Determination of pork belly composition by non-invasive measures on the primal

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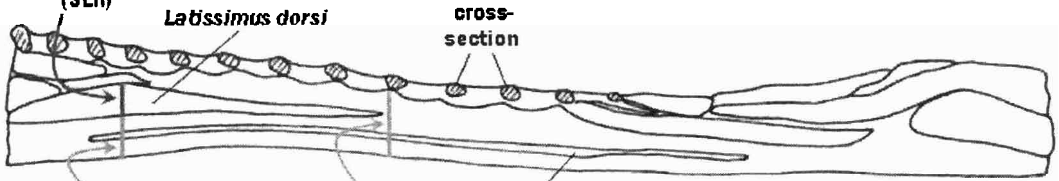
Introduction

To date, backfat thickness has been the best predictor of belly composition. However, in a primal-sorting system, backfat thickness, which is measured on the loin, would be unavailable on the belly. Therefore an equivalent or better estimator measured directly on the primal would be advantageous. The fattest part of the belly falls approximately 1/3 of the belly length posterior to the shoulder-belly cut located between the 2nd and 3rd ribs and perpendicular to the longitudinal axis of the carcass. The same area is associated with minimal measurement error due to the uniformity of muscle distribution. Under commercial conditions, maximum sorting flexibility occurs very early on the belly fabrication line, as markets differ in preferences regarding skin and rib removal. This study was conducted to attempt to identify one or more non-invasive measuring sites on the primal belly which would equal or surpass the backfat depth predictor of belly composition, and be amenable to adaptation in an on-line monitoring system.

Methods

Hot carcass wt. and grading probe data were collected on 216 crossbred marketweight hogs. Carcasses were fabricated to primals along commercial lines. Belly measurements were made on the belly-loin interface as illustrated in Fig. 1. Depth of *cutanteous trunci* was included in SFt and SThk measurements when present. Bellies were then sheet-ribbed, scapula tip removed, skinned, and lightly trimmed (squared at the ham-belly interface; mammary glands lifted with a cut bevelled to leave the first lean streak exposed). Belly was weighed, temperature recorded, reweighed when submerged in water, and specific gravity (SG) calculated. Percent fat (%F) was calculated using available beef fat and protein coefficients, and a water coefficient of 1. A subsample of 10 bellies, chosen to represent the full range of fatness, was subjected to proximate analysis for comparison to %F as calculated from SG.

Figure 1: Belly-loin interface showing measurement sites



Results

Means and standard deviations (SD) of hot carcass data and belly measurements in Table 1 show typical market pigs of sufficient variety to furnish bellies over a moderately wide fatness range (<20 to >50%F).

Correlation of percent fat determined chemically and by SG was r = 0.99 ($P \leq 0.0001$). SG %F values tended to be lower than chemically determined fat for very fat bellies, and higher for very lean ones. Some of this error can be attributed to fat bellies floating, and some to the use of beef coefficients in the calculation of %F from SG. Lard is slightly denser than tallow (Altman et al, 1968), so coefficients for the former would be marginally higher.

Simple correlations in Table 2 show a strong relationship between both Probe Fat and SFt, and %F ($r = 0.79$, $P \leq 0.0001$). SThk was also strongly correlated with %F ($r = 0.73$, $P \leq 0.0001$), although SLn was not ($r = -0.18$, $P \leq 0.001$).

Table 3 shows the derivation of equations for the estimation of %F using stepwise regression (max R^2) with grading probe information and with belly measurements. Of the information acquired at grading, Probe Fat alone gave R^2 of 0.6246 (RMSE = 7.94), with minimal improvement on the addition of hot carcass weight, and no improvement with Probe Lean. In comparison: of the belly measurements, SFt alone produced $R^2 = 0.6318$ (RMSE = 7.79) with further small improvements on the addition of SThk and SLn. Primal belly weight made no contribution.

Conclusion

Belly fatness can be estimated at least as well from a single non-invasive fat depth measurement on the primal belly, as from backfat thickness at the grading site. The efficacy of the former can be further improved with the addition of one fat and one lean measurement.

References

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Table 1: Means and SD of hot carcass and belly measurements

	n	Mean	SD
Hot Carcass Wt (kg)	216	85.14	3.69
Probe fat depth (mm)	216	20.83	4.04
Probe lean depth (mm)	216	55.74	5.87
Est. Lean Yield (%)	216	59.14	2.10
Primal Belly Wt (kg)	216	6.99	0.55
Trimmed Belly Wt. (kg)	216	4.32	0.47
Side Thickness (cm)	216	3.42	0.64
Side Lean (cm)	216	1.72	0.21
Side Fat (cm)	216	2.30	0.45
Specific Gravity of Belly	216	102.01	0.70
% Fat	215	38.96	4.59

Table 2: Simple correlations of hot carcass and belly measurements

	Probe Fat	Probe Lean	Est. Lean Yield	Primal Belly	Trimmed Belly	SThk	SLn	SFt	SG	%F
Hot Wt.	0.33***	0.19**	-0.16	0.54***	0.54***	0.29***	0.11	0.20**	-0.24**	0.19**
Probe Fat	1	-0.16	-0.79***	0.45***	0.58***	0.77***	-0.16	0.81***	-0.78***	0.79***
Probe Lean		1	0.26***	-0.05	-0.05	-0.07	0.08	-0.10	0.19**	-0.19**
Est. Lean Yield			1	-0.33***	-0.42***	-0.60***	0.17	-0.63***	0.61***	-0.62***
Primal Belly				1	0.89***	0.54***	0.18**	0.47***	-0.43***	0.43***
Trimmed Belly					1	0.65***	0.14	0.60***	-0.60***	0.60***
SThk						1	-0.05	0.80***	-0.73***	0.73***
SLn							1	-0.03	0.19**	-0.18**
SFt								1	-0.78***	0.79***
SG									1	-0.97***

** $P \leq 0.001$ *** $P \leq 0.0001$

Table 3: Stepwise regression (max R^2) equations for prediction of percent fat in the belly. Equation shows all variables submitted. Final step shows all variables utilized.

Step	Equations				R^2	RMSE
Eq 1: %F = Hotwt + Probe Fat + Probe Lean						
	Intercept	Probe Fat	Hotwt			
1	20.31	0.8952			0.6246	7.94
2	27.91	0.9240	-0.0963		0.6300	7.86
Eq 2: %F = SThk + SFt + SLn + Primal Wt.						
	Intercept	SFt	SThk	SLn		
1	20.39	8.0868			0.6318	7.79
2	18.97	6.0221	1.8060		0.6546	7.34
3	24.51	6.0456	1.7404	-3.1200	0.6748	6.95