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Research Article

EFFECT OF FREEZE-THAW CYCLE ON QUALITY OF RABBIT MEAT

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ABSTRACT

Present investigation was carried out with a view to ascertain quality of fresh and frozen thawed rabbit meat during frozen storage. Rabbit meat samples collected from retail shop packaged in HDPE (high-density polyethylene) were stored at -18±1^{0}C and analyzed for changes in physico-chemical and microbiological quality after thawing for 12 h at refrigeration temperature. The results indicated that pH, thiobarbituric acid (TBA), tyrosine values and drip loss of frozen thawed rabbit meat increased significantly with storage. The extract release volume (ERV) values decreased considerably during frozen storage but were near to cut off limit at the end of storage. Microbiological quality revealed that standard plate count (SPC) and *E. coli* count decreased considerably during frozen storage indicating that frozen rabbit meat after thawing at refrigeration temperature could be safely stored for 60 days without any deterioration in microbiological quality. None of the meat samples revealed the presence of salmonella.

Key words: Freeze-thaw, quality, rabbit meat

Interest towards rearing of rabbit for meat production generated in India during the last decade. The introduction of rabbit for meat was done in 1978 (Gulyani and Karim, 2008). Kerala has the highest rabbit population in India (Sharma, 2006). There are no religious taboos for the consumption of rabbit meat among non vegetarian group. The slaughter age of rabbit is 12-15 wk, which gives 2 kg slaughtered weight. Rabbit meat is lean as compared to other meat and is a boon for patients ailing from hypertension and heart diseases. Rabbit meat contains important fatty acids viz., myristic, palmitic, cis n-7 palmitoleic, oleic, linoleic and arachidonic acids (Ramirez *et al*., 2005).

At present, India is not exporting rabbit meat. For the domestic marketing, the rabbit meat is subjected to freezing till it reaches to retailer. Delay in transportation and fluctuation in market rates necessitates storage of rabbit meat for longer time. Due to break in cold chain during transport or storage, meat may pass through freeze thaw cycle. Such frozen meat fetches lower market prices than fresh meat. In order to protect consumers and to detect the mal practices carried out while selling such meat, it is necessary to differentiate the quality of fresh rabbit meat with that of thawed frozen rabbit meat. The present study was designed to study the physico-chemical and microbiological quality of fresh rabbit meat and to study the effect of freeze-thaw cycle on these parameters

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MATERIALS AND METHODS

Collection and Processing of Meat Samples: Rabbit meat was collected from 3-4 months age male rabbit dressed at local meat shops at Parbhani. Care was taken to avoid contamination of meat during dressing as well as collection of samples. Dressed carcass was then transferred to sterilized polyethylene pouches, kept on ice packs and transported to the laboratory. Meat samples were immediately washed with clean water and kept in a chiller (at 4±1^{0}C) for ageing.

Analysis of Fresh Meat Samples: Fresh meat samples after processing were analyzed to assess its quality on the basis of physico-chemical characteristics and microbiological profile. Physico-chemical parameters such as pH (AOAC, 1995), thiobarbituric acid (TBA) number (Willson *et al.,* 1976) tyrosine value and extract release volume (ERV; Strange *et al.,* 1977) and proximate composition (moisture, protein, fat; AOAC, 1995) were studied.

Microbiological Quality: Fresh meat samples were subjected to standard plate count (SPC), *E. coli* and Salmonella detection as per the standard method of APHA (1984).

Meat Quality During Frozen Storage: Aseptically collected meat samples after processing were packed in low-density polyethylene pouches and stored in a freezer at -18±2^{0}C for 60 days. Samples were removed from the freezer after 15, 30, 45 and 60 days of storage, which were immediately thawed for 12 h at refrigeration temperature (4±1^{0}C) and analyzed for changes in physico-chemical characteristics and microbiological quality as done for fresh meat samples.

Drip loss: Drip loss was estimated by measuring the exudates meat juices after thawing of samples for 12 h at 4^{0}C. Drip was measured after weighing the meat sample and comparing the weight with the initial weight before freezing.

Drip loss = (Initial weight-Final weight of meat sample)/ Initial weight of meat sample x 100

Statistical Analysis: The data obtained were subjected to statistical analysis using Completely Randomized Design (CRD) (Snedecor and Cochran, 1989).

RESULTS AND DISCUSSION

The data pertaining to physico-chemical properties and proximate composition of fresh rabbit meat are presented in Table 1.

pH: The pH of fresh rabbit meat was found between 5.1-5.69. In general pH falls during post-mortem glycolysis due to conversion of muscle into meat. In mammals, pH of meat is around 5.54 to 5.60. Doifode (2007) reported that pH of fresh goat meat varied between 5.59 to 5.65. The rate and extent of change in pH is influenced by intrinsic factors such as species, type of muscle and variations between individuals.

TBA Value: The TBA value is used as an indicator of food quality and is known to be the most popular test for measuring oxidative deterioration of lipids in muscle foods (Wilson *et al.,* 1976). The threshold value of TBA is 1-2 mg malonaldehyde/kg which is indicative of rancidity in meat (Watts, 1962). The TBA value of fresh rabbit meat sample ranged between 0.11 to 0.24 malonaldehyde/kg. Doifode (2007) reported slightly higher values in fresh goat meat.

Tyrosine Value: Tyrosine value is an indicator of proteolysis as it measures tyrosine and tryptophan present in non-protein extract of meat (Strange *et al*., 1977). Estimation of tyrosine value has been used as one of the methods for detecting microbial spoilage in meat and sea-foods (Jay, 1996). Present findings of tyrosine values in fresh rabbit meat samples are in close agreement with Doifode (2007) and Kandeepan and Biswas (2007).

Table 1
Physico-chemical properties and proximate composition of fresh rabbit meat

Parameters	Range (Mean±SE)
pH	5.51–5.69 (5.6±0.01)
TBA value (mg malanoaldehyde /kg)	0.11–0.24 (0.18±0.01)
Tyrosine value (mg/100g)	18.09–21.12 (19.60±0.42)
ERV (ml)	20.70–23.10 (21.90±0.15)
Moisture (%)	71.50-72.83 (72.16±0.42)
Protein (%)	19.03-21.40 (20.21±0.06)
Fat (%)	6.40-6.63 (6.50±0.02)

ERV: The ERV technique has been shown to be useful in determining incipient spoilage in meat as well as in predicting storage shelf-life. In general meat having better sensory profile and low microbial load releases more ERV as compared to poor quality meat with higher microbial load. The findings of ERV value of fresh rabbit meat sample are in close agreement with the observations of Doifode (2007) for goat meat.

Proximate Composition: Mean moisture content of fresh rabbit meat samples was 72.16±0.42 % while mean protein content was 20.21±0.06 %. The fat content was found to be in the range of 6.40 to 6.63 %. The results pertaining to moisture, protein and fat contents of rabbit meat are almost similar to those reported by Bazar *et al*. (2008).

Microbial Quality of Fresh Rabbit Meat: The SPC of fresh rabbit meat samples was in the range of 4.52 to 4.69 log cfu/g. This finding is comparable with earlier findings of Doifode (2007) in fresh goat meat. *E. coli* of fresh rabbit meat samples was between 2.10 to 2.18 log cfu/g. Similar findings were reported by Rathod *et al*. (2004) for fresh goat meat. None of the fresh rabbit meat sample in this study was positive for Salmonella species.

Physico-chemical and Microbiological Changes during Frozen Storage : The observations related to changes in pH, TBA and tyrosine values of frozen-thawed rabbit meat at frozen temperature are presented in Table 2.

pH: The pH of frozen-thawed rabbit meat showed an increasing trend with increase in storage period. The increase in pH was, however, non significant up to 15th

day of storage. The findings are in conformity with those of Kandeepan and Biswas (2007). The significant (P<0.05) increase in pH may be attributed to the fact that meat undergoes autolysis resulting in decrease in ERV and water.

TBA Value: During storage period of 60 days the TBA values increased significantly (P<0.05). The increase may be attributed to aerobic packaging and oxygen permeability of packaging material (Brewer *et al*., 1992) that leads to faster lipid oxidation of meat (Strange *et al*., 1977). Sen and Sharma (2003) and Kandeepan and Biswas (2007) also reported significant increase in TBA values during frozen storage of meat samples. The findings regarding TBA values are in conformity with the results of Doifode (2007).

Tyrosine Value: An increasing trend was recorded in tyrosine values during frozen storage. The tyrosine value after 15th day increased significantly (P<0.05); the increase in tyrosine value particularly at the end of storage period might be attributed to liberation of proteolytic enzymes in the late logarithmic phase of growth (Sen, 1996). The present findings are in agreement with that of Doifode (2007) for goat meat and Kandeepan and Biswas (2007) for buffalo meat.

Drip Loss: The drip loss was zero in fresh rabbit meat samples, which increased significantly (P<0.05) during storage (Table 2). A similar increase in drip loss was reported by Doifode (2007) for goat meat and Kandeepan and Biswas (2003) for buffalo meat. Higher drip loss may be attributed to partial decrease in water holding capacity to increased denaturation of muscle protein and partly due to enhanced movement of water within extra cellular spaces.

ERV: At zero day, ERV of fresh rabbit meat was observed to be significantly (P<0.05) higher than stored meat. Thereafter ERV of rabbit meat declined significantly (P<0.05) with the progress of storage up to 60 days. In the present investigation ERV of 17.05 ml at the end of 60 days storage was almost equal to cut off limit for meat spoilage that is 17 ml (Pearson, 1968). A similar declining trend in ERV values was reported by Doifode (2007) for frozen goat meat and Jayesh and Venkatramanujam (2002) for frozen stored mutton.

Proximate Composition: The observations of proximate composition of thawed rabbit meat as influenced by frozen storage are presented in Table 2.

Moisture: A decline in moisture content was observed during storage and such a decline may be accounted for the myofibrillar distortion undergone by the meat in the freezer that lead to poor water retention ability of the meat (Kandeepan and Biswas, 2007).

Protein: The present study showed a decrease in protein content of rabbit meat with increase in frozen storage (Table 2). Initial protein content of fresh rabbit meat was 20.55 % which declined significantly (P<0.05) with progress of storage period; the decrease might be the result of increased drip loss.

Fat: Like that of protein, the fat content of rabbit meat varied significantly (P<0.05). Non significant variation in fat content of stored rabbit meat was observed between 15th and 30th day of storage. Thereafter, significant (P<0.05) reduction was noticed towards the end of storage. A similar declining trend in fat content during frozen storage was reported by Doifode (2007) for goat meat and Brewer and Harbers (1991) for raw ground pork. Lipid oxidation during frozen storage of meat was mainly due to losses in triglycerides fractions.

Microbiological Quality: Storage related changes in microbial quality of rabbit meat are presented Table 3. It was observed that the SPC of rabbit meat decreased significantly (P<0.05) during frozen storage of 60 days. A similar decline in SPC during freezing of buffalo meat was observed by Kandeepan and Biswas (2005). The decrease in SPC may be attributed to sudden frozen

Table 2

Storage related physico-chemical changes in frozen thawed rabbit meat

Storage period in days	pH	TBA (mg malon-aldelyde/kg)	Tyrosine (mg/100g)	Drip loss (%)	ERV (ml)	Moisture (%)	Protein (%)	Fat (%)
Zero	5.55^{a}±0.04	0.11^{a}±0.01	19.73^{a}±0.49	Zero	22.40^{a}±0.76	71.10^{a}±0.52	20.55^{a}±0.08	6.24^{a}±0.03
15	5.57^{a}±0.01	0.20^{a}±0.02	21.38^{a}±0.46	2.33^{a}±0.17	21.20^{b}±0.30	68.23^{b}±0.89	19.45^{b}±0.24	6.15^{b}±0.02
30	5.75^{b}±0.04	0.31^{b}±0.03	24.17^{b}±0.29	4.00^{b}±0.17	20.22^{c}±0.30	65.83^{bc}±0.85	18.88^{b}±0.20	6.09^{b}±0.02
45	5.80^{b}±0.06	0.42^{c}±0.02	26.28^{c}±0.54	7.95^{c}±0.44	19.25^{d}±0.22	63.87^{c}±0.91	17.80^{c}±0.16	5.91^{c}±0.04
60	5.94^{c}±0.07	0.54^{d}±0.02	28.61^{d}±0.52	8.75^{d}±0.50	17.05^{e}±0.23	61.88^{c}±1.11	16.92^{d}±0.30	5.75^{d}±0.04
SE ±	0.04	0.03	0.56	0.24	0.31	0.83	0.19	0.02
CD	0.13	0.10	1.70	0.74	0.94	2.51	0.58	0.07

The means with different superscripts within each column differ significantly (p<0.05)

Table 3
Storage related changes in microbiological quality of frozen thawed rabbit meat

Storage period (days)	SPC (log cfu/g)	*E. coli* count (log cfu/g)	*Salmonella* count
Zero	4.59^{a}±0.03	2.01^{a}±0.06	ND
15	4.22^{b}±0.03	1.86^{b}±0.04	ND
30	3.97^{c}±0.02	1.69^{c}±0.20	ND
45	3.65^{d}±0.06	1.51^{d}±0.02	ND
60	3.40^{e}±0.03	1.35^{e}±0.02	ND
SE ±	0.07	0.04	ND
CD	0.23	0.13	ND

Means with different superscript within each column differ significantly ($p<0.05$)

shock to microorganism during freezing of meat.

E. coli: During frozen storage of rabbit meat *E. coli* count decreased significantly ($P<0.05$) with progress of storage period. The variation in *E. coli* count was observed to be significant ($P<0.05$) indicating that frozen storage of rabbit meat helped to reduce the count. The decrease in *E. coli* count during frozen storage was also reported by Bhadekar (1983) and Kulkarni (1984) for buffalo meat. Storage of meat samples at -18±1^{0}C might be having greater effect on ice formation on both sides as well as within the cells which might have reduced the count during storage.

***Salmonella*:** It was observed that rabbit meat samples were negative for salmonella species. During entire study, none of the meat samples shows the presence of salmonella. The present study findings are in agreement with that of Doifode (2007) for goat meat and Biswas *et al.* (2006) for buffalo meat.

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