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Research Article

EATING QUALITY AND PHYSICO-CHEMICAL PROPERTIES OF FRESH EMU MEAT SAUSAGES PREPARED IN COMPARISON WITH BROILER AND SPENT HEN MEAT SAUSAGES WITH OAT FLOUR AND CORN FLOUR

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ABSTRACT
As most of farmers are opting emu farming for their livelihood, it is very difficult to foresee the future of emu meat industry in India without enough scientific data on meat and meat products. Fresh emu meat sausages were prepared in comparison with spent hen meat and broiler meat with added fat, with oat and corn flour at 3% levels. Prepared sausages are analysed for physico- chemical parameters like emulsion stability, pH, cooking loss and water holding capacity, proximate composition for nutrition analysis and organoleptic parameters for eating quality. Emu meat sausages recorded significantly ($p<0.05$) higher pH with no difference in pH with the oat and corn flour. There is no significant difference was observed among the flour types in all three species meat sausages. Broiler meat sausages had shown significantly ($p<0.05$) higher emulsion stability and lower cooking loss compred to other two. Spent hen meat sausages had shown lower moisture ($p<0.05$) and higher crude fat level than other two.oat flour added sausages had shown higher crude fibre percentage. No significant difference was observed in crude protein level. There is no significant difference was noticed in mean tenderness, flavour and juciness values between three meat type sausages. Emu sausages had shown lower ($p<0.01$) colour and appreance scores and broiler meat sausages had shown better overall acceptability scores. in overall corn flour added sausages had shown better colour and appreance, tenderness, juiciness and overall acceptability scores than oat flour added sausages.

Key Words: *Emu Meat, Broiler Meat, Spent Hen Meat, Oat Flour, Corn Flour, Sausages*

INTRODUCTION
Emu farming is expanding steadily especially in the southern states due to the economic potential of the it's meat, fertile eggs, oil and skin and feathers. Majority of the existing farms are rearing the birds for breeding and multiplication purpose. As most of farmers are opting emu farming for their livelihood, It is very difficult to foresee the future of emu meat industry in India without enough scientific data on meat and meat products. Eggs or young birds are being sold and only those bids which have problems and sufficiently aged are slaughtered. With the result, the meat that is obtained is tougher, dark in colour and less palatable due to its low fat content (Fitzgerald *et al.,* 1999) not readily moving in the market. Processing of such meat as emulsion based products like sausages with suitable inclusion of other ingredients, binders, permitted processing agents etc., can be used to develop products which have better appeal, taste and palatability that can compete with those of poultry and red meats in the market. Broiler meat also got lesser fat, cholesterol, and calories, but more protein with acceptable flavour. These qualities made broiler meat most popular this meat popular and number one in most parts of the world (Narahari and Kumar, 2008). Meat from spent hens is usually tougher and less juicy when compared to broiler meat as it is harvested at the end of the egg laying capacity of the birds. Hence increased utilization of meat from spent hen through further processed products has been attempted by several workers (Seideman *et al.,* 1981). Reddy and Srinivasarao (1997) reported that the development of comminuted meat products offers an important avenue for the profitable disposal of spent hens. Rongsensusang *et al.,* (2005) opined that meat from spent bird is inferior compared to the broiler meat

and can effectively be utilized by developing value added products. Non meat products derived from a variety of plant and animal sources are used extensively as fillers, binders and extenders in comminuted meat systems to improve the quality and to reduce the production cost. Steenblock *et al.,* (2001) added oat up to 3% levels to determine the effects on the quality characteristics of light bologna and fat free frankfurters were used and determined that addition of oat fibre produced greater yields and a lighter red colour. Yadav *et al.,* (2008) studied the effect of incorporation of corn flour in quail meat rolls as extenders at the level of 3%,6%,and 9% and observed significant ($p<0.05$) increase in emulsion stability and cooking yield.

Hence the present study is taken up to develop a recipe for emu meat sausages and to assess the quality of the product during storage in comparison to the sausages formulated with broiler meat and spent hen meat which already have sizeable consumer patronage.

MATERIALS AND METHODS

Preliminary trials were conducted for standardization of added fat content, spice mix, condiments levels to be included. Boneless emu meat was procured from the commercial outlet of a nearby emu farm which is marketing meat from emu birds slaughtered at the age of 14-15 months. Spent layer birds of 72 weeks age and broilers of 6-7(Babcock) weeks of age were procured from local farm. Boneless meat was obtained in post rigor stage from the carcasses after manual deboning under hygienic conditions and frozen at -18 ^{0}c overnight for subsequent processing. Sausages were prepared with Emu, Spent hen and broiler meats with the recipe indicated in Table 1.

Table 1: Sausage Recipe

Ingredient	**Emu /broiler/spent hen meat**	
	Corn flour 3%	**Oat flour 3%**
i) Lean meat	74.0	74.0
ii) broiler fat	3.0	3.0
iii) Spice mix	1.5	1.5
iv)Green condiments	6.25	6.25
v) common salt (sodium chloride)	1.7	1.7
vi)sodium tripolyphosphate (STPP)	0.25	0.25

Frozen meat was thawed at room temperature. After thawing, meat was cut into small pieces and minced (Siemen S.P.A, Mrasango, Italy) using 4 mm plate meat mincer. Minced meat was chopped in bowl chopper along with salt (2.5%), Sodium tripolyphosphate, (0.25%).The temperature in bowl chopper was kept low by adding water in the form of slushed ice intermittently throughout the process. Following this 3 % fat was added and chopped for one minute. Spice mix at the rate of 1.8 % was added and minced for 30 seconds. Finally 3% corn or oat flour was added and chopped for 1 minute to make emulsion. Emulsion made was then stuffed into natural sheep casings of 16mm diameter using manual sausage stuffer. Emulsion stability was estimated as per the method outlined by Baliga and Madaiah (1971), 15 g of emulsion was weighed and packed in polyethylene bag and heated at 80° C for 20 min in a constant temperature water bath. The fluid released was drained and sample was weighed. pH was measured using digital pH meter of (Oakton Instruments, USA). About 5g sample was homogenized with 45 ml of distilled water in a laboratory blender for about one minute (Trout *et al.,* 1992). Water holding capacity it was determined as per the method described by Weirbicki *et al.,* (1962). 25 grams of the batter was blended by addition of 75 ml water for 90 sec .in high speed blender. 35 grams of meat slurry centrifuged (Remi instruments Ltd., Mumbai) at room temperature at 1000 rpm for 15 min. After centrifugation the volume of supernatant liquid was collected in graduated cylinder, and the percent of swelling determined as per the following formula.

$$WHC = \frac{300 - 11.43}{100} X S$$

Where S is the supernatant collected.

Percent cooking loss was determined by calculating weight differences for sausages before and after cooking in boiling water bath for 20min (Baliga and Madaiah, 1970). The moisture, fat, protein and crude fibre content were determined using the techniques recommended by AOAC (1995). The crude fibre of the sample (moisture and fat free) was determined by using fibre bag method using Fibertech (Gerhardt) instrument as per approved method of AOAC (1995). The sausages cooked in boiling water were later fried in a shallow pan and subjected to a 5 member taste panel to evaluate color and appearance, flavor, juiciness, tenderness and overall acceptability on a 9 point hedonic scale. Where 9 are excellent and 0 is extremely poor. For three trials conducted data recorded and analyzed using SPSS version 20.0 of windows, SPSS Chicago (US). The data on all parameters are analyzed using UNIVARIATE analysis, Tukeys b test.

RESULTS AND DISCUSSION

The pH of emu broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 2.

Table 2: Physico chemical properties of emu,broiler and spent hen meat sausages with oat and corn flour

Parameter	Flour	Emu	Broiler	Spent hen	Mean
pH	OAT 3%	6.10^{bA}± 0.04	5.81^{aA}± 0.01	5.84^{aA}± 0.06	**5.91^{A}±0.01**
	CORN 3%	6.08^{bA}± 0.02	5.82^{aA}± 0.02	5.84^{aA}± 0.06	**5.93^{A}± 0.01**
		6.09^{b}±0.04	5.81^{a}±0.02	5.84^{a}±0.09	**5.91**±0.14
WHC	OAT 3%	47.73^{aA}±0.26	48.63^{aA}±1.49	46.05^{aA}±2.46	**47.46^{A}±0.77**
	CORN 3%	48.01^{aA}±0.47	49.07^{aA}±1.65	47.00^{aA}±1.47	**48.89^{A}±0.77**
		47.87^{a}±0.61	48.84^{a}±2.44	46.52^{a}±3.18	**47.74±2.41**
EMULSION	OAT 3%	8.61^{aA}± 0.40	8.43^{aA}± 0.68	9.33^{bA}± 0.48	**8.79^{A}±0.26**
STABILITY	CORN 3%	8.77^{aA}± 0.35	7.88^{aA}± 0.39	9.21^{bA}± 0.71	**8.62^{A}±0.26**
		8.70^{ab}±0.35	8.16^{a}±0.58	9.18^{b}±0.54	**8.71±0.66**
COOKING	OAT 3%	8.24^{bA}± 0.32	7.17^{bA}± 0.24	8.14^{bA}± 0.43	**7.85^{A}±0.26**
LOSS	CORN 3%	8.27^{bA}± 0.35	6.96^{bA}± 0.19	8.09^{bA} ± 0.43	**7.772^{A}±0.26**
		8.25^{a}±0.52	7.06^{b}±0.35	8.11^{a}±0.66	**7.81**±0.73

*Means bearing same superscripts along the rows (a, b, c) (A,B)along the columns do not differ significantly (p>0.05) **p<0.01,*p<0.05*

There was no significant difference in pH between the flours in all the three meat sausages. Mean pH values are significantly higher (p<0.05) in emu sausages followed by spent hen meat sausages with non-significant differences between them. Bhattacharya *et al.,* (2007) observed a trend of relative differences in pH of duck sausages and opined that this might be due to variation in glycogen reserves and quantity and quality of glycolytic enzymes. A high pH in restructured emu steaks with added phosphates was observed in the study of Shao *et al.,* (1999) similar trend was reported in buffalo meat nuggets by Thomas *et al.,* (2006), in buffalo meat cutlets by Eyasahmed *et al.,* (2007) and in mutton nuggets by Sangtam *et al.,* (2006). They attributed this slight higher pH to addition of phosphate in the formulation. Reddy *et al.,* (2004) recorded pH values of 5.81± 0.08 and 6.01± 0.11 in emu meat sausages and patties without addition of polyphosphates respectively. Seydim *et al.,* (2005) reported initial meat pH of ratite bird ostrich at 6.16± 0.06. A final pH above 6.0 was also found for ostrich carcasses at 2-6 h after bleeding (Sales and Horbanczuk, 1998). Berge *et al.,* (1997) reported that depletion of glycogen reserves following

ante mortem stress in ratites might be the major reason for relatively high pH values compared to other meats.

The water holding capacity (%) of emu, broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 2. There are no significant differences between flours and within the flours in all the three meat type sausages in terms of mean water holding capacity. Mean water holding capacity values of all the three groups of meat sausages are not differing significantly which can be attributed to ratio of salt and phosphate used and due to usage of flours. Similar findings were observed in goat meat patties by Pawar *et al.,* (2005).

Emulsion stability of emu, broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 2. Emulsion stability is significantly higher in case of oat flour added sausages irrespective of the meat used. This may be due to higher moisture retention in sausages wit oat flour. Kurt *et al.,* (2012) observed similar results with oat and corn flour incorporated beef patties. Emulsion stability of broiler meat sausages is significantly higher ($p<0.05$) than those emu meat and spent hen meat. Similar observations were reported in broiler, spent hen and spent duck sausages by Bhattacharya *et al.,* (2005).

Mean cooking loss values of emu sausages with 3% oat flour, 3% corn flour were 8.24±0.32, 8.27±0.35 respectively. Cooking loss of broiler meat sausages with 3% oat flour, 3% corn flour were 7.17±0.24, 6.96±0.19 respectively. Mean values of cooking loss of spent hen sausages with 3% oat flour, 3% corn flour were 8.14± 0.43, 8.09± 0.43 respectively. Increased cooking yields probably due to the ability to keep the moisture in matrix. Kurt *et al.,* (2012) reported slightly higher yields for oat flour based buffalo meat patties compared tocorn flour extended patties. Cooking loss was higher in emu meat sausages and spent hen meat sausages probably due to lower water binding capacity, which is in conformity with the findings of Singh *et al.,* (2002). Higher fat content in spent hen meat sausages observed in this study might be another reasonas suggested by Singh *et al.,* (2002). Higher stability of emulsion from broiler meat results in better retention of water and fat in meat matrix (Bhattacharya *et al.,* 2007).

Table 3: Proximate composition of emu,broiler and spent hen meat sausages with oat and corn flour

Parameter	Flour	Emu	Broiler	Spent hen	Mean
MOISTURE	OAT 3%	69.73^{aA} ±0.05	69.86^{aA}±0.18	63.88^{aA}±0.32	67.82^{A} ± 0.05
	CORN 3%	69.85^{aA} ±0.20	69.90^{aA}±0.08	64.16^{aA}±0.24	67.96^{A}±0.15
		69.79^{b}±0.23	69.88^{b}±0.21	64.01^{a}±0.46	67.89±2.83
CRUDE	OAT 3%	17.39^{aA} ±0.14	17.53^{aA}±0.15	17.35^{aA}±0.18	17.42^{b}±0.08
PROTEIN	CORN 3%	17.18^{aA} ±0.16	17.29^{aA}±0.09	17.26^{aA}±0.11	17.24^{a}± 0.08
		17.28^{a}±0.26	17.41^{a}±0.23	17.30^{a}±0.23	17.33±0.23
CRUDE FAT	OAT 3%	4.96^{aA} ± 0.64	6.19^{aB}±0.16	9.57^{aB}± 0.21	6.90^{A}± 0.13
	CORN 3%	4.93^{aA} ± 0.59	6.16^{aA}± 0.03	9.45^{aB}± 0.19	6.84^{A}± 0.13
		4.94^{a}±0.95	6.17^{b}±0.17	9.50^{c}±0.31	6.80±2.05
CRUDE	OAT 3%	1.01^{bA} ± 0.05	0.93^{bA} ± 0.02	0.91^{bA}± 0.04	0.94^{B}± 0.02
FIBRE	CORN 3%	0.73^{aB} ± 0.02	0.73^{aB} ± 0.02	0.62^{aA}± 0.01	0.69^{A}± 0.02
		0.86^{b}±0.16	0.82^{ab}±0.11	0.76^{a}±0.16	0.82±0.14

*Means bearing same superscripts along the rows (a, b, c) (A,B)along the columns do not differ significantly ($p>0.05$) **$p<0.01$,*$p<0.05$*

Moisture (%) of emu, broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 3. The moisture percentage of emu sausages and broiler meat sausages did not differ significantly but they recorded significantly higher levels than spent hen meat sausages. This might be because of the fact that moisture content of muscle decreases with increase in age as reported by Lawrie *et al.,* (1998). Similar results were reported by Bhattacharya *et al.,* (2007) in spent chicken and spent duck

meat sausages and alsoin spent hen meat patties by Rajnish *et al.,* (2008). Spent hen meat sausages recorded higher levels of fat when compared to those of broiler and emu meat sausages.

Crude protein (%) of emu, broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 3.Biswas *et al.,* (2006) also noticed in his study that there was no significant variation in protein content between broiler and spent hen meat patties. Protein content of all the sausages were within the permissible limit of Bureau of Indian standards (BIS, 1992b) which specified that the minimum protein content of sausages should be 14%.

Crude fat of emu, broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 3. It is expected as emu meat is reported to contain lower fat values is at around 2% (Berge *et al.,* 1997) the fat content of emu sausages was significantly lower than that of broiler and spent hen meat sausages. It was noticed that the fat content of spent hen meat sausages differed significantly which might be due to the higher fat content of the spent hen meat, as by Brahma *et al.,* (1985) and Sharma (1999). But fat content of all three groups of sausages are within the permissible.

Limits of BIS (1992b) which specified that the maximum fat content of sausage should not be above 20%.

Crude fibre of emu, broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 3. Crude fibre content in 3% corn flour incorporated sausages recorded significantly lower levels when compared to those 3% oat flour incorporated sausages with non-significant differences in them. The range of values of crude fibre content in sausages attributed due to flours, condiments and spices observed in the this study are in accordance with the crude fibre values of meat products with flours, onion paste reported by Biswas *et al.,* (2011).

Table 4: Organoleptic quality of emu,broiler and spent hen meat sausages with oat and corn flour

Parameter	Flour	Emu	Broiler	Spent hen	Mean
Colour and appearance	OAT 3%	6.22^{aA} ± 0.05	7.56^{bA} ±0.11	6.50^{aA}±0.06	**6.76^{B}±0.04**
	CORN 3%	6.33^{aA}± 0.01	7.67^{bB} ±0.01	6.81^{aA}±0.14	**6.93^{A}±0.04**
		6.27^{a}±0.08	7.61^{c}±0.13	6.65^{b}±0.23	**6.84**±0.59
Tenderness	OAT 3%	7.44^{aB} ± 0.06	7.78^{aB} ±0.05	7.06^{aA}±0.06	**7.42^{A}± 0.07**
	CORN 3%	7.84^{aA} ±0.33	7.83^{aA} ±0.17	6.94^{aA} ±0.06	**7.53^{B} ± 0.07**
		7.64^{b}±0.42	7.80^{b}±0.18	7.00^{a}±0.10	**7.48**±0.44
Juiciness	OAT 3%	7.50^{abA} ±0.00	7.89^{aB} ±0.06	7.39^{aA}±0.06	**7.591^{A}± 0.072**
	CORN 3%	8.06^{cA}±0.11	7.90^{aA} ±0.21	7.83^{aA}± 0.17	**7.930^{B}± 0.072**
		7.79^{a}±0.32	7.89^{a}±0.23	7.61^{a}±0.31	**7.76**±0.30
Flavour	OAT 3%	7.17^{aA} ±0.01	7.28^{aA}± 0.11	7.17^{abA}±0.01	**7.207^{A}±0.056**
	CORN 3%	7.28^{abA} ±0.15	7.34^{aA}±0.17	7.33^{bA}±0.10	**7.316 ^{A}±0.056**
		7.23^{a}±0.17	7.30^{a}±0.22	7.25^{a}±0.13	**7.26**±0.17
Overall acceptability	OAT 3%	7.13^{aA} ±0.03	7.59^{bA} ±0.04	6.99^{aA}± 0.05	**7.258^{A}± 0.017**
	CORN 3%	7.41^{bB} ±0.03	7.65^{bB} ±0.03	7.09^{aA}± 0.04	**7.382^{B}± 0.017**
		7.26^{b}±0.16	7.61^{c}±0.05	7.03^{a}±0.08	**7.30**±0.26

*Means bearing same superscripts along the rows (a, b, c) (A, B) along the columns do not differ significantly (p>0.05) **p<0.01,*p<0.05*

Mean Colour and appearance scores of emu, broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 4.Overall mean scores of colourand appearance of broiler meat sausages are significantly (p<0.01) higher followed by spent hen meat sausages and emu meat sausages.Emu meat sausages appeared darker in colour and appearance with significantly lower scores, which may be due to dark red colour of emu meat with higher pigment content (26µg Fe /g) Iron is very sensitive to oxidation (Berge *et al.,* 1997). Similar colour and appearance scores were reported for emu sausages and nuggets by Prabhakar reddy *et al.,* (2004).

Tenderness scores of emu, broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 4. Chicken sausages prepared from broiler meatscored higher tenderness scores, as it is having finer fibre and higher moisture percentage. There is no significant difference of tenderness scores between flours levels in all meat types.

Mean juiciness scores of emu, broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 4. Inclusionof oat fiber caused a decrease in the intensity of the taste and fatty aroma of the meat products. Similar results were observed with oat fiber in pork sausages Barbara *et al.,* (2005) and by Hughes *et al.,* (1997) who reported that oat fibre can partially offset low fat frankfurters when added water replaces fat. Chang *et al.,* (1997) reported that chicken frankfurters with higher oat bran were scored to be less juicy and grainy by taste panelists. Similarly, a slight decrease in juiciness with the increased level offlour inclusion was observed, probably due to bulk density of product at higher level of extension.

Mean flavour scores of emu, broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 4. Total mean flavor scores of emu meat sausages are significantly ($p<0.05$) higher followed by broiler meat sausages and spent hen meat sausages .No differences are observed between the flours. With the addition of spices or marination to emu meat, gamey flavour may be less noticeable or reduced in intensity (Fitzgerald *et al.,* 1999).

Mean overall acceptability scores of emu, broiler and spent hen meat sausages with 3% oat flour and 3% corn flour were shown in Table 4. Overall acceptability scores of 3% corn flour sausages recorded significantly higher ($p<0.01$) values than sausages with oat flour.brolier meat sausages had shown higher overall acceptability score followed by emu meat sausages and spent hen meat sausages, from this it can be concluded that emu sausages can be prepared with corn flour at 3 percent with more or less similar overall accepTable eating quality with broiler meat sausages and better quality when comared with spent hen meat sausages.

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