{C} - \text{CH}_2 - \text{CH}_2 - \text{CH} - \text{COOH} \\
\text{NH}_2 & \quad \text{NH}_2 & \quad \text{NH}_2 \\
\text{Lysine} & & \text{Glutamine}
\end{align*}
\]

Transglutaminase is getting used in a wide variety of foods, particularly since large quantities of microbial transglutaminase became commercially available. It is generally assumed that the effects of transglutaminase in foods are due to its crosslinking activity. The 3 reactions catalysed by microbial transglutaminase: protein cross linking, incorporation of a free amine and hydrolysis of a glutamine residue [3]. The use of transglutaminase improved the functional property and structure of the products. The modification with transglutaminase enzyme induced drastic changes in the physicochemical properties as well as in the rheological behaviour of the products.

I would like to give same new results about the use of transglutaminase enzymes and emulsifiers in different pasta systems made from T. aestivum and pea flours.

**RAW MATERIALS**

In my tests, commercially available wheat flours (T. aestivum, T. durum) with an ash content of 0.55 % and yellow pea flour were used, in particle sizes of 250-500µm. Water-soluble transglutaminase enzyme ACTIVA®STG-M having an enzyme activity of 20-30 Ug-1, was obtained from Ajinomoto Co. Hamburg, Germany. Emulsifiers were used: lecithin (L) Lucas Meyer, Germany and diacylglycerols, Dimodan PM (DPM) originated from Grindsted, Denmark.

**Pasta models:** wheat flour and water was mixed to dough with 40% moisture content. The amount of TG enzyme was varied between 10-200 mgkg-1 using distilled water, based on the amount of flour. Pasta products from T. aestivum flour were prepared by German pasta maker, NUDELMEISTER 8495 [4]. In case of pea noodle model systems the amount of yellow pea flour and water was counted to obtain 40% moisture content in the dough with the addition of 1.2% (w/w) emulsifier related to flour too. A suspension was made from the emulsifiers and water. The temperature of suspension was raised up to 97°C. The mixture was stirred for 15 min in a mixer. The amount of TG Enzyme in pea systems was varied between 50-200 mgkg-1, based on the amount of flour. After mixing the enzymatic treatment followed for 60 min at room temperature. A dough-processing machine produced macaroni and by pressing them through a teflon matrix. Pasta produced with wheat flour were dried at 39°C and at 87% relative humidity for 24 hours and the pea noodles were dried at 39°C and at 110°C for 1 hour, at 70°C for 2 hours as well as at room temperature. After drying the samples were stored at room temperature for another 48 hours [5]. (All the pasta models were made in duplicate). The dried pastas were ground in a LABMILL ‘Q-C-114-type grinder to a particle size 200 - 450 µm. The pastas were investigated only in powder form. The regular pasta was used only for the determination of the cooking quality and - properties.

**METHODS**

Compositional analysis.

The composition (dry matter-, protein- and fat contents of raw materials was determined according to Karácsonyi [6] in triplicate. Sensory assessment and the calculation of the total score were carried out according to the Hungarian Standard [7].

Method of cooking test (amount of water uptake, cooking loss) was made according to Karácsonyi [6] (water: pasta = 25:1, tap-water, pH of cooking water = 6.80, cooking time 5 min, electric cooker). All determination were performed in triplicate and were statistically evaluated by ANOVA ANALYSIS [8] with a probability level based on P =0.05.

Protein fractionation procedures.

Water, salt, alcohol and alkali-soluble protein fractions were obtained by extraction from the pasta products according to methods of to Feillet [9]. At pea noodle products were isolated only salt-soluble protein fraction. The amount of soluble fractions was determined by Micro-Kjeldahl Method. The molecular weight distributions of the fraction were established by SDS-PAGE-electrophoresis according Laemmli [10] for 110 min at 140 V (32 mA). Proteins were separated in a 12.5 % acrylamide gel. Mini-gels (100x100x1 mm) were used. The gels were fixed and stained in one step in a mixture of 12.5 %TCA and 0.25% Coomassie Brilliant Blue R-250.

**DISCUSSION**

The compositions of raw materials are listed in Table 2.

<table>
<thead>
<tr>
<th>Protein (d.m.%)</th>
<th>Fat (d.m %)</th>
<th>Dry matter (%)</th>
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<tbody>
<tr>
<td>11.83±0.32</td>
<td>1.78±0.32</td>
<td>88.35±0.78</td>
</tr>
<tr>
<td>15.23±0.46</td>
<td>2.45±0.82</td>
<td>89.42±0.50</td>
</tr>
<tr>
<td>18.51±0.46</td>
<td>1.75±0.32</td>
<td>89.40±0.50</td>
</tr>
</tbody>
</table>

Table 2. Composition of raw materials

**Figure 2** shows the molecular weight distribution of the soluble protein fractions in T. aestivum wheat flour systems, the pasta properties are presented in Figure 3.

We could not find great differences in the amount and change of molecular weight distribution of salt soluble fraction of the wheat flour fractions, but we could detect a difference in the amount and molecular weight distribution of gluten proteins. Pasta on wheat basis produced with the TG-Enzyme has shown excellent quality parameters. Pasta without additives has shown a lower quality level. Pasta with supplement of 40 mgkg-1 enzyme TG has shown excellent sensory results. The TG-Enzyme has influenced and changed the molecular weight distribution of the soluble protein fractions. The TG-Enzyme could integrate LMW fractions into the developed protein structure. The cooking time of pasta products produced with TG-Enzymes is longer than that of products without this enzyme (22 -26 min). For improving the quality of pasta products from T. durum 10-40 mgkg-1 TG-Enzyme is enough.

Pean seeds contain only salt soluble albumin and globulin, so without additives it is impossible to form a pasta structure, but the use of TG-Enzyme ACTIVA®STGM we could produce pasta products. The gel slab can be seen on Figure 4. On the basis of electrophoreses great differences were observed in the molecular weight distribution as TG enzyme developed direct covalent bindings, while emulsifiers developed only secondary interaction. This resulted better structure and noodle products with higher quality (Figure 5).

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Fig. 2 Molecular weight distribution of gluten protein fractions (Gliadin and Glutenin) of T. aestivum based pasta products made with 10-80 mgkg⁻¹ TG Enzyme

Lines: 1 Standard (Pharmacia Sweden), 2: flour, 3: pasta10 mgkg⁻¹TG, 4: pasta 20 mgkg⁻¹TG, 5: pasta 30 mgkg⁻¹TG, 6: pasta 40 mgkg⁻¹TG, 7: pasta 50 mgkg⁻¹TG, 8: pasta 60 mgkg⁻¹TG, 9: pasta 70 mgkg⁻¹TG, 10: pasta 80 mgkg⁻¹TG

Fig. 3. Pasta properties based on T.aestivum flour with 10-80 mgkg⁻¹ transglutaminase enzyme

Fig. 4. Molecular weight distribution of salt soluble fraction of yellow pea noodle products (YPNP) made with 160 mgkg⁻¹ TG enzyme or 1.2% w/w% Lecithin(L) or 1.2% w/w% Dimodan PM(DPM) with different drying temperature and time.

Pea noodle products have shown different quality level depending on the applied amount of enzyme. The TG-Enzyme has influenced and changed the amount of soluble protein fraction. 50-100 mgkg⁻¹ TG-Enzyme is not enough to integrate the LMW fractions into the developed structure. The best sensory assessment and cooking features was found by the use of 140 –160 mgkg⁻¹ enzyme yellow noodle systems: the product has a good cooking quality: high water uptake and low cooking losses. The TG-Enzyme has influenced and changed the molecular weight distribution of the soluble protein fractions: the amount of HMW protein subunits were higher than in the fraction of yellow pea flour.

CONCLUSION

Pasta produced with the TG-Enzyme i.e. ACTIVA®STGM have shown excellent quality parameters. The TG-Enzyme has influenced and changed the molecular weight distribution of the soluble protein fractions. The TG-Enzyme could integrate LMW fractions into the developed protein structure. The use of enzyme resulted in pasta products with high cooking quality from different raw materials. It was possible to produce pasta products from yellow pea flours with by using TG- Enzyme. The emulsifiers could not develop a similar good structure. The use of enzyme resulted in pasta products with different cooking quality. The optimal amount of TG-Enzyme seems to be 140-160 mgkg⁻¹ in yellow pea flour pasta systems, 10-40 mgkg⁻¹ in T. durum and 40-80 mgkg⁻¹ in T. aestivum wheat flour systems.

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REFERENCES
