A Study on the Quality Characteristics of Fermented Dry-cured Ham manufactured by Pork

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***Abstract*— This study has been conducted aiming to produce high value added fermented dry-cured ham with pig's hind leg through developing high quality port products. Any quality change during process of fermented dry-cured ham has been carefully investigated, and we have examined and compared quality of fermented dry-cured ham made with YLD and YBD pork. The fermented dry-cured ham was produced by preserving pig's hinder legs with salt amounting 6% of the weight of hinder leg for 60 days at relative humidity 75±5%, temperature 3±1℃. After completing preservation, hinder legs have soaked in ice water for 14 hours then been cleaned. The drying process was implemented by keeping them at relative humidity 80±10% with temperature 20±3℃ for 60 days then after the aging process was done at room temperature for another 60 days.**

The result of this research was consequently showed that the fermented dry-cured ham made with YLD pork had good quality with its water content, crude protein containment, salinity, redness and in TBA and VBN, whereas the one made with YBD pork was excellent in crude fat and lightness.

***Index Terms* — Fermented Dry-cured Ham, YLD and YBD pork, quality analysis**

I. INTRODUCTION

However, well-being foods shall be selected in various criteria according to counties but 'The health', a popular medical journal in America has issued the world 5 well-being foods, names of which are Kim chi of Korea, Natto of Japan, Olive of Spain, Yogurt of Greece and the Lens bean of India.. Three of them, Kim chi, Natto and Yogurt are common in that they are all fermented foods. There also fermented foods such as fermented sausage or fermented fresh ham out of meat products. The fermented fresh ham is not widely known yet in domestic market, Moreover, it takes lots of time for fermenting and maturing, and also requires cost for constructing production facility. But recently it is being popular with young people as wine consumption is expanding in public, so more researches on characteristics of fermented fresh ham are required in Korea too.

In this study, we have compared quality of fermented fresh ham made with YLD pork which is most popular in domestic market and the ham made with YBD pork, a hybrid from Berkshire which the NPPC (National Pork Producer Council of America) has presented as excellent meat quality in order to select the most suitable pork breed to fermented fresh ham and to create high value added fermented ham using hind legs of pig. Also we have investigated any quality change during the period of production so as to acquire exact data for quality change.

II. MATERIALS AND METHODS

1. Formulation and processing of Fermented Dry-cured Ham

Pigs used as for material meat were 3 hybrid one (Yorkshire x Landrace x Duroc), and YBD (Yorkshire x Berkshire x Duroc), 180 days aged, 1st class meat quality, 5 hind legs taken from 110-120Kg weighed standard pigs. We have tested 3 times in repeat. We have removed sacrum, cheek bones and tail bones out of hind legs in the test room at temperature below 10℃ to produce fermented fresh ham. Those hind legs were treated to curing after shaping. The curing was processed as to spread Korean bay salt (produced by Cheongjungwon) with amount of 6% of weight of legs on meat part and to rub a little and to put them in cooling room with relative humidity 75±5% and temperature 3±1℃ for 60 days, then after, soak them in clean ice water for 14 hours to clean. Later the drying process was implemented in the room at relative humidity 80±10% with temperature 20±3℃,for 60 days and the aging process was done at room temperature for another 60 days. The presented material was open for quality analysis after cutting hind legs by 10cm depth, removing biceps femora's.

2. Analysis methods

Chemical composition was measured with AOAC(1998), and the weight loss was measured by indicating weight lost in each process comparing to that of material by percentage(%). pH test was done applying Eikelenboom, G etc and pH level was measured with pH meter(Standard pH meter PHM210, MeterLab France) WHC(water holding capacity) was calculated with filter paper press method of Grau and Hamm(1953) and salt content was measured with digital salinity meter (PAL-03S, ATAGO, Japan) after diluting by 2 times with adding the same weighed distilled water. Water activity was examined using water activity tester (Auspector AQS-2-TC, Nagy, Germany). Meat color was measured to classify L*(lightness), a*(redness), and b*(yellowness using color meter (CR-310, Minota, Japan). The volatile basic nitrogen value (VBN) was measured using Conway micro diffusion method, and Thiobarbituric acid value (TBA) was measured

using method of Witte91970). Samples were collected with 1 inch diameter, 0.5 inch height evenly for each piece using Bourne's texture profile analysis (1978) and we have measured TPA (Texture profile analysis) using texture analyzer (TA-X2i, Stable micro system, England). Microorganism test was conducted for 3 aspects, Total plate counts, Lactic acid bacteria and Coli form according to ordinance of national Veterinary Research & Quarantine Service. A Sensory property was implemented with 10 candidates who were well trained for sensory test by 7 points measuring method. Statistic computation was done to get its significance verification ($p<0.05$) using SAS program (Statistic Analytical System, USA, 1996) by Multiple range test of Duncan and t-verification method.

III. RESULTS AND DISCUSSION

1. Quality Variation in the Process of Fermented Dry-cured Ham Production

According to the analysis of chemical composition while producing the fermented dry-cured ham, moisture content showed the tendency to decrease significantly over the time ($p<0.05$); crude protein content and crude fat content showed the tendency to increase significantly over the time ($p<0.05$); and weight loss increased significantly over the time ($p<0.05$)(Table 1).

Table 1. Changes in chemical composition and weight loss of dry-cured ham during the processing time

composition	Time(day)				
	0	60	60(+1)	120	180
moisture(%)	74.18±0.13^{a}	61.20±0.03^{c}	61.68±0.05^{b}	34.88±0.8^{e}	36.78±0.60^{d}
crude protein(%)	20.09±0.06^{b}	18.03±0.05^{d}	17.77±0.08^{e}	29.55±0.05^{a}	18.42±0.05^{c}
crude fat(%)	3.96±0.13^{c}	1.78±0.18^{e}	4.62±0.45^{b}	4.93±0.13^{a}	2.13±0.21^{d}
crude ash(%)	1.67±0.23^{d}	3.57±0.04^{b}	1.91±0.01^{c}	0.82±0.11^{e}	7.79±0.03^{a}
Weight loss(%)	-	14.93±0.78^{c}	13.86±0.64^{c}	29.72±0.67^{b}	34.32±1.20^{a}

0day : raw meat, 60days : End of curing, 60(+1)days : End of washing, 120days : End of drying, 180days : End of aging
$^{a-d}$: Values with different superscripts in the same row differ significantly ($p<0.05$).
Mean±S.D

pH value was the lowest in 0 day of the production process, and increased gradually to the highest in the 120th day of the process($p<0.05$). Water holding capacity was the highest in 0 day of the production process, and decreased gradually to the lowest in the 120th day of the process ($p<0.05$)(Fig. 1).

Salt content had increased until the 60th day of the process; at the 60th (+1) day, it decreased significantly ($p<0.05$); and then, it increased again to show the highest value in the 120th day of the process ($p<0.05$). Water activity was the highest value (0.994) in 0 day of the production process, and the lowest value (0.853) in the 180th day of the process(Fig.2).

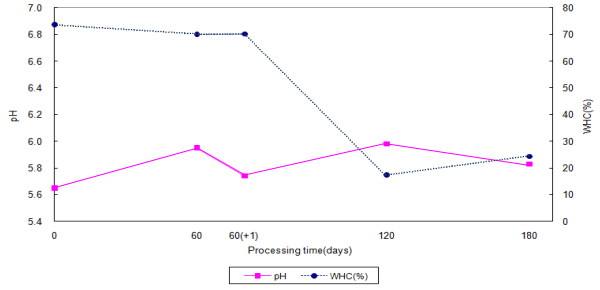

Fig. 1. Changes of pH and water holding capacity(WHC) of dry-cured ham during the processing time.
0day: raw meat, 60days: End of curing, 60(+1)days: End of washing, 120days: End of drying, 180days: End of aging

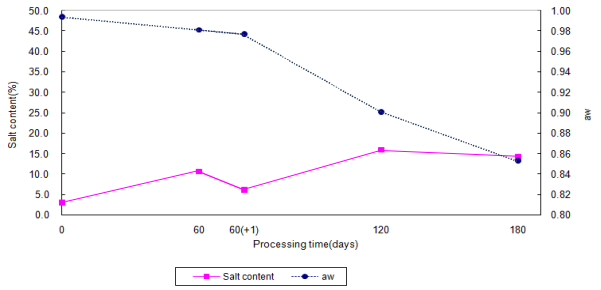

Fig. 2. Changes of salt content and water activity(a_w) of dry-cured ham during the processing time.
0day: raw meat, 60days: End of curing, 60(+1)days: End of washing, 120days: End of drying, 180days: End of agin

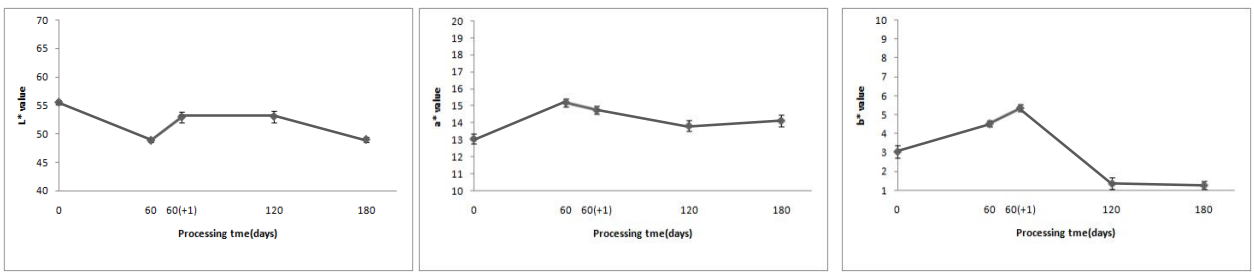

Fig. 3. Changes of meat color of dry-cured ham during the processing time.
0day: raw meat, 60days: End of curing, 60(+1)days: End of washing, 120days: End of drying, 180days: End of aging
L^{*} : lightness a^{*} : redness b^{*} : yellowness

According to the analysis of meat color, lightness (L*) was the highest value in 0 day of the production process ($p<0.05$), and the lowest value in the 60th day and the 180th day of the process ($p<0.05$). Redness (a*) was the lowest value in 0 day of the production process, and the highest value in the 60th day of the process, which was significant ($p<0.05$). Yellowness increased gradually to the 60th (+1) day, and after then, it tended to decrease(Fig.3).

Both TBA and VBN showed the tendency to increase over the time during the producing process ($p<0.05$)(Fig.4).

Total plate count and lactic acid bacteria increased, but the coliform showed negative response all the time during the production process(Fig.5).

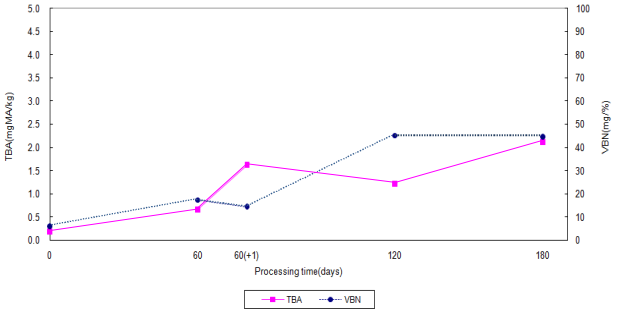

Fig. 4. Changes of TBA and VBN value of dry-cured ham during the processing time.
0day: raw meat, 60days: End of curing,
60(+1)days: End of washing, 120days: End of drying,
180days: End of aging.
TBA : thiobarbituric acid value
VBN : volatile basic nitrogen value

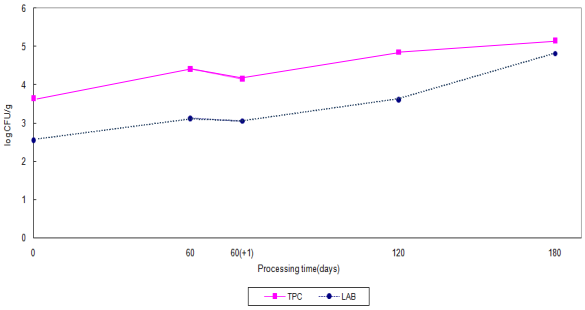

Fig. 5. Changes of TPC and LAB of dry-cured ham during the processing time.
0day: raw meat, 60day: End of curing,
60(+1)days: End of washing, 120days: End of drying,
180days: End of aging
TPC: Total plate count LAB: Lactic acid bacteria

For texture profile analysis, hardness and shear force were the lowest value in 0 day of the production process, and increased significantly in each section to the highest value in the 180th day of the process ($p<0.05$). Springiness was the significantly highest value in the 60th day of the production process ($p<0.05$), and cohesiveness, gumminess, and chewiness showed the tendency to increase during the production process ($p<0.05$)(Table 2).

Table 2. Changes of texture properties and shear force of dry-cured ham during the processing time

Traits	Time(day)				
	0	60	60(+1)	120	180
hardness(kg)	6.83±0.23^{e}	13.01±1.29^{d}	16.38±0.67^{c}	26.12±0.95^{b}	29.90±1.31^{a}
springiness(mm)	0.48±0.07^{b}	0.87±0.07^{a}	0.59±0.22^{b}	0.43±0.04^{b}	0.50±0.03^{b}
cohesiveness	0.49±0.01^{b}	0.57±0.04^{ab}	0.47±0.15^{b}	0.64±0.01^{a}	0.65±0.00^{a}
gumminess	3.31±0.07^{d}	7.41±0.22^{c}	7.68±2.14^{c}	16.82±0.80^{b}	19.34±0.77^{a}
chewiness	1.63±0.22^{d}	6.49±0.65^{c}	7.80±0.08^{b}	7.23±0.93^{bc}	9.56±0.32^{a}
shear force(kg)	4.23±0.21^{e}	8.55±0.42^{d}	6.92±0.29^{c}	13.34±0.53^{b}	14.76±0.51^{a}

0day:raw meat, 60days:End of curing, 60(+1)days:End of washing, 120days:End of drying, 180day:s End of aging
$^{a-d}$: Values with different superscripts in the same row differ significantly ($p<0.05$).
Mean±S.D

2. Quality Features of the Fermented Dry-cured Ham

According to the result of chemical composition, moisture and crude protein contents were significantly higher in YLD pork than in YBD pork ($p<0.05$), and crude fat content was significantly higher in YBD pork than in YLD pork ($p<0.05$)(Table 3).

Table 3. Comparison of chemical composition of dry-cured ham manufactured by YLD and YBD crossbreed pigs

Composition	Pig breed	
	YLD	YBD
moisture(%)*	56.00±0.60	53.89±0.60
crude protein(%)*	28.04±0.05	26.87±0.07
crude fat(%)*	3.24±0.21	6.17±0.63
crude ash(%)*	11.86±0.03	13.00±0.00

YLD : Yorkshire×Landrace× Duroc YBD : Yorkshire× Berkshire×Duroc
* : $p<0.05$
Mean±S.D

There was no significant difference in pH, water holding capacity, and water activity between YLD pork and YBD pork. Salt content was significantly higher in YBD pork than in YLD pork ($p<0.05$). For meat color, lightness (L*) and yellowness (b*) were significantly higher in YBD pork than in YLD pork ($p<0.05$) and redness (a*) was significantly higher in YLD pork than in YBD pork ($p<0.05$). In the result of TBA, there was no significant difference between YLD pork and YBD pork, and in the result of VBN, it was significantly higher in YBD pork than in YLD pork ($p<0.05$). According to the result of microbial counts, both total plate count and lactic acid bacteria were rather higher in YBD pork than in YLD pork, but not significant(Table 4).

Table 4. Comparison of pH, water holding capacity, water activity, Salt content, meat color, VBN, TBA and microbial counts of dry-cured ham manufactured by YLD and YBD crossbreed pigs

Traits	Pig breed	
	YLD	YBD
pH	5.83±0.01	5.74±0.01
WHC(%)	24.36±0.51	23.70±0.75
a_w	0.853±0.05	0.836±0.03
Salt content(%)*	14.15±0.07	17.30±0.00
Meat color L-value*	49.02±0.46	53.33±0.91
a-value*	14.12±0.35	12.43±0.31
b-value*	1.27±0.22	2.84±0.22
TBA(mgMA/kg)*	2.12±0.13	2.24±0.13
VBN(mg/%)*	44.65±0.49	51.67±0.50
TPC(log CFU/g)	5.15	5.26
LAB(log CFU/g)	4.81	4.96
Coliforrm	-	-

YLD : Yorkshire×Landrace× Duroc YBD : Yorkshire× Berkshire×Duroc
L-value : lightness a-value : redness b-value : yellowness
TPC: Total plate count LAB: Lactic acid bacteria TBA : thiobarbituric acid value VBN : volatile basic nitrogen value
* : $p<0.05$
Mean±S.D

For texture profile analysis, hardness, gumminess, chewiness, and shear force were significantly higher in YBD pork than in YLD pork ($p<0.05$), and springiness and cohesiveness were not significantly different between YLD pork and YBD pork(Table 5). According to sensory properties, tenderness, flavor, juiciness, saltiness, and overall acceptance were not significantly different.

Table 5. Comparison of texture profile analysis, shear force of dry-cured ham manufactured by YLD and YBD crossbreed pigs

Traits	Pig breed	
	YLD	YBD
hardness(kg)*	29.90±1.31	33.15±0.61
springiness(mm)	0.50±0.03	0.60±0.08
cohesiveness	0.65±0.00	0.68±0.03
gumminess*	19.34±0.77	20.77±0.33
chewiness*	9.56±0.32	11.70±0.91
shear force(kg)*	14.76±0.51	18.48±0.48

YLD : Yorkshire×Landrace× Duroc YBD : Yorkshire× Berkshire×Duroc
* : $p<0.05$
Mean±S.D

IV. CONCLUSION

The test result indicated that there was no significant difference between pig breeds in sensory test but we think the YLD pork which indicated lower salinity, better structural feeing, lower change in protein decay and higher redness would bring us better quality products than YBD one. Controlling humidity and temperature during production process shall be most important for producing fermented fresh ham and think it would be one of good income sources of high profit in domestic market if researches on producing fermented fresh ham are to continue.

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