

Research on quality and shelf life of cool meat of some popular chicken breeds in Vietnam

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Abstract

In the world, almost all chicken meat is used in chilled or frozen meat to ensure quality and food hygiene and safety, but in Vietnam, the habit of using hot chicken meat is still quite common (do not lower the carcass temperature after slaughter, in storing, transporting or consuming), leading to a very high risk of food poisoning from this raw material. The study was conducted to evaluate the quality of cool (chilled) chicken meat of 02 common breeds of chicken raised in Vietnam, Indian River Meat (coding C2) and Tam Hoang (coding C3), raised at commercial chicken farms, slaughtered and chilled at the factory of 3F Food Co., Ltd (Binh Duong province). Chicken carcasses were chilled down to 0-4°C immediately after slaughter and then cut and packed for transportation at this temperature. This study has developed 19/75 sensory property terms that strongly influence the overall quality of cool chicken meat. The results of evaluating the quality of cool chicken meat at 1, 3, 5, 7, 10, and 14 days showed that, in the period from day 1 to day 5, the values of pH, TVB-N, and total aerobic microorganisms (TAM) values of chicken breasts and thighs of both C2 and C3 showed very little variation and were within the allowable limits, respectively. The sensory properties were evaluated not to be inferior to that of freshly slaughtered meat surgery. By day 7, there were signs of quality deterioration, pH, TVB-N, and TAM all exceeded the regulations, and the level of bad sensory properties gradually increased. Thus, chicken meat products in this study should be stored for up to 5 days.

Keywords: *Chicken meat, cold storage, quality criteria: pH, TVB-N, microorganisms, sensory.*

1. INTRODUCTION

Chicken meat with high protein content, vitamins, minerals, and essential polyunsaturated fatty acids, especially omega 3 fatty acids, as well as high humidity and pH

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are favorable conditions for the growth of microorganisms, especially toxic pathogenic microorganisms such *Salmonella*, *Campylobacter*, *E.coli*, *Staphylococcus aureus*,... A 2012 study showed that most of the poultry slaughter places (98%) and markets (100%) in the suburban area of Hanoi only achieved the poorest veterinary hygiene standards and regulations. *Salmonella* spp contamination rate in carcasses was 40.6% [1]. Currently, in Vietnam, the slaughter, storage, and consumption of these raw materials are still mainly manual, the chicken meat slaughtered manually in slaughterhouses is stored and transported at room temperature and sold at markets, so the risk of infection with pathogenic microorganisms is very high, seriously affecting consumers health. Besides, there are now a number of large corporations such as CP, Dabaco, 3F Food, ... having an industrial chicken slaughter process, the carcass is cool (chilled) immediately by cold air, ice, or a combination of both, and then the meat is stored, transported, and consumed at 0 - 4°C, the meat has better quality and better food safety, but the shelf life and sensory quality of this cool (chilled) meat have not been specifically evaluated to help consumers better understand and change their habits of using hot fresh meat that does not guarantee food.

2. MATERIALS AND METHODS

2.1. Materials

- White feathered Indian River Meat chicken breed (also known as Delaware breed) originated from the US, raised to 60 days old, slaughter weight 2.9 - 3.1 kg (coded as C2);
- Colored feather Tam Hoang chicken breed originated from China, 90 days old, slaughter weight 2.0 - 2.2 kg (coded as C3).
- Slaughtered chicken meat is cool (chilled) by the method of combining ice and cooled air so that the temperature at the deepest part of the thigh reaches 4°C before taking samples for testing.

2.1.1. Location

Two breeds of industrially raised chickens were purchased from a chicken farm, brought to and slaughtered, cooled, filtered, and sampled at 3F Viet Food Co., Ltd with a slaughter capacity of 24,000 heads/day, An Lap commune, district, Binh Duong province.

- Conduct the quality assessment of chilled chicken meat at the Quality Center for Agro-Forestry-Fisheries Region IV (National Agro-Forestry-Fisheries Quality Assurance Department (NAFIQAD) - Ministry of Agriculture and Rural Development. Sensory Assessment Department in Ho Chi Minh City).

2.1.2. Cool (chilled) chicken sample production process

Raw chickens → Hang and anesthetize chickens with electric → Slaughter → Dipping and plucking → Remove legs and offal → Cool chicken (chilled) → Cutting & sampling

2.1.3. How to take samples

- Cutting, sampling at 2 places: breast and thigh. Cutting is carried out in a room with a temperature $\leq 12^{\circ}\text{C}$. Cutting time is not more than 3 min/head.

- Microbiological, physicochemical samples: 150 grams/sample (meat including skin). Microbiological samples: taking 5 samples/chicken breed/storage mode. Physicochemical samples: taking 3 samples/chicken breed/storage mode. Chicken meat samples are always stored and transported in cold conditions of 0 - 4°C.

- Sensory evaluation sample: cutting rectangular pieces along the meat fiber, meat with skin, fat, about 1.5 cm thick, weight 30 grams/sample for samples used to evaluate raw meat and 40 grams/sample for samples used to evaluate cooked meat.

2.2. Methods

2.2.1. Physicochemical analysis methods

- Determination of pH according to TCVN 4835:2002 (ISO 2917:1999) - Meat and meat products.

- Determination of total volatile base nitrogen (TVB-N) content according to TCVN 9215:2012

2.2.2. Microbiological analysis method

- Determination of *E.coli* according to TCVN 7924 - 2:2008 (ISO 16649-2:2001)

- Determination of *Salmonella* according to TCVN 10780-1:2017 (ISO 6579-1:2017)

- Determination of total aerobic microorganisms according to TCVN 4884-1:2015 (ISO 4833-1:2013)

2.2.3. Sensory analysis method

The sensory criteria and evaluation criteria are consistent with TCVN 12429-3: 2021. The sensory panel of 10 people (6 women, 4 men) was selected with expertise related to food, meat processing, etc., trained and evaluated by sensory experts.

Sensory analysis according to ISO 11035:1994 - Sensory analysis - Identifying and selecting descriptors to build sensory profiles by multi-dimensional approach and principal component analysis PCA (Principal Components Analysis).

Method of evaluating the overall quality score of the samples according to TCVN 3215-79.

2.2.4. Data processing methods

XLSTAT software version 19.02 to analyze and process sensory evaluation data; Minitab software version 20.2. The Turkey standard was used to compare mediums.

3. RESULTS AND DISCUSSION

3.1. Evaluation of the physicochemical indicators of cool chicken meat of 2 chicken breeds during the storage period

3.1.1. pH indicator

Meat samples of 2 chicken breeds C2, C3 were slaughtered and cut to take samples at the breast and thigh positions, stored and maintained at 0 - 4°C, measuring pH at different times of 1, 3, 5, 7, 10, 14 days and the results are shown in Figure 1 and Figure 2.

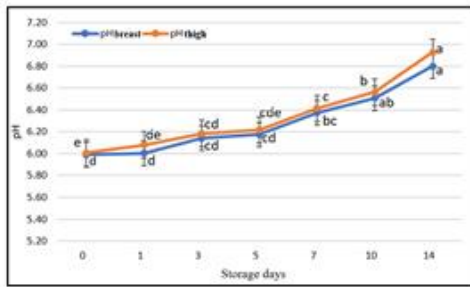


Figure 1. pH of C2 chicken meat over storage time

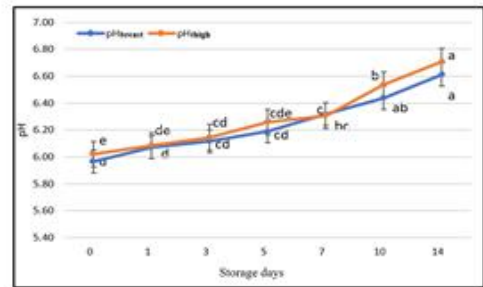


Figure 2. pH of C3 chicken meat over storage time

pH is considered an important indicator for assessing the quality of meat. According to TCVN 7046:2020 [2] and TCVN 12429-3:2021 [3], pH at 5.5 - 6.2 gives good quality meat. Some documents in the world, Ristic.M, 2010 [4] have given the pH value for assessing the quality of chicken meat; freshly slaughtered chicken breast meat with $\text{pH} \leq 5.8$ will have the characteristics of soft, pale, and oozing liquid (PSE meat), $\text{pH} \geq 6.3$ chicken meat is dark, hard (DFD meat) and good quality chicken meat has a pH value between 5.9 - 6.2. Results showed that pH values in both breast meat and thigh meat of the two chicken breeds increased slightly in the first 5 days of storage and were less than 6.25. On the 7th day, the pH increased more in the C2 chicken sample, reaching 6.4, and the C3 sample was 6.3. This shows that meat protein starts spoilage change to produce NH_3 , causing pH to increase and exceed the allowable threshold gradually. After 10 - 14 days, the chicken meat pH increased to 6.93/6.8 with the C2 chicken sample (thigh/breast), pH of the C3 sample was 6.71/6.61, quite similar to Antonia Albrecht's study (2019) [5], at the end of 12 days of storage, chicken meat pH was 6.95.

3.1.2. TVB-N indicator

TVB-N (total volatile nitrogenous base compounds) is considered an indicator of spoilage due to the profound autolysis of meat protein and the growth of specific spoilage microorganisms, especially *Pseudomonas spp.*, *Enterobacteriaceae*, the results of the evaluation of TVB-N content of two chicken breeds C2 and C3 are shown in Figures 3 and 4.

The value of TVB-N gradually increased with storage time and was similar to pH. The value of C2 chicken breeds increased higher than that of C3. The value of TVB-N after 5 days in all 4 samples of the 2 chicken breeds was less than 20 mg/100g. By 7 days of storage, the breast and thigh sample of the C2 chicken breed had increased to 23.4 and 25.47 mg/100g, and the C3 breed was 21.73 and 22.1 mg/100g. And according to the study of Farahnaz G.M et al. (2017) showed that when TVB-N in chicken meat after 7 days reached 23 mg/100g, the sensory value was significantly reduced, corresponding to a decrease in meat quality [6].

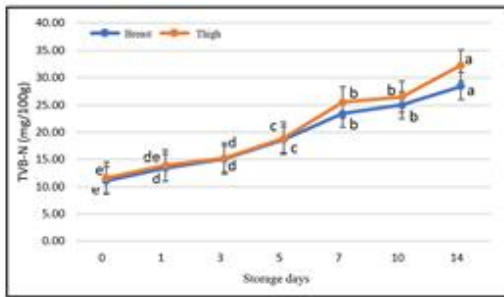


Figure 3. The value of TVB-N of C2 chicken meat over storage time

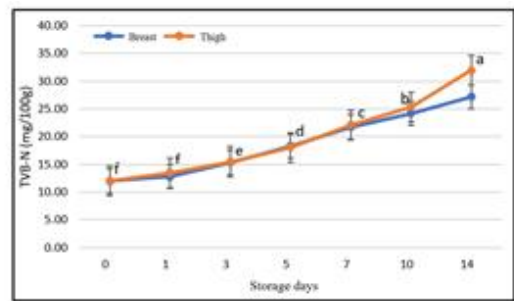


Figure 4. The value of TVB-N of C3 chicken meat over storage time

3.2. Evaluation of microbial indicators of cool meat of 2 chicken breeds over storage time

Along with the assessment of physicochemical indicators, the assessment of microbial content during storage is very important in relation to food quality, safety, and hygiene. Analyzing 03 microbial indicators on days 1, 3, 5, 7, 10, and 14th day of storage. The results showed that in both chicken breeds, the *E.coli*, *Salmonella* contents, all of the analytical milestones were met, showing that current production and hygiene practices are controlling the hazards of these two criteria well. The Total Aerobic Microorganisms (TAM) indicator slightly increased with the storage time. In chicken breed C2 both breast meat and thigh meat, the TAM on the first day was $1,7 \times 10^2 - 2,9 \times 10^3$ CFU/g on day 5 increased to $4,2 \times 10^3 - 1,0 \times 10^5$ CFU/g. Similar to the C3 chicken breed, TAM increased from $2,7 \times 10^2 - 2.4 \times 10^3$ CFU/g on the first day to $5.8 \times 10^2 - 2.6 \times 10^5$ CFU/g on day 5 but still met the requirements of QCVN 8-3:2011/BYT. But by the 7th day, the TAM indicators in both chicken breeds exceeded the limit. This result is quite consistent with the TVB-N and pH values obtained above. After 5 days of storage, TAM increased sharply, leading to an increase in TVB-N and pH values.

3.3. Evaluation of sensory indicator for cool meat of 2 chicken breeds during storage time

3.3.1. The relationship between quality score and sensory indicator

From the list of 75 given terms by the sensory evaluation panel, evaluate the correlation between the overall quality score and the intensity score of the properties through the correlation coefficient R. The terms with the absolute value of $R \geq 0.67$ are considered to be strongly correlated with the overall quality score. Nineteen properties that have a strong influence on the overall quality of the cool chicken meat product are presented in Table 1.

Table 1. Correlation between quality score and intensity of sensory properties

Term	Correlation coefficient R	Term	Correlation coefficient R
Fresh meat		Cooked meat	
Odor_Characteristic of raw chicken	0.860	Characteristic odor of cooked chicken	0.950
Odor_Characteristics of raw chicken skin	0.842	Odor of stewed bone broth	0.938
Odor_Rotten	- 0.943	Odor of boiled eggs	- 0.931
Odor_Boiled eggs	- 0.900	Lactic odor	- 0.676
Odor_Rancid	- 0.861	Rancid odor	- 0.906
Odor_NH ₃	- 0.883	NH ₃ odor	- 0.903
Meat_Elasticity	0.755	Taste_Umami	0.840
Meat_Viscosity	- 0.905		
BW_Brown color	- 0.706	BW_NH ₃ odor	- 0.902
BW_Rancid odor	- 0.816	BW_Taste Umami (Meat taste)	0.682

3.3.2. Evaluation of sensory indicator of cool meat of 02 chicken breeds during storage time

According to TCVN 3215-79, the overall quality level is divided into 6 levels: Bad - Very Poor - Poor - Moderate - Fair - Good corresponding to the quality scale from 0 to 5 points. The study results showed that the assessed meat samples had the highest overall quality score at the storage time of 1 day, 3 days, and 5 days (3.15 to 3.65 points, respectively). Thereafter, the quality score decreased gradually from day 7 to day 10, and on day 14 the quality score decreased significantly across all samples ($P < 0.05$). Evaluation between the two chicken breeds showed that the overall quality score of the C2 breed had a faster decline, and the score was lower than that of the C3 breed, especially at storage days 10 and 14. At that time, thigh meat has faster and more significant loss of quality than breast meat. This decrease is similar to the change in pH, TVB-N, and TAM values.

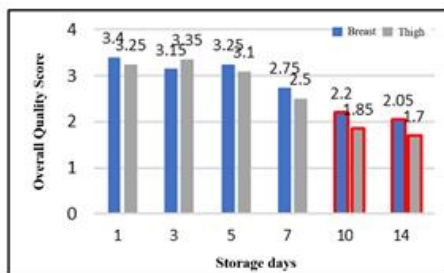


Figure 5. Correlation between quality and Storage time of chicken breed C2

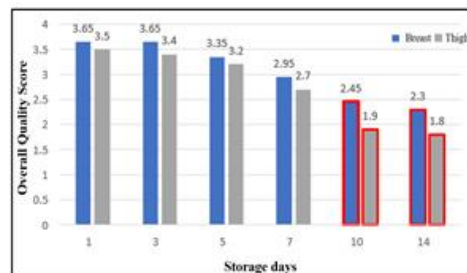


Figure 6. Correlation between quality and Storage time of chicken breed C2

The method of building sensory profiles by multi-dimensional approach and analysis of main components PCA describes the change of sensory characteristics of cool meat samples of C2 and C3 chicken breeds with storage time, the F1 và F2 reached 86,83% for C2 sample and 85.58% for C3 sample, it is quite high (Figure 7).

Products on 1st, 3rd, 5th, 7th days are characterized by good properties such as: High elasticity, characteristic odor of raw chicken meat, cooked chicken and chicken skin, odor of bone broth, sweetness in meat and boiled water, clear boiled water, over time of storage, the scores for these sensory properties have decreased gradually. As for the days 10, 14, the samples of both C2 and C3 chicken breeds are characterized by properties such as ammonia odor, rancid odor, boiled egg odor, etc.

This descriptive result is completely similar to the study of Wendy Katiyo [4] when performing sensory properties according to PCA, whereby on day 10 and day 14 all sensory panel members detected high-quality grease on the surface of meat and TAM at these 2 times also exceeded the allowable level, by more than 7 cfu/g, the odor intensity appeared and gradually increased. The intensity of positive odors (odor of fresh chicken) decreased with storage time, and negative odors (odor of rotten eggs, ammonia, etc.) increased.

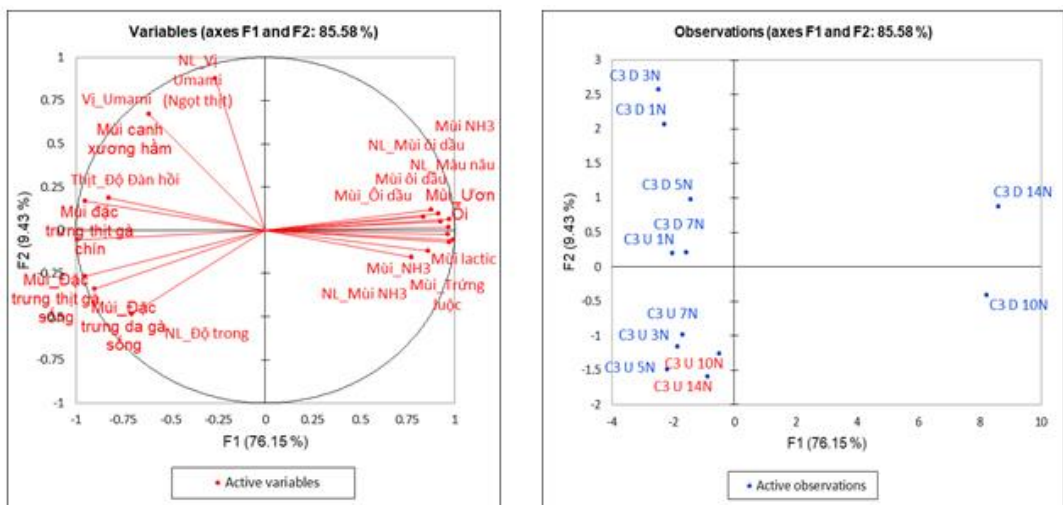


Figure 7. Description of sensory characteristics of C3 chicken breed during storage (F: is the number of times the term is mentioned out of the total number of times the term can be mentioned, expressed as a %)

3.4. Propose the shelf life for cool chicken meat of 2 chicken breeds

The research results shown that up to 7 days of storage, the overall sensory quality scores of breast and thigh meat samples in both chicken breeds decreased, along with that, the values of pH, TVB-N and TAM have exceeded Vietnamese regulations as well as international regulations for reference. At 6 days, the above values shown on the graphs by extrapolation all tend to increase and begin to exceed the allowable threshold (pH > 6.3, etc), combined with further sensory evaluation, showed that the color and odor characteristics of chicken meat has begun to decrease. Therefore, to be sure to fully meet the requirements of

food safety and hygiene and sensory evaluation, the cool meat of the 2 chicken breeds in this study should have a shelf life of 5 days.

4. CONCLUSION

Research to evaluate the quality of cool meat during storage time of 02 popular chicken breeds in Vietnam, Indian River Meat (C2) and Tam Hoang (C3), has obtained valuable results: (1) During the period from 1 day to 5 days, the pH value and TVB-N content were relatively stable, only slightly increased and still within the allowable limits as prescribed in TCVN 7046:2020 and TCVN 12429-3:2021, then started to have a strong increase beyond allow; (2) During storage, the quantity of *E.coli* and *Salomonella* have met the regulations, the Total Aerobic Microorganisms indicator in the first 5 days was in accordance with the regulations ($< 5 \times 10^5$ CFU/g) but then increased sharply, from the 7th day of storage, all two types of samples of the 2 breeds have not met the regulations; (3) Sensory evaluation results showed 19 characteristic sensory properties and the corresponding quality score for each type of breast and thigh meat of each breed according to the storage time. By the 5th day, the quality score is quite high (3,1-3,25 (C2) and 3,2-3,35 (C3) respectively when analyzing PCA are good sensory properties such as high elasticity, characteristic taste, etc. From the 7th day, the quality score showed signs of decreasing quite clearly. On the 10th and 14th day, all samples were characterized by negative sensory properties such as ammonia odor, and rotten egg odor... From the above evaluation, it is found that the shelf life of 5 days is suitable for both chicken breeds in the study to ensure food hygiene and safety, and sensory quality.

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Nghiên cứu đánh giá chất lượng và thời hạn sử dụng thịt mát của một số giống gà phổ biến ở Việt Nam

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Tóm tắt

Trên thế giới gần như thịt gà được sử dụng đều ở dạng thịt lạnh (mát) hoặc cấp đông để đảm bảo chất lượng và vệ sinh an toàn thực phẩm (VSATTP), tuy nhiên ở Việt Nam thói quen sử dụng thịt gà nóng (không hạ thấp nhiệt độ thân thịt sau giết mổ, khi bảo quản, vận chuyển hay tiêu thụ) còn khá phổ biến dẫn đến nguy cơ ngộ độc thực phẩm rất cao từ nguồn nguyên liệu này. Nghiên cứu này được thực hiện nhằm đánh giá chất lượng thịt gà mát của 02 giống gà được chăn nuôi phổ biến ở Việt Nam là Indian River Meat và Tam Hoàng được nuôi tại trại gà thương phẩm, được giết mổ, làm lạnh tại nhà máy sản xuất của Công ty TNHH Thực phẩm 3F (Bình Dương). Thân thịt gà được làm lạnh xuống 0 - 4°C ngay sau khi giết mổ và sau đó được pha lọc, bao gói vận chuyển luôn đảm bảo ở nhiệt độ này. Nghiên cứu này đã xây dựng 19/75 thuật ngữ tính chất có ảnh hưởng chặt chẽ đến chất lượng tổng thể của sản phẩm. Kết quả đánh giá chất lượng thịt gà mát ở 1, 3, 5, 7, 10 và 14 ngày cho thấy, trong giai đoạn từ ngày 1 đến ngày 5 các giá trị pH, TVB-N và tổng số vi sinh vật hiếu khí (TSVSVHK) của thịt ức và đùi của cả 2 giống gà C2 và C3 đều có sự biến động rất ít và nằm trong các giới hạn cho phép, tương ứng là các tính chất cảm quan được đánh giá không thua kém với thịt mới giết mổ. Đến ngày thứ 7 có dấu hiệu của việc suy giảm chất lượng, các chỉ tiêu pH, TVB-N và TSVSVHK đều vượt quá các quy định và mức độ các tính chất cảm quan không tốt tăng dần, do vậy với các sản phẩm thịt gà trong nghiên cứu này nên được bảo quản trong thời hạn tối đa 5 ngày.

Từ khóa: Thịt gà, giống gà, bảo quản lạnh, chỉ tiêu chất lượng: pH, TVB-N, vi sinh vật, cảm quan.