Studies on the Quality of Restructured Pressed Smoked Duck Steak**

Chia-Cherng Huang*, Tzu-Yuan Wang, Andrew Jeng-Fang Huang and Shirley Chai-Ching Lin[1]
I-Lan Branch Institute, Livestock Research Institute, Council of Agriculture, Executive Yuan. 28-1 Je-Hsin Village, Wu-Chieh, I-Lan, Taiwan, ROC

ABSTRACT : The objectives of this study were to investigate the quality characteristics of restructured pressed smoked duck steak from the breast meat of Cherry Valley ducks. Different levels of isolated soybean protein (ISP) (0, 15 and 30 g·kg^{-1}) or carrageenan (5, 10 and 15 g·kg^{-1}) were added to manufacture the restructured pressed smoked duck steak. The results were as follows: No significant differences were observed for moisture, crude fat, crude protein, cooking loss and water holding capacity of products from all treatments. The panel test scores showed that color, flavor and binding ability of products were considered acceptable. The drip loss in control sliced-products was significantly higher than products containing ISP or carrageenan ($p<0.05$) during storage at -18°C for 12 weeks. The pH value, volatile basic nitrogen (VBN) value and thiobarbituric acid (TBA) value of vacuum-packaged products did not change significantly during storage at -18°C for 6 weeks. However, TBA values increased with storage time. The viable bacterial counts were about 10^3-10^4 CFU/g during storage at -18°C for 12 weeks. The products remained good quality during the storage period. *(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 9 : 1316-1320)*

Key Words : Duck, Restructured Meat, Smoked Duck Steak

INTRODUCTION

Duck farming plays a role in supplementing the income of the rural economy of Taiwan. During recent decades, due to an increase in the popularity of duck meat, it has become the major poultry meat for exportation. During 1996, approximately 49 million ducks were produced in Taiwan and 39 million of these were slaughtered, which had a production value of 112 million U.S. dollars (Taiwan Agriculture Yearbook, 1997).

Frozen duck meat is the major poultry export product from Taiwan. However, domestic duck consumption is limited to traditional processed meat products, such as pressed duck, salted duck, and roasted duck, etc. Recently, electrical slaughtering has been introduced into this industry in order to increase availability of duck meat for processing into ready-to-eat food. Very few studies have been reported describing processing techniques and their effects on the quality characteristics of duck meat products. Therefore, Chen et al. (1985) studied the manufacturing of Chinese-style duck products and their evaluation. Restructured meat steak has been studied with the application of modern processing techniques, such as massaging and tumbling. These techniques had been reported to improve the quality of products (Theno et al., 1977; Krause et al., 1978; Wiebe and Schmidt, 1982). Seideman et al. (1982) reported restructured meat steak manufactured from spent hens to improve the meat quality and promote the economical value of spent hen meat.

In order to enhance duck meat consumption, smoked duck steak has been studied and provided to both domestic and foreign markets (Huang, 1995). Carrageenan and ISP (isolated soy protein) have been reported to decrease drip loss in many products, thereby improving product quality and enhancing product yields (McMindes, 1991; Romine et al., 1991; Brewer et al., 1992). To develop the production of and enhance the quality of duck meat products, this study was conducted to investigate the effects of carrageenan and ISP on the quality of restructured pressed smoked duck steak.

MATERIALS AND METHODS

Preparation of restructured pressed smoked duck steak

Frozen breast meat from 10-weeks old of Cherry Valley duck was purchased from the duck slaughterhouse (Ger-Chean Foods Industrial Co., LTD., I-Lan, Taiwan). After thawing, the meat was trimmed of excessive skin and fat, which refers to the skin and fat overhanging the breast meat. Different levels of ISP (0, 15 and 30 g·kg^{-1}) or carrageenan (0, 5, 10, and 15 g·kg^{-1}) were added to curing mixture. Based on a meat weight of 100 g, the curing mixture contained sodium nitrite 0.01 g, sodium chloride 1.4 g, sodium erythorbate 0.05 g, sodium polyphosphate 0.3 g, sugar 1.0 g, monosodium glutamate 0.5 g, white pepper 0.1 g, garlic powder 0.15 g, bay leaf powder 0.02 g, and water 15 g. Breast meat and curing mixture were tumbled and massaged at 3-5°C at 18 rpm under vacuum for 4 h. This 4 h time span consisted of regularly alternating 20 min periods

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* Address reprint request to Chia-Cherng Huang. Tel: +886-3-9503107, Fax: +886-3-9501950, E-mail: cchuang@mail.tlri.gov.tw.

[1] Department of Animal Science, National Ilan Institute of Technology, No.1.Road Shen-Lung, Ilan Taiwan, ROC.

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of tumbling and rest. After tumbling and massaging, meat and curing mixture was placed at 3-5°C for 2 days. Two pieces of breast meat with skin facing outside were pressed in a stainless steel wire box (17×9×5 cm^3) to manufacture restructured pressed smoked duck steaks. Manufacture of this product was based on the following procedures conducted in an automatic smokehouse (Kerres CS700 aut. EL, Germany): 1) Drying at 50°C for 50 min; 2) Smoking at 60°C for 60 min using elm chips as a smoke source; 3) Cooking until internal temperature reaches 75°C. This temperature is measured using a manually inserted probe; 4) Drying at 60°C for 20 min; 5) Chilling. The product was vacuum-packaged and stored at -18°C. The chemical composition, water holding capacity, cooking loss, drip loss, test panel, total viable counts, pH value, TBA value, and VBN value were investigated during storage for 0, 3, 6, 9, and 12 weeks. There were three trials carried out in this study. In each trial, meat samples were collected at the same time from the same batch of birds. The batch varied from trial to trial.

Analysis

Chemical composition : Moisture, crude fat, crude protein and ash were determined according to AOAC (1980).

Water holding capacity : A 10 g sample of the ground duck steak were centrifuged at 4,000 rpm for 20 min. The water holding capacity was calculated according to the method of Fleming et al. (1974).

Cooking loss : After drying and smoking, the duck steak was cooked at 85°C until an internal temperature of 75°C was reached. Cooking loss was calculated based on the following formula:

$$\text{Cooking loss (\%)} = \frac{\text{Original weight - weight of products}}{\text{Original weight}} \times 100$$

Drip loss : The frozen duck steak was partly thawed and sliced to a thickness of 0.3 cm. This slice was held at 3°C in a refrigerator for 24 h to collect the drip water. Drip loss was calculated using the following formula:

$$\text{Drip loss (\%)} = \frac{\text{Weight of drip water}}{\text{Weight of sliced duck steak}} \times 100$$

Test panel : 0.3 cm thick slices of products were taken from different treatments and placed in a dish for the test panel. A panel test was performed by a trained taste panel using the 9-score system (Huang, 1995). Using this system, scores can range from 9 (excellent) to 1 (extremely poor). Binding ability, color, flavor, and over-all acceptance were investigated. Binding ability was assessed by the appearance and texture as judged by the panel. The score of flavor refers to the panel members' personal preference for this product.

pH value : A 10-g sample of duck steak plus 100 ml distilled water was homogenized (Niseis, AM-6, Japan) at 15,000 rpm for 2 min. The pH value was measured (Orion Res. Incorporated. EA-940, U. S. A.) (Ockerman, 1981).

Determination of total viable counts from duck meat : A 10-g sample of the duck steak was aseptically removed and mixed in a stomacher lab blender (Model # 400, Seward, England) with 90 ml sterile saline for two min. One ml of homogenate sample was aseptically diluted stepwise through a series of tubes containing 9 ml of sterile saline buffer (Huang and Lin, 1995). One ml diluent of each sample tube was placed on a plate, followed by the addition of 12-15 ml agar (Plate count agar, Difco). After being gently shaken, the mixture was incubated at 37°C for 48±3 h (FDA, 1978).

TBA (Thiobarbituric acid) value : TBA value was determined using the distillation method of Tarladgis et al. (1960) and as descried by Ockerman (1981). Results were expressed as mg of malonaldehyde per kg of sample.

VBN value : Volatile basic nitrogen was measured by Conway's method (National Bureau of Standards, 1982).

Statistical analysis

Data were analyzed by analysis of variance with the General Linear Models procedure of the SAS package (SAS Institute, Inc., 1988). Comparison of treatment means was based on Duncan's multiple range test.

RESULTS AND DISCUSSION

Quality characteristics of restructured pressed smoked duck steak

The moisture, ash, crude fat, and crude protein of products were 69.21-70.84%, 2.39-2.79%, 4.35-4.93 and 20.05-21.60%, respectively (table 1). No differences were observed among treatments for moisture, crude fat and crude protein. The treatments containing 5 and 15 $g \cdot kg^{-1}$ carrageenan had better water holding capacity (table 2). Foegeding and Ramsey (1986) also reported similarly that the addition of carrageenan increased water holding capacity of low-fat Frankfurter sausage. After vacuum-packaging and freezing at -18°C for 12 weeks, drip losses in the duck steaks containing ISP or carrageenan tended to be lower than observed for the control group (table 3). The scores of panel test showed that no significant differences were observed for colour, flavor, and binding ability among treatments (table 4). A trend of better flavor was noted in the products with ISP or carrageenan compared with the control. The treatment with 15 $g \cdot kg^{-1}$ carrageenan had a higher score in binding ability and over-all acceptance. They had functions of decreasing drip loss as well as increasing binding ability. The steaks had scores of over-all

Table 1. Proximate chemical composition of restructured pressed smoked duck steaks

Treatment[1]	Moisture (%)	Ash (%)	Crude fat (%)	Crude protein (%)
A	70.28	2.47	4.53	20.79
	±2.52[a]	±0.21[b]	±0.72[a]	±3.65[a]
B	69.60	2.40	4.35	21.60
	±0.33[a]	±0.25[b]	±0.72[a]	±2.74[a]
C	69.21	2.57	4.50	21.17
	±0.29[a]	±0.28[ab]	±0.81[a]	±3.12[a]
D	70.84	2.39	4.93	20.05
	±0.05[a]	±0.09[b]	±0.61[a]	±3.37[a]
E	69.77	2.79	4.37	20.55
	±0.22[a]	±0.01[a]	±0.67[a]	±3.60[a]
F	69.65	2.79	4.63	21.09
	±0.23[a]	±0.02[a]	±1.22[a]	±2.41[a]

[1] A: Control; B: 15 g·kg^{-1} isolated soybean protein added; C: 30 g·kg^{-1} isolated soybean protein added; D: 5 g·kg^{-1} carrageenan added; E: 10 g·kg^{-1} carrageenan added; F: 15 g·kg^{-1} carrageenan added.

[a,b] Means within the same column with different letters are significantly different ($p<0.05$) (n=6).

Table 2. The cooking loss and water holding capacity of restructured pressed smoked duck steaks

Treatment[1]	Cooking loss (%)	Water holding capacity (free water) (%)
A	13.88±3.75[a]	3.73±0.90[a]
B	13.31±3.22[a]	3.64±0.90[a]
C	14.15±2.15[a]	3.92±0.67[a]
D	14.60±2.16[a]	3.42±0.81[a]
E	12.43±3.64[a]	3.70±0.95[a]
F	12.86±3.22[a]	3.38±0.48[a]

[1] A, B, C, D, E, F: see table 1.

[a] Means within the same column with the same letters are not significantly different ($p>0.05$).(n=6)

acceptance between 6.27-7.23 (table 4).

Quality change of restructured pressed smoked duck steak during storage

The product was vacuum-packaged and stored at -18°C for 12 weeks. The population of viable bacterial count ranged from an initial 10^3 CFU (colony forming unit) /g to 10^4 CFU/g after 9 weeks during storage period irrespective of treatment (table 5). After 12 weeks of storage, viable

Table 3. The drip loss (%) of restructured pressed smoked duck steaks during storage at -18°C

Treatment[1]	Storage time (wks)				
	0	3	6	9	12
A	0.72±0.37[bx]	1.25±0.43[ax]	1.10±0.40[ax]	1.23±0.34[ax]	1.26±0.44[ax]
B	0.70±0.22[bx]	0.81±0.28[ay]	0.99±0.33[axy]	0.89±0.33[ax]	0.85±0.49[ay]
C	0.71±0.60[bx]	0.85±0.53[ay]	0.94±0.37[axy]	1.13±040[ax]	1.18±0.52[axy]
D	0.69±0.27[bx]	1.04±0.44[axy]	1.04±0.37[ax]	0.97±0.37[ax]	1.02±0.41[axy]
E	0.75±0.34[cx]	0.87±0.27[by]	0.83±0.16[by]	0.94±0.36[ax]	0.94±0.13[ay]
F	0.75±0.18[bx]	1.10±0.40[axy]	0.88±0.46[axy]	0.90±0.55[ax]	0.99±0.31[axy]

[1] A, B, C, D, E, F: see table 1.

[a,b,c] Means within the same row with different letters are significantly different ($p<0.05$).

[x,y] Means within the same column with different letters are significantly different ($p<0.05$) (n=6).

Table 4. Panel test score of restructured pressed smoked duck steaks

Treatment[1]	Color	Flavor	Binding ability	Over-all acceptance
A	6.47±1.46[a]	6.23±1.65[a]	6.67±1.37[a]	6.27±1.62[b]
B	7.10±1.49[a]	6.57±1.57[a]	6.80±1.61[a]	7.00±1.41[ab]
C	7.03±1.75[a]	6.47±1.68[a]	6.57±1.61[a]	6.73±1.66[ab]
D	6.60±1.77[a]	7.00±1.64[a]	7.03±1.35[a]	6.93±1.44[ab]
E	6.87±1.61[a]	7.00±1.64[a]	6.76±1.33[a]	6.67±1.79[ab]
F	6.93±1.60[a]	6.77±1.68[a]	7.23±1.45[a]	7.23±1.59[a]

[1] A, B, C, D, E, F: see table 1.

Panel evaluation: 9: excellent, 5: fair, 1: extremely poor.

[a,b,c] Means within the same column with different letters are significantly different ($p<0.05$).

Table 5. Change in viable bacterial counts of restructured pressed smoked duck steaks during storage at -18°C

Treatment[1]	Storage time (wks)				
	0	3	6	9	12
	CFU/g				
A	6.7×10^{3a}	7.2×10^{3a}	6.8×10^{3a}	7.7×10^{3a}	1.3×10^{4a}
B	1.2×10^{3a}	1.5×10^{3a}	1.1×10^{4a}	1.8×10^{4a}	4.9×10^{4a}
C	1.9×10^{3c}	2.4×10^{3c}	4.5×10^{3bc}	1.2×10^{4ab}	1.6×10^{4a}
D	1.1×10^{3a}	3.6×10^{3a}	2.6×10^{3a}	2.8×10^{4a}	1.4×10^{4a}
E	2.0×10^{3a}	3.5×10^{3a}	2.7×10^{3a}	2.4×10^{4a}	5.8×10^{4a}
F	1.1×10^{3b}	1.0×10^{3b}	1.1×10^{4a}	1.1×10^{4a}	1.2×10^{4a}

[1] A, B, C, D, E, F: see table 1.
[a,b,c] Means within the same row with different letters are significantly different ($p<0.05$) (n=6).

Table 6. Change in pH value of restructured pressed smoked duck steaks during storage at-18°C

Treatment[1]	Storage time (wks)				
	0	3	6	9	12
A	6.34 ± 0.06^{abyz}	6.38 ± 0.02^{axyz}	6.26 ± 0.03^{cy}	6.27 ± 0.09^{bcx}	6.33 ± 0.03^{abcx}
B	6.34 ± 0.06^{ayz}	6.36 ± 0.04^{ayz}	6.36 ± 0.10^{axy}	6.29 ± 0.11^{ax}	6.34 ± 0.06^{ax}
C	6.36 ± 0.04^{aby}	6.46 ± 0.08^{ax}	6.41 ± 0.06^{ax}	6.27 ± 0.10^{bx}	6.30 ± 0.07^{bx}
D	6.28 ± 0.02^{ay}	6.26 ± 0.04^{aw}	6.32 ± 0.06^{axyz}	6.32 ± 0.04^{ax}	6.32 ± 0.11^{ax}
E	6.33 ± 0.04^{ayz}	6.30 ± 0.02^{ayw}	6.30 ± 0.02^{ayz}	6.37 ± 0.14^{ax}	6.35 ± 0.17^{ax}
F	6.46 ± 0.09^{ax}	6.44 ± 0.12^{axy}	6.40 ± 0.10^{abxy}	6.35 ± 0.04^{abx}	6.31 ± 0.04^{bx}

[1] A, B, C, D, E, F: see table 1.
[a,b,c] Means within the same row with different letters are significantly different ($p<0.05$).
[x,y,z] Means within the same column with different letters are significantly different ($p<0.05$) (n=6).

Table 7. Change in VBN value of restructured pressed smoked duck steaks during storage at -18°C

Treatment[1]	Storage time (wks)				
	0	3	6	9	12
	mg%				
A	13.62 ± 1.54^{ax}	12.73 ± 2.07^{ax}	13.75 ± 0.56^{axy}	14.13 ± 0.42^{ax}	13.44 ± 0.28^{ax}
B	12.65 ± 1.05^{bx}	12.49 ± 1.26^{bx}	14.23 ± 0.60^{axy}	14.18 ± 0.61^{ax}	13.64 ± 0.61^{abx}
C	12.81 ± 1.56^{ax}	13.44 ± 1.80^{ax}	13.56 ± 1.32^{ay}	14.47 ± 1.24^{ax}	14.19 ± 0.58^{ax}
D	13.27 ± 1.92^{ax}	13.78 ± 0.50^{ax}	14.60 ± 0.51^{axy}	14.21 ± 0.82^{ax}	14.13 ± 1.05^{ax}
E	13.30 ± 2.45^{ax}	14.06 ± 1.74^{ax}	14.40 ± 0.26^{axy}	14.60 ± 0.65^{ax}	13.69 ± 0.97^{ax}
F	12.95 ± 1.61^{ax}	13.49 ± 2.35^{ax}	14.84 ± 1.00^{ax}	14.28 ± 1.60^{ax}	13.45 ± 1.32^{ax}

[1] A, B, C, D, E, F: see table 1.
[a,b,c] Means within the same row with different letters are significantly different ($p<0.05$).
[x,y,z] Means within the same column with different letters are significantly different ($p<0.05$) (n=6).

bacterial counts were approximately 10^4 CFU/g also. pH values ranged between 6.28-6.46 (table 6). VBN values were 12.49-14.47 mg% (table 7), which were less than the rancidity level 20 mg% (Pearson, 1968). A trend of increased TBA was observed after 6 wks storage (table 8). However, TBA values were less than 0.27 mg/kg, under the acceptable rancidity level 1.0 mg/kg. Therefore, the values of total plate counts, pH, VBN and TBA were not significantly changed during the storage time of duck steaks containing ISP (15 and 30 $g\cdot kg^{-1}$) or carrageenan (5, 10 and 15 $g\cdot kg^{-1}$) compared with control group. The products were acceptable and no deterioration occurred when storage at -18°C for 12 weeks.

CONCLUSION

In order to enhance the utilization and promote the economic value of duck meat, the restructured pressed smoked duck steak is a good new duck meat product. Drip loss, binding ability, water holding capacity and cooking loss of the products with ISP and carrageenan are better than control group. The duck steak sustained good quality

Table 8. Change in TBA value of restructured pressed smoked duck steaks during storage at -18°C

Treatment[1]	Storage time (wks)				
	0	3	6	9	12
	mg/kg				
A	0.166±0.048^{bxy}	0.238±0.039^{ax}	0.241±0.015^{ax}	0.227±0.026^{axyz}	0.216±0.049^{ay}
B	0.159±0.027^{by}	0.224±0.030^{ax}	0.212±0.034^{abxy}	0.249±0.083^{axy}	0.232±0.059^{ay}
C	0.158±0.018^{cy}	0.206±0.033^{bxy}	0.213±0.046^{bxy}	0.271±0.040^{ax}	0.236±0.065^{aby}
D	0.165±0.036^{bxy}	0.163±0.036^{bz}	0.184±0.050^{by}	0.176±0.028^{by}	0.228±0.038^{ay}
E	0.197±0.035^{bcx}	0.168±0.020^{cz}	0.176±0.035^{bcy}	0.209±0.033^{byz}	0.253±0.032^{ax}
F	0.145±0.029^{by}	0.183±0.041^{byz}	0.172±0.051^{by}	0.238±0.020^{axy}	0.270±0.035^{ax}

[1] A, B, C, D, E, F: see table 1.

[a,b,c] Means within the same row with different letters are significantly different ($p<0.05$).

[x,y,z] Means within the same column with different letters are significantly different ($p<0.05$) (n=6).

during storage at -18°C for 12 weeks.

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