PHYSICOCHEMICAL CHARACTERISTICS OF BA-TSENG FRESH SAUSAGE AS AFFECTED BY LACTIC ACID-INDUCED GELLED EGG WHITE POWDER AND SODIUM LACTATE USING RESPONSE SURFACE METHODOLOGY

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Key Words: RSM, Lactic acid-induced gelled egg white powder, Sodium lactate (SL)

Introduction

Response surface methodology (RSM) consists of a group of mathematical and statistical procedures that can be used to study relationships between one or more responses and a number of factors. RSM has been effectively used to optimize formulations in a variety of meat products such as frankfurter. Egg albumin is abundant in vitamins, minerals and amino acids and could be an important ingredient in many processing food products due to its functional properties such as foaming capacity, emulsifying ability, coagulation and gel formation. Many organic acid such as lactic acid, ascorbic acid, succinic acid and citric acid that had been extensively used in fresh meat and processing products to enhance their microbiological safety. Lactic acid is very cheap and can be bactericidal and bacteriostatic effectiveness with adaptable addition ratio. Sodium lactate is a very useful additive, which can prolong shelf-life, enhance flavor, water-holding capacity, antioxidant ability, cooking yield and decrease water activity of meat products, and inhibit growth of aerobic bacteria, *L. monocytogenes*, *Salmonella*, *E. coli* and *S. aureus* as well without affecting pH value of meat products. Therefore, this research was to study the physicochemical characteristics of fresh pork sausage formulated with Ba-Tseng powder (Chinese herbs) as affected by lactic acid-induced gelled egg white powder and sodium lactate using RSM.

Materials and methods

1. *Fresh pork sausage manufacture*: The fresh pork sausage was manufactured with 85% chilled shoulder picnic (85/15) which ground through 9 mm steel plate, and 15% 3 mm cubes backfat (0/100). The formula of Ba-Tseng fresh pork sausage was shown **Table 1**. The Ba-Tseng powder were mixed with Chinese herbs of *Radix Angelicas Sinensis*, *Radix Ligustici Chuanxiong*, *Radix Glycyrrhizae*, *Poria*, *Radix Codonopsitis Pilosulae*, *Rhizoma Atractylodis Lanceae*, *Radix Paeoniae* and *Radix Rehmanniae*.

Table 1. The formula of Ba-Tseng fresh pork sausage

Ingredients	Percent (%)
Salt	1.5%
Sugar	3%
Monosodium glutamate	0.8%
Allspice	0.1%
White paper	0.2%
Ba-Tseng powder	0.5%
Acid-induced gelled egg white powder	1%, 1.5%, 2%
Sodium lactate	0%, 1%, 2%

2. *Experimental design*: The RSM was used to study the simultaneous effect of differing concentration of 1, 1.5, 2.0% lactic acid-induced gelled egg white powder (X2) (gelled by 6, 8, 10% lactic acid solution(X1)) and 0, 1, 2% SL (X3). This experimental design were based on the Box and Behnken (1960), three-variable and three-level.
3. *Analysis items*: The pH of the tested sample was measure using a pH meter. Hunter *a* value of the tested sample was recorded using a color difference meter. The thiobarbituric acid (TBA) value of the samples were determined according to the Tarladgis et al., (1960) as modified by Aipser and Watts (1962) and Ockerman (1974), and was expressed as mg malonaldehyde equivalent/kg sample. The Total plate counts (TPC) and *Coliform* were obtained as described by FDA. (1996). The metmyoglobin (MMb) content was determined using the procedure of Chu et al., (1987) and Trout (1989), and then calculated using the formula by Krzywicki (1982). After pan-broil, a total of fifteen panelists were employed to perform overall acceptance of the products. A seven point scale was used in this experiment and was expressed: One point-dislike extremely, Four point-neither like nor dislike, Seven point-like extremely.

Results and Discussion

Figure 1 and 2 show the counter plots of the effects of lactic acid solution and acid-induced gelled egg white powder on pH (A), TPC (B), *Coliform* (C), Hunter *a* value (D), MMb (E), TBA (F) and overall acceptance (G) after 7-day, 14-day storage at 4℃ of Ba-Tseng fresh pork sausage, respectively. The pH values of all samples were maintained between 5.0~5.6 during storage periods (Fig. 1, 2-A). The pH value of SL is neutral which may influence pH value of products. The combined corporation of 6-10% concentration of X1 , 1-2% additions of X2 and X3 had the optimal results on prevention the growth of TPC and *Coliform* (Fig. 1, 2-B and C). The lactic acid treatment of retail beef reduced total CFU and *E. Coli* numbers immediately after treatment (Stivarius et al., 2002). On the other hand, microbial growth was also inhibited by incorporation of up to 2% SL in ham and shelf-life was doubled (Anonymous, 1988). The color stability of products was increased with the lower concentrations of X1 and additions of X2 (Fig. 1, 2-D). The samples treated with organic acids were significantly lighter (p<0.05) than the untreated control, which were indicated by their higher *L* value than *a* value (Kotula and Thelappurate, 1994; Stivarius et al., 2002). The MMb content was clearly affected by storage time and the additions of X2, moreover, the 6~7% concentration of X1 and additions of 1.0~1.7% X2 had lower values (Fig. 1, 2-E). The MMb content was relatively high in both low and high pH muscle and was not catalytically active at high pH (Yasosky et al., 1984). Rate constants for MMb accumulation and oxymyoglobin autoxidation, both indicators for fresh meat color were increased (p<0.05) with decreasing pH value (Tam et al., 1998). Jimenez-Villarreal et al. (2003) found that the

oxymyoglobin is more stable at higher pH values. The TBA value of all samples increased with the increased storage time, and the sample of addition of 1.0~1.1% X2 were lower values (Fig. 1, 2-F). Evidence suggested that the inhibition could be the result of pH effects on metal catalysts (Yasosky et al., 1984). Wills (1965) showed that Fe, Mn, Co and Cu were catalysts of lipid oxidation. Regression analysis indicated an inverse relationship between pH and TBA values (Chen et al., 1993). The lower concentration of X1 and addition of X2 was the better overall acceptance of sensory properties (Fig. 1, 2-G). The results were agreed with the increase of lactic acid concentrations lead to less favorable off odor characteristics compared to ground beef with higher pH (Nassos et al., 1983).

Conclusions

According to the results of RSM showed that the different concentration of X1 and addition of X2 were the significantly effect factors on this experiment. Therefore, the establishment of RSM could be the acknowledge of understanding the physicochemical characteristics of fresh sausage formulated with Chinese herbs of Ba-Tseng as affected by lactic acid-induced gelled egg white powder and sodium lactate.

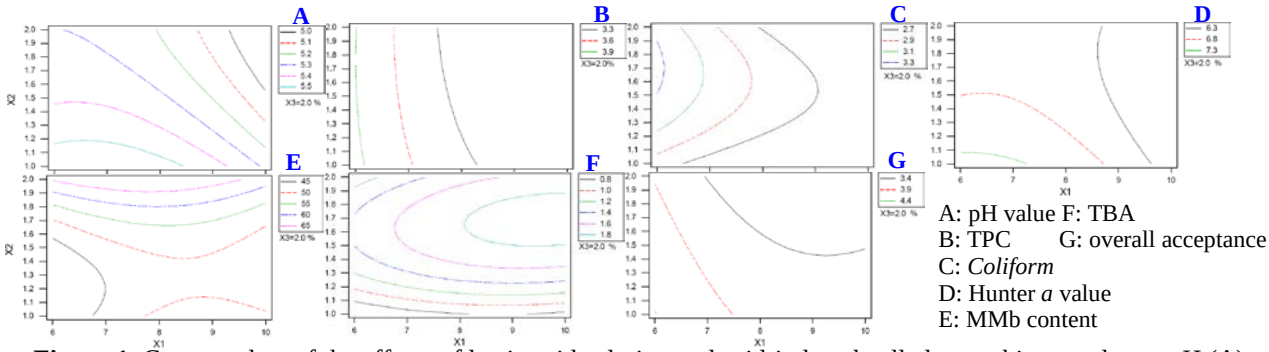

Figure 1. Counter plots of the effects of lactic acid solution and acid-induced gelled egg white powder on pH (A), TPC (B), *Coliform* (C), Hunter *a* value (D), MMb (E), TBA (F) and overall acceptance (G) after 7-day storage at 4℃ of Ba-Tseng fresh pork sausage.

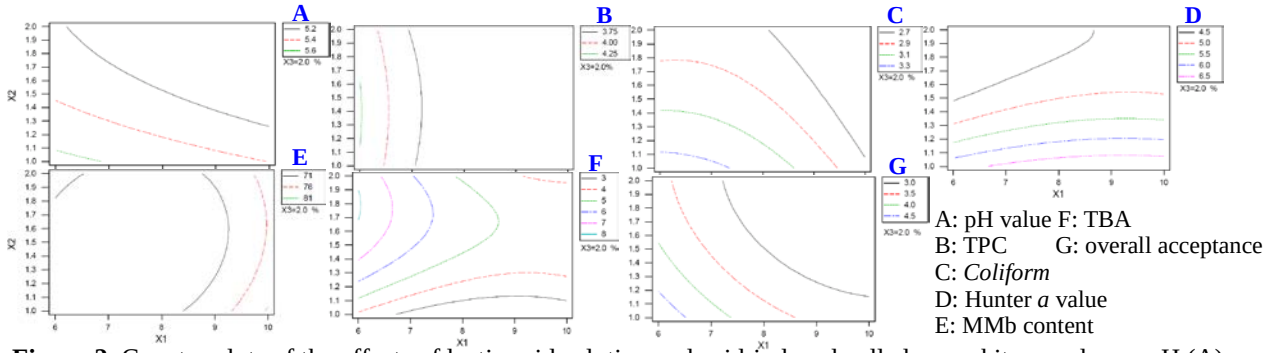

Figure 2. Counter plots of the effects of lactic acid solution and acid-induced gelled egg white powder on pH (A), TPC (B), *Coliform* (C), Hunter *a* value (D), MMb (E), TBA (F) and overall acceptance (G) after 14-day storage at 4℃ of Ba-Tseng fresh pork sausage.

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