Productivity, carcass quality and meat quality of pigs fed slaughterhouse residuum.

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Summary
The effects of fermented slaughterhouse residuum (FSR) on the meat production of fattening pigs were investigated. FSR was prepared from fresh slaughterhouse residuum (SR) by fermentation under aerobic conditions. In Experiment I, it was mixed with formula feed in 20 to 80 portions by weight to fatten pigs (trial group, 5 head); the other group was fed only formula feed (control, 5 head). In Experiment Ⅱ, blood meal was added to the SR in an amount such that the resulting mixture would be 5% blood meal. This mixture, following fermentation, was mixed with formula feed in a 20 to 80% proportion and given to the trial group. Productivity of the trial group was essentially the same as that of pigs fed formula feed in each experiment. The health and nutritional conditions during the fattening period were normal. Hardly any undesirable effects of FSR and blood meal feed on carcasses, meat and processing quality could be observed, compared to the control.

Introduction

SR contains rice straw and formula feed as the main ingredients, and blood, digestive juice, intestinal tissues, meat, feather and skin. These constituents may be processed in such a way as to become a source of feed for pigs. In Japan, 19,288,000 head of pigs and 1,494,000 head of cattle were slaughtered in 1984, according to a statistical report (1985). From their remains, about 58,800 tons of residuum were burned or utilized as compost. We have already conducted on investigation on the possibility of converting residuum into pig feed by fermentation under aerobic conditions (Oshida et al., 1985b). In the present research, a study was made of the productivity and carcass and meat quality of fattening pigs fed formula feed to which had been added FSR and blood meal to determine if such a formula would serve properly as pig feed.

Materials and Methods

Preparation of FSR: SR was obtained from a local meat corporation. Three fermentation tanks (base: 50×50 cm, height: 100 cm) were set up for the aerobic treatment (Oshida et al., 1985b). While dry-air was being supplied from the bottom, fresh raw SR was placed in each tank without being mixed or cutting back the residuum content. While introducing various amounts of air into the SR at rates ranging from 0～15 L/min, the fermentation process temperature was carefully observed to determine the most suitable volume of air for the process. The number of bacteria was examined before and after fermentation. Coliform bacilli, Salmonella and viable bacteria were incubated with desoxycholate agar, DHL agar and heart infusion agar, respectively (Fujita et al., 1977), followed by counting the number of each. The SR chemical composition was also investigated before and after fermentation.

Table I Method for fattening tests

	Experiment I		Experiment Ⅱ	
	Trial	Control	Trial	Control
Head number	5	5	4	4
Feed(%) FSR	20*	0	20**	0
Formula***	80	100	80	100
Testing period(days)	63		71	
Slaughter age(days)	180		188	

* Only fermented slaughterhouse residuum (FSR)
** 5% blood meal was added to slaughterhouse residuum followed by fermentation (BL-FSR)
*** Trade name:Nisshin High Quali

Experimental animals: Two experiments were carried out using rotational crossing piglets. When each pig weighed approximately 100～110 kg, the animals were slaughtered. Data for head number, feed, testing period and slaughter age are presented in Table 1. The feed composition used in each experiment is given in Table 2.

Experiment I: Ten piglets (about 56 kg) were divided into 2 groups, one group given feed 20% FSR by weight (trial group, 5 head) and the other, only formula feed (control, 5 head). The palatability of the FSR was found acceptable by the pigs even when the amount of FSR in the feed was 60% by weight (Oshida et al., 1985b). The percentage of FSR in the feed as (20%) was determined on the basis of FSR yield during fermentation and feeding test data on " liquid fermented feed " prepared from pig excreta and urine (Oshida et al., 1980 and 1982). During the feeding test, blood was collected from each of the pigs each week and analyzed for total protein, albumin/globulin, glucose, total-cholesterol, red blood cell count, hemoglobin, hematocrit, serum iron, glutamic oxaloacetic transaminase, alkaline phosphatase, lactate dehydrogenase and blood urea nitrogen. The left side of each carcass was used in the performance tests to determine carcass quality. A sample of loin meat (M.longissimus thoracis, 24 hr postmortem) was analyzed for determination of physicochemical characteristics such as pH, color and chemical composition of the meat. The chemical composition and processing quality of the meat were investigated using a cooked cured loin roll. Sensory evaluation was also performed according to the method of Scheffé.

Table 2 General composition of experimental feed(DM%)

	Experiment I		Experiment Ⅱ	
	Trial	Control	Trial	Control
Crude protein	14.0	13.3	16.3	15.1
Crude fat	4.6	3.5	4.6	3.6
Crude fiber	4.6	3.8	4.2	3.7
Crude ash	4.9	4.6	5.1	4.9
Nitrogen free extract	71.9	74.8	69.8	72.7

Table 3 Formulation of pickle for loin roll

Additives	Percent of pickle
Salt	7.0
Sugar	4.0
Color developing agent*	0.3
Chemical seasoning	0.4
Spice	0.7
Phosphate	0.6

* Trade name:Syosei(7% $NaNO_2$,10% KNO_3,83% NaCl)

Table 4 Productivity of pigs given FSR and BL-FSR feed

	Experiment I		Experiment Ⅱ	
	Trial	Control	Trial	Control
Initial body weight(kg)	56.2	56.1	60.7	60.6
Final body weight(kg)	103.8	103.0	111.8	109.8
Daily weight gain(g/day)	727	744	719	694
Feed conversion	3.52	3.63	4.17	3.82
Feed efficiency	0.28	0.28	0.24	0.26

Experiment Ⅱ: In this experiment, the by-product, blood meal, was examined for utilization as pig feed. Blood meal was added to and mixed with SR in an amount such that it would be 5% the latter. The mixture thus obtained was fermented. Eight piglets (about 60.5 kg) were divided into 2 groups, and feeding was conducted by the same method as that in Experiment I. Following the feeding period, meat production was determined.

Preparation of loin roll: M. longissimus thoracis (24 hr postmortem) was cured with pikle for 2 weeks (Table 3), smoked for 5 hr and cooked at an internal temperature of 63℃ or above.

Results and Discussion

Suitable aeration volume: The fermentation of SR proceeded successfully on adjusting the aeration volume to 0.1 L/min/kg SR. This volume was determined on the basis of changes in temperature of SR and bacterial growth occuring within it. The number of Coliform bacilli and Salmonella decreased by fermentation due to the self-heating of growing thermophiles (data not shown).

Productivity: The data for productive performance in Experiments I and II are shown in Table 4. Feed consumption by the trial group was similar to that of the control group, as evident from body weight increase in both experiments. In Experiment I, the daily weight gain and feed conversion ratio in the trial group were 727 g and 3.52, respectively. These values for the control group were 744 g and 3.63, thus indicating the productivity of the two groups to be essentially the same. Similar results were obtained in Experiment II.

Blood constituents: Changes in certain blood constituents of Experiments I and II are shown in Table 5. The blood and serum constituents of the trial and control groups did not change during either experiment, and was essentially the same for both groups. All the pigs in both experiments were in good health according to clinical observation and blood test results.

Carcass quality: Macrofindings showed the carcasses of all the experimental pigs to be normal; their quality is presented in the Table 6 and within the normal range in all cases. There were no significant differences between trial and control groups in the two experiments, all carcasses being basically the same.

Table 5 Changes in body weight and blood constituents with health and nutritional conditions of pigs during experiment

	Experiment I								Experiment II							
	0		3		6		9		0		3		6		10 week(s)	
	T*	C**	T	C	T	C	T	C	T	C	T	C	T	C	T	C
Body weight(kg)	56.2	56.1	70.4	75.3	83.7	87.0	103.8	103.0	60.7	60.6	75.9	75.2	92.3	90.7	111.8	109.8
TP(g/dl)	6.5	6.9	6.9	7.2	6.9	7.2	6.8	6.9	6.4	6.6	6.9	6.5	6.7	6.4	7.1	6.6
A/G	1.37	1.27	1.61	1.97	1.30	1.67	1.67	1.47	1.61	1.62	1.33	1.30	1.67	1.90	1.50	1.50
Glu(mg/dl)	111	103	81	83	80	87	93	83	96	78	84	85	83	71	83	83
T-chol(mg/dl)	109	113	94	111	102	108	108	125	121	124	105	108	117	100	109	92
RBC($\times10^4$/mm^3)	788	739	816	812	830	818	823	765	877	762	460	559	603	665	669	663
Hb(g/dl)	14.7	13.9	14.8	15.2	15.6	15.4	15.8	15.0	14.5	14.0	13.9	13.3	14.3	13.8	14.1	13.4
Ht(%)	42.7	41.0	42.6	44.0	44.2	43.8	44.0	41.2	44.5	44.9	44.3	42.5	41.9	42.4	41.6	39.1
Fe(μg/dl)	183	188	133	156	188	171	135	141	185	148	146	129	215	197	235	192
GOT(Karmen unit)	35.9	42.0	39.3	27.7	36.8	24.4	35.1	32.6	19.4	21.1	27.4	15.3	19.0	16.9	22.5	13.0
GPT(Karmen unit)	27.7	29.6	18.6	18.5	23.0	14.4	33.9	30.8	20.1	19.5	20.9	17.7	25.4	19.6	26.3	18.1
ALP(King-Armstrong unit)	15.2	13.5	12.8	13.4	11.0	8.7	11.5	9.9	11.7	12.8	13.1	13.6	11.1	12.1	8.4	9.0
LDH(Wróblewski unit)	349	401	560	449	306	360	338	332	458	504	913	587	601	398	789	706
BUN(mg/dl)	14.3	13.1	9.2	12.0	12.7	13.5	13.9	13.8	14.6	13.0	12.8	13.5	16.8	14.1	17.2	15.4

*Trial group **Control group

Table 6 Carcass quality of experimental pigs

	Experiment I		Experiment II	
	Trial	Control	Trial	Control
Final body weight(kg)	103.8	103.0	111.8	109.8
Carcass weight(kg)	68.0	69.9	72.4	72.4
Dressing percent(%)	65.4	67.7	64.7	65.9
Carcass length(cm)*	97.2	97.0	94.8	98.5
Loin length(cm)**	70.7	71.9	73.8	73.0
Eye muscle aerea(cm²)	18.6	17.5	26.3	29.5
Ham traits(%)	28.7	28.5	32.2	33.6
Back fat thickness(cm)	2.3	2.5	3.4	3.1

*First cervical-publis **First lib-last lumber

Table 7 Physicochemical characteristics of meat

		Experiment I		Experiment II	
		Trial	Control	Trial	Control
Visual color score*		3.2	3.2	2.8	2.8
Hunter value	L	48.8	46.6	42.2	41.5
	a	17.8	18.8	19.2	19.2
	b	10.6	9.9	9.9	10.0
	b/a	0.60	0.53	0.52	0.52
Total heme pigments**		5.91	6.82	6.06	6.33
pH		5.51	5.52	5.58	5.53
Moisture(%)		71.7	72.4	72.9	73.6
Crude protein(%)		17.1	17.3	19.9	19.3
Crude fat(%)		4.3	4.5	3.3	2.4
Crude ash(%)		1.2	1.2	1.4	1.2
Melting point of fat (°C)	Back	35.4	34.9	31.6	31.8
	Abdominal	43.6	43.4	44.2	43.6

*Evaluated against Pork Color Standard of Japan (Nakai et al, 1975)

**Determined by the method of Okayama and Nagata (1979), unit; μmoles/100g meat

Physicochemical characteristics of the meat: The visual color score based on the Pork Color Standard of Japan, Hunter value and total heme content did not differ significantly in either group for both experiments. The Hunter L value and heme content, however, seemed to be affected by FSR feed. The results are shown in Table 7 which also indicates the chemical composition of loin meat for both experiments. The chemical composition of the meat in both groups was similar, all values being in the normal range.

Processing quality of the meat: The results of the processing quality analysis of cooked cured loin roll are shown in Table 8. In Experiment I, no significant differences in color were evident in the two groups but were detected in the color forming ratio between the trial and control groups in Experiment II. However, the pinkish color characteristic of meat products was of passing quality in all samples examined. The chemical composition of the meat product was not affected by the FSR or the blood meal.

Sensory evaluation: The number of panels in Experiments I and II was 52 and 30, respectively. The panels consisted of all girl students between 18 and 20 years of age. The loin meat, after being grilled in a microwave oven, as well as the loin rolls of trial and control groups were compared for color, odor, tenderness, flavor and given total point evaluations. No significant differences could be found between the two groups in either experiment (data not shown).

Table 8 Processing quality of cooked cured loin roll

		Experiment I		Experiment II	
		Trial	Control	Trial	Control
pH		5.69	5.87	6.02	6.01
Residual NO_2^-(ppm)*		12.5	13.4	15.8	12.6
Moisture(%)		70.7	71.7	70.0	71.2
Crude protein(%)		18.6	19.2	17.6	17.5
Crude fat(%)		4.3	2.8	2.6	2.2
Hunter value	L	60.1	58.1	57.5	56.5
	a	13.0	14.0	14.7	15.0
	b	7.9	7.5	6.9	7.1
	b/a	0.61	0.56	0.47	0.47
Color forming ratio(%)**		74.2	73.8	60.4	50.3

*Determined by the method of Mirna and Schütz (1972)

**Determined by the method of Sakata and Nagata (1983)

The livestock industry showed endeavor as much as possible to alleviate the present problem of food shortage at a time of acute world population expansion. For the past 10 years, Japan has been engaged in attempts at developing sources of livestock feed from materials not directly fit for human comsumption, such as slaughterhouse waste and vegetable residuum. Waste production per year in Japan from pig slaughter is estimated as follows: 76,000 tons of blood, 46,000 tons of bone and 28,680 tons of residuum. Slaughterhouse residuum has high fat content (Oshida et al., 1985a), and the blood meal is rich in protein (Autio et al., 1984). It is thus considered that these materials could be used as sources of feed. The safety aspects of such materials should be given carefully consideration,especially in view of the possible presence of pathogenic microorganism and eggs of parasites. Particular care should be taken to insure that blood meal is not affected by infectious disease or hypoproteinemia. In the present research, a decrease in Coliform bacilli and Salmonella by self-heating during fermentation was confirmed. Health and nutritional conditions were shown to be normal by blood checks and macrofindings on pig carcasses. The quality of the pork from a trial pig was found quite comparable to that of a pig given conventional formula feed. The present data thus confirm that slaughterhouse residuum adequately qualifies as a usable source of pig feed.

In future experiments, the authors intend to investigate the effects of greater concentrations of blood meal and the presence of various amounts of bone containing marrow in SR on the meat productivity of pigs.

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