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Research Article

STORAGE STABILITY OF CHEVON ROLLS INCORPORATED WITH ETHANOLIC EXTRACTS OF *ALOE VERA* AND CINNAMON BARK UNDER MODIFIED ATMOSPHERE PACKAGING AT REFRIGERATION TEMPERATURE (4±1°C)

MANJEET RATHOUR, O.P. MALAV, PAVAN KUMAR*, MANISH KUMAR CHATLI and NITIN MEHTA
Department of Livestock Product Technology, College of Veterinary Science,
Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana-141004, Punjab, India

ABSTRACT

The present study was conducted to assess the storage stability of chevon rolls incorporated with various pre-standardized phyto-extracts viz. Control (C, without phyto-extracts), 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±1°C) under modified atmosphere packaging for 35 days. The products were analyzed for pH, oxidative stability, microbial quality and sensory attributes at a regular interval of 7 days upto 35 days. The pH showed a gradual decreasing trend with the advancement of storage period irrespective of treatments. 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) showing lower values than controls during storage. Overall acceptability scores exhibited significantly ($P<0.05$) decreasing trends with increasing storage, however, the score was highest for T_1 during storage. Thus, chevon rolls incorporated with ethanolic extracts of *aloe vera* and cinnamon bark could be successfully stored upto 35 days under refrigerated condition (4±1°C) under modified atmosphere packaging.

Key words: Chevon rolls, phyto-extracts, modified atmosphere packaging, storage stability

Goat meat (Chevon) is one of the most widely consumed meat in the world particularly in tropical countries such as India. Similar to other meats, chevon is also rich in nutrients therefore readily perishable (Das *et al.*, 2007). There has been a sudden outburst of demands for meat based convenient and ready-to-eat meat products due to rapid urbanization, industrialization, nuclear family, working women, higher family income etc (Singh *et al*., 2014a, b; Singh *et al*., 2015 a, b, c; Kumar *et al*., 2016). Chevon rolls are convenient, ready-to-eat, nutritious emulsion based meat products that are widely relished by consumers (Rathour *et al*., 2017a, b). 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 *et al*., 2017b). However, chevon rolls like other meat products, are deficient in antioxidants and are more prone for lipid peroxidation and spoilage. This problem of lipid peroxidation could be overcome by incorporating phyto-extracts such as ethanolic extracts of *aloe-vera* powder and cinnamon bark. These compounds exhibit antioxidants and antimicrobial activities due to presence of bioactive molecules. Incorporation of phyto-extracts in place of plant powder in meat during processing could be a promising alternative as these phyto-extracts are required in lesser amount and do not compromise the organoleptic attributes.

Packaging plays a very important role in transport, marketing as well as extending shelf life of meat products. Packaging material protects the food and prevents entry of oxygen into the package and moisture loss. Application of proper packaging such as modified atmosphere packaging (MAP) retards deteriorative changes and enhances storage stability of products. Three principal gases used in MAP are carbon dioxide (to inhibit bacteria and moulds), nitrogen (to avoid oxidation of fats and pack collapse), and oxygen (to prevent anaerobic growth). MAP can increase the shelf-life of meat and poultry by 50–400% (Rao and Sachindra, 2002). Thus, the present study was undertaken to evaluate storage stability of chevon rolls incorporated with *aloe vera* and cinnamon bark extracts during refrigerated storage (4±1°C) under modified atmosphere packaging in terms of various physico-chemical, microbiological and sensory parameters.

MATERIALS AND METHODS

Goat meat required for the experiments was obtained after slaughtering goat as per standard procedure in the experimental slaughterhouse of Department of Livestock Products Technology, College of Veterinary Science,

*Corresponding author: vetpavan@gmail.com

GADVASU, Ludhiana, Punjab, India. The dressed carcasses were 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 followed by storage at -18±1°c for subsequent use. The frozen deboned meat was thawed by keeping it overnight at refrigeration temperature (4±1°C), cut into small chunks of uniform size and minced twice through meat mincer (MADO Eskimo Mew 714, Spain).

The chevon rolls were prepared as per Rathour et al. (2017a). Three batches of chevon rolls were prepared viz. without incorporating phyto-extracts (Control; C), by incorporating 0.40% aloe vera extract (T1) and 0.25% cinnamon bark extract (T2). The treated as well as control chevon rolls were packaged in polyester/polyethylene laminated plastic pouches (100/100µ) under modified atmosphere packaging conditions (50% CO_2, 50% N_2) with packaging machine (Ramon Packaging Machine VP-580 A Model, type 19/S/CL, Germany). The control as well treated samples were stored at refrigeration temperature (4±1^{0}C) and examined for various quality attributes on 1st, 7th, 14th, 21st, 28th and 35th day.

The pH was estimated as per the procedure of Trout *et al*. (1992). Thiobarbituric acid reacting substances (TBARS) value of chevon rolls was 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). Microbiological quality such as standard plate count, psychrophilic count and coliform count of chevon rolls was determined as per APHA (1984).

A seven member panel comprising of scientists and postgraduate students of the Department evaluated chevon rolls for various sensory attributes viz., appearance and colour, flavour, tenderness, juiciness and overall acceptability on 8-point descriptive scale, where 8=extremely desirable and 1=extremely undesirable (Keeton, 1994). Potable water was provided in between samples to cleanse the mouth palate.

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. 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 of chevon rolls exhibited a decreasing trend with the advancement of storage period in all samples (Table 1). Comparatively higher pH of T_2 was attributed to the incorporation of ethanolic extract of cinnamon bark. On 35th day of storage, control samples recorded the lowest and significantly lower ($p<0.05$) pH than the treated samples. The gradual decrease in pH value of MAP stored products might be due to

Table 1
pH and microbial quality of modified atmosphere packaged chevon rolls incorporated with optimum level of phyto-extracts (Mean±S.E.)

Treatment		Refrigerated storage period (days)					
		1st	7th	14th	21th	28th	35th
C	pH	6.14±0.02^{c}	6.02±0.04^{bB}	5.84±0.07^{bc}	5.56±0.02^{ab}	5.15±0.07^{aAB}	5.13±0.06^{aB}
T_1		6.21±0.02^{b}	5.83±0.01^{abA}	5.73±0.06^{ab}	5.67±0.02^{ab}	5.46±0.08^{aAB}	5.22±0.01^{aC}
T_2		6.25±0.06^{d}	6.20±0.04^{cdA}	6.02±0.06^{bcd}	5.90±0.08^{bc}	5.82±0.02^{Bb}	5.27±0.07^{aC}
C	SPC (log_{10} cfu/gm)	2.57±0.06^{ABa}	3.27±0.05^{Ca}	3.85±0.04^{Bb}	4.19±0.08^{Cc}	5.45±0.02^{Cd}	6.16±0.03^{Be}
T_1		2.05±0.05^{Aa}	2.10±0.06^{Aa}	2.71±0.08^{Ab}	3.31±0.02^{Ac}	4.09±0.02^{Ad}	5.10±0.03^{Ae}
T_2		2.10±0.04^{Aa}	2.30±0.03^{Aab}	2.94±0.02^{Ab}	3.63±0.05^{ABc}	4.12±0.06^{Ac}	5.24±0.03^{Ad}
C	Psychrophilic count	ND	ND	ND	ND	2.78±0.0^{Ba}	4.01±0.05^{CDb}
T_1	(log_{10} cfu/gm)	ND	ND	ND	ND	ND	2.88±0.06^{A}
T_2		ND	ND	ND	ND	ND	3.05±0.07^{AB}

*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

incorporation of fermentable carbohydrates in the product during preparation leading to the production of lactic acid. Similar findings of decreasing pH in frozen patties containing aloe vera and mustard have also been reported (McCarthy *et al*., 2001). Incze (1992) attributed the decrease in the pH to increase in psychrophilic and lactobacillus count during storage period, thus leading to breakdown of fermentable carbohydrate.

Oxidative Stability Parameters: TBARS values exhibited a significant (P<0.05) increasing trend from day 1 to day 35 for all samples (Fig. 1) throughout MAP storage. This might be due to increased lipid oxidation and production of volatile metabolites. Similar trends of increasing TBRAS value have been reported by Kumar *et al*. (2013) in emu meat nuggets and Kumar *et al.* (2015) in chevon patties. Throughout MAP storage, mean TBARS value of control samples was higher than the treated samples which might be due to antioxidant effect of phyto-extracts in treated samples. The mean values of TBARS were recorded below the threshold value i.e., 1-2 mg malonaldehyde/kg meat prescribed by Watts (1962). Between the treatments, significantly lower (P<0.05) TBARS value was noticed for the T_1 as compared to T_2 throughout MAP storage period.

Free fatty acid (FFA) content also followed a similar trend as shown in the TBARS values (Fig. 2). FFA values were significantly higher (P<0.05) in control chevon rolls than all the treatments throughout the storage in MAP packaging. Between the treatments significantly lower (P<0.05) FFA value was noticed for the T_1 throughout the storage period. Lower TBARS and FFA values in T_1 might be due to strong antioxidant activity of aloe vera extract due to the presence of α-tocopherol (vitamin E), carotenoids, ascorbic acid (vitamin

Table 2
Effect of refrigerated storage on sensory attributes of modified atmosphere packaged chevon rolls incorporated with optimum level of phyto-extracts (Mean±S.E.)*

	Storage period (days)					
Treatment	1	7	14	21	28	35
			Appearance			
C	7.28±0.01^{a}	7.21±0.01^{a}	7.13±0.02^{a}	6.95±0.03^{abA}	6.90±0.01^{ab}	6.61±0.03^{b}
T_1	7.39±0.08^{a}	7.20±0.02^{ab}	7.15±0.07^{ab}	7.13±0.06^{abB}	6.99±0.06^{b}	6.73±0.03^{cC}
T_2	7.47±0.06^{a}	7.18±0.01^{b}	7.05±0.01^{b}	7.01±0.05^{bAB}	6.89±0.09^{b}	6.70±0.03^{cB}
			Flavour			
C	7.51±0.08^{a}	7.12±0.01^{a}	6.91±0.04^{a}	6.81±0.09^{bAB}	6.66±0.01^{bc}	6.51±0.07^{c}
T_1	7.49±0.06^{a}	7.20±0.07^{b}	7.12±0.08^{bc}	7.02±0.01^{bcB}	6.93±0.02^{c}	6.80±0.08^{cC}
T_2	7.52±0.08^{a}	7.17±08^{b}	7.13±0.01^{ab}	6.69±0.09^{bcA}	6.64±0.09^{b}	6.78±0.05^{dB}
			Juiciness			
C	7.19±0.04^{a}	7.12±0.01^{a}	6.78±0.02^{b}	6.65±0.07^{bA}	6.50±0.01^{b}	6.09±0.08^{cA}
T_1	7.35±0.02^{a}	7.23±0.01^{ab}	7.08±0.03^{bc}	7.00±0.04^{bcB}	6.91±0.02^{c}	6.50±0.02^{dB}
T_2	7.32±0.06^{a}	7.15±0.08^{ab}	7.03±0.04^{b}	6.94±0.04^{Bab}	6.89±0.05^{b}	6.63±0.01^{cC}
			Texture			
C	7.27±0.06^{a}	7.02±0.02^{aA}	7.13±0.02^{Aa}	7.21±0.08^{Bb}	6.90±0.04^{bAB}	6.46±0.08^{bA}
T_1	7.32±0.06^{a}	7.15±0.02^{abB}	7.13±0.09^{abA}	7.07±0.01^{abAB}	6.97±0.01^{cB}	6.85±0.01^{dC}
T_2	7.24±0.01^{a}	7.10±0.01^{abB}	7.00±0.04^{abB}	6.88±0.05^{bcA}	6.59±0.04^{cdA}	6.75±0.01^{dB}
			Overall acceptability			
C	7.62±0.01^{b}	7.59±0.04^{b}	7.45±0.04^{b}	6.76±0.05^{Aa}	6.60±0.04^{bA}	6.68±0.01^{aA}
T_1	7.78±0.04^{c}	7.71±0.02^{c}	7.52±0.07^{cb}	7.48±0.04^{Bb}	6.84±0.02^{bB}	6.96±0.05^{cC}
T_2	7.71±0.01^{c}	7.65±0.05^{b}	7.40±0.07^{bc}	7.37±0.02^{bcB}	6.77±0.02^{cB}	6.87±0.04^{dB}

*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

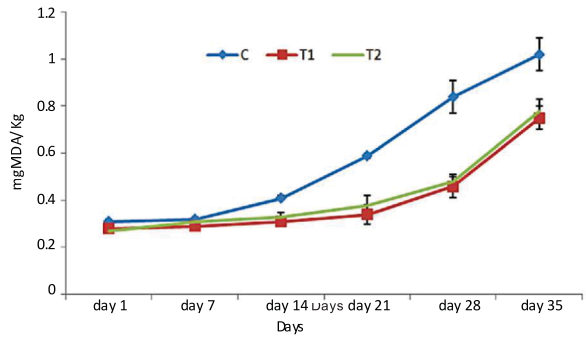

Fig. 1 : Thiobarbituric acid reacting substances (TBRAS) value of chevon rolls during MAP storage
C=control; T_1=chevon rolls with 0.40% *aloe vera* extract; T_2=chevon rolls with 0.25% cinnamon bark extract

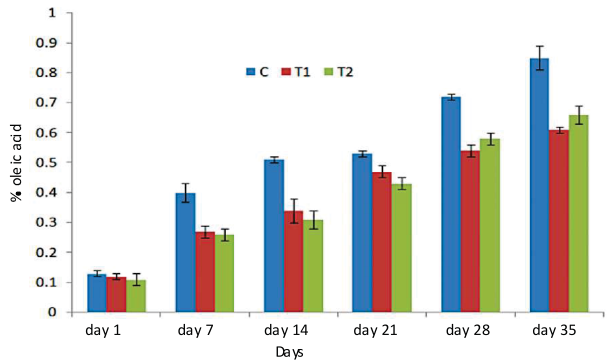

Fig. 2 : Free fatty acid (FFA) value of chevon rolls during MAP storage
C=control; T_1=chevon rolls with 0.40% *aloe vera* extract; T_2=chevon rolls with 0.25% cinnamon bark extract

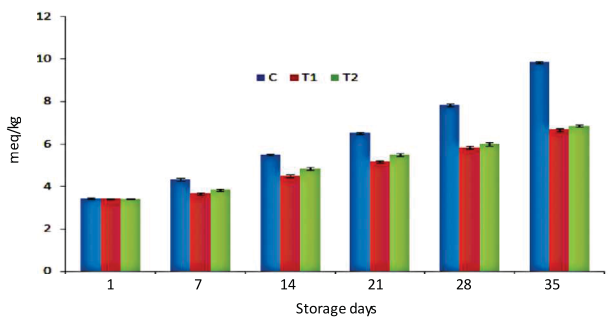

Fig. 3 : Peroxide value (PV) value of chevon rolls during MAP storage
C=control; T_1=chevon rolls with 0.40% *aloe vera* extract; T_2=chevon rolls with 0.25% cinnamon bark extract

C), flavonoids, tannins and anthraquinones (Bhat *et al*., 2015). Pearson (1968) reported that minced beef had FFA content in the range of 0.38 to 1.74% and had a maximum acceptability limit of 1.8% FFA in view of their progressive increase during storage. In the present study, FFA content of all the products was well below this limit even on 35th day of storage.

Peroxide value of all samples followed an increasing trend similar to TBARS values and FFA values, but the value was significantly lower ($P<0.05$) in treated products throughout the storage period except on 1st day of storage (Fig 3). This could be due to antioxidant effect attributed to polyphenolic constituents of phyto-extracts which function as antioxidants by terminating free radical chain-type reactions. MAP (50% CO_2+50% N_2) gas mixture is also helpful in retarding peroxidation of fats by exclusion of oxygen from the package. Though, peroxide value followed an increasing trend during storage, however, it was the 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.

Microbiological Quality: Microbiological quality of control chevon rolls varied significantly ($P<0.05$) with treatments (Table 2) during MAP storage under refrigeration conditions. The lower microbial count noticed in phyto-extracts incorporated chevon rolls might be attributed to antimicrobial effect of phyto-extracts (Ahn *et al.*, 2004). Coliforms were not detected throughout the study in all the products. It could be due to hygienic conditions followed during the preparation of chevon rolls as well as the high heat treatment followed during cooking. Psychrophilic count was detected on 28th day of storage in control and 35th day of storage in treated rolls. However, it was lower than 4.6 $\log_{10}$ cfu/g, indicative of acceptability of cooked *aloe vera* extract and cinnamon extract incorporated chevon roll in modified atmosphere packaging.

Sensory Quality: Mean sensory scores of MAP packaged chevon rolls during refrigerated storage at 4±1°C are presented in Table 2. The mean scores for all the sensory attributes for control (C) and treatments showed a decreasing trend with increase in storage period. The appearance score showed significant ($P<0.05$) decrease in treatments as well as control with the progress of storage period. However, the scores were significantly ($P<0.05$) lower in control as compared to treated products. T_1 and T_2 showed comparable sensory scores upto the 14th day of storage thereafter significantly higher ($P< 0.05$) scores was observed for the T_1. However, there was a decrease in the score throughout

the storage. The most probable cause of decrease in appearance score might be attributed to non-enzymatic browning reaction between lipid oxidation products and amino acids. A decreasing trend was reported in appearance scores in pork patties by Verma *et al.* (2015). The sensory panelists rated treatments as acceptable even on day 35th i.e., the last day of the storage. Treatment product (T_1) showed the highest appearance score on 35th day of storage. The flavour score of the products showed a decreasing trend as the days of storage advanced. The flavour scores of treatments were significantly higher ($P<0.05$) than control throughout the storage period. However, among the treatments the score for the T_1 was significantly higher ($P<0.05$) than the control and other treatment product towards the end of storage that is on 28th and 35th days. The lipid peroxidation deteriorates the nutritive value, produces toxic substances (viz. malondaldehyde, peroxides, oxysterols) and compromises the organoleptic properties due to production of off-odours, changes in colour and appearances. There was no off-odour in the treated products even on the last day of storage.

The juiciness scores of all samples decreased significantly ($P<0.05$) as the day of storage progressed and were significantly higher in treated products as compared to controls during storage. This could be due to better moisture retention in chevon rolls due to lower decline in pH of treatment products in comparison to control. A linear significant decrease of the juiciness scores with advancement of storage days could be possible due to gradual loss of moisture from chevon rolls. The observations are in accordance with Nag *et al.* (1998) and Rao and Reddy (2000) who reported linear decrease in juiciness scores of the products with increase in storage period. The texture scores showed a declining trend with advancement of storage period. The texture scores of treatment were comparable upto day 21. The most probable cause might be increased loss of water from rolls 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. The tenderness scores of treatments were recorded better than control during entire storage period. This could be due to lower degradation of proteins due to the presence of flavonoids and polyphenolic compounds in treatments. The texture and juiciness scores were significantly higher ($P<0.05$) in T_1 than T_2 as compared to control on 35th day of storage.

As the storage progressed, scores for overall acceptability showed significantly ($P<0.05$) decreasing trends. Continuous decrease in overall acceptability scores might be due to decrease in other sensory parameters namely appearance and colour, flavour, juiciness, and texture. Among the treatments, the scores were comparable except on days 28th and 35th of storage, whereas the significantly higher ($P<0.05$) overall acceptability scores were observed for treatments than control, with highest overall acceptability score was recorded for T_1. The sensory panelists rated the phyto-extracts incorporated chevon rolls under MAP acceptable even on day 35th, the last day of refrigerated storage.

Hence, it was concluded that the aerobically packaged *aloe vera* and cinnamon bark extract incorporated chevon roll can be stored for 35 days without any marked loss in physico-chemical, microbiological and sensory properties under modified atmosphere packaging at refrigeration temperature.

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