51st International Congress of Meat Science and Technology
August 7-12, 2005 – Baltimore, Maryland USA

EFFECTS OF FEEDING PERILLA SEEDS TO PIGS ON FATTY ACID COMPOSITIONS AND PALATABILITY OF PORK

Mitsuharu Ishida*, Tatsushi Inoue and Jin Kobayashi

Miyagi Agricultural College, 2-2-1 Hatatate Sendai, 982-0215, Japan

Key Words: egoma, perilla, pork, alfa-linolenic, palatability

Introduction

Perilla known as *shiso*/Japanese basil is commonly used in the Japanese cuisine as mostly a garnish. A type of perilla called *egoma* has a long history of cultivation for extracting oil. *Egoma* seeds contain 35-40% of oil and extracted *egoma* oil has an unique fatty acid profile in which alfa-linolenic acid is contained as high as 60%. Alfa-linolenic acid is one of n-3 fatty acids and many nutritionists and researchers feel that compared with n-6 fatty acids n-3 fatty acids are under consumed. The Japanese health authority is suggesting a recommended n-6:n-3 ratio as close as 4. Well informed and health orientated consumers have started to opt for n-3 fatty acids rich food ingredients and this would be even true for animal products. Such value added products are increasingly advantageous. If a certain resource of n-3 fatty acids is available, a profile of fatty acids of the pork can be altered so that it contains increased n-3 fatty acids by adding n-3 fatty acids to feed but its efficacy should be assessed and the resource of the fatty acids should be carefully chosen so that it does not affect or intervene production cost, productivity and health of the animals and also palatability of the products.

Objectives

The present study is aimed to produce pork with enhanced n-3 fatty acids by supplementing conventional concentrate with ground *egoma* seeds. Two levels of *egoma* supplementation were set for comparison of its efficacy. Assessment of palatability of the pork was also made by analysing free amino acids profiles and sensory tests by a panel.

Methodology

Experimental design

Fifteen barrows (Landrace x Large white x Duloc mean live weight 30kg) were allocated to three groups to receive diets which were made of conventional concentrate supplemented with *egoma* seeds at 3% level (ES3), 1% level (ES1) and concentrate only as a control diet. Soybean meal was also added to the ES1 and control diets at 4 and 6% levels, respectively, so that lipid contents were similar among the diets. The basal concentrate was premixed and commercially available but had different constituents for

growth and fattening. The basal diet was changed when the pigs reached weight approximately 70kg. Biopsy was performed to take subcutaneous fat tissues at the buttocks every three weeks to monitor changes in fatty acids composition. The pigs were slaughtered when a mean live weight reached approximately 105kg for the whole group and performances of meat production were recorded for each pig. *M. longissimus dorsi* (loin) were separated from the carcasses between the 12^{th} and 13^{th} ribs and were stored at -30 for chemical analyses.

Fatty acid assays

Approximately 10g of each sample were homogenized in 50ml of physiological saline and lipids were extracted by a method described by Folch *et al*.. The extracted lipids were weighed as total lipids and were then dissolved with 10ml of chloroform and an aliquot sample was taken into a test tube with a screw cap and the solvent was removed by blowing with N_2 gas. The intermuscular, inner and outer subcutaneous fat tissues of the loins were separated and 0.1g of the aliquot samples was put into test tubes. Methanol containing 0.5N sodium hydroxide was added to the tubes for saponification then boron trifluoride methanol solution was added to form methyl esters for gas chromatography. A Hitachi G-3000 gas chromatography apparatus was employed to analyse fatty acids. The apparatus was equipped with a flame ionisation detector (FID) and fitted with a 0.3mm x 30m glass column packed with DB-WAX. Temperatures for the FID and the column oven were constant and set for 300 and 210 , respectively. Nitrogen carrier gas was used at a rate of 30ml/min.

Free amino acid and peptide assays

The loins were thawed under refrigeration and aged for up to four days. Samples were taken on the 2^{nd} and 4^{th} day of aging. Aliquot samples, approximately 5g, were homogenized with 75% ethanol and the filtered extracts were made up to a 100ml volume. The extracts were added with 1ml of 2% sulfosalicylic acid, supernatants were injected to an amino acid analyser (Shimazu, LC-10).

Sensory evaluation

Slice samples were taken from the loin on the 2^{nd} and 4^{th} day of aging under refrigeration. The samples were fried with a small amount of cooking oil on a hot plate. Palatability for flavour, umami, texture, oiliness and total palatability were scored from 1for poor to 5 for excellent by a panel consisting of 5 volunteers.

Results & Discussion

Meat production performances

A summary of meat production performances is shown in Table 1. Mean dressing percentage of ES3 group was significantly ($P<0.01$) greater than the control group (74.5% vs 63.3%) although means of carcass weight were all similar among the groups

ranging between 71.9 and 74.4kg. The mean dressing percentage of the ES1 was between the two groups without any statistical significance. There were no significant differences in final live weight and back fat thickness among the groups.

Lipid contents and fatty acid compositions in diets

Total lipid contents in each diet and fatty acid compositions are shown in Table 2. All the diets were prepared to be containing similar amounts of lipids but they varied within a tolerable range. The fattening diets supplemented with *egoma* at 3 and 1% levels contained 13.2 and 7.1% of alfa-linolenic acid, respectively compared with 2.7% of the control diet. Contents of other major fatty acids such as myristic, palmitic, palmitoleic, stearic acids were all similar among the diets. Ratios of n-6:n-3 fatty acids in ES3, ES1 and the control diet for fattening were 2.98, 6.28 and 17.3, respectively.

Changes in fatty acid composition in fat tissues during fattening

Changes in fatty acid composition in fat tissues taken by biopsy are shown in Table 3. Levels of alfa-linolenic acid in fat tissues of ES3 and ES1 pigs increased with advancement of growth and fattening while that of the control groups was not greatly changed. Levels of linoleic acid stayed similar levels throughout the period. Statistical significances were obtained among the groups throughout the period for level of alfa-linolenic acid and ratio of n-6:n-3 fatty acids.

Lipid contents and fatty acid compositions in loin

Levels of total lipids were 3.47%, 3.33% and 3.19% for ES3, ES1 and the control groups, respectively. No statistical difference was found among the group. Table 4 shows fatty acid compositions of total lipids, intermuscular, inner and outer subcutaneous fat tissues of the loin. Levels of alfa-linolenic acid in total lipids were 1.34%, 0.73% and 0.39% and linoleic acid were 7.61%, 8.08% and 9.28% for ES3, ES1 and the control groups, respectively ($P<0.01$). There was no significant difference in other polyenic fatty acids. Consequently, ratios of n-6:n-3 fatty acids were 3.28, 5.37 and 8.34 for ES3, ES1 and the control groups ($P<0.01$). Similar tendencies were found for intermuscular, inner and outer subcutaneous fat tissues.

Changes in free amino acids and peptides

Generally, free amino acids and peptides, which are major contributing factors to improve taste and flavour of meat, increase with the process of aging. This is believed to be caused by endo- and exopeptidase activities on fragments of protein and free peptides produced during tenderisation. Changes in free amino acids and peptides in the loin are shown in Table 5. Levels of glutamic acid in the control group increased most during aging but no statistical significance was obtained. Glycine and alanine are related to sweetness and these amino acids interact with glutamic acid to enhance umami taste. Levels of glycine of the control group (83.5μmol/100g) were slightly higher than ES3 (73.2μmol/100g) and ES1 (76.8μmol/100g)on the 2nd day of aging whereas respective alanine levels were 71.2μmol/100g, 86.3μmol/100g and 78.3μmol/100g. Amino acids such as phenylalanine, tyrosine, leucine, isoleucine, valine are considered to contribute to bitterness. These amino acids in this study were considerably low compared with the

levels of alanine and glycine except for leucine. Total levels of free amino acids increased on the 4th day of aging. Dipeptides tended to increase in ES3 and ES1 groups.

Sensory evaluation

Sensory evaluations of the pork from each group are summarised in Table 6. The panel tended to show greater palatability for the pork of the control group than that for the ES groups although any statistical significance was not obtained. Palatability increased for all the groups from the 2nd to 4th day of aging.

Conclusions

Supplementing with *egoma* seeds to pigs successfully produced n-3 fatty acids enhanced pork with improved dressing percentages. Pork produced from the pigs supplemented at a 3% level achieved an almost ideal n-6:n-3 fatty acids ratio. Although statistical significance was not observed and the results were not conclusive, palatability might be affected by supplementing with *egoma* seeds.

Tables and Figures

Table 1. Meat production performances of pigs supplemented with *egoma* seeds

	Live weight (kg)	Carcass weight (kg)	Dressing (%)	Back fat thickness(cm)
ES3	98.4	73.4	74.50[a]	1.6
ES1	106.5	74.4	69.78[a]	1.9
Control	113.0	71.9	63.55[b]	1.8

Values with different superscripts are statistically significant (P<0.01)

Table 2. Total lipid contents and fatty acid compositions of diets (%)

	Total lipids	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	n6:n3
Basal diet growth									
ES3	6.4	0.67	16.4	2.33	6.39	35.5	32.7	6.06	5.39
ES1	5.8	0.73	16.2	2.02	6.20	35.1	35.7	4.11	8.67
Control	5.9	0.70	16.5	2.17	6.41	36.6	35.8	1.83	19.58
Basal diet fattening									
ES3	4.8	0.38	14.1	0.59	3.83	28.7	39.2	13.15	2.98
ES1	4.0	0.38	14.4	0.59	3.69	29.3	44.6	7.10	6.28
Control	4.1	0.39	15.1	0.58	3.88	31.3	46.1	2.67	17.28

Table 3. Changes in fatty acid composition in fat tissues taken by biopsy (%)

	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	n6:n3
3rd week								
ES3	1.18	21.7	4.07	11.2	45.0	14.9	2.03[a]	7.3[a]
ES1	1.30	21.9	3.88	12.0	45.2	14.7	1.09[b]	13.5[b]
Control	0.13	20.0	3.78	11.0	45.8	17.3	0.97[c]	17.9[c]
6thweek								
ES3	1.14	21.5	2.98	11.9	43.9	15.0	3.67[a]	4.1[a]
ES1	1.18	21.4	3.27	12.2	44.1	15.5	2.42[b]	6.4[b]
Control	1.32	21.6	3.56	11.9	45.7	14.8	1.13[c]	13.1[c]
9thweek								
ES3	1.25	21.7	2.85	12.9	42.8	14.1	4.43[a]	3.2[a]
ES1	1.20	23.7	2.47	14.6	43.7	12.2	1.80[b]	6.8[b]
Control	1.22	21.9	3.26	12.5	45.3	14.9	0.97[c]	15.3[c]

Values with different superscripts are statistically significant (P<0.01)

Table 4. Total lipid contents of loin and fatty acid compositions of total lipids, intermuscular, inner and outer subcutaneous fat tissues (%)

	Content	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	n6:n3
Total lipids									
ES3	3.47	1.38	24.7	4.30	11.9	48.8	7.61[a]	1.34[a]	5.7[a]
ES1	3.33	1.20	24.5	3.89	13.8	47.8	8.08[b]	0.73[b]	11.1[b]
Control	3.19	1.18	23.6	4.18	12.5	48.9	9.28[c]	0.39[c]	23.8[c]
Intermuscular									
ES3		1.30	24.5	1.28	16.0	38.9	13.6	4.43[a]	3.06[a]
ES1		1.24	25.4	1.21	17.7	38.8	13.6	2.06[b]	6.62[b]
Control		1.22	24.5	1.31	16.6	40.8	14.5	1.00[c]	14.53[c]
Inner subcataneous									
ES3		1.44	24.0	1.20	15.9	39.9	13.3	4.31[a]	3.08[a]
ES1		1.30	24.8	1.08	17.6	39.1	14.1	2.06[b]	6.84[b]
Control		1.28	23.8	1.22	16.2	40.8	15.8	1.01[b]	15.65[c]
Outer subcataneous									
ES3		1.20	23.6	1.48	15.4	40.1	13.7	4.50[a]	3.05[a]
ES1		1.27	24.0	1.21	17.1	39.6	14.7	2.16[b]	6.79[b]
Control		1.15	22.5	1.38	14.1	42.3	17.3	1.22[c]	14.15[c]

Values with different superscripts are statistically significant (P<0.01)

Table 5. Changes in free amino acids and peptides in the loin with process of aging (μmol/100g)

	Glutamic acid	Glycine	Alanine	Valine	Iso-leucine	Leucine	Phenyl-alanine	Taurine	Carnosine	Anserine
2nd day										
ES3	11.9	73.2	86.3	4.0	tr	36.6	15.8	178.7	1198.3	128.4
ES1	14.0	76.8	78.3	4.8	tr	33.3	16.8	159.5	1175.6	119.0
Control	10.3	83.4	71.2	13.5	8.5	18.8	16.3	205.8	1092.2	104.0
4th day										
ES3	19.5	77.6	92.8	8.4	tr	26.3	16.7	176.2	1184.8	123.2
ES1	23.6	82.7	67.8	13.2	4.7	41.7	19.3	199.2	1173.4	113.2
Control	21.6	86.3	86.3	11.2	10.9	58.3	20.1	208.1	1126.9	110.7

Table 6. Mean scores of sensory evaluation for palatability of loin from the pigs supplemented with egoma

	Flavour	Umami	Texture	Oiliness	Total palatability
2nd day					
ES3	3.0	3.0	3.2	2.9	3.1
ES1	3.2	3.3	3.0	3.1	3.1
Control	3.6	3.6	3.6	3.2	3.6
4th day					
ES3	3.3	3.1	3.2	3.0	3.1
ES1	3.0	3.3	3.4	3.2	3.4
Control	3.8	3.5	3.3	3.6	3.6