CONSTRUCTION OF RESPONSE MODEL FOR PREDICTING EFFECT OF THREE POLYSACCHARIDES ON TEXTURE PROFILE OF EMULSIFIED SAUSAGE

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Abstract –Texture is one of the most important characteristics of emulsified sausage. Three kinds of polysaccharides were used in emulsified sausage made from pork and uncooked salted egg white to improve texture properties; these polysaccharides include mix starch (MS) of sweet potato starch and glutinous rice flour, konjac flour (KF), and k-carrageenan (CG). Using Box-Behnken design and ANOVA, four response models were constructed to separately predict firmness, adhesiveness, elasticity, and water holding capacity (WHC). These models can predict well effects of MS (6%–8%), CG (0.4%–0.6%), and KF (0.8–1.2) on four texture properties and can also be used to design formulas for different types of sausage with different firmness, adhesiveness and elasticity. To obtain maximal firmness, elasticity and WHC, and minimal adhesiveness of emulsified sausage, optimal composition should be 7.43% MS, 0.54% CG, and 20% KF.

Key Words –emulsified sausage, textural profile, polysaccharide, response model.

I. INTRODUCTION

Texture of emulsified sausage (ES) depends on structure of matrix formed by proteins, water, and non-meat ingredients [1]. Salted egg white (SEW) which is too salty to be direct eaten can be used in ES to reduce waste of protein resource and save salt cost in production. SEW in sausage would negatively affect texture, because of its declined adhesiveness and thickness, compared with unsalted egg white. Starch, carrageenan [1] and konjac gel [2, 3] are polysaccharides widely used in meat product to decrease fat content and improve textural properties. However, response model of starch, carrageen and konjac combination on texture properties of ES has not been reported yet. This study focused on mathematical model construction of this three kinds of polysaccharides and their effects on firmness, adhesiveness, elasticity, and water holding capacity (WHC) of ES made from pork and SEW.

II. MATERIALS AND METHODS

Frozen lean meat, fat, and uncooked salted egg white were thawed at 4 ℃ prior to sausage preparation. Lean meat, fat and albumen were at the ratio of 3.5:1.5:0.5 in the sausage. Lean meat was grounded in a chopper for 1 min at 3000 rpm. Then, starch, KF , CG, and fat were added, and ground for another 1 min. Chilled uncooked SEW, some flavor ingredients, and sodium carbonate of 0.4% based on total mass of sausage, were added to the batter and chopped for last 0.5 min. Meat batter was stuffed into collagen casings with 2 mm in diameter. Sausage sections were vacuum packaged and cooked 40 min in water bath at 80 ℃ and then 30 min at 90 ℃. Sausage sections were cooled to ambient temperature and stored at 4 ℃ overnight for analysis. According to the work of Lu et al. (2014) [4], sample sausages were cut into 2 cm cylinders, and firmness was measured by P/50 probe of TA-XT PLUS textural analyzer (SMS Co., UK). Elasticity and adhesiveness of sausages were sensory-evaluated; scores of 1 to 9 were corresponding to lowest to highest elasticity and adhesiveness. Sausages were cut into cylinders of 10 mm height and were placed on and covered with dried filter paper. A 1 kg weight was placed on top of paper for 10 min at room temperature. Samples' weight before and after pressed by weights was used in equation WHC=10- $(M_0-M_1)/M_0$, Where M_0 is the sample mass before pressed; M_1 is sample mass after pressed.

III. RESULTS AND DISCUSSION

The designed experimental scheme from Design-Expert.8.05 (Stat-EaseInc., Minneapolis, USA) and resulting data for firmness, adhesiveness, elasticity and WHC were shown in table 1. Predicted response models with only significant terms were shown in equations (1)–(4).

$$\text{Firmness}=166.62+6.97A+17.52B+21.92C-6.39AB+6.70AC-9.69BC-12.61A^2+27.50B^2 \quad (1)$$

$$Adhesiveness=7.47+0.85B+0.21C-0.53BC-0.82A^2+0.99B^2-0.35C^2 \quad (2)$$
$$Elasticity=8.28+0.46B+0.74C+0.35BC-0.32A^2-0.55B^2-0.64C^2 \quad (3)$$
$$WHC=7.62+0.13A+0.12B+0.90C+0.07AC-0.12BC-0.33B^2+0.14C^2 \quad (4)$$

The four models were statistically significant through ANOVA. MS, CG, and KF showed different effects on different properties. KF presented more positive effect on elasticity and WHC than on adhesiveness; interaction of CG and KF reduced adhesiveness and increased elasticity benefiting consumers' acceptability. Confirmation experiment on the predicted optimal conditions of 7.43% MS, 0.54% CG, and1.20% KF resulted in less deviation between predicted and actual values (Table omitted) when dependent variable goals were set as maximal firmness, elasticity, WHC, and minimal adhesiveness.

Table1 Design scheme and result data

Std No.	A (MS %)	B (CG %)	C (KF %)	Firmness/g	Adhesiveness	Elasticity	WHC
1	-1 (6)	-1 (0.4)	0 (1.0)	150.99	6.75	6.89	7.05
2	1 (7)	-1	0	177.32	6.79	7.11	7.29
3	-1	1 (0.6)	0	199.21	8.58	7.79	7.34
4	1	1	0	200.00	8.46	7.88	7.62
5	-1	0 (0.5)	-1 (0.8)	132.68	6.01	6.42	6.88
6	1	0	-1	133.59	6.32	6.68	6.94
7	-1	0	1 (1.2)	159.75	6.62	8.01	8.42
8	1	0	1	187.45	6.29	8.19	8.89
9	0 (8)	-1	-1	143.13	6.50	6.23	6.24
10	0	1	-1	198.14	9.18	6.53	6.82
11	0	-1	1	211.21	8.10	6.96	8.25
12	0	1	1	224.46	8.68	8.65	8.35
13	0	0	0	169.00	7.15	8.41	7.59
14	0	0	0	161.25	7.62	8.19	7.66
15	0	0	0	169.82	7.54	8.48	7.56
16	0	0	0	166.13	7.52	8.12	7.71
17	0	0	0	168.75	7.53	8.21	7.58

IV. CONCLUSION

Combining MS, CG, and KF in ES can improve texture properties, among which KF was the most effective. Significant response models were designed for firmness, adhesiveness, elasticity, and WHC, as affected by the three used ingredients. These models can be used to design formula for different types of sausage with different firmness, adhesiveness, and elasticity when MS, CG, and KF are used as additives for improving texture.

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REFERENCES

1. Patrascu, L., Dobre, I., & Alexe, P. (2010). K-carrageenan effects on texture characteristics of meat emulsified sistems. Studia Universitatis Babes-Bolyai Chemia LV(3): 75-82.
2. Ruiz-Capillas, C., Triki, M., Herrero, A. M., Rodriguezsalas, L., & Jiménezcolmenero, F. (2012). Konjac gel as pork backfat replacer in dry fermented sausages: processing and quality characteristics. Meat Science 92(2): 144-150.
3. Jiménez-Colmenero, F., Triki, M., Herrero, A. M., Rodríguez-Salas, L., & Ruiz-Capillas, C. (2013). Healthy oil combination stabilized in a konjac matrix as pork fat replacement in low-fat, PUFA-enriched, dry fermented sausages. Lebensmittel-Wissenschaft und-Technologie 51(1): 158–163.
4. Lu, F., Luo, L., Li, X., & Li, B. (2014). Effect of edible gums on the qualities of sausage of eryngii. Advance Journal of Food Science & Technology 6(8): 973-980.