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Effect of different tenderizers with vacuum tumbling on quality of spent Japanese quail

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Abstract

A study was conducted to standardize the method for quality improvement of spent Japanese quail carcasses with ginger extract (5.0%), papain (0.05%) and sodium bi carbonate (2.5%) in conjunction with vacuum tumbling (1.5 hr). The treated samples were evaluated for various physico-chemical and organoleptic characteristics along with 1.5 hr vacuum tumbling and control samples. pH, water holding capacity, cooking loss, collagen content and collagen solubility values were significantly ($P < 0.05$) increased and fragmentation values were significantly ($P < 0.05$) decreased in samples treated with tenderizers with 1.5 hr vacuum tumbling as compared 1.5 hr vacuum tumbling and control samples. The results of sensory attributes of this experiment showed that all the sensory attributes scores were significantly ($P < 0.05$) higher for samples treated with 5.0% ginger extract with 1.5 hr vacuum tumbling, except tenderness. The overall acceptability significantly ($P < 0.05$) higher for samples treated with 5.0% ginger extract with 1.5 hr vacuum tumbling followed by 2.5% sodium bi carbonate with 1.5 hr vacuum tumbling and 0.05% papain with 1.5 hr vacuum tumbling samples. Therefore, 5.0% ginger extract with 1.5 hr vacuum tumbling was more effective for quality improvement of spent Japanese quail carcasses in a shorter marination period.

Keywords: Japanese quail, spent, carcass, vacuum, tumbling, tenderizers, quality

1. Introduction

Japanese quail (*Coturnix coturnix japonica*) is one of the smallest avian species reared for meat and egg production. Broiler quails are slaughtered at about six weeks of age (Shanaway, 1994) [21]. The old breeding birds are also slaughtered and sold on the commercial market without any distinction being made on age. This has led to decreased acceptability among consumers, since the meat derived from the spent Japanese quail is poor in functional properties, darker in colour and apparently tougher upon consumption after cooking (Boni *et al.*, 2010) [4]. The meat from spent Japanese quail's offers good scope for processing in to products, subject to successfully overcoming toughness and improvement of eating quality from spent Japanese quail meat. Tenderness is the major factor affecting consumer satisfaction and eating quality. In order to improve tenderness, different mechanical, chemical and enzymatic methods are adopted to tenderize tough cuts of meat (Mendiratta *et al.* 2004; Bhat, *et al.*, 2018) [16, 3]. Tenderization of meat has been carried out by addition of tenderizers in to meat and holding for extended periods of time by static marination. In an effort to provide expedited the tenderization process various mechanical methods were tried in conjunction with tenderizers. These include blade tenderization, tumbling, electrical stimulation, hydrodynamic pressure, high pressure treatment (Bhat, *et al.*, 2018) [3]. Marination of muscle food could also be performed by vacuum tumbling in tumbler. The tumbler, which consisted of a drum with baffles inside, allowed for the impact of products against themselves, resulting in a relatively uniformly marinated product in a reduced time (Gasbarro, 1975) [9]. The marination coupled with tumbling under vacuum is a unique means of tenderization and improvement of quality by loosening the muscle structures, disrupting muscle cells and destroying the connection between the myofibers and the connective tissue (Popat *et al.*, 2018) [19]. In this perspective, a study was conducted for tenderness and quality improvement of spent Japanese quail carcasses by using of papain, ginger extract and sodium bi carbonate in conjunction with vacuum tumbling.

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2. Materials and Methods

2.1. Spent Japanese quail carcasses

Spent Japanese quails were procured from Instructional Livestock Farm Complex and were slaughtered according to the standard slaughter and dressing protocol. The dressed spent Japanese quail carcasses were stored at $4 \pm 2^\circ\text{C}$ until use. The time lag between slaughter of spent Japanese quail and commencement of experiment was about 2 hr.

2.2. Ginger extract

Fresh ginger was purchased from local market. The ginger was peeled, sliced, ground in a mortar with pestle and squeezed through two layer of cheese cloth to produce a crude ginger extract. The yield of crude extract was approximately 50% of the peeled ginger. For 5.0% ginger extract treatment, 5 ml of ginger extract was dissolved in 5 ml distilled water and the mixture was sprayed on 100 gm of carcass.

2.3. Papain

Readily available papain enzyme powder procured from a standard firm (HiMedia, Mumbai) was used in this study. For 0.05% papain treatment, 0.05 gm of papain powder was dissolved in 10 ml distilled water and the mixture was sprayed on each 100 gm of carcass.

2.4. Sodium bicarbonate (SB)

Sodium bi carbonate used was of analytical grade and was procured from standard firm. For 2.0% sodium bi carbonate treatment, 2.0 gm of sodium bi carbonate was dissolved in 10 ml distilled water and the mixture was sprayed on every 100 gm of carcass.

2.5. Treatment method

The dressed whole quail carcass tenderized with vacuum tumbling 1.5 hr (treatment I), ginger extract 5.0% + 1.5 hr vacuum tumbling (treatment II), 0.05 % papain + 1.5 hr vacuum tumbling (treatment II), sodium bi carbonate 2.5% + 1.5 hr vacuum tumbling (treatment III) and control (without tenderizer and vacuum tumbling). The required concentration of ginger extract, papain and sodium bi carbonate were dissolved with distilled water (10 ml) and sprayed on 100 gm of spent quail carcass. For control and vacuum tumbling, only 10 ml of distilled water (without tenderizer) was used. After through mixing by hand, the whole quail carcasses were packed in polyethylene bag and vacuum tumbled for 1.5 hrs. After vacuum tumbling, the samples were analyzed for various physico-chemical parameters and sensory attributes.

2.6. Physico-chemical analysis

2.6.1. pH

The pH of the samples was determined by homogenizing 10 gm of sample with 50 ml distilled water with the help tissue homogenizer for 1 minute. The pH of the suspension was recorded by immersing the combined glass electrode of digital pH meter.

2.6.2. Water holding capacity

Water holding capacity of the sample was measured as per the procedure reported by Wardlaw *et al.* (1973) [28]. 20 gm of minced meat was placed in centrifuge tube. 30 ml of 0.6M NaCl was added to the tube and the mixture was stirred for 1 min with a glass rod. The tube was then kept in refrigerator temperature ($4 \pm 1^\circ\text{C}$) for 15 min., stirred for 1 min and then centrifuged at 5000 rpm for 15 min. The supernatant was

measured and water holding capacity (as ml of 0.6M NaCl retained by 100 gm of meat) was expressed in percentage.

2.6.3. Cooking loss

The method was based on the emulsion stability test reported by Baliga and Madaiah (1971) [1] with slight modifications. 20 gm small pieces of samples were rolled into balls and placed in polyethylene bags. The samples were cooked at 80°C in a thermostatically controlled water bath for 20 min. After draining out of the exudate, the cooked mass was cooled and weighed again. The cooking loss was calculated as percentage weight loss.

2.6.4. Fragmentation index

Fragmentation index values were determined by the procedure outlined by Davis *et al.* (1980) [8]. 10 gm of 7 mm cubes of cooked frozen BRM were added to 50 ml of cold sucrose (0.24 M) and potassium chloride (0.02 M) solution in a 100 ml centrifuge tube. After 5 min, sample was blended for one min at full speed in tissue homogenizer. The resulting homogenate was filtered through a preweighted muslin cloth. The residue and muslin cloth were blotted twice on Whatman No. 1 filter paper and the residue was allowed to air dry at 50°C for 5 h. The fragmentation index was reported as weight in gm x 100.

2.6.5. Collagen content and collagen solubility

Collagen content and collagen solubility were determined by the method described by Mahendrakar *et al.* (1989) [15] with some modifications.

2.7. Sensory evaluation

The control and treated whole quail carcass samples were enrobed with batter consisting of curd (53%), common salt (11%), condiments mix – onion + garlic 3:1 (22%) and spice mix (11%) @ 18% w/w. Smooth and even coating of batter was ensured. After 4 hours holding, the whole quail carcasses were deep fried in heated vegetable oil for 10 min till golden brown colour appeared. Experienced sensory panel members evaluated the products for appearance, flavour, juiciness, tenderness and over all palatability on a 9 - point descriptive scale.

2.8. Statistical analysis

The experiment was repeated four times. The data generated from each experiment were analyzed statistically by following standard procedures (Snedecor and Cochran, 1989) [22] for Analysis of Variance (ANOVA) comparing the means and to determine the effect of treatment by using SPSS-16 (SPSS Inc., Chicago, IL., USA). The level of significant effects, least significant differences were calculated at appropriate level of significance ($P < 0.05$).

3. Results and Discussion

3.1. Physico-chemical characteristics

Results of effect of different tenderizers with vacuum tumbling on physico - chemical characteristics of spent Japanese quail carcasses are presented in Table 1. The pH value of 2.5% sodium bi carbonate with 1.5 hr vacuum tumbling sample was significantly ($P < 0.05$) higher as compared to 5.0% ginger extract with 1.5 hr vacuum tumbling, 0.05% papain with 1.5 hr vacuum tumbling, vacuum tumbling and control samples. However, pH value between 5.0% ginger extract with 1.5 hr vacuum tumbling, 0.05% papain with 1.5 hr vacuum tumbling, 1.5 hr vacuum

tumbling and control did not differ significantly between them. Higher pH values of sodium bi carbonate treated products might be due to alkaline nature of sodium bi carbonate (Mendiratta *et al.* 2004) [16]. The present findings of our experiment were in conformity with the results of Sheard and Tali (2004) [23] and Sen *et al.* (2003) [20] they reported that sodium bi carbonate treatment increased the pH of cooked pork loin and sodium bi carbonate increased the pH up to 7.79 in broiler meat, respectively. There was a significant ($P<0.05$) increase in water holding capacity values observed for all treated samples as compared to control and vacuum tumbling samples. However, water holding capacity values for 5.0% ginger extract with 1.5 hr vacuum tumbling and 0.05% papain with 1.5 hr vacuum tumbling samples did not differ significantly between them but differ significantly ($P<0.05$) from 2.5% sodium bi carbonate with 1.5 hr vacuum tumbling sample. Increased water holding capacity of ginger extract, papain and sodium bi carbonate treated samples might be due effect of vacuum tumbling and higher pH of treated samples. Mendiratta *et al.* (2004) [16] also reported increased water holding capacity of papain and sodium bi carbonate treated samples as compared to control might be due to higher pH. Increased pH improved the water holding capacity of meat as reported for rabbit meat by Miles and Lawrie (1970) [17]. Studies on beef by Bouton *et al.* (1973) [5] reported a linear increase in water holding capacity with increasing pH. Tyszkiewicz *et al.* (1977) [27] studied the effect of mechanical tenderization of pork meat on tissue damage and protein availability. They concluded that the main factor causing the elevation of water holding capacity of meat was mechanical disruption of the contractile structure integrity. Thus, it may be concluded that vacuum tumbling contributed to higher water holding capacity by increase in pH and mechanical disruption of muscle fibres.

Significantly ($P<0.05$) increased cooking loss was observed in sample treated with 0.05% papain with 1.5 hr vacuum tumbling sample followed by 5.0% ginger extract with 1.5 hr vacuum tumbling and 2.5% sodium bi carbonate with 1.5 hr vacuum tumbling samples. All treatments differed significantly ($P<0.05$) between them and from control and 1.5 hr vacuum tumbling samples. Decrease in cooking loss of spent hen meat treated with papain and sodium bi carbonate was reported by Mendiratta *et al.* (2004) [16]. Tenderization of meat with papain results in extensive degradation of meat structure leading to unfavourable mushy texture due to over tenderization (Cronlund and Woychik, 1987) [7] which resulting in increased cooking losses in papain treated sample as compared to other treated samples. Pawar *et al.* (2003) [18] also reported that papain treatment increased cooking loss.

The reports of the present study were also in conformity with the above findings.

Significantly ($P<0.05$) lower fragmentation index value was observed for 0.05% papain with 1.5 hr vacuum tumbling followed by 5.0% ginger extract with 1.5 hr vacuum tumbling and 2.5% sodium bi carbonate with 1.5 hr vacuum tumbling samples. However, the fragmentation index values between control and vacuum tumbling sample did not differed significantly between them but differed significantly ($P<0.05$) from all treated samples. The decreased fragmentation values of treated samples might be due to synergistic effect of tenderizers and vacuum tumbling. Cronlund and Woychik (1987) [7] reported that papain treatment could result in extensive degradation of meat structure leading to undesirable mushy texture. This might result in significantly decreased fragmentation values of papain treated samples as compared to other treated samples.

The mean collagen content values were significantly ($P<0.05$) higher for 0.05% papain with 1.5 hr vacuum tumbling samples followed by 5.0% ginger extract with 1.5 hr vacuum tumbling and 2.5% sodium bi carbonate with 1.5 hr vacuum tumbling samples. Collagen content of all treated samples differed significantly ($P<0.05$) between them. Significantly ($P<0.05$) higher collagen content in papain treated samples might be due to effect of papain on proteolysis of collagen (Bawa *et al.* 1981) [2]. The mean collagen solubility values differed significantly between 5.0% ginger extract with 1.5 hr vacuum tumbling, 0.05% papain with 1.5 hr vacuum tumbling and 2.5% sodium bi carbonate with 1.5 hr vacuum tumbling samples. However, the collagen solubility values of control and 1.5 hr vacuum tumbling samples did not differ significantly between them but differed significantly from other treatments. Collagen solubility values of ginger extract treated samples in our experiment were in agreement with Thompson *et al.* (1973) [26] who reported significant increase in collagen solubility of ovine muscle with ginger extract. Takagi *et al.* (1992) [25] reported higher collagen solubility in beef meat treated with papain as compared to water treated control. Significantly ($P<0.05$) higher collagen content in papain treated samples as compared to other treated samples might be due to the effect of papain on proteolysis of collagen (Bawa *et al.*, 1981) [2]. Kang and Rice (1970) [11] reported that papain solubilised 15% connective tissue proteins and 60% salt soluble proteins. Takagi *et al.* (1992) [25] reported significantly higher collagen solubility in beef treated with papain as compared to water treated control and alkaline elastase treated samples. Higher collagen solubility due to papain treatment has also been reported by Brooks *et al.* (1985) [6].

Table 1: Effect of different tenderizers with vacuum tumbling on physico- chemical characteristics of spent Japanese quail carcasses (Mean±SE)

Parameters	Control	Vacuum tumbling (1.5 hr)	+ 5.0 % Ginger extract + 1.5 hr vacuum tumbling	0.05 % Papain + 1.5 hr vacuum tumbling	2.5 % Sodium bi carbonate + 1.5 hr vacuum tumbling
<i>Physico – chemical Parameters*</i>					
pH	6.38±0.15 ^a	6.42±0.12 ^a	6.48±0.14 ^a	6.50±0.15 ^a	6.90±0.14 ^b
Water holding capacity (%)	22.50±0.13 ^a	25.70±0.20 ^a	32.40±0.15 ^b	35.76±0.16 ^b	39.90±1.69 ^c
Cooking loss (%)	30.60±0.14 ^a	32.24±0.14 ^a	40.72±0.16 ^c	45.37±0.15 ^d	38.18±0.17 ^b
Fragmentation Index	860.15±0.18 ^a	820.00±0.18 ^a	620.00±0.15 ^c	530.00±0.15 ^d	690.00±0.14 ^b
Collagen content (mg/gm)	1.20±0.17 ^a	1.30±0.15 ^a	2.62±0.12 ^c	3.80±0.17 ^d	1.47±0.18 ^b
Collagen Solubility (%)	10.10±0.20 ^a	11.50±0.17 ^a	18.52±0.17 ^d	20.92±0.15 ^c	14.47±0.18 ^b

*Number of observations = 4.

Means bearing same superscripts row- wise do not differ significantly ($P<0.05$).

3.2. Sensory characteristics

Results of effect of different tenderizers with vacuum tumbling on sensory attributes of spent Japanese quail carcasses are presented in Table 2. There was significant ($P<0.05$) improvement in sensory acceptability scores for all treated products as compared to control. The mean appearance and colour, flavor, juiciness and overall acceptability scores were significantly ($P<0.05$) higher for 5.0% ginger extract with 1.5 hr vacuum tumbling samples as compared to other treated samples. However, scores for tenderness were significantly ($P<0.05$) higher for 0.05% papain with 1.5 hr vacuum tumbling samples as compared to other treated samples. Overall acceptability scores for 5.0% ginger extract with vacuum tumbling samples were significantly ($P<0.05$) higher followed by 2.5% sodium bi carbonate with 1.5 hr vacuum tumbling, 0.05% papain with 1.5 hr vacuum samples. The control and 1.5 hr vacuum

tumbling samples were did not differ significantly between them. Lowest acceptability scores for papain treated as compared to other treated samples of our experiment might be due to excessive degradation of meat structure leading to undesirable mushy texture (Cronlund and Woychik, 1987) [7]. Low juiciness scores of papain treated products were in agreement with Gerelt *et al.* (2000) [10], who reported lower juiciness and taste in papain treated meat products when compared to control. They further reported that papain causes bitterness which might be due to the production of bitter peptides during proteolytic degradation of meat proteins. Significant increase in tenderness of culled cow meat treated with 0.1% papain was reported by Gerelt *et al.* (2000) [10]. However, lower overall acceptability scores in papain treated products might be due to texture deterioration causing mushiness and bitter flavour (Cronlund and Woychik, 1987) [7].

Table 2: Effect of different tenderizers with vacuum tumbling on sensory characteristics of spent Japanese quail carcasses (Mean±SE)

Parameters	Control	Vacuum tumbling (1.5 hr)	+ 5.0 % Ginger extract + 1.5 hr vacuum tumbling	0.05 % Papain + 1.5 hr vacuum tumbling	2.5 % Sodium bi carbonate + 1.5 hr vacuum tumbling
Sensory attributes **					
Appearance & colour	6.5±0.10 ^b	6.5±0.10 ^b	8.0±0.10 ^d	6.0±0.12 ^a	7.0±0.13 ^c
Flavour	6.0±0.15 ^a	6.5±0.10 ^b	8.5±0.10 ^d	6.0±0.14 ^a	7.0±0.12 ^c
Juiciness	6.0±0.12 ^a	6.5±0.15 ^b	8.0±0.15 ^d	6.5±0.13 ^b	7.5±0.14 ^c
Tenderness	6.0±0.12 ^a	6.5±0.14 ^b	8.0±0.12 ^d	8.5±0.14 ^e	7.0±0.13 ^c
Overall acceptability	6.2±0.12 ^a	6.5±0.12 ^b	8.2±0.12 ^d	6.7±0.14 ^b	7.2±0.13 ^c

**Number of observations = 32.

Sensory attributes were evaluated on a 9 – point descriptive scale (wherein 1 = extremely undesirable; 9 = extremely desirable).

Means bearing same superscripts row- wise do not differ significantly ($P<0.05$).

In the present study, ginger extract treatment improved all the sensory scores, except tenderness. Improvement in colour, appearance and juiciness of samples treated with ginger extract of our present findings are in agreement with Syed Ziauddin *et al.* (1995) [24]. Labell (1987) [13] reported an increase in the flavour of poultry meat treated with 2% ginger powder. He attributed that the increase in flavour of ginger treated samples might be due to flavour producing reaction which occurred during cooking. Lee *et al.* (1986) [14] reported that application of 0.5 to 1.0 (w/w) crude ginger extract greatly enhanced the tenderness of beef steaks and sliced beef without any detrimental effect of mushiness, which was a problem with other proteolytic enzymes. Kim and Lee (1995) [12] also reported that precooked lean beef treated with 0.5% to 1% (v/w) ginger extract in the absence of salt was sufficient to give acceptable tenderness of meat. Our present findings are consistent with the reports of Labell (1987) [13] and Syed Ziauddin *et al.* (1995) [24]. Labell (1987) [13] reported that addition of ginger powder at 2% weight of meat helped to preserve flavour, texture and reduced the shrinkage of microwaved meat and poultry. Syed Ziauddin *et al.* (1995) [24] also reported that buffalo meat treated with sodium chloride and ginger extract alone or in combination were acceptable to trained sensory panelists in terms of colour, aroma, texture and juiciness.

4. Conclusion

Spent Japanese quail carcasses treated with 5% ginger extract with 1.5 hr vacuum tumbling were rated better for all sensory attributes with favourable physico-chemical characteristics followed by 2.5% sodium bi carbonate with 1.5 hr vacuum tumbling, 0.05% papain with 1.5 hr vacuum tumbling. Therefore, combination of 5.0% ginger extract + 1.5 hr

vacuum tumbling appeared to be optimum for improvement of tenderness and eating quality of spent Japanese quail carcasses in a shorter marination time.

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