Legume-enriched Pasta
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Legume-enriched Pasta: how structure impacts starch and protein digestibilities and protein allergenicity

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Interest of Mixing Durum Wheat and Legume in Pasta

Inspired by The Mediterranean diet and its health benefits

Durum wheat pasta structure

Macroscopic structure of dry and cooked pasta

Impact of legume flour addition

Methodology

GLYCEMIC INDEX

Durum wheat pasta structure

Supramolecular structure

Pasta composition

Impact of legume flour addition

100% Durum wheat pasta (control) 35% Split pea pasta

100% Durum wheat 35% Split pea

13.3 77.6 2.4 0.7

16.1 67.0 6.2 0.2

35% legume fortified pasta: higher protein and fibre contents

100% Durum wheat pasta: a low glycemic index (GI) food

Structure/ Nutrition: what is known on durum wheat pasta

Durum wheat pasta structure

Pasta structure and nutritional properties: impact of Legume addition and changes in process

100% Durum wheat

35% Split pea

GI

Glutens

Glutenins

Starch and Protein Digestibilities

Allergenicity

Legume effect: higher hardness and lower breaking energy

Legume pasta, rich in Lysine and fibres, is associated with a low glycemic index (GI) as compared to control Durum wheat pasta.

Pasta composition

Protein

Starch

Fibre (% db)

100% Durum wheat 35% Split pea

13.3 77.6 2.4 0.7

16.1 67.0 6.2 0.2

35% legume fortified pasta: higher protein and fibre contents

100% Durum wheat pasta (CONTROL) 35% Split pea pasta LT-dried

Increased protein and fibre contents in legume-enriched pasta lead to higher hardness and lower breaking energy compared to control Durum wheat pasta.

Main hypothesis:

- Pasta compactness (Fardet et al., 1998; Granfeld et al., 1991)
- Encapsulation of starch by proteins (McGimpsey et al., 1994; Fardet et al., 1998)
- Physical structure of starch (Englyst et al., 2000; Ingledew et al., 1992; Holm et al., 1988)

Structure of legume-enriched pasta (Supramolecular structure): Presence of IgE- Reactive Fragments in digestion juices: inhibition ELISA, pools of sera from allergic patients to wheat or legumes.
Supramolecular structure of cooked pasta

SE-HPLC after protein extraction

**Legume pasta**

- Non covalent bonds
- Covalent bonds
- Weaker protein network

Covalent (S-S) Non covalent Covalent (others)

0 10 20 30 40 50 60 70 80

% of total protein content

**Durum wheat**

35% Split pea

Non covalent bonds S-S bonds Other covalent bonds

Pasta samples

<table>
<thead>
<tr>
<th>Sample</th>
<th>% Available carbohydrates</th>
<th>RAG value</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Durum wheat</td>
<td>52.5 ± 1.0*</td>
<td></td>
</tr>
<tr>
<td>35% Split pea</td>
<td>62.5 ± 1.1*</td>
<td></td>
</tr>
</tbody>
</table>

No change in the in vitro starch digestibility (RAG)

No effect of structural modifications made by pasta fortification with 35% of legume flour on the RAG value

In vitro starch digestibility of cooked pasta

**Impact of drying treatments**

35% Split pea

Freeze-drying: LT (55°C) CONTROL VHT.LM (90°C)

Macroscopic structure of dry and cooked pasta

**Degree of Protein hydrolysis (%, n=3)**

Freeze-drying No significant difference VHT.LM

Higher porosity could increase accessibility to amylases

Stronger protein network at a supramolecular level

**Microscopic structure of cooked pasta**

Starch Proteins

Freeze-drying

VHT.LM

Effet of drying No major impact

No change in the in vitro allergenicity of digestion juices (nature and quantity of released fragments)
In vitro allergenicity of digestion juices of cooked pasta

**Conclusions (1)**

**COMPOSITION**

- Freeze-drying: No significant difference
- VHT.LM: Changes concerned wheat proteins
  - Presence of IgE-RF from some wheat proteins (γ gliadins, LTP...)

**Processing**

- More fibres: Non-gelatinised starch at the core
- Weaker protein network
- Same RAG value
- Changes DH and IgE-RF

**Structural elements involved in starch digestibility**

- Pasta porosity: YES
- Protein network thickness: No changes
- Nature & quantity of interactions between proteins: YES

**Hypothesis:** A highly aggregated protein network would be more resistant to protein hydrolysis, which could delay hydrolysis of starch by amylases.

**Conclusions (2)**

**Conclusions (3)**

- Protein network thickness: No changes
- Nature & quantity of interactions between proteins: YES

**A highly aggregated protein network would be more resistant to protein hydrolysis, which could delay hydrolysis of starch by amylases.**