Journal of Animal Research: v.7 n.1, p. 69-75. February 2017

DOI: 10.5958/2277-940X.2017.00010.9

Effect of *Aloe vera* Gel and Arjun Tree Bark Extract Incorporation on Quality of Buffalo Male Calf Meat Rolls During Refrigeration (4±1 °C) Storage

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Received: 31 Aug., 2016 **Revised:** 16 Dec., 2016 **Accepted:** 22 Jan., 2017

ABSTRACT

The study was conducted with an objective to evaluate the effect of Aloe vera gel and Arjun *(Terminalia arjuna)* bark extract on shelf life of buffalo male calf meat rolls at refrigeration (4±1°C) storage. The meat rolls were prepared with incorporation of 4% Aloe vera gel (T_1) and 2% Arjun tree bark extract (T_2) and compared with control (C) meat rolls. The products were assessed for their physico-chemical, sensory and microbiological quality at 0, 4, 8, 12, 15, 18 and 21 days. However, the sensory scores and moisture content decreased and microbial load, TBA value and free fatty acids (FFA) increased as the days of storage increased for control as well as treated products. The rate of decline in sensory score and moisture content and rate of increase in microbial load, TBA vale and FFA during storage were higher in control samples as compared to treated (T_1 and T_2) meat rolls. It was concluded that Aloe vera gel (4%) and Arjun tree bark extract (2%) incorporation showed their antioxidant and antimicrobial effects, by keeping the treated products organoleptically acceptable and microbiologically safe up to 21 days of refrigeration storage.

Keywords: Aloe vera, arjun tree, buffalo calf, rolls, shelf-life

While food has long been used to improve health, our knowledge of health is now being used to improve foods. The understanding of relationship between nutrition and health has resulted in the development of concept of functional foods. A promising approach in improving health care is zeroing on to produce a healthier food supply as preventive health care strategy (Decker and Park, 2010).

The processing of meat leads to generation of many functional compounds beneficial to human health but also pose a health hazard due to high amount to added salt and fat that somehow is proved to be a predisposing factor for cardiovascular diseases, diabetes mellitus and cancer (Cross *et al*., 2010).

Aloe vera pulp by regulating blood pressure, improving circulation of the blood, lowering cholesterol and making blood less sticky may be able to help lower the risk of heart disease. Its ingredients are active against bacteria and also help to treat fungal and viral infections (Lawless and Allen, 2000) while antioxidant effects are becoming of interest.

Arjun tree is traditionally used for several medicinal purposes in India and the bark of this plant is known to contain a crystalline compound, arjunine, lactone, arjunetin and essential oils which act as natural antioxidants (Javed *et al*., 2016). There has been much interest recently in the antibacterial and antioxidant activity of polysaccharides, which is greater and more diverse than previously realized.

Hence, this study was conducted to evaluate the effect of Aloe vera gel and Arjun tree bark extract on sensory and microbiological qualities of buffalo male calf meat rolls during refrigeration storage.

MATERIALS AND METHODS

Buffalo male calves meat (10-12 months old) was procured from local meat market of Hisar city, Haryana. Aloe vera *(Aloe barbadensis)* leaf and Arjun tree **(***Terminalia arjuna)* bark was collected from the CCS Haryana Agricultural University, Hisar campus. The permission from Institutional Animal Ethics Committee was not required.

Preparation of Aloe vera gel

Fresh Aloe vera leaves were washed and cleaned with muslin cloth properly. Crude gel was taken out by scrapping with plastic spatula after opening the leaves with the stainless steel knife. The gel was kept under refrigeration.

Preparation of Arjun tree bark extract

Arjun tree bark was shade dried for 7 days followed by drying in a hot air oven at 45±2 °C for 12 h. The bark was ground to a fine powder and 10 g powder was dissolved in 90 ml of 80 % ethyl alcohol and kept in the orbital shaker for 3 hrs followed by incubated at 37±1 °C for 72 h (Sinha *et al.*, 2008). The alcoholic extract was filtered and filtrate was dried in hot air oven (45±2 °C) drier for 12-14 h till a final pasty consistency with 50±2% yield was obtained.

Preparation of meat rolls

Buffalo male calf carcasses (10-12 months old) were washed thoroughly with warm water spray and deboned manually after trimming of fat and connective tissue. Deboned meat was frozen for 24 h and then minced in an electrical meat mincer (Mado Primus, MEW 613) and used for preparation of buffalo veal meat rolls.

The treatments consisted of 4% Aloe vera gel (T_1) and 2% Arjun tree bark extract (T_2) in addition to control (C) meat roll ingredients, thoroughly mixed emulsion was stuffed in autoclavable beakers and steam cooked for 40 min, cooled to room temperature, packaged in polythene bags and stored at refrigerated (4±1 °C) temperature for further studies.

Composition of meat rolls emulsion

Ingredients (g)	C	T_1	T_2
Meat	76.0	76.0	76.0
Sodium chloride	2.5	2.5	2.5
STPP	0.5	0.5	0.5
Spice mix	2.0	2.0	2.0
Condiments (Onion:Garlic, 2:1)	3.0	3.0	3.0
Sunflower Oil	3.0	3.0	3.0
Water	10.0	10.0	10.0
Sodium nitrite	0.02	0.02	0.02
Semolina	3.0	3.0	3.0
Aloe vera gel	0.0	4.0	0.0
Arjun bark extract	0.0	0.0	2.0
Total Qty	100.02	104.02	102.02

Studied Parameters

The moisture content (AOAC, 2005), TBA value (Witte *et al*., 1970) and free fatty acids (Koniecko, 1979) were estimated to evaluate the physico-chemical properties. Sensory scores (colour, flavor, texture, Juiciness, tenderness and overall acceptability) were evaluated by a six member experienced panel of judges consisting of teachers and postgraduate students of College of Veterinary Science, LUVAS, Hisar, using 8-point descriptive scale (Keeton, 1983), where 8=excellent and 1=extremely poor. Microbiological (Total plate counts, Psychrotrophic counts and Yeast and mould counts) quality parameters of the treated and control products were analyzed at 0, 4, 8, 12, 15, 18 and 21th day of storage following the methods as described by APHA (1984).

The experiment was repeated thrice in duplicate and the results were analyzed using completely randomized design as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Physico-chemical properties

A decrease in moisture content during storage was observed in control as well as treated rolls (Table 1). This might be due to loss of moisture from the product

during storage as the packages material was permeable to moisture. The decline in moisture content was highest in control followed by T_2 and T_1, respectively. This trend was maintained till the end of storage day. It might be due to faster loss of moisture in control samples during storage and lower initial moisture level of T_2 treated rolls (Biswas *et al*., 2011).

Increase in TBA value during storage was observed in control as well as treated rolls. On the 15th day of the storage, a significantly ($p \leq 0.05$) higher TBA value of control was recorded than T_1 and T_2 treated rolls. It could be due to an initial higher fat content in control and further due to antioxidant properties of T_1 and T_2. The strong antioxidant properties of Aloe vera gel (Zapata *et al*., 2013) and Arjun tree bark extract (Shahriar *et al*., 2012) have been reported earlier.

The significant ($p \leq 0.05$) increase in free fatty acid content in the present study with the increase in storage period was due to enzymatic or microbial lipolysis of fat (Modi *et al*., 2007).

The control samples had significantly ($p \leq 0.05$) higher free fatty acid than both treated products during entire storage period. This could be attributed to release of more free fatty acids from higher fat containing control products. Among treatments, initially the FFA value of T_1 rolls was lower than T_2 rolls, but at the end of storage both the treated samples showed similar FFA values due to their strong antioxidant properties (Zapata *et al*., 2013; Shahriar *et al*., 2012).

Table 1: Physico-chemical properties of buffalo calf meat rolls incorporated with Aloe vera gel and Arjun tree bark extract stored at refrigerated (4±1 °C) temperature (N=6)

Treatments	Storage days						
	0	4	8	12	15	18	21
				Moisture (%)			
C	64.38^{dA} ±1.27	64.08^{dA} ±1.27	62.84^{cA} ±0.86	60.23^{bB} ±0.86	57.20^{aB} ±0.86	VS	VS
T_1	67.31^{eB} ±1.54	67.22^{eB} ±1.54	65.87^{dB} ±0.54	62.68^{cC} ±1.23	59.11^{bC} ±0.61	57.53^{aB} ±1.31	56.21^{aB} ±0.86
T_2	63.69^{eA} ±1.21	63.17^{eA} ±1.21	61.73^{dA} ±1.01	58.89^{cA} ±0.58	55.38^{bA} ±1.11	54.47^{bA} ±0.86	52.23^{aA} ±0.86
				TBA value (mg malonaldehyde/kg			
C	0.57^{aB} ±0.04	0.63^{bB} ±0.02	0.79^{cB} ±0.03	0.91^{dB} ±0.03	1.17^{eB} ±0.06	VS	VS
T_1	0.49^{aA} ±0.03	0.55^{bA} ±0.03	0.64^{cA} ±0.02	0.72^{dA} ±0.04	0.90^{eA} ±0.03	1.02^{f} ±0.04	1.15^{g} ±0.04
T_2	0.48^{aA} ±0.05	0.53^{bA} ±0.04	0.59^{cA} ±0.03	0.67^{dA} ±0.02	0.86^{eA} ±0.04	0.98^{f} ±0.05	1.10^{g} ±0.03
				Free Fatty Acid (% oleic acid)			
C	0.15^{aC} ±0.002	0.16^{aC} ±0.006	0.41^{bC} ±0.005	0.63^{cB} ±0.006	0.98^{dC} ±0.009	VS	VS
T_1	0.10^{aA} ±0.004	0.12^{aA} ±0.009	0.16^{bA} ±0.004	0.19^{cA} ±0.002	0.37^{dB} ±0.005	0.50^{eA} ±0.002	0.59^{f} ±0.009
T_2	0.12^{aB} ±0.005	0.14^{abB} ±0.005	0.17^{bcB} ±0.006	0.19^{cA} ±0.003	0.38^{dA} ±0.008	0.51^{eB} ±0.005	0.59^{f} ±0.008

Means±SD with small letters superscripts row wise and capital letters column wise differ significantly ($p \leq 0.05$).

VS= Visibly Spoiled

Sensory quality

There was a significant ($p \leq 0.05$) decline in colour score during storage in control, T_1 and T_2 treated rolls after 8th, 15th and 8th day, respectively (Table 2). The more decrease in colour scores with the advancement of storage interval in control rolls was due to some pigment oxidation and non-enzymatic browning resulting from reaction between lipid oxidation products and amino acids. These results are in accordance with the findings of Che Man *et al*. (1995). Early decline in colour of T_2 rolls was perhaps due to surface dehydration in aerobic packaging. Similar decline in colour scores during storage have also been reported in duck patties (Biswas *et al*., 2011). Slower declines of colour in T_1 treated meat rolls during storage was contributed due to its antioxidant properties which caused restricted pigment oxidation and non-enzymatic (Che Man *et al*., 1995) as well as sufficient amount of moisture in T_1 to maintain the product colour.

There was a significant ($p \leq 0.05$) decline in flavour score during storage in control, T_1 and T_2 treated meat rolls after 4th, 8th and 8th day, respectively. The faster decline of flavour scores in control might be a multi-factorial effect

Table 2: Sensory quality of Aloe vera gel and Arjun tree bark extract incorporated buffalo calf meat rolls at refrigeration (4±1 0C) storage (N=12)

Treatments	Storage days						
	0	4	8	12	15	18	21
				Colour			
C	$7.50^{b} \pm 0.51$	$7.20^{b} \pm 0.40$	$7.00^{b} \pm 0.41$	$6.50^{a} \pm 0.40$	$6.25^{a} \pm 0.40$	VS	VS
T_1	$7.00^{b} \pm 0.00$	$7.10^{b} \pm 0.40$	$7.00^{b} \pm 0.51$	$6.70^{b} \pm 0.54$	$6.50^{ab} \pm 0.40$	$6.20^{a} \pm 0.40$	$6.15^{a} \pm 0.40$
T_2	$7.33^{c} \pm 0.54$	$7.00^{c} \pm 0.63$	$7.05^{cb} \pm 0.75$	$6.56^{b} \pm 0.54$	$6.00^{ab} \pm 0.75$	$5.85^{a} \pm 0.40$	$5.80^{a} \pm 0.40$
				Flavour			
C	$7.41^{c} \pm 0.51$	$7.20^{bc} \pm 0.40$	$6.70^{ab} \pm 0.51$	$6.20^{a} \pm 0.75$	$6.10^{a} \pm 0.40$	VS	VS
T_1	$7.16^{c} \pm 0.51$	$7.00^{bc} \pm 0.51$	$7.00^{bc} \pm 0.63$	$6.50^{ab} \pm 0.54$	$6.20^{a} \pm 0.75$	$6.11^{a} \pm 0.54$	$6.00^{a} \pm 0.40$
T_2	$7.00^{d} \pm 0.51$	$6.83^{cd} \pm 0.40$	$6.67^{cd} \pm 0.51$	$6.33^{abc} \pm 0.51$	$6.00^{ab} \pm 0.63$	$5.88^{a} \pm 0.40$	$5.75^{a} \pm 0.40$
				Texture			
C	$7.50^{c} \pm 0.45$	$7.20^{bc} \pm 0.75$	$6.80^{ab} \pm 0.75$	$6.30^{a} \pm 0.51$	$6.20^{a} \pm 0.40$	VS	VS
T_1	$7.16^{c} \pm 0.52$	$7.20^{c} \pm 0.41$	$6.80^{bc} \pm 0.40$	$6.30^{ab} \pm 0.51$	$6.20^{ab} \pm 0.63$	$6.05^{a} \pm 0.40$	$5.83^{a} \pm 0.51$
T_2	$7.00^{c} \pm 0.41$	$7.00^{c} \pm 0.63$	$6.67^{bc} \pm 0.51$	$6.33^{ab} \pm 0.51$	$6.00^{a} \pm 0.89$	$6.10^{a} \pm 0.40$	$5.80^{a} \pm 0.40$
				Juiciness			
C	$7.33^{cB} \pm 0.49$	$7.20^{cB} \pm 0.51$	$6.80^{bc} \pm 0.40$	$6.20^{abA} \pm 0.51$	$6.00^{aA} \pm 0.40$	VS	VS
T_1	$7.33^{cB} \pm 0.54$	$7.30^{bcB} \pm 0.51$	$7.20^{bc} \pm 0.51$	$6.80^{abcB} \pm 0.40$	$6.60^{aB} \pm 0.81$	$6.35^{aB} \pm 0.63$	$6.31^{aB} \pm 0.40$
T_2	$6.83^{cA} \pm 0.51$	$6.82^{cA} \pm 0.63$	$6.83^{c} \pm 0.40$	$6.30^{bA} \pm 0.54$	$6.10^{abA} \pm 0.89$	$5.82^{aA} \pm 0.51$	$5.80^{aA} \pm 0.40$
				Tenderness			
C	$7.41^{bB} \pm 0.49$	$7.30^{b} \pm 0.51$	$6.50^{aA} \pm 0.83$	$6.20^{aA} \pm 0.40$	$6.30^{aA} \pm 0.40$	VS	VS
T_1	$7.33^{cB} \pm 0.52$	$7.20^{c} \pm 0.75$	$7.11^{bcB} \pm 0.81$	$7.00^{bcB} \pm 0.54$	$6.80^{abcB} \pm 0.75$	$6.51^{abB} \pm 0.51$	$6.20^{aB} \pm 0.40$
T_2	$6.83^{cA} \pm 0.54$	$7.00^{c} \pm 0.63$	$6.33^{bA} \pm 0.40$	$6.00^{bA} \pm 0.54$	$6.17^{abA} \pm 0.63$	$5.75^{aA} \pm 0.40$	$5.50^{aA} \pm 0.40$
				Overall acceptability			
C	$7.41^{c} \pm 0.51$	$7.00^{c} \pm 0.63$	$6.80^{bc} \pm 0.75$	$6.20^{ab} \pm 0.75$	$6.10^{a} \pm 0.40$	V S	V S
T_1	$7.16^{b} \pm 0.51$	$7.20^{b} \pm 0.51$	$7.00^{b} \pm 0.89$	$6.70^{ab} \pm 0.51$	$6.20^{a} \pm 0.75$	$6.11^{a} \pm 0.51$	$6.10^{a} \pm 0.40$
T_2	$7.00^{d} \pm 0.51$	$7.00^{d} \pm 0.63$	$6.67^{cd} \pm 0.52$	$6.33^{bc} \pm 0.51$	$6.17^{abc} \pm 0.81$	$5.85^{ab} \pm 0.89$	$5.65^{a} \pm 0.40$

Means±SD with small letters superscripts row wise and capital letters column wise differ significantly ($p \leq 0.05$). VS=visibly spoiled

due to increased lipid oxidation resulting in malonaldehyde formation, liberation of free fatty acid as compared to T_1 and T_2 treated meat rolls because Aloe vera (Zapata *et al*., 2013) and arjun tree **(**Shahriar *et al*., 2012) are known to their strong antioxidant properties.

A significant ($p \leq 0.05$) decline in texture scores during storage was observed after 4th day of storage in control rolls but it was observed after 8th day for T_1 and T_2 treated rolls. An early decline in texture scores of control samples again as compared to treated meat rolls during storage might be due to more loss of moisture in control during storage. Further it might be contributed due to degradation of muscle fiber protein by bacterial action (Jay, 1996) resulting in decreased water binding capacity.

Juiciness score of T_1 treated roll was significantly higher from control and T_2 on 8th day and this trend was maintained till the end of storage period. It was due to faster loss of moisture in control samples during storage and lower initial moisture level of Arjun tree bark extract treated rolls (Shahriar *et al.,* 2012). Perhaps, the meat rolls with lower moisture were perceived as less juicy by panelists (Garcia *et al.,* 2006).

However, the tenderness scores for T_2 meat rolls was significantly lower than control and T_1 samples on 0 day, but after 4th day, this trend changed and T_1 meat rolls maintained significantly higher tenderness scores than control and T_2 roll till end of the storage. An early decline in tenderness scores for control samples during storage might be due to more loss of moisture and degradation of muscle fiber protein by bacterial action in control during storage.

The progressive reduction in overall acceptability scores with an increase in storage period was a resultant of decreased value of other sensory attributes. Increased lipid oxidation, protein degradation and some bland flavour due to fat degradation in control samples as compared to treated meat rolls are mainly responsible for lower overall acceptability scores in control at the end of the storage period. However, control samples were visibly spoiled after 15 days of storage but both the treated (T_1 and T_2) meat rolls were well in the acceptable range even at the end of the storage period of 21 days.

Microbiological quality

Total plate counts, Psychrotrophic counts and Yeast and mould counts (log cfu/g) followed a gradual increasing pattern (Table 3) during the storage period in control as well treatments. The TPC did not differ significantly between control, T_1 and T_2 treatments till 4th day of storage period

Table 3: Microbiological quality of Aloe vera gel and Arjun tree bark extract incorporated buffalo calf meat rolls at refrigeration (4±1 0C) storage (N=6)

Treatments	Storage days						
	0	4	8	12	15	18	21
				Total plate counts			
C	$1.78^{a} \pm 0.16$	$1.86^{a} \pm 0.12$	$2.19^{bB} \pm 0.11$	$3.18^{cB} \pm 0.14$	$5.13^{dB} \pm 0.17$	VS	VS
T_1	$1.70^{a} \pm 0.12$	$1.76^{ab} \pm 0.13$	$1.94^{bA} \pm 0.10$	$2.18^{cA} \pm 0.12$	$3.43^{dA} \pm 0.14$	$4.71^{e} \pm 0.11$	$5.27^{f} \pm 0.12$
T_2	$1.73^{a} \pm 0.13$	$1.81^{a} \pm 0.09$	$1.92^{aA} \pm 0.16$	$2.28^{bA} \pm 0.13$	$3.58^{cA} \pm 0.13$	$4.73^{d} \pm 0.12$	$5.23^{e} \pm 0.13$
				Psychrotrophic counts			
C	$1.31^{a} \pm 0.24$	$1.44^{a} \pm 0.22$	$1.72^{a} \pm 0.23$	$2.21^{b} \pm 0.30$	$2.60^{bB} \pm 0.33$	VS	VS
T_1	$0.94^{a} \pm 0.23$	$1.21^{a} \pm 0.23$	$1.43^{a} \pm 0.23$	$1.94^{b} \pm 0.23$	$2.30^{bcAB} \pm 0.23$	$2.74^{cd} \pm 0.23$	$3.11^{d} \pm 0.23$
T_2	$0.91^{a} \pm 0.23$	$1.13^{a} \pm 0.23$	$1.32^{a} \pm 0.23$	$1.86^{b} \pm 0.23$	$2.04^{bA} \pm 0.23$	$2.58^{c} \pm 0.23$	$2.87^{c} \pm 0.23$
				Yeast and mould counts			
C	$0.58^{a} \pm 0.09$	$0.61^{aA} \pm 0.14$	$0.78^{bB} \pm 0.12$	$0.89^{cB} \pm 0.08$	$0.96^{dB} \pm 0.15$	VS	VS
T_1	ND	ND	ND	ND	ND	0.74^{bA}	0.85^{b}
T_2	$0.51^{a} \pm 0.10$	$0.59^{aB} \pm 0.09$	$0.64^{bA} \pm 0.07$	$0.73^{bcA} \pm 0.11$	$0.81^{cA} \pm 0.08$	$0.86^{dB} \pm 0.12$	$0.98^{b} \pm 0.07$

Means±SD with small letters superscripts row wise and capital letters column wise differ significantly ($p \leq 0.05$), VS=Visibly Spoiled; ND=Not Detected

but after that the counts increased significantly ($p \leq 0.05$) with increase in storage interval. On 15th day of storage, the TPC counts in control samples were significantly higher than that of T_1 and T_2 treated meat rolls.

The counts for psychrotrophs for control, T_1 and T_2 meat rolls were statistically similar till 12th day but after that the counts were increased significantly and found higher in control.

The yeast and mould counts were not detected in T_1 treated meat rolls till 15 days. However, the yeast and mould counts were statistically similar for control and T_2 buffalo male calf meat rolls till 4th day but after that the counts were significantly higher in control as compared to both the treated samples. Sajadi (2015) claimed that Aloe vera gel contains a blend of carbohydrates, glycoprotein as well as a variety of nutrients, vitamins and minerals and has strong anti-fungal properties and Javed *et al*. (2016) reported that methanolic extract of *Terminalia arjuna* has moderate antifungal effects.

The control sample was visibly spoiled on 18th day but the counts in both the treated (T_1 and T_2) meat rolls were well within the safety limits (Jay, 1996) at the end of the storage (21 days). The antimicrobial action of Aloe vera gel (Zapata *et al*., 2013) and Arjun tree bark extract (Mahbuba *et al*., 2012) was clearly noticed during storage.

It is concluded that control meat rolls were visibly spoiled after 15 days of storage but Aloe vera gel (4%) and Arjun tree bark extract (2%) incorporation showed their antioxidant and antimicrobial effects including antimycotic effect of Aloe vera gel, keeping the treated products organoleptically acceptable and microbiologically safe up to 21 days of storage at refrigeration temperature.

REFERENCES

AOAC, 1995. Official Methods of Analysis, 16th Edn, Association of Official Analytical Chemists, Washington, DC.

APHA. 1984. Compendium of Methods for Microbiological Examination of Foods. 2nd Edn. American Public Health Association, Washington, DC.

Biswas, A.K., Kumar, V., Bhosle, S., Sahoo, J. and Chatli, M.K. 2011. Dietary fibres as functional ingredients in meat products and their role in human health. *Int. J. Livest. Prod.,* **2**: 45-54.

Che Man, Y.B., Bakar, J. and Mokri, A.A.K. 1995. Effect of packaging films on storage stability of intermediate deep fried mackerel. *Int. J. Food Sci. Technol*., **30**: 175-179.

Cross, A.J., Ferrucci, L.M., Risch, A., Graubard, B.I., Ward, M.H. and Park, Y. 2010. A large prospective study of meat consumption and colorectal cancer risk: an investigation of potential mechanisms underlying this association. *Cancer Res*., **70**: 2406-2414.

Decker, E.A. and Park, Y. 2010. Healthier meat products as functional foods. *Meat Sci*., **86**: 49-55.

Garcia, M.L., Caceres, E. and Selgas, M.D. 2006. Effect of inulin on the textural and sensory properties of mortadella, a spanish cooked meat product. *Int. J. Food Sci. Technol*., **41**: 1207- 1215.

Javed, T., Riaz, S., Uzair, M., Mustafa, G., Mohyuddin, A. and Ahmad, B. 2016. Biological activity of *Terminalia arjuna* on Human Pathogenic Microorganisms. *Pak. J. Pharmaceut. Res.,* **2(1)**: 23-27.

Jay, J.M. 1996. Prevalence of Listeria spp. in meat and poultry products. *Food Control*, **7**: 209-214.

Kawai, K., Beppu, H., Shimpo, K., Chihara, T., Yamamoto, N., Nagatsu, T., Ueda, H. and Yamada, Y. 1998. In vitro effects of *Aloe arborescens* Miller var.natalensis Berger (Kidachi aloe) on experimental *Tinea pedis* in guinea-pig feet. *Phytotherapy Res. Prot.,* **12(3)**: 178–182.

Keeton, J.T. 1983. Effect of fat and NaCl/phosphate levels on the chemical and sensory properties of pork patties. *J. Food Sci*., **48**: 878-881.

Konieko, E.K. 1979. In: Handbook for meat chemists. Avery Publishing Group Inc., Wayne, New Jersey, USA.

Lawless, J. and Allen, J. 2000. Aloe vera: Natural wonder care. 1st Edn. Thorsons, HarperCollins, Hammersmith, London, W6 8JB. Pp-5-12.

Mahbuba, A., Islam, S., Mazumdar, R.M., Fakruddin, M., Das, S., Bhuiyan, H. and Prodhan, S.H. 2012. A biological tool to combat against multidrug-resistant Salmonella isolated from poultry of Chittagong City, Bangladesh. *Int. J. Nat. Sci.,* **2(1):** 71-75.

Modi, V.K., Sachindra, N.M., Nagegowda, P., Mahendrakar, N.S. and Rao, D.N. 2007. Quality changes during the storage of dehydrated chicken kebab mix. *Int. J. Food Sci. Technol*., **42**: 827-835.

Sajadi, K. 2015. Antifungal Effect of Aloe Vera Gel on Penicillium Citrinum in Culture Media and UF Cheese. *Int. J. Food Engin.*, **1(1)**: 61-64.

Shahriar, M., Akhter, S., Hossain, M.I., Haque, M.A. and Bhuiyan, M.A. 2012. Evaluation of in vitro antioxidant activity of bark extracts of *Terminalia arjuna. J. Med. Plants Res.,* **6(39)**: 5286-5298.

Sinha, M., Manna, P. and Sil, P.C. 2008. *Terminalia arjuna* protects mouse hearts against sodium fluoride-induced oxidative stress. *J. Med. Food,* **4**: 733-40.

Snedecor, G.W. and Cochran, W.G. 1994. Statistical methods. 8th Edn. The Iowa State University Press Ames, Iowa, USA.

Witte, V.C., Krauce, G.F. and Bailey, M.C. 1970. A new extraction method for determining 2 thiobarbituric acid values for pork and beef during storage. *J. Food Sci*., **35**: 582.

Zapata, P., Navarro, D., Guillén, F., Castillo, S., Martínez-Romero, D., Valero, D. and Serrano, M. 2013. Characterisation of gels from different Aloe spp. as antifungal treatment: Potential crops for industrial applications. *Ind. Crops Prod*., **42**: 223-230.