SOURCES OF VARIATION IN BELLY SOFTNESS IN PIGS

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Background

Among the traits currently of importance to Canadian processors and exporters of pork bellies are the physical dimensions (width, thickness), the content and distribution of lean and the softness. Considerable attention has been given to methods for predicting the chemical composition of bellies from carcass or belly measurements (Fredeen et al. 1975, Johnson et al. 1984, Pfeiffer et al. 1993, Baulain et al. 1998, Tholen et al. 1998). Factors affecting belly softness have received less attention (Schinckel et al. 2000).

Objective

The current research study was designed to investigate potential sources of variation in pork belly softness.

Methods

A total of 184 Duroc and 46 Yorkshire pigs (equal numbers of gilts and boars) were fed a wheat/soya/barley/corn based grower ration and a wheat/soya/barley based finisher ration including no additional lipid sources except tallow. Pigs were shipped for slaughter at a weight of 116 ± 6 kg. Approximately 40 min after slaughter, backfat thickness was measured with a Hennessey Grading Probe at the 3rd and 4th last ribs, 70 mm from the carcass mid-line. On the day following slaughter, the carcass was broken into primal cuts. After the ribs were removed from the primal belly, it was square-trimmed and its length was measured.

The softness of the skin-on bellies was determined by draping them, skin-down, over a rod, 5 cm in diameter, for a 2 min period and then measuring the angle (degrees) to which they bent, as well as the distance between their two hanging ends 15 cm below the top of the rod. This technique is similar to that used by Schinckel et al. (2000).

Digital images of a cross-section of each belly were obtained perpendicular to its longitudinal axis and midway between its ends at approximately the 12th rib From these images, belly width, thickness, cross-sectional area and percentage of fat and lean in the cross-section were assessed using simple computer imaging techniques.

After skin removal, the remainder was ground and used for analysis of fat by Soxtec and protein by Kjeldahl (AOAC 1997). Iodine values were determined using subcutaneous belly fat (Cuppett 2001).

The data were analyzed using standard general linear model and correlation procedures (SAS 2001).

Results and Discussion

The effects of breed and sex on belly traits are shown in table 1. Backfat measurements with a Hennessey grading probe indicated that, at a similar age and weight, Duroc pigs were fatter than Yorkshire pigs and gilts were fatter than boars. Neither belly length nor width was affected by breed or gender. Thickness and area of the cross-section of the belly were not affected by gender, but Duroc pigs had a greater average belly thickness and cross-sectional area than Yorkshire pigs. The percentage of lean area in the belly cross-section was higher in Yorkshire pigs than in Duroc pigs and higher in boars than in gilts.

Chemical composition of bellies was also affected by gender and breed, with Duroc pigs having 5.5% more chemical fat and 1.6% less protein than the Yorkshire pigs and boars having 6.7% less fat and 1.3% more protein than gilts. The percentage of fat area in the cross-section of the belly was highly correlated with fat (r = 0.83) and protein (r=-0.83) content of the whole belly.

Belly bend angle and width, the measures of belly softness described in the Methods section, were much higher for gilts than for boars and much higher for Duroc pigs than for the Yorkshire pigs. The high correlation (r=0.91) between these two measures of softness indicates that they are associated with similar belly properties. Belly iodine value, a measure of the degree of unsaturation of fatty acids, was higher in Yorkshire than in Duroc pigs and was higher in boars than in gilts.

Absolute values of coefficients of correlations of belly bend angle and width with the other belly traits were less than 0.10 for carcass weight, belly length and belly width, 0.40-0.55 for belly thickness, cross-sectional area and iodine value and 0.60-0.76 for backfat, belly lean area, chemical fat and protein (Table 2). Most of these traits were associated with, or confounded with, fatness.

A large range of belly chemical fat (12 to 45%) was observed. In agreement with Fredeen et al. (1975), belly fat content was quite highly correlated with backfat measurement (r=0.80). Inclusion of any one of the fat measures (backfat, belly chemical fat, % of fat area in belly cross-section) as a covariate in the the statistical model including sex, line and their interaction almost, or completely, eliminated breed and sex effects for belly traits used in table 1. In other words, the effects of breed and sex on belly traits arose as a result of differences in fatness.

Multiple correlation analyses with bend angle and width as dependent variables and other belly traits as independent variables is presented in table 3. Chemical fat, belly cross-sectional area and belly length together account for 61% of the variation in belly bend angle. Chemical fat, belly cross-sectional area and belly length together account for 59% of variation in belly bend width. Iodine value was negatively correlated with fat content (r=-0.66), and after including a belly fat content in the multiple correlation analysis, iodine value did not account for additional variation in softness. The degree of unsaturation appeared to be totally confounded with fat content, the extent of unsaturation decreasing as the fat content increased. This is interesting in light of the findings of Schinckel et al. (2000) that treatment with conjugated lineoleic acid decreased fatness while increasing belly firmness through deposition of an increased proportion of saturated fatty acids.

Conclusions

Within the pigs evaluated, breed and sex appeared to be major sources of variation in belly traits, but these effects could be explained, for the most part, by differences in fat content. Belly softness was much more highly correlated with the amount of belly fat or backfat depth than with belly dimensions such as thickness. The degree of saturation of the fat had very little effect on the belly softness measures after adjustment for fat differences.

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Table 1. Least square means (±SE) of belly traits by sex within breed.

Trait	Duroc		Yorkshire		R^2	Probability	
	Boar	Gilt	Boar	Gilt		Breed	Sex
Slaughter Age (days)	157.8±0.5	158.0±0.5	157.6±1.0	157.6±1.0	0.00	ns	ns
Hot Carcass Weight (kg)	91.7±0.5	90.7±0.5	93.5±0.9	92.8±0.9	0.04	0.01	ns
Backfat (mm)	17.3±0.3	18.9±0.3	14.9±0.5	16.2±0.5	0.22	<0.0001	<0.0001
Belly Length (cm)	57.1±0.3	57.4±0.3	56.8±0.2	57.6±0.4	0.02	0.50	0.07
Belly Width (cm)	21.7±0.1	21.4±0.1	21.7±0.1	21.5±0.2	0.01	0.10	0.49
Belly Thickness (mm)	28.6±0.2	28.5±0.2	27.4±0.5	27.1±0.5	0.05	0.0009	ns
Belly Area (cm^2)	60.3±0.8	60.4±0.8	56.8±1.5	58.0±1.5	0.03	<0.0001	<0.0001
Belly Lean (% of area)	56.2±0.7	50.4±0.7	63.5±1.4	59.4±1.4	0.30	<0.0001	<0.0001
Belly Chemical Fat (%)	24.6±0.5	32.3±0.5	20.2±1.0	25.8±1.0	0.45	<0.0001	<0.0001
Belly Protein (%)	16.2±0.1	14.7±0.1	17.6±0.2	16.5±0.2	0.42	<0.0001	<0.0001
Belly Bend Angle (degrees)	28.6±1.6	47.7±1.6	18.7±3.1	31.9±3.1	0.33	<0.0001	<0.0001
Belly Bend Width (cm)	13.2±0.6	22.0±0.6	10.8±0.6	16.1±1.2	0.37	<0.0001	<0.0001
Belly Iodine Value (g/100g)	68.0±0.3	66.3±0.3	70.2±0.5	68.6±0.5	0.21	<0.0001	<0.0001

(Statistical Model: Trait = breed + gender + breed*gender + error)

Table 2. Correlations among belly and other traits.

	Belly Bend Angle	Belly Bend Width	Belly Lean Area	Belly Chemical Fat
Hot Carcass Wt.	0.06	0.04	-0.07	0.07
Backfat	0.64	0.57	-0.72	0.80
Belly Length	-0.09	-0.01	-0.09	0.04
Belly Width	0.08	0.10	-0.09	0.05
Belly Thickness	0.48	0.44	-0.47	0.48
Belly Area	0.46	0.50	-0.48	0.43
Belly Lean Area	-0.67	-0.64	-	-0.83
Belly Chemical Fat	0.76	0.71	-0.83	-
Belly Protein	-0.69	-0.67	0.83	-0.93
Belly Iodine Value	-0.52	-0.46	0.59	-0.66

Table 3. Multiple correlations with belly bend angle and width as dependent variables.

Order Included [z]	Belly Bend ANGLE	R^2	Belly Bend WIDTH	R^2
1	Belly Chemical Fat	0.58	Belly Chemical Fat	0.52
2	Belly Area	0.60	Belly Area	0.57
3	Belly Length	0.61	Hot Carcass Wt.	0.59

(Independent variables, listed in table 1, were added sequentially based on highest R^2.)