EFFECTS OF DRYING TEMPERATURES AND FAT LEVELS ON YIELD AND QUALITY OF REFORMED READY-TO-EAT CHINESE SAUSAGE STYLE MEAT SNACK

Rutcharin Limsupavanich[1*], Jutatip Manawattanawong[2], and Pennapa Jitwattanathaworn[2]

[1] Faculty of Agricultural Technology, [2] Faculty of Industrial Education,

King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand

[*] rlimsupa@gmail.com

Abstract – Yield and quality of ready-to-eat reformed Chinese sausage meat snacks, produced from batters containing 3 different fat levels (10, 20, and 30%), and dried either at A) 100°C for 2 h and then at 70°C for 7 h or B) 70°C for 9 h, were investigated. "A" drying method resulted in product core temperature of 72-74°C after 2 h of drying. Methods of drying had no effect on (P>.05) product yields. However, batter contained 10% fat resulted in less drying yield compared to those contained 20% and 30% fat. Meat snacks with 10% fat drying under method A had lower water activity (Aw, 0.76) compared to those contained 30% fat and dried with method B (0.82). Drying method A resulted in less (P<.05) 2-thiobarbituric reactive substances (TBARS) than drying under method B. However, treatment contained 30% fat drying under method A resulted in less TBARS (0.55 mg malonaldehyde/kg. sample) than (P>.05) those dried under method B (0.66, 0.57, and 0.70 for 10, 20, and 30% fat, respectively). Reformed Chinese sausage meat snacks could be produced with 20 or 30% fat using drying method A, based on drying yield, Aw, and TBARS.

Key Words – Kunchiang, Shelf-stable, Semi-dried pork sausage

I. INTRODUCTION

Kungchiang is a popular Chinese style sausage in Thailand produced from coarsely ground lean pork, and backfat mixed together with ingredients before stuffing into natural or artificial casing and dried. A big variation in drying temperatures and time is employed by processors for Kunchiang production. The sausage is usually not fully cooked. Therefore, Thai Industrial Standards Institute [1] recommends that the sausage needs to be cooked before consumption. The popular way of cooking Kunchiang is by frying in oil with high temperature. Despite the high fat content of Kunchiang, frying increases risk of too much fat consumption and is inconvenience to prepare. Convenient and ready-to-eat foods are increasing in popularity among the Thai consumers. It is, therefore, an interest of many local or small processed meat producers to produce convenient and ready-to- eat Kunchiang.

Jerky is a very popular western style dried or semi-dried ready-to-eat meat snack. It can be produced from ground and reformed lean meat, but can also be produced from ground lean and fat. Faith et al. [2], using the commercial household food dryer, studied the effects of drying temperatures (52, 57, 63, and 68°C) on faith of survival of *Escherichea coli* 0157:H7 in beef jerky contained 5 or 20% fat. In order to reduce the survival rate of *E. coli* 0157:H7, the drying time should be increased when the fat level increased. Furthermore, they reported that drying beef jerky with 20% fat level at 68°C for 4 h resulted in a 5 log CFU/g reduction of the pathogen. However, drying for 6 hours resulted in a more completely dried product. In addition, drying of ready-to-eat poultry product contained 10% fat with moist heat at 68°C for 1 min could reduce Salmonella for 7 log CFU/g [3]. We, therefore, used this information as a guideline for setting drying temperatures and time for producing reformed ready-to-eat Kunchiang pork snacks.

Inclusion of pork fat in kunchiang production reduced the cost of raw meat materials. Fat also improves palatability by increasing tenderness and juiciness. However, consumers become more health concern and reject high fat foods. Fat also contributes to oxidative rancidity which affects palatability and storage. The objective of this research was, therefore, to study the effects of drying temperatures and fat levels on drying yield and quality of frozen reformed ready-to-eat Chinese sausage style or Kunchiang meat snacks.

II. MATERIALS AND METHODS

Ready mixed chopped sausage batters contained 10, 20, and 30% fat content were obtained from a local sausage processor 2 days prior to the processing day. On the processing day, each Kunchiang batter was separately reground 200 g for 2 min at a time to make it more homogeneous using a small food processor (Philips Cucina HR 7640). To form meat snacks, 400 g of reground sausage batter was then placed in a low density polyethylene plastic freezer bag (20.2x30.5 cm^2). The batter in the bag was spread to form a sheet of 0.6-cm thick and 20-cm wide. The formed kunchiang batters in plastic bags were then frozen at -15°C for 12 h before being cut into smaller rectangular meat snacks (2.5 x 4.0 x 0.6 cm^3). Care was taken during cutting to remove and prevent plastic residues. Weight of each treatment of reformed sausage meat snacks containing 10, 20 and 30% fat was obtained before placing in a tray drier. Core temperatures were recorded (Testo 175-T3, Testo AG, Germany) before and every hour during drying. Two temperature schemes of drying were employed for each fat treatment: A) 100°C for 2 h and then at 70°C for 7 h or B) 70°C for 9 h. After 9-h drying, each treatment was cooled down at 26°C for 1 h before weighing again for drying yield calculation. Meat snack final product quality, including pH (Mettler Toledo MP 120 pH meter equipped with InLab Basics BNC probe; Mettler Toledo, Thailand), water activity (Aw; Novasina Lab Master-Aw, Novasina, Switzerland), and 2-thiobarbituric reactive substances (TBARS; [4]) was analyzed one day after processing. The experiment was in Randomized Complete Block Design with two processing times as replications. Analysis of Variances and Duncan Multiple Range Tests were performed [5].

III. RESULTS AND DISCUSSION

Core temperatures of Chinese sausage batters during drying under method A (100°C for 2 h and at 70°C for 7 h) are presented in Table 1. Core temperatures of batters (10, 20 and 30% fat, 16±3°C) dried under method A reached 66-67°C in 1 h and 72-74°C in 2 h. After continuation at 70°C for 7 h, the reformed sausage meat snacks reached internal temperatures of 56-60°C.

Table 1 Core temperatures (temp.) of reformed Chinese sausage meat snacks (10, 20 and 30% fat) during drying at 100°C for 2 h and then at 70°C for 7 h (method A).

Drying hour	Drying temp. (°C)	Core temperatures (°C) * 10% fat	20% fat	30% fat
1	100	66.7±3.3	66.2±5.6	66.3±3.8
2	100	71.6±0.7	71.7±0.1	73.8±2.7
3	70	55.9±4.8	57.1±0.4	57.9±0.6
4	70	52.8±0.4	55.5±0.8	56.4±0.3
5	70	57.2±3.0	57.5±1.9	58.5±1.2
6	70	59.2±1.5	58.2±1.4	59.1±0.2
7	70	59.9±0.6	60.1±1.8	59.9±0.8
8	70	59.5±1.4	59.0±2.0	59.8±0.7
9	70	56.2±5.2	59.9±0.9	59.6±0.4

* Data were not statistically analyzed.

Table 2 represents core temperatures of reformed Chinese sausage meat snack drying under method B (70°C for 9 h). Core temperatures of batters (10, 20 and 30% fat, 16±3°C) reached 48-52°C in 1 h, 50-53°C in 2 h, and 60-61°C by the end of drying process. For safety consumption, FSIS [6] suggested to cook ground beef or ground pork to internal temperature of 71°C. Faith et al. [2] 1998 indicated that drying of ground beef jerky containing 20% fat at 68°C for 4 h resulted in a 5 log CFU/g reduction of *E. coli* O157:H7. Therefore, core temperature monitoring in our study indicated that drying reformed Chinese sausage batters under method A (100°C for 2 h and at 70°C for 7 h) had a possibility to increase product safety.

The easy frozen reformed process using plastic freezer bags utilized in this study could result in some product loss, which certainly is a concern for processors. Table 3 showed product losses of approximately 1 to 2.5%. Variation in reforming loss certainly depends on expertise and care of workers. To obtain similar reformed product conformation, processors can also modify reforming process to suit their own production.

Table 2 Core temperatures (temp.) of reformed Chinese sausage meat snacks (10, 20 and 30% fat) during drying at 70°C for 9 h (method B).

Drying hour	Drying temp. (°C)	Core temperatures (°C) * 10% fat	hour	temp. (°C)
1	70	47.5±3.6	49.0±3.3	51.6±0.8
2	70	50.0±2.0	52.6±0.9	53.0±1.3
3	70	51.5±0.5	52.6±1.6	55.6±0.7
4	70	56.6±1.7	56.8±0.8	56.7±1.3
5	70	57.6±1.9	57.7±2.4	57.0±0.5
6	70	58.0±2.2	58.6±2.0	56.5±0.0
7	70	59.0±1.1	58.6±0.9	58.6±1.5
8	70	60.3±0.3	60.8±0.8	59.2±0.1
9	70	60.9±1.2	60.8±0.4	60.2±1.1

* Data were not statistically analyzed.

Drying at different temperatures to reduce product moisture to ensure safety and quality of ready-to-eat product can affect final product yield. Results presented in Table 3 indicate no difference (P>.05) in drying yield of the reformed sausage snacks dried either with method A (100°C for 2 h and at 70°C for 7 h) or B (70°C for 9 h). However, there was a tendency for lower fat content (10%) sausage to lose much weight (P<.05) compared to those contain 20 and 30% fat.

Table 3 Batter reforming loss (%) and reformed sausage meat snack drying yield (%)

Treatment	Reforming loss *	Drying yield
110	2.44±0.08	60.71 c
120	2.23±1.75	65.73 ab
130	1.46±0.39	66.60 a
710	1.95±0.37	62.17 bc
720	0.97±0.20	66.68 a
730	1.63±1.12	67.48 a

110, 120, and 130 = 10, 20, and 30% fat, respectively and dried at 100°C for 2 h and then at 70°C for 7 h (method A).
710, 720, and 730 = 10, 20, and 30% fat, respectively and dried at 70°C for 9 h (method B).
* Data were not statistically analyzed.
abc means in the same column with different letters differ (P<.05).

No difference (P>.05) in Aw of reformed Chinese sausage meat snacks drying either under method A (100°C for 2 h and at 70°C for 7 h) or B (70°C for 9 h, Table 4). However, drying under method A tended to be able to reduce Aw to less than 0.80, a level recommended by FSIS [7] for pathogenic safety production of ready-to-eat and shelf-stable jerky. Furthermore, the lower fat (10%) treatment dried under method A had (P<.05) much lower Aw (0.76) than those contained 30% fat and dried under method B (0.82). The trend in free water reduction of the products was similar to product drying yields presented in Table 3. Moisture reduction is a basic preservation process for dried or semi-dried meat products, especially in lower acid meat product such as this reformed Chinese sausage style ready-to-eat meat snacks (6.3-6.4 pH, Table 4).

Table 4 Water activity (Aw), pH, and 2-thiobarbituric acid reactive substances (TBARS, mg malonaldehyde/kg. sample) of reformed Chinese sausage meat snacks after drying under different methods.

Treatment	Aw	pH	TBARS
110	0.76 b	6.3	0.45 b
120	0.78 ab	6.3	0.46 b
130	0.78 ab	6.3	0.55 ab
710	0.79 ab	6.4	0.66 a
720	0.80 ab	6.4	0.67 a
730	0.82 a	6.4	0.70 a

110, 120, and 130 = 10, 20, and 30% fat, respectively and dried at 100°C for 2 h and then at 70°C for 7 h (method A).
710, 720, and 730 = 10, 20, and 30% fat, respectively and dried at 70°C for 9 h (method B).
ab means in the same column with different letters differ. (P<.05).

Results for TBARS, an indicator for lipid oxidation, which usually relates to unfavorable flavor in meat products, are present in Table 4. Interestingly, reformed Chinese sausage style meat snacks dried under method A resulted in lower TBARS (P<.05) than those dried under method B. Although not statistically different (P>.05), the 30% fat treatment drying under method A also had lower TBARS (0.55 mg malonaldehyde/kg. sample) than those dried under method B (0.66, 0.67 และ 0.70 mg malonaldehyde/kg. sample for 10, 20, and 30% fat, respectively). Drying with high temperature (100°C) for the first 2 hours could inactivate some oxidative enzymes due to the reduction of Aw [8]. In addition, reformed Chinese style sausage meat snacks contain a large amount of sugar in the recipe. Caramelization products, resulted from heating sugar at high temperature, were reported to be able to help retard oxidation [9]. As expected, TBARS tended to increase (P>.05) with increasing fat content.

IV. CONCLUSION

Reformed Chinese sausage style ready-to-eat meat snacks can be produced either with 20% or 30% fat and dried at 100°C for 2 h and continued at 70°C for 7 h. This was based on drying yield of approximately 66-67%, Aw of less than 0.80, and their TBARS (0.46 and 0.55), which were lower than those dried at 70°C for 9 h. Processors can apply this temperature and fat levels for production of similarly ground and reformed ready-to-eat Chinese sausage style meat snacks. Products sensory quality, consumer acceptability, packaging, as well as their shelf-life will be further investigated.

ACKNOWLEDGEMENTS

Appreciation goes to research funding by Industrial and Research Projects for Undergraduate Students (IRPUS) 2009, Industry Division, the Thailand Research Funds, research cooperation by P and P Food Supply Co. Ltd., facility and technical supports by Faculty of Industrial Education, Faculty of Agricultural Technology, and Science Faculty, King Mongkut's Institute of Technology Lad Krabang.

REFERENCES

1. Thai Industrial Standards Institute. 1996. Industrial Product Standards: Kunchiang. TIS 914-2539 (1996), Effective date May 14, 1996. 9 p.
2. Faith, N.G., Coutour, S.L., Alvarenga, M.B., Calicioglu, M., Buege, D.R., and Luchansky, J.B. (1998). Viability of *Escherichia coli* O157:H7 in ground and formed beef jerky prepared at levels of 5 and 20% fat and dried at 52, 57, 63, or 68°C in a home-style dehydrator. International Journal of Food Microbiology, 41:213-221.
3. Juneja, V. K., Eblen, B.S., and Marks, H.M. (2001). Modeling non-linear survival curves to calculate thermal inactivation of Salmonella in poultry of different fat levels. International Journal of Food Microbiology, 70:37-51.
4. Witte, V.C., Krause, G.F., and Bailey, M.E. (1970). A new extraction method for determination 2-thiobarbituric acid values of pork and beef during storage. Journal of Food Science, 35:582-585.
5. SPSS Inc. (2005). SPSS Statistics 13.0. for Windows, SPSS Inc., Deleware, USA.
6. FSIS. (2006). Meat preparation: Food safety of jerky. Food Safety and Inspection Service Fact Sheets, United States Department of Agriculture. Available: http://www.fsis.usda.gov/FactSheets/ Jerky_and_Food_Safety/index.asp., April 20, 2009.
7. FSIS. (2005). Principles of preservation of shelf-stable dried meat products. Food Safety and Inspection Service, United States Department of Agriculture. Available: http://www.fsis.usda.gov/ PDF/ FSRE_SS_7Principles.pdf, April 20, 2009.
8. Leistner, L. (2007). Combined methods for food preservation. In M.S. Rahman, Handbook of Food Preservation, 2nd ed. (p. 880), USA: CRC Press.
9. Rahman, M.S. and Perera, C.O. (2007). Drying and food preservation. In M.S. Rahman, Handbook of Food Preservation, 2nd ed. (pp 403-432), USA: CRC Press.