Improvement of fat quality of lean pigs by dietary intervention

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Abstract

More than 85 % of all pig carcasses merchandized annually at South African auction markets are of the leaner type and are classified as P and O with a backfat thickness of less than 18 mm. A large survey on the fat quality of baconer pigs recently conducted on carcasses at a South African abattoir indicated that 83 % of carcasses from the P and O classification groups had backfat of poor quality. The fatty acid pattern of pig adipose tissue generally reflects the fatty acid pattern of the dietary fat. This approach was used in this study where gilts were randomly divided into two groups receiving either a control (typical South African finishing) or experimental (optimized for improving fat quality) diet. The pigs were slaughtered at 95 kg live weight. Lipid quality characteristics (iodine value, refraction index and fatty acid profile) of subcutaneous fat of the two treatments were compared. All pigs obtained P or O gradings and fat quality of experimental pigs were significantly better than that of the control group for all parameters measured. Subcutaneous fat from experimental pigs conformed to most international fat quality requirements. It was concluded that leaner pigs could produce fat of good quality with the aid of dietary intervention.

Introduction

The global meat industry responded successfully to the consumer demand for leaner and healthier pork by producing leaner pigs (Blanchard, 1995). As pigs become leaner, their fat tends to become softer and more unsaturated (Sather *et al*., 1995). Fat quality problems was reported in many European countries (Affentranger *et al*., 1996). The same trend regarding leanness and fat quality problems is currently observed in South Africa. A survey recently conducted by Hugo & Roodt (2005) on South African pigs indicated that 83 % of pigs in the P and O classification groups had inferior fat quality (backfat iodine value > 70). In pigs and other monogastric animals, the fatty acid composition of the fat tissue triglycerides can be changed by altering the fatty acid composition of dietary fat, which are absorbed intact from the small intestine and incorporated directly into fat tissue (Rhee *et al*., 1990). This implies that dietary manipulation may be used to solve the problem of soft and low quality backfat of pigs, and that was the approach followed in this study.

The first aim of this study was to identify feed ingredients with the potential to improve fat quality of pigs. These ingredients were then used to formulate an experimental diet which can be used to improve the fat quality of South African pigs cost effectively. The second aim was to illustrate experimentally that it is possible to produce baconer pigs in the P and O classification groups with good fat quality.

Methods

A questionnaire was sent to the major suppliers of pig feeds in South Africa to identify available feed ingredients and their inclusion levels. All available lipid containing feed ingredients were analyzed for iodine value and fatty acid composition to identify feedstuffs with the potential of improving fat quality. Diets were formulated with the aim of improving the fat quality of pigs cost effectively. A feeding trial was then performed, comparing a control diet (typical finishing diet) with an experimental diet (optimized for fat quality). Fourteen Large White x Duroc gilts weighing on average ± 43 kg were randomly divided into two groups and assigned to each of the control and experimental diets. Pigs were individually penned and had *ad libitum* access to feed and water. At ± 95 kg live weight the pigs were slaughtered at a commercial abattoir.

Firmness of the backfat was measured, using a Fat Hardness Meter MK2 at the position between the second and the third last rib. The colour of the backfat (L*, a*, and b* values) was determined at the same position with a Minolta CR-200 tristimulus colour analyzer. A core sample of both layers of backfat was taken 45 mm from the mid-dorsal line between the second and third last rib. This fat was used to determine lipid quality characteristics like total extractable fat content (Folch *et al*., 1957), refraction index (AOAC, 2000), iodine value (AOAC, 2000) and fatty acid profile (Slover & Lanza, 1979) of control and experimental pigs and compared with international cuidelines for good fat quality. Chemical stability of subcutaneous fat was compared between the two treatments by using an accelerated oxidation test (Schaal oven test - McGinley, 1991) and peroxide value determinations (AOAC, 2000). Data was statistically analyzed using an analysis of variance (ANOVA) and Tukey-Kramer (multiple comparison test at α=0.05) procedures (NCSS, 2007).

Results

Feed formulations are presented in Table 1. Table 2 clearly indicate that the first objective of this experiment was achieved. The palmitic (C16:0), stearic (C18:0) and total SFA content of the experimental diet was much higher than that of the control diet. Linoleic (C18:0) and total PUFA were occurring in much lower levels in the experimental diet compared to the control diet. This was confirmed by the much lower iodine value of the experimental diet compared to the control diet. At the time of the experiment there was no price difference between the two formulations. No significant differences were observed in growth performance and carcass characteristics between treatments (Table 3). Three carcasses from each group received a P classification while four carcasses from each group received an O classification.

Minolta colour measurements of the backfat did not differ significantly between treatments. The fat hardness measurement of the experimental group was significantly higher than that of the control group (Table 3). Significant differences were also observed in refraction index and iodine values between treatments (Table 3). In both cases the experimental group had values lower than the internationally proposed maxima for good fat quality while the control group had values higher than these maxima.

Table 1. Percentage composition of control and experimental diets on an air dry basis

Component	**Control diet (%)**	**Experimental diet (%)**
Yellow maize meal	65.30	24.20
Wheaten bran	12.30	-
Barley	-	24.20
Feed wheat	-	24.20
Feather meal	-	5.00
Soya oilcake	9.40	9.40
Fish meal	5.20	5.20
Sunflower oilcake	3.60	3.60
Synthetic lysine	0.08	0.08
Savanna lime	1.30	1.30
Mono calcium phosphate	1.70	1.70
Fine salt	1.00	1.00
Mineral and vitamin premix	0.20	0.20

Table 2. Iodine value and fatty acid profiles of the control versus the experimental diet

Treatment	**Iodine value**	**C16:0**	**C18:0**	**C18:1**	**C18:2**	**SFA**	**MUFA**	**PUFA**
Control	100.58	13.23	2.62	31.03	43.77	17.75	33.40	48.72
Experiment	79.84	21.38	4.59	30.73	29.48	29.15	37.24	33.13

The experimental group had a significantly higher content of saturated fatty acids (C16:0 and C18:0) than the control group in backfat. (Table 3) The stearic acid (C18:0) content of the experimental group was higher than the internationally proposed minimum of 12 % while the control group had a lower value. Backfat from the experimental group had a significantly lower linoleic acid (C18:2) content than that from the control group and was lower than the internationally proposed maximum of 15 % while C18:2 content of the control group was higher than this maximum (Table 3). Fatty acid differences were also reflected in the fatty acid ratios. The experimental group conformed to the following international guidelines while the control group did not: total PUFA, C18:0/C18:2 ratio and double bond index (Table 3). An interesting observation was the n-6/n-3 ratio which did not differ significantly between treatments, which imply that although subcutaneous fat from the experimental group was much more saturated than that from the control group, it was not inferior from a health point of view compared to the control group (Table 3).

Results from the Schaal oven test illustrate that subcutaneous fat from the experimental group was significantly more resistant to oxidation than fat from the control group (Table 4). It took fat from the experimental group 12.86 days to reach a peroxide value of 100 compared to 10.71 days for fat from the control group.

Table 3. A comparison in growth performance, carcass characteristics, physical properties of backfat, chemical properties of backfat, fatty acid content of backfat and fatty acid ratios between the control and experimental groups

	International guideline	Control group	Experimental group	Significance level
Number of pigs	-	7	7	-
Growth performance				
Initial weight (kg)	-	43.30 ± 3.07	43.33 ± 3.33	NS
Slaughter weight (kg)	-	96.79 ± 4.83	95.36 ± 4.57	NS
Average daily gain (kg)	-	0.97 ± 0.06	0.95 ± 0.08	NS
Feed conversion ratio	-	2.87 ± 0.16	3.01 ± 0.13	NS
Carcass characteristics				
Carcass weight (kg)	-	78.34 ± 5.18	77.80 ± 3.76	NS
Dressing percentage		80.89 ± 1.49	81.59 ± 1.24	NS
Backfat thickness (mm)	> 15 mm	12.71 ± 2.43	12.86 ± 3.34	NS
Lean meat content (%)	< 57 %	69.32 ± 0.98	69.26 ± 1.34	NS
Physical properties				
Minolta *L**	-	78.44 ± 1.81	78.65 ± 1.96	NS
Minolta *a**	-	2.03 ± 1.63	2.00 ± 1.94	NS
Minolta *b**	-	10.99 ± 1.40	10.39 ± 0.95	NS
Fat Hardness	-	501.96 ± 91.23	643.56 ± 126.41	*
Refraction index	< 1.4598	1.46074 ± 0.00041	1.45976 ± 0.00029	**
Chemical properties				
Extractable fat (%)	> 84 %	76.08 ± 2.76	74.76 ± 2.84	NS
Iodine value	< 70	70.83 ± 3.73	62.01 ± 2.18	**
Fatty acid content				
C16:0	-	22.67 ± 1.20	24.65 ± 0.65	**
C18:0	> 12 %	11.67 ± 1.39	13.60 ± 1.50	**
C18:1c9	-	37.28 ± 1.35	38.57 ± 1.21	NS
C18:2(n-6)	< 15 %	16.63 ± 2.14	11.31 ± 0.72	**
Fatty acid ratios				
SFA (%)	> 41	36.92 ± 2.00	40.87 ± 2.00	**
MUFA (%)	< 57	42.83 ± 1.93	44.90 ± 2.18	NS
PUFA	< 15	19.64 ± 2.40	13.55 ± 0.78	**
C18:0/C18:2	> 1.2	0.71 ± 0.13	1.21 ± 0.14	**
Double Bond Index	< 80	87.36 ± 4.12	75.80 ± 2.14	**
n-6/n-3	< 6	8.18 ± 0.68	7.50 ± 0.55	NS

Means with different superscripts differ significantly
NS = Not significant; * = P < 0.01; ** = P < 0.001

Table 4. Results of accelerated oxidation test for backfat (Schaal oven test)

	Control group	Experimental group	Significance level
Days to reach peroxide value of 100	10.71 ± 1.20	12.86 ± 0.77	**

** = P < 0.001

Conclusions

This study illustrated that it is possible to formulate diets with the potential of improving fat quality, with feed ingredients available in South Africa, in a cost effective manner. It was illustrated experimentally that by utilizing such a diet it is possible to produce baconer pigs in the P and O classification groups with subcutaneous fat quality conforming to most international guidelines.

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