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Chantal C. Brossard, Maud Petitot, Cecile Barron, Marie-Anne Legoux, Evelyne Paty, Sandra Denery-Papini, Valérie Micard

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Changes in pasta protein network induced by drying and their relationship to protein digestibility and allergenicity

BROSSARD C. ^{1*}, PETITOT M.^{2,3}, BARRON C.², LEGOUX M.A.¹, PATY E.,⁴ DENERY S.^{1**} and MICARD V.²

1. UR 1268 Biopolymères, Interactions, Assemblages, INRA, F-44316 NANTES

2. UMR1208 Ingénierie des Agropolymères et Technologies Emergentes, INRA – UMII – SupAgro – CIRAD, F-34060 MONTPELLIER

3. Crecepal, Panzani, F-13013 MARSEILLE

4. CHU Necker. Pneumo Allergologie Infantile - 149 Rue de Sèvres – F-75015 PARIS

** : presenting author * e-mail: brossard@nantes.inra.fr



Pasta is a popular food which possesses interesting nutritional quality but may trigger allergic reaction in sensitized people. Many questions remain open for research area, including the relationship between pasta processing, pasta structure and resulting nutritional properties. The purpose of this study was to characterise the structure of pasta dried at different conditions and to relate it to the *in vitro* digestibility and allergenicity of proteins. Four drying profiles were studied: Low Temperature 55°C (LT), High Temperature 70°C (HT), Very High Temperature 90°C applied either from the beginning of the cycle, when the moisture content of spaghetti was high (20%) (VHT) or at the end of the drying cycle, when the moisture content of pasta was low (12%) (VHT_LM).

Methods

Proteins: Size Exclusion HPLC (SE-HPLC) after protein extraction with SDS (detergent), then with DTE (reducer) in dried and cooked pasta (Fig.1)

Microstructure: Confocal Laser Scanning Microscope of cross sectioned cooked pasta after protein staining with fuchsin acid (Fig. 2).

Protein digestibility: *In vitro* digestion of cooked pasta composed of a buccal phase (α -amylase, pH7), a gastric phase (pepsin, PH2) and an intestinal phase (pancreatin, pH7). Protein hydrolysis was evaluated by measuring the increase in free amine groups in protein extracts (Fig. 3).

Protein allergenicity: Juices from *in vitro* bucco-gastric or pancreatic digests were used to inhibit recognition of wheat proteins by IgE from a pool of allergic patients (table 1).

Microstructure of cooked Pasta

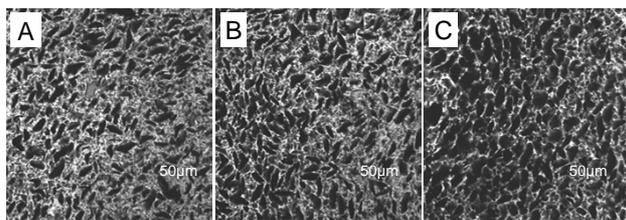


Fig.2: Example of CLSM images of LT cooked pasta at the central (A), intermediate (B) and external (C) zones of pasta strand.

⇒ **Localisation effect:** External zone: looser protein network with swollen starch granules: creation of a moisture gradient during cooking

⇒ **Drying profile:** LT ≠ other drying profiles

Allergenicity of Digests from Cooked Pasta

Table 1. Competitive ELISA with digestion juices from cooked pasta and a pool of sera from allergic patients to wheat. Percentage of inhibition obtained with digestion juices at the end of the gastric phase (5 minutes by α -amylase and 3 hours by pepsin) and at the end of the intestinal phase (end of gastric phase + 3 hours by pancreatin) are presented.

Distinct letters by protein indicate significant difference between mean values ($p < 0.05$)

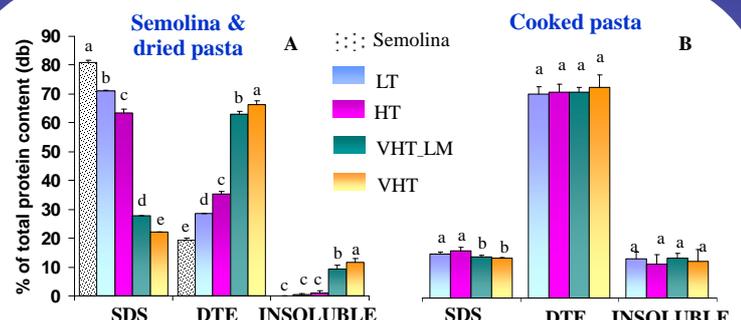
		Digestion juice from the end of	LT	HT	VHT	VHT_LM
α-gliadin	gastric phase		66 ^a	64 ^a	44 ^b	40 ^b
	intestinal phase		16 ^{cd}	14 ^{cd}	10 ^d	19 ^c
γ-gliadin	gastric phase		88 ^a	79 ^{bc}	80 ^{abc}	81 ^{ab}
	intestinal phase		78 ^{bc}	75 ^{bc}	72 ^c	77 ^{bc}
Low MW glutenins	gastric phase		93 ^a	91 ^{ab}	90 ^{ab}	87 ^b
	intestinal phase		51 ^d	66 ^c	46 ^d	63 ^c
Albumin/globulin fraction	gastric phase		28 ^a	26 ^{ab}	24 ^{ab}	24 ^{ab}
	intestinal phase		14 ^c	16 ^c	14 ^c	21 ^b

⇒ **Wheat fraction** IgE reactive peptides from different wheat fractions are present in all tested digestion juices.

⇒ **Digestion step:** digests from gastric phase are richer in IgE reactive peptides than those from intestinal phase, difference depends on wheat fraction.

⇒ **Drying process:** compared to LT process, increasing the drying temperature led to a reduction in gastric digests and an increase in intestinal digests of IgE reactive peptides, specially for VHT_LM.

Protein Solubility



Distinct letters by parameter (SDS, DTE or Insoluble) within a graph (A or B) indicate significant difference between mean values ($p < 0.05$).

Fig. 1: Peak surfaces of SE-HPLC elution profiles of SDS-soluble, DTE-soluble and calculated unextractable protein fractions in semolina and dried pasta (A) and in cooked pasta (B)

Dried pasta are different but Cooked pasta are similar

⇒ Increasing drying temperatures led to increased protein aggregation (lower protein solubility in SDS)

⇒ Aggregation probably occurred through disulphide bonds (increased DTE-soluble fraction) and through other covalent bonds (presence of insoluble proteins) with VHT drying profiles.

⇒ Cooking led to an increased protein aggregation, especially for LT and HT pasta

⇒ Aggregation during cooking probably occurred through disulphide bonds (increase in DTE-soluble fraction) and other covalent bonds (increase in insoluble fraction)

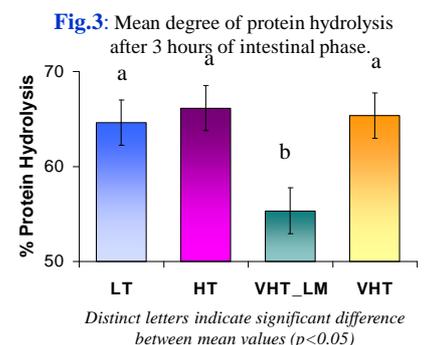
Protein digestibility in Cooked Pasta

⇒ **Bucco-gastric phase**

no significant effect of the drying profile (data not shown)

⇒ **Intestinal phase**

VHT_LM drying profile significantly decreased protein digestibility (by 10%) compared to other drying processes.



Distinct letters indicate significant difference between mean values ($p < 0.05$)

VHT_LM decreased significantly protein digestibility (by 10%) and increased allergenicity of intestinal digests. This could not be explained by a different protein spatial distribution at a microscopic level. VHT_LM cooked pasta presented a higher proportion a high molecular weight protein aggregates (data not shown) which may have contributed to this lower digestibility and higher allergenicity. Both gluten and soluble proteins seemed to be involved. It appears that applying VHT at the end of the drying cycle led to the formation of specific protein aggregates.

Diapositive 1

d3 remplacer 20 ppm
gluten par 20 ppm
dj161659; 01/09/2009