P - 129

Optimization of Drying Temperature and Time for Processing of Pork Jerky Using Response Surface Methodology

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Introduction

Historically, jerky is among the oldest of meat products that is preserved by salting and drying. Jerky is a product that is easy to prepare, light weight, has a rich nutrient content, and is shelf-stable without refrigeration. However, large diversity in processing parameters of jerky may cause variation in effectiveness of drying for inactivating microbial survival or growth that may be present in the raw material. In addition to pathogenic bacteria outbreaks involving fermented meats, there has been at least one documented outbreak involving a dried and semi-dried meat (Keene *et al.*, 1997). Gailani and Fung (1986) reported that hurdles in jerky preparation include drying temperature, low water activity (>0.85), and depending on the composition of the marination mixture. The final product reaches a constant a_w of 0.70~0.75 and it then ready for consumption and normally shelf stable for 6 months and left unpacked (Torres *et al.*, 1994). The growing consumer preference for high quality food with good flavor, texture, and nutrition, one of the drawbacks of jerky is its hard chewiness (Kuo and Ockerman, 1985). Since production of pork jerky is rather as empirical process and suffers from lack of control of time and temperature, the present study was undertaken to investigate the operating parameters for better heating for drying methods. The response of meat proteins to severe heat treatment combined with low water content has some practical importance. Therefore, the objective of this study was to establish by means of physico-chemical determination and the optimization of drying temperature and time for processing of pork jerky.

Materials and Methods

1. Materials

Pork loins were purchased frozen from local market, and the frozen pork was thawed at

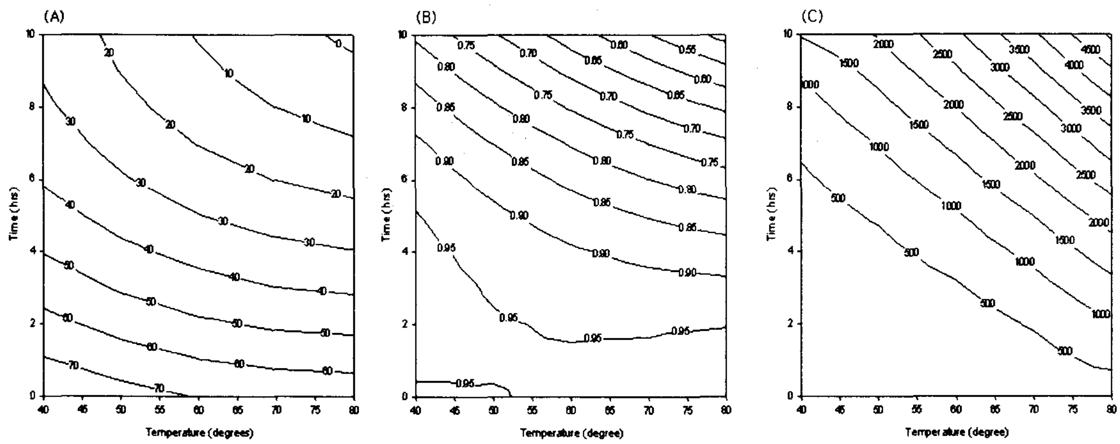

Fig. 1. Contour plots for response variables of moisture content (A), water activity (B) and cutting force (C) of pork jerky for different drying temperature and time.

Table 1. Sensory evaluation of pork jerky for 7 hours at different drying temperature

Temperature (℃)	Color	Flavor	Juiciness	Tenderness	Overall acceptability
40	3.43 ± 0.45^{B}	2.37 ± 0.35^{B}	4.77 ± 0.41	0.97 ± 0.52^{D}	2.07 ± 0.68^{B}
50	4.37 ± 0.24^{B}	2.67 ± 0.26^{B}	4.57 ± 0.55	2.70 ± 0.50^{C}	2.53 ± 0.87^{B}
60	4.43 ± 2.05^{B}	3.47 ± 1.74^{B}	3.57 ± 0.58	6.07 ± 0.49^{B}	4.97 ± 0.54^{A}
70	8.17 ± 0.29^{A}	6.10 ± 0.53^{A}	2.80 ± 0.55	7.37 ± 1.21^{AB}	6.47 ± 0.18^{A}
80	8.13 ± 0.19^{A}	7.57 ± 0.44^{A}	2.57 ± 1.04	7.93 ± 0.17^{A}	5.73 ± 0.87^{A}

$^{A\sim C}$: Means in the same column with different superscripts are significantly different ($P<0.05$)

4℃ overnight, sliced to 0.5cm thickness and cut into pieces of $10\times4.0\times0.5$ cm^3. The sliced pork samples were dried at different temperatures between 40 to 80℃ for the time ranged from 0 to 10 hr.

2. Measurements

- Moisture content: The percentage of pre-dry weight and g water per g dry weight.
- Water activity: The water activity was measured with a water activity meter.
- Cutting force: Cutting force was measured using the Instron Universal Testing Machine (Model 3343). Crosshead speed was 100 mm/min and full scale load was 50 kg.

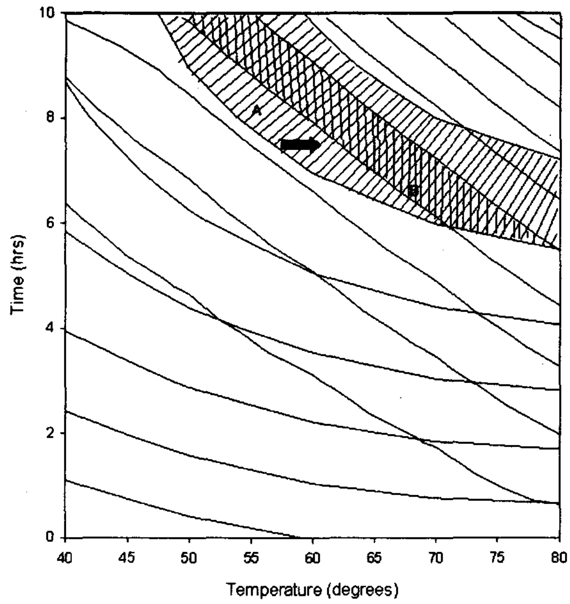

Fig. 2. Superimposing contour map of optimization condition for the moisture content (A) and cutting force (B) on pork jerky for different drying temperature and time.

Table 2. ANOVA and response surface statistics for pork jerky optimizing at different drying temperature and time

Response	Range	Temp p-value	Time p-value	Temp-Time p-value	R^2
% Total moisture content	71.42~5.03	0.0077	<0.001	0.0074	0.95
Water activity	0.97~0.55	0.4040	<0.0001	<0.0001	0.96
Cutting force (g)	5013~122	0.0004	<0.0001	<0.0001	0.97

- Sensory evaluations: The panelists evaluated each characteristic of the sample using a 9-point hedonic scale, where one (1) was "dislike extremely" and nine (9) was "like extremely."
- Statistical analysis: Treatment differences were analyzed using analysis of variance (ANOVA) with the general linear model (GLM) (SAS, 1997). In addition, response surface curves were fit using a second order model of the form: $\hat{y} = 0.989 - 0.002x + 0.055x_2 + 0.00003x_1^2 - 0.0004x_2^2 - 0.0009x_1x_2$. Where, y is the measured response, x_1 is the dried temperature, x_2 is the dried time and all $\hat{y}$ terms are coefficients.

Results and Discussion

The moisture content, water activity and cutting force of pork jerky are shown in Fig. 1.

The moisture content varied from 71.42 to 5.03% in accordance with processing steps. Moisture content decreased with increasing dried temperature and time ($P<0.05$). The results showed rapidly decreasing values with higher temperature in moisture content ($P<0.05$). ANOVA showed that both drying temperature and time, and their interaction were significant factors at $P<0.01$ for moisture content (Table 2). Response surface analysis showed a saddle surface with maximum R^2 was 0.95. The water activity varied from 0.97 to 0.55 in accordance with processing steps. In general, a_w decreased with increasing drying temperature and time within the data range ($P<0.05$). ANOVA showed that drying temperature was not significant ($P>0.05$) but drying time was significant factors to a_w ($P<0.01$), as were the interactions between the two factors (Table 2). Response surface analysis showed a saddle surface with the maximum R^2 was 0.96. The cutting force values were varied from 5013 to 122 g in accordance with processing steps. The cutting force value was increased with increasing drying temperature and time ($P<0.05$). Fig. 1. showed that both drying temperature and time were significant factors to cutting force ($P<0.01$), as were the interaction between the two factors. The R^2 for the surface was 0.97. The sensory panels were convened to assess the effect of the different temperature on the color, flavor, tenderness, and overall acceptability in pork jerky during drying for 7 hrs (Table 1). Color, flavor and tenderness scores were improved by increasing drying temperature, especially seem to significant ($P<0.05$) with higher scores at 70 and 80℃ drying temperature. The overall acceptability scores ranged from 2.07 to 6.47. The 60, 70 and 80℃ drying temperature had higher likeability scores than the 40 and 50℃. Results demonstrated that for optimization of drying condition of pork jerky can be made where pork is dried at 70℃ drying temperature with 7 hrs drying time.

Conclusion

Predicted values on final moisture content, water activity, cutting force of dried pork sample in experimented ranges were good agreement with experimented values with correlation coefficient (R^2) of 0.95, 0.96, and 0.97, respectively. Response surface analysis showed that the optimum drying condition for the pork jerky, based on water activity, cutting force and sensory evaluation were obtained at the temperature of 65～70℃ for 7～8 hr.

References

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