Full Length Article

QUALITY EVALUATION OF CHICKEN SAUSAGES FROM SPENT BROILER BREEDER HENS DURING FROZEN STORAGE

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ABSTRACT

The current study was designed to evaluate the influence of three different ground vegetable oil seeds on various physico-chemical, microbiological and sensory attributes of chicken sausages from spent broiler breeder hen stored under frozen (-18±1°C) condition. Chicken sausages were incorporated with ground poppy, sesame and peanut seeds each at 10 % level separately as three treatments and were analyzed for their keeping quality along with high fat control. The mean values of FFA, TBARS, tyrosine values, standard plate count, psychrophilic count and yeast and moulds counts were significantly (P<0.05) influenced by formulation during frozen storage and values increased significantly (P<0.05) throughout the storage period in all chicken sausages. Chicken sausages with ground sesame scored lowest standard plate counts (5.66 log CFU/g) than any others after 180 days of storage at 18±1°C. Coli forms, lacto bacillus and anaerobic counts could not be detected during entire storage period. Scores for all sensory attributes decreased significantly (P<0.05) during storage in all treatments irrespective of formulation. Study proved that, the three ground vegetable oil seeds were effective by delaying the lipid oxidation, microbial growth and preserving sensory quality during frozen storage and among them ground sesame seed was more potent to be a better preservative.

Keywords: Chicken sausages, Freezing, Quality, Spent hens, Vegetable oil seed.

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INTRODUCTION

A nutritious diet is necessary to lead a healthy life and it can reduce the risk of diseases which would help in maintaining better health status and moreover a secure life (Chetan *et al*., 2017). Health concerns about fat utilization and changes in consumer's preferences have led to comprehensive research on functional foods (Yang *et al*., 2007).

Consumption of meat from spent hens is limited by its poorer sensory quality, in particular poorer tenderness, compared to meat from broilers (Komiyama *et al*., 2010). Efficient utilization of spent hen meat in foods may revolutionize meat industry by standardizing appropriate and economic technology for processing such underutilized meat into value-added meat products that are palatable and economically viable (Kumar *et al*., 2015). The incorporation of vegetable oilseeds in meat products may have a positive effect on consumer health as they are free of cholesterol, higher ratio of unsaturated to saturated fatty acids and antioxidant properties. (Sanjeewa *et al*., 2010). The present study was undertaken keeping in view the necessity for proper utilization of less expensive meat from spent broiler breeder hens to produce cheaper and economically viable nutritious value added chicken sausages with addition of natural antioxidant substances like ground vegetable oil seeds. In this context, replacing synthetic antioxidants by natural compounds is considered as a useful strategy to prevent lipid oxidation of meat products (Fernandes *et al*., 2018). The poppy seed (Papaver somniferum L.) contains plenty of nutrients including antioxidants, tocopherols and other micronutrients (Aleem Muhammad *et al*., 2021). Sesame seeds contain sesamolin, sesaminol lignan and sesamin, which have more potent antioxidant and antimicrobial properties (Kumar and Singh 2015). Peanuts are excellent source of phenolic compounds, particularly proanthocyanidins (Opio and Photchanachai 2018). This study investigated the keeping quality of frozen functional chicken sausages added with three different ground oilseeds.

MATERIALS AND METHODS

The present research was carried out in the Department of Livestock Products Technology, College of Veterinary Science, Tirupati, Andhra Pradesh, India.

Raw material source: Spent broiler breeder birds (females) of 72 weeks age were purchased from Chandragiri local market and were slaughtered, deboned and harvested meat was utilized for the present study. All subcutaneous fat and inter muscular fat were removed from the meat and used as the fat source. All the dry spice ingredients purchased from the local market were cleaned thoroughly and dried in a hot air oven at 50ºC for 60 minutes. The ingredients were ground separately in a blender (Model: Panasonic MX-AC 3005) and sieved through a fine mesh and were stored at room temperature in air tight container for further use. Other non meat ingredients like sugar, salt, garlic, onions and binder were purchased from local supermarket. Onions and garlic were peeled off and made a fine paste in a ratio of 3:1 with help of mixer grinder. Selected oilseeds like poppy, sesame and groundnut seeds were

purchased from local super market. Three oilseeds were thoroughly cleaned separately, dry roasted in a pan and made into paste and were used to incorporate as partial replacer of animal fat in formulation of low fat sausages. The pastes were freshly prepared on the day of incorporation.

Method

Preliminary trials were conducted to select the optimum level of three ground vegetable oilseeds as partial fat replacers in the standardization of chicken sausages from spent broiler breeder hens (Table 1). Four experimental groups included in this study were as follows: Control (15 % chicken fat), T1 (5% chicken fat+10 % ground poppy seed), T2 (5% chicken fat+10 % ground sesame seed) and T3 (5% chicken fat+10 % ground peanut seed). For preparation of sausages, meat and fat were separately subjected to thorough mincing a meat mincer (Continental CCE 89/189) and the minced meat was chopped with salt, sugar, phosphate, fat, ice flakes, refine wheat flour, spices and condiments for 8 min in a bowl chopper (Schadfen 58452 written). The treatment and control batters were stuffed into synthetic cellulose casings (SCC21) using horizontal sausage stuffer (SIRMAN – V15, Italy) and then linked, tied and cooked at 80°C/40 min in moist heat. All the four batches were aerobically packed and kept at frozen (18±1° C) temperature for 180 days. The products were analysed the changes in the quality of sausages by physico chemical, microbiological and organoleptic evaluation at every 30 days interval over a period of six months.

Table 1. Formulations of functional spent broiler breeder hen sausages fortified with optimum level of ground vegetable oil seeds as fat replacer

Ingredient	Control	T1	T2	T3
Chicken meat (%)	85	85	85	85
Chicken fat (%)	15	5	5	5
Ground Poppy seed (%)	0	10	-	-
Ground Sesame seed (%)	-	-	10	
Ground groundnut seed (%)	-	-	-	10
Salt (%)	1.8	1.8	1.8	1.8
Sugar %	1	1	1	1
Polyphosphate(STPP)%	0.3	0.3	0.3	0.3
Ice %	10	10	10	10
Dry Spice mix %	2	2	2	2
Wet Condiment mix*	3	3	3	3
Refined wheat flour	3	3	3	3

* Onion: Garlic paste (3:1)

Analysis

The pH of the samples was determined by the procedure of Jay (1964). FFA values were determined based on the procedure of Koniecko (1979). The procedure of Witte *et al.* (1970) was followed to determine TBARS values of the samples. Tyrosine value of stored samples was determined based on the procedure of Strange *et al.* (1977). All the microbiological parameters of standard plate count, psychrophilic count, yeast and moulds count, coliform count, lactobacillus count and anaerobic counts were determined as per the methods described by APHA (2001). Sensory evaluation of chicken meat sausages thus prepared as per the standardized formulations were cooked separately in preheated oven at 180°C for 2 minutes and subjected to sensory evaluation on a 9 point hedonic scale by a semi-trained six member taste panel. The data (for six trails) obtained in the present study was analyzed statistically as per the methods outlined by Snedecor and Cochran (1980). Chicken sausages prepared were analyzed during storage period during frozen temperature (-18±1° C) at regular interval of 30 days to determine quality of the product by physico-chemical, microbiological and sensory parameters.

RESULTS AND DISCUSSION

Effect of formulation and storage period on the physico - chemical quality of chicken sausages stored at 18±1°C.

All the treatments along with control were not spoiled up to 180 days of storage at (-18±1°C). Formulation did not significantly influence the mean pH values but significantly affected the mean values of FFA, TBARS and tyrosine values. Control sausages recorded significantly ($P<0.05$) higher FFA, TBARS and tyrosine values than treatments (Table 2). Cyprian *et al*. (2017) observed higher thiobarbituric acid-reactive substances (TBARS) values in groups with higher lipid content. Among treatments, T2 sausages recorded significantly ($P<0.05$) lower FFA, TBARS and tyrosine values than other treatments throughout the storage period. This might be due to superior antioxidant activity of sesame seeds over poppy and groundnut seeds (Morris 2002). Similar trend was reported by Kanchan Kumari (2013) in chicken cutlets incorporated with sesame seeds and Pawar *et al*. (2013) in fish culets.

The mean values of pH, free fatty acid (percent oleic acid), TBARS and tyrosine values were significantly ($p<0.05$) affected by storage period with the highest values observed on day 180. Irrespective of the formulation, the mean values of pH, free fatty acid (percent oleic acid), TBARS and tyrosine values were increased significantly ($P<0.05$) as storage period progressed in all sausages. This significant increase in mean values might be due to the concomitant increase in the bacterial load which release metabolites during their metabolism and cause deamination of proteins (Jay 1996). The increase was also attributed to higher degree of oxidation and loss of free acidic groups of meat protein upon cooking (Lawrie 1998). Similar trend was reported by, Modi *et al*. (2006) in chicken curry, Teruel *et al*. (2014) in frozen chicken nuggets, Rajesh *et al*. (2015) in spent hen meat nuggets Holman *et al.* (2018) in frozen meat and Dipak *et al. (*2019) chicken nuggets.

Table 2. Effect of storage (-18±1°C) and formulation on physico-chemical quality of chicken sausages (Mean ± SE)

S. No.	Frozen Storage days							
1.	pH							
	Treatments	D ay 0	D ay 30	D ay 60	D ay 90	D ay 120	D ay 150	D ay180
	Control	6.31±0.007 a1	6.32±0.004 a12	6.33±0.004 a23	6.34±0.004 ab3	6.35±0.007 a3	6.37±0.007 b4	6.39±0.006 c5
	T1	6.30±0.01 a1	6.31±0.005 a12	6.32±0.006 a2	6.33±0.003 a23	6.34±0.004 a34	6.35±0.001 ab45	6.37±0.006 ab5
	T2	6.31±0.009 a1	6.31±0.004 a1	6.32±0.005 a12	6.33±0.003 a23	6.34±0.005 a23	6.35±0.004 ab3	6.35±0.006 a3
	T3	6.32±0.006 a1	6.32±0.004 a1	6.33±0.004 a12	6.34±0.003 ab23	6.35±0.004 a34	6.36±0.005 ab4	6.36±0.006 ab4
2.	FFA (% oleic acid)							
	Control	0.146±0.002 c1	0.160±0.001 d2	0.177±0.002 e3	0.218±0.005 a4	0.284±0.005 b5	0.383±0.003 b6	0.448±0.008 d7
	T1	0.130±0.001 b1	0.149±0.003 bc2	0.168±0.003 de3	0.214±0.004 a4	0.269±0.008 b5	0.318±0.01 a6	0.424±0.003 bc7
	T2	0.124±0.001 a1	0.136±0.001 a1	0.158±0.003 bc2	0.213±0.001 a3	0.247±0.009 a4	0.305±0.006 a5	0.400±0.009 a6
	T3	0.129±0.001 ab1	0.147±0.003 bc2	0.165±0.004 cd3	0.212±0.005 a4	0.267±0.005 b5	0.316±0.003 a6	0.423±0.003 bc7
3.	TBARS (mg of malonaldehyde)							
	Control	0.219±0.001 b1	0.288±0.004 d2	0.453±0.009 d3	0.655±0.002 d4	0.746±0.007 e5	0.830±0.002 d6	0.945±0.01 g7
	T1	0.214±0.001 b1	0.283±0.005 cd2	0.341±0.011 b3	0.521±0.006 c4	0.643±0.010 d5	0.739±0.012 b6	0.926±0.007 f7
	T2	0.210±0.001 a1	0.270±0.009 bc2	0.319±0.003 ab3	0.461±0.003 b4	0.570±0.005 b5	0.727±0.004 b6	0.874±0.004 d7
	T3	0.210±0.001 a1	0.282±0.004 cd2	0.334±0.007 b3	0.511±0.005 c4	0.625±0.003 cd5	0.730±0.005 b6	0.896±0.003 e7
4.	Tyrosine (mg)							
	Control	0.498±0.005 b1	0.732±0.018 d2	0.894±0.012 d3	1.193±0.010 d4	1.443±0.041 c5	1.701±0.040 c6	2.21±0.03 d7
	T1	0.467±0.007 a1	0.722±0.012 d2	0.838±0.003 c3	1.13±0.013 c4	1.43±0.02 c5	1.676±0.025 bc6	2.168±0.031 d7
	T2	0.450±0.007 a1	0.704±0.011 bcd2	0.829±0.006 c3	1.02±0.025 b4	1.33±0.035 b5	1.608±0.008 b6	2.06±0.02 c7
	T3	0.466±0.006 a1	0.717±0.008 cd2	0.832±0.007 c3	1.111±0.018 c4	1.321±0.019 b5	1.616±0.032 b6	2.136±0.013 cd7

Means bearing same numerical superscripts in each column and same alphabetical superscripts in each row do not differ significantly (P<0.05).

Table 3. Effect of storage (-18±1°C) and formulation on microbial quality of chicken sausages (Mean ± SE)

S.No.	Frozen Storage days							
1.	Standard plate count (cfu/g)							
	Treatments	D ay 0	D ay 30	D ay 60	D ay 90	D ay 120	D ay 150	D ay180
	Control	2.97±0.009 ^{c1}	3.05±0.016 ^{d1}	3.29±0.066 ^{b2}	3.87±0.044 ^{c3}	4.39±0.074 ^{c4}	5.39±0.023 ^{a5}	5.81±0.009 ^{b6}
	T1	2.84±0.016 ^{b1}	2.99±0.009 ^{bc2}	3.19±0.05 ^{ab3}	3.65±0.02 ^{ab4}	4.18±0.03 ^{ab5}	5.31±0.05 ^{a6}	5.79±0.007 ^{b7}
	T2	2.74±0.014 ^{a1}	2.94±0.017 ^{ab2}	3.13±0.052 ^{a3}	3.62±0.025 ^{a4}	4.12±0.037 ^{a5}	5.34±0.043 ^{a6}	5.66±0.056 ^{a7}
	T3	2.81±0.015 ^{b1}	2.97±0.021 ^{abc2}	3.18±0.033 ^{ab3}	3.63±0.039 ^{ab4}	4.17±0.044 ^{ab5}	5.30±0.053 ^{a6}	5.79±0.005 ^{b7}
2.	Psychrophilic count (cfu/g)							
	Control	ND	ND	ND	1.32±0.113 ^{c1}	1.99±0.067 ^{d2}	2.29±0.085 ^{d3}	2.73±0.013 ^{e4}
	T1	ND	ND	ND	1.28±0.093 ^{bc1}	1.78±0.048 ^{c2}	2.21±0.087 ^{cd3}	2.42±0.064 ^{d3}
	T2	ND	ND	ND	1.44±0.051 ^{c1}	1.62±0.066 ^{b1}	2.01±0.094 ^{c2}	2.18±0.074 ^{c2}
	T3	ND	ND	ND	1.27±0.099 ^{bc1}	1.73±0.024 ^{bc2}	2.25±0.086 ^{d3}	2.55±0.075 ^{d4}
3.	Yeast and mould count (cfu/g)							
	Control	ND	ND	ND	1.168±0.030 ^{b1}	1.25±0.018 ^{b2}	1.30±0.016 ^{e23}	1.33±0.015 ^{c3}
	T1	ND	ND	ND	1.05±0.018 ^{ab1}	1.11±0.016 ^{ab2}	1.20±0.020 ^{d3}	1.29±0.023 ^{c4}
	T2	ND	ND	ND	0.868±0.174 ^{ab1}	1.068±0.031 ^{ab1}	1.12±0.024 ^{c1}	1.15±0.017 ^{a1}
	T3	ND	ND	ND	1.03±0.012 ^{ab1}	1.08±0.007 ^{ab2}	1.14±0.01 ^{c3}	1.12±0.01 ^{b4}

Means bearing same numerical superscripts in each column and same alphabetical superscripts in each row do not differ significantly ($P<0.05$).

Table 4. Effect of storage (-18±1°C) and formulation on sensory quality of chicken sausages (Mean ± SE)

S. No.	Frozen Storage days							
1.	Appearance							
	Treatments	Day 0	Day 30	Day 60	Day 90	Day 120	Day 150	Day 180
	Control	7.62±0.14 ^{a1}	7.26±0.12 ^{a2}	7.06±0.08 ^{a2}	6.62±0.11 ^{a3}	6.41±0.09 ^{a34}	6.16±0.11 ^{a4}	5.48±0.08 ^{a5}
	T1	7.72±0.11 ^{a1}	7.27±0.11 ^{a2}	7.09±0.12 ^{a2}	6.65±0.14 ^{a3}	6.49±0.10 ^{a34}	6.23±0.12 ^{a4}	5.59±0.09 ^{a5}
	T2	7.87±0.11 ^{a1}	7.31±0.08 ^{a2}	7.11±0.10 ^{a2}	6.76±0.10 ^{a3}	6.50±0.11 ^{a34}	6.26±0.09 ^{a4}	5.69±0.10 ^{a5}
	T3	7.75±0.09 ^{a1}	7.31±0.09 ^{a2}	7.08±0.10 ^{a2}	6.73±0.08 ^{a3}	6.47±0.08 ^{a34}	6.25±0.08 ^{a4}	5.68±0.08 ^{a5}
2.	**Flavour**							
	Control	7.50±0.11 ^{a1}	7.20±0.10 ^{a1}	6.90±0.10 ^{a2}	6.68±0.10 ^{a2}	6.36±0.12 ^{a3}	6.08±0.12 ^{a3}	5.30±0.07 ^{a4}
	T1	7.66±0.11 ^{a1}	7.22±0.09 ^{a2}	6.91±0.08 ^{a3}	6.68±0.10 ^{a3}	6.36±0.12 ^{a4}	6.08±0.10 ^{a4}	5.38±0.08 ^{ab5}
	T2	7.69±0.12 ^{a1}	7.26±0.08 ^{a2}	6.95±0.10 ^{a23}	6.72±0.09 ^{a34}	6.43±0.09 ^{a4}	6.09±0.11 ^{a5}	5.41±0.08 ^{ab6}
	T3	7.63±0.102 ^{a1}	7.29±0.09 ^{a2}	6.95±0.09 ^{a3}	6.61±0.11 ^{a4}	6.41±0.19 ^{a4}	6.01±0.11 ^{a5}	5.47±0.08 ^{ab6}
3.	**Juiciness**							
	Control	7.54±0.11 ^{a1}	7.31±0.11 ^{a1}	6.90±0.07 ^{a2}	6.77±0.08 ^{a2}	6.41±0.09 ^{a3}	6.05±0.18 ^{a4}	5.41±0.09 ^{a5}
	T1	7.70±0.11 ^{a1}	7.33±0.11 ^{a2}	6.94±0.09 ^{a3}	6.79±0.10 ^{a3}	6.41±0.11 ^{a4}	6.00±0.10 ^{a4}	5.37±0.07 ^{a6}
	T2	7.73±0.12 ^{a1}	7.34±0.10 ^{a2}	6.98±0.08 ^{a3}	6.80±0.08 ^{a3}	6.44±0.11 ^{a4}	6.02±0.11 ^{a5}	5.54±0.09 ^{ab6}
	T3	7.68±0.09 ^{a1}	7.33±0.12 ^{a2}	6.93±0.09 ^{a3}	6.76±0.11 ^{a3}	6.45±0.10 ^{a4}	6.00±0.09 ^{a5}	5.50±0.07 ^{ab6}
4.	**Tenderness**							
	Control	7.82±0.11 ^{a1}	7.12±0.10 ^{a2}	6.91±0.10 ^{a2}	6.61±0.08 ^{a3}	6.20±0.10 ^{ab4}	5.97±0.11 ^{a4}	5.38±0.09 ^{a5}
	T1	7.81±0.11 ^{a1}	7.04±0.10 ^{a2}	6.90±0.15 ^{a23}	6.61±0.09 ^{a3}	6.19±0.12 ^{ab4}	5.95±0.11 ^{a4}	5.34±0.07 ^{a5}
	T2	7.81±0.09 ^{a1}	7.11±0.07 ^{a2}	6.91±0.10 ^{a2}	6.61±0.10 ^{a3}	6.20±0.09 ^{ab4}	5.98±0.10 ^{a4}	5.36±0.08 ^{a5}
	T3	7.80±0.09 ^{a1}	7.09±0.12 ^{a2}	6.90±0.10 ^{a2}	6.62±0.08 ^{a3}	6.16±0.09 ^{a4}	5.95±0.09 ^{a4}	5.34±0.07 ^{a5}
5.	**Overall acceptability**							
	Control	7.65±0.10 ^{a1}	7.19±0.10 ^{a2}	7.04±0.09 ^{a2}	6.50±0.10 ^{a3}	6.34±0.12 ^{a34}	6.09±0.10 ^{a4}	5.50±0.09 ^{a5}
	T1	7.66±0.12 ^{a1}	7.20±0.11 ^{a2}	7.05±0.09 ^{a2}	6.56±0.11 ^{ab3}	6.36±0.08 ^{a34}	6.11±0.08 ^{a4}	5.51±0.09 ^{a5}
	T2	7.68±0.12 ^{a1}	7.22±0.09 ^{a2}	7.06±0.09 ^{a2}	6.59±0.15 ^{ab3}	6.38±0.11 ^{a34}	6.13±0.11 ^{a4}	5.54±0.09 ^{a5}
	T3	7.66±0.08 ^{a1}	7.20±0.12 ^{a2}	7.04±0.09 ^{a2}	6.58±0.14 ^{ab3}	6.37±0.10 ^{a34}	6.12±0.09 ^{a4}	5.52±0.09 ^{a5}

Means bearing same numerical superscripts in each column and same alphabetical superscripts in each row do not differ significantly ($P<0.05$).

Effect of formulation and storage period on microbial quality of chicken sausages stored at -18±1°C

Mean standard plate and psychrophilic counts of all the treatments were differed significantly (P<0.05) from each other and also from control. Chicken sausages incorporated with ground vegetable oil seeds recorded significantly (P<0.05) lower counts than control. This might be due to antimicrobial properties of oilseeds. Among treatments, sausages with ground sesame seed recorded significantly (P<0.05) lower counts followed by sausages containing ground peanut seed and ground poppy seed respectively (Table 3). Similar trend was reported by Biswas *et al*. (2017) in chicken products.

The means of standard plate counts were influenced by storage period and were increased significantly as storage period advances irrespective of the formulation. Similar trend was reported by Rajesh Kumar *et al*. (2015) in spent hen meat nuggets and Rovira *et al*. (2023) in beef meat. Chicken sausages incorporated with ground vegetable oil seeds recorded lower counts than control though it was not significant. This is in conformity with Soher *et al.* (2013) in chicken burger. Regardless of formulation, psychrophilic, yeast and mould counts were not recorded in any of the sausages up to 60 days of frozen storage. The mean psychrophilic, yeast and mould counts of sausages increased significantly (P<0.05) as frozen storage progressed from 90 to 180 days. Similar increase in counts are in agreement with Nath *et al*. (2016) in chicken nuggets, Lengkey *et al*. (2016) in spent chicken sausages and Khursheed *et al*. (2017) in chicken meat balls. Regardless of formulation, coliform, lactobacillus and anaerobic counts could not be detected in any of the sausages throughout the frozen storage period. These results are in agreement with Karthikeyan *et al*. (2000) in goat meat keema and Dipak *et al. (*2019) chicken nuggets.

Effect of formulation and storage period on sensory quality of chicken sausages stored at -18±1°C

Formulation did not influence the mean appearance, juiciness, tenderness and overall acceptability scores of sausages significantly. The mean flavour scores of sausages were significantly (P<0.05) influenced by the formulation (Table 4). All the treatments scored slightly higher than control. The scores of all treatment groups for all sensory parameters were comparable throughout the storage period. Similar pattern was observed by Kanchan Kumari (2013) in chicken meat cutlets. The mean scores of all sensory parameters were significantly (P<0.05) influenced by the storage period and were decreased as storage period progressed irrespective of the formulation. The decrease in sensory scores of sausages with advancement of storage period might be due to pigment and lipid oxidation (Bhat *et al*., 2011) and increased TBA values of samples (Tarladgis *et al*., 1960). These results are in agreement with Pawar *et al*. (2013) in fish cutlets and Dipak *et al. (*2019) in chicken nuggets.

CONCLUSION

All the three different ground vegetable oil seeds added antioxidant and antimicrobial properties to the chicken

sausages from spent broiler breeder hens as evidenced by significantly lower values for almost all the microbial and oxidation parameters than control and also preserved the sensory quality at frozen temperature. Thus, chicken sausages of good acceptability and better storage stability could be prepared by incorporating ground vegetable oilseeds.

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