

Original Research Article

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Influence of Different Thawing Methods on Physico-chemical and Microbiological Characteristics of Broiler Chicken Meat

R. Rajkumar, A. Irshad*, and C. Pandiyan

Department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal, TANUVAS, Tamil Nadu, India

*Corresponding author

ABSTRACT

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A good thawing of broiler meat is one that minimizes process time and microbial growth risk. Hence, the present study was carried out to investigate the influence of physico-chemical and microbiological characteristics of broiler chicken meat and leg samples by different thawing methods. The thawing methods like room temperature, running tap water, refrigerator and microwave oven thawing were selected and studied. The various thawing methods didn't influence the drip loss per cent, pH value of broiler breast and leg meat samples. The water holding capacity has been slightly increased corresponding with earlier research reports. Further, the water activity of broiler breast was little higher as compared to leg meat in microwave oven thawing than the others methods. The physical properties of toughness and firmness of broiler breast and leg meat has been meagerly influenced with respect to thawing methods. The total viable count of microwave oven thawed meat samples had less count than the other methods. *E. coli* and *Salmonella* species were not noticed in the broiler meat samples during the entire period of the experiment.

Introduction

Low temperature storage is the most common method used for meat and meat products preservation. However, some quality changes will still take place during freezing, frozen storage and thawing, especially texture, flavour and colour due to osmotic removal of water, oxidation of protein and fat, myosin denaturation and mechanical damage (Benjakul *et al.*, 2003). Scientifically meat refrigeration process has been done by reducing the temperature of the meat to a value below which the rate of bacterial growth is either severely slowed (chilling) or

stopped (freezing). Freezer storage is an excellent method of meat preservation than chilling process. The length of time meat samples are held at frozen storage also determines product quality. Freezing reduces enzyme activity in meat and stops the growth of bacteria and molds and therefore the quality of the meat is retained longer, as compared to freezing cooked meat or poultry. When frozen meat is thawed, much of the original moisture found in the meat is lost as purge (juices that flow from the meat). A good thawing regime is one that minimizes process time, microbial growth risks, drip loss, and other quality losses. The main

objective of this study is to analyze the effect of different thawing method on the physico-chemical and microbiological characteristics broiler chicken meat. Hence the experiment designed for thawing of broiler chicken meat at different methods such as room temperature (as control), running tap water (at 28 degree Celsius) refrigerator condition (at 4 °C) and microwave oven thawing.

Materials and Methods

The study materials of forty eight pairs of musculus pectoralis and leg portion were sourced from 35-day old ROSS 308 broiler chickens held together in one production cycle on liter with unlimited access to standard feed mixtures dedicated for broiler chickens. Slaughtering and dissection of the chickens was undertaken at Department of livestock products technology (meat science), Veterinary College and Research Institute, Namakkal, Tamil Nadu, according to industry standards set for poultry slaughter houses. The birds were mechanically slaughtered after antemortem examination and subsequently allowed for blood-letting, plucked and mechanically gutted. The carcasses were chilled in water (2°C) and the chilled carcasses were mechanically dismembered and the skinless breast meat and leg piece were manually cut out. The study materials were packed in LDPE sachets and stored under -18°C for a week. On the day of experiment, samples were transported to the laboratory by using insulated box made of stainless steel. The experiment was conducted at Department of livestock products technology (meat science), Veterinary College and Research Institute, Namakkal, Tamil Nadu state, India.

The packed frozen broiler meat samples were unsealed and the meat packs were thawed viz. (a) Room temperature ($30 \pm 2^\circ\text{C}$), (b) Running tap water ($28 \pm 1^\circ\text{C}$), (c)

Refrigeration ($4 \pm 1^\circ\text{C}$) and (d) Microwave oven (2450 MHZ) respectively. The time taken for thawing at room temperature was 180 minutes; running water was 60 minutes; at refrigeration temperature was 14 hours and in microwave oven was 10 minutes for the samples.

Weight of the experimental meat samples were recorded before and after thawing. Drip loss of the chicken breast and leg meat (expressed as per cent moisture lost) was determined as per the method suggested by Benli (2016). The estimation of pH of meat sample was measured by using digital pH meter (Model 361, Systronics, India). About 5g of meat was homogenized in a tissue homogenizer with 45 ml of distilled water for about one minute. The pH was recorded by immersing the combined glass electrode of digital pH meter in the homogenate. Water holding capacity of meat sample (as percent water retained by the meat sample) was analyzed by filter paper press method as suggested by Hamm (1960) with slight modification. 500 mg of meat was pressed between two filter papers by applying 2.8 kg weight for 5 mins. Weight of meat flake and filter paper after pressing was recorded.

The firmness and toughness of breast and leg meat was analyzed by using the food texture analyzer (model: TA-XT plus, Stable Microsystems), connected to a computer programmed with the texture analysis software. Thirty-six measurements for each meat samples were recorded. The term firmness is the maximum peak force (F) during the first compression cycle (first bite) and the unit is Newton.

The total viable count (TVC), *E. coli* and Salmonella count of broiler breast and leg meat samples were carried out as per the procedure followed by Bhandari *et al.*, (2013).

A total of twelve replications were made to find out the suitable thawing procedure for broiler meat. Statistical analyses were performed using SPSS software (SPSS 15.0 K for Windows, Chicago, IL), and all data were expressed as means \pm standard error of the mean (SEM) values. Data were submitted to one-way analysis of variance. Significant differences among means of the nine replicates were compared by Tukey's test at $p < 0.05$.

Results and Discussion

Drip loss (%)

The results of the weight (g) of investigated broiler meat samples before thawing had a mean value of 1.44, 1.40, 1.45 and 1.37 for the treatments Control, T1, T2 and T3 respectively and noticed no significant difference among them. Similarly, the weight (g) of meat samples after thawing had a mean value of 1.42, 1.37, 1.43 and 1.36 for the Control and treatments and had no significant difference among them. The drip loss (per cent) of the control and experimental groups (T1 to T3) were 1.61, 2.13, 1.00 and 1.60 respectively and looked a similar trend as that of before and after thawing weight.

Benli, (2016) studied the drip loss per cent of chicken breast obtained from a retail market and placed in a freezer at -20°C for 72 hours for three days. The chicken breast samples after defrosting using home based thawing practices such as i) thawing in a refrigerator ($+4^{\circ}\text{C}$, 24 hours); ii) thawing on a counter at room temperature (22°C , 6 hours); iii) thawing in warm water (37°C , 40 minutes); iv) thawing in a microwave (180 W, 10 to 13 minutes); and v) thawing under tap water (20°C , 1 hour) and reported 0.62, 1.47, 0.93, 3.47 and 1.14 respectively. Woelfel *et al.*, (2002) and Van Laack *et al.*, (2000) reported a mean drip loss values laid between 0.42%

and 3.32% for broiler meat in the commercial processing plants. The various thawing methods viz., room temperature, tap water, refrigerator and microwave has little variation in the drip loss as compared to each other but the variation is not statistically significant. In the present investigation, the broiler meat samples has been purchased from commercial local retail sale outlets the drip loss percentage were in accordance with the findings of Benli, (2016), Woelfel *et al.*, (2002) and Van Laack *et al.*, (2000) respectively. In general, poultry meat is far less prone to drip as suggested by Emad *et al.*, (2014). The drip loss of muscle can lead to less acceptability, due to the loss of tasteful constituents, e.g. some amino acids or nucleotides.

pH Value

In the present study, the pH of breast meat sample had a significant difference ($P < 0.01$) between control and treatments and the room temperature thawed breast meat has low pH value as compared to treatments (Table 1). Tap water, refrigerator and microwave thawing has no effect in the pH value and are at par with one another. Saelin *et al.*, (2017) studied the pH of non-marinated broiler breast meat stored at 4°C on day 0 was 6.08 and on day 10 was 6.27. Anna *et al.*, (2018) studied the pH of stored frozen broiler chicken breast meat up to one month and thawed using atmospheric air, water, and microwave oven and reported a pH value of 5.96, 6.01 and 5.91 respectively. Effect of thawing temperature viz., 2°C , 18°C and 0°C on pH of pre-rigor frozen chicken breast muscles were 5.83, 5.77 and 5.79 respectively. The ultimate pH of 18°C thawed muscle was lower than that of 0°C thawed and 2°C chilled muscles (Yu *et al.*, 2005). The present results pertaining to the breast meat are in accordance with the findings of Saelin *et al.*, (2017), Anna *et al.*, (2018) and Yu *et al.*,

(2005) respectively. Benli, (2016) evaluated the pH value of chicken breast obtained from a retail market and placed in a freezer at -20°C for 72 hours for three days. The chicken breast samples after defrosting using home based thawing practices such as i) thawing in a refrigerator ($+4^{\circ}\text{C}$, 24 hours); ii) thawing on a counter at room temperature (22°C , 6 hours); iii) thawing in warm water (37°C , 40 minutes); iv) thawing in a microwave (180 W, 10 to 13 minutes); and v) thawing under tap water (20°C , 1 hour) had a pH value of 6.10, 6.07, 6.14, 6.20 and 6.18 respectively. The pH value of leg meat of had a significant difference ($P < 0.01$) between control and treatments. Mostly all the thawing methods had a similar trend in the pH value of leg meat but there is a marked difference has been noticed statistically in the tap water and microwave oven thawing methods over the refrigerator thawing. Yu *et al.*, (2005) studied the effect of thawing temperature on pre-rigor frozen chicken leg muscles stored viz., 2°C , 18°C and 0°C had a pH value of 6.15, 6.10 and 6.12 respectively. The pH value of broiler leg meat in the current investigation is at par with reported pH values of Yu *et al.*, (2005).

Water Holding Capacity (WHC)

The major risk to the quality of frozen meat is the reduction of water holding capacity (WHC), which is manifested as loss of exudate upon thawing. The water holding capacity (%) of breast meat samples for the control and treatments were 74.28, 72.09, 70.34 and 70.79 respectively and showed no significant difference among them. The water holding capacity (%) of leg meat samples for the control and treatments were 77.15, 70.20, 66.68 and 71.70 respectively and exhibited a significant difference ($P < 0.01$) among them. Room temperature thawed broiler leg meat has higher amount of WHC than the other methods. Netsai *et al.*, (2015) reported that the WHC of the chicken breast thawed by

water immersion thawing (control) had 63.36 per cent and for the ohmic thawing treatments (at different electrical field strengths from 2.5 to 10 V/cm and NaCl concentrations from 0.00 to 0.14 %w/w), the WHC was in the range of 62.76 to 65.42% respectively and showed no significant difference among them. Ali *et al.*, (2016) found that the broiler breast meat samples kept at -20°C and subjected to zero (fresh) freeze-thawing had around 52 per cent of WHC. The present results pertaining to WHC of broiler breast and leg meat had a higher water holding capacity as compared to the values of Netsai *et al.*, (2015) and Ali *et al.*, (2016). The method of analysis of water holding capacity of meat samples might also be a reason for the variation in the present study. The higher water-holding capacity of roe deer meat samples stored at -26°C for 10 months could be attributed to the fact that they had slightly lower water content (greater thawing drip loss) and a higher content of proteins that could bind water (Tomasz *et al.*, 2018). The present results of WHC of broiler breast and leg meat samples could be related with the opinion of Tomasz *et al.*, (2018).

Water activity (a_w)

The water activity of breast meat samples had a significant difference ($P < 0.05$) between control (0.95) and treatments T1 (0.95), T2 (0.95) and T3 (0.96) respectively. Microwave oven thawing of broiler breast meat has higher water activity than the other methods of thawing. The water activity of leg meat samples had a significant difference ($P < 0.01$) between control (0.94) and treatments T1 (0.95), T2 (0.95) and T3 (0.95) respectively. Oliveira *et al.*, (2015) studied the water activity of frozen (fast freezing to -36°C in 2 hours) chicken half breast samples and stored under freezing temperatures (-18°C). The samples were thawed by using methods like refrigerator, microwave oven, electric oven, immersion in water and room

temperature and the values were 0.991, 0.993, 0.993, 0.993 and 0.992 respectively. Elgadir (2017) reported that broiler chicken breast muscles (Fed with standard mixture) had a_w value of 0.96 and increased to 0.99 at the end of the storage period of one week at 4°C. In the present study, the microwave oven thawing of broiler breast meat has higher water activity than the other methods of

thawing. In case of leg meat, room temperature thawing had little lower water activity as compared to other thawing methods. It is evident that the water activity of broiler breast and leg meat was not affected by thawing methods and the findings are at par with those of Oliveira *et al.*, (2015) and Elgadir (2017).

Table.1 Physico-chemical and microbiological properties of various thawing process on the quality of frozen broiler meat samples

Parameters* (Mean ± SE)	TC (Control) Room Temp	T1 Tap Water	T2 Refrigerator	T3 Microwave
Weight of broiler meat before thawing (g) ^{NS}	1.44±0.03	1.40±0.02	1.45±0.01	1.37±0.03
Weight of broiler meat after thawing (g) ^{NS}	1.42±0.02	1.37±0.02	1.43±0.01	1.36±0.03
Drip loss (%) ^{NS}	1.61±0.386	2.13±0.398	1.00±0.092	1.60±0.129
pH of breast meat (P <0.01)	5.70 ^{ab} ±0.04	6.22 ^a ±0.09	5.99 ^a ±0.12	6.13 ^a ±0.12
pH of leg meat (P <0.01)	6.46 ^a ±0.05	5.99 ^{ab} ±0.16	6.23 ^a ±0.10	5.94 ^{ab} ±0.10
Water holding capacity of breast meat (%) ^{NS}	74.28±1.33	72.09±2.17	70.34±1.40	70.79±0.76
Water holding capacity of leg meat (%) (P <0.01)	77.15 ^a ±0.82	70.20 ^b ±1.35	66.68 ^b ±1.05	71.70 ^b ±0.52
Water activity of breast meat (P < 0.05)	0.95 ^b ±0.004	0.95 ^b ±0.004	0.95 ^b ±0.005	0.96 ^a ±0.004
Water activity of leg meat (P <0.01)	0.94 ^{ab} ±0.004	0.95 ^a ±0.004	0.95 ^a ±0.002	0.95 ^a ±0.002
Firmness of breast meat (P <0.01)	4.31 ^a ±0.208	3.48 ^{ab} ±0.124	4.10 ^a ±0.205	3.28 ^{ab} ±0.186
Firmness of leg meat NS	5.80±0.280	5.86±0.349	5.92±0.312	5.75±0.396
Toughness of breast meat (P < 0.01)	28.72 ^a ±1.416	24.99 ^a ±1.675	26.95 ^a ±1.408	22.81 ^{ab} ±1.402
Toughness of leg meat (P < 0.01)	31.31 ^{ab} ±2.981	35.34 ^a ±1.961	29.63 ^{ab} ±2.680	40.06 ^a ±3.035
TVC of breast meat (log 10 cfu/g) (P <0.01)	2.79 ^a ± 0.04	2.68 ^a ±0.04	2.41 ^b ±0.02	2.28 ^c ±0.02
TVC of leg meat (log 10 cfu/g) (P <0.01)	2.73 ^a ± 0.03	2.65 ^a ±0.03	2.38 ^b ±0.02	2.27 ^c ±0.02
E.coli and Salmonella count of breast and leg meat (log 10 cfu/g)	Not detected			

*n=48

Texture profile analysis

The average firmness of breast meat samples had a significant difference (P < 0.01) between control (4.31) and treatments T1 (3.48), T2 (4.10) and T3 (3.28) respectively. When the groups were compared by the breast meats in terms of firmness, the highest value

was found to be in the group thawed at room temperature while the lowest value was found to be in the group thawed by microwave oven. Even though all the thawing methods appear similar but tap water and microwave oven thawing had lesser firmness as compared to the other methods of thawing. The average firmness of leg meat samples had no

significant difference between control (5.80) and treatments T1 (5.86), T2 (5.92) and T3 (5.75) respectively. It is evident that firmness of leg meat was higher than that of breast meat, might be due to dense myofibrils in the leg meat.

The average toughness of breast meat samples had a significant difference ($P < 0.01$) between control (28.72) and treatments T1 (24.99), T2 (26.95) and T3 (22.81) respectively. When the groups were compared by the breast meats in terms of toughness, the highest value was found in control (room temperature) sample. The lowest value was found in T3 (microwave oven) is significantly different from all other thawing methods. When the toughness of the leg meat is considered, the control and treatment samples are found to be significantly different ($P < 0.01$). Room temperature thawed leg meat was having higher toughness and is similar to refrigeration thawing. Moreover, the microwave oven thawed meat is at par with tap water thawing. Therefore, it could be inferred that the thawing methods affected the physical properties of toughness and firmness of broiler breast and leg meat. Our findings related to texture properties of the breast and leg meat are in closer to the findings of Lin *et al.*, (2014) and Hasan *et al.*, (2018) respectively. Lin *et al.*, (2014) studied the firmness and toughness properties (TA-XT plus, Stable Microsystems) of Taiwan game hen breast and thigh meat samples reared under cage, floor and free-range system and the samples were stored at $-20 \pm 1^\circ\text{C}$ and thawed at $4 \pm 1^\circ\text{C}$ for 12 hours. Taiwan game hen breast meat had firmness of 3.14, 3.42 and 4.64 respectively. Further the firmness of thigh meat had 4.49, 4.22 and 5.99 and the toughness of thigh meat had 22.6, 13.2 and 35.3 respectively. Breast meat had 6.88, 6.99 and 9.08 respectively. Free-range birds had greater firmness and toughness in both breast and thigh meat, which was associated with higher collagen content in both breast and

thigh meat, compared with the other groups. Hasan *et al.*, (2018) analyzed the cooked broiler breast and leg meat samples for firmness and toughness by using TA-XT Plus Texture Analyzer (Stable Micro Systems, England) and found that breast meat had a firmness (kg) of 2.0 and toughness (kg) of 11.09 and subsequently the leg meat had a firmness (kg) of 2.29 and toughness (kg) of 16.56.

Microbiological quality

The total viable count (log 10 cfu/g) of (TVC) of breast meat and leg meat had a significant difference ($P < 0.01$) among the control and treatments. Both the samples had a higher count in the room temperature and tap water thawing, followed by refrigeration thawing and finally microwave oven thawing. The result of the total viable count of breast and leg meat are far below to the prescribed limit by the FSSAI, (2012). Moreover, the *E.coli* and salmonella were absent in these samples.

Based on the findings, it was concluded that the thawing methods such as room temperature, tap water, refrigerator and microwave oven has not much influenced the drip loss, pH value of broiler breast and leg meat samples. The water holding capacity has been slightly increased corresponding with earlier research reports. Further, the water activity of broiler breast was little higher as compared to leg meat in microwave oven thawing than the others methods. The physical properties of toughness and firmness of broiler breast and leg meat has been meagerly influenced with respect to thawing methods. The total viable count of microwave oven thawed meat samples had less count than the other methods and *E. coli* and salmonella species are not seen in the broiler meat samples. These microbiological standards are within the prescribed limits by the FSSAI, (2012).

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