2014 International Conference on Food and Nutrition Technology
IPCBEE vol. 72 (2014) © (2014) IACSIT Press, Singapore
DOI: 10.7763/IPCBEE. 2014. V72. 8

Effect of Different Drying Conditions on Quality Characteristics of Restructured Duck Tender Jerky

Yong-Jae Kim [1], Ko-Eun. Hwang [1], Fu-Yi. He [1], and Cheon-Jei Kim [1 +]

[1] Department of Food science and Biotechnology of Animal Resources, Konkuk University, Seoul, 143-701, Korea

Abstract. Aim of this study is to evaluate quality characteristics of restructured duck tender jerky that was made with three different drying conditions. Drying condition divided normal type, stair type and reverse stair type. Chemical composition, water activity, pH value, instrumental color, sensory test were evaluated. Stair type drying showed lower water activity and pH value (p<0.05) than normal type while it maintain similar moisture contents. In lightness redness, all treatments showed no significant difference (p>0.05). However, jerky dried by reverse stair type show highest yellowness (p<0.05). Stair type drying presented lowest pH value and CIE b* value and superior score at tenderness and juiciness (p<0.05).

Keywords: Jerky, Duck tender, Drying conditions.

1. Introduction

Jerky is old and traditional meat product that has been made since ancient Egypt. Before developing cold and frozen technologies, jerky was a one of method to prolong preservation period. Preservation of jerky resulted from high moisture protein ratio (shelf stable) and lower water activity (microbial safety) [1] [2]. And jerky also has been considered as nutritious snack that contains a high-protein and low-fat food. So jerky is one of popular meet product and prefers to consumers [2].

Although jerky is typical meet product, its raw meat is greatly limited. Jerky was mainly made by beef and pork and occasionally made by poultry [3]. And jerky was produced to different forms that contains whole-muscle jerky and restructured jerky [4]. There are various type of drying methods in making jerky, such as natural drying, hot air drying, freeze-drying, and so on [5]-[7]. Hot air drying that use circulated heated air is effective to eliminate moisture quickly, then jerky acquire microbial safety and economy of time. However rapid drying causes quality deterioration of meat and lipid oxidation [7]. So careful setting of drying condition is required for making good quality jerky.

Duck meet is fourth consuming meet in Korea. However its consumption pattern was limited to grilled duck, duck soup and smoked duck. Grilled duck and duck soup only used raw duck meet, smoked duck is most duck processed food that is circulating in the Korean market. Lack of duck processed food is caused by difficulties of duck processing and brings to retarded growth of duck industry. Duck has a thicker skin and more plentiful unsaturated fatty acid than chicken, and these traits bring to rancid flavour of duck that led to make processed food hardly. Duck tender is considered as by-product so their price is lower than other duck meat cut. Therefore aim of this study investigated that different drying condition affect quality characteristics of restructured duck tender jerky.

2. Materials and Methods

2.1. Preparation of Restructured Duck Tender Jerky

+ Corresponding author. Tel.: + 82-2-450-3684; fax: +82-2-444-6695.
E-mail address: kimcj@konkuk.ac.kr (C.J Kim)

Manufacturing procedure of restructured duck tender jerky with different drying condition was presented in Fig. 1. Trimming duck tender that was used as raw meat for restructured jerky. Trimming duck tender was ground by a grinder with 8 mm plate and then mixed using a mixer after 20 min. The restructured jerky consisted of the raw meat and additives. Additives were added at a ratio to duck tender. The ration was as in the following nitrite pickling salt, soybean sauce, lemon juice (1%), jamona (0.5%), black sugar (3%), black pepper, ginger powder, monosodium glutamate (0.1%), garlic powder, onion powder (0.2%), and gluconodeltalactone (0.03%). The restructured duck tender jerky mixture was stuffed into cellulose casing that was 11mm in diameter. After stuffing, duck tender jerky formed to a thickness of 3 mm. Three different drying conditions were stair type, reverse stair type and normal type. Each detailed conditions were presented in Table 1.

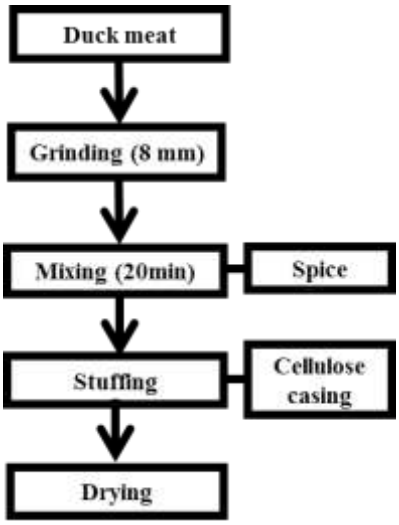

Fig. 1: Manufacturing procedure of restructured duck tender jerky with different drying condition

Table 1. Drying condition of restructured duck tender jerky by different drying methods.

Drying condition								
Stair type			Reverse stair type			Normal type		
Method	Temperature	Time (min)	Method	Temperature	Time (min)	Method	Temperature	Time (min)
Fast drying	55℃	30	Fast drying	75℃	10	Fast drying	75℃	20
Hot smoke	60℃	30	Hot smoke	73℃	30	Hot smoke	75℃	30
Slow drying	65℃	120	Slow drying	73℃	140	Slow drying	75℃	50
Slow drying	73℃	90	Slow drying	65℃	120	Slow drying	85℃	100
Dry cook	75℃	10	Slow drying	60℃	30			
			Slow drying	55℃	30			

2.2. Chemical Compositions

The chemical compositions of the samples were determined using standard AOAC (2000) methods. The moisture content was determined based on the weight loss after 12 h of drying at 105℃ in a drying oven

(SW-90D, Sang Woo Scienctific Co., Bucheon, Korea). The fat content was determined using the Sohxlet method with a solvent extraction system (Soxtec® Avanti 2050 Auto System, Foss Tecator AB, Höganas, Sweden). The protein content was determined using the Kjeldahl method with an automatic kjeldahl nitrogen analyzer (Kjeltec® 2300 Analyzer Unit, Foss Analytical AB, Höganäs, Sweden) and the ash content was determined according to the AOAC (2000) method.

2.3. Water Activity

Three pieces of the restructured duck tender jerky samples from each treatment were selected and cut into a small pieces using cooking knives and were chopped prior to measurement of water activity. The shopped pieces were put into water activity cups, and their water activity were measured with a water activity meter (BT-RS1, Rotronic, Swiss)

2.4. pH Values

The pH values of the samples were measured using a pH meter (Model 340, Mettler-Toledo GmbH, Schwerzenbach, Switzerland). The pH of the restructured duck tender jerky was measured after blending 5 g of sample with 20 mL of distilled water for 60 s in a homogenizer (Ultra-Turrax SK15, Janke & Kunkel, Staufen, Germany).

2.5. Instrumental Color

The instrumental color analyses of the Restructured duck tender jerky were conducted as follows. The color measurements were acquired using a colorimeter (Chroma meter CR-210, Minolta, Japan; illuminate C, calibrated with a white standard plate CIE L* = 97.83, CIE a* = -0.43, CIE b* = +1.98), which consisted an 8 mm diameter measuring area and a 50 mm diameter illumination area. The color values (CIE L*, a*, and b*) were measured on the sample surfaces and data were collected in triplicate for each sample.

2.6. Sensory Evaluation

Restructured duck tender jerky samples were evaluated by trained sensory panel for color, flavor, tenderness, juiciness, off-flavor and total acceptability. The samples as previously described were cooled to room temperature at 25±1 ℃ and cut and served to the panelists in random order. The sensory evaluation was performed by the panelists under fluorescence lighting. Panelists were instructed to cleanse their palates between samples using water. The color, flavor, tenderness, juiciness, and total acceptability (1 = extremely undesirable, 10 = extremely desirable) of the samples were evaluated using a 10-point descriptive scale. But low score in off-flavor means no off-flavor.

2.7. Statistical Analysis

Analysis of variance was performed on all the variables measured using the General Linear Model (GLM) procedure of the SAS statistical package (SAS Institute, Inc., 2010). Duncan's multiple range test ($p<0.05$) was used to determine the differences between treatment means.

3. Result and Discussion

Chemical composition and water activity of restructured duck tender jerky following different drying method were showed Table 2. The protein contents presented no significant difference between treatments ($p>0.05$). Significantly highest fat and ash contents was founded at reverse stair type drying, because these was condensed by decreasing moisture contents. Jerky is typical intermediate moisture food that requires to semi-moist and low water activity. Moisture contents is important to various attributions of jerky such as texture and preservability [8]. Generally higher moisture contents indicates soft texture. While lower moisture contents show higher microbial safety, because moisture contents is closely related to water activity. In this study, reverse stair type drying shows lowest moisture contents. The range water activity in restructured duck tender jerky is 0.72-0.79. These result agreed with study of Chang et al [9]. Banwart reported that lower water activity extend food storage period [10]. Reverse stair type drying showed lowest water activity. Stair type drying has lower water activity than normal type drying without significant difference of moisture contents. This result indicates stair type drying can produce soft and microbial stable jerky in comparison with normal type drying.

The color and pH value of restructured duck tender jerky with different drying condition were presented in Table 3. Meat color is one of the most important quality traits that influence consumer choice and is affected by various factors that contains pH, moisture contents, and meat pigment. The lightness (CIE L^* value) of treatments resulted in the ranged 32.20-35.49 and redness (CIE a^* value) of treatments resulted in the raged 15.32-15.98 and yellowness (CIE a^* value) of treatments resulted in 13.77-15.59. When these results compare with other study that investigated beef jerky with different drying methods [11], lightness is similar and redness is higher than beef jerky. These difference resulted from color of raw meat. There were no significant difference in lightness and redness (p>0.05). The reverse stair type drying and stair type drying expressed respectively highest and lowest yellowness (p<0.05).

The pH of restructured duck tender jerky was 5.66-5.74. These result similar to observation of Yang and Lee [12] that reported the pH of commercial beef jerky was 5.4-5.8. Stair type drying had lowest pH value (p<0.05). Lowering pH delayed and inhibited growth of mould that cause spoilage of dried meat product [13].

Table 2. Chemical composition and water activity of restructured duck tender jerky with different drying methods.

Traits	Drying condition		
	Stair type	Reverse stair type	Normal type
Moisture (%)	22.52±0.37^{A}	18.96±0.36^{B}	22.49±0.10^{A}
Fat (%)	4.92±0.11^{AB}	5.42±0.57^{A}	4.84±0.06^{B}
Proteins (%)	56.29±1.60	57.09±3.45	57.26±1.44
Ash (%)	5.94±0.01^{B}	6.59±0.41^{A}	5.44±0.07^{C}
water activity	0.76±0.01^{B}	0.72±0.01^{C}	0.79±0.01^{A}

All values are mean ± standard deviation of three replicates.
$^{A-C}$ Means within a column with different letters are significantly different ($p < 0.05$).

Table 3. Color and pH value of restructured duck tender jerky with different drying methods.

Traits	Drying condition		
	Stair type	Reverse stair type	Normal type
CIE L^*	32.20±0.40	35.49±2.33	32.57±1.19
CIE a^*	15.98±0.47	15.53±1.03	15.32±1.05
CIE b^*	13.77±0.79^{B}	15.59±0.92^{A}	14.89±0.92^{AB}
pH	5.66±0.01^{B}	5.74±0.01^{A}	5.74±0.01^{A}

All values are mean ± standard deviation of three replicates.
$^{A, B}$ Means within a column with different letters are significantly different ($p < 0.05$).

In this study, the sensory evaluation of restructured duck tender jerky consisted of color, flavour, tenderness, juiciness, off-flavor, and total acceptablilty. Sensory evaluation result were presented in Table 4. The sensory characteristics of jerky are affected diverse factors, such as drying temperature and time, raw meat. There were no significant differences presented in color, flavour, off-flavor, and total acceptability (p>0.05). However, the tenderness and juiciness of jerky with stair type drying was higher than jerky with reverse stair type (p<0.05). From these result, it is considered that water contents in jerky close related with tenderness and juiciness of jerky.

In conclusion, the results of this study indicate that stair type drying condition is suitable for making high quality restructured duck tender jerky. Because stair type drying condition satisfy both microbial safety (lower water activity and pH value) and sensory attributes (better tenderness and juiciness).

Table 4.Sensory evaluation of restructured duck tender jerky with different drying methods.

Traits	Drying condition		
	Stair type	Reverse stair type	Normal type
Color	8.00±0.71	7.89±0.78	8.00±0.71
Flavor	7.33±0.71	6.89±0.60	7.11±0.93
Tenderness	6.29±1.11^{A}	4.89±0.93^{B}	6.22±1.56^{A}
Juiciness	5.78±0.13^{A}	5.44±0.12^{B}	5.44±0.13^{B}
Off-flavor	3.14±0.38	3.43±0.53	3.57±0.53
Total acceptability	7.22±0.10	7.22±0.13	7.33±0.87

4. Acknowledgement

This study was supported by the Brain Korean 21plus (BK 21+) Project from Ministry of Education and Human Resources Development.

5. References

[1] Calicioglu, M., Sofos, J. N., and Kendall, P. A. (2003) Influence of marinades on survival during storage of acid-adapted and non adapted Listeria monocytogenes inoculated postdrying on beef jerky. *Int. J. Food Microbiol*. 86, 283-292

[2] Fernández-Salguero, J., Gómez, R., and Carmona, M. A. (1994) Awof Spanish intermediate-moisture meat products. *Meat Sci*., 38, 341-346.A. Gray. *Modern Differential Geometry*. CRE Press, 1998.

[3] Konieczny, P., Stangierski, J., and Kijowski (2007) Physical and chemical characteristics and acceptability of home style beef jerky. *Meat Sci*. 76, 253-257.

[4] Faith, N. G., Le Coutour, N. S., Alvarenga, M. B., Calicioglub, M., Buegeb, 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 688C in a home-style dehydrator. *Int. J. Food Microbiol*. 41, 213-221.

[5] Edward, S. D. and Pauline, E. M. (1965) Comparison of beta-carotene content of dried carrots prepared by three dehydration process. *Food. Technol*. 19, 1597-1603.

[6] Holdsworth, S. D. (1971) Dehydration of food products. *J.Food Technol*. 6, 331-338.

[7] Labelle, R. L. and Moyer, J. C. (1966) Dehydrofreezing red tart cherries. *Food Technol*. 20, 1345-1352.

[8] Yang, H. S., Hwang, Y. H., Joo, S. T., and Park. G. B. (2009) The physicochemical and microbiological characteristics of pork jerky in comparison to beef jerky. *Meat Sci*. 82, 289-294.

[9] Chang, F. S., Huang, T. C., and Pearson, A. M. (1996) Control of the dehydration process in production of intermediate moisture meat products: *A review. Adv. Food Nutri. Res*. 39, 71-114.

[10] Banwart, G. J. (1979) Basic food microbiology. AVI Publishing Company Inc., Westport. CT. USA

[11] Lim, D. G., Lee, S.S., Seo, K. S., and Nam, K. C. (2012) Effects of different drying methods on quality traits of Hanwoo beef jerky from low-valued cuts during storage. *Korean J. Food Sci. An.* 32, 531-539

[12] Yang, C. Y. and Lee, S. H. (2002). An evaluation of quality of the marketing jerky in domestic. I. Investigation of outward appearance, food additives, nutrient content and sanitary state. Korean J. Food Nutri. 15, 197-202.

[13] Leistner, L. (1987) Shelf stable product and intermediate moisture foods based on meat. In Rockland, L. and Beuchat, L. B. (eds.), Awtheory and application to food, Marcel Dekker Inc, New York, pp. 295-328.