5-P68

TECHNOLOGICAL AND CHEMICAL QUALITY OF PIG ADIPOSE TISSUE: EFFECT OF BACKFAT THICKNESS

A Hugo[1], G Osthoff[1] and PJ Jooste[2]

[1] Department of Food Science, University of the Orange Free State, PO Box 339, Bloemfontein, South Africa
[2] Animal Nutrition and Animal Products Institute, Private Bag X2, Irene, South Africa

Keywords: backfat quality, fatty acid, pig

Background:
Backfat thickness is very important in the South African pork classification system because it is used to calculate the percentage meat of each carcass. In the South African pork grading system, backfat thickness are measured between the 2nd and 3rd last rib, 45 mm from the carcass midline. During 1996, 27.9 % of all pigs slaughtered in South Africa had a backfat thickness of less than 12 mm while 67.3 % had a backfat thickness of less than 18 mm. Only 12.8 % had a backfat thickness of more than 23 mm. The remaining 19.9 % of pigs had a backfat thickness of between 18 and 22 mm (Red meat information booklet, May 1997). This low backfat thickness are the result of the low slaughter weight of pigs in South Africa. Wood (1984) defined good quality fat in pigs as firm and white and poor quality fat as soft, oily, wet, grey and floppy.The properties of the fat determine the kind of product in which it can be used. Soft unsaturated fat is not suitable for bacon or fermented sausage manufacture (Houben & Krol, 1983, Whittington, et al., 1986). Prabucki (1991) suggested the following quality criteria for backfat: not less than 18 mm fat thickness in the middle of the back, no empty fat tissue (84 - 90 % lipid content), double bond index of less than 80 and < 59 % total unsaturated fatty acids. Davenel et al. (1999) suggested that good quality backfat must contain at least 12 % stearic acid (C18:0). The maximum polyunsaturated fatty acid (PUFA) limit that have been proposed for good quality backfat is 15 % (Warnants et al., 1996) while maximum proposed iodine value is 70 (Barton-Gade, 1987). Another good measure for fat hardness is the C18:0/C18:2 ratio, a ratio of above 1.2 and below 1.2 are considered as firm and soft respectively (Honkavaara, 1989). The fat quality of pigs are monitored at abattoirs in Switzerland (Hauser & Rhyner, 1991) and also incorporated into the payment system for pigs. A modified iodine value is used to judge subcutaneous pig fat quality. Too high values lead to a reduction in producers gross margins (Affentranger et al., 1996).

Objectives:
The objectives of this study was to determine how backfat thickness influence backfat lipid quality of pigs, to determine how fat quality of these pigs compares with international requirements and to determine the optimum backfat thickness in terms of fat quality.

Methods:
Sixty pigs of the same genetic source, of the same age, reared under the same conditions and fed the same diet were used. When the average weight of all the pigs reached 90 kg, the first group was slaughtered. The remaining pigs were slaughtered with weekly intervals until a final slaughter weight of 120 kg was reached. After Hennessey grading data from all pigs were finally divided into three backfat thickness groups. Core samples of both bacfat layers was taken 45 mm from the mid-dorsal line between the 2nd and 3rd last rib. Samples intended for iodine value and fatty acid analysis were stored in liquid nitrogen. Extraction of total lipid was done according to the technique of Folch et al. (1957). Methylation to prepare fatty acid methyl esters (FAME) was done by using methanol-BF3. FAME were quantified using a Varian GX 3400 flame ionization gas chromatograph, with capillary column (100 m, 0.25 µm ID, 0.2 µm film thickness). Identification of FAME was made by comparing retention times with those of standards (Sigma).Backfat softness was determined with a Hardness meter MK2, values were adjusted to 4 °C. Backfat colour (L, a and b values) was determined with a Minolta CR-200 tristimulus colour analyzer. Protein content, Hanus iodine value and refraction index of backfat was done according to AOAC (1990). The hydroxyproline content was determined according to ISO (1978). The total collagen content of backfat was estimated as % hydroxyproline x 7.14 (Wood et al., 1989). Double bond index (DBI) was determined according to the method of Alam & Alam (1986). Peroxidizability index (PI) was determined according to the method of Pamplona et al. (1998). Differences in parameters between different treatments were determined by using a GLM ANOVA procedure (NCSS, 2000). The Newman-Keuls multiple range test (α=0.05) was used to identify differences between treatment means.

Results and discussion:
Results are presented in Table 1. Only fatty acids occurring at more than 1 % were indicated. Fat hardness as well as refraction index showed an increase with increased backfat thickness. Colour improved significantly with increased backfat thickness. The L (lightness) value showed a significant increase, while the a (redness) and b (yellowness) values showed significant decreases. This implied that backfat is becoming whiter in colour as backfat thickness increase. Moisture, collagen and protein content decreased significantly with increasing backfat thickness, this is important from a meat product formulation point of view. Extractable fat content increased significantly with increased backfat thickness, coming very close to Prabucki's (1991) minimum value of 84 % in the thick backfat group. Backfat is also becoming significantly more saturated. Polyunsaturated fatty acid content decrease significantly with increased backfat thickness, and reach the critical value of 15 % at a backfat thickness of 17 mm. The C18:0:C18:2 ratio increased significantly as backfat thickness increased but could not reach 1.2 at a backfat thickness of 23 mm. A significant decrease was also found in total unsaturated fatty acids with increased backfat thickness, with the 23 mm bacfat thickness group coming very close to Prabucki's (1991) very rigid limit of less than 59 % unsaturated fatty acids.. Although iodine value also showed a significant decrease with increased backfat thickness all backfat thickness groups were below the critical value of 70. DBI also increased significantly with increased backfat thickness and reached the critical value of less than 80 at a backfat thickness of approximately 17 mm. PI showed a significant decrease as backfat thickness increase which may indicate better oxidative stability of thicker backfat.

Conclusions:
From this study it could be concluded that technological properties, chemical composition and expected oxidative stability of backfat improve with increased backfat thickness. It could further be concluded that South African pigs will easily conform to international standards regarding fat quality if slaughter weights and subsequent backfat thickness can be increased.

Pertinent literature:

Alam, S.Q. & Alam, B.S., 1986. *Effect of essential fatty acid deficiency on acyl group composition, membrane fluidity and adenylate cyclase activity in plasma membranes of rat submandibular salivary glands.* **Journal of Nutrition**, 116, 1620-1630.

Affentranger, P., Gerwig, C., Seewer, G.J.F., Schworer, D & Kunzi, N., 1996. *Growth and carcass characteristics as well as meat and fat quality of three types of pigs under different feeding regimens.* **Livestock production science**, 45, 187-196.

AOAC. 1990. **Official Methods of Analysis**, 15th ed. Association of Official Analytical Chemists, Virginia.

Barton-Gade, P.A., 1987. *Meat and fat quality in boars, castrates and gilts.* **Livestock Production Science**, 16, 187-196.

Davenel, A, Riaublanc, A. Marchal, P. & Gandemer, G., 1999. Quality of pig adipose tissue: Relationship between solid fat content and lipid composition. **Meat Science**, 51, 73-79.

Folch, J., Lees, M. and Sloane-Stanley, G.H. 1957. *A simple method for the isolation and purification of total lipids from animal tissue.* **Journal of Biological Chemistry**, (226): 497-509.

Hauser, A. & Rhyner, G., 1991. *Fettqualitat bei Mastschweinen im schlachthof St. Gallen.* **In: Schweinefleischqualitat - Qualitatsshweinefleisch. Tagunsbericht**, 22. May 1991, ETH-Zurich, Institut fur Nutztierwissenschaften. 139-141.

Honkavaara, M.,1989. *Influence of porcine stress and breed on the fatty acid profiles of subcutaneous and intramuscular total lipids.* **Fleischwirtschaft**, 69 (9), 1429- 1432.

Houben, J.H. & Krol, B., 1983. *Pig fats and the manufacture and storage of meat products.* **In Fat quality in lean pigs Special Report EUR 8901: A CEC Workshop Held in Brussels, Belgium**, 15-26.

ISO, 1978. *Meat and meat products – Determination of L (-) – hydroxyproline content (Reference method), 1st ed.*, **International Organization for Standardization.** Ref. No. ISO 3496-1978 (E).

NCSS. 2000. *Statistical System for Windows.* Gruncher Statistical Systems, Kaysville, Utah.

Pamplona, R, Portero-Otin, M, Riba, D, Ruiz, C, Prat, J, Bellmunt, MJ & Barja, G. 1998. *Mitochondrial membrane peroxidizability index is inversely related to maximum life span in mammals.* **Journal of Lipid Research**, 39, 1989 1994.

Prabucki, A.L., 1991. *Qualitsanforderungen an Schweinefleisch.* **In: Schweinfleischqualitat - Qualitatsshweinefleisch.** Tagunsbericht, 22. May 1991, ETH-Zurich, Institut fur Nutztierwissenschaften. 5-10.

Warnants, N., Van Oeckel, M.J. & Boucque, 1996. *Incorporation of dietary polyunsaturated acids in pork tissues and its implications for the quality of the end products.* **Meat Science**, 44(1), 125-144.

Whittington, F.M., Prescott, N.J., Wood, J.D. & Enser, M., 1986. *The effect of dietary linoleic acid on the firmness of backfat in pigs of 85 kg live weight.* **Journal of the science of food and agriculture**, 37, 753-761.

Wood, J.D., 1984. *Fat deposition and the quality of fat tissue in meat animals.* **In: Fats in animal nutrition**, Wiseman, J. (Ed.), 407-470. Butterworths.

Wood, J.D., Enser, M., Whittington, F.M., Moncrief, C.B, & Kempster, A.J., 1989. *Backfat composition in pigs: Differences between fat thickness groups and sexes.* **Livestock Production Science**, 22, 351-360.

Table 1: Summary of results on backfat quality.

	Backfat thickness groups: 1	2	3	Significance level
n	20	20	20	
Fat thickness (mm)	11.69 ± 1.86	16.68 ± 1.25	23.12 ± 3.75	
Physical measurements:				
Fat hardness	508.30 ± 96.47^a	556.73 ± 102.07^b	657.75 ± 82.53^c	***
Bacfat colour (L value)	77.55 ± 1.43^a	78.22 ± 1.33^b	78.38 ± 1.35^b	***
Backfat colour (a value)	1.83 ± 1.20^c	0.43 ± 1.85^b	-0.58 ± 1.09^a	***
Backfat colour (b value)	10.07 ± 1.16^c	9.37 ± 1.37^b	8.07 ± 1.08^a	***
Refraction index	1.4598 ± 0.0005^c	1.4594 ± 0.0006^b	1.4588 ± 0.0004^a	***
General chemistry:				
Protein (%)	4.89 ± 1.09^c	4.05 ± 1.14^b	2.85 ± 0.84^a	***
Collagen (%)	2.49 ± 0.65^c	2.21 ± 0.60^a	1.71 ± 0.52^c	***
Fat (%)	76.01 ± 3.64^a	78.70 ± 3.66^b	82.50 ± 2.94^c	***
Fat free dry matter (%)	5.75 ± 2.29	5.84 ± 2.43	5.95 ± 2.34	NS
Moisture (%)	18.53 ± 3.24^c	15.53 ± 3.94^b	11.60 ± 3.18^a	***
Iodine value	67.00 ± 7.05^c	63.94 ± 6.76^b	62.04 ± 3.81^a	***
Fatty acid composition:				
C14:0 (Myristic)	1.74 ± 0.27^b	1.68 ± 0.31^b	1.60 ± 0.24^a	**
C16:0 (Palmitic)	21.19 ± 1.30^a	22.07 ± 1.68^b	23.04 ± 1.30^c	***
C16:1c9 (Palmitoleic)	2.84 ± 0.37^b	2.75 ± 0.39^b	2.60 ± 0.40^a	***
C18:0 (Stearic)	12.22 ± 1.58	12.43 ± 1.53	12.56 ± 1.60	NS
C18:1c9 (Oleic)	39.07 ± 1.56^a	39.83 ± 1.45^b	40.79 ± 1.76^c	****
C18:1c7(Vaccenic)	2.63 ± 0.42^c	2.47 ± 0.46^b	2.23 ± 0.37^a	***
C18:2c9,12 (Linoleic)	12.94 ± 1.37^c	12.45 ± 1.47^b	11.41 ± 1.63^a	***
C18:3c9,12,15 (Linolenic)	1.04 ± 0.18^b	1.01 ± 0.17^b	0.93 ± 0.19^a	***
C22:6c4,7,10,13,16,19 (Docosahexaenoic)	1.20 ± 0.38^c	0.73 ± 0.49^b	0.44 ± 0.33^a	***
Saturated (%)	36.85 ± 2.25^a	37.49 ± 2.48^a	38.34 ± 2.57^b	***
Mono Unsaturated (%)	45.60 ± 1.93^a	46.25 ± 1.62^b	47.06 ± 2.01^c	***
Poly Unsaturated (%)	16.16 ± 1.82^c	15.10 ± 1.93^b	13.69 ± 1.98^a	***
Total Unsaturated (%)	61.76 ± 1.98^b	61.34 ± 2.50^{ab}	60.75 ± 2.50^a	*
C18:0/C18:2	0.96 ± 0.18^a	1.02 ± 0.22^a	1.12 ± 0.26^b	***
Double Bond Index	84.21 ± 4.09^c	80.89 ± 5.51^b	77.69 ± 4.85^a	***
Peroxidizability index	27.60 ± 4.23^c	23.12 ± 5.10^b	19.65 ± 4.00^a	***

Means with different superscripts differ significantly NS = not significant * = p<0.05 ** = p<0.01 *** = p<0.001