Development of extruded high-protein alternatives to meat

Mats Stading[1,2] and Marco Berta[1]

[1] Research Institutes of Sweden, Bioscience and Materials, 402 29 Gothenburg, Sweden
[2] Chalmers University of Technology, Department of Materials and Manufacturing Technology, 412 96 Gothenburg, Sweden

ABSTRACT

By combining rheology, food science, materials science and creative culinary ingenuity we have developed healthy, plant-based protein foods with low carbon footprint that are equally attractive to meat. Starting from a mixture of proteins we have extrude structures with fibrous, desirable texture and chewiness. The taste and flavour is bland and an experienced chef has applied his magic to create succulent protein food dishes.

INTRODUCTION

Global meat consumption per capita doubled between 1961 and 2009. Even if the increase in European meat consumption has slowed in recent years, in Europe it is 85 kg per capita, twice the world average, and is forecasted to increase by 10% from 2007 to 2030[1-3]. In the EU, consumption corresponds to around 20 kg of pure protein; a realistic expectation is that within 10 years this level could be reduced by the introduction of protein-rich vegetable foods and educational programs to 10 kg of animal protein per year. The increases in meat eating are alarming from the nutritional perspective, as excessive consumption has been linked to health problems. Expansion of animal production results in undesirable clearing of forestlands and increases in emissions of climate-affecting gases. It is clear that increased intake of vegetable alternatives is preferable for economical, sustainability, and health reasons. All new alternatives to meat will have to be sufficiently attractive in their own right to make their way into the market. Clearly, if the alternatives do not appeal to us both aesthetically and nutritionally, we will stick to meat beyond what we and the planet can manage.

The use of plant based protein ensures a climate friendly product, which is also healthy due to the protein quality of the mixture. The influence of rheology in the extrusion process is crucial for the development of the final structure, which is necessary to create a desirable texture.

MATERIALS AND METHODS

Wheat gluten from Lantmännen Reppe (Lidköping, Sweden) and pea protein from Cosucra (Warcoing, Belgium) was mixed in different ratios together with water at room conditions using a Z-mixer (Reologen i Lund, Öved, Sweden) to a viscoelastic melt. The protein melt was transferred to the rheometer (ARES G2, TA Instruments, New Castle, USA, and Stresstech HR, Reologica, Lund, Sweden) and evaluated using a parallel plate system with 30 mm plate diameter, gap=1mm. The complex shear modulus was monitored in the linear region for temperatures between 20-95°C, 2°C/min.

RESULTS

Gluten and pea protein was mixed with water to a melt at various protein ratios, and

typical result is shown in Fig. 1. Increased temperature did not induce any apparent changes in the protein structure as observed by a moderate decrease in moduli. Cooling from 95-30°C, on the contrary induced a significant increase in moduli which could depend on both strand formation in the proteins and phase separation. There is no visible macroscopic phase separation, but when the sample is removed from the bottom plate there a structure of macroscopic fibres are apparent (see Fig. 2).

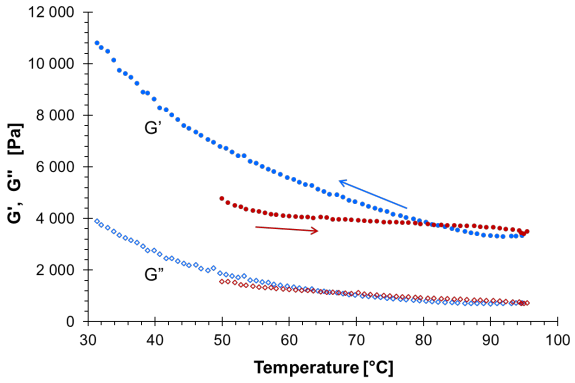

Figure 1. Heating (red) and cooling (blue) of a 50/50 gluten/pea protein mixture monitored by G' (filled symbols) and G" (open symbols).

The fibre formation has also been observed for other plant protein mixtures such as soy/gluten[4]. The authors associated the fibre formation mainly with separation of the different protein phases.

CONCLUSIONS

Plant based proteins can easily be mixed into melts. At specific conditions (protein type and ratio, mixing, heating) the protein melts can form macroscopic, fibrous structures with a texture mimicking that of meat. The basic rheological result can be extended to food extrusion, thus developing desirable alternatives to meat[5].

Figure 2. Fibre formation in the gluten/pea protein melt after heating and cooling.

REFERENCES

1. Steinfeld, H. et al. (2006) "Livestock's Long Shadow: environmental issues and options", in FAO.

2. Westhoek, H. et al. (2011) "The Protein Puzzle - The consumption of meat, dairy and fish in the European Union." *PBL Netherlands Environmental Assessment*.

3. *FAOSTAT consumption data*. (2010) Available at faostat.fao.org

4. Grabowska, K. J., Tekidou, S., Boom, R.M. and van der Goot, A-J. (2014) "Shear structuring as a new method to make anisotropic structures from soy-gluten blends", *Food Res. Int.*, **64**, pp 743-751.

5. www.smat.nu, accessed on 2017-01-25 describing plant based alternatives to meat.