International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Storability and Physico-Chemical Quality of Ready to Eat Bovine Tripe Rolls under Different Storage Conditions

Wilson.G.Karibe[1], Catherine N. Kunyanga[2], Jasper K. Imungi[3]

Department of Food Science, Nutrition and Technology, University of Nairobi, P. O. Box 29053-00625 Kangemi, Nairobi, Kenya

Abstract: ***Cooked ready to eat bovine tripe rolls were developed from a combination of rumen, reticulum, abomasum and omasum parts of bovine tripe. Blade tenderization and mincing treatments were used to improve the tenderness of the products which were stored at refrigerated condition in vacuum and aerobic packages. Evaluation of the products was done for physico-chemical and sensory characteristics at methodical interval of 7 days during the storage period of 28 days. Significant changes (p<0.05) in sensory and physico- chemical characteristics were observed in minced and blade tenderized products under different packaging conditions. The cooking losses (9.07%-12.09%) and shear force values (2.31N-4.43N) among the minced, blade tenderized and control (Non-tenderized tripe) products differed (p<0.05) significantly during storage. The storage period caused notable changes (p<0.05) in pH, peroxide value, Thiobarbituric acid (TBA) value, Moisture content, tyrosine value and extract release volumes (ERV) under different packaging conditions. The average pH ranged from 6.4 to 6.0, ERV (22.2-17.9), Peroxide value (1.81-16.04 meq/kg), TBA (0.55-0.91mg malonaldehyde/kg) and tyrosine value (0.43-0.78 mg tyrosine /100g). The extract release volume, TBA and peroxide values for vacuum packed products were significantly (p<0.05) lower than in aerobically packed products. Sensory evaluation scores for all the samples under vacuum packaging were well within the acceptable limits up to 28 days of storage at 4±1 °C. However, all the samples stored aerobically were acceptable until 21 days of storage after which extremely high off odors due to increased lipid oxidation which reduced their scores significantly (P<0.05). Hence, vacuum packaging was extra effectual than aerobic packaging in inhibiting oxidation of lipids, protecting the organoleptic quality of the product as well as extending the shelf-life of the ready to eat product.***

Keywords: Bovine tripe, Blade tenderization, Mincing, Aerobic packaging, vacuum packaging

1. Introduction

The population of livestock in Kenya is about 14.1 million for indigenous cattle and 3.4 million for exotic cattle while over 70% of the whole population is raised by the pastoralists (Farmer and Mbwika, 2012). Although cattle are slaughtered mainly for meat, large volumes of by-products with significant value are also generated. Most of the by-products constitute an excellent source of nutrients such as minerals and vitamins (Garcia et al., 2011). However, a lot of the slaughter by-products especially bovine tripe are not fully utilized because of the socio-cultural beliefs, their natural state and lack of technology for value addition (Abegaz, 2009).

Bovine tripe accounts for approximately 0.75%-2.0% yield by live weight (Ockerman and Hansen, 2000), which is about 5.62kgs/cattle. In Kenya, majority of communities in the pastoral regions and other slaughter establishments/slabs discard tripe after slaughter due to its innate toughness caused by large amounts of collagen that makes it extremely hard to chew. This toughness coupled with poor keeping quality and its low value aesthetically has made it hard to utilize tripe in commercial applications for value addition (Parivell, 1999). It is not practical to discard tripe because it has strong economic potentials in the development of new products with added value upon overcoming the above limitations successfully by enhancing tenderness using appropriate processing technologies (Toldra and Reig, 2011). The added value is realized through shelf stability, improved sensory qualities (flavor and texture) or even more convenience in terms of handling of the final product.

Blade tenderization and mincing are well acknowledged and recognized mechanical techniques of tenderizing meat and meat by-products in the meat industry (Alaa et al., 2014). The two processes disrupts the structure of muscles, break down the external part of the meat by-product and releases the myofibrillar proteins consequently increasing solubilisation and extractability of muscle proteins leading to enhanced product yield and softness of the end by-products or meat (Pietrasik and Shand 2004). According to Benito-Delgado et al., (1994), blade tenderization entails penetrating the muscles with sharp thin blades which are closely spaced. The long muscle fibers are cut into smaller and shorter segments significantly improving the tenderness of the meat cuts. Most researchers have reported that mechanically tenderized ready to eat meat products are less tough than the control ones and that mechanical tenderization is one of the frequently used and effective methods of tenderizing meat and meat-by-products. Research has also shown that mechanical tenderization of meat products decreases the shear force required to chew cooked meat products (Flores et al., 1986). Mincing entails passing fresh meat /by-product via a meat mincer which disintegrates the connective tissues making them softer and less obstructive upon cooking. It is becoming one of the most employed techniques in development of new meat products and meat processing (Anna et al., 2008).

Bovine tripe is a commodity that spoils easily, hence there is need to strategize on a preservation technique that can slow down the rate of spoilage and still maintain the products quality during storage. If suitable storage and packaging conditions are used, they play a significant role in preserving the products quality during storage (Lavieri & Williams, 2014). It has been reported that meat products developed through mechanical tenderization had more desirable acceptability until the 15th day during refrigerated storage in vacuum packages (Anna et al., 2008). It has also been shown that vacuum packaging creates anaerobic environment and conditions that retain the quality and extends the oxidative shelf-life of meat and meat-products. Therefore, the current study was designed to evaluate the efficacy of mechanical tenderization methods on the physico –chemical qualities of cooked bovine tripe rolls during refrigerated storage (4±1 °C) under vacuum and aerobic packages.

2. Materials and Methods

2.1 Sample collection and preparation

The bovine tripe was obtained from a local slaughterhouse (Bahati slaughterhouse, Limuru) which possesses the required authorisation from local authorities about health and hygiene practices. Other ingredients were bought from an authorised supplier in Nairobi city. Fat and other extraneous substances attached to the surface of tripe were separated using a knife followed by thorough washing. The tripe was then cut into (8×8cm) pieces for ease of mechanical tenderization. The already processed casings with internal diameter of 5 cm were bought from authorized processor in Nairobi city. Other ingredients were bought from an authorised supplier in Nairobi city.

2.2 Product formulation and treatments

The formulated ready to eat product consisted of the following ingredients: bovine tripe, common table salt, sodium triphosphate, $NaNO_2$, ascorbic acid, spices, and flakes of ice. A series of preparatory trials were carried out in order to develop the final formula for a ready to eat bovine tripe rolls. Different additives and seasonings used in the formulations are shown in Table 1. Blade tenderization (BT) and mincing are the treatments that were used to prepare bovine tripe. Bovine tripe pieces were tenderized three times using a blade tenderizer which is operated mechanically. This was followed by sectioning the tenderized pieces into even chunks of 2 cm by 2 cm and was used to prepare blade tenderized bovine tripe rolls.

Bovine tripe pieces subjected to partial freezing (-2°C) were ground twice using a meat grinding machine and a 3 mm plate and used to prepare ground/minced cooked bovine tripe rolls. 2 cm by 2cm bovine tripe chunks (Non-tenderized) were used to prepare the control products.

Table 1: Additives and seasonings for a 500g product formulation

Additives	Quantity (gm.)	Seasonings	Quantity (gm.)
Common salt	8	White pepper	1
Sodium tripolyphosphate (STTP)	1.5	Nutmeg	0.15
Ascorbic acid	0.15	Mace ground	0.3
Monosodium glutamate (MSG	0.25	Coriander & Ginger	0.4
NPS	1.5		
Total	**11.4**	**Total**	**1.85**

2.3 Preparation of the product

After tenderization and mincing, bovine tripe samples (BT samples and minced samples) were weighed separately and mixed in meat mixing machine at a speed of 250rpm for 5min with sodium triphosphate and sodium chloride. After 5 minutes, ascorbic acid, additives and seasonings, $NaNO_2$ and ices flakes were incorporated into the mass and mixing proceeded for another 5 minutes in order to get a homogenous mass.

500 grams of the homogenous meat mixture was put manually into casings. Cooking of the stuffed mixture took place hot water that had been pre-heated till the inner temperature of 83 ±1°C was achieved and retained for 15 minutes. Probe thermometer was used to record the temperature.

After cooking was done, the RTE bovine tripe rolls were left to cool down packed in LDPE and put in a refrigerator to chill for about 13 hours. Thereafter, the mass was cut into thin pieces using a meat slicing machine and packed under both vacuum and aerobic conditions using PET pouches. Storage of the samples was done at 4±1 °C and evaluation carried out at 0, 7, 14, 21 and 28 days.

Blade tenderization	Mincing
Bovine tripe	Bovine tripe
Removal of fat and extraneous matter (Trimming)	Removal of fat and extraneous matter
Cut into 10×10 cm chunks	Partial freezing (-2°C)
Blade tenderize	Mincing (using 3mm plate)
Section into uniform pieces (2cm)	Addition of salts &spices
Addition of salts and spices	
Mixing of ingredients completely (meat mixer)	Mixing of ingredients
Stuffing	Stuffing
Cooking (internal temp 83◦C)	Cooking (internal temp 83◦C)
Cooling	Cooling
Package in LDPE	Package in LDPE
Chilling in refrigerator (13 hrs)	chilling in refrigerator
Package in PET	Package in PET
Store at 4◦C and Evaluation	Store at 4 ◦C & Evaluation

Figure 1: The RTE Bovine tripe rolls processing logical flow

2.4 Analytical methods

2.4.1 Proximate composition

2.4.1.1 Determination of Moisture content

The AOAC approved method 950.46 (AOAC, 2006) was used. Approximately 5g of the sample was weighed in aluminium made dish which was placed in an oven at 105ºC for approximately 5 hours. Cooling followed and both the dish and the residue were weighed. The difference in weight between the original fresh sample weight and the dried sample gave the moisture content. This was expressed as per cent moisture content.

2.4.1.2 Determination of Fat content

The soxhlet method according to AOAC Approved method 954.02 (AOAC, 2006) was used to determine the crude fat content of the products. 5g of pounded sample was accurately weighed into an extraction thimble containing cotton wool which was then transferred into the sohxlet extractor and extraction of the fat done in a tared flask for 8 hours using petroleum ether (B.P. 40-60oC). Evaporation of the fat was done in a rotary evaporator. The drying of the residue was done in an air oven at 105ºC for about 1 hour and then weighed. Determination of the fat content was done and values expressed in form of percentage of the sample dry matter content.

2.4.1.3 Determination of Protein content

The approved AOAC (2006) Kjeldahl 992.15 method was used for crude protein determination. 0.5g of the sample were accurately weighed and placed in a Kjeldahl flask, folded in a nitrogen free filter paper. A catalyst tablet and sulphuric acid were carefully added to digest the sample in a fume chamber. Phenolphthalein was used as the end point indicator before the Kjeldahl flask was connected to a distillation unit. 40% NaOH solution was used for back titration against a 0.1N NaOH solution. 6.25 were used as the standard conversion factor for Nitrogen into crude protein content of the sample.

2.4.1.4 Determination of Ash Content

The approved AOAC (2006) Method 942.05 was used. Charred samples were placed in dishes followed by heating for 6 hours at 525ºC till the ash that was white in colour was gotten to a constant weight. The weight of the obtained ash was dived by the sample weight and expressed into percentage.

2.4.1.5 Determination of Crude fiber

Method 978.10 of AOAC (2006) was used. Ten gram of sample was digested with 200 ml of boiling 0.225N Sulphuric acid in heating mantle for 30 minutes with condenser. After boiling, the contents were filtered in the fluted funnel and washed with boiling water to free from acids. This was then boiled with preheated 200 ml of 0.313N NaOH for 30 minutes in heating mantle with condenser. The sample was then filtered and washed in fluted funnel. The material was dried, weighed and then ashed in the furnace at 540˚C. Subtraction of ash weight from weight of acid, alkali treated sample give weight of crude fiber.

$$\text{Crude fiber (\%)} = \frac{\text{Weight of crude fiber}}{\text{Weight of sample taken}} \times 100$$

2.4.2 Determination of cooking loss

The methods described by Pietrasik and Shand (2004) were used to determine the cooking losses. A sample of known weight was cooked until its centre attained a temperature of 83°C. Cooking loss was expressed as per cent loss in weight between the initial and the after cooking weights of the sample.

2.4.3 Determination of Shear force Value

The Procedure described by Anna et al., (2008) was used. Bovine tripe rolls were sliced into 1 cm^2 sections and positioned perpendicularly to the blade. Warner–Bratzler shear press machine was used to shear the sections. The recording was done to get the average shear force values of 10 observations that were made.

2.4.4 Determination of Peroxide Value (PV)

Determination of PV was done using the procedure of Richards and Hultin (2000) but the method was slightly modified as per Maqsood et al., (2015) descriptions. Cumene hydro peroxide at a concentration of 2ppm was used to prepare a standard curve with the concentration range of 0.5-2 ppm.

2.4.5 Determination of Extract Release Volume (ERV)

Jay and Hollingshed (1990) methods were used to determine ERV. Fifteen grams of ground product were measured and mixed thoroughly with 60 ml of distilled water in a homogeniser. The suspension was rapidly transferred into a funnel supplied with paper number one (Whatman) The ERV of the product was determined by recording the volume of the filtrate obtained in the initial 15 minutes.

2.4.6 Determination of Thiobarbituric Acid Value (TBA)

The methods of Witte et al., 1970 were used in estimation of TBA values. Trichloroacetic acid extracts obtained from all the products were employed in determination of the absorbance at 532 nm. Calculation of TBA was done as mg malonaldehyde per kg of product sample making use of standard graphs formulated using known concentration of malonaldehyde as reference.

2.4.7 Determination of Tyrosine Value

The methods described by Strange et al 1977 were used to determine the tyrosine value of the samples. 2.5 ml of Trichloro acetic acid (TCA) extract was diluted with equal quantity of purified H_2O in test tubes. To this, 10ml of 0.5N sodium hydroxide was added followed by 3ml of dilute folin ciocalteu phenol reagent. After mixing, the mixture was kept for 15 minutes a room temperature. The developed blue color was measured as absorbance value at 660 nm in a spectrophotometer using a blank (5ml of 5% TCA) for comparison. With reference to a standard graph, the tyrosine value was calculated and expressed as mg of tyrosine /100gm of the sample.

2.4.8 Determination of PH

Estimation of pH was done by adopting the procedure laid down by AOAC (2006) method 981.12 using digital pH meter (Elico model L 1-10 T, Chennai) with a glass probe electrode. About 10 g of each sample were mixed thoroughly for 1min in a blender with 50 ml of distilled water and the volume topped up to 100 ml and pH was recorded.

2.4.9 Sensory Evaluation

Sensory evaluation was conducted on days 0,7 14, 21, 28 days of storage by lining up a panel of 11 semi-trained members who are familiar with meat products and whose key focus was on Appearance and colour, odour, taste, tenderness, juiciness and overall acceptance. Coding was done randomly using three digit codes to enable subjective, unbiased and independent exercise among the panelists. They were instructed to finish with all attributes of one sample before proceeding to another to aid objectivity. Rinsing water was duly provided for mouth rinsing between samples tasting. Panelists were subjected to similar operating conditions. A nine point hedonic scale was used by the panelist for their judgment with 9 being like extremely and 1 dislike extremely as described by Meilgaard *et al.*, (2006).

2.5 Statistical analysis

The data were analysed using one-way analysis of variance (ANOVA) and the Duncan's multiple range tests for multiple mean comparisons. The data were processed using Genstat software version 15.0 and significance was defined at P<0.05. Sensory analysis descriptive data was analysed using SPSS for windows version 20 and the difference in means done using the Duncan's multiple test at P<0.05.

2.5 Results and Discussion

2.5.1 Shear Force Value (SFV) of the Products

Results for the shear force values of the ready to eat bovine tripe rolls are shown in figure 2. Tenderness and hardness are very important attributes when chewing meat products and can determine consumer preference of the product. In this study, the two attributes were determined using shear force. The product processed by mincing had the lowest SFV of 2.31 N while the control product (made of bovine tripe not subjected to mechanical tenderization) had the highest SFV of 4.43 N. The SFV for control product (non-tenderized tripe rolls) were significantly higher (p<0.05) compared with the minced bovine tripe rolls and blade tenderized bovine tripe rolls. The mean SFV for blade tenderized product was marginally higher than the minced product, however, the difference was still significant (p<0.05).

Mincing drastically reduced the hardness of the bovine tripe hence the low shear force values. Berry et al., (1999) also observed that shear force value of cooked beef patties reduced significantly after mincing. Keller et al., (1994) found that meat products developed from meat with large particles had higher shear force values. Mechanical treatment of the samples caused disruption of the structure of connective tissues and weakens the protein network in the tripe leading to lower SFV. Other authors found that mechanical treatment decreases the force needed to shear the roasts meat samples (Flores et al., 1986) and reduces Warner-Bratzler hardness shear force values (Shackelford et al., 1989) of cooked meat products. It has been shown that mechanical tenderization improves the tenderness of less tender cuts of meat products and hence has currently become an efficient and effective technology of improving tenderness of meat and meat products (Pietrasik and Shand 2004). This adds value to the whole carcass by allowing the processors to sell products that are tender, raise the final returns of meat processors and leads to satisfaction of the demands of all the consumers.

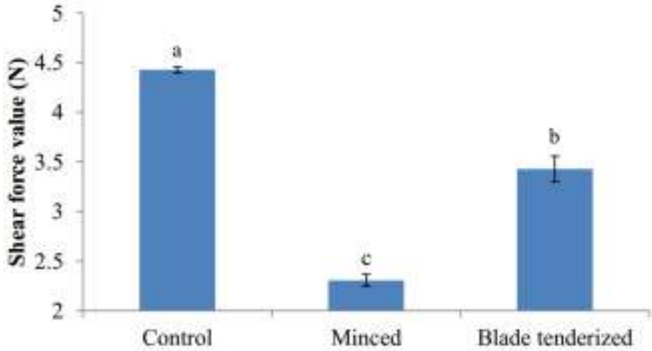

Figure 2: Shear force values of differently processed bovine tripe rolls. (The error bars indicate standard error of the mean. Bar with different letters are significantly different at p<0.05.)

2.5.2 Cooking Losses of the RTE products

Results for cooking loss of the RTE bovine tripe rolls are presented in the figure 3. The losses ranged from 9.07% for Control (Untreated tripe samples) to 12.09% for the minced samples. The cooking losses for the three products differed significantly (p<0.05), but the losses were significantly lower in the product that was not subjected to any mechanical treatment (Control). The low cooking losses of the control product are as a result of its larger size of the particles and lower extraction levels of the protein due to less mechanical disruption of the tripe structure (Anjaneyulu et al., 1989). The higher cooking losses of the minced products are due to effects of mincing where the myofibrillar proteins are fragmented increasing the surface area for loss. (Bowker et al., 2007). Lin and Keeton (1994) investigated and found that use of coarse mincing in meat products that are pre-cooked increases cook yield due to improved extractability of the proteins which causes greater solubilisation of protein muscles. Pietrasik and Shand (2004) also reported that blade tenderization results in increased cooking losses due to the holes created by the blade tenderizer which increases moisture loss.

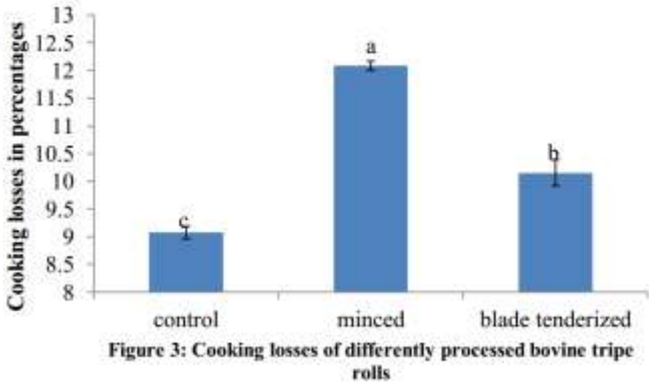

Figure 3: Cooking losses of differently processed bovine tripe rolls. (The error bars indicate standard error of the means. Bar with different letters are significantly different at p<0.05)

2.5.3 Proximate composition of differently processed tripe during storage

Results for overall treatment means for proximate composition which include moisture content, crude fat, crude protein, crude ash and crude fiber contents are shown in table 2. The following were the average ranges observed across all the products; Moisture content 68.66-72.25%, Crude protein 62.81-66.97%, crude fat 7.60-7.92%, crude fibre 2.31-2.61% and crude ash 3.71-3.93%. Results for change in proximate composition of the products during the storage period at 4±1°C under vacuum and aerobic packaging conditions are shown in figures 4-8.

Table 2: Proximate composition of differently processed tripes

Storage condition	Treatments*	Proximate Components				
		Moisture	Crude Protein	Crude Fat	Crude Fiber	Crude ash
Vacuum	Control	72.25±1.69[a]	66.97±3.61[a]	7.72±0.42[a]	2.61±0.18[a]	3.93±0.24[a]
	Minced	70.36±1.49[b]	66.95±2.78[a]	7.78±0.30[a]	2.31±0.16[a]	3.84±0.18[a]
	BT tripe	68.93±0.82[c]	62.81±1.14[b]	7.60±0.85[a]	2.33±0.23[a]	3.78±0.10[a]
Aerobic	Control	70.07±2.71[bc]	66.00±5.14[a]	7.92±0.44[a]	2.56±0.20[a]	3.82±0.24[a]
	Minced	69.47±3.17[cd]	65.94±6.19[a]	7.69±0.28[a]	2.60±0.24[a]	3.85±0.33[a]
	BT tripe	68.66±2.62[cd]	63.08±4.67[b]	7.75±0.82[a]	2.52±0.23[a]	3.71±0.22[a]

*Values with different letters in the superscript along a column are significantly different at $p<0.05$. All values are in dry matter basis except for moisture. **KEY: BT- Blade tenderized**

2.5.3.1 Moisture Content of bovine tripe rolls

Packaging significantly affected the moisture content ($p<0.05$) with vacuum packaged products retaining higher overall moisture content than aerobically packaged products. The results are in accordance to the findings of Vaudagna et al., (2002), who found out that vacuum packaging reduces loss of water in meat products. The results are in line with the findings of Lin et al., (2004), who reported that vacuum packaging results in lower weight loss of the meat products. The control products (non-tenderized mechanically) had the highest moisture content which ranged from 70.07 to 72.25 for aerobic and vacuum conditions respectively. The moisture content for the control product differed significantly ($p<0.05$) from the minced and Blade tenderized products. Blade tenderized (BT) products recorded the lowest moisture content in both aerobic and vacuum conditions but the difference was not significant at $p<0.05$. The lower moisture content in tenderized products could be due to high losses of moisture during mincing which increases the surface area for moisture loss. The water in BT products was also poorly bound hence easily lost (Anna et al., 2012). Blade tenderization creates holes in the meat products that increase moisture loss (Pietrasik and Shand (2004). Moisture content decreased gradually during storage in both packaging conditions (figure 4). These changes are attributable to loss of moisture via the packaging materials containing some permeable films (Anna et al., (2008), Sahoo and Anjaneyulu (1997). Biswas *et al.*, (2011 b) and Sharma et al (2017) also reported decrease in, moisture content of meat products during cold storage.

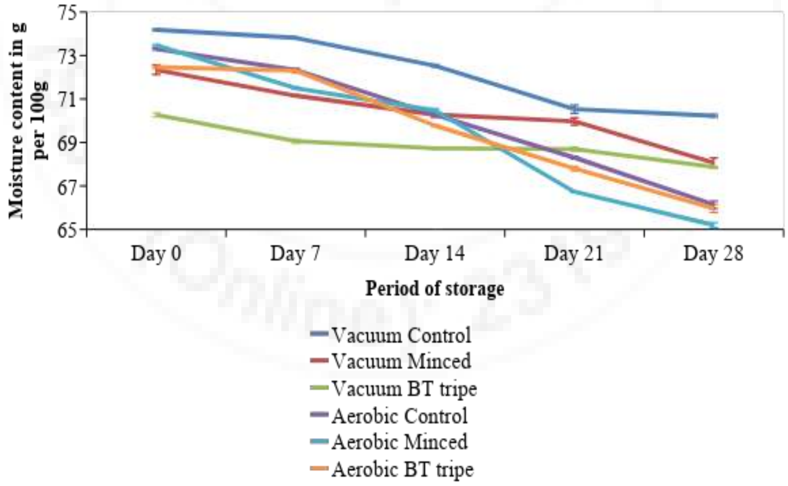

Figure 4: Moisture content of bovine tripe rolls stored for different days
(The error bars indicate standard error of the means)

2.5.3.2 Protein content of bovine tripe rolls

The crude protein of minced products and control products (non-tenderized mechanically) did not differ significantly ($p<0.05$) in both packaging conditions. However, there was a significant difference ($p<0.05$) between the blade tenderized products and all the other products that were not tenderized. Blade tenderized products had the lowest protein content of 62.81 and 63.08 for vacuum and aerobic packages respectively. These results were in agreement with Pietrasik and Shand 2004, who found that the protein content of blade tenderized meat roasts was lower compared to non-tenderized. There was a slight increase in crude protein content in all the products during the storage period (figure 5). This is due to reduction of moisture during storage which leads to a corresponding increase in density of the proteins in the product (Nielson, 2010; Gerber, 2007). Sharma et al., 2002 also reported that a decrease in moisture content leads to an increase in protein of the meat products. Sachdev *et al.*, 2002 also found that protein content increased when moisture reduced significantly during the refrigeration and frozen storage of cooked chicken meat. Similar findings were reported by Rahman et al.,2017, who observed an

Paper ID: ART2019472 DOI: 10.21275/ART2019472

increase in protein content of cooked beef during refrigerated storage. Resident microorganisms whose population increases during storage also utilize non-protein nitrogenous materials to synthesize proteins resulting in the increase of protein content (Agunbiade et al., 2010).

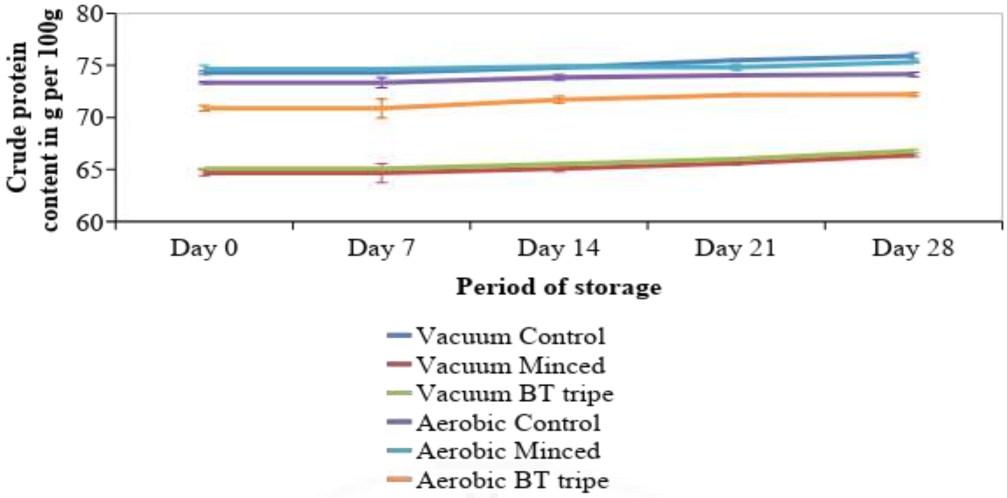

Figure 5: Protein content of Bovine tripe rolls stored for different days
(The error bars indicate standard error of the means; All values are in dry matter basis)

2.5.3.3 Crude Fat content of bovine tripe rolls

Crude fat content of all the products ranged from 7.60% to 7.92 % in the developed products. The difference in crude fat was not significant ($p<0.05$) in all the products. The type of the package had no significant effect on the crude fat content. Malik and Sharma, (2014) also observed that packaging had no effect on crude fat of the RTE buffalo meat products stored under vacuum and aerobic conditions. As the storage period advanced, a corresponding increase in fat was observed across all the products under aerobic and vacuum packaging conditions (Figure 6). This can be attributed to the effects of concentration of moisture loss (Sharma et al., 2017). These findings also corroborates with report of Rajkumar et al., (2004), who observed that moisture loss contributed to the higher crude fat content of the goat patties during refrigerated storage. Fernandez et al., (2005) also reported that as the moisture content reduces nutrients density increases.

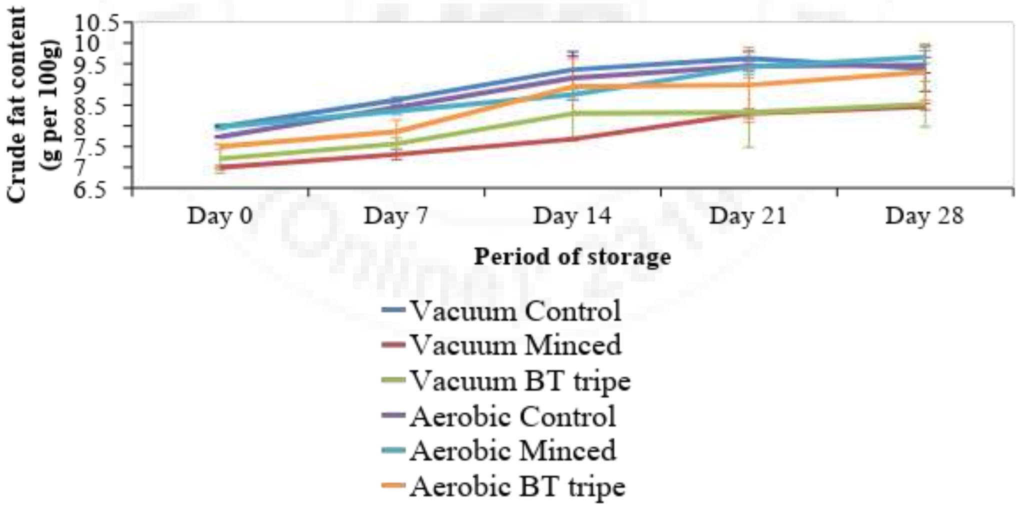

Figure 6: Crude fat content of tripes stored for different days. (The error bars indicate standard error of the means)

2.5.3.4 Crude Fibre of bovine tripe rolls

The average Crude fibre content in all the products ranged from 2.31 % to 2.61 % on dry matter basis (Table 2). The content was almost the same in all the products under aerobic and vacuum packaging condition and the slight difference noted was not significant ($p<0.05$). The overall crude fibre content increased ($p<0.05$) across the storage period but the increases were insignificant (Table 7). This increase can be attributed to decrease in the moisture content of the products with refrigeration storage which increased the density of crude fibre (Sharma et al., 2017; Nielson, 2010; Fernandez et al., 2005). The present findings are also in line with earlier report (Thind *et al.,* 2006), who found that the fibre content of cooked chicken patties increased with decrease in moisture content during the extended cold storage.

International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

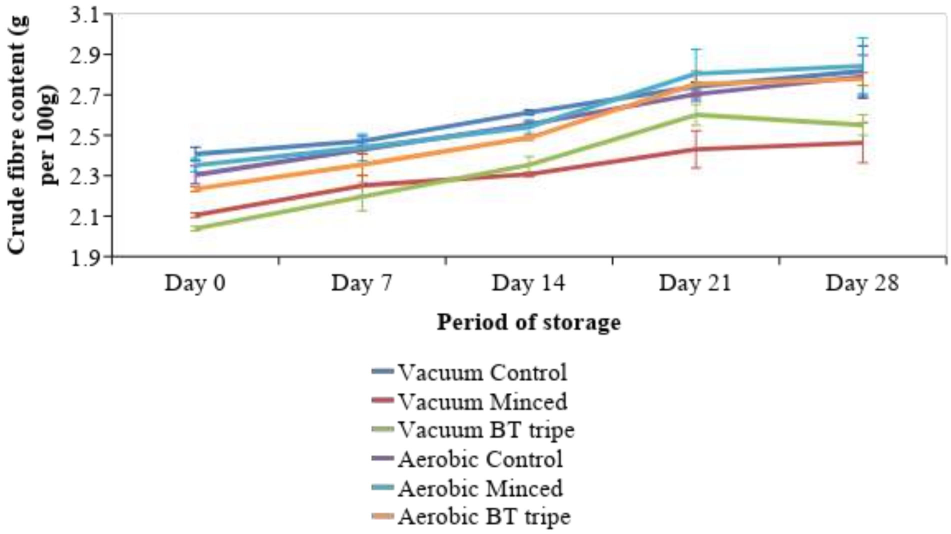

Figure 7: Crude fibre content of tripes stored for different days. (The error bars indicate standard error of the means)

2.5.3.5 Crude Ash of bovine tripe rolls

The crude ash content ranged from 3.71% to 3.93% for blade tenderized aerobically packaged product and control (untenderized product) vacuum packed product respectively. There was a slight difference in crude ash content in all the products but the difference was not significant ($p<0.05$). The crude ash content increased gradually during the refrigerated storage in both packaging conditions but the increase was not significant ($p<0.05$). According to Rahman et al., (2017), the increase can be attributed to the decrease in the moisture content of the products during the refrigerated storage that led to increased concentration of the minerals/higher mineral density. Thind *et al.*, (2006), also reported increase in ash content of cooked chicken patties with increase in the storage period.

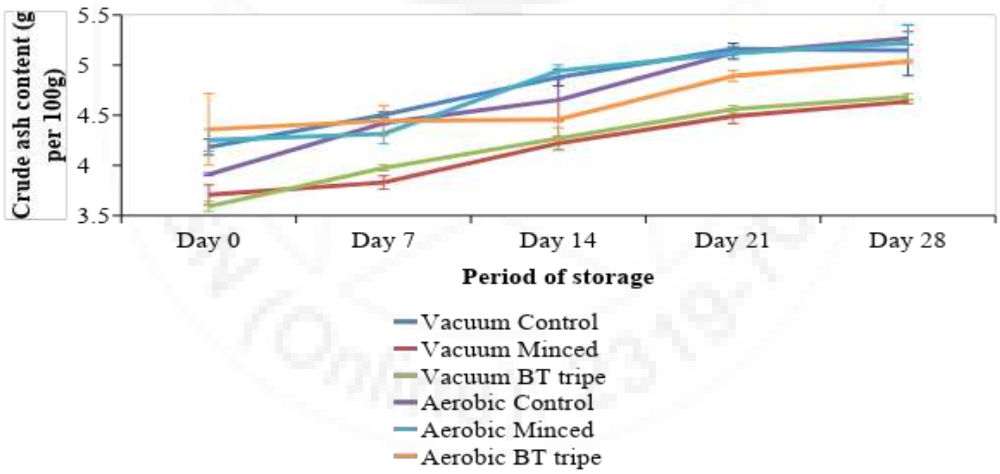

Figure 8: Crude ash content of tripes stored for different days. (The error bars indicate standard error of the means)

2.5.4 Changes in Physico-chemical characteristics during storage

2.5.4.1 pH

There results for Changes in pH of aerobically and Vacuum packed mechanically tenderized Bovine tripe rolls during the 28 days refrigerated storage are shown in Table 3. There was no significant ($p<0.05$) difference in the pH of minced, blade tenderized and control (non-tenderized tripe) RTE bovine tripe rolls. The vacuum packaged products had a higher pH compared to aerobically packaged products. This corroborates with the findings of Muthulakshmi *et al.*, (2015) who observed that hen meat samosa stored under vacuum had higher pH than aerobically packed ones. In the vacuum packaged products, pH declined significantly ($p<0.05$) as the storage period increased until the 14th day. Afterwards, the pH increased significantly. The decrease can be attributed to cross linking reactions whereby the amino groups are removed from the product causing the pH to decrease (Ockonkwo et al., 1992). Proteolysis yields compounds that are nitrogenous and they could have caused increase in pH after the 14th day (Aksu & Kaya 2005). In aerobically packaged products, pH significantly ($p<0.05$) decreased throughout the storage period. Throughout the storage period, the microbial counts increases, breaks down carbohydrates and produce lactic acid which decreases the pH (Incze, 1992). The above results are in agreement with the findings of Devatkal and Mendiratta (2001) who also found that the pH of cooked restructured pork rolls reduced significantly during storage under refrigeration conditions.

The average treatment means for blade tenderized products had greater pH values than the control and minced products in both packaging conditions. This is due to higher proteolytic activities in comparison with other products (Anna et al., 2012)

Table 3: Changes in pH of Vacuum and aerobically packaged Bovine tripe rolls during refrigerated storage (4±1 °C) for 28 days

Storage condition	Treatment*	Storage period (days)					Treatment means ± SE
		0	7	14	21	28	
Vacuum	Control	6.3±0.02[a]	6.2±0.01[a]	6.1±0.01[a]	6.1±0.04 [a]	6.3±0.02 [a]	6.2±0.01[A]
	Minced	6.4±0.02[a]	6.3±0.01[a]	6.0±0.02[b]	6.1±0.01 [a]	6.2±0.02[b]	6.2±0.01[A]
	BT tripe	6.4±0.03[a]	6.3±0.02[a]	6.1±0.02[b]	6.2±0.01[a]	6.3±0.01[a]	6.3±0.03[B]
Aerobic	Control	6.3±0.02[a]	6.2±0.02[a]	6.0±0.02[b]	5.9±0.02[b]	5.9±0.02[c]	6.0±0.02[A]
	Minced	6.3±0.01[a]	6.2±0.02[a]	6.0±0.02[b]	5.9±0.12[c]	5.8±0.02[c]	6.0±0.04[B]
	BT tripe	6.4±0.02[a]	6.2±0.03[a]	6.1±0.03[b]	6.0±0.02[bc]	5.8±0.02[c]	6.1±0.02[B]
Average		6.4±0.02[a]	6.2±0.02[a]	6.1±0.02[b]	6.0±0.04[b]	6.0±0.02[b]	

*Values with different letters (lowercase along the row and upper case along the column) were significantly different at p<0.05.

2.5.4.2 Extract Release volume (ERV)

Results for the ERV for the RTE bovine tripe rolls are shown in table 4. The average treatment means for extract release volume ranged from 19.4±0.31 to 20.6 ± 0.30 in both packaging conditions. The study showed that ERV values for blade tenderized rolls were significantly (p<0.05) lower compared with the control (non-tenderized) and minced bovine tripe rolls. However, overall treatment means for the minced and control products did not differ significantly in both aerobic and vacuum packaging conditions.

ERV values decreased significantly (p<0.05) as the storage period advanced but the all the values were below the specified limit of 17 millilitres for meat products (Pearson 1967). The ERV decreased as storage period progressed due to increase in microbial growth (Kumar et al., 2007). The current results are in accordance with the report of Jay and Shelef (1976). They discovered that storage of meat results into multiplication of microorganisms which consequently causes change in proteins of meat and meat products through proteolysis and hence cause increase in hydration capacity which causes decrease in extract release volume values. ERV is very good indicator of spoilage in meat products. It is based on the amount of aqueous extract released from slurry of product when allowed to pass through filter paper for a given period of time (Pearson 1967). The product with a relatively low microbial population releases large volumes of extract (High ERV) while product in the process of microbial spoilage with high bacterial growth releases less (Low ERV).

Table 4: Changes in Extract Release volume (ERV) in (ml) for RTE bovine tripe rolls

Storage condition	Treatments*	Storage period (days)					Treatment means ± SE
		0	**7**	**14**	**21**	**28**	
Vacuum	Control	22.1±0.62[a]	21.6±0.28[a]	21.0±0.38[a]	19.5±0.12[a]	18.6±0.12 [b]	20.6±0.30[A]
	Minced	22.5±0.63[a]	21.5±0.31[a]	19.9±0.32[ab]	19.4±0.24[b]	18.7±0.28[a]	20.4±0.36[A]
	BT tripe	21.9±0.58[a]	20.2±0.46[b]	19.2±0.28[b]	18.1±0.26[c]	17.8±0.18[c]	19.4±0.35[B]
Aerobic	Control	22.2±0.61[a]	21.1±0.58[a]	20.3±0.22[b]	19.1±0.52[b]	17.8±0.12[c]	20.1±0.41[A]
	Minced	22.5±0.62[a]	21.2±0.36[a]	20.2±0.22[b]	19.0±0.22[b]	17.3±0.18[c]	20.0±0.32[A]
	BT tripe	21.7±0.60[a]	20.8±0.12[a]	20.4±0.28[b]	18.2±0.42[bc]	17.4±0.12[c]	19.7±0.31[B]
Average		22.2±0.61[a]	21.1±0.35[a]	20.2±0.28[b]	18.9±0.30[c]	17.9±0.17[c]	

*Values with different letters (lowercase along the row and upper case along the column) were significantly different at p<0.05.

2.5.4.3 Peroxide value

Table 5 shows the peroxide values of the RTE bovine tripe rolls. As observed, peroxide values increased significantly throughout the storage period from 1.81±0.15 on day 0 to 16.04±3.58 meq/kg on 28[th] day, indicating no tendency to stabilize regardless of the packaging used. This can be attributed to accumulation of primary oxidation products. Vacuum packed products had lower peroxide values throughout the storage period compared to the aerobically packed products but the difference was not significant (p<0.05). This is due to absence of enough oxygen to initiate peroxidation reactions (Sharma et al., 2017). The overall treatment means for vacuum and aerobically packed products differed significantly (p<0.05) with vacuum packed samples exhibiting way lower peroxidation values of between 7.43- 7.47 meq/kg compared to aerobically packed samples range of 11.05-11.81meq/kg. Peroxide values are low at the beginning of the shelf-life of food (Abou- Charbia, 2002). The polyunsaturated and unsaturated fatty acids present in the fats, usually react with oxygen to form fatty acid hydro- peroxide which are unstable and breakdown into various compounds which consequently produce off-flavors; leading to a stale, rancid flavour in foods and increase in peroxide values (Kerler and Grosch, 1996). Peroxide value is essential in indicating the primary oxidation stages and its detection in meat products show that odor and taste are deteriorating and the product is becoming rancid (Jin et al., 2009). Bimbo (1998) found that the recommended peroxide values in most meat products range from 3-20meq/kg. Therefore vacuum packaged RTE bovine tripe rolls exhibited a better keeping quality compared to aerobically packaged products as the peroxide values were far much below the limits. However, all the products were well within the allowable set limits of 25meq/kg in foods (Evranuz, 1993).

Table 5: Peroxide Values as O_2(meq/kg) of RTE bovine tripe rolls.

Storage condition	Treatment*	Storage period (days)					Average
		0	**7**	**14**	**21**	**28**	
Vacuum	Control	1.81±0.06^{a}	5.22±0.61^{b}	7.84±0.20^{c}	9.76±0.13^{d}	12.71±0.11^{e}	7.47±3.88^{A}
	Minced	1.77±0.14^{a}	4.95±0.09^{a}	8.18±0.72^{c}	9.71±0.41^{d}	12.55±0.70^{e}	7.43±3.90^{A}
	BT tripe	1.83±0.19^{a}	4.79±0.28^{b}	7.98±0.52^{c}	10.21±0.56^{d}	12.50±0.47^{e}	7.46±3.95^{A}
Aerobic	Control	1.84±0.12^{a}	6.19±0.27^{b}	11.46±0.48^{c}	16.42±0.51^{d}	19.31±0.56^{e}	11.05±6.65^{B}
	Minced	1.83±0.18^{a}	6.62±0.42^{b}	12.04±0.37^{c}	16.72±0.26^{d}	19.67±0.05^{e}	11.38±6.74^{B}
	BT tripe	1.78±0.26^{a}	7.32±0.23^{b}	13.83±2.28^{c}	16.61±0.53^{d}	19.51±0.42^{e}	11.81±6.73^{B}
Average		1.81±0.15^{a}	5.85±1.00^{b}	10.22±2.55^{c}	13.24±3.46^{d}	16.04±3.58^{e}	

*Values with different letters (lowercase along the row and upper case along the column) were significantly different at $p<0.05$.

2.5.4.4 Thiobarbituric acid value (TBA)

The rate of secondary break down of lipids in the bovine tripe rolls and expressed as mg malonaldehyde/kg meat product is shown in table 6. The average day values for the TBA were between 0.55 and 0.91 mg malonaldehyde/kg. TBA values increased progressively during the entire period of refrigerated storage. However, all the TBA values obtained ranged within the limits of 1 to 2 mg malonaldehyde/kg specified for meat products (Anna et al., 2012) for the whole period of storage under aerobic and vacuum packaging conditions. TBA values for control products (non-tenderized) were significantly lower than minced and Blade tenderized (BT) products in both aerobic and vacuum packaging during the entire storage periods. Minced bovine tripe rolls had higher ($p<0.05$) overall TBA values means than BT products. Aerobically packed products showed significantly ($p<0.05$) higher TBA values than vacuum packed products for the entire storage period. This is because the oxygen was not available in the latter to propagate the oxidative lipids reactions and hence prevented disintegration of primary oxidation products to secondary products (Devatkal et al., 2004). Many researchers have reported an irrevocable increase of TBA values of meat products stored under refrigeration conditions during the entire storage time (Rajkumar et al., 2004; Singh et al., 2014). Microbial load and TBA values correlate positively as Sudheer et al. (2011) observed and hence the increased microbial counts during storage might have caused rise in oxidative changes which eventually caused increase in TBA values ((Jay, 1996). The results for the current study are in agreement with Brenesselova et al., (2015) who observed that vacuum packed ostrich meat products had lower TBA values compared to non-vacuum packed products during 21 days under refrigeration. Fernandez-Lopez et al., (2008) also found that malonaldehyde values in the ostrich steaks under aerobic package were significantly higher compared to vacuum-packaged counterparts under refrigeration temperature for 18 days. Therefore vacuum packaging can be employed as a more efficient and effective approach of slowing down oxidation of lipids and its deleterious effects in meat products.

Table 6: Thiobarbiturica acid values (TBA) in (mg malonaldehyde/kg) of RTE bovine tripe rolls

Storage condition	Treatment*	Storage period (days)					Treatment means ± SE
		0	**7**	**14**	**21**	**28**	
Vacuum	Control	0.52±0.04^{a}	0.58±0.02^{a}	0.64±0.01^{ba}	0.74±0.02^{c}	0.76±0.02^{c}	0.65±0.02^{A}
	Minced	0.54±0.02^{a}	0.64±0.03^{b}	0.78±0.02^{c}	0.82±0.01^{c}	0.94±0.01^{d}	0.74±0.02^{B}
	BT tripe	0.56±0.03^{a}	0.65±0.02^{b}	0.72±0.01^{b}	0.74±0.02^{c}	0.82±0.04^{c}	0.70±0.02^{B}
Aerobic	Control	0.53±0.02^{a}	0.59±0.04^{a}	0.68±0.02^{b}	0.84±0.02^{c}	0.96±0.02^{d}	0.72±0.02^{A}
	Minced	0.56±0.01^{a}	0.66±0.02^{b}	0.79±0.01^{c}	0.83±0.01^{c}	0.98±0.03^{d}	0.76±0.01^{A}
	BT tripe	0.56±0.02^{a}	0.68±0.03^{b}	0.75±0.04^{c}	0.79±0.01^{c}	0.97±0.02^{d}	0.75±0.02^{A}
Average		0.55±0.02^{a}	0.63±0.03^{b}	0.73±0.02^{c}	0.79±0.02^{c}	0.91±0.02^{d}	

*Values with different letters (lowercase along the row and upper case along the column) were significantly different at $p<0.05$.

2.5.4.5 Tyrosine value

Results for tyrosine value for the RTE bovine tripe rolls are shown in table 7. The average days means ranged between 0.43-0.78 mg tyrosine/100 g. There was a significant ($p<0.05$) and progressive increase in tyrosine value as the storage period advanced. However, vacuum packed products recorded lower tyrosine values that aerobically packaged products during the entire storage time. According to Daly et al., (1976) , tyrosine value effectively monitors the quality of meat and meat products during storage and continuous increase indicates denaturation and successive proteolysis of proteins. The average treatment means for tyrosine value were between 0.64-0.68 mg tyrosine/100 g for aerobically packaged products but the difference was not statistically significant. There was a significant difference ($p<0.05$) between the blade tenderized tripe rolls, minced tripe rolls and control (non-tenderized rolls) under vacuum packaging condition. Pearson (1967) reported that increase of tyrosine value in meat and meat products can be attributed to the denaturation process that generated free amino acids. The results of the present study corroborates with the findings of Anna et al., (2008); Anna et al.,(2012) who found that tyrosine values of vacuum and aerobically packed cooked buffalo rolls increase with storage period under refrigeration conditions.

Table 7: Tyrosine value in (mg tyrosine/100 g) of RTE bovine tripe rolls

Storage condition	Treatment*	Storage period (days)					Treatment means ± SE
		0	**7**	**14**	**21**	**28**	
Vacuum	Control	0.44±0.03^{a}	0.58±0.02^{b}	0.66±0.03^{c}	0.72±0.01^{d}	0.77±0.02^{d}	0.63±0.02^{A}
	Minced	0.43±0.02^{a}	0.56±0.01^{b}	0.62±0.02^{c}	0.66±0.01^{c}	0.73±0.01^{d}	0.60±0.01^{A}
	BT tripe	0.44±0.01^{a}	0.51±0.02^{b}	0.56±0.04^{b}	0.62±0.01^{c}	0.68±0.04^{c}	0.56±0.02^{B}
Aerobic	Control	0.43±0.02^{a}	0.65±0.03^{c}	0.69±0.02^{c}	0.78±0.03^{d}	0.86±0.02^{e}	0.68±0.02^{A}
	Minced	0.44±0.01^{a}	0.63±0.02^{c}	0.65±0.01^{c}	0.79±0.04^{d}	0.85±0.03^{e}	0.67±0.02^{A}
	BT tripe	0.42±0.02^{a}	0.62±0.02^{c}	0.61±0.03^{c}	0.75±0.01^{d}	0.81±0.02^{e}	0.64±0.02^{A}
Average		0.43±0.02^{a}	0.60±0.02^{b}	0.63±0.03^{c}	0.72±0.02^{d}	0.78±0.02^{d}	

*Values with different letters (lowercase along the row and upper case along the column) were significantly different at p<0.05.

2.5.5 Changes in sensory attributes of RTE bovine tripe rolls during storage

The scores for the sensory attributes of bovine tripe rolls during refrigeration storage are presented in table 8. Packaging and storage time had a significant effect (p<0.05) on the sensory characteristics of the RTE bovine tripe rolls; BT-Blade Tenderized.

The overall days' means for appearance and color ranged between 8.2 ± 0.09 and 6.8±0.15 and a significant (p<0.05) decrease was observed during the entire storage period in both packaging conditions. Decrease in color and appearance scores with storage can be attributed to non-enzymatic browning due to oxidation of lipids and also surface drying of the products (Chenman et al., 1995). Overall treatment means showed that minced tripe rolls and blade tenderized rolls had better color and appearance ratings than the control products (Non-tenderized mechanically).Vacuum packaged bovine tripe rolls had significantly (p<0.05) higher scores than the aerobically packaged ones.

Odor scores reduced significantly (p<0.05) during the storage period in both vacuum and aerobic packagings. However, vacuum packaged products had significantly higher scores than aerobically packed products throughout the storage period. Overall treatment means for odor scores for control, minced and blade tenderized products did not differ significantly (p<0.05) in vacuum packed products. Odor reduction during the entire storage time could be attributed to increased growth of microorganisms and oxidation of lipids (Devatkal & Mendiratta 2001). Aerobically packed rolls recorded lower odor scores due to presence of oxygen which accelerated microbial growth and faster break down of lipids resulting in faster production of off odours.

Taste scores decreased as storage period advanced in all the products in both packaging conditions. The overall treatment means showed that there was a significant (p<0.05) difference between vacuum packaged bovine tripe rolls and aerobically packaged rolls. Vacuum packed rolls had higher taste scores than aerobically packaged ones. This is due to presence of enough oxygen in aerobic packages which initiated peroxidation reactions and favored faster growth of microorganisms. This caused development of rancid taste and deterioration of organoleptic quality with storage (Rajkumar et al., 2004).

Table 8: Sensory evaluation of vacuum and aerobically packed RTE bovine tripe rolls during refrigerated storage (4± 1 °C)

Storage Conditions	*Treatments/ Parameters*	*Storage Period (days)*					*Treatment Means ± SE*
		0	7	14	21	28	
	APPEARANCE &COLOR						
Vacuum	Control	8.3±0.08^{a}	8.0±0.22^{a}	7.8±0.26^{a}	7.4±0.21^{a}	7.1±0.02^{a}	7.7±0.16^{A}
	Minced Tripe rolls	8.2±0.11^{a}	8.2±0.08^{a}	8.1±0.12^{a}	7.7±0.12^{a}	7.5±0.09^{a}	8.0±0.10^{A}
	BT-Tripe rolls	8.3±0.14^{a}	8.1±0.14^{a}	8.1±0.12^{a}	7.9±0.14^{a}	7.3±0.24^{ab}	7.9±0.16^{A}
Aerobic	Control	8.2±0.12^{a}	7.9±0.12^{a}	7.2±0.08^{a}	6.1±0.14^{bc}	5.9±0.24^{c}	7.1±0.13^{B}
	Minced Tripe rolls	8.2±0.08^{a}	8.0±0.08^{a}	7.4±0.12^{a}	6.6±0.12^{b}	6.2±0.22^{bc}	7.3±0.12^{B}
	BT-Tripe rolls	8.1±0.06^{a}	7.9±0.06^{a}	7.3±0.16^{a}	6.5±0.24^{b}	6.5±0.06^{bc}	7.3±0.13^{B}
	Average ± SE	8.2 ± 0.09^{a}	8.0±0.11^{a}	.7±0.14^{b}	7.0±0.16^{c}	6.8±0.15^{c}	
	ODOR						
Vacuum	Control	8.1±0.08^{a}	7.9±0.12^{a}	7.1±0.16^{b}	6.5±0.14^{c}	6.1±0.24^{c}	7.1±0.15^{A}
	Minced Tripe rolls	8.2±0.07^{a}	7.9±0.08^{a}	6.8±0.18^{b}	6.5±0.11^{c}	6.2±0.22^{c}	7.0±0.13^{A}
	BT-Tripe rolls	8.1±0.12^{a}	7.8±0.06^{a}	6.9±0.11^{b}	6.6±0.23^{c}	6.1±0.06^{c}	7.1±0.12^{A}
Aerobic	Control	8.4±0.11^{a}	7.0±0.11^{b}	6.1±0.06^{c}	5.1±0.10^{d}	4.3±0.18^{e}	6.2±0.11^{B}
	Minced-Tripe rolls	8.2±0.09^{a}	7.2±0.09^{b}	6.4±0.17^{c}	4.9±0.11^{d}	4.5±0.12^{de}	6.2±0.12^{B}
	BT-Tripe rolls	8.3±0.18^{a}	7.1±0.12^{b}	6.3±0.14^{c}	5.2±0.08^{d}	4.6±0.16^{de}	6.3±0.14^{B}
	Average ± SE	8.2 ± 0.11^{a}	7.5±0.10^{a}	.6±0.14^{b}	5.8±0.12^{c}	5.3±0.16^{c}	
	TASTE						
Vacuum	Control	7.8±0.09^{a}	7.6±0.12^{a}	7.2±0.05^{a}	6.6±0.06^{a}	6.2±0.21^{ba}	7.1±0.11^{A}
	Minced Tripe rolls	7.9±0.05^{a}	7.7±0.17^{a}	7.1±0.10^{a}	6.7±0.15^{a}	6.3±0.27^{ba}	7.1±0.15^{A}
	BT- Tripe rolls	7.8±0.29^{a}	7.6±0.28^{a}	7.1±0.13^{a}	6.8±0.28^{a}	6.4±0.06^{ba}	7.1±0.21^{A}
Aerobic	Control	7.4±0.04^{a}	7.1±0.01^{a}	6.0±0.05^{ab}	5.8±0.14^{b}	4.6±0.08^{c}	6.2±0.06^{B}
	Minced Tripe rolls	7.8±0.09^{a}	6.9±0.13^{a}	6.3±0.11^{ab}	5.9±0.12^{b}	4.7±0.04^{c}	6.3±0.10^{B}
	BT-Tripe rolls	7.7±0.13^{a}	6.8±0.05^{b}	6.2±0.09^{ba}	5.7±0.07^{b}	4.5±0.10^{c}	6.2±0.09^{B}
	Average ± SE	7.7 ± 0.12^{a}	7.3±0.13^{b}	6.7±0.08^{c}	6.3±0.14^{c}	5.4±0.13^{c}	

TENDERNESS							
Vacuum	Control	6.6 ± 0.02^{a}	6.2 ± 0.11^{a}	6.1 ± 0.15^{b}	5.5 ± 0.31^{c}	5.2 ± 0.09^{c}	5.9 ± 0.14^{A}
	Minced Tripe rolls	7.8 ± 0.07^{a}	7.6 ± 0.19^{a}	7.2 ± 0.16^{a}	6.7 ± 0.16^{a}	6.1 ± 0.07^{b}	7.1 ± 0.13^{B}
	BT- Tripe rolls	7.1 ± 0.11^{a}	6.8 ± 0.02^{a}	6.7 ± 0.18^{a}	6.4 ± 0.04^{a}	6.1 ± 0.08^{b}	6.6 ± 0.09^{B}
Aerobic	Control	6.5 ± 0.08^{a}	6.2 ± 0.25^{a}	6.2 ± 0.23^{ab}	5.3 ± 0.12^{c}	5.1 ± 0.10^{c}	5.8 ± 0.16^{A}
	Minced Tripe rolls	7.9 ± 0.29^{a}	7.5 ± 0.56^{a}	7.3 ± 0.01^{a}	6.3 ± 0.15^{a}	5.7 ± 0.12^{c}	6.9 ± 0.23^{B}
	BT-Tripe rolls	7.2 ± 0.23^{a}	6.6 ± 0.09^{a}	6.4 ± 0.02^{a}	6.2 ± 0.08^{a}	5.5 ± 0.12^{c}	6.4 ± 0.11^{B}
	Average ± SE	7.2 ± 0.13^{a}	6.8 ± 0.20^{b}	6.7 ± 0.13^{c}	6.1 ± 0.14^{c}	5.6 ± 0.10^{c}	
JUICENESS							
Vacuum	Control	7.9 ± 0.08^{a}	7.7 ± 0.16^{a}	7.2 ± 0.25^{a}	6.0 ± 0.11^{b}	5.9 ± 0.04^{b}	6.9 ± 0.14^{A}
	Minced Tripe rolls	8.4 ± 0.17^{a}	8.4 ± 0.13^{a}	8.3 ± 0.19^{a}	6.6 ± 0.26^{b}	6.2 ± 0.08^{b}	7.6 ± 0.13^{B}
	BT - Tripe rolls	8.1 ± 0.12^{a}	7.9 ± 0.12^{a}	7.7 ± 0.28^{a}	6.4 ± 0.02^{b}	6.2 ± 0.12^{b}	7.3 ± 0.09^{B}
Aerobic	Control	7.5 ± 0.18^{a}	7.7 ± 0.20^{a}	7.2 ± 0.13^{a}	6.0 ± 0.22^{b}	5.4 ± 0.31^{c}	6.8 ± 0.16^{A}
	Minced Tripe rolls	8.3 ± 0.09^{a}	8.1 ± 0.48^{a}	7.3 ± 0.11^{a}	6.3 ± 0.19^{b}	5.8 ± 0.02^{c}	7.2 ± 0.23^{B}
	BT-Tripe rolls	8.4 ± 0.05^{a}	7.6 ± 0.19^{a}	6.9 ± 0.08^{ab}	6.1 ± 0.05^{b}	5.7 ± 0.21^{c}	6.9 ± 0.11^{A}
	Average ± SE	$\mathbf{8.1 \pm 0.12^{a}}$	7.9 ± 0.21^{a}	7.4 ± 0.17^{a}	6.2 ± 0.14^{b}	5.9 ± 0.13^{c}	
OVERALL ACCEPTABILITY							
Vacuum	Control	7.3 ± 0.12^{a}	7.1 ± 0.19^{a}	6.8 ± 0.11^{ab}	6.5 ± 0.10^{b}	6.2 ± 0.05^{b}	6.8 ± 0.11^{A}
	Minced Tripe rolls	8.1 ± 0.77^{a}	8.0 ± 0.14^{a}	7.5 ± 0.15^{a}	7.3 ± 0.09^{a}	7.1 ± 0.04^{a}	7.6 ± 0.24^{B}
	BT-Tripe rolls	8.2 ± 0.05^{a}	8.0 ± 0.22^{a}	7.4 ± 0.05^{a}	7.1 ± 0.04^{a}	6.8 ± 0.07^{ab}	7.5 ± 0.09^{B}
Aerobic	Control	7.4 ± 0.09^{a}	7.2 ± 0.05^{a}	6.5 ± 0.13^{b}	6.3 ± 0.32^{b}	5.8 ± 0.18^{c}	6.6 ± 0.15^{A}
	Minced Tripe rolls	8.2 ± 0.21^{a}	8.1 ± 0.06^{a}	7.6 ± 0.11^{a}	7.3 ± 0.25^{a}	5.7 ± 0.09^{c}	7.4 ± 0.14^{B}
	BT – Tripe rolls	8.1 ± 0.26^{a}	8.0 ± 0.09^{a}	7.4 ± 0.12^{a}	7.2 ± 0.02^{a}	5.8 ± 0.36^{c}	7.3 ± 0.17^{B}
	Average ± SE	$\mathbf{7.9 \pm 0.25^{a}}$	7.7 ± 0.13^{b}	7.2 ± 0.11^{c}	7.0 ± 0.14^{c}	6.2 ± 0.13^{c}	

Values with different letters (lowercase along the row and upper case along the column) were significantly different at $p<0.05$

Storage days' mean scores for tenderness ranged between 7.2 ± 0.13 and 5.6±0.10 and the scores reduced as the storage period advanced. Tenderness was not significantly ($p<0.05$) affected until the 7th day of storage. Thereafter, a significant decrease in tenderness was noted in both packaging conditions. This could be attributed to degradation of protein muscles during storage under refrigerated conditions (Ann et al., 2012). The average means for all the treatments showed lesser scores for tenderness for control products (non-tenderized bovine tripe rolls) and larger scores for minced and blade tenderized bovine tripe rolls.

Storage days' mean scores for juiciness ranged between 8.1 ± 0.12 and 5.9±0.13 and the scores reduced as the storage period advanced in both aerobic and vacuum packages. However, the decrease was not of any statistical significance ($p<0.05$) until after the third week of refrigerated storage. Dehydration and moisture loss of the bovine tripe rolls during storage under refrigeration could be attributed to decrease in juiciness scores (Anna et al., 2008). The average treatment mean scores for juiciness revealed significantly ($p<0.05$) larger scores for blade tenderized and minced tripe rolls than in control samples.

The overall acceptability ratings declined with the advancement of storage time. This is due to decrease in scores for odor, color and appearance, juiciness and tenderness throughout the course of storage. The overall acceptability of the RTE products in both packaging conditions did not differ significantly ($p<0.05$) until the 14th day of storage. Devatkal and Mendiratta (2001) reported similar findings of the reduction in general acceptability of pork rolls throughout the duration of storage. Minced and blade tenderized rolls had significantly ($p<0.05$) higher overall acceptability scores compared to the control products (non-tenderized tripe rolls) in both aerobic and vacuum packaging conditions. Overall acceptability scores for vacuum packed products were higher than aerobically packed products during the entire storage period.

3. Conclusion

Mechanical treatment (Blade tenderization and mincing) is beneficial in improving the tenderness and eating quality of bovine tripe. There were significant changes in the sensory and physico-chemical characteristics of products during refrigerated storage under vacuum and aerobic conditions but the standards remained inside the limits approved for RTE meat products. Both aerobic and vacuum packaged products were acceptable up to 28 days under refrigeration but the sensory scores after 21st day of storage were higher in vacuum packed products than aerobically packed products. Therefore, the current study shows that vacuum packaging has a definite advantage over aerobic packaging in extending the storage life of RTE meat products with no significant effect on the overall eating and sensory qualities the product.

4. Acknowledgement

I would like to acknowledge and thank the Federal ministry of Education and Research, Germany (BMBF) for their sponsorship of this study through the project, RELOAD (Reducing losses adding value). I greatly thank my supervisors, Dr. Catherine N. Kunyanga and Prof. Jasper K. Imungi for their guidance, patience, unending encouragement and invaluable inputs that led to the successful completion of this study.

References

[1] Abegaz, M., (2008) Mobilizing aid for trade for SPS-related technical cooperation in East Africa. *Report of research work for the Standards and Trade Development Facility*, pp.28-29.

[2] Abou-Charbia, H.A., Shehata, A. A and Shadidi, F. (2002) Effect of processing on oxidative stability and lipid classes of sesame oil , *Food research international*, 33:331-340.

[3] Agunbiade, ShedrachOludare; Akintobi, Olabiyi A. and Ighodaro, Osasenaga Macdonald, (2010) Some Biochemical and Organoleptic changes due to Microbial growth in Minced Beef packaged in Alluminium polyethylene trays and Stored under Chilled condition, *Life Science Journal* 7(2).

[4] Aksu MI, Kaya M. (2005) Effect of storage temperatures and time on shelf-life of sliced and modified atmosphere packaged Pastirma, a dried meat product, produced from beef, Journal of Science Food Agriculture. 85:1305–1312.

[5] Alaa El-Din A. Bekhit , Alan Carne , Minh Ha & Philip Franks (2014) Physical Interventions to Manipulate Texture and Tenderness of Fresh Meat: A Review, International Journal of Food Properties, 17:2, 433 453, DOI: 10.1080/10942912.2011.642442

[6] Anjaneyulu, A. S. R., Sharma, N., & Kondaiah, N. (1989) Evaluation of salt, polyphosphates and their blend sat different levels on physico-chemical properties of buffalo meat patties. Meat Science, 25, 293–306.

[7] Anna Anandh M, Radha K, Lakshmanan V, Mendiratta SK (2008) Development and quality evaluation of cooked buffalo tripe rolls, Meat Science 80:1194–1199

[8] Anna Anandh,M., Venkatachalapathy. R., K. Radha and V. Lakshmanan (2012) Quality and shelf life of cooked buffalo tripe rolls at refrigerated storage under vacuum packaging condition. Journal of Food Science and Technology DOI 10.1007/s13197-012-0646-7

[9] AOAC (2006) Official methods of analysis Proximate Analysis and Calculations Meat - item. *Association of Analytical Communities, Gaithersburg, MD, 17th edition, 2006.*

[10] Benito-Delgado J, Marriott NG, Claus R, Wang H, Graham PP (1994) Chuck longissimus and infraspinatus muscle characteristics as affected by rigor state, blade tenderization and calcium chloride injection. Journal of Food Science 59:295–299

[11] Berry, B. W., George, M. E. B., & Eastridge, J. S. (1999) Hot processing and grind size affect properties of cooked beef patties. Meat Science, 53, 37–43.

[12] Bimbo, P.A. (1998) Guidelines for characterizing food grade fish oil: International fish meal and oil manufacturers association. Research report 9: 473-483.

[13] Biswas S, Chakraborty A, Patra G and Dhargupta A (2011 b) Quality and acceptability of duck patties stored at ambient and refrigeration temperatures, *International Journal of Livestock Production* 1:1–6.

[14] Bowker, B.C.; Liu, M.N.; Solomon, M.B.; Eastridge, J.S.; Fahrenholz, T.M.; Vinyard, B. (2007) Effects of hydrodynamic pressure processing and blade tenderization on intramuscular collagen and tenderness-related protein characteristics of top rounds from Brahman cattle. Journal of Muscle Foods , *18*, 35–55.

[15] Brenesselova, M., Kor_enekov_a, B., Ma_canga, J., Marcin_c_ak, S., Jevinov_a, P., Pipov. (2015) Effects of vacuum packaging conditions on the quality, biochemical changes and the durability of ostrich meat, Meat Science, 101, 42- 47.

[16] Chenman B, Baker J, Morki AAK. 1995. Effect of packaging films on storage stability of intermediate deep-fried mackerel. International Journal of Food Science and Technology 30:175–181.

[17] Daly MC, Morrisey PA, Buckley DJ (1976) Quality of raw minced beef, Irish Journal of Agricultural Research 15:283

[18] Devatkal S, Mendiratta SK. (2001) Use of calcium lactate with salt phosphate and alginate calcium gel in restructured pork rolls. Meat Science, 58:371–379.

[19] Devatkal, S., & Mendiratta, S. K. (2001) Use of calcium lactate with salt phosphate and alginate calcium gel in restructured pork rolls, Meat Science, 58, 371–379.

[20] Devatkal, S., Mendiratta, S. K., and Kondaiah, N. (2004) Quality characteristics of loaves from buffalo meat, liver and vegetables. Meat Science 67, 377-383.

[21] Evranuz, Ö.E. (1993). The effects of temperature and moisture content on lipid per-oxidation during storage of unblanched salted roasted peanuts: shelf life studies for unblanched salted roasted peanuts. *International Journal Food Sci*ence *Technology*, 28, 193–199.

[22] FAOSTAT (2011): FAO Statistical Database at http://faostat.fao.org/, last accessed on 2012 0701.

[23] Farmer, E., and Mbwika, J. (2012) End market analysis of Kenyan livestock and meat: a desk study. *Report number MicroREPOR*, *184*.

[24] Fernández-Ginés, J. M., Fernández-López, J., Sayas-Barberá, E., and Pérez-Alvarez, J. (2005) Meat products as functional foods: A review, *Journal of food science*, 70(2), R37-R43.

[25] Fernandez-Lopez, J., Sayas-Barber_a, E., Munoz, T., Sendra, E., Navarro, C., & Perez- Alvarez, J. A. (2008) Effect of packaging conditions on shelf-life of ostrich steaks. Meat Science, 78, 143-152.

[26] Flores, H. A., Kastner, C. L., Kropf, D. H., & Hunt, M. C (1986) Effects of blade tenderization and trimming of connective tissue on hot-boned, restructured, pre-cooked roasts from cows Journal of Food Science, 51, 1176–1179.

[27] García-Llatas, G., Alegría, A., Barberá, R., & Farré, R. (2011) Minerals and trace elements, In L. M. L. Nollet, & F. Toldrá (Eds.),Handbook of analysis of edible animal by-products (pp. 183–203). Boca Raton, FL, USA: CRC Press.

[28] Incze K. (1992). Raw fermented and dried meat products. Fleischwirtschaft. 72:58–62.

[29] Jay JM, Shelef LA (1976) Effect of microorganisms in meat proteins at low temperature. Journal of Agriculture and Food Chemistry 24:1113–1116

[30] Jay JM. 1996. Spoilage of fresh and processed meat, poultry and sea food. In: Modern food microbiology. 4th edition,New Delhi: CBS publishers and distributors; p. 199–233.

[31] Jay, J.M. and Hollingshed, A.M., (1990) Two methods for determining extract release volume (erv) of fresh and spoiled beef and poultry meats. *Journal of Food Science*, *55*(5), pp.1475-1476.

[32] Jin, S. K., Kim, I. S., Choi, Y. J., Kim, B. G., and Hur, S. J. (2009) The development of imitation crab sticks containing chicken breast surimi. LWT-Food Science and Technology 42, 150-156.

[33] Keller, J. E., Skelley, G. C., & Acton, J. C. (1994) Effect of meat particles and causing diameter on summer sausage properties during drying. Journal of Milk Food Technology, 37, 101–108.

[34] Kerler, J. and Grosch, W (1996). Odorants contributing to warmed- over flavour (WOF) of refrigerated cooked beef. *Journal of Food Science*, 61: 1271-1274.

[35] Kumar RR, Sharma BD, Manish K, Chidanandaiah, Biswas AK. (2007) Storage quality and shelf life of vacuum packaged extended chicken patties, Journal of Muscle Foods. 18:253–263.
[36] Lavieri, N., & Williams, S. K. (2014) Effects of packaging systems and fat concentrations on microbiology, sensory and physical properties of ground beef stored at 4 ± 1◦C for 25 days. Meat Science, 97, 534-541.
[37] Lin, K. W., & Keeton, J. T.(1994). Determination of optimum particle size for low fat precooked ground beef patties. Journal of Muscle Foods, 12, 63–76.
[38] Lin, L.C. and Huang, K.Y. (2004) Comparing of vacuum shrink packaging and vacuum packaging with vacuum shrink packing treatment process on storage properties of Taiwan country chicken during chilled storage. *Journal of Agriculture and Forestry*, 53(3): 251-260.
[39] Malik .A. H & B. D. Sharma (2014) Shelf life study of hurdle treated ready-to-eat spiced buffalo meat product stored at 30±3 °C for 7 weeks under vacuum and aerobic packaging. Journal of Food Science and Technology 51(5):832–844. DOI 10.1007/s13197-011-0592-9
[40] Maqsood, S., Abushelaibi, A., Manheem, K., Al Rashedi, A., & Kadim, I. T (2015) Lipid oxidation, protein degradation, microbial and sensorial quality of camel meat as influenced by phenolic compounds. LWT- Food Science and Technology, 63, 953-959.
[41] Meilgaard, M., Civille, G. V. and Carr, B. T (2006) Sensory evaluation techniques 4th edition, Florida – USA: CRC Press, 464p.
[42] Muthulakshmi, M., Muthukumar, M., Rajkumar, R.S., Girish P.S. and Mooventhan, P (2015) International Journal of Science, Environment and Technology. 4: 33 – 39.
[43] Ockonkwo TM, Obanu ZA, Ledward DA. (1992) The stability of some intermediate moisture smoked meats during storage at 30°C and 38°C Meat Science. 30:245–255.
[44] Parivell, B. R. (1999). Quality characteristics and utilization of rumen meats from goat, sheep and buffalo. M.V.Sc. Thesis, Deemed University, Indian Veterinary
[45] Pearson D (1967) Assessing beef acceptability, Food Manufacturing 42:42.
[46] Pietrasik K, Shand PJ (2004) Effect of blade tenderization and tumbling on the processing characteristics and tenderness of injected cooked roast beef, Meat Science 66:871–879
[47] Rahman M.D.N, Habibur.R, Rokeya .B,S.Islam; Abdur .R (2017) Nutritional Quality Changes of Cooked Beef Due to Refrigeration Storage." IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), vol. 11, no. 10, pp. 49-56.
[48] Rajkumar, V., Agnihotri, M. K., and Sharma, N (2004) Quality and shelf life of vacuumed and aerobic packed chevon patties under refrigeration, Asian-Australian Journal of Animal Science 17, 548-553.
[49] Rajkumar,V., M.K. Agnihotri and N. Sharma, (2004) Quality and shelf-life of vacuum and aerobic packed chevon patties under refrigeration, Asian journal of Animal Science.
[50] Richards, M. P., & Hultin, H. O. (2000) Effect of pH on lipid oxidation using trout hemolysate as a catalyst: a possible role for deoxyhemoglobin. Journal of the Agricultural and Food Chemistry, 48, 3141-3147.
[51] Sachdev, A.K.; Ram, G.; Yadav, A.S. and Tanwar, V.K. (2002) Effect of seasons and quality of cooked chicken stock, *Indian Journal of Poultry Science*, 37 (1): 67-72.
[52] Sahoo J, Anjaneyulu ASR (1997) Effect of natural antioxidants and vacuum packaging on the quality of buffalo meat nuggets during refrigerated storage. Meat Science 47:223–230
[53] Shackelford, S. D., Reagan, J. O., Mann, T. F., Lyon, C. E., & Miller, M. F. (1989) Effects of blade tenderization, vacuum massagetime and salt level on chemical, textural and sensory characteristics of precooked chuck roasts. Journal of Food Science, 54, 843–845,905.
[54] Sharma Shruti, Himanshu Prabhakar, S.S. Thind, Manish Chatli and Amarjeet Kaur (2017) Evaluation of the Effect of Incorporation of Functional Ingredients on the Shelf Life of Chicken Patties Using Different Packaging Conditions during Frozen Storage. *International Journal of Current Microbioliology and Applied Sciences* 6(11): 2797-2809. doi: https://doi.org/10.20546/ijcmas.2017.611.330
[55] Sharma, B.D.; Kumar, S. and Nanda, P.K. (2002) Optimization of shory term tumbling schedule for the processing of cured and restructured buffalo meat blocks, *Indian Journal of Animal Science.* 72(8): 684-688.
[56] Singh P, Sahoo J, Chatli M K and Biswas A K (2014) Shelf life evaluation of raw chicken meat emulsion incorporated with clove powder, ginger and garlic paste as natural preservatives at refrigerated storage (4±1°C). *International Food Research Journal* 2:1363–73.
[57] Strange, E. D., Benedict, R. C., Smith, J. L., & Swift, G. E. (1977). Evaluation of rapid tests for monitoring alterations is meat quality during storage. I. Infact meat. Journal of Food Protection, 40, 843–847.
[58] Sudheer K, Mandal PK, Das C, Pal UK, Santosh Kumar HT, Rao VK. (2011) Development of restructured chicken block utilizing gizzard and its refrigerated storage stability, Journal of Food Science and Technology. 48:96–101.
[59] Toldrá, F., & Reig, M. (2011) Innovations for healthier processed meats, Trends in Food Science and Technology,22, 517–522
[60] Vaudagna, S. R., Sanchez, G., Neira, M. S., Insani, E. M., Picallo, A. B., Gallinger, M. M., and Lasta, J. A. (2002) Sous vide cooked beef muscles: Effects of low temperature-long time (LT-LT) treatments on their quality characteristics and storage stability. International Journal of Food Science and Technology 37, 425-441.