THE EFFECT OF INTRAMUSCULAR FAT ON EATING QUALITY OF PORK DEPENDING ON END POINT TEMPERATURE

M. D. Aaslyng and Støier. S

The Danish Meat Research Institute, Maglegårdsvej 2, DK-4000 Roskilde

Background

Intramuscular fat (IMF) has for long been known to increase the tenderness of meat. However, the extent of the effect of the IMF has been different in different experiments which might indicate that the effect depends on factors like aging time, end point temperature etc. This leads to a theory that the IMF fat increases the robustness of the meat towards a rougher treatment.

Objectives

The objective of this study was to investigate the effect of IMF on the eating quality of pork, *longissimus dorsi* (LD) and *biceps femoris* (BF), cooked to two end point temperatures to find out whether the IMF would increase the robustness of the meat. In LD the effect of fatty acid composition was also investigated.

Materials and methods

Biceps femoris: BF from two groups of slaughter pigs (DLY), one group fed with roughage (IMF 2.3%, std. 0.6) and one with feed without roughage (IMF 3.3%, std 0.8) (n=20 per group), was excised from one side the day after slaughter and frozen at -18°C without further aging. The meat was cooked as whole roasts in the oven at a temperature of 140°C until the meat had an end point temperature of 65°C or 75°C respectively. A trained sensory panel conducted a sensory profile with the following attributes: Hardness at first bite, tenderness, chewing time, sour flavour, piggy flavour, colour (light to dark grey), uneven colour. On another piece of meat the juiciness was assessed as juiciness after 3 chews (juiciness 1), juiciness after 10 chews (juiciness 2) and juiciness when the sample is ready for swallowing (juiciness 3). The attributes were assessed on a 15-cm line scale from nothing (zero) to very much.

Longissimus dorsi: LD was excised from both sides of slaughter pigs selected at random at a Danish abbatoir. The loins were vacuum packed and frozen without further aging (-18°C). They were divided into three groups (n=20) of low (0.8-1.3%), medium (1.6%-2.0%) and high (2.3%-4.1%) IMF. The fatty acid composition of the intramuscular fat was determined by GC-FID after extraction. The meat was pan-fried as 2-cm thick chops until an end point temperature of 65°C or 80°C. A trained sensory panel conducted a sensory profile with the following attributes: Hardness while cutting, hardness at first bite, tenderness, fibrous, crumbliness, chewing time, chewing rest, roasted meat flavour, sour flavour, piggy flavour. On a separate piece of meat the juiciness was assessed after 3 chews and after 20 chews. The attributes were assessed on a 15-cm line-scale from nothing (zero) to very much.

Results and discussion

Biceps femoris: There were no interactions between IMF content and end point temperature meaning that the effects of IMF was the same for both temperatures. The content of IMF caused a significant decrease in hardness at first bite, chewing time and the piggy flavour as well as increased the tenderness (Table 1). The IMF had no effect on the juiciness, sour flavour or appearance at either end point temperatures. Higher end point temperatures increased the darkness (6.9 to 8.0) and the uneven colour of the meat (5.0 to 5.6) as well as decreased the juiciness (both 1, 2 and 3 from 6.7/6.8/6.8 to 4.6/4.6/4.5) and the sour flavour (3.9 to 3.6) irrespective of the IMF.

Table 1. Effect of intramuscular fat on the sensory profile of *biceps femoris*

	2.3%	3.3%
Hardness at first bite	7.8	6.3
Tenderness	7.0	8.7
Chewing time	10.4	8.9
Piggy flavour	3.5	2.6

IMF increased the tenderness of BF even though it is a rather tough muscle in which the tenderness to a large degree is determined by the amount of connective tissue. As the tenderness did not decrease when cooked to a higher end point temperature the effect of the IMF on robustness was not seen. IMF did not affect the juiciness and even though the juiciness decreased by an increase of the end point temperature, the IMF had no effect on robustness with respect to this attribute. IMF reduced the piggy flavour irrespective of the end point temperature.

Longissimus dorsi: There was no interaction between IMF and the end point temperature except for juiciness. For the other attributes the effect of IMF was the same irrespective of the temperature (Table 2).

Table 2. Effect of intramuscular fat and end point temperature on the sensory profile of *longissimus dorsi.*

	IMF			End point temperature	
	Low (0.8-1.3%)	Medium (1.6-2.0%)	High (2.3-4.1%)	65°C	80°C
Hardness while cutting	7.7[a]	6.9[b]	6.6[b]	6.6[a]	7.5[b]
Hardness at first bite	6.6[a]	6.3[b]	6.0[c]	5.9[a]	6.8[b]
Tenderness	5.7[a]	6.7[b]	7.3[c]	7.2[a]	5.9[b]
Fibrous	7.8[a]	7.2[b]	7.1[b]	7.1[a]	7.6[b]
Crumbliness	0.4	0.3	0.3	0.3	0.4
Chewing time	9.7[a]	8.9[b]	8.4[c]	8.5[a]	9.5[b]
Chewing rest	8.7[a]	7.9[b]	7.4[c]	7.6[a]	8.4[b]
Roasted meat flavour	7.2[a]	7.4[b]	7.6[b]	7.2[a]	7.6[b]
Sour flavour	5.4[a]	5.2[b]	5.0[b]	5.8[a]	4.6[b]
Piggy flavour	0.9	0.9	0.9	1.1[a]	0.7[b]

Different letters in the same line for IMF respectively end point temperature show significant differences.

IMF increases the tenderness and decreases the hardness, chewing time and chewing rest irrespective of the end point temperature. The tenderness increased over the entire interval of IMF even though the difference was largest from low to medium IMF.

As for the BF an increasing IMF content will decrease the sourness of the meat. As the intensity of piggy flavour was very low, no effect of IMF was seen on this attribute but the roasted meat flavour slightly increased from low to medium IMF whereas a further increase in IMF did not further increase the roasted meat flavour.

There was a significant interaction between IMF and the end point temperature for juiciness both after 3 and after 20 chews (see Table 3). At the low end point temperature there was no difference between IMF groups whereas the group with low IMF had a lower juiciness compared to the other groups at 80°C.

Table 3. Effect of IMF in LD on juiciness depending on end point temperature.

End point temperature	65°C			80°C		
IMF-group	Low (0.8-1.3%)	Medium (1.6-2.0%)	High (2.3-4.1%)	Low (0.8-1.3%)	Medium (1.6-2.0%)	High (2.3-4.1%)
Juiciness, 3 chews	4.7[a]	4.7[a]	4.6[a]	2.7[b*]	3.1[c]	3.0[c]
Juiciness 20 chews	8.6[a]	8.4[a]	8.5[a]	5.5[b]	6.0[c]	5.9[c]

Different letters in same line shows significant differences *: significance only P=0.06

The fatty acid composition was analysed and given as percentage of the total fatty acid content. The phospholipids are more unsaturated compared to the triglycerides. As the amount of phospholipids are almost the same for all samples the amount of triglycerides will vary with increasing amount of intramuscular fat. The degree of saturation will therefore be larger in the samples with a high amount of IMF compared to those with a low amount of IMF. To investigate the effect of fatty acid composition on the texture we did a PLS-regression with the absolute content of fatty acids (% fatty acid*content of IMF) as X-matrix and the texture attribute as Y-matrix for each of the three IMF-groups.

The composition of fatty acids did only explain 26% of the variation in the group with low intramuscular fat but it explained 44% of the variation in the other two groups. The fatty acid composition seems therefore to have a larger influence on the texture in the triglycerides compared to the phospholipids. Table 4 shows the correlation between measured and predicted value of the texture attributes predicted from the fatty acid composition for each of the three IMF-groups.

Table 4. Correlation (calibrated) between measured and predicted value of the sensory attributes predicted from the fatty acid composition.

	Hardness at cutting	Hardness at first bite	Tenderness	Chewing time	Chewing rest	Fibrous	Crumbleness
Low IMF 0.8-1.3%	0.45	0.47	0.44	0.46	0.50	0.49	0.46
Medium IMF 1.6-2.0%	0.67	0.72	0.85	0.88	0.88	0.82	0.81
High IMF 2.3-4.1%	0.75	0.75	0.80	0.81	0.82	0.85	0.83

If the amount of intramuscular fat is above a certain level, the fatty acid composition can predict around 80% of the variation in texture.

The regression coefficients showed that it was not a single or a few fatty acids, which influenced the texture. The picture was that the saturated fatty acids had a positive influence on the tenderness whereas the unsaturated fatty acids decreased the tenderness.

Conclusions

Intramuscular fat increases the tenderness in both LD and BF irrespective of end point temperature. The juiciness was only affected in the LD where there was an interaction as there was no difference in juiciness at 65°C whereas the meat with a low content of IMF was less juicy at the low end point temperature. The IMF increases the roasted meat flavour (in LD) and decreases the piggy flavour (BF) and the sour flavour (LD and BF). However, the difference was between the low and medium IMF group as no further increases in IMF did not further affect/change the flavour. The fatty acid composition influenced the texture especially in the medium and high IMF groups. The meat in this experiment w as not aged and the influence of IMF might therefore be smaller had the meat been aged for a longer time.

It can therefore be concluded that the IMF increases the general eating quality of meat irrespective of the cooking temperature.