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## **Consumer-relevant aspects of pork quality**

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**This paper deals with selected consumer-relevant problems with regard to pork quality which have to be solved to achieve high sensory and technological quality of meat. These problems are particularly PSE and DFD deviations, too low intramuscular fat content and too high polyunsaturated fat content of the backfat. Owing to intensive work done by international meat research, their causes and possible solutions are well-known today. Thus, a comprehensive optimization of the meat quality can be achieved through corresponding measures in the management of the animal production (genetics, feeding), in the pre-slaughter treatment of animals, as well as in the slaughtering and chilling technology. Nevertheless, it is often difficult to put these ideas into practice, because the market honours such efforts only hesitantly and sets rather quality harming signals through the still persistent orientation on carcass composition with unchanged preference of very lean carcasses.**

**KEY WORDS: DFD fault / fatty acids / intramuscular fat content / pigs / pork quality / PSE fault**

When concerning the term “meat quality” we have to distinguish between the two completely different levels. First one is quality of the product. In the case of pork that means the carcass composition as well as the quality of lean meat and adipose tissue. This

aspect of quality can be determined directly by looking at the product. The second one, the process quality, regards all the measures used in animal production and pre-slaughter treatment of animals, as well as the treatment of carcasses and meat. Of course the process quality influences the product quality, but it can be observed that consumers consider the process quality more and more as a value as such. Beyond that, the appreciation of a certain kind of meat depends not only on the objective quality, but also on psychological and social factors.

With respect to palatability and technological suitability we can try to form a model of a desired quality of pork:

- pink/reddish colour;
- good water-holding capacity during storage, processing and cooking;
- high tenderness, juiciness and species-typical flavour;
- no flavour deviations;
- high microbiological stability;
- white adipose tissue with solid consistency and high oxidative stability.

However, for a number of reasons this desired pattern of quality is not realized constantly. In particular the following complaints are often brought forward:

- regarding the sensoric field, consumers say the meat is too tough, too dry and tastes poor;
- meat processors and retailers complain about high chilling and cooking loss and a pale colour as well;
- sometimes the shelf life may be a problem;
- further complaints of processors concern flavour deviations, soft backfat and accelerated fat spoilage.

Searching for the reasons, these complaints can be assigned to typical quality complexes. Most important one is the PSE condition (pale, soft, exudative) being responsible for bad palatability, poor water-binding capacity and pale colour. In addition the so-called *Hampshire* effect may increase the cooking loss. The DFD condition (dark, firm, dry) deteriorates the flavour and the microbiological stability. A further important reason for poor palatability is low intramuscular fat content and – mentioned in passing – boar and certain feedstuff taint. Soft backfat and disposition to rancidity are mainly caused by high content of polyunsaturated fatty acids, more or less in combination with poor protection against oxidation.

### **PSE condition**

#### **Occurrence and reasons**

**PSE** fault is a quality deviation of pork which can occur more or less intensively. Although this problem has been a topic of research in many countries for more than three decades and a lot of improvements have been achieved, it has not been completely solved so far.

The principal condition in the development of PSE meat is low pH value, say <5.8, which coincides with a temperature close to body temperature so that proteins denature and membrane lesions occur. An increased light reflection, causing a pale colour of the meat, and a decreased water-holding capacity with increased loss of weight during storage, processing and retailing, and reduced tenderness and juiciness after cooking are the most important after-effects in practice. In particular, because of the poor water-holding capacity PSE gives rise to considerable monetary loss illustrated by the following example. In Germany about 44 million pigs are slaughtered per year. They provide about 300 million boneless loin which is about 6 euro/kg. Only 1% drip loss confined to the loin causes a monetary loss of 18 million euro/year. In reality, the drip loss during storage and retailing is much higher and concerns other cuts as well.

The rapid pH fall is due to an accelerated breakdown of ATP and glycogen, resulting in a fast accumulation of lactate and protons and in a rise of the muscle temperature. There is a variety of reasons for that derailment of post-slaughter muscle metabolism. Most important is an insufficient muscle metabolism caused by a genetic defect at the ryanodine receptor 1 (RYR1), which is characterized by an increased Ca<sup>++</sup> release from the sarcoplasmic reticulum [Martens 1998, Wendt *et al.* 2000]. A further important point is a forced secretion of typical stress hormones, the catecholamines. Causes are pre-slaughter stress (transport, lairage), a poor stunning method and a long interval between stunning and sticking. A third point is strong muscle contraction which occurs in the course of stunning and hanging during exsanguination. Finally, some factors directly influencing the body temperature have to be considered, *i.e.* strain prior to slaughter, scalding and inefficient chilling of the carcasses.

#### Prevention

In order to prevent or at least to reduce the intensity of PSE condition a bundle of measures has to be taken. Above all, it is necessary to eliminate the most important component of stress susceptibility, *i.e.* the genetic disposition to the *malignant hyperthermia syndrome* (MHS). This condition appears as the reaction to specific trigger substances, *e.g.* halothane, which had been used in the so-called halothane test until the

Table 1. Causes and meat quality traits as related to three malignant hyperthermia syndrome (MHS) gene types [Haas *et al.* 1997]

Trait	NN (n=150)	Nn (n=511)	nn (n=18)
Lean content - FCM (%)	55	54	60
pH, value (loin)	6.46	6.17	5.67
Frequency of pH, > 6.00 (%)	97	82	11
EC <sub>24</sub> (loin)	3.9	5.3	8.9
Frequency of EC <sub>24</sub> < 4.0 (%)	92	75	17

EC - electric conductivity.

nineties of the last century. Since detecting the „ryanodin receptor gene” and developing a practical gene diagnostic test based on the PCR technique [Fujii *et al.* 1991] the determination of all MHS genotypes is possible (*NN*, *Nn*, *nn*). Table 1 shows some selected meat quality traits, which verify the superiority of the homozygous-negative genotype (*NN*) to the heterozygous and the homozygous-positive genotype. However, the latter has a clearly higher lean content of carcass which is decisive for the final profit.

In one of our own experiments [Fisher *et al.* 2000] sires of six different lines were compared when mated to crossbred dams of *NN* line (Large White  $\times$  German Landrace). The lowest mean values of pH<sub>1</sub> were shown in the offspring by Pietrain *nn* sires (Tab. 2), followed by the only further crossbred containing the *nn* genotype (by Hampshire  $\times$  Pietrain sires). The most desirable values were found in the offspring by Hampshire or Duroc  $\times$  Hampshire sires. The pH<sub>1</sub> difference between the offspring by Pietrain *NN* and Pietrain *nn* sires amounted to about 0.2 (6.50 and 6.31, respectively) and corroborates very well the results of Matthes [2004]. The mean values of drip loss appeared in a nearly reverse order to the pH levels. Again the crossbreds containing the mutated gene (*n*) were found the worst. But in the lean meat content of carcass, Pietrain *nn* was found – at least numerically – superior to the offspring by sires of all the remaining lines. That is the reason why this genotype is still frequently used in practice.

Breeding efforts have to be accompanied by an improvement of pre-slaughter treat-

Table 2. Selected quality traits of *st. longissimus dorsi* and lean meat content of carcass (HGF4) in offspring ( $n=30-34$ ) sired by boars of different breeds when mated to Large White  $\times$  German Landrace dams [Fischer *et al.* 2000]

Trait	Ha	Du	Pi/W	Pi/nn	H $\times$ Pi/nn	Du $\times$ Ha
pH <sub>1</sub>	6.61 <sup>a</sup>	6.47 <sup>a</sup>	6.50 <sup>ab</sup>	6.31 <sup>b</sup>	6.41 <sup>ab</sup>	6.54 <sup>ab</sup>
EC <sub>24</sub> (mS/cm)	3.6 <sup>a</sup>	4.0 <sup>ab</sup>	4.3 <sup>ab</sup>	4.4 <sup>a</sup>	5.3 <sup>ab</sup>	4.0 <sup>ab</sup>
Drip loss (%)	1.4 <sup>a</sup>	1.2 <sup>a</sup>	1.5 <sup>a</sup>	2.4 <sup>b</sup>	2.6 <sup>b</sup>	1.6 <sup>a</sup>
Lean content (%)	53.9 <sup>ab</sup>	52.4 <sup>ab</sup>	54.6 <sup>ab</sup>	55.9 <sup>a</sup>	53.8 <sup>ab</sup>	51.0 <sup>b</sup>

74-78 h post mortem.

Ha - Hampshire sires.

Du - Duroc sires.

Pi - Pietrain sires.

<sup>ab</sup> Within row means bearing different superscripts differ significantly at  $P < 0.05$ .

ment and slaughter conditions with the following most important items:

- careful transport and lairage, sufficient lairage time (2-4 h);
- optimized stunning, short time interval between stunning and sticking, sticking in horizontal position;
- intensive chilling.

But, strangely enough, striking effects of housing and feeding animals cannot be expected.

## **DFD condition**

### **Occurrence and reasons**

Related to carbohydrate metabolism is also the pork quality fault **DFD**. But in contrast to the PSE the problem is not the too fast glycogen breakdown, but lack of glycogen in the muscle fibres at the time of slaughter. Thus, the normal ultimate pH from 5.4 to 5.8 cannot develop. The *post mortem* fall in pH stops at values above 6.0 and is responsible for most of the other typical alterations. So, a more closed structure of the muscle proteins causes a decreased light reflection and light scattering. In addition the diffusion of oxygen into the muscle tissue is impeded, resulting in a reducing formation of oxymyoglobin. The meat shows a dark purple colour which is rejected by the consumer. Much more important is the reduced microbiological stability of DFD meat. The lack of carbohydrate residues diminishes the “Maillard reaction” during roasting. That – in combination with the lack of lactic acid and other flavour compounds (e.g. inosine-monophosphate) – causes the reduced flavour intensity and a stale taste, which is absolutely undesirable. The only advantage is that DFD meat reveals a good water-holding capacity during storage and heating. At high pH values the  $\text{NH}_2$  groups of the proteins carry no positive loads ( $\text{NH}_3^+$ ), resulting in a reduced mutual attraction of the protein molecules and providing more space for water. Because of the better yield in processing of cooked ham, raw material with mild deviations to DFD (ultimate pH from 5.8 to 6.2) may even be preferred [Müller 1988].

A lack of nutrients, e.g. after uncommonly long transport and lairage time, may be a reason for the exhaustion of glycogen deposit in the muscle at the time of slaughter. But more important are high catecholamine secretion and strong muscle contractions, both caused by various pre-slaughter strain situations, in particular during lairage. However, the carbohydrate supply (the „glycolytic potential”) varies considerably from muscle to muscle [Fischer and Dobrowolski 2001]. The highest values could be found in muscles prone to PSE, *i.e.* in the loin (*M. longissimus dorsi*) and big muscles of the ham (e.g. *M. biceps femoris*, *M. gluteus medius*, *M. semimembranosus*). Very low levels are shown by some muscles of the neck (*M. semispinalis capitis*, *M. splenius*, *M. spinalis*), of the shoulder (*M. supraspinatus*, *M. infraspinatus*) and muscles lying next to the bone of the ham (e.g. *M. vastus intermedius*). These muscles are bound to show DFD fault after inappropriate handling of animals before slaughter. So, in the *M. semispinalis capitis* undesired high ultimate pH values can occur after a lairage time of even 12 hours [Fischer *et al.* 1986].

### **Prevention**

Prophylactic measures have to aim at the optimization of pre-slaughter treatment:

- careful transport;
- short lairage time ( 2-4 h);
- maintaining the social fattening groups during transport and lairage;

– application of easily digestible carbohydrates after long and stressful transport.

Only small effects can be expected from special breeding efforts and other farming measures. But it is generally accepted that the DFD condition is more a problem of beef than of pork. And its prevention can be organized more easily than the prevention from PSE.

### Intramuscular fat content

#### Definition

The term intramuscular fat (IMF) requires an exact definition. It refers to the total lipids within the muscle tissue, without fasciae, crude tendons and epimysium. The IMF consists of different groups of compounds. The first group concerns the membrane lipids (mainly phospholipids). Their content is rather small – about 0.5% – and fairly constant. Moreover, very small triglyceride droplets can be found in the muscle fibres. It is interesting that the thin connective tissue surrounding the muscle fibres and bundles (endomysium and perimysium) also includes numerous fat cells containing triglycerides. Their content and composition are highly variable. Above all, this part of the IMF influences the sensory traits positively. It is clear that considering the two main fractions of intramuscular lipids and their location, the finally determined content

Table 3. Means and ranges (minimum, 1st and 3rd quartile, maximum) for intramuscular fat content<sup>1</sup> of muscles in pigs (n=90) of different breeds [Fischer 1994]

Muscle	Mean	Min.	25 %	75 %	Max.
dt. rectus femoris	1.1	0.1	0.7	1.4	3.5
dt. adductor femoris	1.2	0.5	0.9	1.4	2.4
dt. psoas major	1.2	0.5	0.9	1.5	3.0
dt. longissimus dorsi (15 <sup>th</sup> th. v.)	1.3	0.3	0.9	1.4	5.2
dt. biceps brachii (caput long.)	1.8	0.5	1.4	2.0	3.4
dt. longissimus dorsi (5 <sup>th</sup> l. v.)	1.8	0.4	1.3	2.3	5.1
dt. gluteus medius	1.9	0.5	1.3	2.4	7.3
dt. longissimus dorsi (8 <sup>th</sup> th. v.)	2.0	0.5	1.5	2.5	4.1
dt. biceps femoris	2.1	0.9	1.5	2.4	5.0
dt. supraspinatus	2.4	0.8	1.9	2.9	5.0
dt. infraspinatus	2.4	0.4	1.9	2.9	4.7
dt. spinall	2.5	0.7	1.9	3.3	4.9
dt. semimembranosus	2.8	0.3	2.1	3.5	5.3
dt. serratus ventralis	4.1	1.9	3.0	4.9	8.2
dt. semitendinosus	5.2	2.2	3.7	4.1	21.2
dt. arpectus	5.8	2.7	4.5	4.8	12.2
dt. semispinalis capalis	7.0	2.9	5.4	8.2	17.4
Smallest significant difference (P<5%)	0.34				

<sup>1</sup> Fat to be ether extractable without preparatory hydrochloric-acid treatment.

depends on the analytical procedure. Only a preparatory treatment with hydrochloric acid increases the IMF estimate by about 0.4%. And the solvents used are decisive as to how many polar lipids will be extracted. Moreover, the IMF shows a wide topographic variation in the carcass. Examining 90 carcasses of different breeds Fischer [1994] found muscle-specific mean IMF values varying from 1.1 to 7% (Tab. 3). Just cuts, frequently used for short cooking (e.g. the loin), where a moderate IMF content for sensory reasons is needed urgently, show the lowest IMF levels. The most striking examples are the tenderloin (*M. psoas*) and the main part of the loin (*M. longissimus dorsi*). Summarizing, IMF content declarations are valid only when they refer to the location in the carcass.

#### Impact

Bejerholm and Barton-Gade [1986] suggest an optimum IMF range of 2.5-3.0% with respect to the eating quality, but that is currently not provided by the most of the modern pig breeds. As a long-term measure the IMF can be introduced as a target trait in the selection procedure. This is done in Switzerland. But it is a long way because of the relation of IMF content to the whole carcass fatness which is evident in most breeds. A short way is to use special breeds and (or) crossbreds. A typical breed suitable for that is Duroc which can provide high IMF content simultaneously with a comparatively low backfat thickness [Wood *et al.* 2004]. In our already mentioned experiment the crossbreds by Duroc sires showed the highest but also the widest-spread IMF values compared to the progeny of sires of remaining breeds that is in line with results of many other studies. And, as expected, the grilled meat samples from the offspring sired by

Table 4. Intramuscular fat content (*M. longissimus dorsi*) and sensory traits of grilled chops in offspring ( $n=30-34$ ) sired by boars of different breeds when mated to Large White  $\times$  German Landrace dams [Fischer *et al.* 2000]

Trait	Ha	Du	Pi-Pi <sup>2</sup>	M- <i>ms</i>	Max M- <i>ms</i>	Du:Ha
IMF (%)	1.63	2.11 <sup>a</sup>	1.46 <sup>b</sup>	1.36 <sup>b</sup>	1.58 <sup>b</sup>	1.78
Juiciness <sup>1</sup>	3.7 <sup>a</sup>	3.7 <sup>a</sup>	3.5	3.3 <sup>b</sup>	3.6	3.6
Tenderness <sup>1</sup>	3.9	4.2 <sup>a</sup>	3.8	3.4 <sup>b</sup>	3.9	3.8
Flavour <sup>1</sup>	3.4	3.7 <sup>a</sup>	3.3 <sup>b</sup>	3.2 <sup>b</sup>	3.5	3.4
Overall acceptability <sup>1</sup>	3.5	3.8 <sup>a</sup>	3.4 <sup>b</sup>	3.3 <sup>b</sup>	3.6	3.5

<sup>1</sup>6-point scale, 6 – the best.

Ha – Hampshire sires.

Du – Duroc sires.

Pi – Pietrain sires.

<sup>a,b</sup>Within rows means bearing different superscripts differ significantly at  $P < 0.05$ .

Duroc boars obtained the best sensory score (Tab. 4).

A further possibility to increase the IMF content is offered by nutrition. Sundrum *et al.* [2000] replaced the usual protein concentrate consisting of post-extractive soy-

bean meal, fish meal and synthetic lysine, methionine and threonine in the diet by other protein sources such as faba beans, potato protein, peas, and lupines without synthetic amino acids, so that in the diets containing lupines an adequate level of the most important amino acids was not completely ensured. This led not only to a lower daily gain and a longer fattening period, but also to a smaller *M. longissimus* cross-section area and less lean content of carcass. And, as an unexpected side effect, the IMF content increased more than twice. In a second experiment with similar diets a sensory evaluation was included, and the benefit of the higher IMF was confirmed by higher score [Hoppenbrock *et al.* 2000].

Only small effects on IMF content of pork can be expected from increasing the slaughter weight. Although such an influence has basically been found in several studies, the effect is not really striking. Even in our tests with live weights up to 160 kg the IMF content of *M. longissimus dorsi* did not improve at all. Only in the *M. triceps brachii* and *M. semimembranosus* a small rise could be observed (Fischer *et al.* unpublished).

It generally should be pointed out that, as with the PSE problem, there is an antagonism between desirable and undesirable traits. We still cannot consider the IMF separately from the fat content of the whole carcass. More adipose tissue of carcass is always accompanied by a smaller lean meat content. The profit a farmer obtains depends usually on the lean content. Thus, producing pigs with a higher IMF content is worthwhile only if he gets a financial compensation for the less lean meat per cent of carcass.

### **Fat quality**

Generally, in pig fat the saturated (SFAs), monounsaturated (MUFAs) and polyunsaturated (PUFAs) fatty acids are represented. Among the PUFAs there are certain long-chain fatty acids with three and more double bonds. Most of them are n-3 FAs, but their content is normally very small (overall 1-3 %). The FAs profile is most important in evaluating the quality of fat, and is interesting for two completely different reasons. Firstly, the FA composition shows an impact on various features of the product quality, such its technological attributes (firmness, storage stability), nutritive value and palatability. Secondly, the profile can be altered easily by measures available in animal production. That concerns in particular the PUFAs.

#### **Influences on fatty acid profile**

Monogastric animals consume all kinds of dietary FAs and incorporate them into the body fat. Moreover, pigs will synthesize FAs *de novo*. In that way palmitic, stearic and oleic acid emerge. Thus, the adipose tissue of the pig contains a mixture of the dietary, with the *de novo* synthesized FAs. The ability of a pig to retain fat as a whole is largely genetically determined. The higher it is, the more *de novo* fatty acids will be produced, and the more will these FAs dilute the incorporated dietary FAs. Thus, under



the same feeding conditions the fatter pig will show a smaller PUFAs concentration in the backfat than the leaner pig. How stringently these mechanisms work is illustrated by three regression lines showing the relation between PUFAs concentration in feed and backfat at different levels of lean meat content of carcass (Fig. 1). The basis for this calculation was a feeding trial with 8 different diets with PUFAs contents between

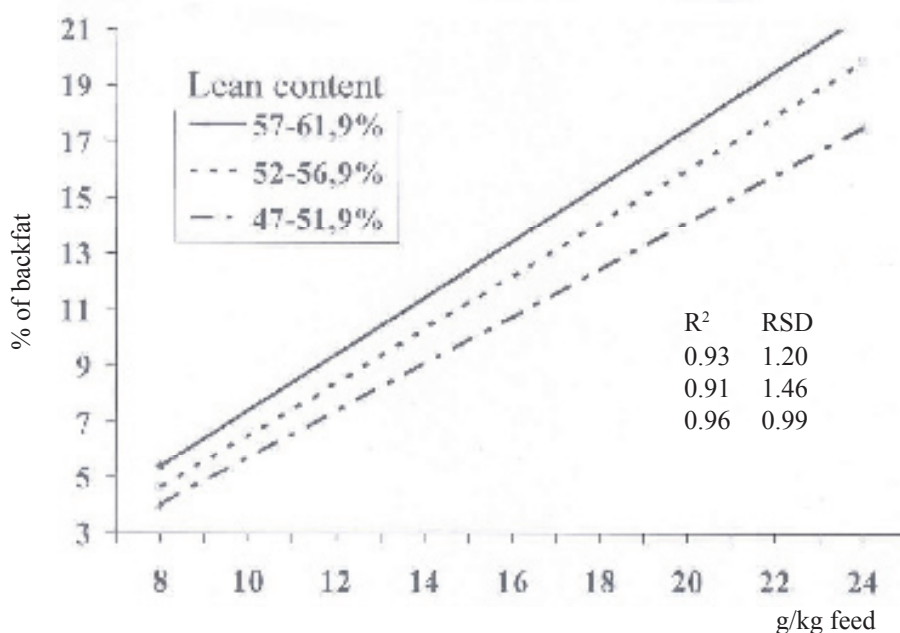


Fig. 1. Relation of PUFAs proportion (linoleic + linolenic acid) in feed and backfat at different ranges of lean meat content of carcass [Fisher *et al.* 1992].

11 and 26 g/kg at 13.5 MJ ME/kg [Fischer *et al.* 1992].

#### Impact of PUFAs

As the PUFAs percentage can be controlled so easily, it is of interest how their importance may be assessed. It is not amazing that the opinions are divided.

From the nutritional point of view, high PUFAs levels are regarded as desirable for health reasons. With regard to the diet as a whole, nutrition experts maintain that the relation PUFA/SFA should be higher than 0.45 and the ratio n-6 to n-3 be less than 4 [Department of Health 1994]. But the sensoric disadvantages of high concentrations of polyenic acids (in particular those with three and more double bonds), can be considerable, even in fresh meat.

In a feeding trial carried out by Kratz *et al.* [1999], a standard diet for four groups of fatteners was enriched with 2.5% supplement of tallow (from cattle), soybean oil,

olive oil or linseed oil. According to the specific FAs profiles of the supplements, four completely different FA profiles of backfat were found. Most striking was the rather

Table 5. Proportion(%) of back fat fatty acids after feeding various fat supplements to pigs at a level of 2.5% [Krats *et al.* 1999]

Fat supplement	SFA	MUFA	PUFA	
			C18:2	C18:3
Tallow	42.3	48.2	8.2	0.7
Olive oil	37.4	51.1	9.8	0.8
Soybean oil	39.0	39.4	18.4	1.8
Linseed oil	38.5	38.4	11.9	9.4

Table 6. Sensory evaluation of lean and lean + backfat samples after feeding various fat supplements to pigs (n=16-18) at a level of 2.5% [Fischer and Krats 1999]

Fat supplement	n	Juiciness'	Tenderness'	Flavour'	Overall acceptability'	Flavour'
			lean (dt. <i>longissimus dorsi</i> )			lean + back fat
Tallow	14	3.04	3.54	3.08*	3.20*	3.41*
Olive oil	14	3.04	3.45	3.14*	3.22*	3.58*
Soybean oil	18	2.89	3.22	2.88*	2.97*	3.03*
Linseed oil	17	2.90	3.31	2.41*	2.47*	2.19*

'4-point scale, 4 - the best.

\*Within columns means bearing different superscripts differ significantly at P<0.05.

high linoleic acid content in the soybean oil group (18.4%) and the extraordinary content of linolenic acid (9%) in the linseed group (Tab. 5).

Pork chops from these animals (*M. longissimus dorsi* with and without a rind of backfat) were kept deep frozen for 5-6 months and then grilled and evaluated by a taste assessing panel. In particular with respect to the flavour of combined meat/fat samples, feeding tallow and olive oil both appeared clearly superior to the other treatments (Tab. 6). The linseed group showed the poorest flavour due to the extremely high content of linolenic acid which undergoes fast oxidation due to its three double bonds. Thus, an increase of the concentration of n-3 fatty acids in the body fat of pigs needs the protection against oxidation by supplementing the feed with antioxidants on a high level.

From the technological point of view the adipose tissue with a firm consistency and good storage stability will be needed, particularly with respect to the production of dry cured products. Thus, the PUFAs content of the raw material should not exceed 14% for dry sausages that are to be stored moderately long, and 12% for products to be stored for a long time [Stiebing *et al.* 1993].

Possibilities of altering the quality of pig fat can be summarized as follows:

– the higher the intake of dietary FAs, the more they alter the FAs profile of animal

- fat;
- the more „non *de novo* FAs” (particularly PUFAs) are concentrated in the feed, the more the pig-specific FA pattern of body fat will be altered;
  - the leaner the carcass, the less FAs are provided by *de novo* synthesis, the less those FAs taken are diluted, and the higher is the dietary FAs content of body fat.

### Conclusions

Answering the question what good pork quality depends on, some major points can be presented, as follows.

- (1) There should be no quality faults, either PSE or DFD. This is ensured when 45 min *post mortem* the pH is clearly higher than 6.0, while 24 h *post mortem* ranges between 5.5 and 5.9. That can be achieved by using homozygous MHS-negative terminal crossbreds, optimizing pre-slaughter treatment, and slaughter and chilling technology.
- (2) For sensory reasons we need enough IMF, with an optimum value of 2.5-3% of the *longissimus dorsi* muscle. For the short-term the crossbreds with at least 50% Duroc blood can be used. Based on longer-term considerations special lines with higher IMF content should be established.
- (3) For most applications a limited proportion of PUFAs, and moreover a limited proportion of PUFAs with three or more double bonds will be needed. Apart from the special requirements for processing of long-stored dry-cured products, where the PUFA content in the outer layer of the backfat should not exceed 12%, less than 15% may be a reasonable compromise between the demands of nutritionists and technologists. This means, for example, that in pigs with about 57% lean content of carcass, 17 g PUFAs per kg feed should not be exceeded.

Production process aiming at accomplishing all these aims on a high level of reliability is not easy. What is needed is good will, common efforts of all people involved, and high-level organization. That works best in the frame of contracts as they are made in the production systems of various brand label programmes.

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