EFFECT OF SODIUM NITRITE AND SODIUM LACTATE ON QUALITY OF CHINESE BASTED MEAT (CHAR SIU) STORED AT AMBIENT TEMPERATURE

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Abstract – Shelf stable Chinese basted meat (Char siu) was developed using hurdle technology and their quality was evaluated during ambient temperature (25±1℃) storage. This study was designed to investigate the sodium nitrite and sodium lactate using response surface methodology with post-package reheating on keeping quality of vacuum packed char siu. Results indicated that pH and total acceptability were significantly affected by both addition sodium nitrite and sodium lactate. Lactic acid bacteria and Coliform was not detected in 150 ppm sodium nitrite and 2% sodium lactate treated Char siu at ambient temperature. Overall, the addition of 150 ppm sodium nitrite and 2% sodium lactate could effectively give Char siu stable shelf life for 10 days stored at ambient temperature.

Key Words – Response surface methodology (RSM), Shelf life, Traditional Chinese processed meat

I. INTRODUCTION

The Chinese basted meat (Char siu) is a famous traditional Chinese processed meat, it is usually used as one ingredient in various complex entrees consumed at family meals. Char siu literally means "fork burn/roast" after the traditional cooking method for the dish, long strips of seasoned boneless pork are skewered with long forks and placed in a covered oven or over a fire. The acceptance of traditional Chinese processed meat is relatively high, but the change is less, and the issue of preservation causes difficulty in marketing.

The stability and safety of most foods is due to combined actions of several preservative factors. To prevent the microbial spoilage and food poisoning, several hurdles are used minimally in optimum combination, thereby contributing for improvement in sensory qualities, safety, stability as well as their nutritional and economic properties [5]. The present study is an example of hurdle combination using sodium nitrite, sodium lactate and other method. Sodium nitrite has been found to give flavor and color to the meat, inhibit lipid oxidation that leads to rancidity, and inhibit growth of disease-causing microorganisms. Honikel reported that the 30 ppm of sodium nitrite residue was the lowest level of inhibiting *Clostridium botulinum* spore growth [7].

Response surface methodology (RSM) is a statistical technique that has been effectively used to optimize formulations in a variety of food products such as pork sausages [9] and bologna [4]. RSM consists of a set of mathematical and statistical procedures to investigate relationships between one or more responses (dependent variables) and a number of factors (independent variables).

The objectives of this study was to develop safe and acceptable of Char siu using RSM with varying levels of sodium nitrite and sodium lactate stored at ambient temperature.

II. MATERIALS AND METHODS

Processing of basted meat

Fresh Boston butt were purchase from Shang-Lee Food Co., LtD (Taiwan). The Boston butt were tumbled with sodium nitrite and sodium lactate in tumbler (SORIT VVT-5083, Switzerland). After tumbling, boston butt were curing for 2 days, and then were dry in a drying oven (G. T. Co., Ltd., Taiwan) in 45℃ for 1 hours. After drying, roasted in 180℃ for 10 minutes. The final products were then vacuum packed. Char siu were put into 90℃ hot water bath within 10 minutes at 0 hours and 48 hours. Samples were stored at ambient temperature in an incubator at 25±1℃, for a period of 10 days.

Analytical procedures

The pH value was determined using a digital pH meter (MP320, Mettler Toledo, Switzerland) [8]. Water activity in the ground samples was measured by water activity meter (NOVASINA TH2/RTD-33/BSK, Switzerland). Put whole dish into the before the temperature balance stable on 25℃ [11].Sodium nitrite residue was analyzed by the A.O.A.C. official method [2]. Measure the wavelength of 540nm absorbance value (O.D.). Total aerobic bacteria, lactic acid bacteria count, and coliform count were detected in this experiment. Sample solutions for microbiological analyses were prepared by stomacher (Stomacher Model 400, England) mix perfectly 10 g sample with 90 ml sterile sterilized water. Sensory evaluation using 9-point descriptive scale test [3]. The panelists evaluated the samples for color, odor, tenderness, juiciness, saltiness, flavor and total acceptability using a standard score sheet. The test panels were selected from graduate students in a University and had obtained preliminary training. Higher average score signified better preferences.

Statistical analysis

Data were analyzed with two-factor face-centered central composite design of Response Surface Regression was analyzed by the SAS statistical software (SAS Institute, 2004). The optimal levels of sodium lactate and sodium nitrite were determined by superimposing the plots for all response variables, showing in Table 1. The optimum formulations were selected for calculating the predicted values of response variables using the prediction equations derived by RSM.

Table 1. Central composite design

No.	X1	X2	Sodium nitrite	Sodium lactate
1	1	-1	200ppm	1%
2	-1	1	100ppm	3%
3	-1	-1	100ppm	1%
4	1	1	200ppm	3%
5	0	0	150ppm	2%
6	0	0	150ppm	2%
7	0	0	150ppm	2%
8	0	0	150ppm	2%
9	0	0	150ppm	2%
10	1.414	0	220.7ppm	2%
11	-1.414	0	79.3ppm	2%
12	0	1.414	150ppm	3.414%
13	0	-1.414	150ppm	0.586%

III. RESULTS AND DISCUSSION

From results of previous studies, the concentraions of sodium nitrite and sodium lactate were 100-200 ppm and 1-3% respectively. Residue nitrite of 150ppm and 200 ppm were up to 30 ppm over the storage period. In total acceptability, 150 ppm of sodium lactate was higher than 100 ppm and 200 ppm. Effect of sodium lactate on microbiological changes of Char siu were not detected during all storage period. The total acceptability, 2% sodium lactate was higher than 1% and 3%, similar with 0 %. Therefore, 150 ppm sodium nitrite and 2% sodium lactate were adopted as center point.

pH value, water activity and residue nitrite were fitted with quadratic linear regression models which lack of fit were not significant ($p>0.05$). Results of analysis of variance (ANOVA) pH, water activity and residue nitrite were listed in Table 2. The pH value of Char siu was significantly fitting a quadratic regression model with sodium nitrite and sodium lactate. Figure 1 showed that the pH value of Char siu combination of 150 ppm sodium nitrite and 2% sodium lactate treatment was higher than others treatments during storage period. Lower pH values were observed for 1% sodium lactate treatment. Anonymous reported that sodium lactate could decrease the water activity of meat products [1]. But in this study, with the increase of sodium lactate, water activity was decreased and then increased (Figure 1). Sodium nitrite residue was affected by addition levels of sodium nitrite. More additional level of sodium nitrite would cause more residual sodium nitrite.

Table 2. Statistical analysis of pH, water activity and residual nitrite concentration of Char siu during ambient temperature storage (25±1℃)

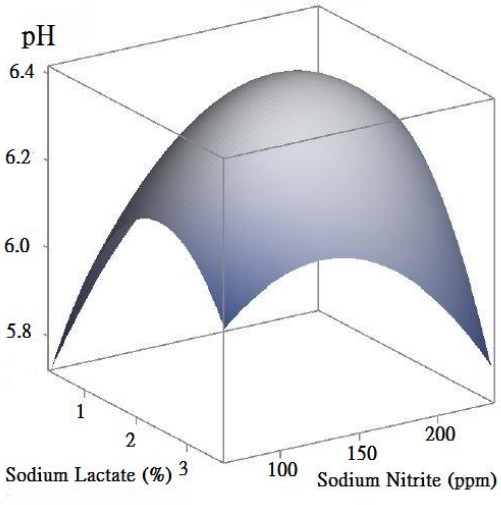
	pH	aW	Residual nitrite
Linear	-	-	**
Quadratic	**	*	-
Cross-product	-	-	-
Total model	**	-	**
Lack of fit	-	-	-
Intercept	**	*	*
X1	*	-	*
X2	*	*	-
X1*X1	*	-	**
X1*X2	-	-	-
X2*X2	**	*	-

X1 = Sodium nitrite, X2 = Sodium lactate, ** = $p<0.01$, * = $p<0.05$, - = Non-significant.

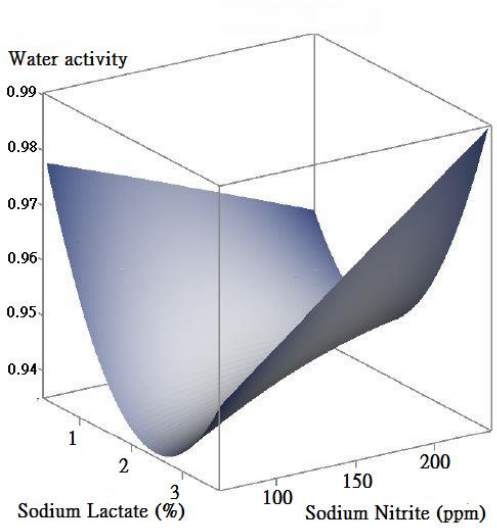
Sodium nitrite residue was significantly linear effect was showed in Table 2 and Figure 1. The residual nitrite was up to 30 ppm during storage period which is sufficient enough to inhibit *Clostridium botulinum* spore growth [7] by adding more than 150 ppm sodium nitrite.

During storage, total aerobic bacteria was not found in most of treatment groups but only in few groups of Char siu were detected (data not shown). Both sodium nitrite and sodium lactate were antibacterial, the permeability of oxygen of package bags made some variable situation, that could be the main reason of this result. Coliform was not detected for all groups during storage. The result of lactic acids bacteria counts were similar to total aerobic bacteria. Unda reported that 2% sodium lactate was effectively antibacterial to anaerobic bacteria [12].

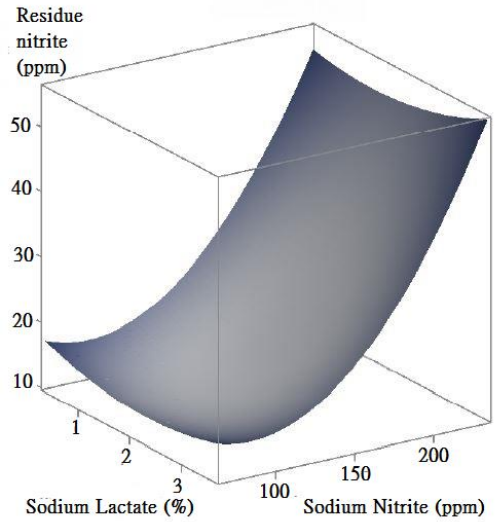
Figure 1. Effect of sodium nitrite and sodium lactate on (a) pH value, (b) water activity and (c) residual nitrite concentration in Char siu on the 10th day of storage.



(a)



(b)



(c)

The results of sensory evaluation were showed in Table 3a and 3b. Color was affected by sodium nitrite, the higher concentration of sodium nitrite the darker color appears. Saltiness and flavor were significantly affected by sodium lactate. Adding sodium lactate in food increases sodium ion concentration, and significantly influences flavor and saltiness in sensory evaluation. The previous study reported that addition of 2% and 3% sodium lactate in pork sausage can increase flavor and saltiness [10]. The total acceptability was significantly affected by sodium lactate and interaction between sodium nitrite and sodium lactate (Table 3b and Figure 2). Higher score of total acceptability were observed for 150 ppm sodium nitrite and 2% sodium lactate treatment.

Table 3a. Statistical analysis of sensory evaluation of Char siu during ambient temperature storage (25±1℃)

	Color	Odor	Tenderness	Juiciness
Linear	-	-	-	-
Quadratic	*	-	-	**
Cross-product	-	-	-	-
Total model	*	-	-	-
Lack of fit	-	-	-	-
Intercept	**	-	-	-
X1	**	-	-	*
X2	-	-	-	-
X1*X1	*	-	-	*
X1*X2	-	-	-	-
X2*X2	-	-	-	-

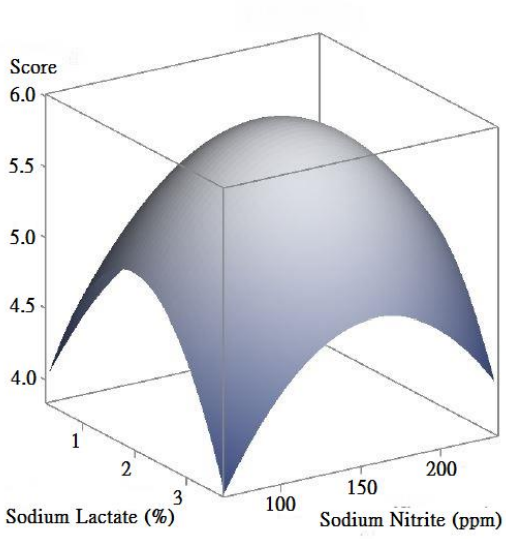
X1 = Sodium nitrite, X2 = Sodium lactate, ** = $p<0.01$, * = $p<0.05$, - = Non-significant.

Table 3b. Statistical analysis of sensory evaluation of Char siu during ambient temperature storage (25±1℃)

	Saltiness	Flavor	Total acceptability
Linear	*	-	-
Quadratic	-	**	*
Cross-product	-	-	-
Total model	*	*	-
Lack of fit	-	-	-
Intercept	*	-	-
X1	-	-	-
X2	*	**	-
X1*X1	-	-	-
X1*X2	-	-	*
X2*X2	-	**	**

X1 = Sodium nitrite, X2 = Sodium lactate, ** = $p<0.01$, * = $p<0.05$, - = Non-significant.

Figure 2. Effect of sodium nitrite and sodium lactate on total acceptability of Char siu on the 10th day of storage. (1 = unacceptable; 9 = acceptable)



IV. CONCLUSION

In conclude, the pH was significant affected by addition of sodium nitrite and sodium lactate. Sensory evaluation of total acceptability was significant affect by 150 ppm sodium nitrite and 2% sodium lactate. During storage period, the total plate count and lactic acids bacteria counts were not detected. Treatments of 150 ppm sodium nitrite and 2% sodium lactate gave Char siu stabile shelf life for storage at ambient temperature.

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