14TH EUROPEAN MEETING OF MEAT RESEARCH WORKERS
BRNO. CZECHOSLOVAKIA AUGUST 26th – 31st 1968

SECTION C 16

W. Sybesma and L. Zuidam

Research Institute for Animal Husbandry "Schoonoord"
Zeist, the Netherlands

Blood Enzymes and Meat Quality.

Introduction

Several kinds of investigations are intended to acquire information on meat quality in pigs before slaughter. Biopsies could be taken because muscle tissue is the originating tissue which eventually turns into meat. The disadvantage of this method is that it will hurt the animal too much for routine use. Blood research is used mostly because blood has been proved indicative of the situation in organs and other tissues in pathological conditions.

This is especially true for blood serum analyses.

Blood tissue i.e. bloodcells are in a way comparable or functionally related to other tissues, for instance to muscle tissues.

Several enzymes in bloodserum stem mostly from other tissues (1).
Enzymes in the blood cells, however, are tissue bound (2).
In the first case these enzymes are indicative for the original tissue. In the second case information can be gained about the types and forms of the enzymes of the bloodtissue. Although there are a lot of basic differences between the metabolism in the red blood cell and

muscle tissue. Our blood investigations were mainly concentrated on enzymes involved in the glycolysis and on ATP because these components play an important role in the etiology of meat quality deviations as well.

Investigations.

1. Blood serum enzymes.

During the 13th meeting results were reported as to the importance of serum LDH_5 in pigs and the expected meat quality (Sybesma and Hessel, 1967).
Only breed differences were found pointing out that an overall unfavourable effect on muscle tissue which may lead to PSE quality gives rise to higher LDH_5 values, probably due to the greater permeability of the membranes.

Stress susceptible breeds tend to show higher LDH_5 values after stress.

This is shown in the following table from Hessel, 1968.

Table 1. Serum LDH_5 before and after muscular exercise in % of the total LDH.

	rigor pH_1	LDH_5 before	LDH_5 after
Piétrain (n=19)	9,5 5,86	4,3	16,4
L.W. (n=21)	5,0 6,39	0,9	6,1

In our opinion high LDH_5 values in the serum are an indication concerning the stress effect. These values have a certain predictive value as to the meat quality.

They may tell something about the stress susceptibility of the pig, but also about the severity of the stressor.

The same seems to be true for fibrinolytic enzymes (Mandrup, 1968). Theoretically results of the blood investigations might be helpfull to reduce the incidence

of PSE by taking special measures for the pigs with high values. We should take in account, however, that stunning as a stressor will always act as such just before slaughter. In genetical investigations LDH_5 can only be of interest when the stress can be standardized.

2. Enzymes in blood cells.

Fildes and Harris (1966) showed that in man - in one individual - the genetically determined variation of adenylate kinase (which catalyses the reversible reaction $2\ ADP \rightleftharpoons ATP + AMP$ in the red blood cell is similar to the variation in muscle tissue.

Huying (1967) found evidence that low fosforylase kinase contents in human blood cells are pathognomonic for a defect of glycogen breakdown in liver and muscle.

In human medicine several glycolytic enzymes deficiences are mostly related to a higher chance of blood breakdown (Oort, 1964). As we speculated in the LDH_5 investigations stress proved capable of affecting the membranes.

Oxydative stress is one of the conditions under which the cell membranes are affected. Therefore we concentrated in the first place on the resistance of erythrocytes of different breed against oxydative stress.

Oxydative stress.

Incubation with acetylphenylhydrazine according to Dacie and Lewis. (1963) resulted in a significantly higher frequency of Heinz bodies in Piétrain blood cells due to oxydation of Hb (table 2). Heinz bodies are visible denaturated and precipitated hemoglobin particles within the red blood cell.

Furthermore applying H_2O_2 to erythrocytes gives an indication about the defence resistance against oxydative stress according to the method of Helleman (1967).

Especially the Piétrain and Dutch Landrace breed showed high hemolysis percentages.

Table 2. Reaction on oxydative stress on erythrocytes of three different breeds.

	Heinz bodies bloodcell	Hemolysis % (H_2O_2) n = 34
Dutch Landrace	- n = 15	29,4 ± 4,12 n = 9
Large White	1,55 ± 0,05 ++ n = 15	5,17 n = 15
Piétrain	1,94 ± 0,05 ++	31,9 ± 5,9 n = 7
Human	-	3,2

($^{++}P < 0,05$).

Checking the vit. E content in these breeds low levels in the blood for the high hemolysis figures were found (Eikelenboom, 1968).

Defence mechanism.

The enzyme glucose - 6-phosphate dehydrogenase (G6PD) catalyses the reaction glucose 6 - P ⟷ 6 P gluconate, the first step in the aerobic hexose monophosphate shunt which is of importance in the defence mechanism especially in the reduction process of oxydated glutathione (GSSG). The glycolytic Embden-Meyerhof pathway (anaerobic) is used for about 90 %.

The content of glutathione (GSH) in the bloodcell is important also because its reducing potential assists the defence against oxydative stress.

Both components were investigated in pig breeds in comparison to humans (table 3) according to the methods described in Dacie and Lewis, 1963.

Table 3. G6PD and glutathione contents of bloodcells of different breeds.

	G6PD (in Marks units per gr. Hb)	GSH (in Mg/100 ml bloodcells).
Dutch Landrace	n = 27 18,9 ± 0,95	n = 27 46,7 ± 1,25
Large White	n = 21 23,4 ± 0,63	n = 23 40,3 ± 1,83
Piétrain	n = 19 22,8 ± 0,97	n = 33 46,8 ± 2,06
Humans	n = 7 11,5 ± 0,42	n = 7 66,9 ± 5,00

The G6PD values in pigs are somewhat higher than in the investigated normal humans. The GSH contents, however, are a little lower.

These results seem to indicate that if the enzyme content is indicative as to the function of the hexose monophosphate shunt the lower reductive capacity due to the lower GSH content is compensated by a higher HMP shunt activity.

Large Whites are lower in GSH whereas the Dutch Landrace has the lowest G6PD concentrations. The meaning of these differences within the breeds are not yet clear. They give no information on relations between trends in the breeds and the meat quality of these breeds.

ATP breakdown.

From the ATP content in (μ mol/ml cells) and the ATP breakdown one gets an impression of the vitality of the red blood cell.

Incubation in a Ringer glucose solution prevents in human blood the breakdown during some hours. NaF (sodium fluoride) blocks the reaction 2-P glycerate $\rightleftharpoons$ P - enolpyruvate and therefore diminishes the ATP restoration also.

Incubation of blood cells of 7 Piétrain and 7 Dutch Landrace animals gave the following results:

	n	0 min.:	20 min.:	40 min.:	60 min.:	80 min.:
Ringer glucose	14	2,07 ± 0,23	1,95 ± 0,21	1,77 ± 0,22	1,68 ± 0,12	1,65 ± 0,18
Ringer glucose with NaF	14	2,07 ± 0,22	1,86 ± 0,17	1,70 ± 0,18	1,58 ± 0,17	1,49 ± 0,15

Table 3:

ATP levels (μ mol/ml cells) after incubation in Ringer glucose and Ringer glucose NaF.

The results indicate that blocking procedures with NaF had much less effect than in human blood. There was no difference in reaction between the Piétrain breed and the Dutch Landrace breed samples. The original level of ATP seems to be a little higher than in human blood (2,07) μ mol/ml cells against 1,3 - 1,6 μ mol/ml in human blood.

Literature.

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