THE EFFECT OF RESTING ON THE DISTRIBUTION OF SALT DURING THE PRODUCTION OF DRY-CURED HAM

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Background

Dry-cured ham is a traditional product in Norway, originally processed over a long period at the farms. During the last decades the production became commercialised. In order to produce cheaper hams, Norwegian dry-cured hams were turned into quickly produced products with large amounts of poorly distributed salt and very little, if any, dry-cured taste. Today, consumers demands have forced the Norwegian meat industry to initiate production of tastier and less salty dry cured hams. As the amount of salt is reduced it becomes increasingly important to achieve an even salt distribution through the ham. Salt diffuses very slowly through the ham, about 2-2,5 cm per week in meat (Hedrick et al., 1994), considerably slower in fat. Because the salt ions needs free water ions for diffusion, the diffusion will slow down and eventually stop as the ham dries. It is therefore important to allow the salt to distribute before drying. This can be done by keeping the hams refrigerated over a period of time (resting) before drying.

Objective

The intention of this study was to investigate the effect of resting on the distribution of salt in dry-cured hams.

Materials and methods

78 hams were included. Raw ham characteristics (weight, colour (CIELAB), pH, subcutaneous fat (calliper) and shape/size) were determined non-destructively. The hams were dry-salted at 1-4°C for 30 days. Half of the hams were placed for drying at 15°C immediately after salting. The rest of the hams were divided into two groups and rested at 1-4°C for two or five weeks before drying, respectively.

Salt distribution was investigated by computerised tomography (Frøystein et al., 1989) after one and three weeks of drying (the latter only after none and two weeks resting). The tomograms (X-ray pictures) (fig.1) obtained were used to evaluate the salt distribution of the hams. To analyse the tomograms four methods were developed, as no standard methods were available. These included determination of salt content near the bone and at the meat surface, a salt profile between these two points and histograms of salt distribution in the cross-section. Obtained results were analysed statistically in Minitab (Minitab, 2000) using GLM and Tukey's test. The influence of raw ham characteristics on uptake and distribution of salt were analysed using Stepwise regression in Minitab.

For further details please refer to Thauland (2002).

Results and discussion

Raw ham characteristics are given in table 1. All hams were small and lean, most had a normal pH between 5,4 and 6,0 in SM and a bit higher in GP. In general, the salt content of the hams increased as the hams became smaller (p=0,000) and leaner (p=0,016). pH and colour was not found to affect uptake and distribution of salt. This could be explained by the small pH range of the hams. Gou et al. (2002) found water transfer inside green hams during drying at 5°C unaffected by the initial meat pH. Adapting the salting time to ham parameters like weight or size and fat content (subcutaneous or other) may help producing hams of equal salt content and maybe also with a better salt distribution.

Hams rested for two or five weeks had more salt near the bone than unrested hams, indicating a better salt distribution in rested hams. The difference was, however, smaller after three weeks of drying than after one week. This could be caused by the missing data of hams rested for five and dried for three weeks, but also suggest a slow salt diffusion in the hams prevails during drying, equalising the salt content in the hams. At the meat surface there was a tendency towards lower salt contents in hams rested for one week, probably due to the diffusion away from the surface and into the hams. Hams without resting had a steeper salt profile between surface and core than rested hams after one week of drying (explained variance 68%).This indicates a better salt distribution in rested hams.

Resting did not affect salt content of the hams; this was expected as the hams rested at high RH (relative humidity) preventing water to evaporate from the hams. The salt content differed between and within muscles. This was also found by Pérez-Alvarez et al. (1997). The salt distribution in hams of different resting time is illustrated in figure 2. Hams with resting had a better salt distribution, especially significant after one week drying, than hams without resting. This was confirmed statistically: Areas with 2-6% salt (medium grey colour code) were smaller in hams with resting than in hams without resting (P_1=0,000 after one week drying, P_3=0,017 after three weeks of drying). In agreement, areas containing 6-9% salt (framed, dark grey colour code) were larger following resting (P_1=0,000 and P_3=0,016). Also the areas with 9-18% salt are smaller in rested hams (P_1=0,013). The salt has diffused from areas of high salt content to areas with less salt, which is from the outer areas and towards the centre of the ham. The difference between two and five weeks resting was quite small. This suggests that much of the total effect of resting upon salt distribution is achieved after two weeks resting. A more accurate conclusion would perhaps be achieved with data from hams rested five and dried three weeks. Either way, rested hams have a more even salt distribution than hams without resting. The differences between hams with and without resting increased during drying. In addition to better salt distribution, this may also be an effect of increased total salt content as the water content decreases.

Conclusion

Resting the hams after salting but before drying resulted in hams with better salt distribution than hams without resting. Resting for five weeks resulted in a better salt distribution than resting for two weeks, but much of the total effect was achieved within the first two weeks. However, little is known of the changes during drying and further studies are needed.

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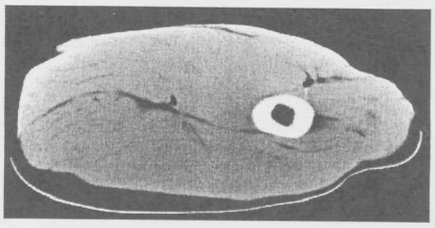

Fig.1 A typical tomogram of a ham with salt gradients. The saltier the meat, the lighter grey the meat is coloured. The almost black area between the meat and the white surface line is fat and connective tissue. Intermuscular fat and connective tissue also appear almost black. The thin white line indicates the surface skin. The "eye" is the bone. The black area surrounding the cross-section is air.

Tab.1 Descriptive statistics of ham meat quality characteristics

Characteristic	n	Mean	S.D.	Min	Max
Ham weight (kg)	78	10,30	1,30	7,34	12,92
pHu *Glueus profundus* (GP)	78	5,88	0,26	5,36	6,72
pHu *Gluteus medius* (GM)	78	5,64	0,22	5,34	6,43
pHu *Semimembranosus* (SM)	59	5,60	0,18	4,96**	6
Subcutaneous fat thickness (mm)*	78	10,41	2,78	6	18
Length as circumference (cm)	78	86,88	4,34	75	97
Width as circumference (cm)	78	71,76	3,38	62	78
Japanese colour grades	78	3,08	0,41	2	4
Lightness (Minolta L*)	78	52,41	2,87	41,4	57,41
Redness (Minolta a*)	78	10,69	2,04	5,06	16,97
Blueness (Minolta b*)	78	7,00	1,87	2,52	10,46

* All hams were lean with very little visible inter- and intramuscular fat.
** Outlier measurement, all other values over 5,3.

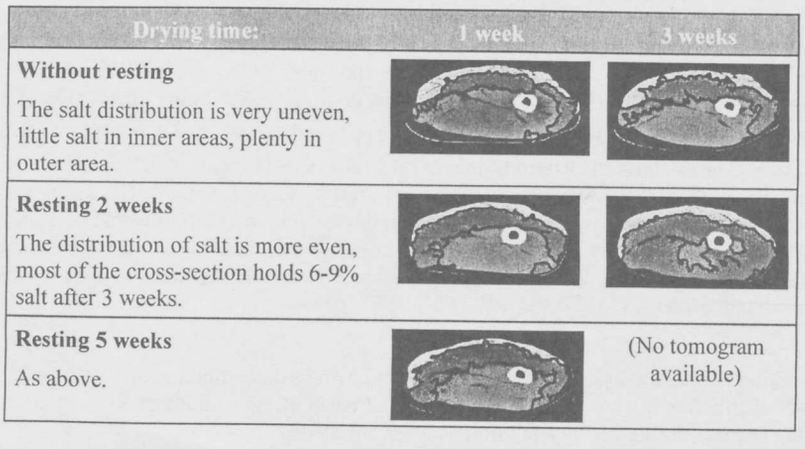

Fig.2 Tomograms showing three different hams, each rested differently. The framed dark grey area of the cross-sections contains 6-9% salt. The dark framed areas are actually red, but they appear dark gray in black and white prints.