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A Study on Food Quality Attributes of Novel Value-Added Emu Meat (*Dromaius novaehollandiae*) Cutlets in Comparison with Beef (*Bos indicus*) and Chicken (*Gallus gallus domesticus*) Cutlets

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ABSTRACT: Red meat is an important part of the human diet for its delicious flavor and taste, provides a rich source of high biological value protein and essential nutrients. However, there is a negative health image like the risk associated with colon cancer and heart disease. Hence, to overcome these hurdles, an alternate solution is required. As we all know ratite meat is lean red meat similar to beef both in taste and appearance. When compared to chicken meat, it's darker in color which may be due to increased myoglobin content. So, as an excellent alternative to red meat, emu must be familiarized among red meat consumers. Moreover, emu meat does not suffer any religious taboos. Hence, a study on the development of a novel value added emu meat cutlet was designed and the same was compared with beef and chicken. The products were compared for their sensory characteristics viz. appearance, flavor, odour, juiciness, texture, and overall acceptability by a taste panel of 5 semi-trained panelists. The cooking yield, proximate analysis, colour by standard Hunter *L*a*b system, and texture profile of the products were also assessed. Data obtained were statistically analyzed and the results of the study showed that the sensory scores, instrumental colour, and texture profile of the emu cutlet were superior when compared to chicken and beef cutlets. Hence, emu meat can be preferably considered as an alternative to red meat for health-conscious consumers who love the traditional taste of red meat. Moreover, it indicated that a high margin of profit could be obtained by the value addition of emu meat.**

Keywords: Cutlet, Emu, Beef, Chicken, Proximate, Sensory, Colour, Texture.

INTRODUCTION

India's livestock resources contribute 4.11 percent of the GDP and 25.6% of the Agriculture GDP (Kirthy Reddy *et al.,* 2022). Demand for biological sources of protein is rising globally due to steady growth in the human population, rising incomes, and increased urbanization (Warren *et al.,* 2020). Meat continues to be an important food in the diet of many people and red meat forms a part of the habitual balanced diet, particularly in developed countries. When included as part of a healthy, varied diet, red meat provides a rich source of high-biological value protein and essential nutrients, some of which are more bioavailable than in alternative food sources (Wyness, 2015). Also, itis an excellent source of high-quality proteins with various micronutrients for growth and human health. However, it is frequently associated with a negative health image due to the risk associated with heavy red meat consumption among consumers with the development of cardiovascular disease and colon cancer, and also due to its nutritionally inadequate fatty acid composition, high-fat content, and high iron content (Amanda *et al.*, 2007; Biesalski, 2005; McAfee *et al.*, 2010).

Game and exotic meat are gaining more attention in the market because consumers are more sophisticated and health-conscious. Emu (*Dromaius novaehallandiae*), the flightless bird native to Australia and found in many countries, is receiving much attention for its nutritional benefits as well as its medicinal value (Jeengar *et al.,* 2015). It is an excellent alternative to red meat for health conscious consumers who love the traditional taste of red meat. As per the statement stated by Maheswarappa and Kiran (2013) emus are classified as ratites along with South African ostriches and South American rheas and are becoming popular as a source of protein, B vitamins, creatine, low-fat, low-cholesterol, and iron-rich red meat alternative. The Emu meat is a lean red meat similar to beef both in taste and

appearance, darker in color compared to poultry meat due to its increased myoglobin (Mb) content, similar to red meats harvested from livestock. It is heart friendly because of its low cholesterol with a favorable fatty acid profile (American Heart Association). According to Horbańczuk and Wierzbicka (2016), Ratite meat can be recognized as a dietetic product mainly because of its low level of fat, high content of polyunsaturated fatty acids (PUFA), favourable n6/n3 ratio, and high iron content in comparison with beef and chicken meat. Emu meat is higher in protein and lower in fat when compared to beef (American Emu Association). A typical emu bird to market will weigh 40 kg at 15–18 months and yield 12 kg of boneless red meat, 8 kg of fat, and 1 square meter of skin. The nutrient profile and quality attributes of emu meat have been investigated by several researchers, and emu meat was found to be a better source of iron than beef (Berge *et al*., 1997). However, emu meat is not much familiarized among Indian consumers though it does not suffer any religious taboos.

In India 1-2% of total meat produced is processed into products for trade as compared to more than 60% in developed countries. There are about 170 processed meat units in India producing several meat products mostly as small-scale units and licensed under Meat Food Products Order (MFPO, 1973). Urban respondents reported an increase in milk, chicken, citrus fruits, and vegetable consumption, but a decrease in rice consumption due to physical inactivity and a decrease in green leafy vegetable consumption due to a lack of availability (Shivani and Vijaya Lakshmi 2022). Today's consumers are no longer satisfied with traditional meat products. Rather they prefer more nutrients and conveniently ready-to-eat meat products especially, in developing countries like India where there is heavy industrialization and globalization have stimulated the growth of per capita income and up-gradation of living standards. This has widened the demand for more convenient meat products and it is amplified by population growth in developing countries.

Moreover, consumer acceptance of and preference for flavor potentially shifts when dealing with value-added or processed meats as opposed to fresh meats (Garmyn, 2020). One of the convenient meat snack products was cutlets which are gaining its place since it provides taste and convenience to the meat consuming population with an exceptional level of satiety. Cutlet is a small, boneless cut of meat mixed with spices and condiments, which can be used in a variety of dishes. A cutlet involves dredging them in flour, followed by beaten eggs and bread crumbs. The breaded cutlets are shallowly pan-fried and served hot with lemon, onion, or other sauces. There is a scope for the development of the processed meat industry especially value-added meat products to cater to the need of the urban population, which consume 70 to 75 % of meat products (Singh, 2004).

Therefore to familiarize emu meat and its value added meat products among the public by creating awareness about the health benefits and advantages of emu meat, an attempt to process emu meat as cutlets were carried out and the same was compared for its quality studies with beef and chicken.

MATERIALS AND METHODS

A comparative study on eating quality parameters of beef, chicken, and emu cutlet was carried out in the Department of Meat Science and Technology, Madras Veterinary College, Chennai-7. Beef, chicken, and emu meat were procured hygienically from the local meat market, and excess fat and connective tissues were removed manually and minced in the meat mincer (OMAS type-TS12, 250/750 watts, Oggiona S. Stefano, Italy) using 4.5 mm plate and used for the preparation of cutlet.

The dough for the cutlet was prepared manually by using meat (beef, chicken, and emu) separately and other ingredients viz., salt, wet condiments (onion, ginger and garlic paste, green chilly), spice mix, fennel, dry condiments (chilly, coriander and turmeric powder), mashed potatoes (Table 1) and cooked at 80°C for 20 minutes. Approximately 25g of dough was molded into different shapes and coated with egg white, rolled over with bread crumbles, and finally subjected to shallow pan frying at 80°C for 2 to 3 minutes (Table 2).

The cooking yield, texture profile analysis (springiness, cohesiveness, gumminess, chewiness, and resilience), proximate analysis (moisture, protein, fat and total ash), Color (*L**, lightness; *a**, redness; *b**, yellowness) and sensory evaluation (appearance, flavor, odour, juiciness, texture, and overall acceptability) were assessed and compared between beef, chicken and emu cutlet.

Table 1: Recipe for cutlet dough.

Sr. No.	Ingredients	Quantity (g)	Gram (%)
1.	Minced meat	250	37.59
2.	Potato	200	30.08
3.	Onion	150	22.56
4.	Green chilly	10	1.5
5.	Spice mix	1.5	0.23
6.	Fennel	2.5	0.38
7.	Chili powder	2.5	0.38
8.	Coriander powder	10	1.5
9.	Turmeric	1	0.15
10.	Ginger garlic paste	10	1.5
11.	Salt	7.5	1.13
12.	Oil	20	3.01
Total		665	100.01

Table 2: Battering, breading and shallow fry.

Sr. No.	Ingredients	Quantity (g)
1.	Egg white	40
2.	Rusk powder	50
3.	Oil	100

Cooking Yield: The weight of the product was recorded before and after cooking from which the cooking yield was calculated using the formula

$$\text{Cooking yield } (\%) = \frac{\text{Weight of cooked product}}{\text{Weight of the raw product}} \times 100$$

Texture analysis: Texture profile analysis was conducted using Stable Micro Systems texture analyzer (Stable microsystem, TA-HD plus texture analyzer

Ltd., England, UK) model attached to software, texture expert. The texture profile was analyzed as per Bourne (1978). Triplicate samples in each trial were compressed twice to form a "two-bite" workforce compression curve. A cylindrical probe of 25 mm was used. The load cell capacity was 50 kg with a load range of 0-500 kg at the crosshead and the char speed was 50mm/min. The following parameters *viz* Springiness (mm), Cohesiveness, Gumminess (kgf/mm), Chewiness (kgf/mm), and Resilience were determined.

Proximate composition: The proximate composition such as protein, fat, moisture, and ash percent of products were analyzed by following the standard procedure of AOAC (1995), for fat estimation, SOCS plus (Model SCS 4, Pelican Equipment Pvt. Ltd., Chennai) and protein estimation KEL pus (Model Classic DX, Pelican Equipment Pvt. Ltd., Chennai) were used.

Instrumental colour value: Colour of the samples was tested using Hunter lab Mini scan XE plus Spectro-colorimeter (Model No. 45/O-L, Reston Virgenia, USA) with the geometry of diffuse/80 (sphere – 8mm view) and an illuminant of D65/10 deg (Bindu *et al.,* 2007) and expressed using the standard Hunter *L*a*b** system (Bindu *et al*., 2007). The instrument was calibrated with black and white tile (*L** = 94, *a** = 1.10, and *b** = 0.6) every time before the colour measurement was taken. The colour was expressed as *L** (lightness), *a** (redness), and *b** (yellowness).

Sensory evaluation: The sensory evaluation was assessed by subjecting the samples to sensory scores like appearance, flavor, texture, juiciness, and overall acceptability by a semi-trained taste panel of five members using a 9-point hedonic scale.

The odour score for samples was judged by using 8-10g of the sample in a Petri plate. The samples were allowed to warm up to the laboratory temperature (for about 20 minutes) before being presented to the panel of judges for assessment of the odour using the 9-point hedonic scale scorecard as described by Pearson (1968).

Statistical Analysis: Data obtained were analyzed statistically by one-way ANOVA using SPSS® for windows® software package (version 13.0), based on the standard procedures outlined by Snedocor and Cochran, (1994) and the means were compared by using Duncan's multiple range test.

RESULTS AND DISCUSSION

Cooking yield: The percentage of cooking yields of beef, chicken, and emu cutlet were 72.31±0.94, 74.53±0.82, and 76.04±1.25 respectively. The cooking yield of emu cutlets was found to be significantly (P<0.01) higher than beef and chicken cutlet. According to Hoffman (2008), most ratites species' meat (ostrich, emu, and rhea) have relatively high ultimate muscle pH values (>6.0) that cause a dark colour and high water-holding capacity. This higher cooking yield may be due to the increased water holding capacity of emu meat. Cooking loss was increased with increasing cooking temperature and time (Nithyalakshmi and Preetha 2015). Hence, an increase in cooking yield may be due to the optimum time temperature maintained during cooking.

Texture profile characteristics: Since cutlet is a comminuted meat product, there was no significant difference (P>0.05) in springiness, cohesiveness, gumminess, chewiness, and resilience between beef, chicken, and emu cutlet (Table 3). Cohesiveness refers to the strength of internal bonds making up the body of the product according to Giese (1995). According to Nithyalakshmi and Preetha (2015), the interaction effect of cooking temperature and time was non-significant for the textural properties of emu meat. Thomas *et al.* (2006) found that the texture profile of re-structured buffalo meat nuggets had higher significant cohesiveness, gumminess, chewiness, and shear force values than emulsion based nuggets.

Proximate analysis: Protein was found to be higher in emu cutlets than in beef and chicken cutlet since emu meat was known to be lean meat with low fat (Fig. 1). The combined effect of cooking temperature and time was significant for moisture content, and protein content in emu meat (Nithyalakshmi and Preetha 2015). Fat was found to be more in beef cutlets since more fat depots were found in beef as marbling. Moreover, the cutlet was a fried product with the addition of more oil. According to Vijayakumar and Biswas (2006), the higher fat in duck cutlets is due to the loss of moisture in the cutlet product. Hence this may also be a reason for higher fat. According to Karthik *et al.* (2016) amino acid profile of emu tikka was superior to that of chicken tikka. This clearly shows that emu meat is a superior meat concerning its nutritional aspect.

Colour: Instrumental colour analysis showed that the emu cutlet had low (P<0.05) lightness *(L*)* value than the beef and chicken cutlet whereas the chicken cutlet was more in (P<0.01) redness *(a*)* and yellowness *(b*)* than beef and emu cutlet (Table 4). According to Bratzler (1958), the colour of meat is important from the standpoint of consumer appeal and salability. According to Nithyalakshmi and Preetha (2015), the interaction effect of cooking temperature and time was non-significant for the colour properties of emu meat. Beef and emu are red meat with colour ranges from light red to dark red. Fletcher *et al.* (2000) stated that cooked chicken nuggets were lighter in colour and less red than raw emulsion. Pakula and Stamminger (2012) noticed that consumers and cooks often assess the degree of doneness (75˚C) of roasted beef by the internal meat colour.

Sensory Evaluation: The taste panel results revealed that flavor, juiciness, texture, and overall acceptability were highly (P<0.01) significant among the beef, chicken, and emu cutlets i.e., the emu cutlets scored a superior rating than the beef and chicken cutlets except in the appearance of the product where there was no significant difference (Table 5). Tenderness, juiciness, and flavor remain the three pillars of cooked meat palatability, all linked to consumer satisfaction (Garmyn, 2020). Ahamed *et al.* (2007) reported that enrobing of meat products helps in the preservation of nutritive value, moisture, and weight loss and also improves juiciness and tenderness. Hence, as a coated

product cutlet was more juicy and tender in nature. Moreover, breading on fried meat enhances the texture, flavor, and appearance of the product (Rao and Delaney 1995). Cross *et al.* (1978) stated that sensory evaluation of meat products was assured qualitatively when sensory attributes such as texture, taste, odour, appearance, and overall acceptability are recognized and analyzed.

Odour: The odour scores of beef, chicken, and emu cutlets were 7.58±0.09, 8.08±0.17, and 8.68±0.04 respectively. Based on the odour score, emu cutlet was more (P<0.01) acceptable than beef and chicken cutlets. Emu meat is higher in protein and lower in fat when compared to beef (American Emu Association). According to Fernandez *et al.* (1997), lipid oxidation is a significant problem related to the off-odour development in meat.

Table 3: Texture profile analysis (mean±SE) of beef, chicken and emu cutlet.

Texture profile analysis	Beef	Chicken	Emu	F-value
Springiness (mm)	0.38^{a}±0.02	0.38^{a}±0.04	0.39^{a}±0.01	0.04^{NS}
Cohesiveness (ratio)	0.28^{a}±0.01	0.29^{a}±0.03	0.30^{a}±0.01	0.47^{NS}
Gumminess (kgf/mm)	2.26^{ab}±0.13	2.17^{a}±0.07	2.67^{a}±0.19	3.50^{NS}
Chewiness (kgf/mm)	0.87^{ab}±0.06	0.83^{a}±0.10	1.10^{a}±0.09	3.19^{NS}
Resilience (ratio)	0.10^{a}±0.01	0.10^{a}±0.03	0.11^{a}±0.01	0.33^{NS}

No. of samples – 6, Means bearing uncommon superscript within rows (a, b, c) differ significantly (P<0.05). NS= Non-significant (P>0.05), **= highly significant (P<0.01), *= significant (P<0.05).

Table 4: Hunter colour score (mean±SE) of beef, chicken and emu cutlet.

Colour	Beef	Chicken	Emu	F-value
*L** (lightness)	52.98^{ab}±0.56	56.69^{b}±1.48	50.86^{a}±1.51	5.46*
*a** (redness)	11.20^{a}±0.38	18.49^{b}±0.46	11.07^{a}±0.64	71.18**
*b** (yellowness)	26.63^{a}±0.39	45.86^{b}±1.09	27.20^{a}±0.57	216.17**
*dE** (total colour difference)	49.78^{a}±0.57	75.24^{b}±1.80	51.88^{a}±1.31	113.67**

No. of samples – 6, Means bearing uncommon superscript within rows (a, b, c) differ significantly (P<0.05). NS= Non-significant (P>0.05), **= highly significant (P<0.01), *= significant (P<0.05).

Table 5: Sensory scores (mean±SE) of beef, chicken and emu cutlet.

Treatments	Appearance	Flavor	Juiciness	Texture	Overall acceptability	Odour score
Beef	7.62^{a}±0.15	7.17^{a}±0.29	7.47^{a}±0.16	7.38^{a}±0.26	6.88^{a}±0.19	7.58^{a}±0.09
Chicken	7.70^{a}±0.18	7.62^{a}±0.04	7.78^{a}±0.25	7.13^{a}±0.29	7.73^{b}±0.12	7.80^{a}±0.23
Emu	7.98^{a}±0.15	8.37^{b}±0.08	8.57^{b}±0.06	8.30^{b}±0.07	8.70^{c}±0.04	8.68^{b}±0.04
F-value	**1.42** ^{NS}	**11.58****	**10.55****	**7.28****	**46.43****	**16.46****

No. of samples – 6, Means bearing uncommon superscript within column (a, b, c) differ significantly (P<0.05). NS= Non-significant (P>0.05), **= highly significant (P<0.01), *= significant (P<0.05).

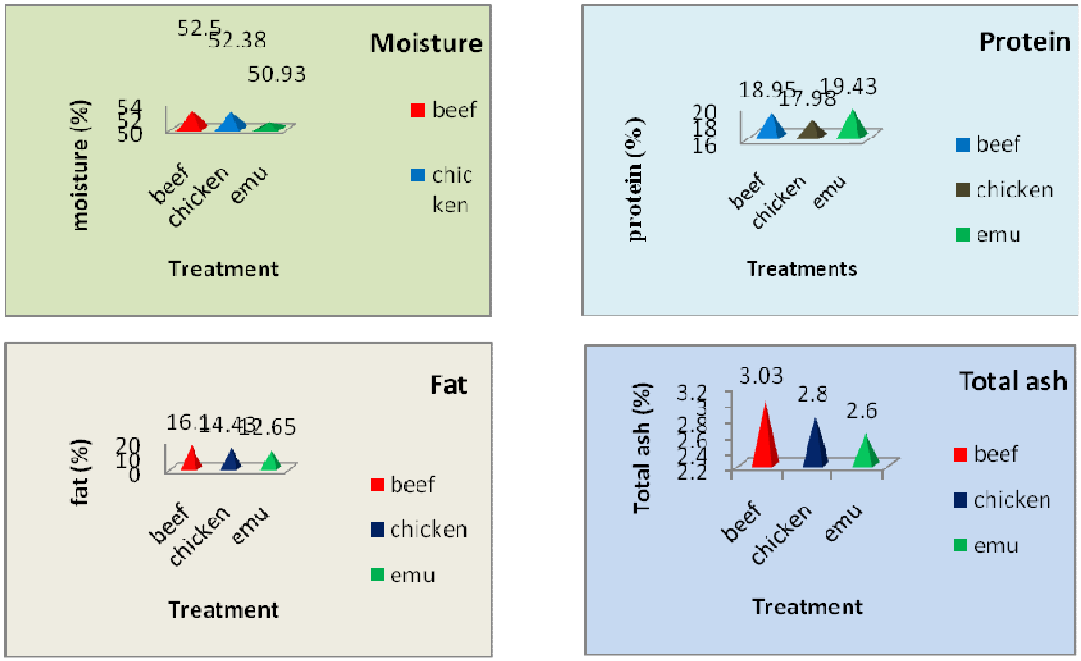

Fig. 1. Proximate composition (%) in cutlet.

CONCLUSIONS

Emu meat is an excellent alternative to red meat in comparison with beef, mutton, chevon, and carabeef. Emu meat plays a major role for health conscious consumers who love the traditional taste of red meat and lower-fat alternatives to beef and mutton. The sensory scores were found to be acceptable. It was observed that a high margin of profit from cutlet could be obtained by value addition. Value improvement can be done by the incorporation of functional (non-meat) ingredients into meat products (Kausar *et al.,* 2019). Hence, converting meat as value added product which in turn increases its functionality. Moreover, there are no religious taboos against emu meat and the demand for convenient meat products is growing. Therefore, emu meat and its value-added meat products among the public could be popularized by creating awareness about the health benefits and advantages of emu meat and meat products.

FUTURE SCOPE

The primary goals of meat processing and further processing are to increase the meat's value, offer consumers more options and convenience, create jobs, make better use of low-value cuts and by-products from slaughterhouses, extend the meat's shelf life, make it easier to incorporate non-meat ingredients, improve marketing and distribution, make more money, and expand export opportunities. According to Kausar *et al.* (2019), the use of functional ingredients in meat products offers processors the opportunity to enhance the functional and nutritional value of their products. In the Indian context, small-scale technologies with locally available ingredients and culinary practices, and low-cost machinery have great potential for widespread adoption. The use of tough meat and by-products from dead animals in the production of high-quality meat products makes use of value added meat products technology. cutlets, nuggets, sausages, patties, croquettes, and other meat products are prepared by making use of homemade appliances, even at a cottage scale. Using a variety of locally available ingredients like fillers, binders, and extenders, many tested formulations have been standardized and put into commercial production.

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Conflict of Interest. None.

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