RELATIONSHIPS BETWEEN MEAT QUALITY TRAITS IN A LINE OF RABBITS SELECTED FOR GROWTH RATE

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ABSTRACT

Relationships between meat quality traits susceptible to be analyzed at the slaughterhouse level (ultimate pH and carcass colour), standard meat quality traits (meat colour, water holding capacity) and chemical composition were analyzed. Rabbits belonged to two groups: a selected group from the 23th generation of a line selected for growth rate and a contemporary control group from the 7th generation of selection of the same line. Correlations indicated that slaughterhouse measurements would help predicting meat colour but they would not provide enough information about water holding capacity, meat texture and chemical composition. The principal components analyses showed that the ultimate pH, yellowness of the carcass, saturated fatty acids percentage, polyunsaturated/saturated fatty acids ratio and n-6:n-3 fatty acids ratio were the traits explaining the main variability in meat quality. No differences between groups was observed when projecting the data on the principal component analyses.

Keywords: Selection for growth rate, meat quality, Principal component analysis, Rabbits.

INTRODUCTION

Rabbit industrial meat is usually produced by a three-way cross, where females from a cross of two lines selected for reproductive traits are mated with males from a line selected for growth rate. The selection for growth rate influences some meat quality traits as water holding capacity and fat content (Piles *et al.*, 2000), and the effect of both selection and the consequent decrease in degree of maturity at slaughter weight affects colour parameters (Gondret *et al.*, 2005; Pascual and Pla, 2007), pH, texture (Gondret *et al.*, 2005), fatty acid profile and oxidative pathway (Pascual and Pla, 2007). The number of quality traits analyzed is high and are correlated. The use of principal component analysis (PCA) helps observing relationships between traits and can also help in determining differences due to the selection. The PCA would also show which traits explain the main observed variability in meat quality.

Analysis of meat quality implies measuring several traits related to chemical composition, water holding capacity and sensory characteristics. However, in rabbit meat production only pH and carcass colour can be measured at the slaughterhouse level, because they are fast, low-cost and non-invasive methods. It would be interesting to relate these slaughterhouse measurements with the more complex and accurate laboratory measurements.

The objective of the present paper is to study the relationships between meat quality traits at slaughterhouse and laboratory levels.

MATERIALS AND METHODS

Animals

The experiment was carried out with 120 rabbits from a synthetic line (R), selected for growth rate between 4 and 9 weeks of age at the Universitat Politècnica de València (Baselga, 2002). Animals came from two groups: Selected (S) and Control (C), with 60 animals each. Animals from group C were offspring of animals coming from embryos vitrified previously in the 7th generation of selection, and animals from group S belonged to the 23th generation of selection. Both groups were contemporary. Animals were slaughtered at 2000±200 g, which is the standard commercial weight in Spain.

Slaughterhouse measurements

Animals were slaughtered at the abattoir on the farm, thus they did not suffer stress due to transport. The carcasses were refrigerated 24 h at 3 °C. At 24h *post mortem*, carcass colour (LC, aC, bC; corresponding to L*, a* and b* in the CIELAB space, respectively) and ultimate pH (pH24h) were measured on the surface of the m. *L. dorsi* at the level of the 4th lumbar vertebra.

Standard meat quality traits

At 24h *post mortem*, standard meat quality variables were measured in the m. *L. dorsi*. Meat colour (LM, aM, bM; corresponding to L*, a* and b* in the CIELAB space, respectively) was measured by cutting the *L. dorsi* muscle at the level of the 6th lumbar vertebra. Water holding capacity (WHC) was measured according to Hamm (1986) and was expressed as the ratio (x100) of muscle area to total area. Percentage of released water (PRW) were measured by compression of meat at the level of the 6th lumbar vertebra. Cooking losses (CL) were obtained after cooking the muscle in a water bath at 80 ºC for 1 h. Shear force (Sfc), shear firmness (Sfm) and total work performed to cut the sample (A) were obtained from the cooked loin using a Warner-Bratzler texture analysis.

Chemical composition and fatty acid profile

Crude protein (MProt), crude fat (MFat) and moisture (MMoist) percentages, saturated (SFA), monounsaturated (MUFA), polyunsaturated (PUFA), n-3, n-6 fatty acids percentages and PUFA/SFA and n-6:n-3 ratios were estimated in the meat of the hind leg using Near Infrared Spectroscopy. All the methods are described in Pascual and Pla (2007) and Pascual and Pla (2008).

Statistical analysis

Least square means were calculated including group and sex as fixed effects to obtain the residuals. Pearson correlation coefficients among the residuals were calculated using SAS (SAS Inst., Inc., Cary, NC). Principal component analyses (PCA) between variables were carried out and data was projected on the axis to test differences between groups using Statgraphics Plus 5.1. PCA's were also carried out with the residuals to observe the relationships between variables.

RESULTS AND DISCUSSION

Several PCAs were performed according to different possible scenarios: when only slaughter house measurements are available, when standard lab traits are taken or in a more complex scenario. The results of the PCAs can differ when augmenting the number of dimensions. Table 1 shows the correlations between the slaughterhouse traits and figure 1 shows the PCAs relating the residuals of the variables. Traits near each other are positively correlated, traits separated by 90º are independent and traits separated 180º are negatively correlated. The principal components (PC) are linear combinations of the variables. Traits lying on the PC and far from the origin define the PC and take most of the variability of the data.

All the measurements obtained at the slaughterhouse level were correlated except in the case of LC and aC (Table 1). Other authors found none or low correlation between pH24h and LC in rabbit (Hernandez *et al.*, 1997, 1998, 2000).

Table 1. Residual correlations between the slaughterhouse measurements (m. *L. dorsi*).

	pH24h	LC	aC	bC
pH24h	1			
LC	-0.49*	1		
aC	-0.26*	0.15	1	
bC	-0.29*	0.27*	0.39*	1

pH24h: ultimate pH; LC, aC, bC: L*, a* and b* in the muscle surface, respectively.

None of the standard meat quality traits included in the PCA (figure 1a) defined the variation observed in the data. Nevertheless, the PCA showed positive correlations of Sfm with Sfc and A (0.92 and 0.92), and Sfc and A were also highly correlated (0.72). The results agree with those found by Bianchi *et al.* (2007). This suggests that meat instrumental texture could be summarized using only Sfc. In the PCA, the bM lay close to LM and aM, with a moderate high correlation (0.51 and 0.41, respectively), but correlation between LM and aM was low.

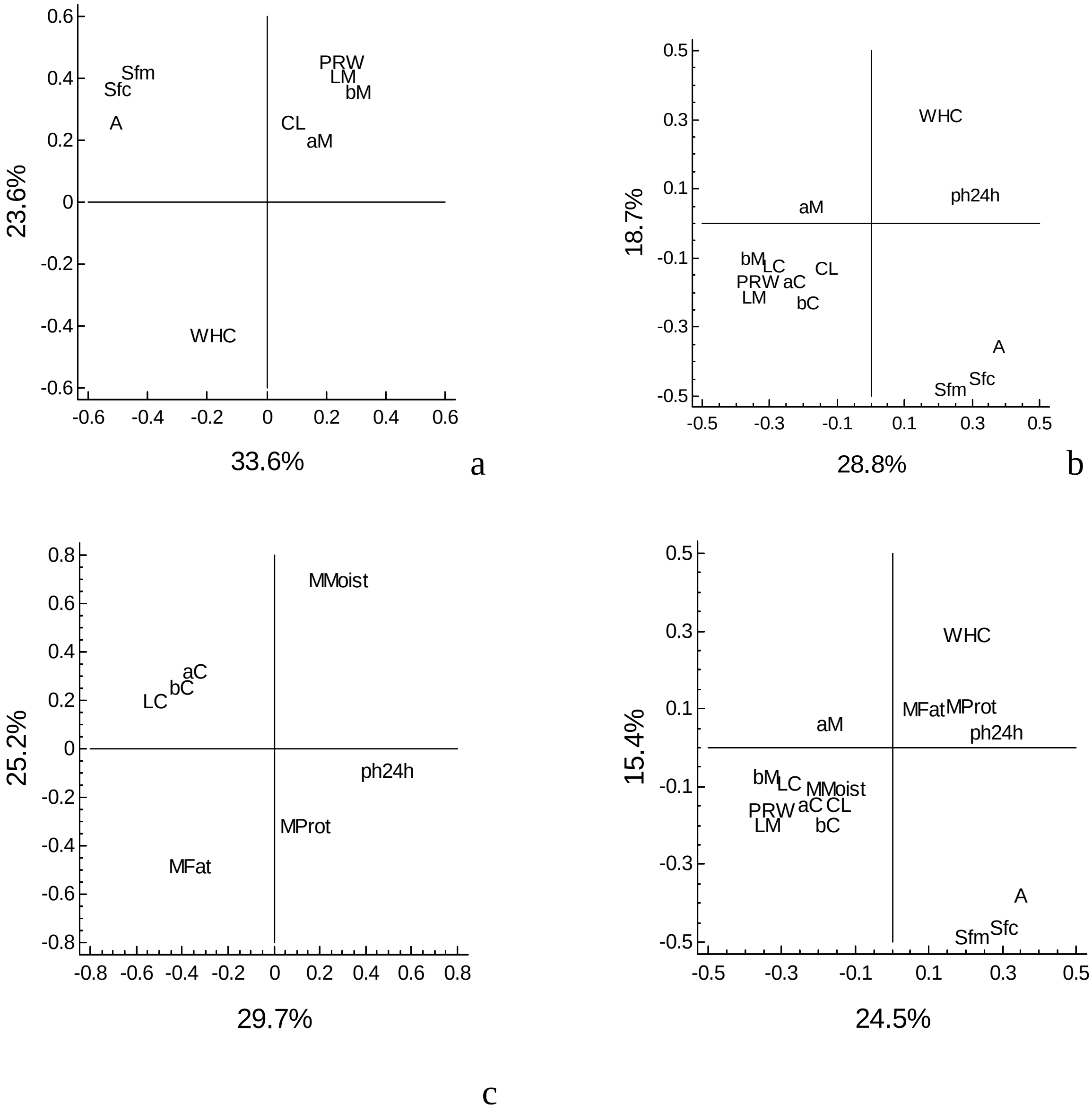
Figure 1b shows the PCA for slaughterhouse and standard meat quality traits. The first PC was determined by pH24h and bM, which lay opposite, close to the axis and far from the origin. None of the traits determined the second PC. The Pearson coefficients showed that pH24h was related to LM (-0.44, as observed by Hernandez *et al.*, 1998) and bM (-0.50) and uncorrelated with CL, WHC and PRW. No correlation with CL and low with WHC had been found in other works (Hernandez *et al.*, 1998, 2000). The pH24h was slightly correlated to A (total work needed for cutting the meat) (0.33). On the other hand, LC was correlated to LM (0.53) and bM (0.41) and slightly correlated with A (-0.28). The aC was slightly correlated with bM (0.27), WHC (-0.29) and PRW (0.32) and bC was only correlated with bM (0.29). These results show that parameters measured at the slaughterhouse could help predicting meat colour, but they do not provide information about other important meat quality traits as water holding capacity and texture traits due to the low correlations with them. The PCA showed the negative correlation between WHC and PRW (-0.63), being both variables unrelated to CL. A low correlation between WHC and CL in rabbit meat was also found by Hernandez *et al.* (1998, 2000).

The representation of the slaughterhouse variables with the chemical composition (Figure 1c) shows that the first PCA was defined by the pH24h. The PCA did not show any clear pathway of relation between the variables, but the Pearson coefficients show that pH24h has no correlation with MProt, MFat and MMoist. Other authors found low or no correlation between pH24h and fat in the hind leg in rabbit (Hernandez *et al.*, 1997, 1998, 2000). Moreover, colour of the surface and chemical composition were uncorrelated or slightly correlated (-0.25 for Lc and MProt). These results show that slaughterhouse measurements do not provide useful information about the chemical composition of the meat.

Figure 1d shows the PCA with slaughterhouse variables, standard meat quality traits and chemical composition, showing similar results to those obtained in figures 1b and 1c. The first principal component was defined by the pH24h and bM.

Figure 1e shows the PCA for the chemical composition and fatty acids profile. The first PC was determined by the SFA and by the P:S lying opposite. This agrees with the correlation coefficients found between SFA and P:S (-0.77). The second PC was determined by the n6:n3 ratio, which had low correlation with PUFA (0.28) and P:S (0.26). The rest of the variables were not well represented by the two first PC. Mmoist lay opposite to MFat (-0.76).

The projection of the data on the PCA's representing the variables did not show any clear difference between the group of rabbits selected for growth rate and the control group, although former analyses of the data showed relevant higher bM and n-3 and lower bC in the selected than in the control group (Pascual and Pla, 2007; Pascual and Pla, 2008).



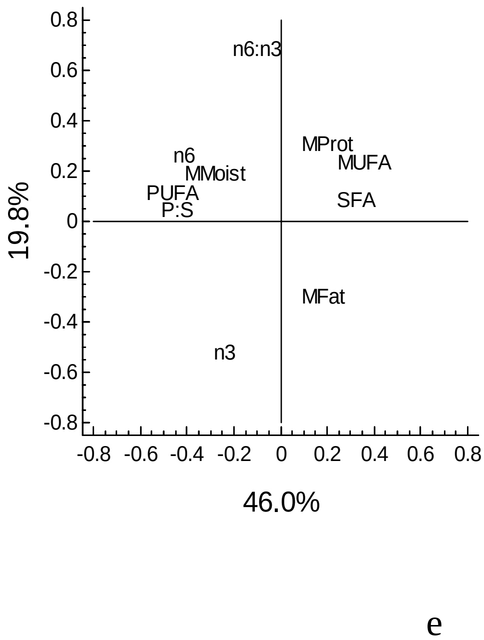


Figure 1: Projection of the meat quality traits in the plane defined by the two first principal components and percentage of variation (in the axis) explained by the each principal component. a: standard meat quality traits; b: slaughterhouse and standard meat quality traits; c: slaughterhouse and chemical composition; d: slaughterhouse, standard meat quality traits and chemical composition; e: chemical composition and fatty acid profile. Variables in the m. *L. dorsi*: pH24h: ultimate pH; LC, aC, bC: L*, a*, b* in the carcass surface, respectively; LM, aM, bM: L*, a* and b*, in the m. *L. dorsi* respectively; CL: cooking loss; PRW: percentage of released water; WHC: water holding capacity; Sfc: shear force; Sfm: shear firmness; A= area. Variables in the hind leg: MFat: fat content; MProt: protein content; MMoist: moisture content; SFA, saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; PUFA/SFA, ratio polyunsaturated/saturated fatty acids; n6:n3: ratio n6 and n3.

CONCLUSIONS

Meat quality traits measured at the rabbit slaughterhouse as pH and carcass colour are related to meat colour but do not provide information about the water holding capacity, meat texture and chemical composition.

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