IMPACT OF COLOUR DIFFERENCES OF PORK AND BEEF ON THE QUALITY OF RAW FERMENTED SAUSAGES

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Abstract - The colour of meat is an important meat quality parameter, but only few studies have been published showing the influence of differing meat colour on meat products. We sorted pork and beef in the colour groups dark, mean and pale according to the lightness (L*) values determined 24 h (pork) or 48 h (beef) after slaughter. After processing to raw fermented sausages the products were ripened for 28 days. The colour groups significantly affect the L* and electrical conductivity (EC) values in pork and beef and the redness (a*) and pH in beef. However, on the sampling days 7, 14, 21 and 28 of storage no differences of the L*, a*, pH, a_w, as well as microbiological and TBARS results could be found between all sausages. In contrast to this did the significant differences between the pork and beef with regard to the L*, a*, pH and EC values result in significant differences of the L* and a* values of the sausages at all sampling days and the a_w, microbiological and TBARS results on some days of ripening. A reason for these varying effects on the sausages might be the higher L* variation between the species than within the species.

Key Words – meat, lightness values, processing

I. INTRODUCTION

Factors like pH value, electrical conductivity, drip loss or colour are important parameters of raw meat that are frequently assessed to analyze meat quality. Meat colour could be easily determined and is therefore an appropriate quality parameter, before meat is further processed, for example, to raw fermented sausages. As meat sometimes shows colour alterations like pale, soft and exudative (PSE) meat the use of this PSE meat could result in lower fat content, reduced product yield, and higher lipid oxidation of sausages [1, 2]. As only few studies have been studied that investigated the impact of meat colour on the quality of products from this meat, the aim of our study was to evaluate the influence of meat colour of pork and beef on the quality of raw fermented sausages produced with this meat. In this study we used not specifically PSE and DFD meat, as these meat alterations are quite rare. Within the study also the effects of the meat species on the sausages were considered, as pork and beef principally show clear colour variation.

II. MATERIALS AND METHODS

Shoulders of 25 bulls and loins of 44 pigs were collected 24 h (pork) or 48 h (beef) after slaughter (p.m.) from two commercial slaughterhouses. On the collection day the lightness (L*), redness (a*), pH and electrical conductivity (EC) values were determined with a colorimeter (Minolta CR 400, Konica-Minolta GmbH, Langenhagen, Germany). Subsequently the meat was cut in pieces (ca. 3 x 3 cm), individually packed in plastic bags, vacuumed and stored at -20°C up to 6 months until sausage production. The mean values (LSM) and standard deviation (SD) values of the muscle L* values were considered to sort the meat into the colour groups dark (LSM - 1 SD), mean (LSM) and pale (LSM + 1 SD) prior to sausage production. In three independent trials for the sausage production dark, mean and pale frozen meat was thawed for 15 min and minced (10 mm cutting plate). The minced meat (69.0 %) of each colour group was mixed with pork backfat (29.5%), glucose (0.15 %), dextrose (0.1 %), the starter culture mixture (Bactoflavour BFL-F05 and SafePro, Chr. Hansen GmbH, Pohlheim, Germany) and curing salt (2.0 %, CS, 99.5 % NaCl, 0.5 % $NaNO_2$). All mixtures were separately homogenized in a cutter for 2 min and subsequently filled into collagen casings (Naturin R2 (50 mm diameter), Naturin-Viscofan GmbH, Weinheim, Germany). The sausages were ripened in a climate chamber for 28 days. On days 1, 7, 14, 21 and 28 samples (10 g) were removed from two sausages per group for microbiological analysis of total viable count number (TVC, in $\log_{10}$ colony forming units (cfu)/g sausage)). The L*, a* were determined on the cutting surface of the sausage after 30 min of blooming and the samples were homogenized (Grindomix GM 120, Retsch GmbH, Haan, Germany). The homogenates were either directly used for pH and a_w value determination, or frozen in plastic bags (-20 °C) for analysis of thiobarbituric acid reactive substances (TBARS). For statistical analysis a general linear model was used (Statistica 10.0, StatSoft, Hamburg). The model considered the fixed effects of the colour group (pale, mean, dark), the species (beef, pork) and their interaction.

P≤0.05 was considered significant. In the following section the effects of the species and colour group*species interaction are presented.

III. RESULTS AND DISCUSSION

The pork and beef showed, as expected, significantly (P≤0.05) different L* values after sorting of the meat according to the L* values with the highest values in the pale, followed by the values of the mean and dark pork and beef. In beef, the a* values were higher (P≤0.05) in pale meat compared to the mean and dark beef. In pork no a* differences could be found between the colour groups (Fig. 1 A). The pH values were not influenced by the colour group in pork. In beef the dark meat had significantly (P≤0.05) higher pH values in comparison to the mean and pale meat. The EC results of the pale beef and pork were significantly (P≤0.05) higher in comparison to the dark meat. The EC values of the mean meat were in-between differing (P≤0.05) either from the EC results of the pale pork, or the dark beef (Fig. 1 B). The meat species influenced all investigated parameters with lower (P≤0.05) L* and higher a*, pH and EC values in the beef compared to the pork (Fig. 1 A and B).

The impact of the colour group on the other meat quality parameters mainly agree with (correlation) results in pork [3, 4] and beef [5, 6, 7]. The missing effect on the pH and a* values in pork is contradictory to these publications. A reason might be that the L* differences between the colour groups in our study are too low. The significant differences between the pork and beef are mainly supported by studies that analyzed either pork, or beef [3, 4, 5, 6, 7, 8, 9]. The colour differences can be related to the myoglobin content in the meat, with probably higher concentrations in the beef than pork [8, 10].

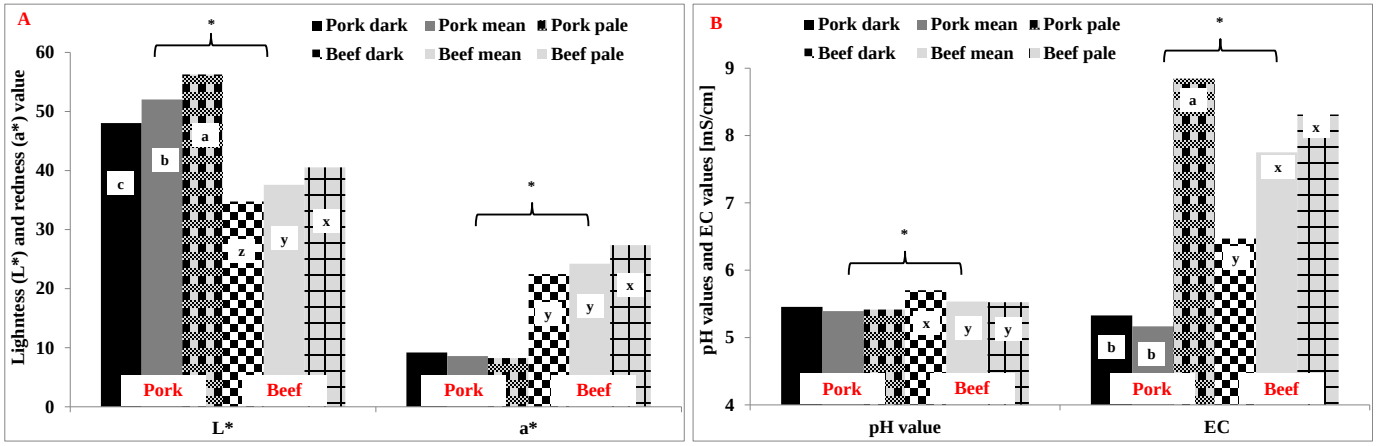

Figure 1. Mean values of the lightness (L*) and redness (a*) (Figure A, left) as well as the pH and electrical conductivity (EC) results (Figure B, right) of pork and beef measured 24 h (pork, N = 44) and 48 h (beef, N = 25) after slaughter after sorting the meat according to the L* values determined at these times in dark, mean, and pale meat; *Effect of the species; ^{abcxy}Effect of the colour group in the pork (abc) or beef (xyz); P≤0.05 was considered significant

The raw fermented sausages produced with the pale, mean and dark pork and beef showed no differences of the L*, a* pH and a_w values at all days. These results partly agree with the data of Townsend et al. [1] who also found no differences of the L*, a*, pH, a_w results between sausages produced with pale (PSE) or normal meat. Honkavaara et al. [2] also found no differing pH values of PSE and normal sausages. With regard to the meat species the pork sausages had at all days significantly (P≤0.05) higher L* and lower (P≤0.05) a* values in comparison to the sausages produced with beef. The pH and a_w values of the beef and pork sausages showed similar results, except for the higher (P≤0.05) a_w values of the beef compared to the pork on days 7 and 28 (Table 1).

Table 1. Mean values and standard errors of the means (SEM) of different quality parameters analyzed during storage of raw sausages depending on the colour group and the species (S) of the slaughtered animal used for production of the sausages (N =3)

Item	Pork			Beef			SEM	S
	Dark	Mean	Pale	Dark	Mean	Pale		
L* day 1	58.0	57.4	58.3	42.8	44.5	44.8	1.2	*
L* day 7	64.3	64.4	65.2	43.8	45.3	45.5	1.6	*
L* day 14	60.3	60.6	61.9	41.6	43.1	43.6	1.5	*
L* day 21	58.5	58.3	59.1	39.7	41.0	42.3	1.5	*
L* day 28	56.5	56.6	58.0	39.3	40.2	40.7	1.3	*
a* day 1	7.7	7.5	6.5	17.9	16.0	16.8	0.8	*
a* day 7	9.6	9.0	8.8	20.7	21.0	20.6	0.9	*
a* day 14	10.1	9.7	9.1	20.3	20.8	20.1	0.8	*
a* day 21	10.6	10.4	10.0	20.0	19.9	19.5	0.7	*
a* day 28	11.5	11.1	10.6	19.7	20.2	19.9	0.7	*
pH day 1	5.3	5.3	5.3	5.2	5.2	5.2	0.02	NS
pH day 7	4.9	4.9	4.9	4.9	4.8	4.9	0.03	NS
pH day 14	5.0	5.0	5.0	5.1	5.1	5.0	0.03	NS
pH day 21	5.1	5.1	5.0	5.0	4.9	5.0	0.03	NS
pH day 28	5.2	5.2	5.1	5.0	5.0	5.0	0.03	NS
a_w day 1	0.96	0.97	0.96	0.97	0.97	0.97	0.001	NS
a_w day 7	0.94	0.95	0.94	0.94	0.94	0.95	0.001	*
a_w day 14	0.92	0.92	0.92	0.92	0.92	0.93	0.001	NS
a_w day 21	0.90	0.90	0.90	0.90	0.90	0.90	0.002	NS
a_w day 28	0.86	0.86	0.87	0.88	0.88	0.88	0.003	*

The effects of the meat species (S) are presented (* = significant ($P \leq 0.05$); NS = not significant ($P > 0.05$))

The colour results are in accordance with the clear differences between the pork and beef, presented in Figure 1. The small differences of the a_w values should not be overestimated. It is interesting to note that the absolute L* values of the pork and beef sausages were clearly higher after processing in comparison to the raw pork and beef L* results. However, the a* results were only higher in the pork but lower in the beef sausages in comparison to the appropriate raw meat a* values. No impact of the meat colour on the TVC and TBARS results of the pork and beef sausages could be determined in the present study (Table 2). This is partly in contrast to the study of Townsend et al. [1] who found higher TBARS values in PSE sausages. The authors argue that the lower pH values of the raw PSE meat increased the TBARS contents. As in the present study the pH values did not differ between the colour groups in pork and only slightly in beef, no TBARS might be expected. With regard to the TVC we unfortunately did not analyse the TVC on the raw meat, but differences might be expected, because Faucitano et al. [11] showed that the TVC results of raw pork of different quality like PSE or DFD meat clearly differs with higher values in dark and lower in the PSE pork. Despite these possible TVC differences of the raw meat it has to be considered that high concentrations of starter bacteria were added to the sausage mixture before ripening and that these bacteria might overlap these initil TVC differences in the raw pork and beef. The meat species has an inconsistent effect on the TVC and TBARS results. The TVC results were significantly ($P \leq 0.05$) lower in the beef compared to the pork sausages on days 1, 21 and 28 but not on the other days. Pork sausages showed on day 1 lower ($P \leq 0.05$) and on day 28 higher ($P \leq 0.05$) TBA results than the beef sausages. The TBARS values of the pork were also tendentially ($P < 0.1$) higher on days 14 and 21 of storage compared to the beef (Table 2). The missing significance of the latter results might be due to the high variation of the TBARS values. As the TBARS content is an indicator for oxidation of mainly unsaturated fatty acids, the higher results in the pork can be explained by the higher percentages of these fatty acids in pig compared to cattle meat [12]. An effect of the pork backfat used for sausage production could be excluded, as the same fat batch was used for all sausages.

Table 2. Mean values and SEM of different quality parameters analyzed during storage of raw sausages depending on the colour group and the species (S) of the slaughtered animal used for production of the sausages (N =3)

Item	Pork			Beef			SEM	S
	Dark	Mean	Pale	Dark	Mean	Pale		
TVC day 1	7.1	7.0	7.1	6.6	6.6	6.7	0.1	*
TVC day 7	7.9	7.6	7.9	7.6	7.5	7.6	0.1	NS
TVC day 14	7.2	7.2	7.3	7.1	7.3	7.3	0.1	NS
TVC day 21	8.0	7.6	7.8	6.6	7.0	6.5	0.1	*
TVC day 28	7.6	7.7	7.6	7.3	7.3	7.1	0.1	*
TBA day 1	0.17	0.25	0.16	0.28	0.36	0.39	0.02	*
TBA day 7	0.33	0.19	0.17	0.28	0.18	0.31	0.02	NS
TBA day 14	0.43	0.32	0.27	0.26	0.21	0.21	0.03	NS
TBA day 21	0.48	0.40	0.32	0.26	0.21	0.30	0.03	NS
TBA day 28	0.40	0.45	0.42	0.21	0.16	0.24	0.04	*

TVC = total viable counts in $\log_{10}$ colony forming units/ g sausage; TBA = thiobarbituric acid reactive substances in µg malondialdehyde/g sausage; the effects of the meat species (S) are presented (* = significant ($P \leq 0.05$); NS = not significant ($P > 0.05$))

IV. CONCLUSION

Pork and beef showed, after sorting according to the L* values, species dependent differences of some meat quality parameters. These meat colour differences did result in similar colour, pH, a_w, TVC and TBARS values of sausages produced with this meat. In contrast to this did the differences of the L* and a* values between pork and beef result in clear differences of the sausages processed from this meat. A reason for these varying effects on the sausages might be the higher L* variation between the species than within the species indicating that higher colour differences within pork or beef might also result in varying colour of sausages produced with this meat.

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