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Evaluation of various methods to determine destruction of muscle cells (#513)

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Introduction

Minced meat and minced meat products such as hamburger need to fulfill rigorous requirements not only regarding their quality attributes such as appearance, texture, taste and microbiological stability, but in Germany also in terms of regulatory requirements ("Leitsätze") concerning "meat-batter-like"-structure. Histology is utilised to detect the content of these stipulated structures, which occur due to pressure, resting time and a combination of unit operations of industrial minced meat production (comminution, mixing, forming). Currently, there is a lack of knowledge about the relationship between material and (critical) process characteristics and their responsibility for generating these structures. To provide a more applicable method, several techniques to analyse minced meat structures were examined.

Methods

Fat content of minced pork shoulder was adjusted with bacon to 20 w/w %. Modification in process conditions – to achieve different "meat-batter-like"-structures, meaning destructions – was set to 1) cutting meat with a knife in pieces like Tatar (Tatar-like), 2) mincing to 3 mm and 3) mincing to 3 mm and mixing for 60 sec.

Cooking loss was determined by calculating difference in weight before heat-treatment and after treatment at 100 °C (30 min, in a bag) and separating solid and liquid phase. Water holding capacity (WHC) was measured from the raw sample between filter paper at 20 °C, on which a 5,000 g stamp was loaded for 5 min. Then moisture loss was determined by calculating the difference in weight. Water content was analysed based on §64 LFGB L06.00-3 and pH-value based on §64 LFGB L06.00-2. For determination of soluble protein content, minced meat (27 %) was stirred for two minutes in a 0.7 mol/L NaCl-solution, left for four hours at 4 °C and then centrifuged at 20,000 rcf at 4 °C for 10 min. Stock solution and supernatant were analysed for protein content via Dumas, whereon soluble protein content was calculated. Colour of samples was measured via L*a*b* measurement with CM-600d from Konica Minolta Sensing Inc. (Marunouchi, Japan). For confocal laser scanning microscopy (CLSM), samples were stained with FITC (protein) and Nile red (fat), left for 1 hour and then measured at 473 nm (FITC emission, argon laser) and 543 nm (Nile red emission, helium-neon laser). Histological analysis was conducted based on §64 LFGB L06.00-13 with a calculation of threshold at confidence intervals of 98 %.

Results

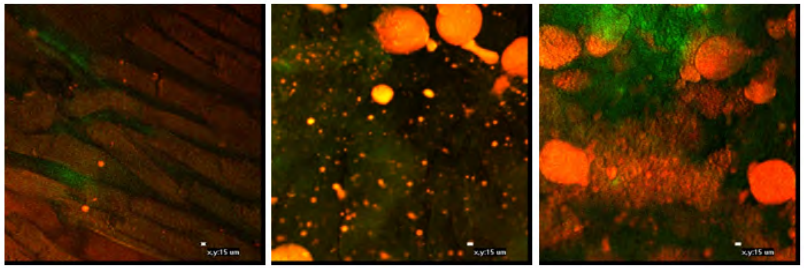
Modifications in process conditions had no influence on cooking loss, which can be explained by identical pH-value for all modifications (pH=5.6). Water content was 64.5 %. Process conditions had influence on moisture loss as well as soluble protein content, especially by comparing Tatar-like cut meat with minced and minced + mixed meat (Fig. 1). Colour measurement showed no differences [data not shown]. Comparing CLSM-images, differences between process conditions are obvious due to a varying protein and fat distribution (Fig. 2). After mincing and especially after mixing, fat is overhead the protein or rather the muscle fibres.

Considering histological examination (Fig. 3), already displayed differences from analyses of moisture loss/WHC, soluble protein content and CLSM, are also present. The use of further methods to analyse the amount of "meat-batter-like"-structure and so meats' destruction is possible; additional experiments are ongoing.

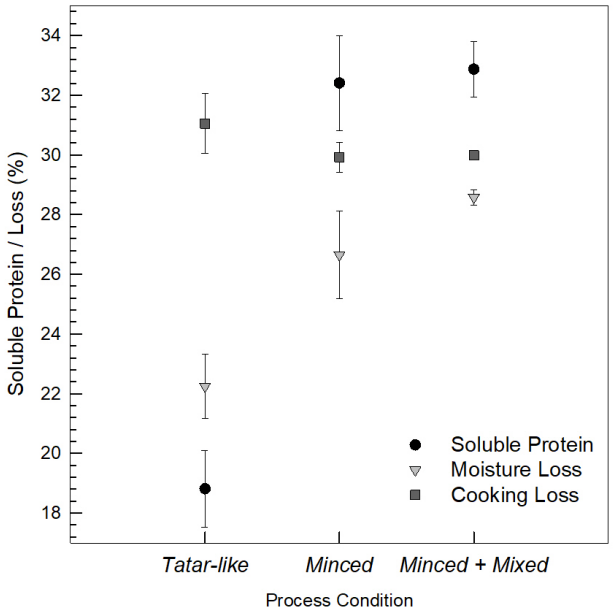
Conclusion

Since it is possible to analyse meats' destruction besides histology with further methods such as WHC, CLSM and soluble protein, industrial more applicable methods are available to analyse the "meat-batter-like"-structure.

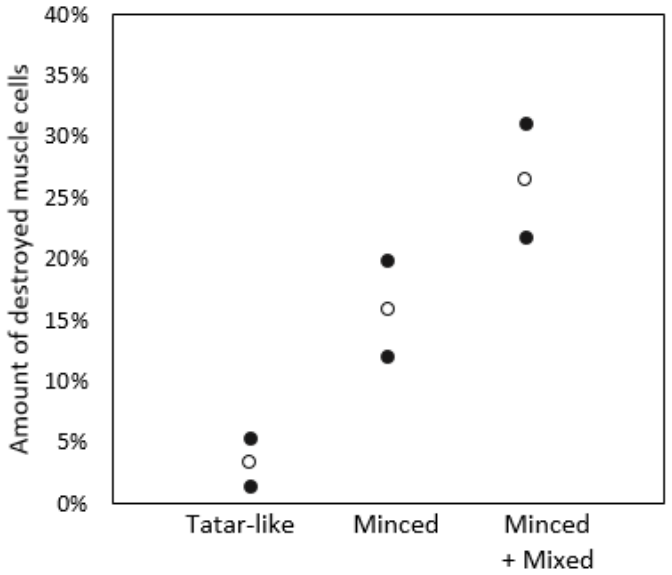
Notes



Confocal laser scanning microsopy images
Figure 2: CLSM images of Tatar-like (left), minced (middle) and minced + mixed (right) process conditions.



Moisture and cooking loss (%) as well as soluble protein content (%)
Figure 1: Moisture and cooking loss as well as soluble protein (%) (n=3) from Tatar-like, minced and minced + mixed process conditions.



Amount of destroyed muscle cells (%) of different process conditions
Figure 3: Statistical evaluation of amount of destroyed muscle cells (%) of different process conditions with thresholds at confidence intervals of 98 %.

Notes