SELECTION ON THE TECHNOLOGICAL QUALITY OF THE MEAT IN POULTRY

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INTRODUCTION

Poultry meat production has been very dynamic over the last decade with an annual increase in the world production of 8.3% between 1987 and 1997 (Mandava and Hoogenkamp, 1999). At the same time, the marketing of poultry has been greatly diversified with a significant increase in joints and processed products. The success of poultry production has been strongly related to improvements in growth and carcass yield, mainly through the increase in breast proportion and reduction in abdominal fatness. Recently, researches have been intensified in order to precise the effect of this selection on the processing quality of meat and the possibilities of including meat quality as a criteria of selection in poultry breeding schemes. Indeed, as the proportion of processed products is growing, meat quality will have a major impact on the development of poultry production, especially for high-quality products in which supply of food additives is limited. As in pork, pH variations significantly affect the storage and the processing qualities of poultry meat, by modifying its water-holding capacity and rheological properties. Low pH in the early stage of rigor onset decreases water-holding capacity and the technological quality of meat. These quality defects are usually referred to as pale, soft and exudative (PSE) meat (Kijowski and Niewiarowicz, 1978 ; Barbut, 1997). High pH meat known as dry, firm and dark (DFD) presents a poor storage quality. In contrast to pork, until recently, very little was known in poultry on the impact of genetics on the post-mortem pH fall and its genetic relationship with meat quality. First estimates of the genetic parameters of meat quality traits have been thus estimated in chicken (Le Bihan-Duval *et al*., 2001) and turkey (unpublished results). Because of the paucity of results in poultry, and because different slaughtered conditions (experimental or industrial) were used for these genetic studies, the results obtained in both species will be presented in this paper.

GENETIC VARIABILITY OF CHICKEN MEAT QUALITY

A genetic study on several quality indicators measured on breast muscle was conducted in an experimental broiler line (Le Bihan-Duval *et al*., 2001). Birds, slaughtered in an experimental processing plant, were not transported before slaughtering. Ultimate pH and trichromatic coordinates (L*: lightness ; a*: redness ; b*: yellowness) were measured on a total of 1076 birds. Part of the animals (about 600) were also recorded for the rate of pH fall (pH at 15 min post-mortem) and the drip loss of meat. REML estimates indicated that meat traits had very significant levels of heritabilities, with the highest values obtained for the color parameters (Table 1). Although breast muscle contains only glycolytic white fibers, a rather large variation in color was observed. The estimated genetic correlation between pH at 15 min post-mortem and ultimate pH was found to be equal to zero, showing that the rate and the extent of the post-mortem pH fall were governed by different genes. This result agreed with the fact that the ultimate pH of the is supposed to be mostly dependent on the initial glycogen reserves of muscle at the time of slaughter, whereas the rate of pH fall is related to the rate of ATP hydrolysis just after death (Bendall, 1973). Ultimate pH appeared as a determining factor of meat quality, as significant correlations were found between this trait and the lightness and drip loss of meat. By contrast, pH at 15 min post-mortem was not genetically correlated with the other quality indicators. Body weight and breast yield appeared poorly genetically related with the measures of pH fall, while moderate negative genetic correlations were observed with the redness and yellowness of the meat. This suggested that selection for growth and muscle development would not alter the pH of meat but could slowly modify its color by decreasing the redness and yellowness indicators. The experimental conditions used for this study ensured a very good consistency of the measurement of meat traits, which may have contributed to the high level of heritability estimates. However, they did not enable to observe real defects of meat quality (especially PSE meat) which are encountered under industrial, and therefore more stressfull, conditions. A second study was thus carried out on turkey under industrial conditions.

Table 1. Estimates of genetic parameters[A] for breast meat quality and growth performances[B] in a broiler chicken line (Le Bihan-Duval *et al.*, 2001)

	pH_{15min}	pHu	L*	a*	b*	DL	BW	BRY	AFP
pH_{15min}	**0.49**	0.02	0.13	-0.23	0.05	-0.29	-0.06	0.12	-0.04
pHu		**0.35**	-0.91	0.14	-0.43	-0.83	0.07	0.13	-0.54
L*			**0.50**	-0.48	0.20	0.80	0.16	-0.07	0.50
a*				**0.57**	0.54	-0.25	-0.30	-0.29	-0.24
b*					**0.55**	0.16	-0.13	-0.39	-0.02
DL						**0.39**	-0.04	-0.16	0.29
BW							**0.35**	0.17	0.19
BRY								**0.55**	-0.17
AFP									**0.62**

[A] Heritabilities on the diagonal, genetic correlations above the diagonal.
[B]pH_{15min} = pH 15 min post-mortem; pHu = ultimate pH; L* = lightness; a* = redness; b* = yellowness; DL = drip loss; BW = body weight; BRY = breast yield; AFP = abdominal fat percentage.

GENETIC VARIABILITY OF TURKEY MEAT QUALITY

This study, conducted in a grand-parental female turkey line (BUT Ltd), aimed to (1) study the effect of the rate of post-mortem pH decline on the processing ability of meat and (2) estimate the genetic variability of the latter trait in relation with the ultimate pH and the color of meat, when meat quality was measured under industrial conditions. On the day of slaughter, the distributions of pH at 20 min post-mortem (pH_{20}) were established for both *Pectoralis superficialis* (PS) (breast muscle) and *Iliotibialis* (IL) muscles (thigh muscle). This enabled to partition meat in three or two groups for breast and thigh muscles, respectively, according to the level of pH_{20}. PS and IT muscles were further processed in LDC commercial plant (Sablé – France) into white cured-cooked meat and turkey ham, respectively. Meat was processed according to "high-quality" French standards (without use of polyphosphates) in order not to hide the effect of raw meat quality. As presented by Fernandez *et al.* (2001), technological yield was significantly lower in the groups showing the lowest pH_{20} either for the white meat and the ham. Lower pH_{20} values were also associated with increased drip and a paler aspect (higher lightness) of meat. REML estimates of genetic parameters for pH_{20}, ultimate pH and color indicators (L*; a*; b*) were calculated, on the total of the available 420 pedigree birds. These birds were progeny of 30 sires and 118 dams. As reported in Table 2, a moderate level of heritability was obtained for the rate of pH fall measured in breast muscle (h^2= 0.22) (Table 2). The same level of heritability was also found for thigh muscle (h^2 = 0.20).

Table 2. Estimates of genetic parameters[A] for breast meat quality and growth performances[B] in a commercial turkey line

	BW	BRY	PH_{20}	pHu	L*	a*	b*
BW	**0.35**	0.13	0.55	0.55	-0.41	0.15	-0.38
BRY		**0.32**	0.61	0.22	-0.24	-0.16	-0.29
PH_{20}			**0.22**	0.60	-0.79	-0.25	-0.20
pHu				**0.16**	-0.53	0.08	-0.01
L*					**0.12**	0.21	0.47
a*						**0.21**	-0.05
b*							**0.14**

[A] Heritabilities on the diagonal, genetic correlations above the diagonal.
[B]BW = body weight; BRY = breast yield; pH_{20} = pH 20 min post-mortem; pHu = ultimate pH; L* = lightness; a* = redness; b* = yellowness.

Other meat characteristics exhibited low to moderate heritabilities, ranging from 0.12 to 0.21, when measured in breast muscle. By contrast, the impact of the genetics appeared extremely low for the same traits measured in thigh muscle, with heritabilities close to zero. To our knowledge, there are no other results in poultry on the genetic parameters of meat quality of the thigh muscle, which has an intermediate metabolic type. However, in the study of Larzul (1997), in pig very low levels of heritabilities for the L* and a* values were also obtained in a red muscle, by contrast with the intermediate heritability values found in some mixed and white muscles. Moreover, our results indicated a strong negative genetic correlation between the rate of pH fall and the lightness of breast meat. This could be explained by the fact that both traits characterize the PSE syndrome, abnormally low pH at an early post-mortem time, when carcass temperature is still high, leading to protein denaturation responsible for color and water-binding capacity alterations. Surprisingly, a significant positive genetic correlation was estimated between the rate and the extent of pH fall in breast muscle. No explanation can be given at this time, as this was not concordant with our first results in chicken nor with the genetic results obtained in pork. According to our results, the lowest pH values, either at 20 min and 24 h post-mortem, were associated with the lowest growth and muscle development performances, with very significant positive genetic correlations. These results did not validate the hypothesis that birds intensively selected for growth and muscle development would be more susceptible to meat defects. On another hand, this trend contrasted with the situation observed in pork, where a genetic antagonism between technological quality and growth or body composition traits is usually reported (Sellier and Monin, 1994).

CONCLUSIONS

Under our experimental conditions, heritabilities of meat quality traits appeared moderate to high, thus showing the interest of genetic approach to improve meat quality in poultry. These first studies also confirmed at a genetic level the influence of pH fall on the technological meat quality, as strong genetic correlations with water-holding capacity and color were found. In the same time, they underlined the importance of the environment under which meat traits were measured since, for example, excessive rate of pH fall could only be observed under industrial conditions. Research is now conducted to better understand the underlying factors, related to stress sensitivity or muscle characteristics, responsible of the variations in quality, and to precise their genetic determinism. More especially, the impact of major genes on meat quality identified in pork should now be tested in poultry.

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