

ANTIOXIDATIVE EFFECT OF SODIUM ASCORBATE, GARLIC AND ONION IN FRESH PORK BELLY AND LOIN DURING REFRIGERATED STORAGE

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Introduction

The palatability of food for consumers is affected by sensorial factors, such as appearance, taste, colour and flavour. In particular, flavour released from meat products has a particular mouthfeel which allowedistinguishes them from other foods. However, oxidative products containing undesirable rancidity are developed due to the oxidation of lipids with long-period storage, and it is one of the reasons for reduced quality and safety of meat and meat products. Thus, natural or synthetic antioxidants for inhibition of oxidative deterioration have been widely studied. The objectives of this study were to evaluate antioxidant and antimicrobial activity of sodium ascorbate (SA), garlic and onion in fresh pork belly and loin, to find volatile compounds to induce rancidity, and to inhibit the production of these compounds.

Materials and Methods

Fresh pork loin and belly slaughtered one day previously were purchased from a wholesale market. Belly and loin cuts were pumped to 110% of their original weight with solution containing 0.5% antioxidants (sodium ascorbate, SA; garlic; onion), 0.5% salt and 0.4% sodium triphosphate for comparison with belly and loin without antioxidants as a control. Thiobarbituric acid reactive substance (TBARS) values were measured by the method of Witte *et al.* (1970). Lipid was extracted by method of Folch *et al.* (1957). Free fatty acid (FFA) and peroxide values (POV) were determined by method of the AOCS (1987) and Lea (1952), respectively. Volatile compounds were extracted by the simultaneous distillation extraction (SDE) method of Heath and Reineccius (1986). Extracted volatile compounds were quantitatively and qualitatively analysed by GC and GC-MS. Total plate count (TPC) agar and violet red bile (VRB) agar were used to determine total bacterial counts and *Enterobacteriaceae*, respectively. The experiment was carried out in triplicate, and data were analysed using two-way analysis of variance in SPSS 12.0 software, with treatment and storage time as factors. Means were separated by the Duncan's multiple range test.

Results and Discussion

Belly containing 0.5% onion had higher TBARS values than control and garlic bellies, and 0.5% garlic belly had lowest TBARS value (Table 1). However, TBARS values were increased with increased storage time in loin, and those of garlic loin were higher than those of the control, SA and onion loins (Table 1). pH values were affected by antioxidants in both belly and loin. These results were due to the different pH of the injection solution (control 7.53, SA 7.39, garlic 7.12, onion 7.02). As shown Table 2, FFA values were increased with increased storage time in both loin and belly, regardless of the addition of antioxidants except for onion loin. However, FFA values of garlic and onion bellies were lower than the control and SA bellies at later storage times, and were decreased by 53 and 31%, respectively, after 28 days of storage, as compared to the control. PO values of control belly and belly containing SA, garlic and onion reached the maximum after 7 and 3, 28 and 28 days of storage, respectively. Therefore, production rates of PO in belly with antioxidants were reduced except for belly containing SA. Approximately 22 volatile compounds were identified from belly and loin, regardless of antioxidants. Among them, C-16 compounds containing hexadecanal were predominant compounds. 2-Pentyl-furan and aldehydes containing 4-pentanal and trans-2-octenal were not detected in SA, onion and garlic loins (Table 3). It took 7 days to reach the total plate counts (TPC) of 10^7 log cfu/g in control and SA bellies, and 7 to 14 days in garlic and onion bellies, respectively. To reach 10^7 log cfu/g of TPC, control, garlic and onion loins took 7-14 days, whereas SA loin took 14 days of storage. Microbial counts of *Enterobacteriaceae* were also similar to those of TPC.

Table 1: Changes of thiobarbituric acid reactive substance (TBARS), pH, Hunter colour values of pork belly and loin as affected by antioxidants during storage at 8°C.

Cut	Parameters	CTL ²	Treatments			Storage time (day)					
			SA ³	Garlic	Onion	0	3	7	14	21	28
Belly	TBARS (MDA mg/kg) ¹	0.27 ^{bc}	0.45 ^{ab}	0.23 ^c	0.47 ^a	0.27	0.24	0.23	0.36	0.57	0.44
	PH	6.30 ^a	6.32 ^a	6.24 ^{ab}	6.14 ^b	6.32 ^a	6.24 ^{ab}	6.34 ^a	6.16 ^b	6.22 ^{ab}	6.24 ^{ab}
Loin	TBARS (MDA mg/kg)	0.04 ^b	0.05 ^b	0.10 ^a	0.03 ^b	0.02 ^b	0.02 ^b	0.05 ^{ab}	0.07 ^{ab}	0.09 ^a	0.09 ^a
	PH	5.96 ^a	5.80 ^b	5.83 ^b	5.83 ^b	5.79	5.85	5.87	5.83	5.89	5.90

¹TBARS = thiobarbituric acid reactive substance; ²CTL = control; ³SA = sodium ascorbate; ^{a-c}Means with a same superscript within a row are not significantly different (P>0.05).

Table 2: Changes in free fatty acid (FFA) and peroxide value (POV) of pork belly and loin as affected by various antioxidants during storage at 8°C.

Cuts	Parameters	Treatment	Storage time (day)					
			0	3	7	14	21	28
Belly	FFA ¹ (%)	CTL ³	1.03 ^{ba}	1.18 ^b	1.29 ^{abA}	1.50 ^{abA}	1.90 ^{abA}	2.22 ^{AA}
		SA ⁴	0.95 ^{ba}	0.83 ^b	0.98 ^{baB}	1.39 ^{abA}	1.90 ^{abA}	1.92 ^{abB}
		Garlic	0.58 ^{cb}	0.66 ^{bc}	0.69 ^{bcB}	0.87 ^{abcB}	0.92 ^{abB}	1.05 ^{abB}
		Onion	0.61 ^{cb}	0.76 ^{bc}	0.90 ^{bcAB}	0.93 ^{bcB}	1.18 ^{abB}	1.54 ^{abB}
	POV ² (meq/kg)	CTL	1.00 ^{ba}	0.67 ^{bb}	2.90 ^{na}	1.73 ^{ab}	0.56 ^{bb}	1.00 ^{bb}
		SA	0.70 ^{baB}	2.41 ^{aA}	1.10 ^{bb}	1.33 ^b	0.79 ^{bb}	1.43 ^{bb}
		Garlic	0.45 ^{bb}	0.71 ^{bb}	1.19 ^{abB}	1.58 ^a	0.68 ^{bb}	1.79 ^{abB}
		Onion	0.86 ^{ca}	1.81 ^{bcA}	0.89 ^{cb}	1.27 ^c	3.00 ^{ba}	5.88 ^{aA}
Loin	FFA (%)	CTL	3.49 ^{caB}	3.76 ^c	4.82 ^{bc}	5.87 ^{ab}	6.57 ^a	5.81 ^{ab}
		SA	2.71 ^{bb}	2.67 ^b	3.42 ^b	3.98 ^b	4.53 ^b	6.44 ^a
		Garlic	3.42 ^{baB}	3.66 ^b	3.70 ^b	5.06 ^a	5.19 ^a	5.33 ^a
		Onion	4.54 ^A	4.48	4.20	5.45	4.51	6.36
	POV (meq/kg)	CTL	0.80 ^d	3.18 ^{cdB}	7.41 ^{abA}	8.17 ^{aAB}	4.27 ^{bcB}	4.67 ^{bcB}
		SA	1.18 ^c	2.20 ^{bcB}	2.59 ^{bcC}	8.95 ^{aAB}	4.19 ^{bb}	4.32 ^{bb}
		Grlic	0.46 ^d	1.55 ^{db}	4.90 ^{cdB}	12.7 ^{abA}	8.76 ^{bcA}	15.5 ^{aA}
		Onion	0.45 ^d	6.01 ^{abA}	8.60 ^{aA}	5.74 ^{abB}	2.12 ^{cdB}	4.25 ^{bcB}

¹FFA = free fatty acid; ²POV = peroxide value; ³CTL = control; ⁴SA = sodium ascorbate; ^{a-c}Means with a same superscript within a row are not significantly different (P>0.05). ^{A-C}Means with a same superscript within a column are not significantly different (P>0.05).

Table 3: Changes of volatile compounds of loin as affected by various antioxidants during storage at 8°C

Compounds	Treatment	Storage time (days)					
		0	3	7	14	21	28
2-pentyl-furan	CTL ¹	5.42 ^A	1.59 ^A	2.11 ^A	2.32 ^A	1.69 ^A	1.57 ^A
	SA ² , Garlic, Onion	t ^B	t ^B	t ^B	t ^B	t ^B	t ^B
4-pentenal	CTL	16.9 ^A	1.66 ^A	5.63 ^A	6.52 ^A	1.73 ^A	4.55 ^A
	SA, Garlic, Onion	t ^B	t ^B	t ^B	t ^B	t ^B	t ^B
trans-2-octenal	CTL	18.1 ^A	1.57 ^A	3.18 ^A	4.79 ^A	4.26 ^A	1.98
	SA, Garlic, Onion	t ^B	t ^B	t ^B	t ^B	t ^B	t

¹CTL = control; ²SA = sodium ascorbate; ^{a-c}Means with a same superscript within a row are not significantly different (P>0.05). ^{A-C}Means with a same superscript within a column are not significantly different (P>0.05). t : trace amount.

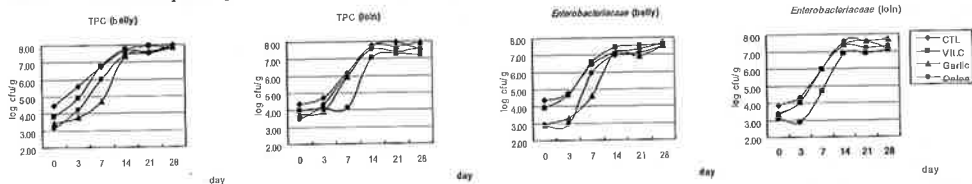


Figure 1: Change of microbiological of pork belly and loin as affected by antioxidants and storage time at 8°C (TPC = total plate count; CTL = control).

Conclusions

Belly was spoiled faster than loin due to the high amounts of fat. The antimicrobial effect of natural ingredients was affected by the muscle cut. Garlic and onion bellies showed antimicrobial effect, resulting in increases in shelf-life. Natural ingredients used in this study showed antioxidant and antimicrobial effect, garlic, in particular, of the natural ingredients may be considered as the best natural antioxidant to control lipid oxidation of food system.

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