EFFECT OF BOVINE PLASMA PROTEIN HYDROLYSATES ON QUALITY PROPERTIES OF COOKED PORK PATTY MANUFACTURED WITH OLIVE OIL SUBSTITUTION

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Abstract – The study investigated the effects of adding bovine plasma protein (PP) hydrolysates on the quality properties of cooked pork patties. Pork patties were prepared as follows: manufactured with pork back-fat (control); replacement of back-fat with 40% olive oil (T1), 40% olive oil and 0.02% BHT (T2), 40% olive oil and 2% PP hydrolysates (T3), and 40% olive oil and 4% PP hydrolysates. The olive oil modified the fatty acid profiles of the pork patties by lowering the SFA percentage. Pork patty added with PP hydrolysates had higher protein content and pH values than the control. All samples containing BHT and PP hydrolysates had reduced levels of TBARS values.

Key Words – plasma protein hydrolysates, olive oil, pork patty, quality characteristics.

I. INTRODUCTION

In recent years, the tendency towards consuming convenience foods has resulted in the increased production of ready-to-eat meats that are easy to prepare and consume. However, chemical and structural changes in lipids and proteins during processing and storage of precooked meat products have an undesirable impact on their quality [1]. The extent and speed of oxidation depends on several factors, such as temperature, the presence of prooxidants and antioxidants, and the molecular nature of the lipids in the products [2].

Synthetic and natural antioxidants have been proposed to minimize lipid oxidation in meat products. However, concerns about the long-term safety and negative consumer perception of synthetic antioxidants have led to an increasing demand for the use of natural antioxidants in meat and meat products [3]. In recently, research has focused on protein and peptides from food sources including meat and meat by-products [4]. Enzymatic hydrolysis has been used to improve solubility and foaming properties. Plasma protein hydrolysates have been shown to possess antioxidant activity [5]. However, hydrolyzed plasma protein has not been used as a functional food ingredient nor has it been evaluated as a potential antioxidant in food quality preservation.

Therefore, the objective of the present study was to evaluate the effectiveness of bovine plasma protein hydrolysates on the antioxidant activity and quality properties of cooked pork patties manufactured with olive oil substitution.

Table 1. Formulation of pork patties added hydrolyzed plasma protein

	Treatments[1)]				
	C	T1	T2	T3	T4
Pork loin	80.50	80.50	80.50	80.50	80.50
Pork back-fat	10.00	6.00	6.00	6.00	6.00
Olive oil	-	4.00	4.00	4.00	4.00
Salt	1.50	1.50	1.50	1.50	
Water	8.00	8.00	7.98	6.00	4.00
BHT	-	-	0.02	-	
Plasma protein hydrolysates	-	-	-	2.00	4.00
Total	100.00	100.00	100.00	100.00	100.00

[1)]Control: manufactured with pork back-fat, T1: replacement of back-fat with 40% olive oil, T2: 40% olive oil and 0.02% BHT, T3: 40% olive oil and 2% plasma protein hydrolysates, T4: 40% olive oil and 4% plasma protein hydrolysates.

II. MATERIALS AND METHODS

1. Preparation of plasma protein hydrolysates

Bovine PP solution [5% w/v 10 mM sodium phosphate buffer (pH 7.0)] was heat treated (90℃, 5 min) and then hydrolyzed with Alcalase, with an enzyme to substrate ratio (E/S) of 2:100 (g/g). The hydrolysates were produced by setting the

hydrolyzation time to 338 min and the temperature to 54℃. After hydrolysis, the pH of the solution was brought to 7.0 and the solution was then heated at 95℃ for 5 min to inactivate the enzyme (degree hydrolysis = 18.78%, respectively).

2. Preparation of pork patty

Pork *longissimus dorsi* muscles (pH 5.54-5.57) were obtained at 48 h post-slaughter from a local market on three different processing days. Three replications of six pork loins (3 pigs) per replicate were used for each treatment. The ingredient composition of the pork patties is presented in Table 1. Each loin had all visible fat and connective tissues trimmed off, and each replication was ground separately through a 3-mm plate twice. For each formulation treatment, the mixture was prepared by blending for 5 min with a Kitchen Aid mixer (5K5SS, Kitchen Aid, St. Joseph, MI). Ground pork patties (approximately 100 g) were made by hand, packaged individually in oxygen-impermeable bags (O^2 permeability, 9.3 mL O^2/m^2/24 h at 0℃).

After packaging, pork patties were cooked in a 90℃ water bath until the internal temperature of the patties reached 75℃. After cooling to room temperature, proximate composition (%), fatty acid composition (%), pH, purge loss (%), color (lightness), and 2-thiobarbituric acid reactive substance (TBARS, mg malondialdehyde/kg) value were analyzed.

Table 2. Proximate composition (%) of pork patties in added plasma protein hydrolysates

Treatments[1)]	Moisture	Crude protein	Crude fat	Ash
C	63.09± 1.16	18.16± 0.26^{B}	10.97± 0.98	1.47± 0.15^{B}
T1	63.60± 0.90	18.77± 0.51^{B}	11.13± 1.25	1.25± 0.05^{C}
T2	62.89± 1.18	19.42± 0.18^{AB}	10.87± 1.20	1.48± 0.04^{B}
T3	63.59± 0.74	20.11± 0.42^{A}	11.65± 0.83	1.92± 0.04^{A}
T4	62.43± 0.68	20.58± 0.36^{A}	11.36± 0.54	1.83± 0.06^{A}

Data are means ± standard deviation.
^{A,B}Means with different superscript capital letters in a column within each treatments differ significantly ($P < 0.05$).

[1)]The same as Table 1.

3. Statistical analysis

Data was analyzed by the procedures of generalized linear model (GLM) of SAS (SAS, 2014). Duncan's multiple range test was used to determine the statistical significance among the means at a 95% significance level.

III. RESULTS AND DISCUSSION

1. Proximate and fatty acid compositions

The pork patties showed no significant differences in terms of moisture (62.43~63.60%) and crude fat (10.87~11.65%) content compared to the control. Also, the crude protein and ash content of the pork patty samples ranged from 18.16% to 20.58% and 1.25% to 1.92%, respectively. In contract, results from other studies support that using mechanically deboned chicken hydrolysates in the manufacture of fish paste increases the protein contents of the final products [6].

Table 3. Fatty composition (%) of pork patties in added plasma protein hydrolysates

Fatty acid	Treatments[1)]				
	C	T1	T2	T3	T4
C12:0	0.09^{A}	0.06^{B}	0.06^{B}	0.06^{B}	0.06^{B}
C14:0	1.35^{A}	0.88^{B}	0.89^{B}	0.91^{B}	0.92^{B}
C14:1	0.06^{A}	0.04^{C}	0.05^{B}	0.04^{BC}	0.05^{B}
C16:0	23.49^{A}	19.77^{B}	19.09^{B}	19.51^{B}	19.46^{B}
C16:1	2.21^{A}	1.87^{B}	1.92^{B}	1.88^{B}	1.95^{B}
C18:0	13.09^{A}	10.19^{B}	9.46^{B}	9.99^{B}	9.82^{B}
C18:1n9c	43.01^{B}	55.33^{A}	56.38^{A}	55.45^{A}	55.13^{A}
C18:1n9t	1.49^{A}	0.17^{B}	0.17^{B}	0.17^{B}	0.17^{B}
C18:2n6c	13.30^{A}	10.15^{B}	10.44^{B}	10.43^{B}	10.80^{B}
C18:3n3	0.06^{A}	0.04^{C}	0.04^{BC}	0.04^{C}	0.05^{B}
C18:3n6	0.05^{A}	0.04^{B}	0.04^{B}	0.04^{B}	0.04^{B}
C20:1	0.55	0.57	0.60	0.58	0.59
C20:2	0.57^{A}	0.40^{B}	0.39^{B}	0.39^{B}	0.40^{B}
C20:3n3	0.04^{A}	0.03^{B}	0.02^{B}	0.02^{B}	0.03^{B}
C20:4n6	0.46^{A}	0.34^{C}	0.32^{C}	0.35^{C}	0.40^{B}

C20:5n3	0.02^{B}	0.02^{A}	0.02^{A}	0.02^{A}	0.02^{A}
C22:6n3	0.05^{A}	0.04^{B}	0.05^{AB}	0.05^{AB}	0.05^{A}
SFA[2)]	38.12^{A}	30.96^{B}	29.56^{B}	30.54^{B}	30.33^{B}
UFA	61.88^{B}	69.04^{A}	70.44^{A}	69.46^{A}	69.67^{A}
MUFA	46.83^{B}	57.45^{A}	58.55^{A}	57.57^{A}	57.33^{A}
PUFA	15.05^{A}	11.59^{B}	11.88^{B}	11.89^{B}	12.34^{B}

Data are means ± standard deviation.
[A,B]Means with different superscript capital letters in a column within each treatments differ significantly (P < 0.05).
[1)]The same as Table 1.

For fatty acid composition no differences due to the added hydrolyzed plasma proteins were observed (P > 0.05), whereas the addition of olive oil to the pork patties significantly reduced the total level of saturated fatty acids (SFAs) compared to the control (P < 0.05). The proportion of oleic acid (C18:1n9c) was increased by the addition of olive oil in the pork patties. Furthermore, the levels of unsaturated fatty acids (UFAs) and monounsaturated fatty acids (MUFAs) were significantly higher in the treatment samples compared to the control (P < 0.05).

2. Physicochemical properties

Pork patties with added PP hydrolysates had higher pH values than the other treatments (P < 0.05). In particular, the sample with added 4% PP hydrolysates had the highest pH values. Generally, the effectiveness of antioxidants is dependent on pH, according to Keokamnerd, Acton, Han, and Dawson [7], who reported an increase in pH of ground chicken thigh meat treated with commercial rosemary preparations.

For purge loss no differences due to the added olive oil were observed (P > 0.05). However, cooked pork patties with added 4% PP hydrolysates had a lower purge loss than the other treatments (P < 0.05).

The partial replacement of pork back-fat with olive oil and added BHT led to cooked pork patties with higher L^*-values, whereas cooked pork patties with PP hydrolysates had lower L^*-values than the other treatments (P < 0.05).

Both BHT and hydrolyzed PP inhibited TBARS formation in patties. The addition of 4% PP hydrolysates was more effective in decreasing the level of TBARS of the pork patties than the addition of BHT (P < 0.05). Patties are highly susceptible to oxidative reactions as mincing increase the exposure to oxygen and cooking promotes the formation of reactive oxygen species (ROS). Furthermore, the use of antioxidants is an effective method for preventing the generation of lipid oxidation products. PP hydrolysates were more effective in improving oxidative stability in cooked pork patties.

Table 4. Changes in pH, purge loss (%), lightness and TBARS values in added plasma protein hydrolysates of cooked pork patties

Treatments[1)]	pH	Purge loss (%)	Lightness (L^*)	TBARS (mg MDA/kg)
C	5.79± 0.03^{D}	0.39± 0.12^{AB}	58.14± 4.2^{B}	0.47± 0.04^{A}
T1	5.80± 0.02^{D}	0.36± 0.16^{AB}	58.89± 2.59^{B}	0.43± 0.05^{A}
T2	5.91± 0.03^{C}	0.61± 0.14^{A}	62.24± 2.04^{A}	0.33± 0.04^{B}
T3	6.00± 0.04^{B}	0.52± 0.17^{A}	54.57± 2.82^{C}	0.31± 0.03^{B}
T4	6.10± 0.01^{A}	0.20± 0.20^{B}	51.76± 1.97^{D}	0.28± 0.02^{C}

Data are means ± standard deviation.
[A,B]Means with different superscript capital letters in a column within each treatments differ significantly (P < 0.05).
[1)]The same as Table 1.

CONCLUSION

A partial (40%) replacement of pork back-fat in cooked pork patties with olive oil resulted in a product with increased levels of UFA and MUFA. Hydrolyzed PP products (2% and 4%) were not only able to reduce weight loss during storage but also improve the oxidative stability in the cooked pork patties. The addition of 4% PP hydrolysates was more effective than the addition of BHT in decreasing peroxide and TBARS levels in cooked pork patties. Therefore, the combination of the antioxidant effect together with the enhanced quality properties highlight the potential for PP hydrolysates to be utilized as attractive natural ingredients in processed muscle foods.

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REFERENCES

1. Lund, M. N., Heinonen, M., Baron, C. P., & Estévez, M. (2011). Protein oxidation in muscle foods: A review. *Molecular Nutrition and Food Research, 55,* 83-95.

2. Park, E. Y., Imaza, H, Matsumura, Y., Nakamura, Y., & Sato, K. (2012). Effects of peptide fraction with different isoelectric points from wheat gluten hydrolysates on lipid oxidation in pork meat patties. Journal of Agricultural and Food Chemistry, 60, 7483-7488.

3. Ahn, J., Gruen, I. U., & Fernando, L. N. (2002). Antioxidant properties of natural plant extracts containing polyphenolic compounds in cooked ground beef. Journal of Food Science, 67, 1364-1369.

4. Li, B., Chen, F., Xang, X., Ji, B., & Wu, Y. (2007). Isolation and identification of antioxidative peptides from porcine collagen hydrolysate by consecutive chromatography and electrospray ionization-mass spectrometry. Food Chemistry, 102, 1135-1143.

5. Saiga, A., Tananbe, S., & Nishimura, T. (2003). Antioxidnat activity of peptides obtained from porcine myofibrillar proteins by protease treatment. Journal of Agricultural and Food Chemistry, 51, 3661-3667.

6. Jin, S. K., Go, G. G., Jung, E. Y., Lim, H. J., Yang, H. S., & Park, J. H. (2014). Effect of mechanically deboned chicken meat hydrolysates on the physicochemical properties of imitation fish paste. Asian-Australasian Journal of Animal Science, 27, 115-122.

7. Keokamnerd, T., Acton, J. C., Han, I. Y., & Dawson, P. L. (2008). Effect of commercial rosemary oleoresin preparations on ground chicken thigh meat quality packaged in high oxygen atmosphere. Poultry Science, 87, 170-179.