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Effects of Ginseng on Lipid Oxidation and Color of Pork and Chicken Breast Meat

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Abstract

Varying amount of ginseng was added to pork and chicken breast meat at various pH for a model system. Pork and chicken breast meat sausages were manufactured with 2.5% of ginseng and varying concentration of nitrite. Ginseng reduced the lipid oxidation in the pork except at pH 4.5 whereas promoted in the chicken breast meat regardless of pH. In the presence of ginseng, nitrite decreased the lipid oxidation of the sausages with increasing concentration. Cured color formation increased with an increase of ginseng upto 7.5% in the pork whereas upto 2.5% in the chicken breast meat. Redness of the pork sausage containing ginseng increased with an increase of nitrite. Lightness of the chicken breast meat sausage containing ginseng decreased with increasing nitrite level.

Key words: ginseng, lipid oxidation, pork, chicken breast meat

Introduction

Oxidative reactions are responsible for color, flavor and odour changes in meat. Oxidation of the bright red oxymyoglobin leads to the formation of the undesirable brown metmyoglobin. The lipids present in muscle also undergo oxidation on storage, giving rise to rancid odours and flavors[1]. In view of the importance of meat color and flavor to the consumers, efforts to find acceptable ways of limiting lipid oxidation are of great importance[2]. Lipid oxidation and the related deterioration in color and flavor can be inhibited by using a variety of substances and environmental factors such as free radical chain stoppers, free radical production preventors and low oxygen partial pressure or moisture content[3]. Among them, ascorbate, phosphate and nitrite are additives having antioxidant effect in meat and meat products.

Recently there has been growing concern about possible health risks from the use of additives in food. Considerable number of consumers read ingredient labels primarily to avoid artificial ingredients and seek natural ones. Given these consumer concerns, food chemists are challenged to seek solutions to the demands of food preservation through the use of natural ingredients[4].

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Ginseng is regared as an elixir of life and its active components are known to be ginsenosides which include various saponins[5]. It also has been shown to have substances exhibiting reducing and antioxidant activities[6]. However, biochemical and pharmacological characteristics of its components still remain to be defined further. Because of its effects claimed, ginseng has been processed into various products such as tea, extracts, liquor and beverage. Among various usages, Samgyetang (a boiled chicken-ginseng dish) is the only example of its muscle food use in Korea. It has long been consumed as a tonic food in Korea.

Therefore, the objective of this study was to investigate the effect of ginseng as an antioxidant or a reducing substance on lipid oxidation and cured color conversion of pork as a red meat and chicken breast meat as a white meat.

Materials and Methods

Sample preparation

Lean pork and chicken breast meat were purchased from a local market. After removing visible fat and skin, lean meat was ground using a grinder with a plate of 5 mm in diameter. Crude fat content of pork and chicken breast meat after grinding was 5.8 % and 5.5%, respectively.

Model system

A model system was prepared by mixing ground

Table 1. Effect of ginseng on TBA values of pork

pH	TBA values (μmole/g meat)					
	Ginseng (%)					
	0	1.0	2.5	5.0	7.5	10.0
3.5	0.396^{aA}	0.391^{aAB}	0.268^{bA}	0.295^{abA}	0.216^{bA}	0.282^{abA}
4.5	0.293^{abAB}	0.456^{aA}	0.297^{abA}	0.298^{abA}	0.277^{abA}	0.224^{bA}
5.5	0.399^{aA}	0.329^{abB}	0.268^{abA}	0.354^{abA}	0.253^{bA}	0.268^{abA}
6.5	0.277^{aB}	0.205^{abC}	0.191^{bA}	0.189^{bB}	0.213^{abA}	0.205^{abA}

[a-b] Values with the different small letter superscripts in the same row are significantly different at 5% level
[A-C] Values with the different capital letter superscripts in the same column are significantly different at 5% level

Table 2. Effect of ginseng on TBA values of chicken

pH	TBA values (μmole/g meat)					
	Ginseng (%)					
	0	1.0	2.5	5.0	7.5	10.0
3.5	0.184^{bcA}	0.144^{cB}	0.190^{bcB}	0.180^{bcB}	0.210^{abB}	0.255^{aA}
4.5	0.138^{cB}	0.195^{abAB}	0.186^{bB}	0.219^{aAB}	0.211^{abB}	0.187^{bB}
5.5	0.157^{dAB}	0.206^{cA}	0.231^{bcA}	0.206^{cAB}	0.293^{aA}	0.259^{abA}
6.5	0.150^{dB}	0.168^{cdAB}	0.189^{bcdB}	0.226^{abA}	0.201^{bcB}	0.254^{aA}

[a-d] Values with the different small letter superscripts in the same row are significantly different at 5% level
[A-B] Values with the different capital letter superscripts in the same column are significantly different at 5% level

meats with commercial white ginseng powder (crude fat content 1.6%). Shortly after mixing, the mixtures were heated at 75℃ in a water bath until the internal temperature of 65℃ was reached. Samples with different pH values were made by mixing the meat mixture (1) and the buffer (2) (0.1 M citric acid and 0.2 M disodium phosphate). For the cured color experiment, sample containing 156 ppm sodium nitrite was prepared at pH 5.8 as described earlier.

Emulsion-type sausage

Sausage was manufactured by chopping ground meat in a silent cutter using the formulation of lean meat 80% and back fat 20% as the meat ingredient, and ice water 15%, sugar 1.0%, salt 1.3%, pepper 0.13 %, nutmeg 0.05%, garlic 0.03%, ginseng powder 2.5% and varying levels of sodium nitrite to the total meat ingredient weight. Batters were stuffed into cellulose casings of 3.5 cm diameter and cooked at 75℃ in a smoke house without smoking until the internal temperature reached 63℃. Then they were chilled by a cold water shower and stored at 3-4℃ in a cold room for 3 weeks.

Lipid oxidation

The TBA values of samples were measured as described in Lee and Cassens[7] by using the method from Ke and Woyewoda[8].

Cured color conversion

For the measurement of cured color conversion in the model system, total heme pigments and nitric oxide-heme pigments were measured according to Hornsey[9] and the conversion percent was calculated by the equation of (nitric oxide-heme pigments/total heme pigments)×100.

Objective color

Color readings of sausage samples prepared by the instrument standared round cell (inner diameter 3 cm and height 1.3 cm) were obtained from Color Difference Meter (Yasuda Seiki Co., UC600 IV, Japan) utilizing the "L" (lightness), "a" (redness) and "b" (yellowness) color system. The instrument was standardized with a white standard plate (L=89.2, a=0.921, b=0.78).

Statistical analysis

Duncan's multiple range tests was used to determine differences between treatment means with the Statistical Analysis System[10].

Results and Discussion

Lipid oxidation

The effect of ginseng on the lipid oxidation of pork and chicken breast meat varied depending upon the kind of meat and pH in the system in which only meat and ginseng were present. In pork, even though the result fluctuated somewhat, the general tendency was that lipid oxidation decreased with the addition of ginseng except in the case of pH 4.5 (Table 1). The antioxidant effect increase was not obvious above the ginseng concentration of 2.5%. In terms of pH, lipid oxidation was lowest at pH 6.5 than at other pH values regardless of concentration. Kwoh[11] reported that lipid oxidation was inhibited at high pH in raw meats and both heme and non-heme iron were active at lower pH values.

On the other hand, TBA values increased with the addition of ginseng to chicken breast meat at all pH values (Table 2). The reason for the increased oxidation in chicken breast meat might be that poultry

Table 3. Effect of sodium nitrite on TBA values of pork sausage containing ginseng during storage

Days	TBA values (μmole/g sausage)			
	Sodium nitrite (ppm)			
	0	40	78	156
1	0.136^{aB}	0.136^{aB}	0.012^{bc}	0.062^{abAB}
7	0.197^{aB}	0.212^{aB}	0.024^{bc}	0.020^{bB}
14	0.385^{aA}	0.313^{aA}	0.180^{bB}	0.101^{bAB}
21	0.339^{aA}	0.342^{aA}	0.320^{aA}	0.154^{bA}

[a-b] Values with the different small letter superscripts in the same row are significantly different at 5% level
[A-C] Values with the different capital letter superscripts in the same column are significantly different at 5% level

Table 4. Effect of sodium nitrite on TBA values of chicken sausage containing ginseng during storage

Days	TBA values (μmole/g sausage)			
	Sodium nitrite (ppm)			
	0	40	78	156
1	0.182^{aC}	0.031^{bD}	0.021^{bc}	0.011^{bD}
7	0.210^{aC}	0.106^{bC}	0.059^{cC}	0.057^{cC}
14	0.383^{aB}	0.324^{bB}	0.313^{bB}	0.183^{cB}
21	0.453^{aA}	0.366^{bA}	0.397^{bA}	0.302^{cA}

[a-c] Values with the different small letter superscripts in the same row are significantly different at 5% level
[A-D] Values with the different capital letter superscripts in the same column are significantly different at 5% level

Table 5. Effect of ginseng on the cured meat color

	Conversion percent					
	Ginseng (%)					
	0	1.0	2.5	5.0	7.5	10.0
Pork	26.48^{aA}	32.50^{bA}	40.01^{cA}	56.80^{eA}	65.30^{fB}	48.35^{dB}
Chicken	44.42^{bB}	43.18^{bB}	50.95^{cB}	53.73^{cA}	53.75^{cA}	30.24^{aA}

[a-f] Values with the different small letter superscripts in the same row are significantly different at 5% level
[A-B] Values with the different capital letter superscripts in the same column are significantly different at 5% level

breast meat has high cytochrome c content[12] and cytochrome c in the presence of ascorbate, which is a reducing agent, promoted the lipid oxidation[7]. It has been reported that ginseng has the reducing activity[6]. The effect of ginseng on lipid oxidation of chicken breast meat in terms of pH was different from that in pork.

In sausages, considering the results of lipid oxidation in the model system, 2.5% of ginseng was arbitrarily chosen to be added at various concentration levels of sodium nitrite. The addition of nitrite to pork sausage containing ginseng did not always lower the lipid oxidation (Table 3). There was no difference in TBA values between the pork sausage at 40 ppm of sodium nitrite and that at 0 ppm. Likewise, no difference was observed between 78 ppm and 156 ppm. With storage time, such phenomena were disappeared.

In the chicken sausage, unlike the pork sausage, nitrite reduced TBA values with increasing concentration (Table 4). According to MacDonald *et al.*[13], when ham was cured only with salt and nitrite, TBA value was lower with higher concentration of nitrite added. Tellefson *et al.*[14] however, showed that when ascorbate and nitrite were added together, malonaldehyde content of turkey muscle emulsion after cooking was lower than when either ascorbate in the formulation, the effect of ginseng on lipid oxidation of pork appeared to be different from that of ascorbate. The reason that the antioxidant effect of the increasing concentration of nitrite was different in the presence of ginseng between pork and chicken breast meat sausage remains to be investigated further. At least the pH did not seem to be the reason for the difference because after mixing and heating, pH values of pork and chicken sausages were 5.8 and 6.0, and 5.8 respectively, regardless of treatments.

Cured color

The conversion of total heme pigments to nitrosylhemochrome in the presence of ginseng was different between pork and chicken breast meat (Table 5). In pork, the conversion increased with increasing concentration of ginseng added upto 7.5% and decreased after that. However, with chicken breast meat the conversion started increasing from 2.5%, maintained fairly constant upto 7.5% and then decreased. The percent of conversion was higher in chicken breast meat than in pork upto 2.5% of ginseng addition. Results suggest that since breast meat has considerably lower heme pigments content than pork, 2.5% of ginseng supplied enough reducing power to form all the nitrosylmyoglobin in chicken breast meat but not in pork until the concentration of 7.5%. According to Siedler and Schweigert[15], ascorbate in a model system containing myoglobin, nitrite and ascorbate gave 60-70% yield of nitrosylhemochrome after heating, independent of the level of nitrite present. However, in the presence of cysteine, the yield was

Table 6. Effect of sodium nitrite on the "L" (lightness) values of cured pork and chicken sausage containing ginseng

Days	Pork				Chiken			
	Sodium nitrite (ppm)							
	0	40	78	156	0	40	78	156
1	52.46^{bA}	53.03^{aA}	50.70^{cA}	48.60^{dB}	61.40^{aB}	59.30^{bA}	56.40^{cC}	53.70^{dB}
7	48.80^{bB}	51.20^{aD}	45.70^{cD}	48.80^{bA}	61.30^{aC}	54.20^{cB}	59.50^{bA}	52.40^{dC}
14	46.60^{cC}	51.40^{aC}	45.80^{dC}	47.90^{bC}	62.40^{aA}	49.70^{dC}	57.60^{cB}	59.50^{bA}
21	45.71^{dD}	52.10^{aB}	46.20^{cB}	46.40^{bD}	59.70^{aD}	49.70^{cC}	49.50^{dD}	59.50^{bA}

$^{a-d}$Values with the different small letter superscripts in the same row are significantly different at 5% level
$^{A-D}$Values with the different capital letter superscripts in the same column are significantly different at 5% level

Table 7. Effect of sodium nitrite on the "a" (redness) values of cured pork and chicken sausage containing ginseng

Days	Pork				Chiken			
	Sodium nitrite (ppm)							
	0	40	78	156	0	40	78	156
1	4.82^{aA}	8.34^{cA}	7.53^{bA}	8.97^{dA}	2.41^{aA}	5.00^{bA}	5.02^{bA}	5.76^{cA}
7	2.18^{aB}	4.61^{cC}	4.09^{bC}	6.60^{dB}	2.36^{aB}	4.24^{bB}	4.98^{dB}	4.42^{cB}
14	2.18^{aB}	5.11^{cB}	4.68^{bB}	6.56^{dB}	0.61^{aC}	4.13^{cC}	4.08^{bC}	4.04^{bC}
21	2.11^{aC}	4.40^{bD}	4.70^{cB}	5.99^{dC}	0.17^{aD}	3.34^{bD}	3.96^{cD}	4.00^{cD}

$^{a-d}$Values with the different small letter superscripts in the same row are significantly different at 5% level
$^{A-D}$Values with the different capital letter superscripts in the same column are significantly different at 5% level

dependent on the level of nitrite used. Conversions of 60-80% nitrosylhemochrome are normal and less than 50% conversion results in brownish hues in cured meats[16]. In this study, only 7.5% of ginseng in the case of pork resulted in the color conversion that is within the normal range. The extent, however, was lower in chicken breast meat at all the levels of ginseng. These results suggest that the color conversion in the presence of reducing agents is different between red and white meat in which heme pigments composition is different. Ahn and Maurer[17] indicated that about 90% hemoglobin was denatured at 74 ℃ while only 15% of myoglobin and 7.5% of cytochrome c were denatured. Another reason for the lower conversion in either kind of meat in this study may be that heating was carried out immediately after mixing meats and nitrite with or without ginseng.

The "L" values of the pork sausage, which measured the lightness of a sample, indicated an initial increase between 0 ppm and 50 ppm nitrite followed by a decrease in lightness with increasing nitrite concentration. The trends were similar during the storage except one with 156 ppm, remaining fairly constant in "L" value (Table 6). Chicken breast meat sausage, on the other hand, showed significant decrease in lightness with an increase of nitrite. However, the change of "L" values during the storage was in lack of consistency.

The results on "a" values indicating redness of the samples showed that the presence of nitrite increased redness of a pork sausage but the sample with 78 ppm resulted in lower value than that with either 40 or 156 ppm (Table 7). Sebranek *et al.*[18] reported that color of the frankfurter decreased with decreasing nitrite concentration in the presence or the absence of erythorbate. After a week of storage, redness decreased remarkably. This indicates that ginseng could not protect nitrosylhemochrome from the oxidation in the presence of oxygen and light. In chicken breast meat sausage, there was a significant increase in "a" values with the increased level of nitrite. During the storage time, the decrease of redness was not larger than in the pork sausage. It might be because chicken breast meat does not have much heme pigments.

The "b" values indicating yellowness of samples decreased with an increase of nitrite in the pork sausage (Table 8). The yellowness did not change appre-

Table 8. Effect of sodium nitrite on the "b" (yellowness) values of cured pork and chicken sausage containing ginseng

Days	Pork				Chiken			
	Sodium nitrite (ppm)							
	0	40	78	156	0	40	78	156
1	11.76^{aA}	10.66^{bB}	10.49^{cA}	9.35^{dD}	11.76^{aD}	12.90^{bC}	13.40^{cC}	14.60^{dB}
7	10.80^{bD}	11.10^{aA}	9.99^{cB}	10.80^{bA}	10.80^{aA}	11.80^{bD}	14.50^{cA}	15.20^{dA}
14	11.20^{aB}	10.20^{cD}	9.66^{dC}	10.40^{bB}	11.20^{aC}	13.80^{bB}	13.90^{cB}	14.60^{dB}
21	10.82^{aC}	10.40^{bC}	9.52^{dD}	9.86^{cC}	10.82^{aB}	14.60^{dA}	12.20^{bD}	14.30^{cC}

$^{a-d}$Values with the different small letter superscripts in the same row are significantly different at 5% level
$^{A-D}$Values with the different capital letter superscripts in the same column are significantly different at 5% level

ciably during the storage. On the other hand, chiken breast meat sausage showed the opposite results to that of the pork sausage indicating the increase of yellowness with an increase of nitrite. The trends were similar during the storage time. Froehlich *et al.*[19] showed similar results to those of the pork sausage in this study for "L" and "b" values but different ones for "a" values in hams cured with increasing level of nitrite.

Considering the results on TBA values and cured color, the component of ginseng having a reducing activity seemed to be different from that having an antioxidant effect. It has been reported that ginseng contains various and fruits[20], and reducing sugars as well[21]. Farr *et al.*[22] suggested that natural antioxidants of vegetable origin comprises of a phenolic type of entity as the chemical structure.

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인삼첨가가 돈육과 닭가슴육의 지방산화와 색택에 미치는 영향

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돈육과 닭가슴육을 이용한 model system에 인삼의 양은 pH별로 첨가량을 변화시키면서 첨가되었다. 또한 돈육과 닭가슴육을 이용한 소시지는 인삼 2.5% 첨가와 함께 nitrite 함량은 변화시키면서 제조되었다. 그 결과 인삼첨가는 돈육에 있어서 pH 4.5인 처리구를 제외하고 인삼내에 존재하는 폴리페놀 등의 성분에 의해 지방산화를 지연시키는 경향이 있는 반면 닭가슴육에 있어서는 pH에 관계없이 돈육에 있어서 보다 산화가 잘 일어나는 경향을 보여 주었다. 인삼과 nitrite를 혼합첨가한 소시지에서는 nitrite 첨가량이 증가 할수록 소지지의 산화는 감소하는 경향을 보여 주었다. 염지육색 형성 정도는 돈육에 7.5%까지 인삼 첨가량을 높임에 따라 증가되었지만 닭가슴육에서는 2.5%까지만 증가하는 경향이었다. 또한 Hunter의 색택에서는 인삼이 첨가된 돈육 소시지에서 적색도가 nitrite 첨가량이 증가함에 따라 증가하였고, 닭가슴육 소시지에서의 명도는 nitrite 첨가량이 증가함에 따라 감소하는 효과를 보였다.