The effect of salt content and $NaNO_2$ on weight loss, pH, proximate composition and chemical parameters of naturally processed dry-cured ham

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Introduction

Dry-cured hams are common ways to keep pork in Southern Europe. Traditionally, the dry-cured hams have been produced using only pork, sea salt, fresh mountain air and time in Southern Europe for 2000 years. These kinds of hams include *Parma* in Italy, *Jamon* in Italy, *Jinhua* in China and *Country ham* in U.S.A. Dry-cured hams are known for their unique sensory characteristics, such as the intense red colour and cured aroma. Sensory characteristics of dry-cured ham are related to its physicochemical composition. Salting is one of the primary steps in dry-cured ham processing; salt is bacteriostatic agent (Careri et al., 1993), which contributes to the typical salty taste of dry-cured ham, and it influences the development of proteolysis phenomena (Arnau et al., 1998).

The aim of this work was to analyze the effect of salt content and $NaNO_2$ on the weight loss, pH, proximate composition, and chemical parameters of naturally processed dry-cured ham.

Materials and Methods

Twelve thighs were obtained from local cross-bred swine (5-6 months, 100-110 kg). Briefly, the hams were placed on shelves in a cold room held at 1-4℃ and salted by individual addition of a controlled amount of salt in the lean part of the raw ham for four weeks. Four different treatments were formulated as follows: (1) The HS group salted with 9.2 g kg^{-1} salt (w/w) (high salt batch), (2) The HS+$NaNO_2$ group salted with the same HS group, following added $NaNO_2$ at 100 ppm, (3) The LS group salted with 6.2 g kg^{-1} salt (w/w) (Low salt batch), (4) The LS+$NaNO_2$ group salted with the same LS group, following added $NaNO_2$ at 100 ppm. All hams were held for four weeks at 1-4℃. After washing to remove salt from the surface, the samples were hung in outside for 8 months (4 months drying and 4 months aging). Then the hams were weighed at each of the stages of processing in order to calculate weight losses. Temperature and relative humidity of environment were measured daily between 15:00 and 16:00 (Figure 1, 2). *Biceps femoris* muscles were removed from hams and analyzed for pH, proximate composition, and chemical parameters.

The pH value of samples was measured in a homogenized sample solution (3 g/27 ml distilled H_2O) with a pH meter (SENTRON ARGUS-X, Netherland). Percentages of moisture, protein, intramuscular fat, and ash content were determined according to the procedure of AOAC (1996). Water activity (Aw) measurement was carried out at 25℃ with a Novasina AW SPRINT – TH 300 instrument (Axair Ltd., Pfäffikon, Switzerland) that allows temperature-controlled measurements of Aw. Salt content (% wet matter) was measured using salinity meter (Takemura, TM-30D, Japan). $NaNO_2$ content was determined according to the procedure of AOAC (1996).

Results were analyzed using the General Linear Models (GLM) of the Statistical Analysis System (SAS, 1998). Significant differences were analyzed by Duncan's Multiple Range test at $p<0.05$.

Results and Discussion

The weight losses of hams at different processing stages are shown in Table 1. The highest weight losses took place at the drying stage (27.46, 28.25, 26.99 and 28.42%). However, there were no significant differences in the weight losses between treatments ($P > 0.05$). The weight losses of hams at the salting step are mainly due to the osmotic effect of salt that covers the whole surface of the ham, whereas the weight loss at subsequent ageing stage is a consequence of dehydration (Goutefongea, 1988).

As shown in Table 1, although the moisture content was significantly affected with addition of $NaNO_2$ ($P< 0.05$), it seems that the differences of processing conditions did not significantly affect fat, protein, and ash content of *Biceps femoris* muscles ($P> 0.05$). The LS hams had significantly higher moisture content than HS+$NaNO_2$ and LS+$NaNO_2$ ($P< 0.05$).

The processing conditions significantly affected the chemical parameters of *Biceps femoris* muscles ($P< 0.05$). The water activity in *Biceps femoris* muscles from LS hams was significantly higher than in muscles from HS and HS+$NaNO_2$ hams ($P< 0.05$). The salt content in *Biceps femoris* muscles from LS+$NaNO_2$ hams was significantly lower than in the muscles from HS and HS+$NaNO_2$ hams ($P< 0.05$). The $NaNO_2$ treatment did not affect the $NaNO_2$ content in *Biceps femoris* muscles ($P> 0.05$).

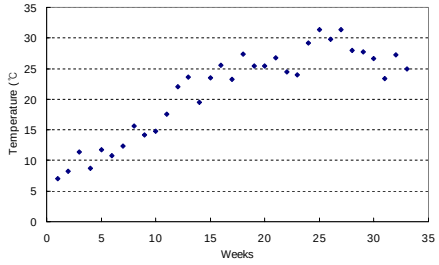

Figure 1. The change of temperature during drying and aging of dry-cured ham

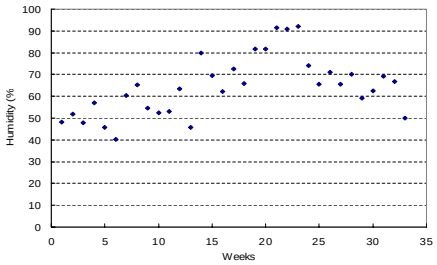

Figure 2. The change of relative humidity during drying and aging of dry-cured ham

Table 1. The effects of salt content and $NaNO_2$ on weight loss, pH, proximate composition and chemical parameters of dry-cured ham processed under Korean environment (n=3)

	HS(1)	HS+$NaNO_2$(2)	LS(3)	LS+$NaNO_2$(4)
Weight loss (%)				
End of curing	4.40±0.30	4.86±0.65	3.87±0.42	4.38±0.80
End of drying	27.46±0.65	28.25±2.16	26.99±0.32	28.42±2.76
End of aging	10.39±0.62	10.24±1.10	10.64±0.42	11.83±1.50
Total weight loss	34.99±0.69	35.55±2.70	34.76±0.59	36.81±3.49
pH				
Raw meat	5.57±0.05	5.65±0.06	5.58±0.06	5.67±0.03
End of curing	5.46±0.04^{b}	5.58±0.02^{ab}	5.56±0.05^{ab}	5.67±0.04^{a}
Dry-cured ham	5.81±0.02	5.79±0.01	5.92±0.05	5.98±0.09
Proximate composition				
Moisture (%)	50.29±1.15^{ab}	48.09±1.16^{b}	53.10±1.03^{a}	48.12±2.08^{b}
Fat (%)	6.15±0.55	7.45±0.90	6.05±0.51	8.45±0.79
Protein (%)	32.71±0.85	33.30±2.12	32.92±1.07	35.05±2.26
Ash (%)	1.13±0.11	1.05±0.11	1.08±0.04	1.39±0.13
Chemical parameters				
Aw	86.03±1.03^{bc}	85.42±0.61^{c}	88.78±0.35^{a}	88.12±0.57^{ab}
Salt content, % wet matter	6.85±0.42^{b}	7.81±0.23^{a}	5.93±0.22^{bc}	5.60±0.22^{c}
$NaNO_2$ content (ppm)	2.35±0.31^{a}	2.33±0.28^{a}	1.28±0.11^{b}	1.71±0.09^{ab}

$^{a-c}$: Values with different superscripts in the same row differ significantly($P<0.05$)

* Mean ± standard error

(1) HS : high salt [9.2 g kg^{-1} salt (w/w)] batch

(2) HS+ $NaNO_2$: high salt [9.2 g kg^{-1} salt (w/w)] + $NaNO_2$ (100 ppm) batch

(3) LS : low salt [6.2 g kg^{-1} salt (w/w)] batch

(4) LS : low salt [6.2 g kg^{-1} salt (w/w)] + $NaNO_2$ (100 ppm) batch

Conclusions

Traditionally, because dry-cured raw ham is not popular in Korea, it has not been consumed and distributed commercially. This approach and technique to producing dry-cured ham in Korea will enable Korean consumers to diversify meat product.

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