Enriching pork products with omega-3 fatty acids may affect pork quality

Beaulieu, A. D.[1], M.E.R. Dugan[2], M. Juarez[2]
[1]Prairie Swine Centre, Saskatoon, SK; [2]Agriculture and Agri-Food Canada, Lacombe Research Centre, AB

Denise Beaulieu

SUMMARY
Carcasses from growing swine (n-96) fed diets containing either 0, 5 or 10 % flaxseed for 76 days were graded and the pork was subjected to a sensory evaluation by a trained taste panel. Feeding flaxseed enriched the omega-3 content of the high fat pork (for example ground pork with 20% added fat) sufficiently to allow a labelling-claim in Canada, however, panellists detected evidence of off-flavours and rancidity in these products. Increasing dietary flaxseed resulted in higher lean yield and reduced belly firmness and fat hardness.

INTRODUCTION
It has been shown that the consumption of omega-3 fatty acids, such as α-linolenic (C18:3) is beneficial to human health. Pork fat is representative of the fatty acids consumed by the pig, and the consumption of flaxseed, or flaxseed oil, by finishing pigs will result in a carcass enriched with omega-3 fatty acids. Several recent experiments conducted at PSCI have examined dietary regimes required to effectively increase omega-3 fatty acid concentration of pork. The flaxseed used has been co-extruded with peas giving a product (Linpro®) with improved handling properties and amino acid balance (i.e. PSCI Annual Report 2008). However, primarily because unsaturated fatty acids are susceptible to rancidity and are "oilier" in nature this experiment was designed to investigate whether increasing the omega-3 fatty acid content of the pork fat had any effect on carcass quality or sensory properties of pork chops and ground pork prepared from these carcasses.

MATERIALS AND METHODS
A total of 96 animals with an initial body weight of 48 ± 2 kg (mean ± SD) were used with 12 pens of barrows and 12 pens of gilts (4 animals per pen). Dietary treatments included 3 levels of flaxseed (0, 5 and 10 %) co-extruded 50:50 with field peas (Linpro®, supplied by O&T Farms, Regina, Saskatchewan, Canada). All diets had equal amounts of field peas and diets were formulated and adjusted every 4 weeks to meet the nutrient requirement of the pigs as they grew (NRC, 1998). After 76 days on test, animals were shipped to Lacombe Research Centre (Lacombe, AB, Canada) and slaughtered in a simulated commercial manner. A trained 8-member panel tasted fresh, frozen loin chops and hamburger and scored each for various attributes using a nine point scale.

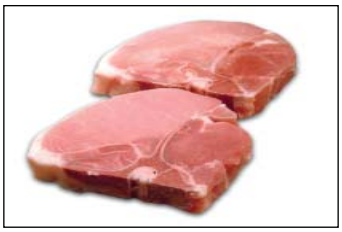
"Feeding co-extruded flaxseed to increase the alpha linoleic acid content in loin muscle did not result in levels sufficient to meet label requirements in Canada"

RESULTS
Performance
Similar to what we have observed in previous studies, feeding 10% flaxseed for 11 weeks had no effect on performance of growing pigs (data not shown).

Carcass quality
Dietary flaxseed did not affect carcass temperature or pH measured 45 min post-slaughter however there was a slight increase in pH at 48 hours post-slaughter (data not shown). Increasing dietary flaxseed also resulted in higher lean yield and reduced belly firmness and fat hardness (Table 1, $P < 0.05$).

Pork from pigs fed flaxseed was slightly darker as indicated by decreased iodine values ($P < 0.01$). No effects of diet ($P > 0.05$) were observed on tenderness of pork chops (shear force), cooking loss or cooking time (data not shown).

Sensory attributes
Panellists detected slight decreases in pork flavour and off-flavour intensity in the fresh frozen and reheated loin chops ($P < 0.05$; Table 1). Conversely in ground pork, except for juiciness, all the sensory attributes measured, including tenderness, pork flavour intensity and off-flavour intensity were negatively affected by feeding co-extruded flaxseed ($P < 0.01$). Furthermore, the percentage of panellists detecting a rancid flavour in ground pork was increased. This may be a result of increased opportunity for oxidation with processing



Raw Pork Chops

Fatty acid composition

The fatty acid composition was determined in intramuscular fat and ground pork. The trends were similar, and thus only the results for the ground pork are presented (Table 2). Dietary flaxseed increased the polyunsaturated fatty acid content of the ground pork, primarily due to a dramatic increase in C18:3 (omega-3) ($P < 0.001$). Although the content of C18:2 (n-6) was increased by feeding flaxseed, the omega-6 /omega-3 ratio was decreased ($P<0.001$), which is also beneficial to human health. The increased C18:3 levels in the ground pork (20 % added fat) seen following 10% dietary flaxseed supplementation would be sufficient to obtain a source claim of 300 mg per 100 gram serving in Canada. However, in pure muscle, with lower fat levels, the C18:3 levels would not meet this requirement.

CONCLUSIONS

Feeding co-extruded flaxseed to increase the alpha linoleic acid content in loin muscle did not result in levels sufficient to meet label requirements in Canada for a source claim if the cuts were trimmed of fat. Moreover, co-extrusion of flax not provide sufficient antioxidant capacity to alleviate texture and flavour problems in high fat products (ie. ground pork) with elevated poly-unsaturated fatty acid content. Although high fat products are required to allow labelling for an omega-3 enriched product, the added fat may result in some negative effects on palatability.

IMPLICATIONS

Although high fat products are required to allow labelling for an omega-3 enriched product, the added fat may result in some negative effects on palatability. Strategies must be investigated to mitigate these effects.

ACKNOWLEDGEMENTS

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Table 1. Carcass traits and sensory attributes of grower pigs fed 0. 5 or 10 % co-extruded flaxseed.

	% flaxseed in diet				
	0	5	10	SEM	*P* value
Carcass traits					
Lean yield, %	57.0	58.1	58.3	0.43	0.04
Belly firmness[a]	381.8	251.9	190.2	16.0	<0.001
Fat hardness[b]	83.6	71.0	55.7	2.4	<0.001
Sensory Attributes					
Fresh frozen loin chop					
Pork flavour intensity[c]	4.79	4.47	4.40	0.09	<0.001
Off flavour intensity[c]	7.39	7.16	6.98	0.11	<0.03
Sustained juiciness[c]	5.70	5.67	5.57	0.10	0.50
Overall tenderness[c]	6.25	5.86	5.88	0.15	0.11
Overall palatability[c]	4.76	4.43	4.36	0.11	0.007
Hamburger, 20 % fat					
Pork flavour intensity[c]	4.69	4.28	3.65	0.08	<0.001
Off flavour intensity[c]	7.47	6.81	5.66	0.11	<0.001
Sustained juiciness[c]	5.62	5.94	5.94	0.09	<0.001
Overall tenderness[c]	7.88	8.05	8.09	0.07	<0.001
Overall palatability[c]	4.74	4.45	3.62	0.09	<0.001

[a]Degree of bending

[b]40-56, moderately soft, 56-66, slightly soft, 66-74, slightly hard, 74-79, moderately hard, and 79-84, very hard

[c]Pork flavour intensity, 9=extremely intense pork flavour, 1=extremely bland pork flavour); off flavour intensity (9=extremely bland, 1=extremely intense); sustained juiciness (9=extremely juicy, 1=extremely dry), overall tenderness (9=extremely tender, 1=extremely tough), overall palatability (9=extremely palatable, 1=extremely unpalatable).

Table 2. Hamburger (20%fat) fatty acid composition (mg/100 g tissue) from finishing pigs fed 0. 5 or 10% co-extruded flaxseed[a].

	Gilts			Barrows				P value[b]	
Fatty acid	0	5	10	0	5	10	SEM	Gender	Diet
C16:0	3797	3608	3168	4473	4148	3660	157	<0.001	<0.001
C18:0	2289	2222	1858	2770	2569	2235	110	<0.001	<0.001
C18:1	6253	6047	5357	6882	6402	5700	185	0.004	<0.001
C18:2	1344	1688	2016	1261	1662	1974	61	0.306	<0.001
C18:3	214	983	2236	176	1030	2326	60	0.504	<0.001
TOTAL	15702	16363	16355	7560	7015	6164	264	<0.001	<0.001
Σ SFA[c]	6360	6087	5251	7560	7015	6164	264	<0.001	<0.001
Σ PUFA[d]	1843	3135	4876	1703	3158	4937	128	0.858	<0.001
Σ omega3[e]	308	1273	2696	261	1331	2800	65	0.509	<0.001
Σ omega6[e]	1520	1847	2169	1425	1811	2124	71.2	0.264	<0.001
Omega6/ omega3	5.45	1.46	0.81	5.57	1.36	0.76	0.18	0.961	<0.001

[a] Only major fatty acids listed

[b] Gender by diet interaction, ($P > 0.05$)

[c] Sum of saturated fatty acids

[d] Sum of polyunsaturated fatty acids

[e] Sum of omega3 or omega-6 fatty acids

[f] Ratio of omega6 to omega3 fatty acids

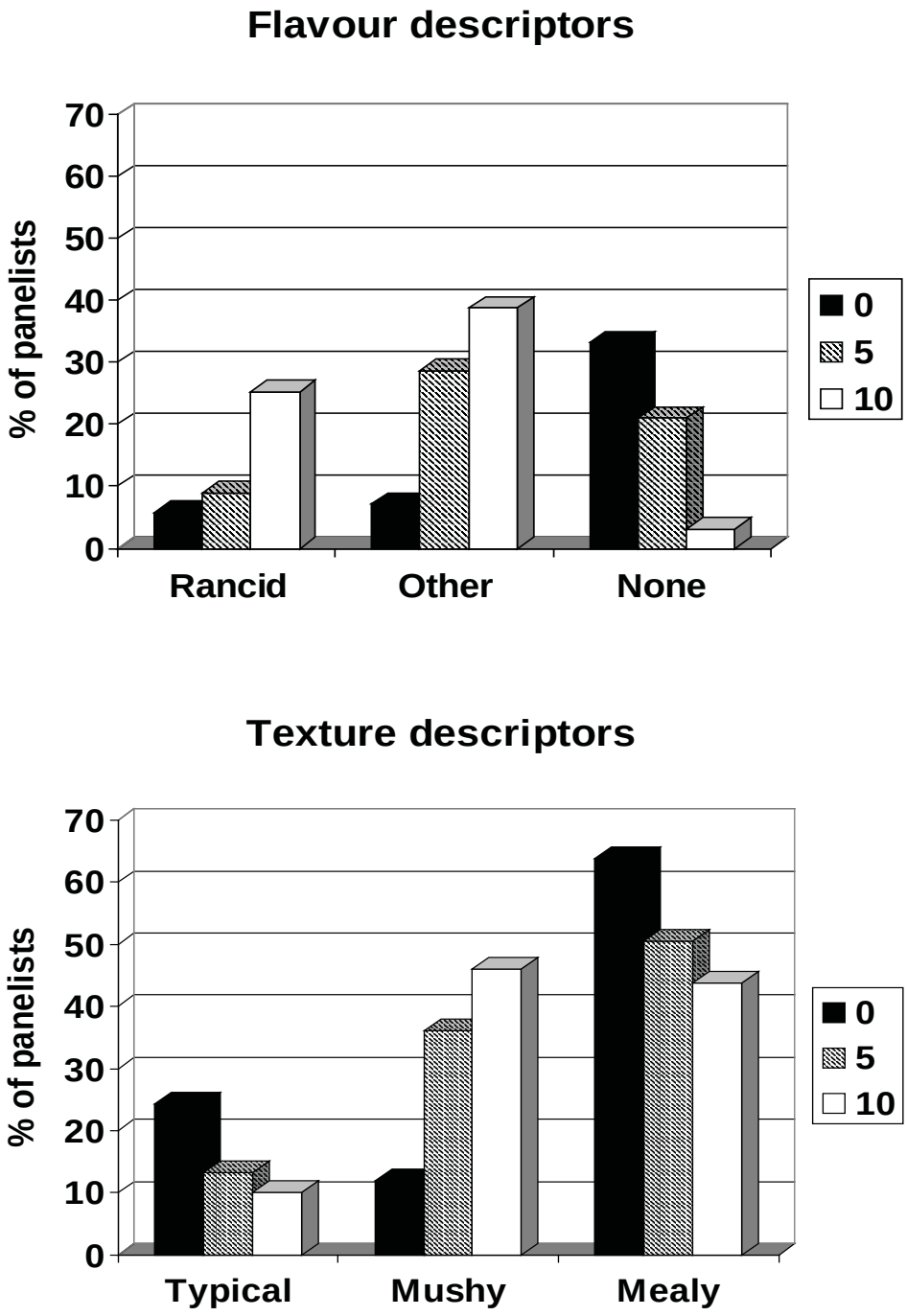

Figure 1. Percentage of panellists reporting cooked hamburger (20%fat) prepared from pigs fed 0, 5 or 10 % co-extruded flaxseed with the indicated attributes. Effect of treatment ($P < 0.05$) for all descriptors.