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S Gayathri
PG Scholar, College of Poultry Production and Management, Tamil Nadu Veterinary and Animal Sciences University, Chennai, Tamil Nadu, India

D Jayanthi
Professor and Head, Department of Poultry Technology, College of Poultry Production and Management, Tamil Nadu, India

K Rajendrakumar
Assistant Professor, Department of Poultry Technology, College of Poultry Production and Management, Tamil Nadu, India

Corresponding Author:
S Gayathri
PG Scholar, College of Poultry Production and Management, Tamil Nadu Veterinary and Animal Sciences University, Chennai, Tamil Nadu, India

EGG sausage standardization and their quality studies under refrigeration temperature

S Gayathri, D Jayanthi and K Rajendrakumar

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Abstract
The work was carried out to complementary contribution to the comprehensive study of the recently recognised promising preparation and standardization of egg sausage and their quality studies under refrigerated temperature (5±2°C). The emulsion prepared from whole egg, minced meat, spices, green condiments and binding agents. The treatment T_1 had significantly decreased pH value (P<0.05) on 0 day and 4th day of refrigerated storage (5±2°C). The treatment T_1, T_2 and T_3 had significantly increased (P<0.01) water holding capacity percent on 4th and 7th day of refrigerated storage. The overall mean tyrosine value of T_1 had decreased significantly (P<0.05). The treatment T_1, T_2 and T_3 had significantly (P<0.05) decreased Thiobarbituric Acid value on 0 day.

Keywords: Egg sausage, chicken meat, physico-chemical characteristics

Introduction
The Poultry Industry is one of the fastest–growing segments of the livestock sector. India stands in 2nd position in egg production and 5th position in meat production. The total egg production in the country is 142.77 billion numbers during 2023-2024. The egg production has increased by 3.17% as compared to previous year (2022-2023). The per capita availability of egg is 103 eggs per annum. The total egg production from commercial poultry is 114.92 billion numbers (Livestock census, 2024).
Eggs are considered as a highly nutritious product. For thousands of years, eggs and egg product have represented an important part of human diet as they are easy to digest and rich in nutrient, containing proteins, minerals, fats and vitamins etc. Eggs naturally possess functional properties like good emulsifying, binding, coagulation and stabilizing abilities which are essential characteristics in manufacturing processes (Stadelman and Cotterill, 1996) [17]. Fresh eggs are difficult to transport. Since, they are bulky, fragile and highly perishable. Moreover, they cause difficulties in stuffing of the sausage mixture into the casing during processing, due to high juiciness and break when cooked. (Attanayake and Jayasena, 2011) [3]. This study was designed to prepare egg sausage using whole eggs, chicken meat, binders and spices. Keeping the above information in view, the present research work has been carried out with the following objectives.
1. To standardize the preparation of egg sausage
2. To study the physio-chemical of egg sausage under refrigerated storage conditions.

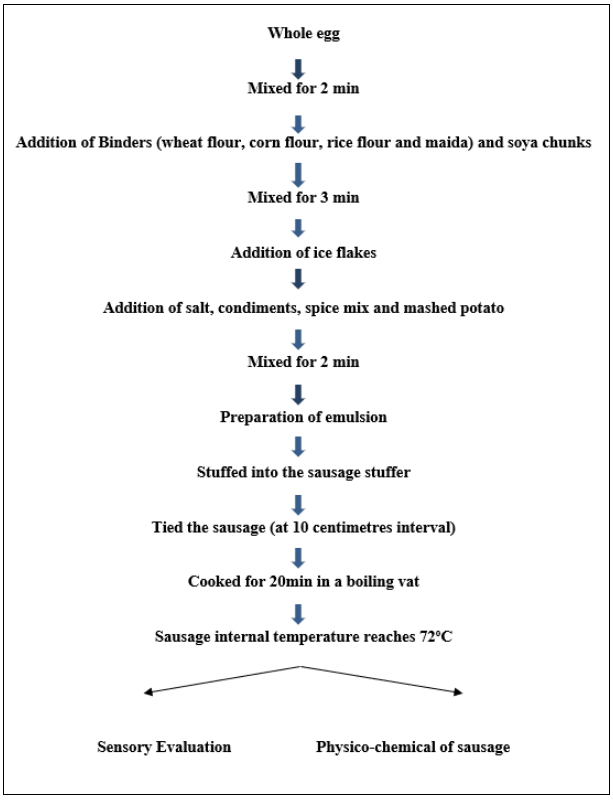
Materials and Methods
The experimental design had five treatments T_1, T_2, T_3, T_4 and T_5 given in Table 1 and flow diagram for preparation of egg sausage also given. The experimental design had five treatments, the first treatments (T_1) contained whole eggs at 35 percent and meat at 35 percent, the second treatment (T_2) contained whole eggs at 68 percent, the third treatment (T_3) contained whole eggs at 68 percent, wheat flour at 5 percent by replacing the corn flour, the fourth treatment (T_4) contained egg white at 68 percent, the fifth treatment (T_5) contained egg white at 58 percent and meat at 10 percent. The remaining ingredients were same for all treatments.

The prepared sausage was packed in a Low-Density Poly Ethylene (LDPE) package and stored at chilling (5±2°C).

Table 1: Formulations for preparation of egg sausage

S. No	Treatment 1		Treatment 2		Treatment 3		Treatment 4		Treatment 5	
	Ingredients	Percent	Ingredients	Percent	Ingredients	Percent	Ingredients	Percent	Ingredients	Percent
1.	Whole eggs	35	Whole eggs	68	Whole eggs	68	Egg white	68	Egg white	58
	Chicken meat	35							Chicken meat	10
2.	Flour									
	Corn flour	5	Corn flour	5	Wheat flour	5	Corn flour	5	Corn flour	5
	Rice flour	5	Rice flour	5	Rice flour	5	Rice flour	5	Rice flour	5
	Maida	5	Maida	5	Maida	5	Maida	5	Maida	5
3.	Soya chunks	2.5	Soya chunks	2.5	Soya chunks	2.5	Soya chunks	2.5	Soya chunks	2.5
4.	Green condiments	3.5	Green condiments	3.5	Green condiments	3.5	Green condiments	3.5	Green condiments	3.5
5.	salt	1.5	salt	1.5	salt	1.5	salt	1.5	salt	1.5
6.	Ice flakes	5.5	Ice flakes	5	Ice flakes	5	Ice flakes	5	Ice flakes	5
7.	Spice mix	2	Spice mix	2	Spice mix	2	Spice mix	2	Spice mix	2
8.	-	-	Mashed potato	2.5	Mashed potato	2.5	Mashed potato	2.5	Mashed potato	2.5

Flow diagram for preparation of egg sausage



Cooking yield

The weight of the egg sausage was measured before and after cooking. The yield was calculated and expressed as percentage of weight of sausage before cooking.

$$\text{Cooking yield (\%)} = \frac{\text{Weight of the sausage before cooking}}{\text{Weight of the sausage after cooking}} \times 100$$

pH

The pH of the egg sausage was measured as per the method recommended by Trout *et al.* (1992). The pH was measured by using a digital pH meter (Model: ELICO LI 617 pH Meter) equipped with a combined glass electrode. Take 10 g of sample and add 90 ml of distilled water and homogenize in a laboratory blender for one minute. The pH meter was calibrated with a buffer solution, which was closer to the sample to be analysed. The pH was measured by immersing the glass electrode of the digital pH meter in the sample.

Water holding capacity

The water holding capacity of egg sausage was estimated by adopting the method recommended by Hamm (1990) [7] with slight modifications. 500 mg of sample was taken and placed in Whatman no. 42 filter paper. The filter paper was placed in between glass slides and applied pressure of 2 kg (40psi) on it for 5 minutes. Weigh the sausage flake after pressing.

Water holding capacity expressed in percentage (%)

$$\text{WHC (\%)} = \frac{\text{Weight of the sausage flake after pressing}}{\text{Sample weight}} \text{ X } 100$$

Tyrosine value (TV)

The method described by Strange *et al.* (1977) [18] was used. Trichloroacetic acid (TCA) extract was prepared by blending 2 g of sample with 10 ml of 20 percent trichloroacetic acid solution for 2 minutes. After homogenization, the contents were transferred to a beaker, mixed and filtered through Whatman filter paper No. 42. Take 2.5 ml of TCA extract, to that add 2.5 ml distilled water. To that 10 ml of 0.5N NaOH and 3 ml of diluted Folin and Ciocalteau reagent was added. After thoroughly mixing, the test tube was kept in a dark place at room temperature for 30 minutes for colour development.

The optical density value was measured at 730 nm using a UV-VIS spectrophotometer. Tyrosine value was calculated as mg tyrosine per g of sample after referring to a standard graph which was prepared as per the procedure described by Pearson (1968).

Thiobarbituric acid value (TBA Value)

Thiobarbituric acid number was determined by a modified method as described by Strange *et al.* (1977) [18] with little modification in the technique. Take 3 ml of Trichloroacetic acid (TCA) extract in a test tube and add 3 ml of Thiobarbituric acid (TBA) reagent. Thiobarbituric acid reagent was prepared by dissolving 0.2833 g of Thiobarbituric acid in a sufficient quantity of distilled water and the volume was made up to 100 ml with distilled water. The test tubes containing the sample were placed in a water bath at 100°C for 30 min along with the control test tube. The test tube was cooled in running water for about 10 min. The optical density value was measured at 530 nm in a spectrophotometer. The value of the TBA number was calculated as mg Malonaldehyde per g of sample.

Statistical Analysis
The data obtained in this study were analysed using one-way ANOVA to arrive at meaningful interpretation as per the method suggested by Snedecor and Cochran, 1994.

Results and Discussion
Cooking yield
The mean (± S.E.) cooking yield of egg sausage was presented in Table 2. T_3 (99.67±0.21) had significantly higher (P<0.01) cooking yield percent when compared to T_4 (98.33±0.21). There was no significant difference (P<0.01) noticed between the treatment groups T_1, T_2 and T_5 in cooking yield percent.
Based on the findings, it was concluded that the addition of 5% wheat flour resulted in considerable improvement in the cooking yield of egg sausage. When starch was added it decreased the cooking loss (Jeng-Yune Li *et al.,* 2003) [9]. The addition of broiler meat and reduction of fat content increased the cooking yield and emulsion stability (Meltem Serdaroglu and Ozlem Degirmencioglu (2004) [11] and Subhasish Biswas *et al.* 2006) [5].

Table 2: Cooking yield of egg sausage (percent) (Mean ± S.E.)

Parameter	T_1	T_2	T_3	T_4	T_5
Cooking yield (percent)	99.33^{AB}±0.42	99.33^{AB}±0.42	99.67^{A}±0.21	98.33^{B}±0.21	99.00^{AB}±0.00

Value given in each cell is the mean of 3 observations
**Mean values bearing different superscripts in a row (A-B) differ significantly (P<0.01)

pH
The mean (± S.E.) pH of egg sausage during refrigerated storage (5±2ºC) from 0 to 7 days presented in Table 3. The pH observed on 0, 4th and 7th day of the refrigerated storage showed no significant (P>0.05) difference with increase in storage days. The overall mean pH value increased numerically from T_1 to T_2.
The result of the study was accordance with earlier work done by Shukla *et al.* (2020) [15], Hossain *et al*. (2021) [8] and Ali *et al*. (2022) [1] who found that during the storage period, overall pH value was slightly increased in chicken patties and broiler breast sausage. The addition of egg white treatment had a neutral pH value of 7.0 at the time of the frozen storage period. The addition of whole egg had a pH of 6.67 ± 0.21. Similar to the present study, earlier work done by Pasdar Hussain *et al.* (2016) [13] found that the chicken meatballs, chicken kabab and chicken fillets had lower pH values.

Water holding capacity (percent)
The mean (± S.E.) water holding capacity of egg sausage during refrigerated storage (5±2ºC) from 0 to 7 days presented in Table 4. The treatment groups showed no significant difference in water holding capacity percent observed on 0 day. The water holding capacity percent observed on 0, 4th and 7th day of the refrigerated storage significantly (P<0.05) decreased with increase in storage days. The overall mean water holding capacity percent of T_1 (73.09±1.72) increased numerically when compared to other treatment groups during refrigerated storage.
The result of this study was similar to Muthia *et al.* (2012) [12] who noticed that the incorporation of egg white at 1percent in duck meat sausage decreased the waterholding capacity. The result of the present study was in accordance with by Hamidon *et al*. (2022) [6] who recorded chicken sausage water holding capacity of 99.97 percent. When the storage period increases, the percent of water holding capacity of the product was decreases. Because the bacterial growth consumes dissolved oxygen and organic matter, which leads to reduction in water quality and capacity to hold dissolved gases. Because the storage period increased, the percent of water holding capacity of the product was decreased. For reason that bacterial growth consumes dissolved oxygen and organic matter, leading to a reduction in water quality and capacity to hold dissolved gases.

Table 3: pH of egg sausage during refrigerated storage (5±2ºC) (Mean ± S.E.)

Storage days	T_1	T_2	T_3	T_4	T_5	F value	Significance
0	6.17^{a} ± 0.16	6.50^{ab}±0.22	6.67^{ab}±0.21	6.83^{b}±0.16	6.50^{ab}±0.22	1.52	*
4	6.50^{a}±0.22	6.83^{ab}±0.16	6.83^{ab}±0.16	7.00^{b}±0.00	6.83^{ab}±0.16	1.97	*
7	6.67± 0.21	7.00± 0.00	7.00± 0.00	7.00± 0.00	7.00± 0.00	1.53	NS
Overall Mean	6.45±0.07	6.70±0.05	6.76±0.06	6.85±0.04	6.84±0.07	-	-
F value	0.23	0.48	0.29	0.53	2.66	-	-
Significance	NS	NS	NS	NS	NS	-	-

Value given in each cell is the mean of 6 observations
* Mean values bearing different superscripts in a row (a-b) differ significantly (P<0.05)
NSNo significant

Tyrosine value (TV) (mg/g)
The mean (± S.E.) tyrosine value of egg sausage during refrigerated storage (5± 2ºC) from 0 to 7 days are presented in Table 5. There was no significant (P>0.05) difference in tyrosine values observed up to 7 days of refrigerated storage.
The tyrosine value observed on 0, 4th and 7th day of the refrigerated storage showed no significant difference (P>0.05) with increase in storage days. The overall mean tyrosine value of T_1 (0.82±0.09) had decreased numerically when compared to other treatment groups during refrigerated storage period.
The results were similar to the Shukla *et al.* (2020) [15] and Sangtam *et al.* (2022) [14] who found that tyrosine values were gradually increased during the refrigerated storage period. Similar increases in the values were recorded in tyrosine values during storage, but the values did not differ significantly (P<0.05) during the entire refrigerated. The initial increase in tyrosine values might be due to variations in the denaturation of proteins during cooking of products. Further increase in tyrosine values during storage might be due to the breakdown of proteins.

Thiobarbituric acid value (TBA value) (mg Malonaldehyde/g)
The mean (± S.E.) Thiobarbituric acid value (mg

Malonaldehyde/g) of egg sausage during refrigerated storage (2 to 7°C) from 0 days to 7 days was presented in Table 6. There was no significant difference between the treatment groups up to 7 days. The higher Thiobarbituric acid reactive substance (TBARS) value noticed during refrigerated storage period. This might due to the production of acidic metabolites by lipid oxidation Kandeepan *et al.* (2010). The interaction within treatment groups in various storage periods showed no significant difference (P<0.05) in TBA values T_1, T_2, T_3 and T_4 treatment groups. However, the treatment T_1 had decreased mean TBA value (0.82±0.33) when compared to other treatment groups at refrigerated storage period.

Table 4: Water holding capacity (percent) of egg sausage during refrigerated storage (5±2°C) (Mean ± S.E.)

Storage days	T_1	T_2	T_3	T_4	T_5	F value	Significance
0	80.13^{w}±1.27	77.63^{w}±0.82	79.15^{w}±0.87	77.77^{w}±1.63	81.26^{w}±2.17	1.14	NS
4	75.10^{Ax}±0.89	75.48^{Aw}±0.95	69.28^{Bx}±1.14	72.89^{ABx}±1.68	73.49^{ABx}±1.49	3.75	**
7	64.05^{Ay}±0.89	64.86^{Ax}±0.55	65.98^{Ay}±0.59	59.70^{By}±1.03	60.05^{By}±1.06	11.20	**
Overall Mean	73.09±1.72	72.66±1.42	71.47±1.44	70.12±2.01	71.60±2.30	-	-
F value	62.74	73.75	57.77	39.83	42.56	-	-
Significance	*	*	*	*	*	-	-

Values given in each cell is the mean of 6 observations
* Mean values bearing different superscripts in a column (w-y) differ significantly (P<0.05)
**Mean values bearing different superscripts in a row (A-D) differ significantly (P<0.01)
NSNo significant

Table 5: Tyrosine value (mg/g) of egg sausage during refrigerated storage (5±2°C) (Mean ± S.E.)

Storage days	T_1	T_2	T_3	T_4	T_5	F value	Significance
0	0.57^{w}±0.14	0.77±0.20	1.12±0.18	0.89±0.18	0.85±0.25	1.01	NS
4	0.80^{wx}±0.13	1.00±0.23	1.17±0.18	0.92±0.11	1.14±0.24	1.35	NS
7	1.09^{x}±0.469	1.01±0.23	1.23±0.20	1.05±0.20	1.17±0.21	0.04	NS
Overall Mean	0.82±0.09	0.92±1.32	1.17±1.04	0.96±0.09	1.05±0.13	-	-
F value	2.77	1.34	0.03	0.50	0.40	-	-
Significance	*	NS	NS	NS	NS	-	-

Value given in each cell is the mean of 6 observations
* Mean values bearing different superscripts in a column (w-x) differ significantly (P<0.05)
NSNo significant

Table 6: Thiobarbituric acid value (mg Malonaldehyde/g) of egg sausage during refrigerated storage (5±2°C) (Mean ± S.E.)

Storage days	T_1	T_2	T_3	T_4	T_5	F value	Significance
0	0.41^{a}±0.97	0.44^{a}±0.04	1.13^{b}±0.40	1.23^{b}±0.21	0.45^{aw}±0.83	3.77	*
4	1.01±1.07	1.49±0.66	1.57±0.33	1.61±0.29	0.95^{x}±0.08	0.49	NS
7	1.05±1.76	1.84±1.71	1.96±1.61	1.67±0.90	1.08^{x}±0.17	1.29	NS
Overall Mean	0.82±0.37	1.26±0.33	1.55±0.26	1.84±0.33	0.83±0.09	-	-
F value	1.98	1.67	0.78	1.75	7.09	-	-
Significance	NS	NS	NS	NS	*	-	-

Value given in each cell is the mean of 6 observations
*Mean values bearing different superscripts in a row (a-b) and within a column (w-x) differ significantly (P<0.05)
NS No significant

Conclusion

To conclude, the present study revealed that sausage can be prepared by incorporating egg replacing the meat. The combination of T_1 meat (35percent) and egg (35percent) had higher organoleptic scores with low physio chemical changes when compared with other combinations. The prepared egg sausage can be stored under refrigerated conditions with acceptable changes in physico-chemical up to one week.

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Conflict of Interest: Not available.

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