Validation of Different Formulation and Processing Conditions on Pork Frankfurters Using Response Surface Methodology

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Abstract – Processing and formulation variables, viz. smoking time (5 to 10 min.), internal core temperature of the pork frankfurters during cooking (75 to 85°C) and fat percent of the formulation (5 to 15%), were evaluated using response surface methodology to validate effect on responses viz. cooking yield, colour and sensory attributes of pork frankfurters with acceptable palatability attributes. Results showed that the optimal conditions validated using the RSM was smoking time (5 min.), internal core temperature of the pork frankfurters during cooking (80°C) and fat percent of the formulation (10 %) under these optimal conditions, the model predicted a maximum response in terms of studied attributes.

Key Words – RSM, Frankfurters, Sensory attributes

I. INTRODUCTION

Frankfurters are consumed worldwide as a result of their convenience and one of the most popular traditional meat products in the world, which are mostly produced from pork, back fat, salt, sugar, garlic, nitrite, and various spices. In general, frankfurters may contain animal fat up to 30% with variable processing conditions. It is well known that the various formulation and processing conditions during development of product are closely related with physico-chemical, colour and sensory properties. Therefore, finding desired values of different formulation and processing conditions that optimize favorable qualities of product will provide more qualified knowledge to obtain better product that have desired technological properties. Response Surface Methodology (RSM) is an effective tool to find these optimum levels of the processing variables for the parameters studied (Lenth, 2009). Ridge analysis involved with RSM computes the levels of these processing variables that maximize and minimize the values of different parameters. Therefore, the objective of this research was to validate the simultaneous effect of three variables viz. smoking time (5 to 10 min.), internal core temperature of the pork frankfurters during cooking (75 to 85°C) and fat percent of the formulation (5 to 15%) on parameters viz. cooking yield, colour analysis and sensory attributes of pork frankfurters and to get optimal conditions which receive a maximum response.

II. MATERIALS AND METHODS

Response surface methodology (RSM) was used to study the simultaneous effect of three composition coded/uncoded variables. The experiments were designed according to a central composite rotable design (CCD), 20 combinations of three variables were performed. For each experimental factor the variance was portioned into components i.e. linear, quadratic and interaction model in order to assess the adequacy of the second order polynominal function and the relative importance of these components. The fitness of the polynomial model equation to the responses was evaluated by the coefficient of R square as well as by the lack of fit using the F-test with 5% level of significance and were analyzed using Design Expert® 9.0 (Stat-Ease Inc., Minneapolis, MN, USA)

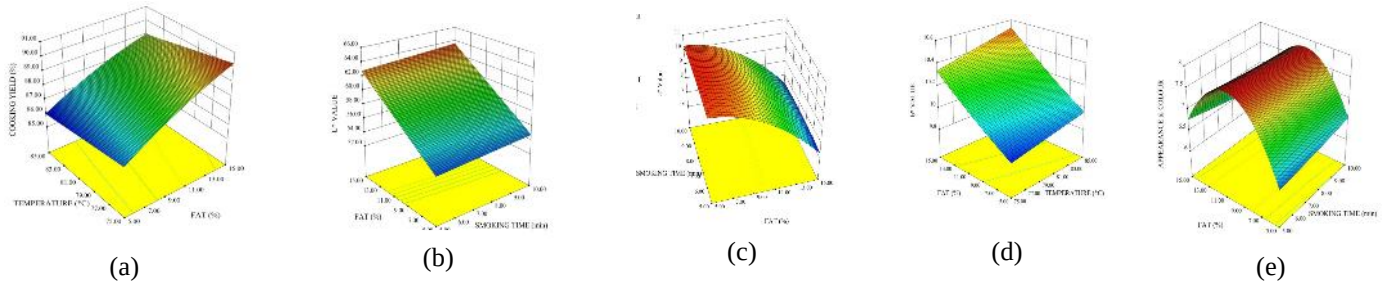
The frozen deboned pork meat after thawing was run through a SS meat mincer (MADO ESKIMO MEW 714, Spain) and minced to a particle size of 6 mm. As per the experimental design and compositions, twenty different emulsions were developed. The emulsion was prepared in bowl chopper (Scharfen TC 11, Germany) along with slow addition of ice. After chopping, the emulsion was stuffed into goat casings (diameter 21-23 mm) and linked at 18-20 cm intervals using Hydraulic sausage filler (Model No. PHX-15, Dadaux, Bersaill, France). Frankfurters were heat processed in a smoke chamber (Smoke "RITE" oven, Model-950C, New Castle, Australia) until the core temperature reached in between 75 to 85°C for smoking time ranging between 5 to 10 min. The obtained products were subjected to evaluate cooking yield, colour analysis (Lovibond RT-300, Reflectance Tintometer, United Kingdom) and sensory attributes (8-point descriptive scale (Keeton 1983).

III. RESULTS AND DISCUSSION

Analysis of variance produced a highly significant ($p < 0.05$) regression model for cooking yield. ANOVA of the quadratic regression models for cooking yield showed that the variables that most influenced cooking yield were internal core temperature and fat percent; this was reflected significantly ($p<0.05$) in a linear, quadratic and interaction term of the variables. The higher the internal core temperature, the lower was cooking yield; this effect was more apparent at low temperatures, declining as temperature was raised (quadratic effect). For smoking time, none of model term had any significance ($p>0.05$), which indicated that smoking time, didn't exert any influence on the cooking yield of the pork frankfurters (Fig. 1a). Increase in fat level lead to significant changes ($p<0.05$) in cooking yield. The greater the fat content, higher the cooking yield.

The *L** values (lightness) of the final products were linearly proportional to the fat content, the high fat products were lighter than the low-fat ones (Fig. 1b). This might be due the increase in the proportion of the whitish fat contributing to the increase in *L** value which was in agreement with Paneras *et al* (1998) and Hand *et al* (1987). In fact, in the present experiment the redness values (*a**) were inversely proportional to fat content and strongly dependent on both internal core temperature of pork frankfurters and fat percent (Fig. 1c). Similar effects have been reported in low-fat pork sausages (Crehan *et al* 2000). As increase in fat percent as well as increase in cooking temperature resulted in significant ($p<0.01$) increase of *b** value (Fig. 1c).

Increase in fat percent of the formulation results in the increase in appearance and colour scores at pick point about 10% fat level and thereafter decreased on subsequent increase in fat percent (Fig. 1d). Similarly increase in both smoking time and temperature had negative correlation appearance and colour scores of the pork frankfurters.
The optimal conditions obtained using the model was as follows: Smoking time (5 min.), internal core temperature of the pork frankfurters during cooking (80°C) and fat percent of the formulation (10 %).



(a) (b) (c) (d) (e)

Figure 1. Response Surface plots for (a) Cooking yield (%), (b) L* value, (c) a* value, (d) b* value and (e) appearance and colour in function with varying fat (%), smoking time (min) and internal core temperature of cooking (°C).

IV. CONCLUSION

The optimal conditions which was validated using the RSM was as follows: Smoking time (5 min.), internal core temperature of the pork frankfurters during cooking (80°C) and fat percent of the formulation (10 %) under these optimal conditions, the model predicted a maximum response.

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