DEVELOPMENT OF FERMENTED FEEDSTUFF WITH HIGH ANTIBACTERIAL ACTIVITIES TO IMPROVE MEAT QUALITY IN FATTENING PIGS

Hyun-Jung Bae , Soo-Kyung Park and Mi-Young Kang*

Department of Food Science and Nutrition, Kyungpook National University, Daegu 702-701, South Korea

* Corresponding author (phone/fax: +82-53-950-6235; e-mail: mykang@knu.ac.kr)

***Abstract*–the effect of fermented feedstuffs made from agricultural by-products on the meat quality in pigs was investigated. *Bacillus subtilis* and *Enterococcus faecium,* isolated from chungkukjang, were used as probiotics. They were cultured in media containing Korean herb, brown sugar, phosphate and calcium and incubated for 18 hr at 35°C. This culture starter (1%) was mixed with the prepared solid feedstuff and fed to fattening pigs. A total of 60 pigs were divided into 2 groups and fed with the experimental diets for 7 weeks. The fermented feedstuff group (FFG) showed higher antivirus activity and immune response than the control group. Moreover, higher scores for sensory characteristics were found in FFG than that of the control group.**

***Index Terms* –** antibacterial, *chungkukjang*, fermented feedstuff, probiotics

I. INTRODUCTION

Nowadays, consumption of meat is increasing due to income improvement and dietary life changes. Accordingly, consumers want a more hygienic and high quality meat. As a result of import liberalization, the domestic livestock meat industry is now competing with imported meat. In order to be competitive, it is necessary for the local meat industry to reduce the production cost and improve the meat quality with no antibiotics residue.

Addition of probiotics in animal feeds was reported to increase the weight gain rate and feed efficiency in young pigs (Han et al., 1993; Min et al., 2002). Kim et al. (2001) found that addition of 1% probiotics improved the weight gain and resulted in a grade A meat. Antibiotic is commonly used to promote the growth of livestock and prevent disease. However, antibiotics residue is a major problem particularly when antibiotics are used for a prolonged period of time (Chang, 1999).

Development of feed additives that could substitute antibiotics is now gaining scientific interest. This study was conducted to develop fermented feedstuff using useful microorganism to improve pork quality in fattening pigs.

II. MATERIALS AND METHODS

A. Agricultural by-product materials for fermented feedstuff preparation

Rice bran, barley bran, *ramen* fragments, dry leftover food, smashed corn, soybean cake and hwangto were used as raw materials for the fermented feedstuff. The composition and energy component of the basal experimental diet for fattening pigs is shown in Table 1.

Table 1. Composition and energy component of the experimental diet

Material	Content (g)	Carbohydrate (g)	Protein (g)	Fat (g)	kcal
Rice bran	17	6.65	2.12	2.92	61.36
Barley bran	17	9.74	2.54	0.57	54.25
Ramen fragments	17	11.08	1.36	1.63	64.43
Dry leftover food	20	8.45	5.13	3.09	82.13
Smashed corn	12.5	8.89	1.05	0.47	43.99
Soybean cake	4.2	1.21	1.92	0.07	13.15
pineapple bran	10	5.56	0.99	0.21	28.09
Hwangto	0.6	-	-	-	-
Chungkukjang	1	0.13	0.44	0.24	4.44
Lysine	0.35	-	0.35	-	1.4
Glucose	0.35	0.35	-	-	1.4
total	100	52.06	15.9	9.2	354.64

B. Isolation and identification of probiotics from chungkukjang

Five grams of chungkukjang was mixed with 30 ml distilled water. The mixture was plated onto NA, MRS and BHI agar media and the plates were incubated for 24 hr at 20°C, 35°C and 50°C, respectively. Pure bacterial cultures were isolated and subjected to 16S rDNA sequence analysis. The resulting 16S rDNA sequence was compared with GENEBANK ribosomal DNA sequence using BLASTN.

C. Preparation of probiotics and fermented feedstuffs

The probiotics were cultured in media containing 5% decocted Korean herb medicine (gyepi, danggui, gamcho,), water, 5% brown sugar, 0.1% phosphate and 0.04% calcium and incubated for 18 hr at 35°C. The probiotics starter (1%) was then added to the solid feeds and fermented for 8 hr at 35°C. The fermented feedstuff was fed to fattening pigs.

D. Analysis of nutritional level

The nutritional level of the developed solid fermented feedstuffs was compared with that of the commercial feedstuffs available in the market.

E. Feeding trial

The pigs, weighing approximately 28 kg and about 70 days of age, were fed with the experimental diets for 7 weeks.

F. pH measurement and Cooking loss

Meat sample (~3 g) was cut into small pieces and homogenized with 27ml of distilled water for 10 sec in a homogenizer. Immediately after homogenization, the pH values were measured using a pH meter. And the meat samples were cut into 2 cm thickness and the initial weight was measured. They were then placed in zipper bag and heated in boiling water. The samples were cooled at room temperature. The formula used for cooking loss is [weight before heating (g) – weight after heating (g)] / weight before heating (g) x 100.

G. Sensory test

The sensory attributes of fresh and cooked meat from pigs fed with the fermented and commercial feedstuff were determined and compared. For the cooked meat, the boston butt, pork belly and hind legs were broiled or boiled. The sensory evaluation was conducted by 5 graduate students using a 9-point hedonic scale.

III. RESULTS AND DISCUSSION

A. Isolation of bacterial strain from chungkukjang

Based from the results of DNA sequence analysis, the 2 bacterial cultures isolated were identified as *Bacillus subtilis* and *Enterococcus faecium*. *Bacillus subtilis* is known as the fermentation bacteria in chungkukjang and weak saprogenous bacterium in intestine. *Enterococcus faecium* is a common *Lactobacillus* found in Korean traditional fermented soybean food and was known to inhibit the growth of *Enterococcus sakazakii*. Furthermore, *E. faecium* was found to promote the growth of useful bacteria when injected to cows and pigs.

B.Nutritional level of fermented feedstuffs

Table 2 shows the nutritional level of fermented and commercial feedstuffs. The contents of crude fat, crude ash, crude fiber, P and Ca were higher in fermented feedstuff than the commercial one. However, the crude protein content was higher in commercial feedstuff. The energy value and pepsin digestion rate were lower in fermented feedstuff (Table 3).

Table 2. Energy content (%) of the commercial and fermented feedstuffs

	Water	Crude protein	Crude fat	Crude fiber	Crude ash	Ca	P
Commercial feedstuff	13.3	18.1	4.17	3.58	5.36	1.04	0.55
Fermented feedstuff	16.5	16.8	7.19	4.73	6.97	1.67	0.76

Table 3. Energy value and pepsin digestion rate of the commercial and fermented feedstuffs

	Energy (ME kcal/kg)	Pepsin digestion rate (%)
Commercial feedstuff	3,916	89.66
Fermented feedstuff	3,848	81.94

C. Anti-virus activity and immune response efficacy of fermented feedstuffs

During the experimental period, animal death occurred due to respiratory disease. As shown in Table 4, the commercial feedstuff group exhibited 27% death rate with 8 dead pigs. On the other hand, 5 pigs died in the fermented feedstuff group with 17% death rate. Animal death in fermented feedstuff group occurred 15 days after the first death occurrence in commercial feedstuff group. In addition, death occurrence in fermented feedstuff group stopped 20 days earlier than that of the commercial feedstuff group. These indicate that the fermented feedstuff has high anti-virus activity and immune response efficacy.

Table 4. Death rate of pigs as a result of respiratory disease

Death occurrence		Commercial feedstuff group	Fermented feedstuff group
Month	Date		
10	5	●	
	⋮	⋮	⋮
	21		●
	24		●
	25	●	●
	27	●	●
	28	●	
	29		●
	31		
11	1	●	
	⋮	⋮	⋮
	14	●	
	18	●	
	21	●	
Total		8	5

D. pH and cooking loss

The pork samples showed pH ranging from 5.79-6.10 (Table 5). The FFG sample exhibited higher pH compared with the control ones. This result may be attributed to a decreased lactic acid production in muscles postmortem (Lee et al., 1979; Raj et al., 1990,1992). And Boston butt, pork belly and hind legs were used for the measurement of cooking loss. Cooking loss is the measurement of drip loss in meat caused by physical force (heat). FFG samples had significantly lower cooking loss compared with the control group (Table 6).

Table 5. pH and Cooking loss of control and FFG meat samples

Part		Control	FFG
pH	Boston butt	6.09±0.15	6.19±0.02
	Pork belly	5.94±0.05	5.97±0.03
	Hind legs	5.79±0.03	6.10±0.03
Cooking loss	Boston butt	43.01±0.35	41.76±0.50
	Pork belly	25.87±0.42	25.32±4.70
	Hind legs	40.40±2.54	36.31±0.61

E.Sensory test

In fresh pork, fermented feedstuff group exhibited scarlet and red meat, while the commercial feedstuff group showed red meat. In particular, the fermented feedstuff group has many connective tissues in their meat. In cooked pork, results of the sensory test are shown in Table 7.

Table 7. Sensory scores of cooked pork samples

item		control	FFG
broiled	Boston butt	5.60±0.40	7.40±0.24
	Pork belly	5.40±0.51	6.00±0.45
	Hind legs	5.00±0.45	6.00±0.32
boiled	Boston butt	5.40±0.24	6.60±0.24
	Pork belly	5.60±0.24	7.00±0.32
	Hind legs	5.40±0.25	6.20±0.37

IV. CONCLUSION

This study demonstrated that the developed fermented feedstuff from agricultural by-products possess high antibacterial activity and nutritional content and could improve the sensory quality of meat in fattening pigs. The use of probiotics in animal feeds may be beneficial as a substitute to antibiotics for the prevention and treatment of disease in fattening pigs and in enhancing the physicochemical and sensory properties of pork.

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