

COMPARISON OF NUTRITIONAL CHARACTERISTICS OF THE SMALL INTESTINE, LARGE INTESTINE AND RECTUM FROM PIG

Ki Hong Jeon*, Young Boong Kim, Young Ho Kim, Dong In Shon, and Na Hyun Lee

Regional Food Industry Research Group, Div. Food Industry Advancement, Korea Food Research Institute,
516, Baekhyun, Bundang, Sungnam, Gyeonggi 463-746, South Korea

*Corresponding author (phone: +82-31-780-9077; fax: +82-31-780-9092; e-mail: khjeon@kfri.re.kr)

Abstract—This study was carried to compare nutritional characteristics in the small intestine, large intestine and rectum from pig. The sample for this study was collected immediately after slaughtering and transferred to the lab after washing. The protein contents of small intestine, large intestine and rectum were 11.74, 7.71 and 8.65% each, fat contents were 7.55, 13.44 and 12.74% each, cholesterol contents were 171.95, 122.60 and 77.13mg/100g each. Unsaturated fatty acid of small intestine was 51.28%, that of large intestine was 55.22% and that of rectum was 60.9% which showed highest result among the samples. In the essential amino acid test, each of above parts showed 4.33, 2.34 and 1.64% respectively. In the mineral contents analysis, small intestine had highest result of 241.24mg/100g in K and large intestine had biggest result of 103.92mg/100g in Na among the above parts.

Index Terms— small intestine, large intestine, rectum, nutrition, comparison

I. INTRODUCTION

Pig is the representative livestock which produces animal protein for human. Also the intestine parts should be continuously produced as a by-product as long as human consumes the meat. Intestine is also the edible part for protein sources but not evaluated highly except the pacific rim and some asian countries. They cook intestines in several ways like roasting, steaming or frying while most of small intestine in western countries are used for sausage casing. By products including intestine parts consists around 30~40% of animal weight. It means it has a value of quantity but not so many researches are studies yet for its value of quality(Barbara A. Anderson. 1988). as well as on the manufacturing procedure to produce processed products for the easier and better consumption. This study was done to understand the nutritional characteristics and to expect more consume for protein sources with competitive price than the loin had.

II. MATERIALS AND METHODS

Sample preparation

Small intestine, large intestine and rectum were collected after slaughtering and transferred to the lab in the refrigerating storage box. Samples were used after washing 3 times and removing water in the sample.

Chemical analysis and cholesterol content

Moisture, crude protein, crude fat, ash contents and cholesterol were analysed by the way of AOAC(1990). For the cholesterol analysis, GC(Hewlett Packard 6890 series GC system) was used with conditions of injector temp. 270°C, oven temp. 260~280°C and detector temp. 290°C.

Fatty acid analysis

Fatty acid analysis was done with below procedure. 10g of each sample were placed in ethyl ether 200ml for 2hrs to extract fat and then evaporated solvent with evaporator. 0.5N NaOH/methanol 2ml was added to the 20g of collected fat from the above procedure and saponificated for 10min in the 105°C dry oven. After cooling for 10min, it was added 2ml of 14% BF₃/methanol and methylated for another 10min in the 105°C dry oven. After cooling again at the room temperature, 2ml of NaCl was added and shook. Also added 2~3ml of HPLC grade hexane and shook again. Supernatant was collected and used in the GC(Hewlett Packard 6890 series GC system) analysis with conditions of injector temp. 230°C, oven temp. 130~230°C and detector temp. 250°C.

Amino acid analysis

Amino acid analysis in the experiment was followed by AOAC method like below. 15ml of 6N HCl was added to exact 1.0g of sample in the test tube and replaced with N₂ before sealing. After hydrolysis for 24 hrs at the 105 °C oven, it was cooled at room temperature and adjusted 50ml at the 50ml flask. After filtering with 0.2 µm membrane, 2ml of filtered liquid was taken and adjusted again at 25ml flask. After derivation under AccQ-Tag(AccQ-Fluor, Reagent Kit,

USA) method, amino acid was analysed in the amino acid analyser (pump PU-980, detector FP-920, autosampler AS-950-10, Jasco, Japan). The conditions for this experiment were like below. Nova-Pack C₁₈ (3.9×150 mm, WATERS, USA); insert vol. 10μL; column temp. 30℃; detector, fluorescence (Ex. 250nm, Em. 395nm); moving phase conditions, B1: mixed buffer 1 (pH 1.0), B2 : mixed buffer 2 (pH 2.0), B3 : mixed buffer 3 (pH 3.0), B4 : mixed buffer 4 (pH 4.0), B5 : Distilled water, B6 : Re-generation solution were followed by gradient method.

Table 1. HPLC conditions for amino acid analysis

Time(min)	Flow(ml/min)	%B1	%B2	%B3	%B4	%B5	%B6
0.0	4	100	0	0	0	0	0
3.0	4	100	0	0	0	0	0
3.1	4	0	100	0	0	0	0
6.9	4	0	100	0	0	0	0
7.0	4	0	0	100	0	0	0
14.9	4	0	0	100	0	0	0
15.0	4	0	0	0	100	0	0
28.0	4	0	0	0	100	0	0
28.1	4	0	0	0	0	0	100

Mineral analysis

3g of sample were ashed by furnace at 450℃ until the color of sample changed white. After cooling at room temperature, 5ml of DW and 3 ml of diluted nitric acid (nitric acid:DW =1:1) was added to the ash and heated until drying. Additional ashing for 1 hr at the furnace at 450℃, it was cooled again and 10ml of diluted hydrochloric acid (hydrochloric acid : DW = 1:1) was added slowly to the crucible and adjusted volume in the 50ml flask. After filtering with non-ash filter paper, it was analysed with ICP-AES with following conditions.

Table 2. ICP-AES conditions for mineral analysis

RF power	1000 W
Nebulizer gas flow	0.7 - 0.8 L /min
Plasma gas flow	12 L/min
Sheath gas flow	0.3 L/min
Nebulizer pressure	2.7 - 3.5 bars for mainhard type
Normal speed of pump	20 rates/min
Wavelength (nm)	P 214.914/ Fe 259.940/ Mg 279.079 Ca 317.933/ Na 588.995/ K 766.490

Vit A and E analysis

Vit A and E were analysed with HPLC (Jasco UV-2075 plus, Japan) from the extracted solution by the method in Korean Food Code (2009). Vit A was detected at 325nm after treated acetonitrile : methanol : D.W. (47 : 47 : 6, v/v/v) solution with 1.0mL/min condition. Vit E was detected also at ex 298nm and em 325nm with mixture solution of acetonitrile : Methanol (50 : 50, v/v) at 1.0mL/min condition.

III. RESULTS AND DISCUSSION

Chemical analysis and cholesterol content

The experiment result for chemical analysis and cholesterol contents of the small intestine, large intestine and rectum from pig was at Table 3. The moisture contents of each sample were ranged at 75.30~78.13% with no significant difference but higher than that of pork loin. Protein content of 11.74% in the small intestine showed highest in the three parts while it was lower than 17.4% of from pork loin. Also, fat contents of 13.44% in the large intestine was almost double to the small intestine but lower in cholesterol content. This showed the same tendency with the data from experiment of Kim et al (1991) that small intestine had higher protein but lower fat content than that of large intestine. The cholesterol contents of rectum was 77.13mg/100g with lowest result from these intestine parts but higher 55mg/100g of cholesterol content from pork loin even though the fat content of pork loin was higher than those of intestines.

Fatty acid analysis

The result of experiment for fatty acid of small intestine, large intestine and rectum from pig was at Table 4. In the 15 kinds of fatty acid found in the sample, oleic acid which was known for working of good flavor (Kim et al, 1998) had highest result of 36.93~41.23% in the list. The contents of saturated fatty acid which was usually found in meat like

palmitic acid and stearic acid were 23.13~27.26% and 12.68~18.44% each in the samples. The contents of linoleic acid in the sample were 10.54~16.08% which was higher than 9.70% of pork loin. With the result of this experiment, the ratio of unsaturated fatty acid and saturated fatty acid was 1:1~1.5:1 which was in the range of nutritionists recommend(Kim et al, 2004).

Table 3. Chemical analysis and cholesterol contents of small intestine, large intestine and rectum from the pig.

	Small intestine	Large intestine	Rectum	Pork loin*
Moisture(%)	77.89±0.77 ^a	78.13±1.06 ^a	75.30±1.65 ^a	71.5
C. protein(%)	11.74±0.48 ^a	7.71±0.21 ^c	8.65±0.13 ^b	17.4
C. fat(%)	7.55±0.88 ^b	13.44±0.05 ^a	12.84±0.22 ^a	19.9
Ash(%)	0.50±0.13 ^b	0.88±0.06 ^a	0.06±0.00 ^c	1.00
Cholesterol(mg/100g)	171.95	122.60	77.13	55

^{a-c} Means in the same row with different letters are significantly different (P<0.05)

*Data from website of Korea Rural Development Administration

Table 4. Fatty acid analysis of small intestine, large intestine and rectum from the pig
(Unit: %)

Items	Small intestine	Large intestine	Rectum	Pork loin*
Myristic acid (C14:0)	2.01	1.81	1.46	1.60
Palmitic acid (C16:0)	27.26	25.75	23.13	24.60
Palmitoleic acid (C16:1)	1.86	1.74	1.81	3.30
Heptadecanoic Acid (C17:0)	0.38	0.87	0.61	—
Margaric acid (C17:1)	0.27	0.45	0.44	—
Stearic acid (C18:0)	18.44	15.10	12.68	12.10
Oleic acid (C18:1)	36.93	39.27	41.23	45.40
linoleic acid (C18:2)	10.54	11.80	16.08	9.70
linolenic acid (C18:3)	0.79	0.85	0.83	0.60
Arachidic acid (C20:0)	0.65	0.85	0.68	0.20
Gadoleic Acid (C20:1)	0.33	0.47	0.51	—
Eicocadienoic acid (C20:2)	—	0.18	—	0.90
Eicosatrienoic acid (C20:3)	—	0.46	—	0.40
Arachidonic acid (C20:4)	0.56	—	—	0.30
Heneicosanoic acid (C21:0)	—	—	0.55	—
SFA	48.74	44.58	39.11	38.50
UFA	51.28	55.22	60.90	60.60

*Data from website of Korea Rural Development Administration

Amino acid analysis

The result of experiment for the amino acid of small intestine, large intestine and rectum from pig was at Table 5. In this experiment, glutamic acid, which was known as a taste factor(Kurihara, 1987), had biggest result among the below 17 kinds of amino acid in the small intestine and large intestine but second largest in the rectum part but lower than that of pork loin. Small intestine had the biggest in EAA of 11.95% and followed by 6.84% in large intestine and 4.76% of rectum but these were lower than 19.78% of pork loin. While 2.41% was in the pork loin, glutamic acid of 1.76% was in the small intestine, 1.01% in the large intestine and 0.70% in the rectum respectively. Also, glutamic acid content was largest in the pork loin next to leucine but aspartic acid and glycine content were higher than leucine content in the each intestine part in the experiment.

Mineral and vitamin analysis

The result of experiment for mineral and vitamin analysis of small intestine, large intestine and rectum from pig was at Table 6. K content of the small intestine, 241.24mg/100g, was almost 3 times than 81.36mg/100g in the large intestine and 78.69mg/100g in the rectum each. And Na content of the large intestine, 103.92mg/100g, showed over 2 times than 44.72mg/100g in the small intestine and 48.46mg/100g in the rectum and 34.0mg/100g in the pork loin. With this experiment, Ca, Na and Fe content was higher than those in the pork loin. Also, Vit A was not detected and the amount of Vit E in the sample was very low at the each sample.

Table 5. Fatty acid analysis of small intestine, large intestine and rectum from the pig
(Unit: %)

Items	Small intestine	Large intestine	Rectum	Pork loin*
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Aspartic acid	1.08	0.63	0.43	1.87
Threonine	0.57	0.32	0.22	1.08
Serine	0.61	0.35	0.23	0.84
Glutamic acid	1.76	1.01	0.70	2.41
Proline	0.72	0.46	0.31	0.68
Glycine	1.04	0.67	0.48	1.38
Alanine	0.71	0.42	0.30	1.58
Cystein	0.12	0.10	0.06	0.28
Valine	0.66	0.36	0.25	1.39
Methionine	0.26	0.14	0.10	0.56
Isoleucine	0.50	0.26	0.18	1.09
Leucine	0.99	0.53	0.38	1.89
Tyrosine	0.40	0.22	0.15	0.74
Phenylalanine	0.51	0.27	0.20	0.92
Lysine	0.85	0.47	0.33	1.43
Histidine	0.29	0.15	0.10	0.69
Arginine	0.89	0.49	0.34	0.95
EAA	11.95	6.84	4.76	19.78

*Data from website of Korea Rural Development Administration

Table 6. Mineral and vitamin analysis of small intestine, large intestine and rectum from the pig
(Unit: mg/100g)

Mineral	Small intestine	Large intestine	Rectum	Pork loin*
Ca	10.18	6.58	5.03	6.0
P	84.69	84.69	61.58	152.0
K	241.24	81.36	78.69	291.0
Na	44.72	103.92	48.46	34.0
Mg	11.82	7.00	4.13	22.4
Fe	0.95	1.36	0.69	0.8
Vit(IU/100g)				
A	0.00	0.00	0.00	5R.E
E	0.87	0.56	0.13	0.06mg

*Data from website of Korea Rural Development Administration

V. CONCLUSION

Chemical analysis and cholesterol content, fatty acid, amino acid, mineral and vitamin content in the small intestine, large intestine and rectum from pig were experimented to understand and compare their nutritional values. The protein contents in the intestine were 7.71~11.74% which was lower than 17.4% of pork loin and also had lower level in the fat content. The amount of cholesterol which small intestine, large intestine and rectum had was 171.95, 122.60 and 77.13mg/100g each. Also, linoleic acid contents of the fatty acid composition in the intestine samples were comparatively higher but had lower oleic acid contents than that of pork loin. Even the amount of amino acid of intestines was much lower than that of pork loin but showed tendency which glutamic acid ratio was highest in the analysis. In the K content, small intestine showed biggest result of 241mg/100g in the experiment and highest Na contents analyzed in large intestine. In the intestines, no Vit A in the intestine was found and had low contents in Vit E.

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