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Additive-free vegan emulsion-type sausages based on meat and fat substitutes (#507)

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Notes

Introduction

The gel-sol-gel transformation of meat proteins during emulsion-type sausage production relies on the ingredients. Salt and water allow solubilization of meat proteins, which in turn link insoluble, crushed meat fibers and homogenized fat particles in a continuous protein-gel network after heating. Owing to unique texture of meat proteins, texture of many vegan analogs is not as good as of meat sausages. Moreover, customers want additive-free products. As it is known that functional plant proteins can form protein-gel networks after heat induction [1], we hypothesized that an additive-free vegan emulsion-type sausage can be made by transferring the gel-sol-gel transformation process to plant proteins. Based on the original process, an improve in texture was assumed if, besides solubilized proteins, insoluble protein fibers (meat substitute) and solid fat emulsions (fat substitute) are used (Fig. 1). To test these assumptions, three independent experiments were carried out. 1) Meat substitute from soy protein concentrate was produced by high-moisture extrusion and the effect of temperature on protein solubility and gelling ability was analysed. 2) Canola oil was dispersed in aqueus suspensions, containing soy or pea protein isolate (fat substitutes), and after heating firmness and stability were determined. 3) Ingredients were combined and vegan sausages, based on protein, fat and water, produced. Firmness and cut resistance at cold (lyoner-type) and hot (wiener-type) state were compared to a vegetarian sausage standard.

Methods

Meat Substitute

Soy protein concentrate (Solae, US) was extruded using twin-screw extruder ZSK 27MV Plus (Coperion GmbH, DE) with dye FKD-750 (DIL e. V., DE), and bowl chopped adding 1/3 water to create crushed fibers. The effect of temperature on protein solubility (20, 70, 90°C) was analysed in comparison to the powder. Least gelation concentration (LGC) was determined according to Sathe et al. [2] (90°C, 15 min). Gel firmness was measured with texture analyzer TA-XT2 (Stable Micro Systems, UK) and elasticity with oscillation rheometer (TA Instruments, DE).

Fat Substitute

Different ratios (65:35, 70:30, 75:25) of canola oil and aqueous protein suspension [8.0–11.5% soy (Yihai Kerry, CN) or pea protein isolate (Cosucra, BE)] were dispersed using Ultra Turrax® T25 with dispersion tool S25N 25G (IKA Labortechnik, DE). After heating (65°C) and cooling (4°C), firmness was determined (v. s.). The effect of protein concentration on elasticity (v. s.), droplet-size distribution (Mastersizer 2000, Malvern Instuments, UK), extractable fat (petrol-ether) and structure (CLSM Eclipse E600, Nikon, JP) was analyzed, using o/w ratio 70:30.

Sausage

70% meat substitute (79% extrudate, 21% water) and 30% fat substitute (70% o/w, 11.5% protein) were dispersed (bowl chopper), filled in artificial casings (Ø 60 mm) and heated to 72 (like a meat sausage) or 85°C (used for veg. standard). Cut resistance and firmness (texture analyzer) were compared to a veg. standard (Frutarom, DE).

Results

Meat Substitute

Even after extrusion, gelling ability was given (Fig. 2 A) but LGC increased and share in soluble proteins halved compared to the powder. Temperature had a positive effect on solubility with highest values for protein powder after heating to 90°C. The extrudate gel was considerably firmer and more elastic than the powder gel, which might be explained by the lower protein solubility which negatively correlates with firmness [3], but notably solid content of extrudate gels was slightly higher than of powder gels. Mixtures of both could be used to modify texture.

Fat Substitute

After detailed analyses of solidyfied emulsions, 70% oil and 11.5% protein in suspension resulted in firmest as well as heat stable products (Fig. 2 B). Soy emulsions proved to be firmer but less elastic and slightly less stable than pea emulsions, as oil droplets were bigger, amount of extractable fat higher and satisfaction of the system reached. Due to different properties both emulsions were used for sausage production.

Sausage

At cold and hot state, cut resistance of sausages made with soy emulsion was significantly higher than of veg. standard, whereas pea-emulsion sausages showed relatively low resistance (Fig. 3). Firmness of both emulsion-type sausages was considerably lower than of veg. standard. These results indicate, that properties of the fat emulsions (firmness, elasticity) and proteins (aggregation) are crucial for overall sausage firmness and bite. A higher heating temperature had a positive impact on cut resistance and firm ness. This can be explained by insufficient protein denaturation and aggregation at low temperatures due to high denaturation temperature (≥ 85°C) of 11S globulins [4, 5]. Reheating had a negative impact on cut resistance which can be explained by the thermoplastic, irreversible character of protein aggregates [6].

Conclusion

We concluded that the gel-sol-gel transformation process can be transferred to plant proteins and that the protein used for fat substitute as well as properties of fat substitute are crucial for overall sausage firmness. The optimal protein and fiber concentration as well as improved fat emulsions are necessary to enhance sausage firmness and bite.

References

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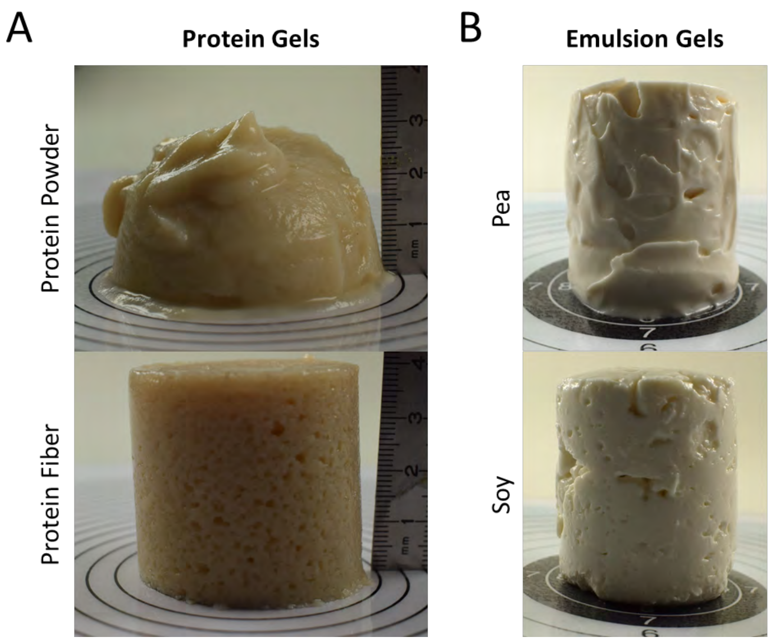

Figure 2, Appearance of meat substitute and fat substitute

A, Appearance of soy protein powder and fiber-based gels (meat substitute). Gels were prepared with least gelation concentration: 14% and 16% solids for powder and fiber-based gels, respectively. **B,** Appearance of pea and soy protein-based fat emulsions. Emulsions were prepared dispersing 70% canola oil in 30% aqueous protein suspension (11.5% protein)

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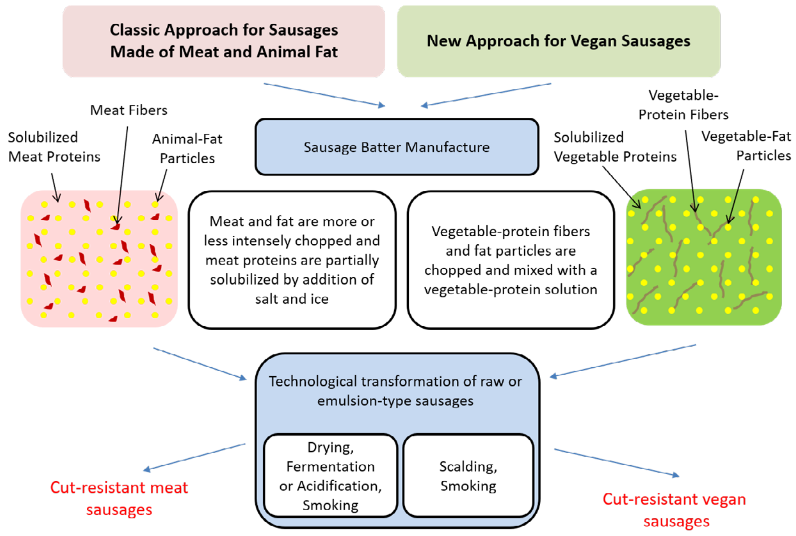

Figure 1. Scheme of sausage manufacture and process transformation to vegan sausages.

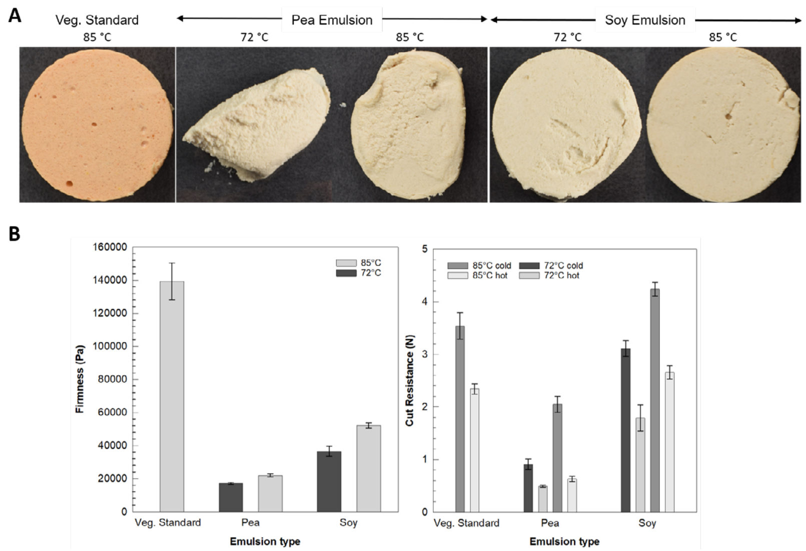

Figure 3, Firmness and cut resistance of pea/soy emulsion-based sausages compared to a veg. standard

A, Intersections of the vegan sausages prepared with soy extrudates and pea or soy protein-based fat emulsion in comparison to the vegetarian (veg) standard. The latter was manufactured at 85°C (manufacturer's instructions), while the vegan sausages were manufactured at both, 72 (meat sausage) and 85°C. **B,** Plotted is the sausage firmness in Pa (left graph) dependent on production temperature, 72 (dark grey bars) or 85°C (light grey bars), and the cut resistance in N of respective sausages (right graph) at cold state (lyoner-type; darker bars) and after reheating (wiener-type; lighter bars).

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