

EFFECTS OF FREEZING STORAGE AND ADDITION OF DRIP ON THE QUALITY CHARACTERISTICS OF CHICKEN MEAT BATTERS

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Abstract— this study evaluated the effects of freezing storage and the addition of drip on the quality characteristics of chicken meat batters. The chicken was frozen at $-20\pm 1^\circ\text{C}$ for 1, 3, and 6 months. In the after, thawed and deboned, chicken meat was used to meat batter and partially drip was added to meat batter (F1D, F3D, and F6D). The pH value gradually increased as freezing storage period increased ($P<0.05$), the cooking loss, emulsion stability, protein solubility, and apparent viscosity value were gradually decreased as freezing storage period increased ($P<0.05$). Additionally, the redness, pH, cooking loss, emulsion stability, protein solubility, and apparent viscosity value were increased with addition of drip ($P<0.05$). The F3D sample showed the lowest springiness value and the F1 sample showed the highest value in cohesiveness, gumminess, chewiness, and hardness value.

Index Terms— chicken meat batter, drip, freezing storage, quality characteristics.

I. INTRODUCTION

Chicken meat has shorter storage times than pork or beef meat, because it has lower texture than red muscle meat and higher pathogenic and spoilage bacterial counts that cause by cross-contamination in the cooling process after slaughter. Thus, chicken meat needs ice or freezing for transportation and storage. Other researchers reported for frozen effect to chicken meat that freezing rate, packaging methods, microbial changes, lipid oxidation, color, and denaturation of myoglobin (Vieira, Diaz, Martínez & García-Cachán, 2009). Many type of chicken meat exist on market, but no research reported about its processing characteristics of emulsion type meat products.

Freezing is a preservation process which can be divided into three distinct phase; freezing properly so called, storage of the frozen product, and the thawing operation. Each of these phases has been considered separately because it presents specific problems both as regards the mode of performing the operation and the quality of the final product. One of freezing problem is drip loss on thawing. The most obvious change is a loss of juice or drip which appears on thawing. This represents a definite loss from an economic and nutritional point of view, and devalues the product owing to its poor appearance when sold after thawing. It does not always affect the juiciness of product, however, because the losses which occur during the cooking process are five to ten time greater (Nusbaum, Sebranek, Topel, & Rust, 1983)

II. MATERIALS AND METHODS

A. Preparation of meat batters and processing

The fresh chickens (whiter semi-broiler) were bred from Konkuk University Chung-Ju farm and slaughtered by common slaughter method. The chickens were sampled at freezing storage days for 0, 1, 3, and 6 at $-20\pm 1^\circ\text{C}$. For each sample was thawed overnight $4\pm 1^\circ\text{C}$. After thawed, drip was collected to one of bottle and kept at $4\pm 1^\circ\text{C}$. Meat batter consisted of 300 g of chopped chicken meat, 100 g pork back fat added, 100 g water, and 7.5 g salt. The samples of drip was added 25 g of drip (F1D, F3D, and F6D), and in proportion to addition of drip water is 25 g reduced.

B. Methods

The pH values of each sample were measured in a homogenate prepared with 5 g of sample and distilled water (20 mL) using a pH meter (Model 340, Mettler-Toledo GmbH, Schwerzenbach, Switzerland). All determinations were performed in triplicate.

The color of cooked and uncooked meat batter samples were measured by the CIE LAB system using a color meter (Minolta Chroma meter CR-210, Minolta Ltd., Osaka, Japan; illuminate C, calibrated with white plate, $L^* = +97.83$, $a^* = -0.43$, $b^* = +1.98$). Six measurements for each of five replicates were taken. Lightness (L^*), redness (a^*), and yellowness (b^*) values were recorded.

Protein solubility was utilized as an indicator of protein denaturation. Sarcoplasmic protein solubility was determined by dissolving 2 g of meat batters in 20 mL of ice-cold 25 mM potassium phosphate buffer (pH 7.2). The meat batter samples and buffer were homogenized on ice with a homogenizer (Model AM-7, Nihonseiki Kaisha Ltd., Tokyo, Japan) set at $1,500 \times g$, and were left to stand on a shaker at 4°C overnight. The mixtures were centrifuged at $1,500 \times g$ for 20 min and the protein concentrations of the supernatants were determined using the Biuret method. Total protein solubility was determined by homogenizing 2 g of muscle powder in 20 mL of ice-cold 1.1 mol/L potassium iodide in a 100 mol/L phosphate buffer (pH 7.2). The procedures for homogenization, shaking, centrifugation, and protein determination are described above. Myofibrillar protein solubility was obtained by determining the difference between the total and sarcoplasmic protein solubilities.

The meat batters were analyzed for emulsion stability using the method of Bloukas and Honikel (1992) with the following modifications. At the middle of a 15 mesh sieve, pre-weighed graduated glass tubes (Pyrex Chojalab Co., Seoul, South Korea, Volume: 15 mL, Graduated units: 0.2 mL) were filled with batter. The glass tubes were closed and heated for 30 min in a boiling water bath to a core temperature of $73 \pm 1^\circ\text{C}$. After cooling to approximately $4 \pm 1^\circ\text{C}$ to facilitate fat and water layer separation, the total expressible fluid and fat separated in the bottom of each graduated glass tube were measured and calculated.

Meat batter viscosity was measured in triplicate with a rotational viscometer (HAKKE Viscotester® 500, Thermo Elctron Corporation, Karlsruhe, Germany) set at 10 rpm. The standard cylinder sensor (SV-2) was positioned in a 25 mL metal cup filled with batter and allowed to rotate under a constant share rate at s^{-1} for 60 s before each reading was taken. Apparent viscosity values in centipoises were obtained. The temperature of each sample at the time ($18 \pm 1^\circ\text{C}$) of viscosity testing was also recorded .

Cooking loss was determined by calculating the weight differences of meat batter before and after cooking as follows:

$$\text{Cooking loss (\%)} = \frac{\text{weight of raw meat batter} - \text{weight after cooking}}{\text{weight of raw meat batter}} \times 100$$

Texture profile analysis was performed at room temperature with a texture analyzer (TA-XT2i, Stable Micro Systems, England). Heat-induced meat batter samples were taken from the central portion of each sample. Prior to analysis, samples were allowed to equilibrate to room temperature (20°C , 3 hr). The conditions of texture analysis were as described follows: ϕ 25mm spherical probe, pre-test speed 2.0 mm/s, post-test speed 5.0 mm/s, maximum load 2 kg, head speed 2.0 mm/s, distance 8.0 mm, and force 10 g. Texture profile analysis (TPA) values were determined by graphing force versus time. Values for hardness (kg), springiness, cohesiveness, gumminess (kg), and chewiness (kg) were determined as described by Bourne (1978).

An analysis of variance was performed on all the variables measured using the general linear model (GLM) procedure of the SAS statistical package (1999). Duncan's multiple range test ($P < 0.05$) was used to determine the differences among treatments

III. RESULTS AND DISCUSSION

The pH and color values of chicken meat batters processed with various freezing storage period and with/without addition of drip are showed Table 1. The pH value gradually increased as freezing storage days increased ($P < 0.05$), and the samples with drip showed significantly high value than samples without drip ($P < 0.05$).

The protein solubility value of meat batters processed with various freezing storage period and with/without addition of drip is showed Table 2. The myofibrillar solubility value gradually decreased as freezing storage days increased ($P < 0.05$), and the samples with drip showed significantly high value than samples without drip ($P < 0.05$). Because, protein was denaturated that the formation of ice crystallization in meat muscle during frozen storage, thus, it cause on drip loss and decrease on water holding capacity (Penny, 1974).

The emulsion stability and apparent viscosity values of meat batter processed with various freezing storage period and with/without addition of drip is showed Table 2. Emulsion stability represents the retention of unseparated fat and moisture in the meat emulsion during cooking (Sarıçoban, Özalp, Yılmaz, Özen, Karakaya, & Akbulut, 2008). The total expressible fluid and fat loss value gradually increased as freezing storage days increased ($P < 0.05$), and the samples with drip showed significantly higher value than samples without drip ($P < 0.05$), as mentioned above, it presumed that sarcoplasmic proteins of drip.

Viscosity development within the batter was mainly related to the water binding capacities of the dry ingredients (Dogan, Sahin, & Sumnu, 2005). The apparent viscosity gradually decreased as freezing periods increased ($P<0.05$), and the samples with drip showed significantly higher value than samples without drip ($P<0.05$). Elevating the viscosity of meat batter is mainly related to the water holding capacity (Lee *et al.*, 2008), and emulsion stability.

The cooking loss values of meat batters processed with various freezing storage period and with/without addition of drip are given in Fig. 1. The cooking loss value gradually increased as freezing storage days increased ($P<0.05$). As mentioned above, cooking loss related with pH, water holding capacity. Lee, Seo, Lee, & Ryu (2004) reported that the water holding capacity of frozen chicken meat showed lower value for 15 days freezing storage. The samples with drip (F1D, F3D, and F6D) was showed lower cooking loss values than samples without drip (F1, F3, and F6) ($P<0.05$).

The texture profile of meat batter processed with various freezing storage period and with/without addition of drip is given in Table 3. Significant difference were found in springiness, cohesiveness, chewiness, gumminess, and hardness ($P<0.05$). The springiness value showed significantly higher than control until freezing for 1 month, however, the value dropped from 3 month to 6 month ($P<0.05$). The cohesiveness value of the control and F3 batters are higher than other batters ($P<0.05$). The gumminess and chewiness value of the F1 batter is showed lowest value ($P<0.05$). And, the hardness value of F1D showed significantly higher than other batters. Park *et al.* (1996) reported that the shear force of frozen chicken breast and thigh meat was decreased as freezing periods increased, which were either vacuum packaged or atmosphere packaged. Yoon (2002) reported that no significant texture toughening, in terms of shear force, was noticed in frozen chicken breasts regardless after 10 months of storage and texture toughening of frozen chicken breast was not always related to the freeze-indicated shrinkage of myofibrils, which did not decrease water binding activity.

IV. CONCLUSION

The pH value gradually increased as freezing storage days increased, and the cooking loss, emulsion stability, protein solubility, and apparent viscosity value were gradually decreased as freezing storage days increased. The F1 samples showed the highest lightness value, F1D showed the highest redness values, and control showed the highest yellowness value ($P<0.05$). After cooked color, the F3 sample showed the highest lightness value, and F3D sample showed higher than other samples in redness value, control and F1 sample showed the highest yellowness value ($P<0.05$). The F3D sample showed the lowest springiness value, and the F1 sample showed the highest value in cohesiveness, gumminess, chewiness, and hardness value. Additionally, the redness, pH, cooking loss, emulsion stability, protein solubility, and apparent viscosity value were increased as addition of drip. Therefore, the addition of chicken drip can contribute to the development of frozen chicken meat products with desirable quality characteristics.

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Table 1. Comparison on the pH of meat batter processed with various freezing storage period and with/without addition of drip

Treatments	Control	F1	F1D	F3	F3D	F6	F6D	
pH	Uncooked	6.02±0.01 ^D	6.12±0.03 ^C	6.13±0.01 ^C	6.18±0.00 ^B	6.20±0.02 ^B	6.20±0.02 ^B	6.30±0.02 ^A
	Cooked	6.31±0.01 ^C	6.31±0.02 ^C	6.32±0.01 ^C	6.40±0.02 ^B	6.41±0.01 ^B	6.41±0.01 ^B	6.48±0.01 ^A

All values are mean ± standard deviation of three replicates.

^{A-E} Treatments with different letters are significantly different ($p<0.05$).

Control : no freezing, F1 : treatment frozen for 1 month, F1D : treatment frozen for 1 month and added drip, F3 : treatment frozen for 3 month, F3D: treatment frozen for 3month and added drip, F6 : treatment frozen for 6 month, F6D : treatment frozen for 6month and added drip.

Table 2. Comparison on the proteion solubility, emulsion stability, and apparent viscosity of meat batter processed with various freezing storage period and with/without addition of drip

Treatments	Control	F1	F1D	F3	F3D	F6	F6D	
Myofibrillar solubility (mg/mL)	117.06±0.87 ^B	114.03±3.28 ^B	125.25±4.54 ^A	100.07±2.80 ^C	115.05±3.17 ^B	93.85±3.58 ^D	99.33±2.01 ^C	
Sarcoplasmic solubility (mg/mL)	41.69±0.62 ^B	41.16±1.01 ^B	48.82±1.76 ^A	34.68±1.39 ^D	36.16±1.20 ^{CD}	27.39±2.72 ^E	37.59±1.29 ^C	
Emulsion stability	Total expressible fluid (mL/g)	10.84±0.46 ^F	12.09±0.64 ^{DE}	11.14±0.11 ^{EF}	14.09±0.52 ^C	12.48±0.26 ^D	17.11±0.91 ^A	15.65±0.72 ^B
	Fat loss (mL/g)	1.27±0.10 ^E	1.70±0.13 ^{DE}	1.46±0.16 ^E	2.39±0.33 ^{BC}	2.08±0.23 ^{CD}	2.96±0.18 ^A	2.77±0.40 ^{AB}
Apparent viscosity (Pas)	49.9±3.62 ^A	43.80±0.92 ^C	47.14±2.48 ^B	31.58±1.25 ^D	41.32±2.52 ^C	27.52±1.16 ^E	32.88±1.15 ^D	

All values are mean ± standard deviation of three replicates.

^{A-F} Treatments with different letters are significantly different ($p<0.05$).

Control : no freezing, F1 : treatment frozen for 1 month, F1D : treatment frozen for 1 month and added drip, F3 : treatment frozen for 3 month, F3D: treatment frozen for 3month and added drip, F6 : treatment frozen for 6 month, F6D : treatment frozen for 6month and added drip.

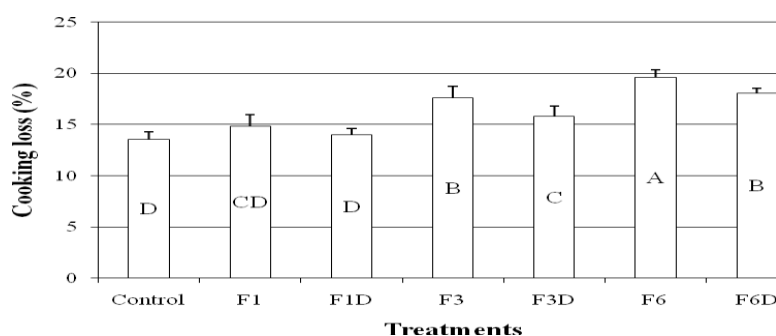


Fig. 1. Comparison on the cooking loss of meat batter processed with various freezing storage period and with/without addition of drip.

^{A-D} Treatments with different letters are significantly different ($p<0.05$).

Control : no freezing, F1 : treatment frozen for 1 month, F1D : treatment frozen for 1 month and added drip, F3 : treatment frozen for 3 month, F3D: treatment frozen for 3month and added drip, F6 : treatment frozen for 6 month, F6D : treatment frozen for 6month and added drip.

Table 3. Comparison on the texture profile of meat batter processed with various freezing storage period and with/without addition of drip

Treatments	Control	F1	F1D	F3	F3D	F6	F6D
Hardness (kg)	0.38±0.04 ^B	0.34±0.03 ^C	0.43±0.04 ^A	0.40±0.05 ^{AB}	0.39±0.03 ^{AB}	0.34±0.03 ^C	0.39±0.04 ^B
Springiness	0.95±0.02 ^B	0.99±0.01 ^A	0.99±0.01 ^A	0.94±0.03 ^{BC}	0.92±0.03 ^C	0.95±0.04 ^B	0.94±0.03 ^{BC}
Cohesiveness	0.54±0.04 ^A	0.42±0.04 ^C	0.42±0.03 ^C	0.54±0.05 ^A	0.51±0.03 ^{AB}	0.50±0.01 ^B	0.52±0.05 ^{AB}
Gumminess (kg)	0.21±0.03 ^A	0.14±0.01 ^D	0.18±0.02 ^{BC}	0.21±0.04 ^A	0.20±0.02 ^{AB}	0.17±0.01 ^C	0.39±0.04 ^{AB}
Chewiness (kg)	0.20±0.03 ^A	0.14±0.01 ^C	0.18±0.02 ^{AB}	0.20±0.04 ^A	0.18±0.02 ^A	0.16±0.01 ^{BC}	0.19±0.03 ^A

All values are mean ± standard deviation of three replicates.

^{A-D} Treatments with different letters are significantly different ($p<0.05$).

Control : no freezing, F1 : treatment frozen for 1 month, F1D : treatment frozen for 1 month and added drip, F3 : treatment frozen for 3 month, F3D: treatment frozen for 3month and added drip, F6 : treatment frozen for 6 month, F6D : treatment frozen for 6month and added drip.