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Storage Stability of Chevon Rolls Incorporated with Ethanolic Extracts of *Aloe vera* and Cinnamon Bark at Refrigeration Temperature (4±1°C)

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ABSTRACT

The present study was conducted to assess the storage stability of chevon rolls prepared by incorporating various phyto-extracts viz. Control (C), T_1 (chevon rolls with 0.40% ethanolic *aloe vera* extract) and T_2 (chevon rolls with 0.25% ethanolic cinnamon extract) during refrigerated storage (4±1ºC) under aerobic packaging conditions. Chevon rolls were stored for 35 days and analyzed for pH, oxidative stability, microbial and sensory attributes at a regular interval of 7 days. The pH followed gradual decreasing trend with the advancement of storage period irrespective of treatments. The various oxidative stability parameters such as PA (peroxide value), TBARS (thiobarbituric acid reacting substances) and FFA (free fatty acid value) followed an increasing trend in all products with treated samples (T_1 and T_2) showed lower value than control. Standard plate count and psychrophilic count were significantly ($P<0.05$) lower in treated products than control and microbial count was better maintained in T_2 than control. As the days of storage increased, scores for overall acceptability showed significantly ($P<0.05$) decreasing trends, however the score was recorded highest for T_1 during entire storage. Thus chevon rolls could be successfully stored upto 28 days under refrigerated condition (4±1°C) under aerobic packaging.

Keywords: *Aloe vera*, cinnamon, phyto-extracts, storage stability, aerobic packaging

Goat meat (Chevon) is one of the most commonly consumed meat in the world particularly in tropical countries, like other meat it is also rich in nutrient therefore readily perishable. Chevon is lower in calories, total fat, saturated fat and cholesterol than traditional meats. Demand for the convenient and ready-to-eat chevon meat products such as chevon rolls is continuously increasing, especially in developing countries due to heavy industrialization and globalization which stimulated growth of per capita income, double income families, less time to cook and up-gradation of living standard (Singh *et al*., 2014a, b; Singh *et al.*, 2015 a, b, c; Kumar *et al*., 2016). Chevon rolls are perfect choice to give the convenient, ready to eat, highly nutritious and economical emulsion based meat product to the consumer. Like meat, these chevon rolls are inherently low in antioxidants and thus are more prone for lipid peroxidation and poor storage life.

During preparation of meat products, incorporation of natural compounds exerting antioxidant potential are increasing day by day over synthetic compounds due to associated ill effects upon consumption of later and consumers increasingly preference for natural compounds (Kumar *et al.*, 2013). Incorporation of the plant components like bark, powder etc. directly into meat products can cause a major change in its organoleptic quality. Moreover, they will be required in a higher concentration to exert their antimicrobial and antioxidant effect. The incorporation of extracts could be a promising approach. Incorporation of ethanolic extracts of *aloe vera* powder at 0.40% level and cinnamon bark at 0.25% were found optimum for development of chevon rolls (Rathour, 2016).

Packaging of meat products plays a crucial role in extending shelf life of meat products as packaging materials acts as

vapour barrier, preventing entry of oxygen into the package and loss of water from the food. It has significant effect on quality of products and also facilitates marketing of these products. The changes taking place during low temperature storage are desiccation, discoloration, development of rancidity, etc. Application of proper packaging such as aerobic packaging retards these changes and extends shelf life of products. Aerobic packaging is an easy, simple, fast and economical packaging technology.

Thus keeping above factors in considerations, present study was undertaken to evaluate storage stability of chevon rolls incorporated with *aloe vera* and cinnamon bark extracts during refrigerated storage (4±1ºC) under aerobic packaging in terms of various physico-chemical, microbiological and sensory parameters.

MATERIALS AND METHODS

Source of materials

Goat meat required for the experiments were obtained after slaughtering goat as per standard procedure in the experimental slaughterhouse of Department of Livestock Products Technology, College of Veterinary Science, GADVASU, Ludhiana, Punjab, India. The dressed carcasses were brought to the laboratory and hot deboned manually. After removal of all separable connective tissues, fat and fascia, and blood vessels the boneless meat was packed in colourless low density polyethylene (LDPE) bags and stored over night at 4±1°C in a refrigerator for conditioning and then frozen at -18±1°c for subsequent use.

The spice mix was prepared by mixing different spices ingredient as per the pre standardized formulation (Singh *et al*., 2014a). Good quality onion, ginger and garlic were procured from local market and cleaned with potable water. Garlic bulbs were peeled manually. The condiment mix was prepared by mixing onion, ginger and garlic paste, respectively in 3:1:1 ratio.

Methodology for Preparation of chevon rolls

Chevon was partially thawed overnight, cut into small cubes and double minced through 4 mm plate in meat mincer (Mado Eskimo Mew-714, Mado, Germany). Three batches of chevon emulsion viz. T_1 with 0.40% ethanolic *aloe vera* extract and T_2 with 0.25% ethanolic cinnamon bark extract, were prepared in a bowl chopper (Seydelmann K20, Ras, Germany). The 90% ethanolic extract of *aloe vera* and cinnamon bark exhibited higher *in-vitro* antioxidant ability than aqueous extract at time, temperature combination of 15 min for 65°C and 9h for 60°C respectively and their levels of incorporation during preparation of chevon rolls were standardized in basic formulation at 0.40% *aloe vera* extract and 0.25% cinnamon extract (Rathour, 2016). Pre-weighed quantity of minced chevon, salt, sodium tripolyphosphate and sodium nitrite was added and chopping was done for about 2-3 minutes. It was chopped again for 2 minutes after the addition of ice flakes. Refined vegetable oil was slowly incorporated while chopping till it was completely dispersed in the batter. Condiment paste, dry spice mix, refined wheat flour and other ingredients were added. Chopping was continued till uniform dispersion of all the ingredients and desired consistency of the emulsion was achieved. Meat emulsion of about 300 gm was filled in stainless steel (SS) cylindrical mold. These were kept in pressure cooker and cooked in hot air stream at 120ºC for 30 min.

Table 1: Formulations of the chevon roll

Name of ingredients (% w/w)	Control	T_1	T_2
Chevon	70.00	69.60	69.75
Ice/Chilled water	9	9	9
Vegetable oil	10	10	10
Condiments	3.80	3.80	3.80
Salt	1.60	1.60	1.60
Refined wheat flour	3.50	3.50	3.50
Dry spices	1.50	1.50	1.50
STPP	0.30	0.30	0.30
Sugar	0.30	0.30	0.30
Nitrite	100 ppm	100 ppm	100 ppm
Aloe vera extract	—	0.40	—
Cinnamon bark extract	—	—	0.25

The treated as well as control chevon rolls were packaged

in 140 gauge low density polyethylene (LDPE) bags under aerobic conditions with packaging machine (Ramon Packaging Machine VP-580 A Model , type 19/S/CL, Germany). One packet from each batch was used for evaluation of physico-chemical, microbiological and sensory parameters of cutlets on the day of processing. The remaining packets from each group were stored at refrigeration temperature (4 ± 1^0C) and examined at intervals of seven days up to 35 days.

pH and oxidative stability parameters

The pH of chevon rolls was estimated as per the procedure of Trout *et al*. (1992) using combined glass electrode of pH meter (ELICO, Model LI 127, Hyderabad, India). The oxidative stability was measured by estimating TBRAS, FFA and PV. TBARS value of chevon rolls were estimated as per Witte *et al*. (1970). The method as described by Koniecko (1979) was followed for quantification of free fatty acids (FFA) and peroxide value (PV).

Microbial quality

Microbiological profile such as standard plate count, psychrophilic count and coliform count in the samples were determined by methods described by APHA (1984). Preparation of sample and serial dilutions were done near a flame in a laminar flow apparatus (Thermo Electron Corporation. D-63505 Langenselbold, Robert Boschstr. 1, Germany) observing aseptic conditions.

Sensory evaluation

A seven member experienced panel comprising of scientists and postgraduate students of the Department of Livestock Products Technology, GADVASU, Ludhiana assessed the chevon rolls for various sensory quality attributes that is appearance and colour, flavour, tenderness, juiciness and overall acceptability, using 8-point descriptive scale, where 8=extremely desirable and 1=extremely undesirable. The potable water was provided in between samples to cleanse the mouth palate.

Statistical analysis

Data was analyzed statistically on SPSS- 16.0 (SPSS Inc., Chicago, IL, USA) software packages as per standard methods (Snedecor and Cochran, 1989) for Analysis of Variance (ANOVA) and Duncan's multiple range test (DMRT) to compare the means. Duplicate samples were drawn for each parameter and the whole set of experiment was repeated three times. Mean values were reported along with standard error. Sensory evaluation was performed by a panel of seven members thrice (n= 21). The statistical significance was estimated at 5% level ($P < 0.05$).

RESULTS AND DISCUSSION

pH

The pH values followed a gradual decreasing trend with the advancement of storage period till the 35th day of storage in both the control and all the treatment products (Table 2). This could be due to presence of some fermentable carbohydrates in the product which leads to the production of lactic acid. Similar decrease in pH during refrigerated storage was reported by Verma *et al*. (2013) in sheep meat nuggets on incorporation of guava powder and Banerjee *et al.* (2012) in goat meat nuggets on incorporation of broccoli powder extract. Similarly McCarthy *et al*. (2001) reported decreased pH values of frozen pork patties containing *aloe vera* and mustard decreased over time. Incze (1992) reported that decrease in the pH might be due to significant ($P<0.05$) increase in psychrophilic and lactobacillus count during storage period producing lactic acid by breakdown of carbohydrates.

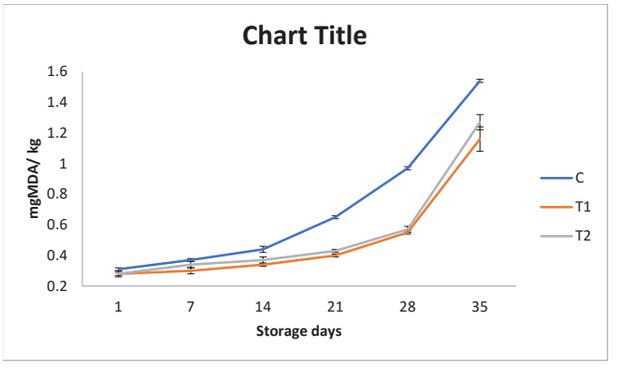

Fig 1: TBRAS value of chevon rolls stored at refrigeration temperature ($4\pm1^{\circ}$C)

C=control, T_1= chevon rolls with 0.40% *aloe vera* extract, T_2= chevon rolls with 0.25% cinnamon bark extract

Table 2: pH and microbial quality of aerobically packaged chevon rolls incorporated with optimum level of phyto-extracts (Mean±S.E.)*.

Treatment	Refrigerated storage period (Days)					
	1st day	7th day	14th day	21th day	28th day	35th day
			pH			
C	6.12±0.06^{b}	5.88±0.06^{bA}	5.71±0.09^{ab}	5.52±0.02^{ab}	5.11±0.07^{Aa}	5.06±0.07^{aAB}
T_1	6.17±0.02^{b}	5.79±0.07^{bB}	5.63±0.09^{ab}	5.60±0.08^{ab}	5.45±0.05^{abAB}	5.01±0.03^{aA}
T_2	6.22±0.05^{b}	6.18±0.07^{bA}	5.98±0.08^{bc}	5.75±0.04^{bc}	5.61±0.04^{abAB}	5.14±0.02^{aB}
			SPC (log_{10} cfu/gm)			
C	2.95±0.03^{Ba}	3.92±0.02^{Db}	4.49±0.02^{Cc}	4.98±0.03^{Dc}	6.07±0.02^{Dd}	7.14±0.04^{Be}
T_1	2.35±0.02^{Aa}	2.47±0.05^{ABa}	3.13±0.08^{Ab}	3.48±0.04^{Ab}	4.62±0.05^{Bc}	5.43±0.07^{Ad}
T_2	2.51±0.07^{ABa}	2.67±0.03^{Ba}	3.22±0.04^{Ab}	4.02±0.04^{BCc}	4.81±0.06^{Bd}	5.93±0.09^{Be}
			Psychrophilic count (log_{10} cfu/gm)			
C	ND	ND	1.59±0.02^{a}	2.42±0.04^{Bb}	3.60±0.02^{Cc}	5.04±0.02^{Ed}
T_1	ND	ND	ND	1.26±0.05^{Aa}	2.35±0.04^{Ab}	4.02±0.03^{BCc}
T_2	ND	ND	ND	1.74±0.06^{ABa}	2.62±0.05^{Bb}	4.58±0.09^{Dc}

*Mean±S.E. with different superscripts row wise (small alphabet) and column wise (capital alphabet) differ significantly (P<0.05). n =6 for each treatment.

C=control, T_1= chevon rolls with 0.40% *aloe vera* extract, T_2= chevon rolls with 0.25% cinnamon bark extract

TBARS value

TBARS values followed a significant (P<0.05) increasing trend from day 1 to 35 for all treatments as well as control products (Fig 1). This could be possibly due to increased lipid oxidation and production of volatile metabolites in presence of oxygen. The increase in TBRAS value were also reported by Bhat *et al*. (2015) in chicken nuggets, Kumar *et al*. (2013) in emu meat nuggets and Kumar *et al.* (2015) in chevon patties. The mean values of TBARS values during the storage period were below the minimum threshold value i.e., 1-2 mg malonaldehyde/kg meat (Watts, 1962). Increase in TBARS value of treatment products were lower than the both the control and further this increase was slower in treatment under aerobic packaging which might be due to antioxidant effect of incorporated phytoextracts. Treatment products had significantly lower (P<0.05) TBARS value than control throughout the storage. Among the treatment significantly lower(P<0.05) TBARS value was noticed for the T_1 throughout the storage period which might be due to strong antioxidant activity of *aloe vera* extract due to the presence of α-tocopherol (vitamin E), anthraquinonescarotenoids, ascorbic acid (vitamin C), flavonoids and tanninsand.

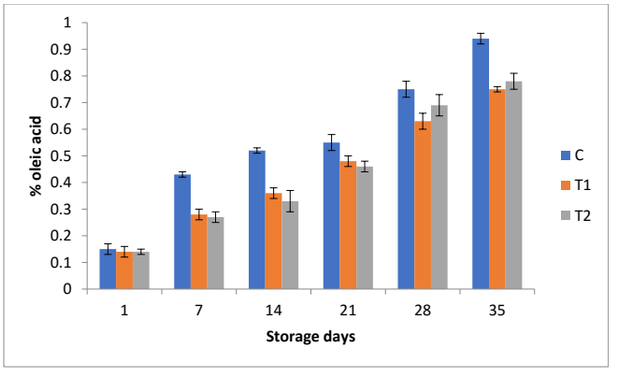

Fig 2: FFA value of chevon rolls stored at refrigeration temperature (4±1˚C)

(C=control, T_1= chevon rolls with 0.40% *aloe vera* extract, T_2= chevon rolls with 0.25% cinnamon bark extract)

Free fatty acids (FFA)

Free fatty acid content also followed a similar trend as shown in the TBARS values, there was positive correlation between TBARS values and free fatty acids

values since both were related with fat oxidation (Fig. 2). FFA values were significantly higher ($P<0.05$) in control than all the treatments throughout the storage period in aerobic packaging irrespective of the treatment. Among the treatments significantly lower ($P<0.05$) FFA value was noticed for the T_1 throughout the storage period which might be due to strong antioxidant activity of *aloe vera* extract due to the presence of α-tocopherol (vitamin E), carotenoids, ascorbic acid (vitamin C), flavonoids, tannins and anthraquinones (Bhat *et al*., 2015).

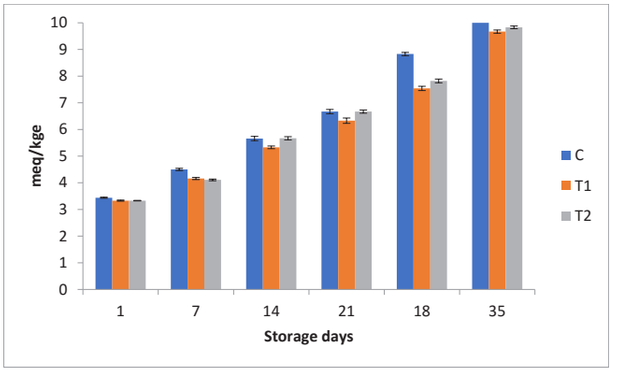

Fig 3: PV of chevon rolls stored at refrigeration temperature (4±1°C)

C=control, T_1= chevon rolls with 0.40% *aloe vera* extract, T_2= chevon rolls with 0.25% cinnamon bark extract

Peroxide value

Peroxide value of both the controls and treatment products followed the similar significantly increasing trend as that of TBARS values and FFA values, but the value was significantly lower ($P<0.05$) in treated products throughout the storage period except the 1st day of storage (Fig. 3). It might be due to inhibition of lipid peroxidation, attributed to polyphenolic constituents of phyto-extract, which function as antioxidants by terminating free radical chain-type reactions. Though, peroxide value followed an increasing trend during storage however; it was lowest in T_1 on 35th day of storage. Increase in peroxide value throughout the storage period might be due to the formation of hydro peroxides during storage than their degradation into secondary oxidation products. These results are in consonance with Botsoglou *et al.* (2014) who studied effect of olive leaf (*Olea europea* L.) extracts on protein and lipid oxidation of frozen n-3 fatty acids-enriched pork patties. Qi *et al*. (2015) while studying on Lychee (*Litchi chinensis* Sonn.) seed water extract as an antioxidant in meat products observed similar increase in PV during aerobic storage period of 15 days.

Microbiological quality

Microbiological quality of the chevon rolls varied significantly ($P<0.05$) between the treatments (Table 2). It was significantly ($P<0.05$) influenced by the incorporation of phyto-extracts and packaging conditions during refrigerated storage. The lower microbial count in treated rolls in the present studies might be due to the antimicrobial effect of phyto-extracts used (Ahn *et al.*, 2004). It has been reported that spoilage of meat products is not noticed until bacterial counts are more than 10^8 cells/cm^2 (Jay,1996). Banon *et al*. (2007) reported that grape seed extract led to decrease in microbial count in beef patties during storage. However, control (C) on 21st day had higher microbial load than the threshold limit. Coliforms were not detected throughout the study in all the products. It reflects the hygienic conditions followed during the preparation of the product as well as the high heat treatment employed during cooking. Psychrophilic count was detected on 14th day of storage and thereafter, it increased significantly ($P<0.05$) in all the products throughout storage. However, it was still lower than 4.6 log10 cfu/g, indicative of acceptability of cooked *aloe vera* extract and cinnamon extract incorporated chevon roll in aerobic packaging. It was lower ($P<0.05$) in phyto-extract incorporated product than control in aerobic packaging.

Sensory quality

The general appearance scores for all the treatment products and control showed a progressive significant ($P<0.05$) decline with increase in storage period but the rate of decrease in the scores for the treatment products was lower (Table 3). The decrease in appearance scores might be due to pigment and lipid oxidation. On 35th day of storage, control product was not evaluated for all the sensory parameters since the values of oxidative properties and microbial counts were quite high for the same. Treatment product (T_1) showed the highest appearance score on 35th day of storage. The flavour scores also showed the similar decreasing trend as seen in the appearance scores for the control and treatment products. The progressive decrease in flavour scores could be correlated to an increase in

TBARS values and free fatty acids in the meat products under aerobic conditions. The flavour scores on 28th and 35th day of storage for the treatment products incorporated with *aloe vera* extract and cinnamon bark extract were significantly higher (P< 0.05) than control which was reflected by lower TBARS, FFA and peroxide values of respective product. The flavour scores for T_1 was more than very good sensory rating (6.52) on 35th day of storage. Juiciness and texture scores followed a decreasing trend throughout the storage, irrespective of treatment; however the rate of decrease was higher (P<0.05) in control product as compared to the products incorporated with phyto-extracts. The progressive decline in juiciness and texture scores might be due to loss of surface moisture and subsequent reduction of pH which leads to denaturation of proteins and degradation of muscle fiber protein by bacterial action resulting in decreased water binding.

A significantly (P<0.05) higher overall acceptability score for treated products than control was observed. However, it followed a decreasing trend in both the groups with the progress of storage period. On 28th and 35th day of storage, the scores for the treatment products was significantly higher (P< 0.05) than control and more than the very good sensory rating. There was sharp and significant decline (P< 0.05) in the overall acceptability of control and all treatment products at 35th day of storage. The regular decrease in overall acceptability scores might be due to decrease in other sensory parameters viz. appearance and colour, flavour, juiciness, and texture. Furthermore, a gradual increase in TBARS, FFA and peroxide values explains the descending trend in the rating of sensory quality of the product during storage.

Table 3: Effect of refrigerated storage on sensory attributes of aerobically packaged chevon rolls incorporated with optimum level of phyto-extracts (Mean±S.E.)*

Treatment	Storage Period (Days)					
	1	7	14	21	28	35
			Appearance			
C	7.14 ± 0.08^{c}	7.01 ± 0.06^{c}	6.93 ± 0.02^{bc}	6.67 ± 0.08^{abA}	6.40 ± 0.01^{Aa}	NP
T_1	7.15 ± 0.02^{c}	6.95 ± 0.02^{bc}	6.90 ± 0.07^{bc}	6.88 ± 0.07^{bcB}	6.74 ± 0.08^{Bb}	6.61 ± 0.03^{Aa}
T_2	7.22 ± 0.06^{c}	6.92 ± 0.08^{b}	6.81 ± 0.07^{b}	6.79 ± 0.05^{bB}	6.64 ± 0.09^{Bb}	6.11 ± 0.07^{aB}
			Flavour			
C	7.38 ± 0.06^{d}	7.07 ± 0.09^{c}	6.74 ± 0.08^{b}	6.52 ± 0.07^{abA}	6.47 ± 0.09^{aA}	NP
T_1	7.14 ± 0.02^{c}	6.93 ± 08^{bc}	6.88 ± 0.01^{bc}	6.69 ± 0.09^{Bb}	6.64 ± 0.09^{bAB}	6.52 ± 0.08^{Aa}
T_2	7.24 ± 0.06^{c}	6.90 ± 0.06^{b}	6.87 ± 0.08^{bc}	6.78 ± 0.06^{bcB}	6.69 ± 0.08^{Bb}	6.17 ± 0.02^{aB}
			Juiciness			
C	7.14 ± 0.09^{b}	7.07 ± 0.09^{b}	6.74 ± 0.05^{a}	6.60 ± 0.08^{Aa}	6.45 ± 0.08^{a}	NP
T_1	7.02 ± 0.08^{a}	6.97 ± 0.01^{a}	6.83 ± 0.03^{ab}	6.74 ± 0.07^{abB}	6.67 ± 0.09^{b}	6.54 ± 0.07^{bA}
T_2	7.07 ± 0.07^{c}	6.90 ± 0.08^{bc}	6.78 ± 0.04^{b}	6.69 ± 0.03^{bAB}	6.64 ± 0.05^{b}	6.14 ± 0.08^{aA}
			Texture			
C	7.21 ± 0.08^{b}	7.17 ± 0.05^{Bb}	7.04 ± 0.09^{bA}	6.82 ± 0.05^{a}	6.69 ± 0.08^{aB}	NP
T_1	7.07 ± 0.07^{c}	6.90 ± 0.04^{Bab}	6.88 ± 0.09^{abAB}	6.83 ± 0.07^{ab}	6.77 ± 0.07^{bB}	6.26 ± 0.06^{a}
T_2	7.10 ± 0.04^{d}	6.95 ± 0.01^{Acd}	6.83 ± 0.06^{cdB}	6.74 ± 0.02^{bc}	6.52 ± 0.08^{abA}	6.18 ± 0.07^{a}
			Overall acceptability			
C	7.42 ± 0.03^{aB}	7.09 ± 0.04^{b}	6.95 ± 0.03^{bc}	6.71 ± 0.09^{b}	6.40 ± 0.05^{Aa}	NP
T_1	7.28 ± 0.07^{ABb}	7.04 ± 0.02^{ab}	6.86 ± 0.07^{b}	6.82 ± 0.06^{b}	6.79 ± 0.08^{Bb}	6.52 ± 0.05^{a}
T_2	7.21 ± 0.08^{dA}	7.15 ± 0.05^{cd}	6.90 ± 0.06^{bc}	6.87 ± 0.09^{bc}	6.77 ± 0.02^{Bb}	6.42 ± 0.02^{a}

*Mean±S.E. with different superscripts row wise (small alphabet) and column wise (capital alphabet) differ significantly (P<0.05). n =21 for each treatment.

C=control, T_1= chevon rolls with 0.40% *aloe vera* extract, T_2= chevon rolls with 0.25% cinnamon bark extract

CONCLUSION

Hence, it was concluded that the aerobically packaged *aloe vera* and cinnamon bark extract incorporated chevon roll can be stored for 28 days without any marked loss in physico-chemical, microbiological and sensory properties under refrigerated storage. The combined effect of phyto-extracts and aerobic packaging successfully maintained the colour, odour and overall acceptability of chevon rolls during storage, hence it is recommended to meat industry as an antioxidant to improve the storage of chevon rolls.

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