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A study on quality and acceptability of emu meat

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Abstract
Nowadays, health conscious consumers are concerned about fat content, nutritive value, wholesomeness, freshness, leanness, juiciness, flavor, and tenderness of meat and meat products. Emu meat is said to be an excellent diet for people suffering from heart ailments. The meat quality traits viz. physico-chemical parameters like pH, water holding capacity, thiobarbituric acid value, fibre diameter, proximate composition, microbiological analysis and sensory evaluation were studied. The physico-chemical parameters revealed a gradual decrease in pH from 0 day (5.69) to 14th day (5.40) of storage period. The progressive fall in pH during the periods of storage is normal. The water holding capacity increases with increase in storage periods. Also, there was a highly significant difference noticed in the water holding capacity of emu meat in different storage periods. The Thiobarbituric acid number increased significantly at different storage periods. The observations revealed significant increase in fibre diameter as increase in 3rd day. The fibre diameter decreased gradually during the storage periods resulting in increased tenderness. There was increased percentage of moisture and protein observed during storage period. The fat percentages were decreased during storage period. The emu meat on the 0 day exhibited higher scores for all the sensory parameters; however, it gradually decreases as the storage period increases. Decreased scores for tenderness and juiciness given on the 14th day by the sensory panelists could be interpreted as the storage period become longer; there was a loss of juiciness of the meat with loss in moisture.

Keywords: Acceptability, emu, juiciness, quality, tenderness

Introduction
Meat is an excellent source of good protein which provides essential amino acids and various micro nutrients in proper proportion to the human beings. It remains to be an economically important, nutritionally valuable and enjoyable commodity to the consumer all over the world. Emu (*Dromaius novaehollandiae*), a native bird of Australia was traditionally farmed for the production of feathers, high quality leather and fat. But recently, it has been adopted in many countries for meat. Emu meat is recognized as a healthy alternative to other red meats due to its leanness, low cholesterol and favourable fatty acids (Sales and Horbanczuk, 1998) [27]. In spite of its healthy composition, emu farmers are finding it difficult to market the new source of meat (Daniel *et al*., 2000) [9].

Emu meat is said to be an excellent diet for people suffering from heart ailments. The tenderness and texture of emu meat enables to be fit for preparations, as it is low in fat, loses moisture quickly and best under moist heat cooking. The emu meat contains less cholesterol. Due to healthful benefits of emu meat, Americans recognized the emu meat as a healthy alternative to beef as red meat with less fat. Emu meat has been touted as a good source of protein, B vitamins, bio-available iron and creatinine (Pegg *et al*., 2006) [23] besides having a low-fat content. Naveena *et al.* (2013) [20]. The moisture content of emu meat was almost similar to the meats from other species and the carbohydrate content was reported to be less than 1.0%. It is proved that red meat has more bio availability with increasing proportion theme iron than plant-based protein foods. Further, it is recognized as a significant source of heme iron compared to poultry and fish (Johnston *et al*., 2007) [15] and an useful source of bioavailable zinc, vitamins like riboflavin (B_6), cyanocobalamin (B_{12}), calciferol (vit D), minerals like calcium and selenium (National Health and Medical Research Council, 2006 [18]; World Cancer Research Fund American Institute for Cancer Research, 2007 [33].

Materials and Methods
The study on acceptability of emu meat was carried out as per the pre-designed program of work. The study was carried out at the Department of Livestock Products Technology, West Bengal University of Animal and Fishery Sciences, Kolkata 700037.

A total of six emu birds were subjected to study. Each one was slaughtered by followed by humane method and the samples were collected for study. The different parameters were studied after following the methods as outlined. Birds for the purpose were collected from Asansol emu farm, Burdwan, West Bengal. The birds were of about same body weight, age, sex and were uniformly reared under farm condition. A Study on acceptability on emu meat was undertaken to ascertain the physico-chemical properties proximate composition analysis, microbiological analysis and sensory evaluation through sensory attributes of emu meat.

Physico-chemical properties

The pH was determined according to method of Trout *et al*. (2000). A10g of sample was homogenized with 50 ml distilled water using mortar and pestle. Then the pH of the suspension was recorded using digital pH meter (Systronics, Model 335). This was based on the percentage of free water in meat, according to the method of Grau and Hamm (1953) [12], as modified by Pohja and Niniyaara (1957) [24] round meat samples, 0.3g each (weighed accurately to 0.001g), placed on Whatman No. 1 paper-filter were exposed to 2 kg pressure between two glass plates for a period of 5 min. Thereafter, using a planimeter, the area of two spots created by extruded meat juice and meat, respectively, was determined (in cm^2). Fibre diameter of emu meat sample was estimated as per the method Johanson (1994). The TBA value was determined according to the method of Witte *et al*. (1970) [32]. The proximate composition such as protein, fat, moisture and ash percent of emu meat samples were analyzed by following the standard procedure of AOAC (2000) [1].

Microbiological analysis

TPC was determined by the method described by APHA (1984) [2]. Readymade media (Hi-media) were used for the analysis.

Sensory evaluation of the meat samples

Emu meat uniformly cut into half square inches size and boiled in pressure cooker for 15 minutes time at 15lb pressure, are allowed for sensory evolution to a trained panel of 5 members amongst the faculty members of the departments of the veterinary college, Kolkata. Panel members were allowed to sit in a well-lighted and ventilated room. A clean glass of drinking water was offered to each member for rinsing the mouth before and after taking of each pieces of meat sample. They were neither informed about the identity of the sample nor allowed any conversation or discussion among themselves during the evaluation process. All the samples were evaluated for tenderness, colour, flavor, juiciness and overall acceptability by using a 9-point hedonic scale as described by Ingham *et al.* (2002) [14].

Statistical analysis

The data collected for various parameter of the study were analyzed by one way ANOVA according to Duncan's multiple range test (Duncan, 1955) [8] and data related to effect of different dosages of inoculation were analyzed with the help of Fisher's test (Independent Sample T test) (Fisher, 1935) [11] using $SPSS^{20}$ software ($p<0.05$) is treated as significant and ($p<0.01$) is noted as highly significant and ($p<0.05$) is considered as non-significant.

Results

Physico-chemical properties

The mean values of the results of pH (Table 1) of emu meat samples of the different storage days (0, 3rd, 7th and 14th) values were significantly decreased ($p<0.01$) 5.69± 0.01, 5.60 ± 0.01, 5.48 ± 0.04 and 5.40 ± 0.02 respectively. The mean values of the results of WHC (Table 1) of meat samples were 1.58 ± 0.01, 2.20 ± 0.02, 2.63 ± 0.01 and 2.84 ± 0.01 in cm^2 (0, 3rd, 7th and 14th) days are respectively. The analysis of variance revealed a highly significant difference ($p<0.01$) respectively. The water holding capacity increased in storage periods.

The mean fibre diameter (Table 1) of meat samples were 48.57 ± 0.02, 52.12 ± 0.02, 51.17 ± 0.01 and 51.87 ± 0.16 um in (0, 3rd, 7th and 14th days) are respectively. The results of fibre diameter within different storage period at 0 day and 3rd storage period there was highly significant difference ($p<0.01$) variance whereas, at 7th and 14th there was no significant difference between days and storage period.

The mean values of the results of TBA (Table 1) of meat samples were 0.54 ± 0.00, 0.61 ± 0.01, 0.69 ± 0.01 and 0.92 ± 0.01mg malonal/kg (0, 3rd, 7th and 14th) days are respectively. There was significant difference ($p<0.01$) in the thiobarbituric acid number of emu meat and it was observed a gradual and highly significant increase in the thiobarbituric acid number of emu meat as storage increased.

Table 1: Physico-chemical Properties (mean± SE) of emu meat of different storage periods

Parameter \ Storage days	0day	3rd day	7th day	14th day
Ph	5.69±0.01^{c}	5.60±0.01^{c}	5.48±0.04^{a}	5.40±0.02^{a}
Water Holding Capacity (cm2)	1.58±0.01^{a}	2.20±0.02^{b}	2.63±0.01^{d}	2.84±0.01^{c}
Fibre diameter (μm)	48.57±0.02^{a}	52.12±0.02^{d}	51.17±0.01^{c}	51.87±0.16^{c}
TBA No. (mg. malonal/Kg)	0.54±0.00^{a}	0.61±0.01^{b}	0.69±0.01^{c}	0.92±0.01^{d}

Mean values bearing same superscript between column with in row does not significant ($p<0.01$).

Proximate composition

The results of Proximate composition (moisture, protein, fat, and ash) is given in Table no-2.

The mean moisture values of the emu meat of different storage days (0, 3rd, 7th, 14th) were presented in (Table-2). The mean moisture percentage are 71.98±0.02, 72.04±0.01, 72.58±0.01 and 72.91±0.02 (0, 3rd, 7th and 14th days) respectively. There was significant difference moisture percentage ($p<0.01$) respectively. The mean values of the results of protein (Table 2) of emu meat of the different storage days (0, 3rd, 7th and 14th) were presented in Table no-2. The mean protein value are 24.16 ± 0.01, 24.08 ± 0.02, 24.18 ± 0.16, 24.27 ± 0.23 on 0, 3rd, 7th, 14th day respectively revealed that there was no significant difference in protein within different storage period.

The mean values of fat percentage of Emu meat samples (Table 2) are 2.65±0.02, 2.53±0.01, 2.40±0.03 and 2.32±0.02 on 0, 3rd, 7th and 14th day respectively. There was significant difference in fat percentage ($p<0.01$) of emu meat samples and it was observed a gradual highly significant increase.

Table 2: Proximate (Mean ± SE) composition of emu meat

Parameter \ Storage days	0 day	3 day	7 day	14 day
Moisture (%)	71.98±0.02[a]	72.04±0.01[b]	72.58±0.01[c]	72.91±0.02[d]
Protein (%)	24.16±0.01	24.08±0.02	24.18±0.16	24.27±0.23
Fat (%)	2.65±0.02[e]	2.53±0.01[d]	2.40±0.02[b]	2.32±0.02[a]
Ash (%)	1.05±0.01	1.07±0.01	1.03±0.01	1.01±0.01

The Mean values bearing same superscript between column with in row does not significant (p<0.01).

The mean values of ash (Table 2) the emu meat samples of the different storage days (0, 3rd, 7th, 14th) were presented in table no-2 with test of significance. Ash values are 1.05±0.01, 1.07±0.01, 1.03±0.01 and 1.01±0.05 on 0, 3rd, 7th and 14th day respectively revealed that there was no significant difference in ash within different storage period.

Microbiological analysis

Total plate count

The mean values for Total plate count (Table 3) of emu meat of 0, 3[3d], 7th, 14th day overall were 5.67±0.37, 5.87±0.01, 6.03±0.02 and 5.70±0.06 log/cfu/g, respectively. The Analysis of variance revealed significant difference (p<0.01) in the Total plate count (TPC) at different observations periods.

Table 3: Microbiological (Mean ± SE) Analysis of emu meat

Parameter	0 day	3 day	7 day	14 day
Tpc(cfu/g)	5.28±0.044[a]	5.62±0.37[d]	5.87±0.015[b]	6.03±0.021[c]

Mean values bearing same superscript between column with in row does not significant (p<0.01).

Sensory evaluation

The result of Sensory evaluation (Colour, Flavour, Tenderness and Juiciness Mean± SE of emu meat of different storage periods have been tabulated (Table 4).

Statistically significant difference (p<0.01) was found among different storage period for flavour meat. It was evident from mean values that in case of colour emu meats were better accepted.

Table 4: Sensory (Mean ± SE) evaluation of Emu meat

Parameter \ Storage days	0 day	3rd day	7th day	14th day
Colour	6.93±0.01 [d]	6.80±0.02 [c]	6.75±0.02 [c]	6.28±0.01 [a]
Flavour	7.03±0.01 [e]	6.98±0.01 [d]	6.78±0.01 [b]	6.59±0.01 [a]
Tenderness	7.60±0.02 [c]	7.56±0.02 [c]	7.40±0.02 [b]	7.29±0.01 [a]
Juiciness	8.28±0.01 [d]	8.10±0.02 [c]	8.01±0.01 [b]	7.90±0.02 [a]
Overall acceptability	7.69±0.01 [d]	7.61±0.01 [c]	7.59±0.01 [b]	7.47±0.02 [a]

Mean values bearing same superscript between column with in row does not significant (p<0.01).

Discussion

A study on various physic-chemical properties, proximate composition, microbiological analysis, sensory evaluation of emu meat in different storage period of emu meat of was carried out in the Department of Livestock Product Technology, West Bengal University of Animal and Fisheries Science Kolkata 700037.

Emu, a native of Australia, has set its foot prints in Indian poultry industry remarkably with an excellent technical and economic feasibility. Emu meat is developing interest in nutritionists owing to its higher protein content, lower fat. Emu meat is an excellent alternative to red meat for the health-conscious consumers. The simple nutritional and management requirements of the bird and its innate acceptability have attracted the growth of emu industry in India. The current study has undertaken the parameters on status of the emu meat produced in west Bengal with its different meat quality aspects to judge its acceptability to the consumers. The meat quality traits studied were physico-chemical parameters like pH, water holding capacity, thiobarbituric acid number, fibre diameter, proximate composition and microbiological analysis, sensory evaluation.

The present study concluded that decrease in pH of meat is usually due to the growth of Lactic Acid Bacteria (LAB), while the increase in pH in meat might be due to growth of proteolytic organisms and production of amines (Shelef 1975) [28]. Lower pH values were also reported in ostrich meat was also due to growth of LAB, resulting in lactic acid production Fernandez-Lopez *et al*., (1997) [10]. The water holding capacity decreased as 0 day and with increase in storage periods. Also, there was a highly significant difference noticed in the water holding capacity of emu meat in different storage periods. This observation can be well correlated to the observation of pH value of the emu meat, the indirect relationship of pH and WHC signified such results agreement with (Hamm and Lawrie 1975) [16].

The Thiobarbituric acid number increased significantly at different storage periods. The observations revealed significant increase in fibre diameter as increase in 3rd day. The results of the present study are in concur with the findings of Tuma *et al*. (1962) [30], Romans *et al.* (1965) [25]. The gradual initially increase in fiber diameter with increase in storage periods could be attributed to the fact of the change associated with muscle fibre structure in the aging. The mean muscle fibre diameter observed in the present study resemblance the previous report (Naveena *et al*., 2013) [20].

This finding was in agreement with the findings of Arif *et al*. (1993) [3], However, the observations obtained by Cifuni *et al.* (2000) [7] were in contrary to the above reports. Increase in TBA values might be due to increase in lipid oxidation and production of volatile metabolites.

Observation on moisture percentage also supported the findings of Ockerman (1985) [21], where it was revealed that moisture percentage was inversely proportional to fat percentage. The moisture, contents observed in this study were comparable to those obtained by Sales (1997) [26] in Ostriches meat.

There was increased percentage of moisture and protein observed in storage period. The fat percentages were decreased in storage period. The emu meat from the 0 day exhibited higher scores for all the sensory parameters. Decreased scores for tenderness and juiciness given to the 14 days by the sensory panelists could be interpreted as the storage period become longer; there was a loss of juiciness of the meat with loss in moisture, Biswas (2002) [4] reported that slight decrease in protein at refrigerated storage might be due to depletion of protein by certain types of bacteria which lead to production of alkalinizing substances.

In this study, observation of fat percentage also supported the findings of Ockerman (1985) [21] where it was revealed that fat percentage was inversely proportional to moisture percentage of any species meat and thus the percentage of different components of proximate analysis can be balanced.

Ash percentage increases with increment of age to a certain period whereas protein and fat percentage increase further with unaltered ash percentage in body system. Lawrie (1985) [17] observed the inter-animal variability in composition of Ash which could not be with respective of data and analysis of study. Emu meat received more in taste panel scores like colour, appearance, tenderness and juiciness. The reduced flavour scores of the emu meat may be attributed to the increased "gamey" flavor which is one of the natural sensory attributes of emu meat. Microbiological quality of the emu meat showed a significantly higher difference in the microbial counts at different storage periods. However, the counts were within the acceptable limits.

Conclusion

The present study concluded that the results of the study indicated that emu meat can be selected for the consumption considering the various favourable characteristics of the meat like meat quality traits: pH, water holding capacity, thiobarbituric acid number, fibre diameter, proximate composition and the organoleptic scores including colour, flavor, juiciness and tenderness scores. The emu meat has a good potential to be used as an alternative source of meat. There is also a need to popularize the quality of emu meat.

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