Physico-chemical characterisation of destructured zones in cooked hams

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Abstract

Destructured zones in cooked ham are still a common problem in the meat industry and the underlying factors are still not clearly identified. To gain basic information about the physical and chemical properties of destructured zones, 2×2 batches of cooked ham of 1 ton each were produced from *M. biceps femoris* and *M. semimembranosus* at two meat processing plants. After slicing (thickness: 1.5 mm), destructured and normal parts were sampled and subjected to further physical and chemical analyses. The destructured parts showed significantly brighter and less intense colour, higher myofibrillar fragmentation, lower hardness, and a slightly lower pH than the normal parts. Dry matter and crude protein content were higher while total and insoluble collagen content was lower in the destructured compared to normal parts. Some of these traits were also influenced by processing site and muscle ($P \leq 0.05$). Further studies should be performed in order to identify the causes for the increased fragmentation and to develop counteracting measures.

Introduction

Destructured areas in cooked cured hams are a well-known problem in the meat processing industry. The defect often results in considerable economic losses for meat processing plants in different European countries. A recent study conducted in seven smaller and larger Swiss meat processing plants revealed that 7-8 % of the cooked cured ham slices are affected by different defaults and up to a third of the losses are due to destructured areas (Hugenschmidt *et al*., 2007).

The aim of the present part of a larger project was to characterise the destructurations by applying different chemical and physical analyses in order to identify potential causes of the defect and finally help to reduce it.

Material and methods

Sampling: Samples of cooked cured hams originated from two large Swiss meat processors. Each of them produced two batches of cooked cured ham of about one ton each according to their own recipes and using *M. biceps femoris* (BF, silverside) and *M. semimembranosus* (SM, topside), respectively. Finally, the ham bars were sliced (thickness: 1.5 mm) by the processors, packed under controlled atmosphere and stored at 5 °C until analysed. The raw material originated from Swiss meat producers and Swiss slaughterhouses exclusively.

Physical methods: Samples of normal and destructured areas in cooked cured hams were always taken from the same individual muscle (n = 87). Hardness was characterised by pressing a standard needle into the sample (ham slice, thickness: 1.5 mm) with constant speed and measuring the force at 1 mm penetration (Universalprüfmaschine Z2.5/TN1S, Zwick, Ulm, Germany). The pH value was determined in 2-3 g homogenised sample using a glass electrode (Metrohm, Herisau, Switzerland). Colour measurements were conducted with a spectrophotometer (Spectroshade, MHT, Switzerland) on a circular sample (height: 3 mm; diameter: 7 mm) placed in an absorbing fixture. The determination of the myofibrillar fragmentation index (MFI) was performed according to the method of Culler et al. (1978).

Chemical analyses: Within a muscle strand of a cooked cured ham slice, the same amount of normal and destructured sample was taken for chemical analyses. Several samples from the same batch were pooled in order to obtain enough material to perform all analyses leading to 19 pooled samples of normal and destructured cooked cured hams, each. The sample material was homogenised and lyophilised before further analyses were performed. Contents of dry matter, crude ash, crude protein, crude fat and sugar were analyzed as described by

Hadorn et al. (2008). The connective tissue content was calculated from the hydroxyproline content, as described by Arneth and Hamm (1971).

Statistical analysis: For the data analyses a linear mixed model with the fixed factors defect (normal / destructured), muscle (BF / SM) and meat processor (A / B) and the random factor sample was calculated using Systat (Systat 12, 2007).

Results and discussion

Physical properties: The results of the colour measurement show, that L*- and b*-values of the destructured areas were significantly higher than in the normal zones (Table 1). In contrast, a*-values were lowered in the destructured areas. Thus, destructured zones of cooked cured ham show a brighter and less intense red colour.

The pH values in the destructured areas were slightly, nevertheless significantly lower in comparison to the normal zones (Δ = 0.07 pH-units). The texture analyses revealed an increased MFI (+ 26.7 %) and a reduced hardness (- 37.5 %) in the destructured areas. The soft texture of these zones may derive from a more intense proteolytic activity during meat ripening as some ripening enzymes are known to be more active at a low pH. Furthermore, a low final pH may lead to a brighter colour due to a more intense denaturation of muscle proteins (cp. higher MFI), notably if the pH decline occurs rapidly (which could not be determined in this investigation).

Table 1. Physical properties of destructured and normal zones in cooked cured hams

	norm.	dest.	p-value
L* (n = 87)	55.9	66.6	0.000
a* (n = 87)	13.6	9.6	0.000
b* (n = 86)	9.5	10.1	0.014
pH (n = 87)	5.95	5.88	0.000
MFI (n = 37)	61.7	78.1	0.000
Hardness [N] (n =87)	0.08	0.05	0.000

n = number of normal / destructured samples

[1] connective tissue protein = 8 × Hydroxyproline (Hyp)

[2] collagen-free muscle protein = CP - CTP

Table 2. Chemical properties of destructured and normal zones in cooked cured hams (g/kg fresh[#] or dry* matter, respectively); n=19

	norm.	dest.	p-value
Dry matter (DM) [#]	286	293	0.104
Crude protein (CP)*	795	814	0.002
Crude fat (CF)*	79.9	79.5	0.913
Crude ash (CA)*	111	101	0.102
Sugar*	26.8	24.2	0.034
Hyp total*	3.30	3.04	0.000
Hyp insoluble*	2.12	1.88	0.000
CTP[1]	26.4	24.3	0.000
CFMP[2]	769	789	0.000

Chemical properties: The dry matter content in the destructured areas was 2.3 % higher than in the normal zones, which may be due to a reduced water binding capacity in the raw meat of the defect areas. Also crude protein contents in the destructured areas were increased by 2.3 % (4.6 % related to fresh matter) as well as those of some amino acids (data not shown).

Crude ash and sugar were 10.1 % and 10.6 % lower in the defect areas than in the normal zones, respectively. This could also be explained with a reduced water binding capacity in destructured cooked cured hams resulting in a decreased binding of the brine, containing sugars and salts.

Normal areas showed a 8.6 % lower content of hydroxyproline than the destructured zones. The insoluble collagen content in the normal areas was even 12.8 % higher than in destructured areas. This is emphasized, because the insoluble connective tissue is thought to be responsible for the "background toughness" at least to some part.

The statistical analyses revealed that apart from the defect (normal/destructured), also the meat processor (A/B) as well as the type of muscle (topside/silverside) had a significant influence on cooked cured ham composition.

Conclusions

From the present study it can be concluded that destructured areas in cooked cured ham differ in several physical and chemical properties from normal zones. Certainly, the bright colour is their most apparent attribute. Also a soft, almost paste-like texture is highly characteristic for the defect.

The slightly lower pH value and the increased MFI of the destructured areas may explain their brighter colour and softer texture as well as the higher dry matter content compared to the normal areas. The low content of insoluble collagen could partly explain the paste-like texture of the defect zones. The cause for the higher content of fat-free-connective-tissue-free-meat remains unclear and needs further examination. To some part this effect could be due to the lower water holding capacity as well as a reduced uptake of the brine and its components (e.g. sugar, salt).

The different analyses of cooked cured hams implicate a wide variation between normal and defect areas, between the two meat processors as well as between the two types of muscle used. Therefore, when comparing frequency and degree of destructurations in cooked cured ham, muscle type and technological processes should also be considered.

References

Arneth W. and Hamm R. (1971): Untersuchungen zur Methodik der Hydroxyprolinbestimmung in Fleisch und Fleischwaren. *Fleischwirtschaft* **10**, 1523.

Chatelain Y., Guggisberg D., Dufey P.A., Vergères G. and Hadorn R., 2007: Farbmessung an Fleisch und Fleischerzeugnissen. *ALP science* **507**, Agroscope Liebefeld-Posieux, Bern, pp. 1-23.

Culler R.D., Parrish F.C., Smith G.C. and Cross H.R. (1978): Relationship of myofibril fragmentation index to certain chemical and sensory characteristics of bovine longissimus muscle. *Journal of Food Science* **43**, 1177-1180.

Hadorn R., Eberhard P., Guggisberg D., Piccinali P. and Schlichtherle-Cerny H. (2008): Effect of fat score on the quality of various meat products. *Meat Science*, doi:10.1016/j.meatsci.2008.03.020.

Hugenschmidt G., Hadorn R., Suter M., Scheeder M. and Wenk C. (2007): Anteil und Schweregrad destrukturierter Zonen in Kochschinken. *Fleischwirtschaft* **87**(9), 100-103.

Systat (2007): Systat, Version 12, Systat Software Inc., San Jose, California, USA.