EFFECT OF FEEDING HEME-IRON ON THE QUALITY OF BOARS PORK MEAT.

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INTRODUCTION

Two of the main technologic properties of the meat are the water retention capacity and the color. The color is the first and main characteristic for the consumer to evaluated the meat quality. In red meats, consumers relate the bright red colour to freshness, while, discriminating against meat that has turned brown in colour (Morrissey et al. 1994).
Andrew et al. (1990) studying the drip losses in stored pig meat found big losses of sarcoplasmatic proteins that affected directly the weight loss and in consequence the economic and nutritional values of the meat.

Iron deficiency is the nutritional disorder with the higher prevalence in the world, mainly in underdeveloped countries. In developed countries this problem have a lower magnitude. Their prevalence in risk groups (menstruating and pregnant women and pre-school age infants) are comprised between 10 to 30% (Fricker et al. 1990, Milman and Kirchoff, 1992). The use of inorganic salt of Fe has been proposed to reduce this iron deficiency prevalence, but bio-availability is the principal factor which limit the solution of iron deficiency disorder. Haem iron ingestion is proposed as a viable alternative, because is not affected by other dietetic factors, been absorbed by endocytosis through the intestinal mucosa cells, as unmodified porfirine ring. Recently O'Sullivan et al. (2002) studying the effect of inorganic iron supplementation on pigs diets found an increase in the level of muscle Fe and also in the color of the meat.

OBJECTIVE

To study the effect of heme iron (administrated as whole hemoglobin or after separation and purification of enzymatic hydrolyzed hemoglobin) on meat quality of finishing boars pigs.

MATERIAL AND METHODS

Animals and diets

Thirty boars of a Landrace × Large White cross weighing approximately 42 kg were weighed at the beginning of the experiment, after three weeks and at the end of the experiment. Boars were slaughtered after 47 days. The feed was prepared from a diet based on cereals, peas, soybean meal and sunflower meal and prepared a basal content of 80 mg/kg of Fe. Diets containing experimental Fe sources were formulated to contain an additional 83 mg/kg of Fe (Table 1).

Table 1. Treatments and supplement levels of iron in feed.

Treatment	Fe Type	Fe Level (mg/kg)
T-1 (Control)	$FeSO_4 \bullet 7H_2O$	80
T-2 (AP-301®) *	Hemoglobin Fe	163
T-3 (Heme Fe)#	Heme Fe from hydrolyzed hemoglobin	163
T-4	$FeSO_4 \bullet 7H_2O$	163

* AP-301® is bovine or porcine red cells (containing whole haemoglobin) spray dried produced by APC EUROPE, S.A.
# Spray dried Heme Fe from hydrolyzed hemoglobin is obtained by enzymatic hydrolysis using blood cellular fraction from healthy beef and pigs. The blood was kept to 4ºC and plasma was separated in cellular fraction.

Slaughter process

Pigs were fasted 15 hours *ante mortem* and transported to the abattoir, about 3 hours after the removal of feed. The animals were kept in the same group of the farm during transport to the pens of the Meat Technology Center, situated in Monells (Girona). The pigs were treated with a minimum stress from farm to previous slaughter stages.
The method of stunning was electrical shock at 250 V/5 seconds. After evisceration, the carcasses were cut in two parts, weighed and classified to obtain carcass quality measurements and kept in a refrigerated room (4°C). At 24 hours meat quality measurements were made.

Carcass Quality

At 45 min post-mortem the carcasses were classified with the Hennessy Grading Probe. Muscle depth (mm) and fat thickness (mm) were measured at 6 cm from the mid line at the 3^{rd} /4^{th} last rib level. Lean content (%) was calculated according to UE normative (2001/775/CE).

Meat Quality

The following parameters of meat quality were evaluated:
The pH was measured in *Semimembranosus* (SM) and *Longissimus dorsi* (LD) muscles at 45 minutes (pH_{45}) and at 24 hours (pHu) *post-mortem*.
Lightness was determined as the average of 3 measures taken in the centre and borders on the surface of LD muscle 3 minutes after cutting, using a spectrochromameter (CM-2002, Minolta) with 8 mm diameter (CIE,1976). Lightness (L*) was taken with the apparatus previously calibrated.
Drip losses were determined by duplicate after 48 hours at 3- 4ºC in a LD slice of approximately 80-100 g, using a net bag and sealed container and following the reference method described by Honickel (1998). The pigments were determined on a sample of LD muscle (from lightness measured) using the method of Hornsey (1956) based in the determination of total pigments by means of extraction method with acetone as principal solvent.

Data were analyzed using the General Linear Model procedure of the Statistical Analysis System (SAS, 1988).

RESULTS AND DICUSSIONS

Carcass and meat quality characteristics

No effects of the treatments (Treat) were observed on carcass weight (75.06 kg ± 7.81).

No effects of the treatment were observed on pH_{45} for both muscles studied (Table 2). Mean values were in the normal range of pH_{45}. In pH_u only small differences no significant were observed among treatments. Mean pHu were lower than normal pH_u. With respect to the L value (Lightness) measurements in LD muscle, was lighter in meat from pigs fed T1, which is indicative of more pale meat. Also this result is an indication that the loins of the carcasses from T-2 and T-3 had a more reddish meat.

Mean drip losses were higher for T1 compared to T2 and T3, indicating that the meat from carcasses of pigs fed T1 were more exudative. Haematin content was not affected by treatment, although meat from pigs fed supplemental Fe tended to have more haematin than meat from pigs fed the control diet. These results are in agreement with the recent report from O'Sullivan et al. (2002) that indicate higher Fe level in the meat of pigs supplemented with 3000 mg iron (II) sulphate / kg of feed iron.

Table2. Least square means and standard errors (S.E.) of meat quality characteristics in boars.

Characteristics	*n*	**T- 1 CONTROL** *Mean ± S.E.*	**T- 2 Hb** *Mean ± S.E.*	**T-3 HEME** *Mean ± S.E.*	**T-4 $FeSO_4.7H_2O$** *Mean ± S.E.*
pH_{45} SM	29	5.96 ± 0.08	6.01 ± 0.07	6.02 ± 0.07	6.04 ± 0.08
pH_{45} LD	29	6.11 ± 0.07	6.28 ± 0.07	6.22 ± 0.07	6.28 ± 0.08
pHu SM	29	5.47 ± 0.02	5.48 ± 0.02	5.48 ± 0.02	5.49 ± 0.03
pHu LD	29	$5,42^{a}$ ± 0.02	$5,45^{a}$ ± 0.02	$5,53^{b}$ ± 0.02	$5,49^{ab}$ ± 0.03
L* (Lightness)	29	$54,50^{b}$ ± 0.60	$51,37^{a}$ ± 0.57	$52,66^{a}$ ± 0.57	$52,94^{ab}$ ± 0.65
Haematin content LD (µg/g muscle)	29	28.78 ± 1.77	29.26 ± 1.65	31.15 ± 1.65	33.31 ± 1.91

Means with different superscripts are statistically different ($p < 0,05$).

CONCLUSIONS

Supplementation with Fe from hemoglobin in the diet of finishing pigs during last 50 days before slaughter influenced the lightness of meat, producing a reddish meat that could be more accepted by consumers and also produce a lower drip losses, which indicated better meat quality.

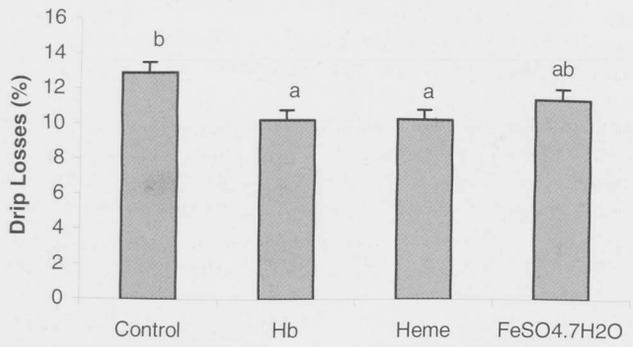

Fig. 1 Mean ± S.E. of Percentage of Drip Losses from LD muscle after 48 h at 3-4 °C. Means with different superscripts are statistically different ($p < 0,05$).

The use of organic Fe supplements as means to increase the Fe level of pig meat could be important to reduce iron deficiency in some at-risk groups such as menstruating and pregnant women and pre-school age infants.

Additional research is warranted to determine the effect of heme Fe (as whole hemoglobin or as heme Fe from hemoglobin) on meat oxidation from pigs.

REFERENCES

- Andrew et al. (1990). The amount and composition of the proteins in drip from stored pig meat. *Meat Science* **27** : 289-303.
- CIE, (1976). Commission Internationale de l'Eclairage. Colorimetry. Publication 15. Bureau Central de la CIE, Vienna, Austria.
- Fricker et al. (1990). Obesity and iron status in menstruating women. *American Journal of Clinical Nutrition* **52**. 863-866.
- Honickel, K. O. (1998). Reference methods for the assessment of physical characteristics of meat. *Meat Science* **49**: 447-457.
- Hornsey, H. C. (1956). The colour of cooked cured pork. I. Estimation of the nitric oxide-haem pigments. *J. Science of Food and Agriculture* **7**: 534-540.
- Milman, N. and Kirschoff, M. (1992). Iron stores in 1396 30- to 60- year-old Danish women: evaluation by serum ferritin and haemoglobin. *Annals of Hematology*, **64**: 22-27.
- Morrissey et al. (1994). Vitamin E and meat quality. *Proceedings of the Nutrition Society*, **53**: 289-295.
- O'Sullivan, et al. (2002). Sensory colour assessment of fresh meat from pigs supplemented with iron and vitamin E. *Meat Science* **60:** 253-265.
- SAS (1988). SAS/STAT user's guide. Release 6.03. Statistical Analysis System, SAS Institute INC., Cary, N.C.