



Quality and Shelf Life of Spent Broiler Breeder Hen Chicken Koftas Incorporated with Vegetable Dried Powders during Refrigerated Storage

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ABSTRACT

The present research was carried out in Department of Livestock Products Technology, College of Veterinary Science, Tirupati, Andhra Pradesh, India during July–October, 2022. The objective of this study was to evaluate the shelf life of chicken koftas incorporated with vegetable dried powders each at 4% level under refrigeration ($4\pm 1^{\circ}\text{C}$) for a period of 20 days on physico-chemical, microbiological and organoleptic quality at an interval of 5 days. The quality parameters were significantly ($p < 0.05$) affected due to incorporation of potato, raw banana and capsicum dried powders and also due to refrigeration storage. The results revealed that there was a significant ($p < 0.05$) increase in the pH, TBARS, Tyrosine and total plate counts as storage progressed. Psychrophilic and coliform counts were not detected in the control and treated koftas during entire storage period. Yeast and mould counts were not detected on 0th day of refrigerated ($4\pm 1^{\circ}\text{C}$) storage in both control and treatments. The counts were detected on 5th day of storage in control and 10th day in treatments and thereafter the counts were increased significantly ($p < 0.05$) in both control and treatments. Sensory evaluation revealed a decrease in the sensory scores with the advancement of storage period. Based on the results, it can be concluded that addition of vegetable dried powders would not only extends the shelf life by protecting the product longer against oxidative rancidity but also had higher acceptability than control and their use in meat products can enhance the shelf life up to 20 days under refrigerated storage without undesirable changes.

KEYWORDS: Keeping quality, refrigeration, spent breeder koftas, vegetable powders

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1. INTRODUCTION

Chicken meat has grown much popularity among consumers and its production, marketing, and consumption is increasing to satisfy public demand worldwide. Consumers' acceptability of this meat has increased owing to its low production cost and high nutritional value (Elshebrawy et al., 2022). However, the rapid increase in poultry farming produced a massive availability of spent hen stocks. Spent broiler breeder hens produce commercial broilers with high hybrid vigour for meat production. Spent hen meat is a good source of nutrients such as proteins and omega-3 fatty acids (Chueachuaychoo et al., 2011) and lower in cholesterol content in particular breast muscle (Ajuyah et al., 1992) which have been shown to have health promoting benefits. Conversely, its meat is usually tougher, dry, and less juicy when compared with broiler meat. Its toughness is linked to increasing connective tissue cross-linking of older animals which prohibited its utilization and market value. Therefore, due to the lower acceptability and poor texture of this meat, it is sold at a lower price in the retail market which reflects on the producer's profits (Mendiratta et al., 2004). Furthermore, most spent hen carcasses are slaughtered, rendered, and converted into protein meals for animal feed owing to their higher protein content (Fan and Wu, 2022). Accordingly, using these hens in the production of value-added meat products with high nutritive value could achieve great profitability for both consumers and producers (Kadioglu et al., 2019). Reddy et al. (2016) showed that spent breeder meat is superior for preparing processed and value-added chicken meat products than spent layer and broiler meat. In spite of modern improved slaughter and food production techniques, lipid oxidation and microbial growth are the primary factors of spoilage of meat during refrigeration storage. Now a day's consumers are demanding the meat products with natural antioxidants due to drawbacks of synthetic antioxidants. Phenolic compounds are an important group of natural antioxidants (Pourreza, 2013). Nowadays, the application of natural-origin antioxidants and antimicrobial extracts in the chicken meat industry is largely increased (Sharma and Yadav, 2020). Some of the vegetables have antioxidant and antimicrobial properties.

Potato (*Solanum tuberosum* L.) are one of the most important staple crops following rice, wheat and corn (Zhang et al., 2017) for human consumption. Moreover, potato is rich in carbohydrates, proteins, phosphorus, iron, calcium, vitamin C, B₁ and B₂ and has high protein calorie ratio (Gopalan et al., 2010). Potato also contains antioxidants as phenolic acids, ascorbic acid and carotenoids (Gumul et al., 2011). Phenolic compounds such as hydroxycinnamic

acid derivatives and flavonoids have been found in potato peel extract (Samotyja, 2019). These compounds are used in a variety of industries, including the food, cosmetics, and pharmaceutical industries (Pap et al., 2004, Venkatachalam et al., 2021). Banana (*Musa ananalu*) is a part of human diet for several years and is that the second most vital fruit crop in Asian country next to mango (Abano, 2010). Green banana flour (GBF) contains 9.37% fibre (Pacheco-Delahaye et al., 2008). GBF is also rich in vitamin C and A, glutathione, flavonoids and phenolics which have potent antioxidant property (Suntharalingam and Ravindran, 1993). Green bell pepper (*Capsicum annuum* L.) is an excellent source of ascorbic acid and a fair source of provitamin A carotenoids (Haytowitz and Matthews, 1984). Vitamin C is known as an important compound in the body, such as collagen production, fat carrier, cholesterol regulator, and immune boosters (Pacier and Martirosyan, 2015). The present study was conducted to determine the shelf life of chicken koftas by incorporating vegetable dried powders like potato, raw banana and capsicum stored at refrigeration temperature (4±1°C) basing on physico-chemical, microbiological and sensory properties of the product.

2. MATERIALS AND METHODS

The present research was carried out in the Department of Livestock Products Technology, College of Veterinary Science, Tirupati, Andhra Pradesh, India during months of July 2022 to October 2022.

2.1. Source of raw material

Spent broiler breeder birds (Females) of 72 weeks age were purchased from Chandragiri local market, transported and slaughtered at the Department of Livestock Products Technology, College of Veterinary Science, Tirupati. Potato, raw banana and capsicum were procured from local vegetable market, washed with tap water for cleaning and removal of extraneous dirt. The cleaned vegetables were peeled manually with peeler, cut into slices and were made into a powder by using a home mixer/grinder.

2.2. Preparation of spent broiler breeder hen chicken koftas

The deboned meat was thoroughly screened for removing excess fat, tendon, etc. After adequate thawing in room temperature, meat was weighed, cut into small chunks and placed in the meat mincer. Meat mincing was done by 6 mm diameter plate and subsequently by 4 mm diameter plate (Sirman TC12E). In a minced meat, required amount of salt, polyphosphate and sucrose was added and chopped for 2 to 3 m. After addition of ice flakes, it was chopped again for 2 m. Thereafter, vegetable oil was added with continuous chopping followed by incorporation of condiment, vegetable dried powders, refined corn flour and spice mix. Chopping ended after formation of uniform batter mix. After preparing

emulsions, small koftas weighing approximately 20 g were prepared and were deep fat fried till the desired brown color and an internal temperature of 72°C is attained.

2.3. Analytical parameters

For shelf-life studies, pH was determined by following the procedure of Trout et al. (1992). Thiobarbituric Acid Reacting Substances (TBARS) value was estimated by the procedure of Tarladgis et al. (1960). Tyrosine value was estimated adopting the procedure of Strange et al. (1977). The Total plate counts (TPC), Psychrophilic counts (PPC), Yeast and mould counts (YMC) and coliform counts g⁻¹ of chicken koftas stored at refrigerated temperature were estimated as per the procedure recommended by Chesnut et al. (1977). The sensory panel consisted of six semi-trained faculty members of the college which evaluated various

sensory attributes like colour, flavour, juiciness, tenderness and overall acceptability by using an 8-point hedonic scale (Keeton, 1983) where, 8=extremely good and 1=extremely poor. The experiment was repeated thrice and the samples were analyzed in duplicate. The data thus obtained was subjected to statistical analysis using SPSS software.

3. RESULTS AND DISCUSSION

3.1. Physico-chemical properties

Effect of incorporation of vegetable dried powders on pH, TBARS and Tyrosine value (TV) of chicken koftas during refrigerated (4±1°C) storage are presented in Table 1.

3.1.1. pH

The overall mean pH values of spent broiler breeder hen

Table 1: Effect of incorporation of vegetable dried powders on physico-chemical and microbial quality of chicken koftas during refrigeration storage (4±1°C) (Mean±SE).

Treatments	Storage days				
	0	5	10	15	20
pH					
C	6.00±0.025 ^b	6.16±0.015 ^b	6.28±0.015 ^b	6.33±0.010 ^c	6.61±0.020 ^c
T ₁	6.12±0.019 ^c	6.15±0.013 ^b	6.19±0.015 ^a	6.25±0.017 ^b	6.31±0.013 ^b
T ₂	6.19±0.013 ^c	6.26±0.018 ^c	6.11±0.013 ^a	6.02±0.016 ^a	6.00±0.013 ^a
T ₃	5.88±0.028 ^a	6.06±0.017 ^a	6.25±0.018 ^b	6.30±0.013 ^c	6.34±0.016 ^b
TBARS value (mg malonaldehyde kg⁻¹)					
C	0.34±0.016 ^c	0.43±0.019 ^c	0.59±0.012 ^b	0.67±0.018 ^b	0.92±0.017 ^d
T ₁	0.30±0.015 ^c	0.36±0.020 ^b	0.56±0.015 ^b	0.62±0.017 ^b	0.75±0.018 ^c
T ₂	0.21±0.013 ^b	0.31±0.018 ^b	0.48±0.018 ^a	0.54±0.015 ^a	0.69±0.014 ^b
T ₃	0.17±0.018 ^a	0.28±0.014 ^a	0.43±0.013 ^a	0.56±0.012 ^a	0.64±0.018 ^a
Tyrosine value (mg 100 g⁻¹)					
C	0.42±0.011 ^a	0.55±0.016 ^b	0.78±0.013 ^b	0.81±0.013 ^a	1.45±0.016 ^d
T ₁	0.45±0.013 ^b	0.53±0.013 ^a	0.62±0.015 ^a	0.83±0.014 ^a	0.94±0.017 ^b
T ₂	0.46±0.014 ^b	0.52±0.001 ^a	0.71±0.014 ^b	0.80±0.017 ^a	0.86±0.014 ^a
T ₃	0.48±0.018 ^b	0.58±0.013 ^b	0.87±0.011 ^c	0.90±0.017 ^b	1.08±0.011 ^c
Total plate count (log CFU g⁻¹)					
C	2.21±0.027 ^c	2.88±0.012 ^d	3.49±0.001 ^c	4.18±0.015 ^d	6.33±0.019 ^d
T ₁	2.13±0.011 ^b	2.65±0.015 ^c	3.14±0.012 ^b	3.97±0.015 ^b	5.32±0.010 ^c
T ₂	2.09±0.029 ^a	2.53±0.021 ^b	3.12±0.015 ^b	4.08±0.014 ^c	5.13±0.014 ^b
T ₃	2.12±0.013 ^b	2.37±0.013 ^a	2.92±0.016 ^a	3.62±0.013 ^a	4.79±0.013 ^a
Yeast and mould count (log CFU g⁻¹)					
C	ND	1.38±0.013	1.56±0.014 ^d	1.92±0.015 ^d	2.34±0.015 ^c
T ₁	ND	ND	1.47±0.019 ^c	1.87±0.018 ^c	2.16±0.014 ^b
T ₂	ND	ND	1.36±0.013 ^b	1.41±0.018 ^b	2.14±0.015 ^b
T ₃	ND	ND	1.22±0.015 ^a	1.39±0.013 ^a	1.84±0.017 ^a

chicken koftas differed significantly ($p < 0.05$) between formulations and refrigerated storage days ($4 \pm 1^\circ\text{C}$). Significantly ($p < 0.05$) lowest mean pH values were recorded by T_2 koftas compared to rest of the formulations. This might be attributed to the availability of more readily utilizable carbohydrate molecules by the microbes and thereby formation of lactic acid (Aksu and Kaya, 2005). The mean pH values of all treatments and control were increased significantly ($p < 0.05$) with advancement of storage period except T_2 , where they were ($p < 0.05$) decreased. This significant ($p < 0.05$) increase in mean pH values might be due to the liberation of metabolites resulting from bacterial activity in addition to protein and amino acid degradation resulting in formation of ammonia (Chandralekha et al., 2012). The decrease in pH in T_2 koftas might be attributed to the metabolic activity of the bacteria and presence of fermentable carbohydrate (Jay et al., 1962, Borch et al., 1996). These results obtained in this study are in accordance with Jamwal et al. (2015) in chicken patties and Malav et al. (2015) in mutton patties. In a study conducted by Jamwal et al. (2015) green tea extract (400 mg kg^{-1}), fig (4%) and red pepper (10%) incorporated in chicken patties showed significantly ($p < 0.05$) lower values in comparison to control which might be attributed to the phenolic and bioactive compounds. Similar observations were made by Malav et al. (2015) who added cabbage powder to mutton patties.

3.1.2. Thio barbituric acid reactive substance (2-TBARS)

During storage, TBARS value of control was observed to be significantly ($p < 0.05$) higher as compared to that of Vegetable dried powders incorporated chicken koftas. The TBARS values of three products increased significantly ($p < 0.05$) throughout storage period of 20 days. The lower TBARS values in treatments might be due to antioxidative properties of dietary fibres as reported in various meat products by Mansour and Khalil (2000) and Raja et al. (2014). Among treatments significantly ($p < 0.05$) lower TBARS values were recorded by T_3 koftas. This might be due to antioxidative property of green bell pepper (*Capsicum annum* L.) which is an excellent source of ascorbic acid and a fair source of provitamin A carotenoids (Serdaroglu et al., 2005). Similar pattern was observed by Bhat et al. (2015) who added aloe vera to chicken nuggets showed significantly ($p < 0.05$) increased TBARS values throughout the storage period. However, the values of TBARS for Aloe vera-enriched nuggets were significantly ($p < 0.05$) lower than control nuggets on Day 7 and onwards. Similar observations were made by Jamwal et al. (2015) who added green tea extract (400 mg kg^{-1}), fig (4%) and red pepper (10%) to chicken patties; Sabikun et al. (2021) who added potato mash to chicken nuggets and Indumathi et al. (2022) who added ground vegetable oilseeds (poppy, sesame and peanut) at 10% level to spent chicken sausages.

3.1.3. Tyrosine value

Tyrosine values increased significantly ($p < 0.05$) during entire refrigerated storage irrespective of treatment and control. Increase in tyrosine values during storage may be attributed to breakdown of proteins. Similar increase in tyrosine values during refrigerated storage were reported by Ponsingh et al. (2010) who added potato flour at 3, 5 and 7% to buffalo meat sausages, Reddy et al. (2016) in turkey meat sausages added with raw carrot and radish paste each at 10% level and Indumathi et al. (2022) in spent chicken sausages added with ground vegetable oilseeds (poppy, sesame and peanut) each at 10% level.

3.2. Microbiological quality

3.2.1. Total plate count

Among the formulations, T_3 koftas recorded significantly ($p < 0.05$) lower total plate counts compared to rest of the formulations. Comparatively lower total plate counts of treated products might be attributed to the bioactive ingredients responsible for antimicrobial properties of antioxidant sources (Katiyar and Mukhtar, 1998, Yang et al., 2000). Regardless of type of formulation, the mean total plate counts ($\log_{10} \text{ CFU g}^{-1}$) were increased significantly ($p < 0.05$) with increase in storage period. This might be due to the permissive temperature and relative availability of moisture and carbohydrate substrate for microbial growth (Zargar et al., 2014 and Gupta and Sharma, 2017). Similar trend was observed by Kumar et al. (2013) in functional restructured chicken meat rolls containing herbal salt substitute blend and 10% barley flour. Total plate counts followed a linear increasing trend from 0 to 21st day of refrigerated storage in treatment product as well as control. However, the total plate count did not differ significantly ($p > 0.05$) between control and functional restructured chicken meat rolls with the progress of storage period except on 0 day; Malav et al. (2015) who added cabbage powder to mutton patties, Mahapatra et al. (2019) who added guava powder at the rate of 1%, 1.5% and 2% to chevon meatballs and Kumar et al. (2021) who added giloy stem powder to spent hen meat patties.

3.2.2. Yeast and mould counts

Yeast and mould counts ($\log_{10} \text{ CFU g}^{-1}$) were not detected on 0th day of refrigerated ($4 \pm 1^\circ\text{C}$) storage in both control and treatments. The counts were detected on 5th day of storage in control and 10th day of storage in treatments and thereafter the counts were increased significantly ($p < 0.05$) in both control and treatments.

This could be possibly due to post processing contamination and handling (Zargar et al., 2014). Significantly ($p < 0.05$) lowest mean yeast and mould counts were observed in T_3 koftas compared to rest of the formulations. The lower

counts may be attributed to the antifungal properties of capsicum dried powder (Yanti and Warsi, 2021). Similar observations were made by Kumar and Tanwar (2011) who added ground mustard to chicken nuggets and Jamwal et al. (2015) in chicken patties added with green tea extract (400 mg kg⁻¹), fig (4%) and red pepper (10%). The yeast and mold counts were detected on Day 14 and 21 of storage and were significantly ($p < 0.05$) lower for the products prepared with addition of green tea extract (400 mg kg⁻¹), fig (4%) and red pepper (10%) as compared to control.

3.2.3. Psychrophilic counts

Regardless of type of formulations, psychrophilic counts could not be detected in any of the treatments and control during entire refrigerated (4±1°C) storage. This might be due to temperature variance for growth of psychrophilic bacteria during refrigerated (4±1°C) storage (Indumathi et al., 2011). These results are correlated with Indumathi et al. (2011) in low fat chevon patties using sodium alginate as fat replacer and Chandralekha et al. (2012) who added pomegranate rind powder to chicken meat balls.

3.2.4. Coliform counts

Coliform counts could not be detected in both control as well as in treatments during the storage period of 20 days. Cooking of product to an internal temperature of 72°C, which might have been lethal to the coliforms and reflecting the good hygienic practices during the processing of products (Malav et al., 2013). Malav et al. (2013) reported that coliforms are not detected in restructured chicken meat blocks extended with sorghum flour and potato. Similar results were observed by Prasad et al. (2011) in chicken koftas added with oat flour (8%) and casein (2.5%) (Table 2).

3.3. Sensory evaluation

During storage period there was a significant ($p < 0.05$) decrease in mean appearance scores in all the formulations of chicken koftas. The decrease in appearance scores could be attributed to some pigment and lipid oxidation resulting in non-enzymatic browning (Verma et al., 2016). Decrease in appearance scores was also relatively higher in control samples than in treated samples might be due to the presence of polyphenol rich compounds which have the capacity to affect the colour and sensory characteristics of the treated products (Monteleone et al., 2004). Decrease in appearance scores with increase in storage period were reported by Jamwal et al. (2015) in chicken patties added with green tea extract (400 mg kg⁻¹), fig (4%) and red pepper (10%), Gupta and Sharma (2017) who added boiled and mashed potato, oat meal to functional restructured spent hen meat slices, Reddy et al. (2016) in turkey meat sausages added with raw carrot and radish paste and Kumar et al. (2021) in spent hen meat patties incorporated with giloy stem powder.

Among the formulations, T₁ koftas scored significantly ($p < 0.05$) higher flavour scores throughout the storage period compared to rest of the formulations. No significant difference ($p > 0.05$) was observed between T₂ and T₃ koftas. Similar findings were observed by Malav et al. (2013) in restructured chicken meat blocks and Gupta and Sharma, (2017) in functional restructured spent hen meat slices. Upon storage, there was a significant ($p < 0.05$) reduction in mean flavour scores in all formulations. Reduction in flavour scores might be due to the increase in the microbial growth and oxidative rancidity (Kumar and Tanwar, 2011). Similar decrease in flavour scores during storage were reported by Das et al. (2013) in spent chicken meat pickle, Jamwal et al. (2015) who added green tea extract (400 mg kg⁻¹), fig (4%) and red pepper (10%) to chicken patties and Kumar et al. (2021) in spent hen meat patties incorporated with giloy stem powder.

The juiciness scores of chicken koftas decreased significantly ($p < 0.05$) during the refrigerated storage which might be due to dehydration and moisture reduction of the product with advancement of refrigerated storage. Decline in juiciness scores was higher in control samples compared to treated products. The lower juiciness scores could be due to the moisture loss coupled with increasing microbial load leading to altering disulphide bonds and protein denaturation lowering water-binding activity (Jay, 1996). Among the formulations, T₃ and T₁ scored significantly ($p < 0.05$) higher values throughout the storage period compared to the rest of the formulations. Similar findings were noticed by Das et al. (2013) in desi spent hen nuggets added fermented bamboo shoot @ 10%; Kumar et al. (2013) who added green banana and soybean hull flours to chicken nuggets and Reddy et al. (2016) in turkey meat sausages added with raw carrot and radish paste.

T₁ koftas (4% potato dried powder) scored significantly ($p < 0.05$) higher texture scores throughout the storage period compared to rest of the formulations. This might be due to good acceptability the potato which increase the crispiness of the product (Ikhlās et al., 2011). Upon storage, there was a significant ($p < 0.05$) reduction in mean texture scores in all formulations. The reduction in scores might be attributed to some dehydration which led to hardening of the texture and also due to breakdown of fat as well as protein (Bhat et al., 2013). Similar decrease in texture scores were reported by Kumar et al. (2013) who added green banana and soybean hull flours to chicken nuggets, Malav et al. (2013) in restructured chicken blocks added with sorghum flour at 9% level and potato at 6% level and Gupta and Sharma (2017) who added boiled and mashed potato, oat meal each at 3% level to functional restructured spent hen meat slices.

The overall mean acceptability scores of spent broiler breeder

Table 2: Effect of incorporation of vegetable dried powders on the Sensory scores of chicken koftas stored under refrigeration storage ($4\pm 1^\circ\text{C}$) (Mean \pm SE)

Treatments	Storage days				
	0	5	10	15	20
<u>Appearance</u>					
C	6.94 \pm 0.020 ^a	6.81 \pm 0.014 ^a	6.68 \pm 0.012 ^a	5.01 \pm 0.014 ^a	SPL
T ₁	7.11 \pm 0.010 ^c	6.93 \pm 0.020 ^b	6.84 \pm 0.019 ^d	6.44 \pm 0.025 ^b	6.69 \pm 0.021 ^d
T ₂	7.09 \pm 0.014 ^b	6.92 \pm 0.021 ^b	6.78 \pm 0.011 ^c	6.52 \pm 0.015 ^c	6.41 \pm 0.012 ^c
T ₃	6.98 \pm 0.009 ^a	6.86 \pm 0.032 ^a	6.70 \pm 0.013 ^b	6.43 \pm 0.022 ^b	6.19 \pm 0.020 ^b
<u>Flavour</u>					
C	7.10 \pm 0.023 ^b	7.02 \pm 0.016 ^c	6.18 \pm 0.012 ^a	5.25 \pm 0.013 ^a	SPL
T ₁	7.16 \pm 0.011 ^c	7.11 \pm 0.012 ^d	6.75 \pm 0.022 ^d	6.32 \pm 0.015 ^b	6.15 \pm 0.012 ^d
T ₂	7.06 \pm 0.012 ^a	6.92 \pm 0.016 ^b	6.60 \pm 0.014 ^b	6.50 \pm 0.018 ^c	6.08 \pm 0.013 ^c
T ₃	7.03 \pm 0.012 ^a	6.81 \pm 0.012 ^a	6.70 \pm 0.011 ^c	6.62 \pm 0.015 ^d	5.95 \pm 0.020 ^b
<u>Juiciness</u>					
C	7.18 \pm 0.011 ^b	6.90 \pm 0.012 ^b	6.27 \pm 0.016 ^a	5.11 \pm 0.014 ^a	SPL
T ₁	7.14 \pm 0.012 ^b	6.75 \pm 0.017 ^a	6.65 \pm 0.023 ^c	6.33 \pm 0.012 ^d	6.11 \pm 0.013 ^d
T ₂	6.94 \pm 0.018 ^a	6.75 \pm 0.017 ^a	6.58 \pm 0.016 ^b	6.26 \pm 0.016 ^c	5.97 \pm 0.019 ^c
T ₃	7.20 \pm 0.012 ^c	7.15 \pm 0.015 ^c	6.82 \pm 0.016 ^d	6.14 \pm 0.013 ^b	5.67 \pm 0.019 ^b
<u>Texture</u>					
C	7.00 \pm 0.009 ^a	6.85 \pm 0.014 ^b	6.50 \pm 0.014 ^b	5.02 \pm 0.015 ^a	SPL
T ₁	7.12 \pm 0.014 ^c	7.06 \pm 0.016 ^d	6.74 \pm 0.017 ^c	6.55 \pm 0.017 ^d	6.13 \pm 0.011 ^d
T ₂	7.07 \pm 0.021 ^b	6.99 \pm 0.016 ^c	6.54 \pm 0.015 ^b	6.35 \pm 0.016 ^c	5.88 \pm 0.030 ^c
T ₃	7.02 \pm 0.013 ^a	6.74 \pm 0.021 ^a	6.43 \pm 0.016 ^a	6.28 \pm 0.012 ^b	5.75 \pm 0.017 ^b
<u>Overall acceptability</u>					
C	7.12 \pm 0.015 ^a	6.83 \pm 0.017 ^a	6.21 \pm 0.012 ^a	4.99 \pm 0.011 ^a	SPL
T ₁	7.21 \pm 0.014 ^b	7.15 \pm 0.012 ^d	6.76 \pm 0.014 ^d	6.49 \pm 0.021 ^d	5.84 \pm 0.019 ^c
T ₂	7.14 \pm 0.015 ^a	7.00 \pm 0.011 ^c	6.57 \pm 0.016 ^c	6.24 \pm 0.009 ^c	5.76 \pm 0.018 ^b
T ₃	7.12 \pm 0.014 ^a	6.96 \pm 0.018 ^b	6.49 \pm 0.015 ^b	6.16 \pm 0.020 ^b	5.74 \pm 0.012 ^b

hen chicken koftas were differed significantly ($p < 0.05$) between formulation. T₁ koftas recorded significantly ($p < 0.05$) higher overall acceptability scores compared to the other formulations and control throughout the storage period. This acceptance might be due to the suitability of potato dried powder in flavour and texture (Ikhlas et al., 2011). Regardless of formulation the mean overall acceptability scores of chicken koftas were significantly ($p < 0.05$) affected by the storage period and were significantly ($p < 0.05$) decreased as storage period advances. This decreasing trend might be due to the lowering of colour, flavour, juiciness and texture of the products during storage (Verma et al., 2016). Similar trend was reported by Das et al. (2013) in chicken pickle, Jamwal et al. (2015) who added green tea extract (400 mg kg⁻¹), fig (4%) and red

pepper (10%) to chicken patties and Yadav et al. (2016) in chicken sausages added with corn bran, dried apple pomace and dried tomato pomace.

4. CONCLUSION

Chicken koftas incorporated with vegetable dried powders were acceptable upto 20th day of refrigerated storage ($4\pm 1^\circ\text{C}$). Therefore, addition of vegetable dried powders had a great potential to be used in preparation of chicken koftas with good acceptability, lower microbial load and health benefits.

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