



Involvement of the Protein Network in the *in vitro* Degradation of Starch from Spaghetti and Lasagne: a Microscopic and Enzymic Study

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ABSTRACT

This study aimed to determine the involvement of the protein network in the *in vitro* degradation of starch from intact pasta strands. The physical structure of pasta was characterised during enzymic treatment by microscopy, and hydrolysis kinetics were interpreted. When incubated with human salivary *alpha*-amylase (HSA), the protein network remained intact, retarding starch degradation. The presence of proteases contaminating pig pancreatic *alpha*-amylase contributed to the partial hydrolysis of the protein network (similar to the effect of pepsin), increasing starch degradation after 1 h of *alpha*-amylolysis in comparison with HSA. Complete accessibility of starch to *alpha*-amylase after 72 h of *alpha*-amylolysis was demonstrated by chromatography, both with intact and degraded protein networks. Two hours pre-treatment of pasta with pepsin or HSA increased respectively the initial degradation of starch and protein. Starch or protein presence, therefore, hinders the action of the enzyme, which does not degrade it. The protein network is not itself a physical barrier to *alpha*-amylase access to starch in pasta. Both microscopy and hydrolysis kinetics have revealed that new physico-chemical factors related to food structure should be considered in the enzymic degradation of pasta.

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INTRODUCTION

Pasta manufactured from *durum* wheat is considered as a source of slow-release carbohydrates since its ingestion leads to low glucose and insulin responses in humans^{1–5} and to the improvement of metabolic control in diabetic subjects^{6–9}. The mechanisms by which starch in pasta is slowly

hydrolysed by *alpha*-amylases are still not fully understood. Pasta is ingested as a solid food with a dense firm texture due to the extrusion process. It then requires a low degree of mastication before swallowing⁶, after which the pasta arrives in the stomach in the form of solid particles. Meals composed of spaghetti delay gastric emptying in comparison to meals composed of rice, potatoes or white bread^{10,11}. This emphasises that the structure of pasta is maintained longer in the stomach than the structure of bread or potatoes. It has been shown, however, that different model carbohydrate foods have the same rate of gastric emptying despite different glycaemic responses¹². Furthermore, recent studies in our laboratory with

ABBREVIATIONS USED: HSA = human salivary *alpha*-amylase; PPA = pig pancreatic *alpha*-amylase; SEM = scanning electron microscopy; SEC = size-exclusion chromatography; DP = degree of polymerisation.

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