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# Effect of Natural Antioxidants on Quality Characteristics of Enrobed Chevon Meat Ball under Chilled or Refrigeration (4±1°C) Storage Conditions

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**A B S T R A C T**

Enrobed or coated chevon ball containing natural antioxidant TP (Tea polyphenol), GSE (Grape Seed Extract) at a level of (0.75%) in the batter mix were cooked and stored under refrigeration temperature (4±1°C) for evaluation of quality. Test samples were compared to control and Synthetic antioxidant BHA (Butylated Hydroxyanisole) containing enrobed chevon balls. The physio-chemical properties and oxidative stability like pH, TBA, FFA of the chevon balls were decreased significantly (P<0.05) with the progress of refrigerated storage (4±1°C) period. Moisture and fat % were deceased significantly (P<0.05) with the storage period. TPC and PC increased significantly (P<0.05). Sensory score like appearance, flavor, juiciness, texture and overall palatability were deceased significantly (P<0.05) during the entire storage period. The results indicated that physico-chemical, microbiological and fat % was significantly (P<0.05) higher in TP (Tea Polyphenol) containing enrobed chevon balls as compared to control and other treatments. But the sensory quality and moisture percent were higher in GSE (Grape Seed Extract) incorporated enrobed chevon balls. It was concluded that Teapolyphenol and grapes seed extract having antioxidant properties and can be used as natural antioxidant for enrobed chevon balls.

## Introduction

In this era of globalization and liberalization, product development and value addition is an imperative for competing the domestic as well as the world market. Now-a-days consumer preferences turned towards the variety of convenient products with better acceptability and lower price tag.

Battered and fried products are very popular in India as well as in world market. Enrobing of the meat is a method of value addition which enhances texture, flavour and appearance of the product and also increase consumer acceptance (Rao and Delaney, 1995). Enrobing of meat products provides advantages such as preserving the nutritive value, preventing moisture and weight loss,

improving juiciness and tenderness. These improvements are brought about by the coating ingredients which act as sealants and also prevent high oil uptake during frying of the product (Cunningham, 1989). Coatings of starch-alginate, starch-alginate-tocopherol and starch-alginaterosemary reduced warmed-over flavor (WOF) in precooked, refrigerated pork chops and beef patties (Hergens-Madsen *et al.,* 1995). The fried meat products are more prone to oxidative changes during refrigeration storage. Oxidation is a major cause of that deterioration because of its negative effects on organoleptic qualities (flavor, color, etc.). Oxidation of lipids can also have a marked negative effect on nutritional value, and could be responsible for the production of toxic compounds (McCarthy *et al.,* 2001). Lipid hydroperoxides formed during the propagation phase of the peroxidation process are unstable and produce various chemicals which adversely affect quality and safety by encouraging coronary heart disease, cancer and stroke (Senate Select Committee, 1977). To overcome this problem, synthetic antioxidants such as butylatedhydroxyanisole (BHA), butylated hydroxytoluene (BHT), tert-butylhydroquinone (TBHQ) have been used as antioxidants in meat products worldwide (Formanek *et al.,* 2001). Nowadays, concerns regarding food safety and toxicity of these synthetic antioxidants prompted research on natural antioxidants derived from plant sources. Some researchers Carpenter *et al.,* (2007) and Naveena *et al.,* (2008) have screened certain natural antioxidants such as pomegranate ellagic acid, tea catechins, grape seed extract, etc. Keeping in above views, the present study is designed to assess antioxidant properties of natural antioxidants like. Tea polyphenol and grapes seed extract in enrobed chevon balls.

## Materials and Methods

Boneless chevon was procured from local meat market and kept at refrigeration (4±1°C) for ageing for overnight. After trimming of fat and tendons, mincing of meat was carried out. Emulsion was made by blending of minced and chopped meat with addition of various ingredients like. Lean meat (60%), Mashed potato (15%), Vegetable oil (6%), Ice flakes (5%), Salt (1.5%), Refined wheat flour (5%), Spice mix (2%), Condiments (5%), Sodium nitrite (0.015%) and Full form STPP (0.50%), and then the balls were cooked in boiling water. Each ball was prepared from 7-10g of emulsion and put in boiling water for 15-20 min till the internal temperature of balls reached to 80±1°C. After cooling at room temperature, chevon balls were enrobed with batter mix containing different levels of natural antioxidant (GSE) and other ingredients like Gram flour (31%), Table salt (1.5%), Sugar (0.5%), Turmeric (1.5%), Capsicum (1.5%), Spice mix (1.5%), Whole egg (25%), Oil (1%), Water (36%), and then breaded (with bread crumbs) and fried. The enrobed chevon balls were cooled at room temperature and packaged in LDPE pouches and subsequently analyzed as per the experimental design. Acceptability of the product was judged on the basis of physico-chemical and sensory qualities characteristics.

Moisture (%) and fat (%) of chevon balls were determined as per the method of AOAC (1995). The pH of chevon balls were measured using digital pH meter (Systronics Digital pH meter 802) as suggested by AOAC, (1995) for which homogenized suspension was made by blending 10 g of sample with addition of 50 ml of distilled water. Thiobarbituric acid number of sample was determined as per Strange *et al.,* (1977) with slight modifications. The free fatty acid (FFA) content of the product was determined using method of AOAC (1995).

A sensory panel comprising of six semi-trained members from academic staff and students of the department were involved to evaluate the quality of chevon ball for various

sensory attributes like., appearance, flavour, juiciness, texture and overall acceptability using 8 point descriptive scale (Keeton, 1983), where '8' denotes 'extremely desirable' and '1' denotes 'extremely poor'.

The microbiological quality of chevon balls was assessed on the basis of total plate count (TPC) and psychrophilic count (PC) as per the procedure of APHA (1984). MacConkey agar and Eosin Methylene Blue agar were used for isolation of E. coli. Isolation of the organisms was made using general, selective and enrichment media and the isolates were identified on the basis of morphological, cultural and biochemical characteristics (Edward and Ewing, 1972).

The data analysis was carried out by using Analysis of variance method, as per the procedure described by Snedecor and Cochran (1989).

## Results and Discussion

The mean values of various parameters namely pH, TBA Value and FFA of enrobed chevan ball containing TP, GSE, BHA and control are presented in Table 1.

In the present study, refrigerated storage had a significant (P<0.05) effect on the pH values of control as well as treatments samples. The pH of enrobed chevon balls followed an increasing trend at progressive storage intervals. The mean pH values of treatment samples were comparable with the mean pH values of control on all days of storage. The increase in pH might be due to accumulation of metabolites of bacterial action on meat and meat products and deamination of meat proteins (Jay, 1986).

The study evidenced that the addition of TP in enrobed chevon balls lower the pH of product as compared to other treatments. Similarly Yadav and Sharma (2008) also found significant (P<0.05) increase in pH of control as well as enrobed patties during storage up to 28 days.

### TBA value

Thiobarbituric acid (TBA) value followed a significant (P<0.05) increasing trend from day 0 to 20 in treatment samples as well as control enrobed chevon balls. The TBA value was significantly (P<0.05) higher in control as compared to other treatments. Similar results were observed by Bhat *et al.,* (2011) and Karim *et al.,* (2012) in different enrobed products. Among the antioxidants treated products, TBA values were lower in TP treated enrobed chevon balls followed by other. The increase in TBA values during storage might be due to oxygen permeability of packaging material that in turn led to faster lipid oxidation (Garg and Mendiratta, 2006). Kang *et al.,* (2007) reported that the patties coated with material containing green tea leaf extract @ 0.5% showed lower TBARS value than the other treatments.

### FFA

The FFA content of enrobed chevon balls also increased significantly (P<0.05) throughout the refrigeration period of 20 days. FFA content decreased significantly (p<0.05) during refrigeration storage among all the treatment groups. Although the lowest FFA contents were observed in TP treated enrobed chevon balls as compared to other. This might be due to potency of the antioxidants to retard the lipolytic changes in meat products. Similar finding were observed by Sharma *et al.,* (2011).

### Proximate composition

The mean values of various proximate parameters namely moisture percent, fat percent content showed a significantly (P<0.05) decreasing trend with increasing

storage period. The significantly ($p<0.05$) changes were observed in proximate composition of the enrobed chevon balls prepared with or without incorporation of antioxidants, during refrigerated storage (4 ± 1°C) presented in Table 2. It was observed that moisture content of the product decreased significantly ($P<0.05$) with the refrigerated storage period of 20 days. The loss of moisture during storage might be due to evaporation of moisture from meat during storage (Arief *et al.,* 1989). These results corroborated with the findings of Karim *et al.,* (2012). The moisture loss was lower in GSE treated enrobed chevon balls as compared to other treatments. Non-significant ($P>0.05$) variation were observed in fat contents of enrobed chevon balls treated with different antioxidants but a significant reduction in fat content of enrobed chevon balls was noted during storage period.

## Microbiological characters

The mean values of various microbiological characteristics of aerobically packaged enrobed chevon balls containing TP, GSE, BHA and control are presented in Table 3.

## Total plate count (log cfu/g)

Total plate count followed a significantly ($P<0.05$) increasing trend from day 0 to 20 in control samples as well as in treatment. Further TP and GSE (@0.75%) containing enrobed chevon balls significantly ($P<0.05$) lower counts than other treatment. The low TPC in TP treated enrobed chevon balls might be due to antimicrobial activity of green tea (Banon *et al.,* 2007). All the products showed a significant ($P<0.05$) increase in TPC on the consecutive day of microbiological assessment. Biswas *et al.,* (2003) also observed that enrobed samples significantly ($P<0.05$) increased the total plate count (TPC) during chilled (21 days at 4±1°C) and frozen (45 days at -18±1°C) storage.

## Psychrophilic count (log cfu/g)

Psychrophilic count followed a significantly ($P<0.05$) increasing trend from day 5 to 20 in products containing antioxidants as well as in control. A gradual increase in psychrophilic counts during storage of different meat products had also been reported by Bhat *et al.,* (2011).

## Coliform

E. coli and Salmonella organisms were not detected in the enrobed chevon balls either with or without antioxidants at the end of storage study. It could be due to the destruction of these bacteria at cooking temperature, much above their death point of 57°C. Further, hygienic practices followed during the preparation and packaging of meat balls could also be one of the reasons for the absence of E. coli and Salmonella.

## Sensory attributes

The effect of enrobing and antioxidants on the sensory scores of enrobed chevon balls held under refrigeration (4±1°) storage conditions is shown in table 4.

Appearance of the enrobed chevon balls was found significantly ($P<0.05$) higher in natural antioxidants treated products. The appearance of the products was found to vary in the order as GSE>TP>BHA>Control. Also, it was observed that the appearance of the products decreased significantly ($P<0.05$) and gradually during 20 days of refrigerated storage. The decrease in appearance scores might be due to pigment and lipid oxidation resulting in non-enzymatic browning. A decrease in appearance and colour scores of meat products with increase in storage period was also reported by Bhat *et al.,* (2011) in chicken meat balls and Karim *et al.,* (2012) in chicken patties.

**Table.1** Effects of natural antioxidants on certain quality character of enrobed chevan balls during refrigeration (4±1°c) storage

| Type of product | Storage period (days) | | | | | Treatment (mean±S.E.) |
|---|---|---|---|---|---|---|
| | **0** | **5** | **10** | **15** | **20** | |
| | **pH** | | | | | |
| Control | 6.1±0.005 | 6.26±0.006 | 6.30±0.003 | 6.35±0.012 | 6.48±0.05 | 6.32±0.02[a] |
| BHA | 6.17±0.014 | 6.26±0.008 | 6.25±0.020 | 6.34±0.020 | 6.45±0.020 | 6.3±0.02[ab] |
| GSE | 6.14±0.023 | 6.26±0.011 | 6.32±0.037 | 6.35±0.014 | 6.47±0.012 | 6.31±0.03[a] |
| TP | 6.16±0.037 | 6.22±0.013 | 6.27±0.008 | 6.33±0.020 | 6.41±0.033 | 6.28±0.02[b] |
| Storage Period (Mean±S.E.) | 6.2±0.01[a] | 6.2±0.005[b] | 6.3±0.12[c] | 6.3±0.008[d] | 6.45±0.01[e] | |
| | **TBA(Thiobarbituricacid) (mg MDA/kg)** | | | | | |
| Control | 0.27±0.004 | 0.31±0.010 | 0.40±0.012 | 0.51±0.014 | 0.61±0.009 | 0.42±0.03[a] |
| BHA | 0.25±0.014 | 0.29±0.005 | 0.36±0.009 | 0.42±0.013 | 0.51±0.008 | 0.37±0.02[b] |
| GSE | 0.24±0.004 | 0.27±0.004 | 0.32±0.013 | 0.38±0.002 | 0.43±0.017 | 0.3±0.02[cd] |
| TP | 0.24±0.004 | 0.27±0.007 | 0.30±0.007 | 0.38±0.014 | 0.42±0.109 | 0.32±0.02[d] |
| Storage Period (Mean±S.E.) | 0.25±0.005[a] | 0.3±0.005[bc] | 0.4±0.012[cd] | 0.42±0.02[de] | 0.49±0.02[e] | |
| | **Free Fatty Acid (meq/kg fat)** | | | | | |
| Control | 0.34±0.005 | 0.91±0.033 | 1.62±0.020 | 2.82±0.02 | 4.43±0.083 | 2.02±0.35[a] |
| BHA | 0.31±0.017 | 0.73±0.003 | 1.31±0.058 | 2.05±0.035 | 3.53±0.093 | 1.58±0.27[b] |
| GSE | 0.28±0.004 | 0.65±0.016 | 1.05±0.063 | 1.48±0.041 | 2.97±0.087 | 1.28±0.22[c] |
| TP | 0.28±0.005 | 0.6±0.020 | 0.99±0.002 | 1.24±0.034 | 2.53±0.122 | 1.13±0.18[d] |
| Storage Period (Mean±S.E.) | 0.30±0.008[a] | 0.7±0.035[b] | 1.24±0.077[c] | 1.90±0.184[d] | 3.36±0.21[e] | |

[a,b,c,d,e] Means within each column not bearing a common superscript differ significantly at $p<0.05$

**Table.2** Effect of natural antioxidants on proximate composition of enrobed chevon balls during refrigeration storage

| Type of Product | Storage period (Days) | | | | | Treatment (Mean ±S.E.) |
|---|---|---|---|---|---|---|
| | **0** | **5** | **10** | **15** | **20** | |
| | **Moisture (%)** | | | | | |
| Control | 63.4±0.2 | 60.9±0.8 | 57.5±0.73 | 54.9±0.1 | 52.9±0.27 | 57.95±0.951$^{ac}$ |
| GSE | 63.9±0.3 | 63.0±0.21 | 62.6±0.08 | 58.7±0.4 | 57.83±1.5 | 61.24±0.655$^{b}$ |
| BHA | 63.6±0.1 | 60.3±0.39 | 58.1±0.61 | 56.7±0.5 | 53.26±0.6 | 58.42±0.861$^{b}$ |
| TP | 63.0±1.3 | 61.6±0.42 | 60.1±0.79 | 58.0±0.2 | 55.8±0.37 | 59.64±0.651$^{c}$ |
| Storage Period (Mean±S.E.) | 64.4±0.3$^{a}$ | 61.5±0.37$^{b}$ | 59.6±0.6$^{c}$ | 57.1±0.4$^{d}$ | 54.95±0.7$^{e}$ | |
| Fat (%) | | | | | | |
| Control | 24.4±0.2 | 24.2±0.15 | 23.5±0.13 | 22.6±0.1 | 21.4±0.2 | 23.2±0.274$^{a}$ |
| GSE | 24.0±0.1 | 23.69±0.0 | 23.1±0.06 | 22.7±0.14 | 21.8±0.01 | 23.1±0.185$^{a}$ |
| BHA | 24.2±0.1 | 23.7±0.1 | 23.2±0.19 | 22.8±0.17 | 21.7±0.07 | 23.1±0.217$^{a}$ |
| TP | 23.9±0.11 | 23.5±0.02 | 23.1±0.03 | 22.8±0.03 | 22.0±0.13 | 23.07±0.15$^{a}$ |
| Storage Period (Mean±S.E.) | 24.1±0.09$^{a}$ | 23.7±0.09$^{b}$ | 23.8±0.07$^{c}$ | 22.8±0.06$^{d}$ | 21.7±0.08$^{e}$ | |

a,b,c,d,e Means within each column not bearing a common superscript differ significantly at p<0.05

**Table.3** Effect of natural antioxidants on microbiological analysis of enrobed chevon balls during refrigeration storage

| Type of product | Storage period (days) | | | | | Treatment (mean±S.E.) |
|---|---|---|---|---|---|---|
| | **0** | **5** | **10** | **15** | **20** | |
| | **TPC(Total Plate Count)** | | | | | |
| Control | 1.2±0.008 | 2.1±0.06 | 2.9±0.03 | 3.2±0.3 | 3.5±0.03 | 2.6±0.21$^{a}$ |
| BHA | 1.17±0.03 | 1.9±0.01 | 2.27±0.08 | 3.1±0.03 | 3.5±0.04 | 2.5±0.20$^{b}$ |
| GSE | 1.13±0.03 | 1.9±0.02 | 2.43±0.03 | 2.9±0.01 | 3.4±0.01 | 2.3±0.192$^{c}$ |
| TP | 1.09±0.08 | 1.8±0.01 | 2.4±0.026 | 2.9±0.03 | 3.2±0.05 | 2.3±0.18$^{d}$ |
| Storage Period (Mean±S.E.) | 1.14±0.01$^{a}$ | 1.9±0.02$^{b}$ | 2.6±0.06$^{c}$ | 3.0±0.03$^{d}$ | 3.4±0.04$^{e}$ | |
| | **PC(Psychrophilic count)** | | | | | |
| Control | 0.19±0.05 | 0.61±0.01 | 1.45±0.07 | 1.8±0.03 | 2.1±0.03 | 1.2±0.17$^{a}$ |
| BHA | 0.18±0.05 | 0.47±0.01 | 1.08±0.04 | 1.5±0.05 | 1.8±0.038 | 1.01±0.1$^{b}$ |
| GSE | 0.19±0.04 | 0.42±0.06 | 1.01±0.03 | 1.4±0.04 | 1.73±0.01 | 0.9±0.14$^{cd}$ |
| TP | 0.18±0.05 | 0.41±0.06 | 0.96±0.02 | 1.4±0.06 | 1.72±0.03 | 0.9±0.14$^{d}$ |
| Storage Period (Mean±S.E.) | 0.19±0.02$^{a}$ | 0.05±0.03$^{b}$ | 2.1±0.06$^{c}$ | 1.5±0.05$^{d}$ | 1.83±0.04$^{e}$ | |

$^{a,b,c,d,e}$ Means within each column not bearing a common superscript differ significantly at p<0.05

**Table.4** Effect of natural antioxidants on sensory attributes of enrobed chevon balls during refrigeration storage

| Type of product | Storage period (days) | | | | | Treatment (mean±S.E.) |
|---|---|---|---|---|---|---|
| | **0** | **5** | **10** | **15** | **20** | |
| | **Appearance** | | | | | |
| Control | 7±0.01 | 6.72±0.012 | 6.37±0.027 | 5.77±0.103 | 5.23±0.145 | 6.22±0.159$^{a}$ |
| GSE | 7.1±0.057 | 6.96±0.033 | 6.82±0.015 | 6.52±0.037 | 6.43±0.035 | 6.76±0.063$^{bc}$ |
| TP | 7±0.058 | 6.98±0.016 | 6.78±0.064 | 6.52±0.020 | 6.04±0.088 | 6.66±0.089$^{c}$ |
| BHA | 6.99±0.006 | 6.83±0.011 | 6.73±0.018 | 6.51±0.054 | 5.97±0.03 | 6.60±0.087$^{d}$ |
| Storage (mean±S.E.) | 7.02±0.023$^{a}$ | 6.87±0.032$^{b}$ | 6.67±0.055$^{c}$ | 6.33±0.100$^{d}$ | 5.91±0.135$^{e}$ | |
| | **Flavour** | | | | | |
| Control | 6.92±0.056 | 6.73±0.012 | 6.26±0.092 | 5.66±0.285 | 4.73±0.261 | 6.06±0.203$^{a}$ |
| GSE | 7.20±0.026 | 7.03±0.033 | 6.85±0.031 | 6.66±0.029 | 6.37±0.011 | 6.826±0.071$^{b}$ |
| TP | 7.18±0.015 | 7.02±0.015 | 6.85±0.025 | 6.65±0.029 | 6.11±0.060 | 6.76±0.091$^{bc}$ |
| BHA | 6.96±0.024 | 6.77±0.034 | 6.58±0.094 | 6.27±0.113 | 5.82±0.069 | 6.48±0.101$^{d}$ |
| Storage (mean±S.E.) | 7.06±0.041$^{a}$ | 6.89±0.042$^{b}$ | 6.63±0.079$^{c}$ | 6.31±0.139$^{d}$ | 5.75±0.196$^{e}$ | |
| | **Juiciness** | | | | | |
| Control | 7.01±0.021 | 6.7±0.011 | 6.37±0.044 | 5.59±0.084 | 4.99±0.055 | 6.13±0.180$^{a}$ |
| GSE | 7.14±0.035 | 7.02±0.037 | 6.82±0.029 | 6.5±0.046 | 6.02±0.050 | 6.70±0.099$^{b}$ |
| TP | 7.10±0.046 | 6.99±0.01 | 6.81±0.031 | 6.55±0.052 | 6.00±0.063 | 6.69±0.096c |
| BHA | 7±0.015 | 6.72±0.024 | 6.51±0.014 | 6.21±0.017 | 5.79±0.127 | 6.44±0.103$^{d}$ |
| Storage (mean±S.E.) | 7.06±0.022$^{a}$ | 6.86±0.046$^{b}$ | 6.63±0.059$^{c}$ | 6.21±0.117$^{d}$ | 5.70±0.130$^{e}$ | |
| | **Texture** | | | | | |
| Control | 6.97±0.03 | 6.74±0.02 | 6.41±0.014 | 5.78±0.099 | 5.38±0.087 | 6.25±0.146$^{a}$ |
| GSE | 7.05±0.053 | 6.97±0.017 | 6.75±0.0240 | 6.48±0.015 | 6.10±0.029 | 6.67±0.085$^{b}$ |
| TP | 7.05±0.05 | 6.92±0.026 | 6.66±0.053 | 6.36±0.100 | 6.02±0.038 | 6.60±0.093$^{c}$ |
| BHA | 6.97±0.023 | 6.78±0.037 | 6.64±0.020 | 6.36±0.040 | 5.87±0.030 | 6.52±0.094$^{d}$ |
| Storage (mean±S.E.) | 7.01±0.021$^{a}$ | 6.85±0.0301$^{b}$ | 6.61±0.040$^{c}$ | 6.30±0.148$^{d}$ | 5.94±0.045$^{e}$ | |
| | **Overall palatability** | | | | | |
| Control | 7.01±0.044 | 6.76±0.032 | 6.43±0.078 | 5.32±0.127 | 4.45±0.072 | 5.99±0.236$^{a}$ |
| GSE | 7.1±0.057 | 6.95±0.032 | 6.72±0.034 | 6.43±0.066 | 6.00±0.112 | 6.64±0.098$^{bc}$ |
| TP | 7.09±0.054 | 6.93±0.041 | 6.69±0.041 | 6.39±0.10 | 5.96±0.028 | 6.61±0.100$^{c}$ |
| BHA | 7.0±0.054 | 6.91±0.017 | 6.61±0.026 | 6.15±0.104 | 5.53±0.052 | 6.44±0.134$^{d}$ |
| Storage (mean±S.E.) | 7.05±0.026$^{a}$ | 6.89±0.026$^{b}$ | 6.61±0.039$^{c}$ | 6.07±0.141$^{d}$ | 5.48±0.191$^{e}$ | |

$^{a,b,c,d,e}$ Means within each column not bearing a common superscript differ significantly at $p<0.05$

The flavour scores of both control and test samples varied significantly (P<0.05) with storage. The flavour and juiciness were significantly (P<0.05) higher in natural antioxidants treated enrobed chevon balls thought the storage period. The progressive decrease in flavour could be attributed to increase in thiobarbituric acid value of meat product (Tarladgis *et al.,* 1960) stored under aerobic conditions. Similar findings recoded by Bhat *et al.,* (2011).

Juiciness scores followed a decreasing trend throughout the period of storage. It could be due to some loss of moisture from the products during storage. The results were in accordance with findings of Biswas *et al.,* (2003). However, the juiciness scores of higher in antioxidant containing enrobed pork patty than control during the entire storage period.

Texture scores followed a decreasing trend throughout the period of storage significantly (P<0.05). Highest score was observed in natural antioxidant containing enrobed chevon balls. However, decreased textural scores at the end of storage might be due to release of moisture and changes in the properties of the proteins and fat during storage. Similar results were presented by Biswas *et al.,* (2003) and Bhat *et al.,* (2011).

The overall palatability of enrobed chevon balls also decreased significantly (P<0.05) throughout the period of storage. Natural antioxidant containing enrobed chevon balls gained highest score of overall palatability during the refrigeration storage period. These findings were in corroboration with the results reported by Biswas *et al.,* (2003) in enrobed pork patty, Bhat *et al.,* (2011) in chicken meat balls, Kenawi *et al.,* (2011) in low fat beef product and Karim *et al.,* (2012) in chicken patties.

From the above findings it can be concluded that Teapolyphenol and grapes seed extract acts as natural antioxidant by, decreasing the TBA, FFA and microbial growth from enrobed chevon balls and improves the sensory attributes like appearance, flavor, juiciness texture as well as palatability of enrobed chevon balls.

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