Quality and Shelf-life of Vacuum and Aerobic Packed Chevon Patties under Refrigeration

V. Rajkumar, M. K. Agnihotri* and N. Sharma
Central Institute for Research on Goats, Makhdoom, P.O. Farah- 281-122, India

ABSTRACT : Patties were prepared using Barbari male goats meat (age about 4 yrs) and packed in HDPE under vacuum (VP) and aerobically (AP). Packed patties were stored at 4±1°C and evaluated for physico-chemical, microbiological and sensory changes on days 0, 5, 10, 15, 20 and 25. Overall mean water activity (a_w), moisture (%), fat (%), pH, TBA number and W-B shear force values (kg/cm^2) of patties were 0.983, 61.93, 18.39, 6.38, 0.150 and 0.86, respectively. Except pH that was significantly higher and TBA number significantly lower in VP patties, treatment had no significant ($p>0.05$) effect on other physico-chemical traits. However, storage period significantly ($p<0.05$) affected physico-chemical traits. Moisture (63.79%) and a_w (0.985) were significantly ($p<0.05$) higher on day 25. Patties became firmer on day 20 onwards as indicated by higher W-B shear force. Though packaging method had no significant effect, storage period influenced microbial counts. The standard plate counts (SPC), which were initially log 5.98 CFU/g decreased significantly ($p<0.05$) on day 10 followed by steady increase and reaching log 4.89 on day 25. Almost similar trend was observed for psychrotrophic bacteria counts. Lactic acid bacteria counts declined as the storage period progressed. Coliforms, and yeast and mould counts were either not detected by the method used or were very low in numbers. All samples of AP patties revealed swollen, greasy and sticky surface with spongy texture on day 20 whereas only some of the VP patties shown such changes on day 20. Results indicated that vacuum packaging had definite advantage in preserving the sensory quality of patties than aerobic packaging but it did not help in extending the shelf-life beyond 15 days. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 4 : 548-553)***

Key Words : Chevon Patties, Vacuum Packaging, Quality and Shelf-life

INTRODUCTION

In India, due to preference for purchase of 'hot' carcass goat meat by the consumers, less emphasis has been given on processing. Economic pressure to minimize cost, maximize product utilization through value addition provides incentive for processing goat meat into consumer oriented convenience meat products (Agnihotri, 2000). Among convenient meat products, patties have got highest degree of preference among the urban meat eaters owing to ease of preparation and better taste. Breed (Rhee et al., 1997) variations, feeding regime (Swan et al., 1998) and age (Agnihotri, 2002) of the animals are reported to affect the quality and composition of goat meat patties. Studies have also been carried out on goat meat patties formulations, standardization of processing techniques (Sharma et al., 1992) and method of cooking (Pawar et al., 2000). Effect of vacuum packaging on microbial and sensory quality of goat meat either as such or inoculated with lactic acid bacteria and stored under refrigeration have been reported (Babji et al., 2000; Babji and Murthy, 2000). Due to paucity of information on effect of vacuum packaging on quality attributes and shelf-life of chevon patties stored under refrigeration, present study was undertaken.

* Corresponding Author: M. K. Agnihotri. Tel: +91-565-2763313, Fax: +91-565-2763246, E-mail: mka@cirg.up.nic.in
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MATERIALS AND METHODS

Meat source

Barbari male goats (n=4) of about four years age, reared under semi-intensive management system, after 18 h fasting with free access to potable drinking water were slaughtered using standard commercial procedure. Dressed carcasses were hand deboned within two hours of slaughter. Knife separable lean, packed in high-density polyethylene (HDPE) bags was stored at -20±2°C till further use. Partially thawed meat on the day of experiment was minced using automatic meat mincer by passing through five mm plates (Talleres Ramon Make P-22, Barcelona) before use.

Dry and green spices mixture

Dry spices mixture (Table 1) was prepared and filled in stainless steel jars. It was stored in cool and dry place and used within two weeks. For preparation of green spices mixture peeled and washed onion, ginger and garlic were weighed in the ratio of 3:1:1, finely chopped and ground. Mixture thus obtained was packed in HDPE and stored at -20±2°C and used within two weeks.

Recipe and preparation of patties

Patties were prepared using standard recipe (Agnihotri, 2002) except, instead of 5.0% vegetable oil 2.5% goat fat was used. To minced meat, 2.5% minced goat fat, 1.5% common salt, 6.0% green spices, 1.5% dry spices mixture, 3.0% refined wheat flour, 0.01% sodium nitrite, 0.3% TSPP

Table 1. Composition of dry spices mixture

S.No.	Dry spices	Composition (%)
1	Clove	5.0
2	Black pepper	25.0
3	Large cardamom seeds	20.0
4	Cinnamon bark	5.0
5	Small cardamom seeds	5.0
6	Cumin seeds	10.0
7	Shia zira (*Carum carvi*)	10.0
8	Red pepper powder	20.0

and 20.0% chilled water were added. Firstly minced meat with common salt was chopped (Model type K 20, Seydelmann, Germany) using 6 cutters knives for 2 min. Sodium nitrite, tetra sodium pyrophosphate (TSPP) were dissolved in 70 ml lukewarm water and mixed followed by addition of other ingredients and chopped for 3 min. Raw patties with an average weight of 88.0 g were molded using glass petri dishes (98 mm internal dia.×15 mm ht), kept on stainless steel plates and cooked to an internal temperature of 75±2°C in preheated (180°C) oven for 20 min. Weight of raw and cooked cooled patties were recorded to calculate percent cooking yield. Patties (average weight 80.0 g) were packed in 15 HDPE (WVTR 5 g/m^2 per 24 h at 38°C and 90% RH) bags under vacuum (VP) (Model 19/S, Roscherwerke GmbH, Germany) and in 18 bags aerobically (AP), four patties in each and stored under refrigeration (4±1°C) for further study.

Analyses of packed patties

Patties were examined for changes in physico-chemical, microbiological and sensory traits during days 0, 5, 10, 15, 20 and 25 of storage. Every time three bags from each treatment were randomly taken out. Samples from each bag were taken for microbiological examination first, followed by physico-chemical traits. Remaining parts of samples were used for sensory examination. Evaluation of freshly prepared patties was done and taken as day 0 values for both AP as well as VP patties.

The pH of patties was determined (Agnihotri and Pal, 1997) by triturating 10.0 g of samples with 90 ml of distilled water and recorded by digital pH meter (Systronics, μ pH system 361). Percent moisture, ether extract were determined as per the method described by Konecko (1979). Water activity (a_w) of patties was directly estimated using water activity meter (AquaLab, Model CX-3TE, Decagone Devices, Inc., USA). Final readings were recorded when three consecutive readings were same. Thiobarbituric acid (TBA) number was estimated as per the method described by Strange et al. (1977). The OD at 532 nm was taken using UV visible spectrophotometer (Model Cintra -5, GBC equipment, Australia) and reported as TBA number. Shear force (kg) required to shear 2 cm cubes of patties was measured with the help of Warner-Bratzler (W-B) shear press of 25.0 kg capacity (Anjaneyulu and Kondiah, 1989). Minimum of twenty shear force recordings (kg/cm^2 cubes) were noted from each treatment.

Cholesterol content of fresh cooked patties was determined using cholesterol test kit (Span Diagnostics Ltd., India) except that instead of blood serum, lipid extract was used. Lipid extract was prepared by taking one gram of minced patties sample and adding 10 ml of freshly prepared 2:1 chloroform: methanol solution and homogenized (Model. PT-MR-2100, Kinematica AG, Switzerland). Homogenate was filtered using Whatman No. 42 filter paper and to 5 ml of filtrate equal quantity of distilled water was added, mixed and centrifuged at 3,000 rpm for 7 min. Top layer (methanol) was removed by suction. Volume of the bottom (chloroform) layer having cholesterol was recorded. From this, 25 μl of the sample was pipetted in a test tube and kept in water bath (100°C) for 2-3 minutes till it dried. To this 5 ml of cholesterol reagent was added, mixed and kept in a boiling water bath for 90 seconds for colour development. The O.D. of standard and test against blank was taken at 530 nm. Total cholesterol (mg %) was calculated as follows:

$$\frac{\text{O.D of sample}}{\text{O.D of standard}} \cdot \frac{\text{Volume of chloroform layer (ml)}}{\text{Weight of the sample taken (g)}} \cdot 200 = \text{Cholesterol in mg\%}$$

where 200 is concentration of standard.

For microbiological analyses a representative 10 g patties sample was withdrawn and homogenized (Model. PT-MR-2100, Kinematica AG, Switzerland) aseptically using 90 ml peptone water (Agnihotri and Pal, 2000). Dilutions were made using 0.1% peptone water. Standard plate counts (SPC) were enumerated on duplicate pour plates of plate count agar (PCA, Hi-Media Laboratories, M 091, Mumbai, India) which were incubated at 37°C for 48 h; psychrotrophic bacteria counts on pour plates of plate count agar (PCA, Hi-Media, M 091) which were incubated at 5±1°C for 10-12 days; coliforms bacteria counts on pour plate of Violet Red Bile Agar (VRBA, Hi-Media, M 049) which were incubated at 37°C for 48 h; lactic acid bacteria (LAB) counts on pour plates of MRS agar (Hi-Media, M 641I) which were incubated at 37°C for 72 h. Freshly prepared acidified potato dextrose agar was used to determine yeast and mould counts by incubating plates at 25±2°C for 7-8 days. Colonies were counted and expressed as log CFU/g patties. The enumeration procedures as described in ICMSF (1978) were followed.

Sensory evaluation

Packets after opening were examined by three Judges for odour. Individual patties after taking the samples were also examined for odour, colour and overall acceptability (Rao et al., 1983).

Table 2. Cooking yield and cholesterol content of fresh patties

Traits	Fresh patties
Cholesterol content, mg/100 g (n=12)	134.84±5.75
Cooking yield, % (n=50)	91.24±0.31

Each value under the head fresh patties is mean (±SE).

Statistical analysis

Statistical analysis was carried out with the MSTATC (Version 2.10) statistical programme to find the effect of treatment, storage period and their interactions on quality traits of patties. Differences between means were tested by critical difference.

RESULTS AND DISCUSSION

Cooking yield and cholesterol content

The cooking yield (Table 2) of fresh patties was 91.24±0.31% and is in the range reported for lamb (Swan et al., 1998) and buffalo meat patties (Anjaneyulu et al., 1989; Anjaneyulu et al., 1990). Agnihotri (2002) reported low cooking yield of 88.69% in spent goat meat patties, which could be attributed to manual mixing of the batter and poor emulsion formation. Total cholesterol content of pre-cooked goat meat patties was 134.84±5.75 mg/100 g, which is higher than values (75 mg/100 g) reported for roasted goat meat (USDA, 1997) and might be due to addition of goat fat in the formulations.

Water activity, moisture and fat

Physico-chemical changes in pre-cooked patties stored under refrigeration are presented in Table 3. Fresh patties had a_w, moisture (%) and ether extract (%) of 0.983, 63.27 and 17.57, respectively. Frazier and Westhoff (1997) had reported a_w 0.98 in processed meat products like fermented sausage. Agnihotri (2002) and Anjaneyulu et al. (1989) reported higher moisture and lower ether extract in goat meat patties. The higher ether extract observed in this study was due to addition of goat fat. Packaging method did not have significant effect on these parameters. Storage period significantly ($p<0.01$) affected a_w, moisture and fat contents of patties. The a_w (0.985) and moisture (63.79%) were significantly ($p<0.01$) higher on day 25. Moisture content, which was initially 63.27% declined significantly ($p<0.05$) to 58.65% on day 10 and steadily increased to 63.79% on day 25. Low moisture and high fat was observed on day 10 and 20. Ground beef patties revealed increase in fat content after 14 days of storage, which decreased with further storage. This was attributed to decrease in water content, which increased latter due to release of water as meat proteins break down began (Maca et al., 1997).

Table 3. Effect of vacuum packaging on physico-chemical properties of chevon patties stored at 4±1°C

Traits	Treatment	Storage period in days						Treatment means±SE
		0	5	10	15	20	25	
Water activity	AP	0.983±0.000	0.983±0.001	0.984=0.000	0.983=0.001	0.983=0.002	0.986±0.001	0.984±0.000
	VP	0.983±0.000	0.983±0.001	0.984=0.001	0.982=0.566	0.982=0.000	0.985±0.001	0.983±0.000
	Storage period mean±SE	0.983^{a}±0.000	0.983^{a}±0.000	0.984^{b}±0.000	0.982^{c}±0.001	0.983^{a}±0.001	$0.985^{b,c}$±0.000	**0.983±0.000**
Moisture, %	AP	63.27±1.08	62.02±0.61	58.28±1.27	62.25±0.77	61.87=0.58	63.78±0.59	61.91±0.79
	VP	63.27±1.08	62.61±0.80	59.02±1.28	61.91±0.56	61.07=0.65	63.80±0.20	61.95±0.71
	Storage period mean±SE	63.27^{a}±0.00	62.32^{a}±0.30	58.65^{b}=0.37	62.08^{a}±0.17	61.47^{a}±0.40	$63.79^{c,a}$±0.01	**61.93±0.50**
Ether extract, %	AP	17.57±1.31	19.04±0.39	21.25±0.99	17.74±0.94	19.06=0.75	16.69±0.50	18.56±0.65
	VP	17.57±1.31	17.19±1.16	20.57±0.88	17.96±0.61	19.41=0.54	16.63±0.18	18.22±0.61
	Storage period mean±SE	$17.57^{a,c}$±0.00	$18.11^{a,c}$±0.92	20.91^{b}=0.34	$17.85^{a,c}$±0.11	$19.24^{a,b}$=0.18	16.66^{c}±0.03	**18.39±0.43**
pH	AP	6.36±0.04	6.40±0.01	6.35±0.02	6.36=0.01	6.30=0.01	6.36±0.05	6.35^{A}±0.01
	VP	6.36±0.04	6.44±0.00	6.41±0.01	6.39=0.01	6.35=0.00	6.48±0.01	6.41^{B}±0.02
	Storage period mean±SE	$6.36^{a,c}$±0.00	6.42^{b}±0.02	$6.38^{a,b,c}$±0.03	$6.38^{a,b,c}$±0.02	6.33^{c}±0.02	$6.42^{d,b}$±0.06	**6.38±0.01**
TBA number	AP	0.148±0.005	0.147±0.005	0.167=0.004	0.138=0.004	0.172=0.007	0.145±0.011	0.153^{A}±0.005
	VP	0.148±0.005	0.156±0.008	0.147=0.003	0.153=0.005	0.152=0.003	0.121±0.003	0.146^{B}±0.005
	Storage period mean±SE	0.148^{a}±0.000	0.151^{b}±0.004	0.157^{c}±0.010	0.145^{d}±0.007	0.162^{e}±0.010	0.133^{f}±0.012	**0.150±0.004**
W-B shear force value, kg/cm^2 cubes	AP	0.82±0.03	0.92±0.03	0.86±0.03	0.81=0.05	0.88=0.06	0.95±0.02	0.87±0.02
	VP	0.82±0.03	0.81±0.03	0.86±0.03	0.78=0.05	0.95±0.04	0.86±0.04	0.85±0.03
	Storage period mean±SE	$0.82^{a,b}$±0.00	$0.86^{a,b}$±0.06	$0.86^{a,b}$=0.00	0.79^{a}±0.02	$0.91^{c,b}$±0.04	$0.90^{c,b}$±0.04	**0.86±0.02**

Each value under the head storage period is mean (±SE) of 6 observations. For WB shear force values are means of 20 observations.

Values in bold face are overall means (±SE) for each trait.

Storage period means bearing uncommon superscripts (small letter) in each cell of a row differ ($p<0.05$).

Treatment means bearing different superscripts (capital letter) for each trait differ ($p<0.05$).

Table 4. Effect of vacuum packaging on microbial counts (log CFU/g) of chevon patties stored at 4±1°C

Traits	Treatment	Storage period (days)						Treatment means±SE
		0	5	10	15	20	25	
SPC	AP	5.98±0.10	5.96±0.23	3.97±0.07	4.43±0.22	4.54±0.21	5.08±0.29	4.99±0.34
	VP	5.98±0.10	5.55±0.31	4.08±0.18	4.48±0.19	4.85±0.18	4.71±0.12	4.94±0.29
	Storage period mean±SE	5.98^{a}±0.00	5.76^{a}±0.21	4.03^{b}±0.06	$4.46^{b,c}$±0.02	$4.69^{b,c}$±0.16	4.89^{d}±0.18	**4.97±0.21**
Psychrotrophic bacteria counts	AP	4.13±0.25	3.90±0.00	3.31±0.07	4.14±0.11	4.45±0.33	4.32±0.22	4.04±0.17
	VP	4.13±0.25	3.90±0.00	4.08±0.18	4.30±0.33	5.19±0.41	4.39±0.11	4.35±0.19
	Storage period mean±SE	$4.13^{a,c}$±0.00	3.90^{a}±0.00	3.70^{a}±0.39	$4.22^{a,c}$±0.08	$4.82^{b,c}$±0.37	$4.35^{b,c}$±0.03	**4.20±0.13**
Lactic acid bacteria counts	AP	4.05	<3.0	<3.0	<3.0	1.61	1.74	ND
	VP	4.05	<3.0	<3.0	<3.0	0.70	1.80	ND
Coliforms[a]	AP	1.24	Nil	Nil	0.67	0.83	Nil	ND
	VP	1.24	Nil	Nil	0.53	0.49	Nil	ND
Yeast and mould counts[a]	AP	Nil	Nil	Nil	<=1	1.50	Nil	ND
	VP	Nil	Nil	Nil	<=1	2.12	<=1	ND

Each value under the head storage period is mean (±SE) of 6 observations.

Values in bold face are overall means (±SE) for each trait. [a]Anova was not done because the counts were <10 on days 5. 10 and 25 of storage.

Storage period means bearing uncommon superscripts in each cell of a row differ ($p<0.05$).

pH, TBA number and shear force value

Fresh patties had pH. TBA number and W-B shear force value (kg/cm^2 cubes) of 6.36. 0.148 and 0.82 (Table 3). Almost similar pH and W-B shear force values were reported in spent goat meat patties (Agnihotri. 2002) and buffalo meat patties (Anjaneyulu et al.. 1989) treated with 0.3% polyphosphate mixture. Method of packaging significantly ($p<0.05$) affected pH and TBA number of stored patties. The VP patties revealed higher pH (6.41) than AP (pH 6.35) patties. Babji et al. (2000) also reported that pH of vacuum-packed goat meat mince increased from 6.00 on day 7 to 6.10 on day 28 of refrigerated storage. Significantly ($p<0.05$) low TBA number (0.146), which is an indication of oxidative stability of meat fat. was recorded for VP than AP (0.153) patties. which is similar to TBA values for vacuum-packed ground beef patties (Maca et al.. 1997). Significant ($p<0.05$) interactive effect between treatment and storage period was observed in case of TBA number and as the storage period advanced TBA values in AP patties increased. Mendonca et al. (1989) found that TBA values increased to 0.162 on day 20 but lowered to 0.133 on day 25 but did not contribute to off flavour development. Similar TBA values for vacuum-packed ground beef (Egbert et al., 1992), fresh pork sausage (Brewer et al.. 1991) and vacuum-packed ground meat patties (Maca et al., 1997) stored in refrigerator were reported. Patties became firmer (0.91 kg/cm^2) on day 20 as indicated by high W-B shear force values. Maca et al. (1997) reported that hardness and fracturability of the vacuum-packed ground beef patties. stored at 4°C did not increase with storage up to 14 days. In our study also there was no significant difference till 15 days. higher values at latter periods may be due to solidification of goat meat fat together with cooked meat particles resulting in more firm texture.

Microbiological evaluation

Fresh pre-cooked patties had SPC. psychrotrophic bacteria, lactic acid bacteria, coliforms and yeast and mould counts of log 5.98, 4.13, 4.05. 1.24 and 0 CFU/g respectively (Table 4). The SPC counts were well within the limits of log 6.0 CFU/g prescribed for cooked meat products (Shapton and Shapton, 1991). Cooked fresh sausage had SPC and psychrotrops of log 4.25 and 4.44 CFU/g (Agnihotri and Pal. 2000) respectively. Higher SPC in our study may be due to oven (dry heat) cooking as against simmering (moist heat) adopted for cooking of sausages. Microbial counts were influenced by storage period but packaging method had no significant effect on them. The SPC, which was initially log 5.98 CFU/g exhibited significant decline on day 10 followed by steady increase to log 4.89 on day 25. Similar trend was observed by Maca et al. (1997) in ground beef patties that had APC log 5.7 initially. which declined on day 7 to log 4.5 and steadily increased to log 5.0 CFU/g on day 21. Egbert et al. (1992) found no difference in APC of ground beef whether stored in oxygen permeable films or impermeable chup packages. Similarly. Goepfert and Kim (1975) reported little influence of packaging type on behavior of microorganisms when ground beef was packed either aerobically or anaerobically. Psychrotrophic bacteria counts. which were initially. log 4.13 declined to log 3.9 on day 5 in our study and steadily increased to log 4.35 on day 25. Psychrotrophic populations are in accordance with the results observed by Babji et al. (2000) and Nottingham (1982) on vacuum-packed meat stored at 4°C. Lactic acid bacteria (LAB) counts declined as the storage period progressed. Significant decline in LAB counts was observed from day 7 to day 28 in vacuum-packed goat meat stored at refrigeration (Babji et al., 2000). This low LAB

Table 5. Sensory changes in goat meat patties packed under vacuum and stored at 4±1°C

Traits	Treatment	Storage period (days)					
		0	5	10	15	20	25
Colour	AP	Yellowish light brown	Dull yellowish brown	Dull yellowish brown	Dull yellowish brown	Whitish dull brown	Light dull brown
	VP	Yellowish light brown	Bright yellowish brown	Dull yellowish brown	Dull yellowish brown	Whitish brown	Reddish brown
Odour	AP	Spicy cooked meat	Spicy cooked meat	Spicy cooked meat	Spicy cooked meat	Bland to moderate spicy	Bland spicy
	VP	Spicy cooked meat	Spicy cooked meat	Spicy cooked meat	Spicy cooked meat	Moderate spicy	Moderate spicy
Overall accept-ability	AP	Yes	Yes	Yes	Yes	No*	No*
	VP	Yes	Yes	Yes	Yes	Yes/No*	No*

* Product has swollen, greasy to sticky surface and became over spongy.

counts may be due to high pH (Babji et al., 2000) of patties till day 25. Grau (1981) observed similar results on high pH vacuum-packed meat. Coliforms, yeast and mould counts were either not detected by the method used or when detected were very low in numbers indicating uniform and better sanitary measures adopted during processing of patties. The low coliform and yeast and mould counts were in accordance with Sutherland et al. (1975) on vacuum-packed beef and with Babji et al. (2000) on vacuum-packed minced goat meat.

Sensory evaluation

The fresh cooked patties had yellowish light brown colour and spicy cooked meat odour that was maintained up to 15 days in both vacuum and aerobic packed patties. Afterwards the deteriorative changes started appearing and all samples of AP patties revealed swollen, greasy and sticky surface with spongy texture on day 20 of storage whereas only few of the VP patties shown such changes on day 20 and all on day 25 of storage (Table 5). Vacuum-packed cured, cooked, sliced turkey fillets and pork fillets under refrigeration had shelf-life of 2 weeks (Pexara et al., 2002) whereas, vacuum-packed tandoori chicken had a shelf-life of 12 days (Pavankumar et al., 1999). Colour of patties that was yellowish light brown on day 0, became whitish dull brown on day 20 for AP and whitish brown for VP. Odour of patties turned to moderate spicy on day 20 for VP and bland to moderate spicy for AP samples with consequential adverse effect on acceptability of the product.

CONCLUSION

Vacuum packaging of patties during storage under refrigeration improved the oxidative stability as indicated by low TBA number. Though the vacuum packed patties had higher pH, conducive for microbial growth but counts did not reveal significant difference suggesting that packaging method had no marked influence on microbial growth. Vacuum packaging had definite advantage in preserving the sensory quality of patties as only few samples shown deteriorative changes after 15 days and became unacceptable on day 25 where as all the samples of aerobically packed patties became unacceptable on day 20.

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