Evaluation of specific populations of commercial pigs produced in Québec for feed performance, carcass yield and lean meat colour

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Département des sciences animales, Faculté des sciences de l'agriculture et de l'alimentation, Université Laval, Sainte-Foy, Québec, Canada G1K 7P4. *Received 30 May 1995, accepted 19 October 1995.*

Hammell, K. L., Laforest, J. P. and Dufour, J. J. 1995. **Evaluation of specific populations of commercial pigs produced in Québec for feed performance, carcass yield and lean meat colour**. Can. J. Anim. Sci. **75**: 517–524. Data from approximately 850 commercial pigs tested in 12 trials, from 1987 to 1990 at the Beaumont test station in Québec were used to determine the effect of growth rate and body composition on growth performance, carcass yield and lean meat colour. Pigs were housed four to a pen and were fed commercial diets. Feed intake and growth rate were measured during the test, and carcass measurements were taken at slaughter and at 24 or 72 h following slaughter. The different groups of pigs were defined according to a 2 × 2 factorial, with one factor being the growth rate [fast growth (FG) or slow growth (SG)] and the second factor being the body composition of the carcass [fat (F) or lean (L)]. The FG commercial pigs reach market weight at a younger age with lower overall feed consumption and generally a better feed conversion than SG pigs. Furthermore, FG pigs have more backfat, longer carcasses and a slightly darker meat. The L commercial pigs had similar growth performances with a better lean meat yield than the F commercial pigs. Growth variables and composition of the carcass had little effect on the meat characteristics measured. The proportion of barrows compared to gilts was higher in the FG and F groups than in the SG and L groups, which could account for some of the differences observed between groups. However, the rate of growth and the type of body composition affected the growth and feed consumption performances as well as the carcass yield in a similar way for both sexes. Overall, less than 3% and less than 2% of the pigs produced meat with a colour standard of 1 (extremely pale) or 5 (extremely dark), respectively. The SG-L group had a slightly higher proportion of pigs with a pale meat colour compared to the other groups.

Key words: Pig, backfat, growth rate, carcass composition, meat colour

Hammell, K. L., Laforest, J. P. and Dufour, J. J. 1995. **Évaluation de populations specifiques de porcs commerciaux au Québec, pour les performances de consommation, le rendement de la carcasse et la couleur de la viande**. Can. J. Anim. Sci. **75**: 517–524. Environ 850 porcs commerciaux ont été évalués à la station d'épreuve de Beaumont, Québec, à l'intérieur de 12 tests effectués entre 1987 et 1990. Les porcs étaient groupés à quatre par parquet et alimentés d'une moulée commerciale. La prise alimentaire et les paramètres de croissance ont été évalués sur test et les mesures de carcasse ont été prises à l'abattage ainsi que 24 ou 72 h après. Un dispositif factoriel 2 × 2 a été utilisé pour comparer 4 groupes de porcs avec comme premier facteur le taux de croissance [croissance rapide (FG) ou croissance lente (SG)] et le deuxième facteur la composition de la carcasse [gras (F) ou maigre (L)]. Les porcs commerciaux du groupe FG atteindre le poids d'abattage à un âge plus jeune, en consommant moins de nourriture totale et ont en général un meilleur taux de conversion alimentaire que les porcs du groupe SG. En plus, les porcs du groupe FG ont une plus grande épaisseur de gras dorsal, une carcasse plus longue et une viande légèrement plus foncée. Les porcs commerciaux du groupe L avaient des performances de croissance semblables et un meilleur rendement en viande maigre que les porcs du groupe F. Le taux de croissance et la composition de la carcasse n'ont pas influencé de façon marquée les caractéristiques mesurés de la viande. En proportion, les groupes FG et F avaient plus de mâles castrés et moins de femelles que les groupes SG et L, ce qui pourrait en partie expliquer les différences obtenues entre les groupes. Toutefois, le taux de croissance et la composition de la carcasse ont affecté les performances de croissance et de consommation ainsi que le rendement de la carcasse de la même façon pour les deux sexes. Globalement, moins de 3% et moins de 2% des porcs étudiés donnaient une viande dont la norme de couleur était de 1 (très pâle) ou de 5 (très foncée), respectivement. Le groupe de porcs SG-L présentait une proportion légèrement plus élevée que les autres groupes de porcs ayant une viande très pâle.

Mots clés: Porc, gras dorsal, taux de croissance, composition de la carcasse, couleur de la viande

Faced with global commercial trade and the competition from other meat productions, the swine industry must have the means to produce the best quality pork possible. More and more the quality of exported pigs determines the viability and the competitiveness of the swine sector. The "Programme d'Évaluation des Porcs Commerciaux, inc."

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Abbreviations: ADG, average daily gain; **BC**, body composition; **F**, fat; **FG**, fast growth; **GR**, growth rate; **L**, lean; **PEPC**, Programme d'Évaluation des Porcs Commerciaux, inc.; **PSE**, pale, soft, exudative; **SG**, slow growth

(PEPC), which involves many participants from Québec's swine industry, evaluates feed and growth performances as well as carcass and meat characteristics of commercial pigs in a test station. The results of this program can be used to propose future production guidelines. Sather and Jones (1988) hypothesized that a relationship exists between the proportion of lean in a carcass and the quality of the meat and that an increase in growth rate of the lean could result in a higher proportion of PSE meat. While this citation references material prior to a complete understanding of the role of PSS, PSE and the halothane gene on meat quality and carcass yield, it addresses a real concern that existed when the PEPC was created in the 1980s to evaluate commercial pigs produced in Quebec. Also, studies involving genetically selected lines of growing-finishing swine have been conducted to examine the relationship between various economic parameters, such as backfat thickness, post-weaning growth and feed efficiency. Vangen (1977) found that over a fixed weight period feed consumption was correlated to the feed/gain ratio. Sather and Fredeen (1978), Bark et al. (1992) and Woltmann et al. (1992) found that pigs selected for a high lean tissue growth gained body weight and muscle faster and were more efficient than slow growers.

However, to the best of our knowledge no report exists about the relationships between different growth and feed intake performances as well as carcass characteristics of a population of commercial pigs that have been selected for fewer days to slaughter and less backfat thickness in order to be more economically viable for the producer. Commercial pigs evaluated in Québec, through PEPC could serve as a data base to examine these various parameters.

The objectives of the present study were to evaluate feed performance, carcass yield and meat characteristics of commercial swine produced in Quebec and to determine the association between meat colour and certain growth performances as well as carcass composition variables in different groups of pigs partitioned into distinct populations based on pre-selected factors such as rate of growth as well as backfat and loin muscle thickness.

MATERIALS AND METHODS

Collection of Data

Data were obtained from 12 trials (trials 3 to 14; trials 1 and 2 were eliminated due to different housing conditions) conducted on commercial pigs at the test station of Beaumont, Quebec (Hammell et al. 1993). Trials took place between January 1987 and November 1990. The original data set included approximately 2900 pigs of different origins, breeds and sex, which were raised during different periods of the year, but only approximately 850 of them were kept for the present experiment.

Pigs of the same sex and genetic type [two pairs of brothers (barrows) or sisters], and coming from the same herd were housed four to a pen. Individual pig weights were recorded at the start (average weight 15 kg and 56.5 d of age), at 4 wk (≅30 kg), at 9–10 wk (≅60 kg) and at the end of test (≅95–100 kg). During the final weigh period, backfat was measured on each pig by ultrasound (Scanmatic SM-1).

All pigs were fed ad libitum a pelleted starter diet (17.9% or 19.7% protein for trials 3–5 and 6–14, respectively) for a period of 3–6 wk (3 wk: trials 13, 14; 4 wk: trial 7; 5 wk trials, 3, 8–12; 6 wk: trials 4–6), and then a grower diet (16.9% protein) until the end of test. All protein levels chosen met the dietary requirements of the pigs. Average feed intake was measured weekly on a per-pen basis. Pigs had free access to drinking water.

At the end of test, the pigs were trucked to a commercial abattoir, slaughtered the next day, chilled for 24 h, then cut-up the day following slaughter, according to standard commercial practices (Anonymous 1972). Hot carcass weight and fat and loin thicknesses were taken the day of slaughter and the remaining carcass measurements as well as meat measurements were taken 24 h (trials 3–8) or 72 h (trials 9–14) after slaughter. Meat colour was assessed visually on the exposed surface of the loin and scored according to the standards of Agriculture Canada (1984: values of 1–5). A colour standard of 1 corresponds to an extremely pale coloured meat, whereas a colour standard of 5 corresponds to an extremely dark coloured meat. The pH (pH meter Fisher model 119 3D, electrode orion # H5815-9) was taken on the loin (Longissimus dorsi), at the same location where fat thickness was measured on the carcass (between the third and fourth last ribs, 7 cm from the dorsal median line of the carcass), and on the exposed muscle of the ham (Semimembranosus). Luminosity L* and chromaticity values a* and b* (Minolta Chroma meter CR-200b) were also measured adjacent to where the pH was taken. High luminosity L* indicates a paler muscle, whereas a low value is associated with darker muscles. Chromaticity values a* and b* are normally used together to calculate the hue and chroma of the meat but were analyzed as independent variables in the present experiment.

Determination of the Groups and Statistical Analysis

The first step was to define the different groups of pigs according to a 2 × 2 factorial, with one factor or treatment being the growth rate (FG or SG) and the second factor or treatment being the degree of fatness of the carcass or body composition (F or L). The pigs were allocated to the four different treatment groups according to whether they were above or below the average of all the pigs (trials 3–14). The three following growth variables (average of all the pigs in parenthesis): test duration (119.04 d); age at slaughter (175.35 d); ADG (693.63 g d^{-1}); as well as the three following carcass composition variables: backfat thickness (on the live animal by ultrasound: 16.51 mm), loin fat thickness (19.05 mm), loin muscle thickness (47.22 mm) were chosen to differentiate the different treatment groups. While ADG is a measure commonly used to evaluate growth rate, other sectors of the pig industry tend to express growth in terms of days to slaughter. Thus, test duration and age at slaughter were also chosen as indicators of growth rate as they are also highly correlated. Since a pig had to satisfy the three discriminating variables for each of the factors to be retained for the analysis, many pigs were not included in any of the groups and were, therefore, excluded from the data set. With only the three discriminating variables for growth, 30% of the data were excluded from the base population for the analysis. For the carcass composition, 23% of the pigs in the base population were excluded when loin fat and backfat were used as discriminating variables. The backfat thickness taken by ultrasound as it is highly correlated with loin fat thickness was used as a safeguard to discriminate the pigs into their various groups. However, since the analysis pertains not only to lean carcasses but also to muscling, the addition of loin muscle thickness as another discriminating variable excluded an additional 37% of the base population. Therefore, 60% of the base population was excluded by using the three discriminating variables for carcass composition. Overall, less than 30% of the pigs (approximately 850 pigs) from the original data set could be classified into either one of the four groups according to their growth rate and carcass composition. The allocation of the pigs into the four different treatment groups based on the three discriminating variables for each factor may have eliminated many pigs, but it was to prevent any overlap and to accentuate the differences between the two groups within each factor in order to better evaluate these specific populations of pigs for feed performance, carcass yield and lean meat colour.

The least square means and standard errors were calculated for the discriminating variables as well as those of feed performance, carcass yield and measurements on the meat. The General Linear Model procedure of the SAS Institute, Inc. (1985) was used for statistical analysis to determine the group effect according to the following model;

$$Y_{ijk} = \mu + G_i + B_j + (GB)_{ij} + e_{ijk}$$

where Y_{ijk} is the individual observation of the *i*th independant growth variable (G), the *j*th body composition variable (B) and the *k*th animal and μ is the overall mean. All main effects are fixed except for the error e_{ijk}, which is an independent random variable normally distributed with mean of 0 and variance σ^2. When a covariate was used, the term + $b(\text{cov}_{ijk} - \overline{\text{cov}})$ was added to the model, where cov_{ijk} is the value of the covariate measured on the *k*th observation and $\overline{\text{cov}}$ is the mean of the covariate. The *b* term is the regression coefficient of the covariate on the variable analyzed.

Age and weight at the start of test were used in the model as covariates for all the variables taken on the live animal, except for backfat. The final liveweight was used as a covariate for the backfat measurement. The hot carcass weight was used in the model as a covariate for the carcass performance variables. The meat variables were analyzed without a covariate. The covariates used were all affected by the treatments, except the initial age at the start of test. Therefore, all the analyses were also done without covariates in the model. Results with and without the covariates did not vary, except for the dressing percentage and the half-carcass weight. The implications of these differences will be discussed in the results. Pearson coefficients of correlation were also calculated between the discriminating variables and the variables within each experimental group.

Pigs originated from different trials and it has been shown previously that there was a trial effect on the variables measured (Hammell et al. 1993, 1994). Therefore, a first analysis was done to evaluate a possible interaction between trials and treatments. For most of the variables studied, the interaction was not significant. When it was, the interaction was due to a difference in the amplitude of the response to one treatment or the other, from one trial to another. in every trial, the direction of the response was the same for all the treatments. The data from the different trials were therefore pooled for the final analysis.

The proportions of pigs with meat classified in each of the 5 colour standards were compared with a chi-square analysis of the data among the four treatment groups. A chi-square analysis was also performed to compare the distribution of the sexes among the four treatment groups.

RESULTS AND DISCUSSION

Composition of the Groups by Sex

Since no control was possible for the distribution of the pigs in the four groups according to the sex, it could have been possible to explain part or all the differences obtained between FG-F, FG-L, SG-F, SG-L groups by different proportions of a certain sex of pig being in one group or the other. Godbout and Minvielle (1990), Ramsey et al. (1990) and Cromwell et al. (1993) have shown that barrows have thicker backfat than gilts. Also, a previous analysis of the data from the PEPC pigs has shown that barrows grow faster and eat more per day than gilts (Hammell et al. 1993), which agrees partly with the results of Cromwell et al. (1993) who also found a better average daily gain but a poorer feed efficiency for barrows compared to gilts.

A chi-square analysis of the data showed that the sexes were not distributed at random within the treatments ($P < 0.0001$). Fourty-six percent of the barrows were found to be in the FG-F group, followed by 22% in the SG-F, 18.5% in the FG-L and 13.5% in the SG-L groups, respectively. By contrast, the majority of the females were in the SG-L group (49.5%) followed by 31% in the FG-L, 11% in the SG-F and 8.5% in the FG-F groups, respectively. Therefore, all the variables were analyzed by including the effect of sex and the interaction between treatments and sex in the model. This analysis failed to show any interaction between sex and treatment for most of the variables measured. Therefore, the treatments had the same effects on the variables measured for both barrows and females. When an interaction was observed, the direction of the response to the treatment was always the same for both sexes, only the magnitude of the response differed from one sex to another. So, for the interpretation of the data, both sexes were considered to react similarly to the treatments.

Discriminating Variables

Results for the three discriminating variables for each of the two factors studied are presented in Table 1. As expected, the stringent criteria used to discriminate between slow and fast growers are reflected in the large differences between the two groups for the age at slaughter, the duration of test and the ADG. Similarly, large differences were also obtained between fat and lean pigs for backfat thickness (both on the live animal and on the carcass) and loin muscle thickness.

Table 1. Characteristics of commercial pig populations in Québec which differ by their GR and BC

Factorial[z] GR	BC	Age at slaughter (d)	Duration of test (d)	Average daily gain (g d^{-1})	Backfat (mm)	Loin fat thickness (mm)	Loin muscle thickness (mm)
Fast	Lean	163.0 (209)	106.1 (213)	777.3 (213)	14.0 (155)	16.1 (212)	52.4 (213)
Fast	Fat	161.7 (220)	105.4 (223)	782.3 (223)	20.4 (223)	24.1 (223)	42.4 (223)
Slow	Lean	188.6 (278)	132.3 (278)	616.6 (278)	13.4 (277)	15.1 (278)	53.3 (278)
Slow	Fat	186.4 (139)	130.1 (139)	621.9 (139)	20.5 (139)	23.6 (139)	41.5 (139)
Factors							
GR							
Fast		162.1 (429)	105.8 (436)	779.8 (436)	17.2 (378)	20.1 (435)	47.4 (436)
Slow		187.5 (417)	131.2 (417)	619.2 (417)	17.0 (406)	19.3 (417)	47.4 (417)
BC							
Lean		175.5 (487)	119.2 (491)	696.9 (491)	13.7 (422)	15.6 (490)	52.8 (491)
Fat		174.0 (359)	117.7 (362)	702.1 (362)	20.4 (362)	23.8 (362)	42.0 (362)
SE LSM		0.6–0.9	0.4–0.6	4.5–6.7	1.3–2.1	0.2	0.3–0.4
Analysis of variance							
Growth rate							
$P <$ value		0.0001	0.0001	0.0001	0.2039	0.0002	0.8427
Body composition							
$P <$ value		0.0018	0.0018	0.1485	0.0001	0.0001	0.0001
Interaction							
$P <$ value		0.1528	0.1528	0.9670	0.0422	0.1630	0.0028

[z]Least square means are presented. The number of pigs per treatment is in parentheses.
SE LSM, Standard error of the least square means. The lowest and highest SE LSM among treatments are presented.

The three discriminating variables chosen for the growth rate (test duration, age at slaughter and ADG) were highly correlated (r = 0.90, –0.89, –0.88 for duration vs. age, duration vs. ADG and age vs. ADG, respectively; $P < 0.0001$) so that a pig with a short test duration and a young age at slaughter was quite likely to have a high ADG and vice versa. The three discriminating variables chosen for body composition (backfat thickness, loin fat thickness and loin muscle thickness) were also correlated (r = 0.89, –0.66, –0.68 for backfat vs. loinfat, backfat vs. loin muscle and loin fat vs. loin muscle, respectively; $P < 0.0001$), although the r value was lower between fat and muscle measurements than between fat thickness measured on the animal and on the carcass. There was an interaction for backfat measurements taken with ultrasound. The difference in backfat thickness between F and L pigs was larger for SG than for FG pigs. The SG pigs had less loin fat than FG pigs and, of course, F had more loin fat than L pigs. This agrees with the results of Yen et al. (1990), who also found that obese pigs had more backfat than lean pigs. Differences were not as obvious for muscle thickness. However, L pigs always had a thicker loin muscle than F pigs, but the difference between the two groups was larger for the SG than for the FG pigs.

Correlations between the three discriminating variables for growth rate and the carcass yield variables were generally relatively low. Correlations between the three discriminating variables for carcass composition and the carcass yield variables were also low except for the estimated lean yield and the classification index (data not shown). This was expectable since both these variables are calculated from the loin fat thickness. The three discriminating variables for growth rate and the three discriminating variables for body composition were not highly correlated to any of the meat measurements, indicating that there is little relation between growth performance, body composition and meat characteristics (data not shown).

Feed Performances and On-test Weights

Feed results should be interpreted cautiously since they are based on means per pen and not on data taken individually on each animal. The data in Table 2 agree with those of Sather and Fredeen (1978), Bark et al. (1992), Woltmann et al. (1992), Mikel et al. (1993) and Friesen et al. (1994) who found that fast growing pigs compared to slow growing pigs had a higher daily feed consumption but a better average daily gain and were therefore younger at slaughter. Robison (1976) and Vangen (1977) also showed a high genetic correlation between ADG and feed conversion. Also, pigs selected for a high ADG and low backfat thickness ate more per day than pigs with a low ADG and a high

Table 2. Effect of GR and BC on feed performances and test weights of commercial pigs in Québec

		Total feed intake (kg)	Daily feed intake (kg)	Feed conversion (liveweight)	Feed conversion (carcass weight)	Initial body weight (kg)	Final body weight (kg)
Factorial[z]							
GR	BC						
Fast	Lean	217.8 (54)	2.00 (54)	2.66 (54)	2.87 (54)	14.8 (213)	97.5 (213)
Fast	Fat	234.9 (61)	2.19 (61)	2.86 (61)	3.10 (61)	17.0 (223)	97.4 (223)
Slow	Lean	234.3 (84)	1.81 (84)	2.89 (84)	3.07 (84)	14.6 (278)	96.5 (278)
Slow	Fat	247.4 (38)	1.94 (38)	3.11 (38)	3.36 (38)	14.4 (139)	95.9 (139)
Factors							
GR							
Fast		226.4 (115)	2.09 (115)	2.76 (115)	2.98 (115)	15.9 (436)	87.5 (436)
Slow		240.8 (122)	1.87 (122)	3.00 (122)	3.21 (122)	14.5 (417)	96.2 (417)
BC							
Lean		226.0 (138)	1.90 (138)	2.78 (138)	2.97 (138)	14.7 (491)	97.0 (491)
Fat		241.2 (99)	2.06 (99)	2.97 (99)	3.23 (99)	15.7 (362)	96.7 (362)
SE LSM		1.8–2.7	0.02	0.02–0.04	0.03–0.04	0.3–0.4	0.2–0.3
Analysis of variance							
Growth rate $P <$ value		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Body composition $P <$ value		0.0001	0.0001	0.0001	0.0001	0.0012	0.1985
Interaction $P <$ value		0.4017	0.0823	0.7153	0.3724	0.0001	0.2961

[z]Least square means are presented. The number of pens (four pigs per pen) or pigs (for the weight variables) per treatment is in parentheses.
SE LSM, Standard error of the least square means. The lowest and highest SE LSM among treatments are presented.

backfat thickness (Vangen 1977). A negative correlation was found between daily feed consumption and age at slaughter ($r = -0.59$; $P < 0.0001$). The ADG and feed conversion were also negatively correlated ($r = -0.50$; $P < 0.0001$). The *F* pigs ate more per day and also ate more food overall which resulted in a poorer feed conversion than for the L pigs (Table 2). The *F* pigs had an ADG similar to that of the L pigs but were slaughtered at a younger age because they started the test heavier. This agrees in part with the results of Yen et al. (1990) who found that obese pigs had a poorer feed conversion ratio but contrary to the present study the obese pigs also had a poorer average daily gain.

Initial body weight was affected by treatments and a significant interaction was found between growth rate and body composition. However, within the FG group, the F pigs were much heavier at the beginning of test than the L pigs, whereas F and L pigs almost had the same weights for the SG group. These results show that the stringent discriminating criteria used to determine the populations of pigs were closely associated to the characteristics of the pigs even before the beginning of test. It seems that heavier pigs at approximately 56 d of age are more likely to become fat pigs, especially if they are fast growers.

Final body weights should have been similar among the groups but the FG pigs were slightly heavier at the end of test than the SG pigs. Furthermore, the ADG and liveweight at slaughter were correlated ($r = 0.42$, P < 0.0001), indicating that the faster growing animals were heavier at slaughter than the slower growers. These results probably reflect the fact that the end of test was based on a specific final liveweight and the pigs were weighed only once a week after reaching ≅60 kg before being shipped to the abattoir. This could favour the slow growers and penalise the fast growers, as the fast growers who were just under the target weight 1 wk would be on the heavy side the following week. A more frequent weighing would have been preferable but hardly feasible in the conditions of the present experiment.

Overall, daily feed consumption was positively correlated to backfat measurements ($r = 0.59$ and 0.54 for backfat and loin fat thicknesses respectively; $P < 0.0001$) and negatively correlated to loin muscle thickness ($r = -0.42$, $P < 0.0001$). Therefore, pigs that eat more per day tend to be fatter. The results of Woltmann et al. (1992) suggest that most of the additional feed intake in the fast growers versus the slow growers resulted in the deposition of fat.

Carcass Characteristics

The L pigs have the heaviest hot carcass weights but the difference between L and F animals is larger for the SG than the FG pigs (Table 3). The SG pigs and L pigs had better

Table 3. Effect of GR and BC on commercial assessment of the carcasses of commercial pigs in Québec

		Hot carcass weight (kg)	Dressing percentage (%)	Classification index	Carcass length (cm)	Half-carcass weight (kg)	Ham yield (%)	Loin yield (%)	Shoulder yield (%)	Estimated lean yield (%)
Factorial[z]										
GR	BC									
Fast	Lean	76.3	78.3	109.2	80.0	33.9	26.3	25.4	26.5	51.6
		(213)	(213)	(213)	(204)	(204)	(204)	(204)	(204)	(213)
Fast	Fat	76.0	77.9	101.8	79.0	33.3	25.5	26.0	26.7	48.1
		(223)	(223)	(223)	(212)	(212)	(210)	(210)	(210)	(223)
Slow	Lean	76.8	79.4	109.4	79.5	33.4	27.0	25.7	26.7	52.0
		(278)	(278)	(277)	(171)	(160)	(156)	(156)	(156)	(278)
Slow	Fat	75.2	78.8	101.9	78.6	33.6	25.5	25.4	26.2	48.2
		(139)	(139)	(138)	(121)	(117)	(116)	(116)	(116)	(139)
Factors										
GR										
Fast		76.2	78.1	105.5	79.5	33.6	25.9	25.7	26.6	49.9
		(436)	(436)	(436)	(416)	(416)	(414)	(414)	(414)	(436)
Slow		76.0	79.1	105.7	79.1	33.5	26.3	25.5	26.5	50.1
		(417)	(417)	(417)	(292)	(277)	(272)	(272)	(272)	(417)
BC										
Lean		76.6	78.9	109.3	79.7	33.6	26.7	25.6	26.6	51.8
		(491)	(491)	(490)	(375)	(364)	(360)	(491)	(360)	(491)
Fat		75.6	78.3	101.9	78.8	33.4	25.5	25.7	26.4	48.2
		(362)	(362)	(361)	(333)	(329)	(326)	(326)	(326)	(362)
SE LSM		0.2–0.3	0.1	0.1	0.1–0.2	0.1	0.1	0.1–0.2	0.1–0.2	0.1
Analysis of variance										
Growth rate										
$P <$ value		0.4897	0.0001	0.4719	0.0104	0.5618	0.0032	0.1982	0.4716	0.0007
Body composition										
$P <$ value		0.0001	0.0001	0.0001	0.0001	0.0952	0.0001	0.5612	0.3372	0.0001
Interaction										
$P <$ value		0.0079	0.5557	0.8132	0.6620	0.0001	0.0209	0.0064	0.0214	0.0291

[z]Least square means are presented. The number of pigs per treatment is in parentheses.
SE LSM, Standard error of the least square means. The lowest and highest SE LSM among treatments are presented.

dressing percentages than FG and F pigs, respectively. No interaction was found between treatments when the analysis was performed with the hot carcass weight as a covariate but a significant interaction was found without a covariate ($P > 0.0426$). The use of the hot carcass weight as a covariate reduced the effect of the difference obtained in dressing percentages between the SG-L and SG-F animals, eliminating the interaction. Growth rate did not affect the classification index but, as expected, F pigs had a lower ($P < 0.0001$) classification index than L pigs. The FG and L pigs had longer carcasses than the SG and F pigs, respectively, but similar half-carcass weights. Yen et al. (1990) also found that obese pigs had shorter carcasses, but contrary to the present study they had a higher dressing percentage. An interaction was observed for half-carcass weight with the F animals being lighter than the L pigs for the FG group, and the opposite for the SG group. The analysis conducted without the hot carcass weight as a covariate for the half-carcass weight showed significant effects of growth rate ($P < 0.0097$) and body composition ($P < 0.0072$), with a significant interaction between the two ($P < 0.0083$). Nevertheless, the differences between treatments, although significant, were quite small. It seems that F pigs lose less weight than L pigs for the fast growers, but the opposite was noted for the slow growers.

Interactions were significant for all the wholesale cut percentages. Ham yield was higher for the L pigs than for the F pigs and the difference between L and F was larger for the SG than the FG group. Loin yield did not differ much between groups although, in the FG group, F pigs had a higher yield than L pigs. Shoulder yield was almost the same for all groups. Nevertheless, the yield was larger for F pigs in the FG group and for L pigs in the SG group. Larger differences were found for estimated lean yield which was always larger for lean than fat pigs. Nevertheless, SG pigs had a better lean yield than FG pigs.

Meat Characteristics

Small differences were observed for the ultimate pH of both the loin and the ham (Table 4). In the SG group, the F pigs had slightly higher pH values than the L pigs, whereas no difference between F and L pigs was observed in the FG group. For the loin, the luminosity L* value was higher for the F than the L pigs in the FG group, whereas it was the opposite in the SG group. This observation was not repeated for the ham since the luminosity L* was higher for the F than the L pigs for both the SG and FG groups. The SG pigs also had a slightly higher luminosity L* value, corresponding to a paler meat than the FG pigs. Muscle marbling could have been a factor affecting the luminosity L* of the muscle but this variable was not measured in the present study. Since, in the present study, the texture of the meat was also not evaluated, it is not possible to assume that meat with a

Table 4. Effect of GR and BC on some meat characteristics of commercial pigs in Québec

		pH Loin	pH Ham	Luminosity L* loin	Chromaticity a* loin	Chromaticity b* loin	Luminosity L* ham	Chromaticity a* ham	Chromaticity b* ham
Factorial[z]									
GR	BC								
Fast	Lean	5.66	5.75	49.3	5.2	3.9	50.6	5.4	3.3
		(187)	(185)	(190)	(148)	(147)	(188)	(146)	(133)
Fast	Fat	5.71	5.77	51.7	5.2	5.2	52.0	5.5	4.7
		(204)	(204)	(196)	(71)	(71)	(196)	(71)	(57)
Slow	Lean	5.58	5.70	52.3	5.1	4.6	51.7	5.3	3.3
		(147)	(204)	(133)	(108)	(106)	(197)	(172)	(146)
Slow	Fat	5.73	5.80	51.7	4.6	4.6	52.2	4.9	4.0
		(104)	(106)	(99)	(49)	(49)	(104)	(55)	(42)
Factors									
GR									
Fast		5.69	5.76	50.5	5.2	4.5	51.3	5.5	4.0
		(391)	(185)	(386)	(219)	(218)	(384)	(217)	(190)
Slow		5.65	5.75	51.9	4.9	4.6	52.0	5.1	3.7
		(251)	(310)	(232)	(157)	(155)	(301)	(227)	(188)
BC									
Lean		5.62	5.73	50.8	5.1	4.3	51.1	5.3	3.3
		(334)	(389)	(323)	(256)	(253)	(385)	(318)	(279)
Fat		5.72	5.78	51.6	4.9	4.9	52.1	5.2	4.3
		(308)	(310)	(295)	(120)	(120)	(300)	(126)	(99)
SE LSM		0.02–0.03	0.02–0.03	0.3–0.5	0.1–0.2	0.1–0.3	0.3–0.4	0.1–0.2	1.5–2.0
Analysis of variance									
Growth rate									
$P <$ value		0.1110	0.5975	0.0004	0.0446	0.6898	0.0445	0.0121	0.1113
Body composition									
$P <$ value		0.0001	0.0084	0.0339	0.2063	0.0038	0.0074	0.3298	0.0001
Interaction									
$P <$ value		0.0251	0.0474	0.0001	0.1885	0.0018	0.1973	0.0785	0.1191

[z]Least square means are presented. The number of pigs per treatment is in parentheses.
SE LSM, Standard error of the least square means. The lowest and highest SE LSM among treatments are presented.

colour standard of 1 is PSE and that meat with a colour standard of 5 is DFD. Approximately 7% (200 of the 2900 pigs in the original data set) of all pigs are in the FG-L category. Interestingly, the frequency of animals found in purebred swine herds tested in Quebec, as of December 1993, for the Halothane gene was 6% for the Hampshire and Duroc, 12% for the Yorkshire and 21% for the Landrace breeds, respectively (Centre de Développement du Porc du Québec 1994). It was not determined if the FG-L pigs were carriers of the Halothane gene. It seems, however, that a more rapid growth did not have a negative effect on meat colour.

Chromaticity a* value was not affected markedly by treatments. For the loin and the ham, it was higher for the FG than the SG pigs. Chromaticity b* value of the loin was higher for the F than L pigs in the FG group whereas no difference was observed between F and L pigs in the SG group. A difference for the chromaticity b* value of the ham between L and F pigs was obtained for both FG and SG pigs.

Relationship of Meat Colour to Growth and Carcass Performances

According to the criteria used to create the colour standard groups on the loin muscle, 2.6% of the pigs in the present study had very pale meat, 22.7% pale meat, 58.6% normal

Table 5. Effect of GR and BC on meat colour of commercial pigs in Québec

		Colour standard				
		1	2	3	4	5
Factorial[z]						
GR	BC					
Fast	Lean	4	50	118	26	4
		(2.0)	(24.8)	(58.4)	(12.9)	(2.0)
Fast	Fat	3	43	126	35	1
		(1.4)	(20.7)	(60.6)	(16.8)	(0.5)
Slow	Lean	11	33	90	25	2
		(6.8)	(20.5)	(55.9)	(15.5)	(1.2)
Slow	Fat	0	30	69	17	1
		(0.0)	(25.6)	(59.0)	(14.5)	(0.9)
Factors						
GR						
Fast		7	93	244	61	5
		(1.7)	(22.7)	(59.5)	(14.9)	(1.2)
Slow		11	63	159	42	3
		(4.0)	(22.7)	(57.2)	(15.1)	(1.1)
BC						
Lean		15	83	208	51	6
		(4.1)	(22.9)	(57.3)	(14.0)	(1.7)
Fat		3	73	195	52	2
		(0.9)	(22.5)	(60.0)	(16.0)	(0.6)

[z]Numbers of animals are presented. Percentages are in parentheses.

meat, 14.9% dark meat and 1.2% very dark meat (Table 5). This is similar to the results of Hammell et al. (1994) who found that when all different cross types of pigs were put together, only 1.8% of the pigs had extremely pale meat and 0.5% had extremely dark meat. A chi-square analysis showed that the repartition between colour groups was significantly different between the four treatments ($P = 0.058$). This effect is especially due to a higher number of animals classified in colour standard 1 for the SG-L group. The pigs in this group were also the oldest at slaughter. Therefore, very few animals were classified as either having very pale or very dark meat. It is not clear whether growth rate and body composition have a significant effect on meat color in commercial pigs.

In conclusion, the results of the present study show that fast-growing commercial pigs in Québec generally have better feed conversion and therefore can reach market weight at a younger age with lower overall feed consumption than slower growing pigs. Furthermore, fast-growing pigs have more backfat, longer carcasses and slightly darker meat. Lean commercial pigs had similar growth performances with a better lean meat yield than the fatter commercial pigs. Growth variables and composition of the carcass had little effect on the meat characteristics measured. Interactions between body composition and growth rate were found for many variables, indicating that the effect of selection for one trait should be considered in conjunction with the other. A disproportion of more barrows in the fast growth and fat groups does not account for the differences between treatment groups. Therefore, the rate of growth and the type of body composition affects the feed consumption performances as well as the carcass yield in a similar way for both sexes. It seems that within the limits of growth performances normally obtained for commercial pigs in Québec, a selection for the faster-growing and leaner animals not only increases growth performance but results in relatively good carcasses with good meat colour.

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