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High-moisture extrudates can rebuild their meat-like structure (#519)

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Introduction

High-moisture extrudates (HME) are known to have a fibrous meat-like structure which allows manufacture of improved meat analogs [1], but only if complete HME chunks are used. If finely chopped HME is required, e. g. in case of emulsion-type sausage analogs, the previously generated fiber structure is destroyed. Nevertheless, based on a sausage meat batter, we assumed that the addition of finely chopped HME, resembling insoluble meat fibers, can improve the texture of sausage analogs. Yet, a preliminary test revealed that the addition of finely bowl-chopped HME (ø approx. 23 – 25 µm) to a vegan sausage compound resulted in grittiness perception [2], which was explainable by the oral particle-perception threshold of approx. 23 µm [3]. Finer particles were neither generated through other devices nor through the addition of water during the bowl-chopping process. As it is known, that gelling reduces the threshold for grittiness perception, too [3], the use of gelled HMEs could be an alternative to particle size diminution. It is known, that solubilized functional plant proteins can form protein gels after heating [4]. However, it is unclear if this is also true for HMEs which already suffered high temperatures and pressures during the extrusion process [5]. For this reason, gelling ability of HME from pea, pumpkin and sunflower was tested and compared to gelling ability of respective protein powders.

Methods

Pea protein isolate, pumpkin and sunflower flour were extruded using twin screw extruder ZSK 27MV Plus (Coperion GmbH, DE) with cooling dye FKD-750 (DIL e.V., DE). HMEs were chopped (vacuum bowl chopper) by addition of 1/3 water. Least gelation concentration (LGC) of chopped HMEs and respective powders was determined according to Sathe et al. [6] using suspensions containing 12-22 % solids (always powder content). The effect of extrusion, and temperature (20, 70, 90 °C) on protein solubility was analyzed via nitrogen content in stock solution and supernatant (Dumas). Effects of Extrusion on gel firmness and elasticity were analyzed via texture analyzer TA-XT2 (Stable Micro Systems, UK) and oscillation rheometer (TA Instruments, Germany). The effect on gel structure was analyzed using confocal laser scanning microscope (CLSM) Eclipse E600 (Nikon, Japan) and scanning electron microscope (SEM) JSM-6460LV (Jeol GmbH, Germany).

Results

Even after extrusion all analyzed proteins possessed gelling ability and the fibrous structure of HMEs was rebuilt. LGC of pea HME increased while share in soluble proteins decreased (about 30 %). By contrast, LGC of pumpkin HME decreased and share in soluble proteins was unaffected while LGC of sunflower HME stayed unaffected with a strong decrease (30 %) in protein solubility (Tab. 1). Li and Lee [7] hypothesized that protein solubility is more negatively affected during extrusion if the amount of cysteine in the protein is high. According to literature sunflower and pea protein have a higher amount in cysteine-rich 2S albumins than pumpkin [8-11], which could explain the higher loss in solubility. Elasticity and firmness of pea HME-based gels was much higher than of powder-based gels. By contrast, elasticity and firmness of pumpkin and sunflower HME-based gels was much lower than of powder-based gels. CLSM and REM analyses of pea protein powder-based gels revealed linked, coarse particles while HME-based gels showed an anisotropic fibrous structure with a finer network, explaining higher firmness and elasticity. In case of pumpkin, the fibrous structure and cross-linking of proteins was nearly absent in powder-based gels. Proteins rather aggregated, explaining the high firmness. In case of sunflower a cross-linked network in both sunflower gel types was revealed, but in the HME-based gels the structure was coarser explaining the higher elasticity and firmness of powder-based gels (Fig. 1). On the one hand the results indicate that extruded proteins can improve the gel-structure as particulate or aggregated structures are converted in a fibrous network which could improve sausage texture and reduce grittiness perception. On the other hand, extruded proteins loosen the gel-network structure which in turn reduced firmness and elasticity of the gels and could have a negative impact on sausage texture.

Conclusion

High-moisture extrudates can form protein gels which rebuilt their fibrous structure. HME-gels could reduce the grittiness perception if added to vegan sausages but may reduce firmness and elasticity. The impact of HME-based gels on sausage texture as well as the effect of salt on gel firmness and elasticity needs to be further analyzed.

Notes

	LGC (%)		Solubility 20 °C (%)	
Protein	Powder	HME	Powder	HME
Pea	16	22	33.8 ± 1.2	24.6 ± 0.3
Pumpkin	32	20	9.3 ± 0.4	10.5 ± 0.4
Sunflower	24	24	16.9 ± 0.9	11.9 ± 2.0

Tab. 1, LGC and solubility of pea, pumpkin and sunflower protein products before and after extrusion

Listed are the least gelation concentration (LGC) in % and the share in soluble proteins in % (at 20 °C) for protein powders of pea, pumpkin and sunflower and respective high moisture extrudates (HME).

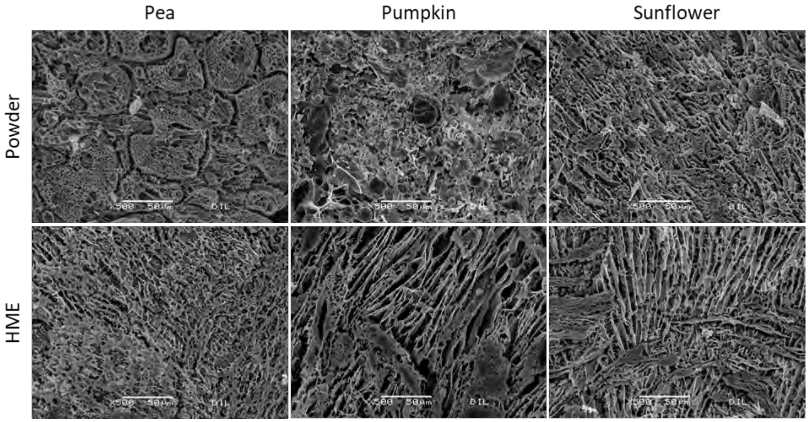

Figure 1, Structural changes of powder and HME-based gels from pea, pumpkin and sunflower.

Gels were prepared with respective LGC. Bars: 50 µm.

Notes