EFFECT OF MOTHER'S FEEDING, PHYSIOLOGICAL STATE, PARITY ORDER AND OFFSPRING'S AGE ON THEIR *POST-MORTEM* pH EVOLUTION OF *LONGISSIMUS DORSI* MUSCLE

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ABSTRACT

The muscle pH evolution and its final value (pHu) have important influence on the keeping qualities of meat, as affecting proteins structures and water holding capacity. Thirty hybrid female rabbits of 15 weeks of age were randomly divided into three groups and fed with one of the three following diets: "C diet" for young females (DE=11.71 MJ/kg DM) was fed *ad libitum*; "R diet" was fed at 80% of *ad libitum* (quantitative rationing), "F diet" was rich in fibre (24.6% vs. 18.7% of C diet; DE=9.77 MJ/kg DM) and fed *ad libitum* (qualitative rationing). The does were inseminated at the 19^{th} week of age. The three diets were administered until the first parturition, afterwards all the does received the C diet *ad libitum*. The offspring received a commercial pelleted diet balanced for growing rabbits. Two newborn rabbits per litter were chosen at the first and second parturition of does. They were then slaughtered at 36 d of age (weaning) and at 81 d of age, respectively. The trial considered the offspring's *post mortem* pH evolution of muscle *Longissimus dorsi* (LD). To analyze the muscle pH evolution according to the time, pH was measured at 1, 2, 3, 4, 5, 6, 24 hours *post mortem*. Each measure was performed in duplicate to obtain reliable data. These analyses evaluated the evolution of m. LD *post mortem* pH according to the offspring's age (36 and 81 days of age), maternal diet (C, R, F), physiological state (pregnant, non-pregnant), and parity order (first, second). Significant differences ($P<0.01$) were found in muscle pH according to the age, having younger rabbits higher m. LD pHu reached with lower decline. Quantitative maternal feed rationing originates higher m. LD pHu of offspring of 81 days of age ($P<0.01$). The physiological state of does had no any effect on the *post mortem* pH of offspring's m. LD. Offspring of the first kindling exhibited significantly higher muscle pH from 6 h *post mortem* onward ($P<0.01$).

Key words: Rabbit, Doe, Feed rationing, Offspring, *Longissimus dorsi* muscle, pH.

INTRODUCTION

Meat is the result of *post mortem* changes characterized by two groups of biochemical events: the onset of *rigor mortis* and the maturation process. The *post mortem* pH variation can be characterized by its rate of fall, which is related to the ATP-ase activity of the myosin, and by its amplitude, which depends on the quantity of glycogen depleted (or on lactated produced). The initial level of reserves is determined by biological factors (muscle, age, sex, genetic type) and also by husbandry factors (herd management, feeding) (Hulot and Ouhayoun, 1999). Many studies report differences between muscles in the acidification process and in ultimate pH (pHu). In meat (a semi-solid compound), the pH is defined as the cologarithm of the H^+ rate of the liquid phase, balanced with the solid phase. Immediately after death of the animal, pH value is near neutrality; within few hours it drops to a stable value (ultimate pH or pHu), depending on muscle and its energy reserves. Generally, the meat instrumental (colour, water holding capacity) and sensory (juiciness and tenderness) characteristics depend on the rate and intensity of the pH drop (Ouhayoun and Dalle Zotte, 1996). Muscular pH is an interesting trait for two reasons: firstly, it acts as a general estimator of fibre typology, of the balance of the energy metabolism pathway and of the level of energy reserves in the muscles, the latter also depends on *ante mortem* treatments. Secondly, it allows certain qualitative characteristics of the meat to be predicted.

The aim of this work was to evaluate the pH evolution of *Longissimus dorsi* muscle of fattening rabbits according to their age (36 or 81 days), to the maternal diets (a control diet compared to 2 types of feed rationing), physiological state (pregnant or non-pregnant) and parity order (first or second order).

MATERIALS AND METHODS

Thirty hybrid female rabbits were used. At 15 weeks of age they were caged in a rabbitry, randomly divided into three groups and to each group was provided one of these experimental diets called: C, F, R. The "C" group was fed with a diet specific for young females, *ad libitum* (DE=11.7 MJ/kg DM). The "F" group was fed "*ad libitum*" with a more fibrous diet (DE=9.8 MJ/kg DM; qualitative rationing), while the "R" group received the C diet, but rationed at 80% of *ad libitum* (quantitative rationing). The farming environmental parameters were constantly controlled, especially the average of temperature was kept around 24.6°C during the warmer month of rearing (July). The young does were artificially inseminated at the 19^{th} weeks of age. The 3 diets were fed for 8 weeks, i.e. until the first parturition; afterwards all the does received the C diet *ad libitum*. The second insemination occurred nine days after the parturition. The offspring obtained from the first and second parturition was used to evaluate the mother's feeding effect on their live performance and qualitative characteristics of carcasses and meat (Dalle Zotte *et al.*, 2008). Two newborn rabbits per litter were selected at the first and at the second parturition of does, chosen with liveweight corresponding to the average liveweight of the whole litter, and they were used for the carcass and meat traits evaluation, including pH (n=120).

Animals were slaughtered according to WRSA Commission recommendations (Blasco and Ouhayoun, 1996). The first slaughtering was performed at 36 days of age (at weaning; n=60), while the second one was performed at 81 days of age (at the end of fattening; n=60). After electrical stunning (90 V x 2 sec) animals were killed by cutting jugular vein and carotid artery. From each carcass the m. *Longissimus dorsi* (LD) was immediately separated for pH measurements and stored at +4°C. To analyze the pH evolution according to the time, pH measurement was repeated at 1, 2, 3, 4, 5, 6 and 24 hours *post mortem*. Each measurement was performed in duplicate to obtain reliable data. The pH analysis on m. LD was carried out *in situ,* by inserting a combined electrode Ingold (406 M3). This instrument was equipped with a conic tip, suited for meat penetration (Xiccato *et al.*, 1990; Parigi-Bini *et al.*, 1992).

Statistical analysis

Variance analysis was performed using the GLM procedure of the SAS program (SAS Institute, 1990) by using 2 models: the first considered only the age effect (36 and 81 days); the second model considered the rabbits of 81 days of age and included diet (C, F, R), physiological state (pregnant, non-pregnant) and parity order (first, second) as fixed effects, and their interactions. Interaction effects were not significant.

RESULTS AND DISCUSSION

The results reported herein indicate that several factors could affect the *post mortem* pH in rabbits' meat. In Figure 1 the pH evolution of m. LD is illustrated according to the rabbits' age (36 and 81 days). *Post mortem* pH of m. LD of rabbits slaughtered at 36 days was significantly higher than that of animals slaughtered at 81 days (P<0.01). It was significantly higher from the first measurement (1 h *post mortem*) and the difference remained until the pHu, obtaining values of 5.75 and 5.69 for 36 and 81 days-old rabbits, respectively. Higher significant differences were found in pH measured at 2, 3, 4, 5, 6 hours *post mortem* (6.4, 6.16, 6.12, 6.02, 5.94 in 36 days-old rabbits vs. 6.23, 5.99, 5.84, 5.72, 5.71 in 81 days-old rabbits).

Figure 1: pH evolution of LD muscle according to the rabbit's age (36 and 81 days) (a, b: P<0.05; A, B: P<0.01)

Several researches studied how age could influence pH value in *post mortem* rabbit meat. The lower value of pH in meat of older rabbits could be linked to metabolic differentiation. In the course of postnatal metabolic differentiation, muscular energy equilibrium comes to favour more and more the glycolytic pathway, with variations that depend on muscle typology and function (Bacou and Vigneron, 1976). The increase in glycolytic energy metabolism, as a function of age, is more pronounced in the *Biceps femoris* muscle than in the *Longissimus dorsi*. This increase is correlated with a decrease in oxidative metabolism, myoglobin level (Ouhayoun *et al*., 1983), and in ultimate pH of *Psoas major* and *Longissimus dorsi* muscles (Dalle Zotte and Ouhayoun, 1995). The lower pH in older animals could be also explained by an energy storage point of view. Younger animals firstly use energy provided by food for growth while as age increases the animals need less energy for this reason, and they store part of this energy as reserve tissue. This tissue could have important role to influence the pHu in meat.

Figure 2 shows the pH evolution in muscle LD of fattening rabbits of 81 days of age according to the maternal diet received before and during their first pregnancy. Significant differences were found only in pH measured at 6 and at 24 hours *post mortem*.

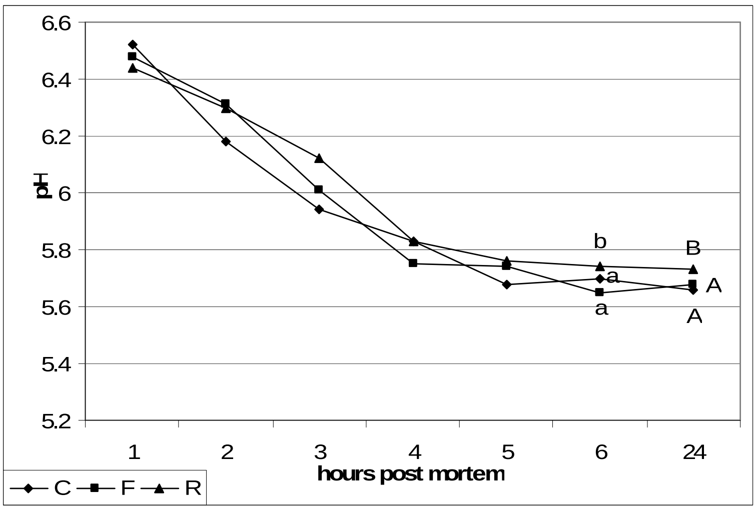

Figure 2: pH evolution of LD muscle of rabbits aged 81d according to the maternal diet (C, F, R) (a, b: P<0.05; A, B: P<0.01)

The rabbits whose mothers were submitted to the quantitative rationing (diet R) exhibited higher pHu than the other 2 groups of rabbits (P<0.01). Feed rationing, whether devised to reduce feed costs or to modify body composition, can have an effect on the muscular metabolism, in so far as it slows down general growth rate. When the amount of feed offered to animals falls below 85% of *ad libitum* intake (as in this case) it could have an important effect on the muscle pH decrease during *post mortem* time. It was demonstrated (Dalle Zotte et al., 2005) that the quantitative maternal feed rationing significantly reduces the αW fibres proportion in muscle *Longissimus lumborum* of weaned rabbits and the higher pHu found is partly dependent on this variation. The R diet provided less energy for does and this could have had a negative repercussion on the fibres' differentiation during foetal life and on the energy reserve storage (glycogen) in offspring muscles during their post-natal life.

The effect of the maternal physiological state (pregnant or empty) on the pH evolution of m. LD of the offspring is showed in Figure 3. The results didn't show significant differences between pHu of rabbits derived from pregnant or empty does indicating that the concurrent lactation and pregnancy didn't increase as strongly the energy deficit to affect the glycogen storage of growing rabbits. In fact, when feed rationed, rabbit does design with priority the ME for milk production, then for foetuses' growth and for the detriment of their body conditions.

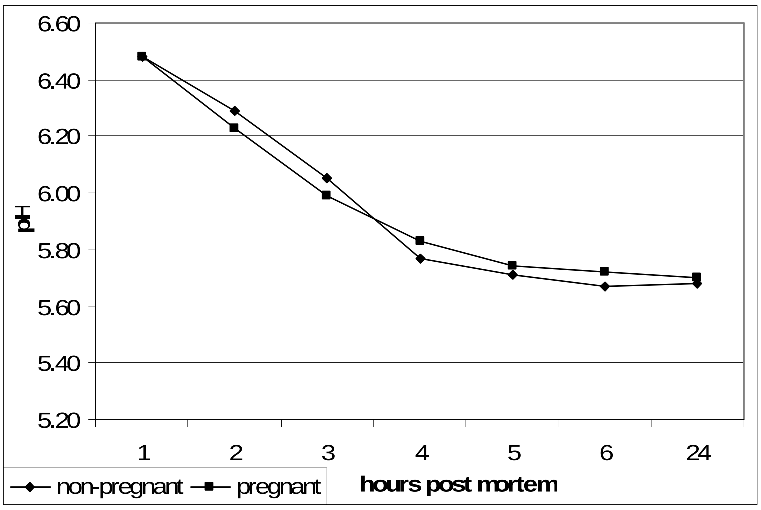

Figure 3: pH evolution of LD muscle of rabbits aged 81d according to the physiological state of does

In Figure 4 the effect of parity order on pHu of m. LD is shown. Significant differences were found (P<0.01) after 4 hours from death: at 4, 5, 6, 24 hours *post mortem* the pH was 5.92, 5.80, 5.81, 5.76 and 5.68, 5.65, 5.58, 5.62, for first and second parity order, respectively. This parity order effect is related to the maternal dietary treatments. Offspring derived from the does of the first parity order were more affected by the maternal dietary treatment than those of the second parity order, which consumed the same commercial diet *ad libitum* for a longer period and then any dietary residual effect disappeared.

CONCLUSIONS

The main and more significant difference was found in rabbits slaughtered at different ages (at 36 and 81 days of life). We confirm that the muscular glycolytic metabolism increases with age and this has important effects on *post mortem* pH evolution. The second variability factor was the diet provided to the offspring's mothers. It is clear that feed has an important role in meat quality and this research showed that maternal feed rationing can influence the muscle pHu. Significant differences were found in growing rabbits whose mothers were fed with the "R" diet. This quantitative rationing brought some differences in pH evolution keeping higher *post mortem* pHu, compared to the other 2 groups. Some significant differences in pH of m. LD were observed between the 2 parity orders, indicating a probable less glycogen reserves in rabbits of the first parity. Any effect was observed due to the mother's physiological state.

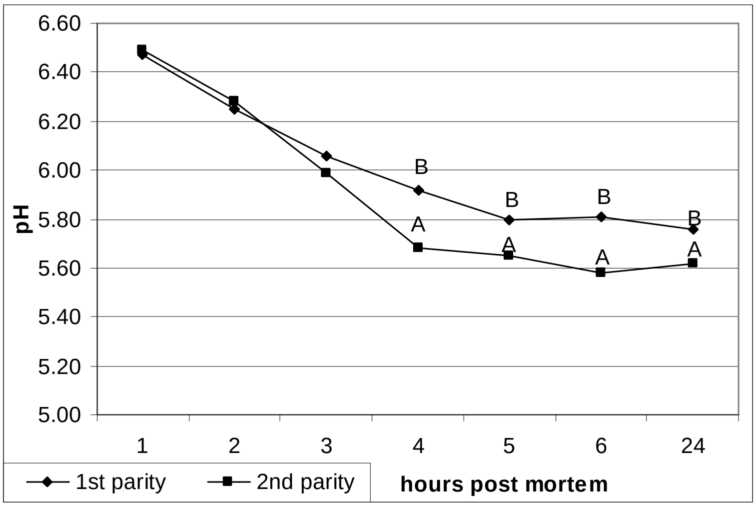

Figure 4: pH evolution of LD muscle of rabbits aged 81 d according to the parity order (first or second) (A, B: P<0.01)

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