Original Research Article

Effect of addition of Whey Protein Concentrate and Skim Milk Powder on shelf life of chicken meatballs during refrigerated storage

ABSTRACT

The shelf life of chicken meatballs made with or without incorporation of whey protein concentrate and skim milk powder was assessed at refrigeration temperature (4±1°C). During storage of chicken meatballs the moisture, protein and fat declined significantly while pH, TBA, Tyrosine values increased significantly. The sensory scores for all the attributes declined with the progress of storage but all the products were acceptable up to 20th day of storage. Similarly, the total plate count, psychrophilic count and staphylococcal count increased significantly during 20 days storage but were within the spoilage limit indicating that the product could be safely stored for 20 days without adversely affecting the sensory and physico-chemical characteristics.

Keywords: Chicken meatball, Whey protein concentrate and Skim Milk Powder

INTRODUCTION

The Indian poultry sector has undergone a dynamic change from a mere backyard rearing activity to a commercial farming in a short span of time. The poultry sector contributes too many other socio-economic spin offs like slowdown of rural-urban migration. Growth witnessed in egg and poultry meat production ensures availability, affordability and food security. Now a day, with increase in poultry population, poultry industry has been transformed into dynamic, agro-based activity. Chicken meat and its products have experienced increasing popularity throughout the world. Poultry meat is considered relatively cheaper and no social taboo is attached to its consumption. Indian poultry industry worth about Rs. 600 billion has emerged as the most dynamic and fast expanding segment of our livestock economy over the past four decade. This sector account for about 0.45% of India's GDP and 10% of livestock GDP, India's output of 3.2 million ton egg and 2.8 million tons poultry meat in 2011, constituting around 5% and 2.8% of the global output of 64 and 100 million ton respectively, has led to its emergence as the 3rd largest egg and 5th largest poultry meat producer in the world (Singh, 2012). Despite cyclic boom and bust, the layer and broiler sectors have been growing at an average rate of 5% and 10% per annum respectively over the last decade. Broiler the meat purpose bird of 6 - 8 wks old is more tender and juicy because of less collagen content (Abe *et al.*, 1996). As the age advances, meat from such birds become poor in flavour, juiciness, and other sensory attributes (Bailey, 1984 and Lawrie, 1991). The meat from spent hen is generally tough, less tender and poor in functional properties because of its increased collagen content and cross-linkages (Wenham *et al.*, 1973). In general poultry meat is more acceptable because of its flavour, ease of digestion, low fat content and high ratio of unsaturated fatty acids, thus can play a significant role in introduction of value added innovative processed poultry products. White meat is the best choice for health conscious people because of its low fat and cholesterol content. Meatballs are a common meat based food product in Asia. Meatballs are usually made of minced meat that is bound together by filler along with other ingredients such as bread crumbs, spices and condiments. This product is usually prepared and rolled by hand and cooked by boiling in East Asia and Southeast Asia and often eaten with noodle and sauce. In other region, however, the meatballs are fried and ready to eat. Chinese meatballs (specifically, a dish common in Shanghai cuisine) are most often made of pork and are usually steamed or boiled, either as-is, or with the addition of soy sauce. Large meatballs, called lion's heads, can range in size from about 5 cm to 10 cm in diameter.

Non meat ingredients such as whey protein play a significant role in the modification of the functional properties due to its heat gelation properties of meat product such as emulsification, water and fat binding capacity and textural properties (El-Magoli et al., 1996; Gujral et al., 2002). Overall they are added as another gelling system that may improve yield and potentially reduce cost of the meat formulation (Hung and Smit, 1993). There are a few studies on the effect of whey protein concentrate and skim milk powder on physic-chemical properties, sensory qualities and microbiological qualities of meatball.

MATERIAL AND METHODS

Chicken meatballs were prepared as per the method of Mandal (1993) with slight modification. Meat from broiler and spent hen after separation of excess fat, tendon and dirt was chilled overnight at 4 ± 1^0 C and then frozen at -18 ± 1^0 C for 24 hours. After adequate thawing at room temperature, it was cut into small chunks and minced in meat mincer. The Chicken meatballs along with addition of non meat ingredients as shown in Table 1. were prepared as given in flow chart.

Table 1. Basic formulation of chicken meatballs

Sr. No.	Ingredients	Quantity (% by weight)
1	Deboned Meat	66.00
2	Chicken fat	05.00
3	Whole egg liquid	05.00
4	Boiled and mashed potatoes	05.00
5	Bread crumb	05.00
6	Green Condiment*	05.00
7	Table salt	01.75
8	Ground dry spices	01.75
9	Sodium Tripolyphosphate	00.48
10	Sodium nitrite	00.02
11	Ice cold water	05.00
	Total	100

*Green Condiment

Onion, garlic and ginger were used as condiments. The external covering of onion, garlic and ginger were peeled off and cut into small bits and blended in 3:1:0.5 ratio using Jyoti electric grinder with suitable blade to make into fine paste.

Fig .1 Flow diagram for preparation of chicken meatballs

Minced meat and fat, salt, nitrite and STPP

↓

Mixing for 30 sec.

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Addition of ice cold water

↓

Mixing for 1 min.

↓

Addition of Bread crumbs and whole egg liquid

↓

Mixing for 1.5 min.

↓

Addition of binders

↓

Mixing for 2 min.

↓

Addition of condiments, and spice mix

↓

Mixing for 2 min.

↓

Dough preparation

↓

Weighing and forming

↓

Frying

↓

Meatballs

↓

Packaging and Storage (4 ± 1^0 C)

The control samples and products containing WPC and SMP after cooling to room temperature were packed in high density polyethylene pouches and stored under refrigeration temperature in aerobic packaged conditions. The samples taken at regular interval of 5 days were analyzed for sensory, physicochemical and microbial quality. The pH of chicken sausage was determined by the method of Trout et al. (1992). The moisture, fat and protein content of chicken meatballs were determined by following the method of AOAC (1995). The weight of chicken meatball was recorded before and after cooking. The cooking yield was calculated and expressed in percentage. Emulsion stability was determined as per the procedure of Baliga and Madaiah (1971). The Tyrosine and TBA value were estimated by Strange et al. (1977). For sensory quality, the products were evaluated for appearance, flavour, juiciness, texture and overall acceptability using 8-point descriptive scale (Keeton, 1983), where 8 was extremely desirable and 1 was extremely undesirable. All the microbiological parameters were determined following APHA (1992). The data obtained from various trials under each experiment (n-12 for each experiment) were subjected to statistical analysis (Snedecor and Cochran, 1989) for analysis of two way variance and Duncan’s multiple range test (DMRT) to compare the means.

RESULT AND DISCUSSION

Sensory quality

Average scores for sensory attributes of chicken meatballs during refrigerated storage (4 ± 1°C) are presented in Table 2.

Table 2 Storage related changes in sensory attributes of chicken meatballs during refrigerated storage (4 ± 1°C)

Type of product	Storage period (days)						Treatment mean
	0	4	8	12	16	20	
	Appearance						
Control	7.40±0.12	7.30±0.12	7.12±0.12	6.86±0.24	6.57±0.12	6.28±0.12	**6.99 [a]**
WPC5%	7.20±0.12	6.98±0.12	6.85±0.12	6.67±0.12	6.58±0.12	6.34±0.12	**6.77 [b]**
SMP5%	7.00±0.12	6.84±0.13	6.80±0.12	6.61±0.12	6.47±0.12	6.29±0.12	**6.67 [b]**
Storage Mean	**7.20 [a]**	**7.04 [ab]**	**6.92 [b]**	**6.84 [b]**	**6.54 [c]**	**6.30 [d]**	
	Flavour						
Control	7.00±0.12	6.97±0.12	6.72±0.12	6.64±0.12	6.52±0.12	5.98±0.12	**6.64 [a]**
WPC5%	6.40±0.12	6.39±0.12	6.32±0.12	6.13±0.12	5.97±0.12	5.75±0.12	**6.16 [b]**
SMP5%	6.80±0.12	6.72±0.12	6.68 ±0.12	6.60±0.12	6.55±0.10	6.10±0.12	**6.58 [a]**
Storage Mean	**6.74 [a]**	**6.69 [a]**	**6.57 [ab]**	**6.46 [b]**	**6.35 [b]**	**5.94 [c]**	
	Juiciness						
Control	7.20±0.12	7.17±0.12	6.98±0.12	6.79±0.12	6.52±0.12	6.20±0.12	**6.81 [a]**
WPC5%	6.80±0.12	6.75±0.12	6.62±0.12	6.59±0.12	6.38±0.12	6.18±0.12	**6.55 [b]**
SMP5%	6.60±0.12	6.59±0.12	6.52±0.12	6.40±0.12	6.30±0.12	6.12±0.12	**6.43 [b]**
Storage Mean	**6.87 [a]**	**6.84 [a]**	**6.71 [a]**	**6.59 [b]**	**6.40 [c]**	**6.17 [c]**	
	Texture						
Control	7.52±0.24	7.44±0.24	7.07±0.12	6.85±0.12	6.52±0.12	6.28±0.12	**6.95 [a]**
WPC5%	6.82±0.12	6.76±0.12	6.59±0.12	6.52±0.12	6.49±0.12	6.31±0.12	**6.58 [b]**
SMP5%	6.75±0.12	6.71±0.12	6.66±0.12	6.57±0.12	6.40±0.12	6.29±0.12	**6.56 [b]**
Storage Mean	**7.03 [a]**	**6.97 [ab]**	**6.77 [b]**	**6.65 [bc]**	**6.47 [c]**	**6.29 [c]**	
	Overall palatability						
Control	7.12±0.12	7.01±0.12	6.82±0.12	6.70±0.12	6.52±0.12	6.12±0.12	**6.72**
WPC5%	7.21±0.12	7.16±0.12	6.99±0.12	6.68±0.12	6.46±0.19	6.28±0.12	**6.80**
SMP5%	7.18±0.12	7.12±0.12	6.88±0.12	6.67±0.12	6.52±0.12	6.32±0.12	**6.78**
Storage Mean	**7.17 [a]**	**7.09 [a]**	**6.89 [b]**	**6.68 [c]**	**6.50 [c]**	**6.24 [d]**	

The sensory scores of appearance for chicken meatball during storage differed significantly ($P<0.05$). The score was stable up to 4th day of storage, thereafter it declined significantly ($P<0.05$) till the end of storage. Among the meatballs, the difference in appearance scores of control (without binders) were significantly ($P<0.05$) higher than chicken meatballs incorporated with binders at the end of storage, this might be due to higher initial appearance scores of control. Rindhe (2008) also reported declining trend for appearance of cooked chicken sausages during refrigerated storage (4±1°C). The decline in appearance scores during refrigerated storage may be attributed to non-enzymatic browning of product. The flavour scores of chicken meatballs affected significantly during refrigerated storage. On 8th day, the flavour score was almost stable, thereafter declined significantly ($P<0.05$) towards the end of storage. As compared to both WPC as well as SMP added product meatball from control (without binders) recorded higher scores throughout storage, this might be due to higher flavour scores of control meatballs at 0 day. The decline in flavour score at the end of storage may be attributed to oxidation of fat and microbial growth (Devtkal *et al.*, 2003). This can be correlated with increase in TBA value at the later part of storage which limits the shelf life of chicken meatballs. Considerable reduction in flavour scores during storage of chicken patties was reported by Girish *et al.* (2004). According to Kumar and Sharma (2003), flavour score was stable upto 14th day of storage in low fat pork patties which decreased significantly ($P<0.05$) on 21st day. It is seen that irrespective of binders used, the juiciness scores of chicken meatballs differed significantly ($P<0.05$) during the refrigerated storage. The differences in scores were marginal up to 8th day of storage, but thereafter the scores decreased significantly ($P<0.05$) during entire storage period. The reduction in juiciness scores might be due to loss of moisture from the product during storage. Irrespective of storage, control (without binders) chicken meatballs recorded significantly ($P<0.05$) higher scores over WPC and SMP incorporated chicken meatballs. The present findings are in agreement with those reported by Rao *et al.* (1999) for smoked chicken sausages and Ghogare (2009) for nuggets during refrigerated storage (4±1°C). Rindhe (2008) reported that the juiciness score of cooked chicken sausages decreases significantly during the refrigerated storage but it is marginal up to 5th day of storage. The sensory scores for texture declined significantly ($P<0.05$) during refrigerated storage of 20 days. The differences were observed to be non significant up to 4th day of storage, thereafter the scores reduced significantly (P<0.05) with the progress of storage. Control product exhibited significantly (P<0.05) higher scores with regard to texture as compared to WPC and SMP incorporated products. The reduction in texture scores in all the products particularly at the later part of storage may be attributed to loss of moisture leading to hardening and also due to breakdown of fat and protein (Reddy and Rao, 1997). Similarly declining trend was observed for overall palatability of meatball during storage. The scores change was non significant up to 4th day of storage, but afterwards decreased significantly (P<0.05) during entire storage period. Moreover, the scores for overall palatability were higher for 5% WPC incorporated chicken meatball indicating that the overall quality was much better than that of control as well as SMP added product. Similar findings were recorded by Rao *et al*. (1999) for smoked chicken sausages. The decrease in sensory scores could be attributed to surface drying and oxidative rancidity during refrigerated storage (4±1°C). Chicken meatballs incorporated with WPC and SMP at 5% level scored significantly (P<0.05) lower score for sensory attributes than control (without binders) may be due to lower level of meat content and higher levels of binders (Kumar *et al.*, 2007). The sensory panelists rated overall acceptability of all chicken meatballs between good to very good even after 20 days of aerobic refrigerated storage.

Physico-chemical properties

The observations on storage related changes in physico-chemical properties of chicken meatballs are presented in Table 3.

Table revealed that the pH of meatballs increased significantly (P<0.05) throughout storage. Subsequent storage resulted in significant increase in pH. Similarly, the pH of product differed significantly (P<0.05) within the treatments. SMP added product recorded highest pH during storage followed by WPC incorporated meatballs. Girish *et al*. (2004) also recorded increase in pH of chicken patties during refrigerated storage. The increase in pH during storage might be due to accumulation of metabolites of bacterial action on meat and meat products and deamination of meat proteins (Jay, 1996). The reports regarding pH variation during storage are conflicting. Some research workers observed increase in pH

(Rindhe, 2008), stable pH (Lin and Chuang, 1999) and decrease in pH (Keeton, 1983).

Table 3 Storage related change in physico-chemical characteristics of chicken meatballs during refrigerated storage (4 ± 1°C)

Type of Product	Storage period (days)						Treatment mean
	0	**4**	**8**	**12**	**16**	**20**	
	pH						
Control	6.23±0.12	6.25±0.12	6.27±0.12	6.30±0.12	6.35±0.12	6.42±0.12	**6.30 [a]**
WPC (5%)	6.26±0.12	6.28±0.12	6.31±0.12	6.34±0.12	6.37±0.12	6.44±0.12	**6.33 [b]**
SMP (5%)	6.28±0.12	6.30±0.12	6.33±0.12	6.37±0.12	6.42±0.12	6.50±0.12	**6.37 [c]**
Storage Mean	**6.26 [a]**	**6.28 [a]**	**6.30 [a]**	**6.34 [b]**	**6.38 [b]**	**6.45 [c]**	
	TBA (mg/Kg)						
Control	0.23±0.01	0.25±0.01	0.27±0.01	0.34±0.01	0.48±0.01	0.70±0.01	**0.38 [b]**
WPC (5%)	0.24±0.01	0.26±0.01	0.28±0.01	0.35±0.01	0.47±0.01	0.59±0.01	**0.37 [a]**
SMP (5%)	0.25±0.01	0.27±0.01	0.30±0.01	0.36±0.01	0.50±0.01	0.61±0.01	**0.38 [b]**
Storage Mean	**0.24 [a]**	**0.26 [b]**	**0.28 [c]**	**0.35 [d]**	**0.48 [e]**	**0.63 [f]**	
	Tyrosine (mg/100g)						
Control	17.21±0.12	17.37±0.12	18.09±0.12	18.58±0.12	18.97±0.12	20.02±0.12	**18.37 [c]**
WPC (5%)	16.15±0.12	16.23±0.12	16.99±0.12	17.68±0.12	17.89±0.12	18.72±0.12	**17.28 [a]**
SMP (5%)	16.74±0.12	16.92±0.12	17.81±0.12	18.12±0.12	18.80±0.12	19.52±0.12	**17.99 [b]**
Storage Mean	**16.70 [a]**	**16.84 [a]**	**17.63 [b]**	**18.13 [c]**	**18.55 [d]**	**19.42 [e]**	

During storage, TBA value of control as well as SMP added chicken meatball was observed to be significantly (P<0.05) higher as compared to that of WPC added products. Irrespective of products made, the TBA values increased significantly throughout storage period of 20 days. The increase in TBA values particularly at the end of storage is indicative of oxidative rancidity but the values on 20th day were within the spoilage limit of 0.60 mg/Kg where the off flavours are generally detected in the product (Greene and Cumuze, 1982). The increase in values may be attributed to aerobic packaging and oxygen permeability of packaging material (Brewer *et al.*, 1992) that led to faster lipid oxidation of product. The products were acceptable and did not show any perceivable rancidity or off odour upto 20 days. Our findings confirm the result of Rajkumar and Berwal (2004) for pastirma made from boneless chevon and Rao *et al.* (1999) for smoked chicken sausages. The findings are in conformity with the results of Reddy and Vijayalakshmi (1998) for chicken meat sausages. Similar increasing trend was recorded in tyrosine values during refrigerated storage, but the values did not differ significantly up to 4th day of storage, thereafter reduced significantly ($P<0.05$) during entire refrigerated storage. Irrespective of storage, the tyrosine values were significantly ($P<0.05$) higher in control product which might be due to initial higher values in fresh product. The initial increase in tyrosine values might be due to variations in denaturation of proteins during cooking of products, further increase in tyrosine values during storage may be attributed to breakdown of proteins (Naveena *et al*. 2001). Increase in tyrosine values during refrigerated storage was reported by Vijayakumar and Biswas (2006) for enrobed duck cutlet and Ghogare (2009) for nuggets.

Compositional parameters

Observations with regard to changes in proximate composition of chicken meatballs are presented in Table 4.

Table 4 Storage related change in compositional characteristics of chicken meatballs during refrigerated storage (4 $\pm$ 1^{o}C)

Type of Product	Storage period (days)						Treat ment mean
	0	4	8	12	16	20	
	Moisture (%)						
Control	60.62±0.63	59.64±0.12	59.38±0.12	58.32±0.70	58.35±0.12	57.61±0.12	**58.99 ^{b}**
WPC (5%)	60.36±0.12	60.15±0.12	59.97±0.12	59.79±0.12	59.31±0.12	59.12±0.12	**59.78 ^{a}**
SMP (5%)	60.92±0.12	60.78±0.12	60.56±0.12	59.89±0.12	58.98±0.12	58.05±0.12	**59.86 ^{a}**
Storage Mean	**60.63 ^{a}**	**60.19 ^{b}**	**59.97 ^{b}**	**59.33 ^{c}**	**58.88 ^{d}**	**58.26 ^{e}**	
	Protein (%)						
Control	19.97±0.12	19.76±0.12	19.52±0.12	19.46±0.12	19.13±0.12	18.61±0.12	**19.41 ^{a}**
WPC (5%)	21.98±0.12	21.76±0.12	21.61±0.12	21.49±0.12	21.31±0.12	20.97±0.12	**21.52 ^{b}**
SMP (5%)	22.43±0.12	22.24±0.12	22.14±0.12	21.98±0.12	21.73±0.12	21.34±0.12	**21.98 ^{c}**
Storage Mean	**21.46 ^{a}**	**21.25 ^{b}**	**21.09 ^{c}**	**20.98 ^{c}**	**20.72 ^{d}**	**20.31 ^{e}**	

	Fat (%)						
Control	14.02±0.12	13.71±0.12	13.62±0.12	13.50±0.12	13.43±0.12	13.24±0.12	**13.58** [a]
WPC (5%)	14.12±0.09	14.05±0.12	13.87±0.12	13.79±0.12	13.51±0.12	13.30±0.12	**13.77** [b]
SMP (5%)	14.32±0.12	14.15±0.12	13.90±0.12	13.81±0.12	13.74±0.12	13.52±0.12	**13.91** [c]
Storage Mean	**14.15** [a]	**13.97** [b]	**13.80** [bc]	**13.70** [c]	**13.56** [c]	**13.35** [d]	

The moisture content of chicken meatballs decreased significantly (P<0.05) with the progress of storage of 20 days. Similarly, the moisture content of both WPC and SMP incorporated sausages were significantly (P<0.05) higher than control indicating the increased hydration ability of protein based binders during the entire storage period. Higher moisture content of WPC added chicken meatball than control may be attributed to formation of complex between whey protein and meat protein to which more moisture was bound through H-bonding and entrapment (Hynd, 1970). The findings are in agreement with those of Rao *et al*. (1999) and Rindhe (2008) for smoked chicken sausages and cooked chicken meatballs respectively. The protein content of WPC and SMP incorporated chicken meatball was significantly (P<0.05) higher than that of control. Increase in protein content in both products may be attributed to increased availability of proteins through WPC and SMP. During storage, the protein content decreased significantly (P<0.05) upto 20 days of storage. The decrease in protein content however non significant between 8th and 12th day of storage. Similar declining trend in protein content of chicken patties during storage was reported by Girish *et al*. (2004). Like that of protein, the fat content was significantly (P<0.05) higher in WPC and SMP treated chicken meatballs. This might be due to better fat retention and increased opportunity for fat protein interaction during storage (Lucca and Tepper, 1994). The fat content of meatball was significantly (P<0.05) decrease throughout the refrigerated storage. Rindhe (2008) also reported the same result during refrigerated storage of cooked chicken sausages.

Microbiological quality

Storage related changes in microbial quality of cooked chicken sausages are presented in Table 5.

Table 5 Storage related changes in microbiological quality of chicken meatballs during refrigerated storage (4 ± 1^{o}C)

Type of Product	Storage period (days)						Treatment mean
	0	4	8	12	16	20	
	Total plate count (log cfu/g)						
Control	2.48±0.06	2.66±0.06	3.01±0.06	3.38±0.06	3.58±0.06	4.14±0.06	**3.21**
WPC(5%)	2.47±0.06	2.63±0.06	2.97±0.06	3.26±0.06	3.57±0.06	4.09±0.06	**3.17**
SMP(5%)	2.50±0.06	2.68±0.06	3.04±0.06	3.38±0.06	3.70±0.06	4.21±0.06	**3.27**
Storage mean	**2.49** ^{a}	**2.66** ^{b}	**3.01** ^{c}	**3.34** ^{d}	**3.62** ^{e}	**4.15** ^{f}	
	Psychrophilic count (log cfu/g)						
Control	1.33±0.06	1.51±0.08	2.01±0.06	2.43±0.06	2.90±0.06	4.08±0.06	**2.38** ^{a}
WPC(5%)	1.29±0.06	1.67±0.06	2.15±0.06	2.43±0.06	2.87±0.06	4.06±0.06	**2.41** ^{a}
SMP(5%)	1.36±0.06	1.71±0.06	2.21±0.06	2.48±0.06	2.94±0.06	4.15±0.06	**2.47** ^{b}
Storage mean	**1.33** ^{a}	**1.71** ^{b}	**2.12** ^{c}	**2.45** ^{d}	**2.90** ^{e}	**4.10** ^{f}	
	Staphylococcal count (log cfu/g)						
Control	2.18±0.06	2.36±0.06	2.71±0.06	3.08±0.06	3.28±0.06	3.84±0.06	**2.91**
WPC(5%)	2.17±0.06	2.33±0.06	2.67±0.06	2.96±0.06	3.27±0.06	3.79±0.06	**2.87**
SMP(5%)	2.21±0.06	2.38±0.06	2.73±0.06	3.05±0.06	3.40±0.06	3.91±0.06	**2.93**
Storage mean	**2.19** ^{a}	**2.37** ^{a}	**2.72** ^{a}	**3.03** ^{a}	**3.34** ^{a}	**3.91** ^{a}	

The total plate count of chicken meatballs increased significantly ($P<0.05$) with the progress of refrigerated storage of 20 days. It is observed that the total plate count of three types of chicken meatballs did not differ significantly indicating that the microbiological quality of meatball made with or without incorporation of binders with regard to TPC was almost equal throughout the storage. At the end of storage, the TPC was far below the incipient spoilage level of 6.70 log cfu/g (Vonholy and Holzapfel, 1991) indicating the acceptability of meatballs on 20th day of refrigerated storage. Reddy and Rao (1996) observed similar increase of total plate count during study of effect of binders on quality of chicken loaves at refrigeration temperature (4±1°C). The psychrophilic count of chicken meatballs increased significantly (P<0.05) throughout refrigerated storage of 20 days, but the differences in psychrophilic count of three types of products were non significant. This may be attributed to growth preference of psychrophilic organisms during storage at refrigeration temperature. At the end of storage, the psychrophilic count of chicken meatballs with or without binders was far below the permissible level as 4.6 log cfu/g in meat and meat product (Cremer and Chipley, 1977). Increase in psychrophilic count during storage of low fat chevon rolls was also reported by Yadav and Sharma, (2004). The Staphylococcal count of chicken meatballs increased significantly (P<0.05) throughout refrigerated storage of 20 days, but the differences in psychrophilic count of three types of products were non significant. Similar observation was recorded by Kumar *et al*. (2007) for pork nuggets stored under refrigeration (4±1°C) for 28 days. The sliminess was observed on surface of chicken meatball on 24th day of storage with detection of slight off flavour. Since the appearance of products was not appealing, the storage study was discontinued after 20th day of refrigerated storage.

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