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GLYCOLYTIC POTENTIAL AND ULTIMATE pH IN VEAL: AN UPDATED PERSPECTIVE ON MEAT QUALITY

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I. INTRODUCTION

Ultimate pH is a key determinant of meat quality, influencing attributes like color, water-holding capacity, and texture [1]. It is primarly driven by muscle glycogen content at slaughter [2], with an inverse relation observed up to a threshold beyond which further glycogen increases no longer significantly affect pH [3] [4] [5]. Furthermore, several studies have shown a relationship between increased glycolytic potential and poorer meat quality, including paler, softer pork or beef with reduced water-holding capacity [6] [7]. However, research on this relationship in veal remains limited and outdated, with most studies dating back to 1980s and 1990s. The present study aims to update the existing data and expand existing data on veal.

II. MATERIALS AND METHODS

Animals. 187 Holstein male calves were reared under the facilities of CIRVEAU (Calves' Innovation and Research Center, French Livestock Institute, Mauron, France). Housed in collective pens (7-8 calves per pen, 2 m²/calf) on wooden slatted floors, they received a basal diet with milk replacer and solid feed twice daily until the day before slaughter. Calves were slaughtered at an average carcass weight of 145 kg after 175 days of fattening.
Transport and Slaughter Procedures. Three trucks were used to transport the calves, in the same density conditions (60 to 64 calves per truck) to the same slaughterhouse. All calves were unloaded after the same transport time (4h) and slaughtered using conventional techniques, after being held for 4h. The carcasses were immediately chilled at 4°C for 24h after slaughter.
Muscle Sampling. A sample of *Longissimus dorsi* (LD) muscle (approximately 2 g) was taken at 45 min postmortem for the determination of glycolytic potential and was immediately frozen in liquid nitrogen. About 200 mg of freeze-dried muscle tissue was homogenized in 10 mL of 0.5 M perchloric acid. Glycogen, glucose and glucose-6-phosphate were simultaneously determined on the homogenate according to Dalrymple et al. [8], after hydrolysis of glycogen with amyloglucosidase. Lactate was determined in the supernatant resulting from the centrifugation of the homogenate (20 min at 2.500 *g*), according to Bergmeyer [9]. Glycolytic potential (GP) was expressed in terms of potential lactate production according to the formula proposed by Monin et al. [10], where brackets indicate concentration: GP = 2([glycogen]+[glucose]+[glucose-6-P]) + [lactate], expressed as micromoles of lactate equivalents per gram of fresh muscle.
Meat Quality. At 24h postmortem, pH measurements were assessed on the left half of the carcass in the LD muscle. To minimize heterogeneity within the muscle, three measurements were taken for each carcass and the means were calculated. Muscle pH was recorded using three portable pH equipped with a specific glass probe (HANNA Instruments HI99161). These pH-meters were supplied with a pH electrode (HANNA Instruments Quick DIN FC2323) specifically designed for use with meat, introduced in a small cut (about 3 cm deep) in LD muscle (at the 13th rib/1st lumbar interface). The pH-meters were recalibrated every 15 carcasses and whenever a difference > 0.3 was observed betwen the three pH meters.
Statistical Analysis. Descriptive statistics summarized the dataset. A locally weighted scatterplot smoothing (LOWESS) technique was applied using the lowess function in R (version 4.4.2). This method performs locally weighted polynomial regression to capture trends in the data without imposing a specific parametric model.

III. RESULTS AND DISCUSSION

Table 1 presents the average values of ultimate pH and GP obtained in this study. The mean ultimate pH recorded is 5.89, while the mean GP (approximately 153 µmol/g) is consistent with the values reported for the same muscle in similar animals by Guinot et al. [11] (151 µmol/g). However, it remains lower than the 190 µmol/g reported by Fernandez et al. [12], likely due to differences in transport conditions and calf age between studies, as well as other potential genetic, physiological, or environmental factor. Previous studies have indicated that in calves, there is no clear relationship between ultimate pH and GP when the latter exceeds 150 µmol/g [1] [2] [13]. This threshold aligns with the findings of the present study (figure 1). These results further underscore the variability observed in the

measured parameters within the sample population, reflecting potential influences such as animal variability, muscle metabolism, and pre-slaughter conditions.

Table 1 – Statistical parameters of the calves under study.

Parameters	n	min	max	median	iqr	mean	sd	se
pH at 24 h postmortem	187	5.46	7.04	5.89	0.27	5.94	0.30	0.02
Lactic Acid[a]	187	5.33	30.97	15.41	6.95	16.36	5.03	0.37
Glycogen[a]	187	8.51	252.39	141.74	74.33	136.60	51.97	3.80
Glycolytic potential[b]	187	17.60	267.65	162.86	76.75	152.96	53.31	3.90

[a] expressed in µmol/g fresh tissue; [b] expressed in µmol lactate equivalents/g fresh muscle

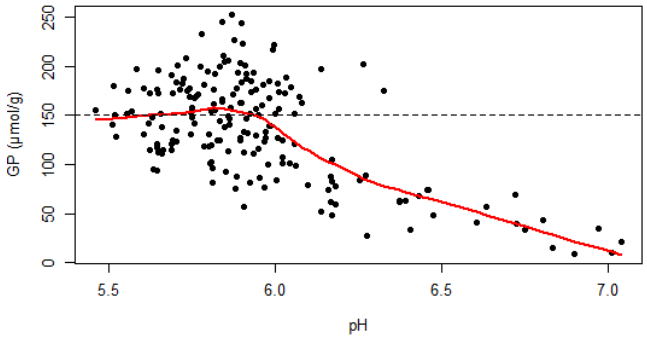


Figure 1. Relationship between glycolytic potential and ultimate pH in calves

IV. CONCLUSION

This study provides updated insights into the relationship between glycolytic potential and ultimate pH in veal, confirming a threshold (150 µmol/g) above which glycolytic potential no longer significantly affects pH. These findings underscore the variability in pH level and so, meat quality, probably influenced by many factors such as animal differences and pre-slaughter conditions.

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