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STABILITY OF HEME PIGMENT AND COLOR FORMATION IN MEAT PRODUCTS: EFFECTS OF VITAMIN E, CARNOSINE AND MILK PROTEIN HYDROLYSATES

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Keywords: vitamin E, carnosine, milk protein hydrolysates, meat color, heme pigment, lipid oxidation

Background:

The addition of NaCl causes discoloration and oxidation of meat during storage[1]. NaCl itself was noted by the present authors to decrease heme pigment in meat, while $NaNO_2$ and sodium ascorbate were considered to be essential for the retention of this substance[2]. Vitamine E acts to retain and accelerate red color in meat, as does also vitamin C (ascorbate). Carnosine, a dipeptide in muscle, reacts as an antioxidant and inhibits lipid oxidation and color deterioration[3]. The hydrolysates produced through the degradation of milk protein using certain proteases were found in a previous study to accelerate color formation in processed meat.

Objectives:

Good marketing requires that the fresh red color of raw meat be retained and the characteristic red color of meat products be preserved. Endogenous reducing substances such as vitamin E and vitamin C are effective for these purposes[4]. Carnosine (β -alanyl-L-histidine) shows antioxidant activity *in vivo*, as does also vitamin E and inhibits lipid oxidation and discoloration in meat[4]. As an endogenous factor, low-molecular weight sarcoplasm is useful for promoting color formation in cooked cured meat[5]. Sustances of natural origin are generally useful in this regard as well as color retention, and for decreasing the amount of nitrite used and its residue in meat. Examination was made of the effects of vitamin E and carnosine on discoloration and decrease in heme pigment in porcine meat by the addition of NaCl and its change in color due to cooking. Milk protein hydrolysates were also studied for their effects on color formation in cooked cured meat products.

Methods:

Exp. 1: Vitamin E was added at 0.02% to salted (2% NaCl) ground loin meat (24 hr postmortem) and stored aerobically at 2~3℃ for 1 week. The Hunter-a value was measured (Minolta 3500-d), and heme pigment was determined from λ max at 383nm by 75% acetone-HCl extraction[2]. $NaNO_2$ (50ppm) was added to the meat which was then cured for 1 week under anaerobic conditions (vacuum-packed). The color forming ratio (CFR) and residual nitrite were determined[5].

Exp. 2: Following treatment with 2% NaCl, minced pork was stored at 2~3℃ for 1 week at 0 and 1.0% carnosine under aerobic conditions. Measurement was made of pH, Hunter-a value, MetMb%, TBAR value and heme pigment content. To carnosine-treated and pH-adjusted meat, $NaNO_2$ (100ppm) was added followed by curing for 1 week. Cooking loss, CFR and residual nitrite were determined during cooking at 75℃ for 60 min.

Exp. 3: Hydrolysates of concentrated milk (SFC400D, Omu Milk Products, Co., Ltd.) and whey protein concentrate (WPC80) were prepared by proteases and lyophilization and added at 5 or 10% meat sample weight along with $NaNO_2$ (17~75ppm). After cooking at 75℃ for 60 min, a* value , residual nitrite content and CFR were measured .

Results and discussion:

Exp. 1: Vitamin E addition was found to inhibit decrease in heme pigment by NaCl (Table 1). CFR of the

cured meat was higher and residual nitrite, lower in vitamine E-added sample compared to the control. In cured meat containing sodium ascorbate, color formation increased by vitamin E addition. In salted ground pork stored at 2~3℃ for 2 weeks under aerobic and anaerobic conditions, lipid oxidation was inhibited by vitamin E during aerobical storage. Under anaerobic conditions, red color was more intense and its decrease appeared less due to the addition of vitamin E.

Exp. 2: Carnosine inhibited a decrease in heme pigment in the presence of NaCl. Metmyoglobin formation and TBAR value decreased, thus indicating lipid oxidation to be controlled by carnosine (Table.2). CFR of nitrite-cured meat increased in the 0.5% carnosine-added sample to more than that in the control. With further increase in carnosine, the pH value rose and cooking loss decreased in cooked cured meat. When the pH value of raw cured meat with carnosine was made the same level as that of the control, this ratio assumed an even higher value. The residual nitrite in the carnosine-added meat decreased (Table.3).

Exp. 3: Milk protein hydrolysate (5~10%)- added sausage showed greater redness (a* value, Fig.1) and CFR, and lower residual nitrite. In myoglobin-model solution, increase in WPC80 proportionately enhanced CFR and decreased residual nitrite. The heating of WPC80 was found to clearly augment its reducing capacity which can be measured with ferricyanide, suggesting this substance to promote color formation in meat products.

Conclusions:

The effects of vitamin E and carnosine on the discoloration of meat and decrease in heme pigment in meat, subsequent to the addition of NaCl were studied. Both substances inhibited decrease in heme pigment in the presence of NaCl and caused increase in CFR. Carnosine increased the pH value of meat and at the same pH level, carnosine enhanced the color formation and nitrite decomposition. Milk protein hydrolysates accelerated reaction of nitrite with myoglobin. Molecular weights of the active component were less than 1,000.

Pertinent literature:

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Table 1. Effects of vitamin E on color stability and heme pigment in raw minced pork

Sample	2% NaCl	2% NaCl +0.02% V. E	0.02% V.E
Hunter-a value	18.0	17.4	13.1
Heme pigment content (mg Mb[1]/g meat)	0.65	0.81	0.83
Relative pigment content[2]	79.3	98.8	101.6

[1] Expressed as myoglobin content.
[2] Ratio of heme pigment content to that of original meat taken as 100.

Table 2. Effects of carnosine on color stability, heme pigment content and lipid oxidation of raw minced pork

Sample	2% NaCl	2% NaCl +1% Carn.	1% Carn.
pH value	5.84	6.56	6.43
Hunter-a value	15.9	17.8	23.1
Heme pigment content[1]	1.37	1.49	1.44
Relative pigment content	89.7	96.7	93.6
MetMb (%)	56.4	26.7	38.6
TBAR value	5.40	0.11	0.30

[1] mg myoglobin/g meat; [2] Malon aldehyde mg/kg meat.

Table 3. Effects of pH on change in processing quality of cooked cured meat

Sample[1]	Control	0.5% Carn.	1% Carn.
pH after cooking	5.90	5.92	5.89
Cooking loss (%)	16.0	16.1	16.1
Hunter-a value	13.7	14.0	(10.0)
Color forming ratio (%)	86.7	88.0	90.3
Residual nitrite (NO_2^-, ppm)	36.0	33.1	31.7

[1] pH of carnosine-added meat was made the same as that of raw control (pH 5.69), followed by cooking.

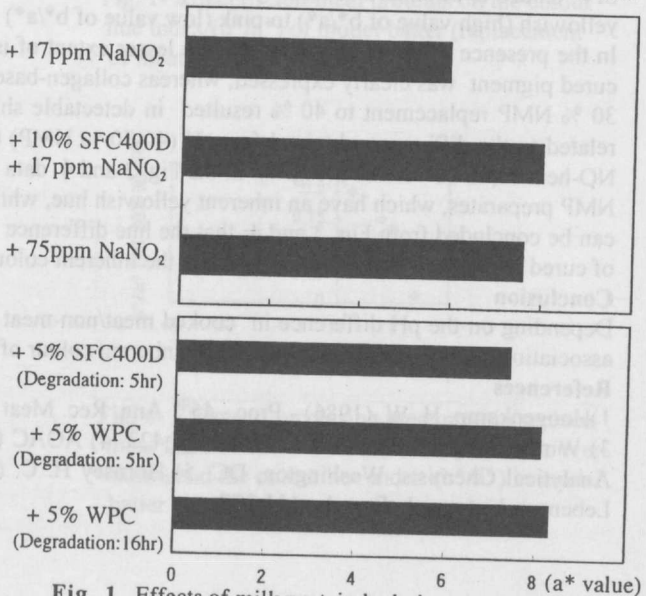

Fig. 1. Effects of milk protein hydrolysates degradated by enzyme on a* value of sausage.