A reaction-diffusion numerical model predicting the gastric digestion of proteins from meat bolus particles

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A REACTION-DIFFUSION NUMERICAL MODEL PREDICTING THE GASTRIC DIGESTION OF PROTEINS FROM MEAT BOLUS PARTICLES.

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Model Parameters are formatted this way.

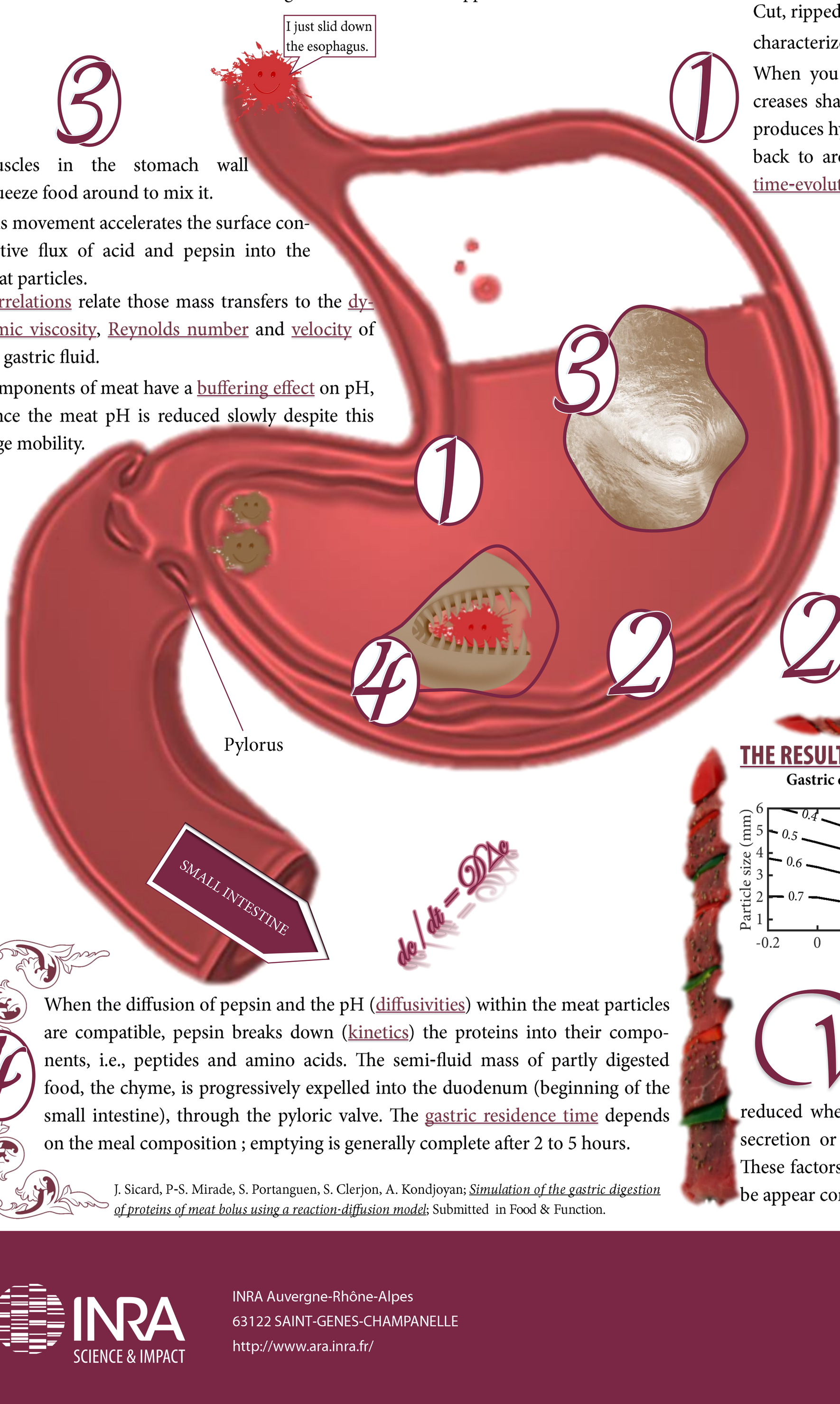
INTRODUCTION

Sarcopenia is a degenerative loss of skeletal muscle mass and strength associated with ageing. A way to slow down those effects is to improve the digestion of proteins. However, the respective impacts of the different phenomena involved are difficult to determine experimentally. Mathematical modelling offers an alternative approach.

THE VITALS

Cut, ripped and crushed meat forms a bolus characterized by a distribution of particles diameters.

When you ingest food, the pH in the stomach increases sharply. Cells along the sides of the stomach produces hydrochloric acid in order to reduce that pH back to around 2. After ingestion, there is hence a time-evolution of pH within the stomach.



Muscles in the stomach wall squeeze food around to mix it.

This movement accelerates the surface convective flux of acid and pepsin into the meat particles.

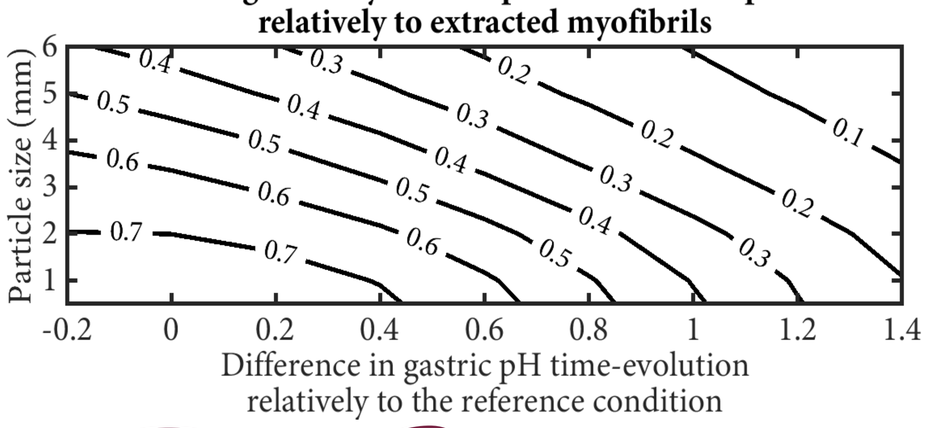
Correlations relate those mass transfers to the dynamic viscosity, Reynolds number and velocity of the gastric fluid.

Components of meat have a buffering effect on pH, hence the meat pH is reduced slowly despite this large mobility.

Glands in the stomach emit a proenzyme : pepsinogen, which upon mixing with the hydrochloric acid activates to become pepsin, a protease whose activity is maximal at pH 2.

THE RESULTS

Gastric digestibility of meat proteins in bolus particles relatively to extracted myofibrils



When the diffusion of pepsin and the pH (diffusivities) within the meat particles are compatible, pepsin breaks down (kinetics) the proteins into their components, i.e., peptides and amino acids. The semi-fluid mass of partly digested food, the chyme, is progressively expelled into the duodenum (beginning of the small intestine), through the pyloric valve. The gastric residence time depends on the meal composition ; emptying is generally complete after 2 to 5 hours.

While meat protein digestibility in the stomach is high in normal physiological conditions, it gets heavily reduced when masticatory capacity, hydrochloric acid secretion or gastric mobility in the stomach decline. These factors all pull in the same direction and tend to be appear concomitantly with advancing age.

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