SHORT COMMUNICATION

Influence of Post-Mortem Ageing Prior to Processing on the Carcass Quality of Japanese Quail

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Abstract

An investigation was carried out to assess the impacts of different ageing periods on various quality attributes of Japanese quail meat. Six-week old 72 birds (36 males and 36 females) were slaughtered after starving for 4 h. Following the dressing operations, the whole carcasses were subjected to the ageing process at 3±1°C for 2½ h. During the ageing process, continuous measurements of pH, water-holding capacity (WHC), shear-force value (SFV) and sensory evaluation of the breast muscles from the carcasses was done at an interval of 30 min. The ultimate pH value of 5.5 – 5.7 was reached in the meat samples within the first h of ageing process. The water-holding capacity (WHC) started to decrease and obtained a minimum percent by the end of first h. Subsequently, the WHC was enhanced at the ageing period of 2½ h. The shear force values were high at 1 h of ageing and were low at 2½ h. The scores of the sensory evaluation revealed that the meat samples that were aged for 2 and 2½ h were superior in terms of flavour, juiciness, tenderness and overall acceptability, when compared to the lesser time aged and unaged meat samples. From the above results, it can be concluded that a minimum ageing period of 2 to 2 ½ h is appropriate to bring about the desirable quality attributes in the Japanese quail meat.

Key words: Ageing, Japanese quail, Shear force,Tenderness and WHC.

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Introduction

The most critical and important quality factor associated with the ultimate satisfaction of the consumers regarding any meat is probably the texture and more specifically the tenderness. It is mainly affected by the maturity of the connective tissues (depends upon the age of the bird) and by the contractile state of myofibrillar proteins (influenced by the stage of rigor mortis). Since, the birds are processed at the market age of 5-6 weeks; the issue regarding the age-related connective tissue toughness has been virtually eliminated. However, if the carcasses were frozen or processed prior to the completion of rigor mortis, the muscle fibres would contract due to the formation of acto-myosin bonds in huge numbers and would shorten the muscles, resulting in a tougher meat (Fletcher, 2002). In addition, subsequent deep-freezing of the carcasses before the completion of rigor mortis, will eventually increases the risk of cold shortening, thereby promoting the adverse effects on meat quality. Therefore, in order to avoid these quality defects, two approaches have been developed *ie* elctrical acceleration of carcass processing and ageing the process , especially before the freezing operations of the carcasses (Thielke *et al*., 2005). Even though, ageing before processing or freezing is considered as the best way to assure sufficient flavour, tenderness and juiciness in the meat, there are no scientific evidences for the minimum ageing period required to produce such adequate quality attributes in Japanese quail meat. Therefore, by considering the valuable advantages of ageing, the present study was envisaged to assess the impacts of different ageing periods on the textural, physico-chemical and sensory attributes of the Japanese quail meat.

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Materials and Methods

Six-week old 72 birds (36 males and 36 females with the average live body weight of 210 and 195 gm respectively were purchased from the Poultry Farm Complex, Department of Poultry Science, Veterinary College and Research Institute, Namakkal, India. The slaughter and dressing of the birds were carried out at the Department of Livestock Products Technology (Meat Science), Namakkal. The 72 birds were divided into six groups with 12 birds in each (6 male and 6 female). Ageing was done every half an hour.

Experimental Procedure

The fresh carcasses obtained immediately after slaughter without ageing process were kept as the control. Breast muscles of six male and six female carcasses were analysed immediately after slaughter for its pH, water-holding capacity (WHC), shear force value and sensory qualities. The remaining 60 fresh carcasses were subjected to the ageing process at a temperature of 3±1°C. Thereafter, these male and female carcasses were analysed for the above said parameters every half an hour until 2½ h.

Physicochemical Analysis of Meat

pH

Five grams of meat sample was homogenized with 45 mL of distilled water for one minute. The pH of the meat was recorded by immersing combined glass electrode and temperature probe of the digital pH meter (Model 361, Systronics, India) directly into meat suspension.

Water Holding Capacity (WHC %)

The WHC measures the ability of muscle proteins to retain its whole or excess water under the influence of externally applied physical force. The WHC of the breast muscles were determined by following the method of Joo (2018) with slight modifications. Around 300 mg of meat sample was placed on a filter paper arranged between two glass slides. On the top of the upper glass slide, a 100 g weight was placed and allowed to stay for 3 min. The released water from the meat sample would be absorbed in the filter paper would leave an impression. With the sharp pencil, the boundary of the impression was clearly demarcated. The area of the two resulted impression present as each half of the filter paper on the account of oozing of fluid by the application of external force (outer circle) and the area of the meat (inner circle) were measured by using graph and the percentage was calculated using the formula given below.

$$\text{WHC (\%)} = \frac{\text{Area of inner circle (area of meat)}}{\text{Area of outer circle (impression by oozing of fluid from meat)}} \times 100$$

Shear Force Value (SFV) of Meat

The shear force values (SFV) of breast muscles were characterized using the Instron Texture Analyser (Model: TA.XT Plus, Stable Microsystems) and Texture Expert Software (Sabikun *et al*., 2019). A Warner-Bratzler meat shearer attached to a blade holder, a slotted blade insert and a heavy-duty platform were used to measure the SFV of the meat samples. Six measurements for each sample were recorded. Once the trigger force is attained, the blade proceeds to shear through the sample. The maximum force denotes the point at which the sample completely fills the triangular cavity of the blade and cuts through the sample surface. After this point, shearing continues throughout the whole sample until the blade has passed through the base plate slot. The blade then returns to its starting position. The results indicate that Chorizos required the largest force and total energy to shear. All determinations were carried out at 15°C.

Sensory Evaluation

The organoleptic properties of breast meat samples were evaluated after being thoroughly cooked by subjecting to sensory analysis for colour, flavour, juiciness, tenderness and overall acceptability by a semi-trained panel using a 9-point Hedonic scale. About 20 g of breast fillet was cooked in a closed container in a pressure cooker in gas stove. After the first whistle of pressure cooker is blown, the flame was kept in sim mode for about 25 min. The cooked meat samples were cut into small cubes of approximately 1.5 cm size and served along with the score-card for sensory evaluation.

Statistical Analysis

The data obtained in this study were statistically analysed by using the approved statistical methods of SPSS Statistics software package (version 28.0.1.1).

Results and Discussion

Physicochemical Analysis of Meat

The results pertaining to the physicochemical characteristics of Japanese quail breast fillets during different ageing periods are presented in Table 1.

pH

Statistical analysis revealed a significant ($p < 0.05$) decrease in pH values after 1st h of ageing followed by a slight increase in the pH values in both male and female carcasses. The decline in pH ceases upon the onset of rigor mortis, following the depletion of glycogen reserves, thereby reaching the ultimate pH. The post-mortem pH decline is an indication of the biochemical status of the muscle and the rate of intramuscular glycolysis leading to accumulation of lactic acid (Thielke *et al*., 2005). The increasing proteolytic activity with postmortem ageing leads to protein denaturation resulting in release of hydrogen ions, thereby resulting in reduced pH (Ali *et al*. 2015; Kim *et al*. 2016). Further, after attaining the ultimate pH values, there was a slight rise in the pH with the advancement of ageing period reaching the final pH values of 5.71 ± 0.02 and 5.74 ± 0.02 at 2½ h of ageing respectively in male and female breast fillets. It has been hypothesized that such a rise in pH may be a result of intensive post-mortem proteolysis (Thielke *et al*., 2005).

Water-Holding Capacity (WHC %)

Statistical analysis revealed a significant ($p < 0.05$) decrease of WHC during the 1st h of ageing followed by a significant

($p < 0.05$) increase, attaining the maximum WHC at 2½ h ageing period in both male and female carcasses. This might be due to the fact that during the conversion of muscle to meat, the post-mortem glycolysis proceeds and the lactic acid builds up in the tissues leading to the ultimate meat pH of 5.5 – 5.7. Coincidentally, this pH is the isoelectric pH of principal meat proteins and so there is a loss of WHC as a consequence of death. In addition, ATP loss and formation of actomyosin can cause loss of WHC, because WHC of actomyosin is less than that of myosin and actin. The reduction in WHC can also be very well explained by two theories *viz.,* Net charge effect and steric effect (space/spatial effect). In the present study, after reaching the minimum values, the WHC started to increase sharply with the increase in ageing period achieving the maximum WHC at the ageing period of 2½ h. This rise in percentage WHC in the post-rigor stage can be attributed to the increase in the pH values because of intensive post-mortem proteolysis, which in turn causes the final pH to deviate from the isoelectric pH of the myofibrillar proteins. This is in agreement with the results of Kristensen and Purslow (2001), who reported that the WHC of pork was decreased initially, which then started to increase during the cold storage at 2°C for 24 h.

Shear Force Value (SFV) of Meat (kg/cm^2)

Shear force value is defined as the amount of force required to cut a meat chunk of one sq. cm. size and it is expressed as kg/cm^2. In this study, SFV of Japanese quail meat were measured as affected by the rigor state, and the results obtained are presented in Table 2. Statistical analysis revealed a significant ($p < 0.05$) increase of SFV during the 1st h of ageing followed by a significant ($p < 0.05$) decrease in the SFV after 1 h of ageing in both male and female carcasses. The reason behind the increased SFV during the 1st h of ageing can be explained by the fact that during the development of rigor mortis, the formation of stable cross-bridges between actin and myosin filaments causes a marked increase in muscle toughness. This is supported by the results of Sabikun *et al.* (2019), who reported that pre-rigor leg muscles of chicken showed a significantly higher WBSF value than the post-rigor leg muscles. Later, the SFV started to decrease sharply with the advancement of ageing period acquiring the minimum SFV at 2½ h ageing period. This fall in SFV during the post-rigor stage might indicate the effect of post-rigor tenderization by endogenic proteolytic enzymes mainly calpains and cathepsins (Schreurs, 2000).

Sensory Evaluation of Meat

The samples of cooked breast fillets were subjected to sensory evaluation and the results are presented in Table 3. The carcasses that were aged for 2 and 2½ h were superior in terms of organoleptic qualities especially the flavour of the meat. The flavour enhancement in meat during post-mortem ageing might be due to the production of inosinic acid and hypoxanthine from mononucleotides (especially AMP and IMP), which is a breakdown product of ATP. This is supported by Takahashi (1996), who reported that in addition to improvement in tenderness as ageing time advances there is also a corresponding improvement in flavour.

Conclusion

The results of the study revealed that the samples of Japanese quail breast fillets that were aged for 2 and 2½ h presented the higher level of tenderness, flavour, WHC and in turn juiciness, when compared to the lesser time aged and unaged meat samples. The minimum ideal period for ageing Japanese quail carcass can be set to 2-2½ h.

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Table 1. Physicochemical charactersistics of Japanese quail breast fillets during different periods of ageing (Mean ± SE)

Parameters / Treatments	pH		Water Holding Capacity (%)	
	Male	Female	Male	Female
Control (0 h)	6.32^{a} ± 0.02	6.47^{a} ± 0.01	54.39^{ab} ± 1.85	56.52^{ab} ± 1.85
T_1 (½ h)	6.08^{b} ± 0.03	6.14^{b} ± 0.02	49.34^{b} ± 1.05	52.31^{b} ± 1.73
T_2 (1 h)	5.51^{e} ± 0.02	5.53^{e} ± 0.02	41.43^{c} ± 1.76	44.82^{c} ± 1.62
T_3 (1½ h)	5.55^{de} ± 0.02	5.58^{de} ± 0.01	45.10^{bc} ± 1.73	47.67^{bc} ± 1.98
T_4 (2 h)	5.61^{d} ± 0.02	5.65^{d} ± 0.02	52.58^{ab} ± 1.43	53.02^{b} ± 1.81
T_5 (2½ h)	5.71^{c} ± 0.01	5.74^{c} ± 0.02	57.80^{a} ± 1.73	60.71^{a} ± 1.62

Means bearing different superscript within a column differ significantly ($p < 0.05$)

Table 2. Shear force value (kg/cm^2) of Japanese quail meat during different ageing periods (Mean ± SE)

Parameters	Male	Female
Control (0 h)	$2.71^{b} \pm 0.14$	$3.05^{c} \pm 0.19$
T_1 (½ h)	$3.41^{b} \pm 0.19$	$3.72^{b} \pm 0.16$
T_2 (1 h)	$5.10^{a} \pm 0.16$	$5.56^{a} \pm 0.18$
T_3 (1½ h)	$3.32^{b} \pm 0.18$	$3.79^{b} \pm 0.17$
T_4 (2 h)	$2.62^{b} \pm 0.16$	$2.99^{c} \pm 0.12$
T_5 (2½ h)	$1.89^{c} \pm 0.17$	$2.05^{d} \pm 0.18$

Means bearing different superscripts within a column differ significantly ($p < 0.05$)

Table 3. Sensory evaluation of cooked Japanese quail breast fillets during different periods of ageing (Mean ± SE)

Parameters	Control (0 h)	T_1 (½ h)	T_2 (1 h)	T_3 (1½ h)	T_4 (2 h)	T_5 (2½ h)
Colour:						
Male	8.67±0.11	8.42±0.15	8.25±0.11	8.33±0.17	8.50±0.18	8.75±0.17
Female	8.58±0.08	8.50±0.18	8.33±0.17	8.42±0.20	8.58±0.15	8.67±0.17
Flavour:						
Male	$8.17^{b}\pm0.11$	$7.75^{bc}\pm0.11$	$7.25^{c}\pm0.17$	$8.42^{ab}\pm0.15$	$8.58^{ab}\pm0.15$	$8.75^{a}\pm0.17$
Female	$8.25^{b}\pm0.11$	$7.83^{bc}\pm0.11$	$7.42^{c}\pm0.20$	$8.50^{ab}\pm0.13$	$8.67^{ab}\pm0.11$	$8.83^{a}\pm0.11$
Tenderness:						
Male	$8.08^{b}\pm0.08$	$7.42^{c}\pm0.20$	$6.58^{d}\pm0.15$	$8.42^{ab}\pm0.08$	$8.58^{ab}\pm0.15$	$8.75^{a}\pm0.11$
Female	$7.83^{b}\pm0.11$	$7.17^{c}\pm0.17$	$6.58^{d}\pm0.08$	$8.25^{ab}\pm0.11$	$8.42^{a}\pm0.08$	$8.67^{a}\pm0.11$
Juiciness:						
Male	$8.08^{b}\pm0.08$	$7.42^{c}\pm0.15$	$6.83^{d}\pm0.15$	$8.42^{ab}\pm0.08$	$8.50^{ab}\pm0.13$	$8.83^{a}\pm0.11$
Female	$7.83^{b}\pm0.11$	$7.33^{c}\pm0.17$	$6.75^{d}\pm0.08$	$8.33^{a}\pm0.11$	$8.42^{a}\pm0.15$	$8.75^{a}\pm0.11$
Overall acceptability:						
Male	$8.21^{b}\pm0.10$	$7.79^{b}\pm0.14$	$7.22^{c}\pm0.10$	$8.45^{ab}\pm0.10$	$8.63^{ab}\pm0.09$	$8.78^{a}\pm0.12$
Female	$8.17^{b}\pm0.11$	$7.75^{bc}\pm0.11$	$7.33^{c}\pm0.17$	$8.42^{ab}\pm0.08$	$8.58^{ab}\pm0.08$	$8.75^{a}\pm0.11$

Means bearing different superscripts within a row differ significantly ($p < 0.05$)

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