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ASSOCIATION OF FSSAI HYGIENE RATINGS WITH THE PHYSICOCHEMICAL, MICROBIOLOGICAL AND SENSORY QUALITY OF RETAIL CHEVON IN NAGPUR, INDIA

Rathod Rohit Kailasrao[1], Kishor Sheshrao Rathod[1*], Kiran Shinde[2], Santana Das[3], Piyush Bhole[4], Bhand Akshata Chandrakant[5], Saurabh Nistane[6], Naina Singh[7]

[1]Division of Livestock Products Technology, Nagpur Veterinary College, Seminary Hills, Nagpur, Maharashtra, India
[2]Division of Animal Nutrition, ICAR-Indian Veterinary Research Institute, Izzatnagar, Bareilly, Uttar Pradesh, India
[3]Division of Livestock Production and Management, ICAR-National Dairy Research Institute, Karnal, Haryana, India
[4]Division of Veterinary Anatomy and Histology, SGSVVP Lokmangal Veterinary College, Solapur, Maharashtra, India
[5]Veterinary Clinic, Sakora Tal-Nandgaon, Nashik, Maharashtra, India
[6]Division of Animal Reproduction, ICAR-Indian Veterinary Research Institute, Izzatnagar, Bareilly, Uttar Pradesh, India
[7]Veterinary Clinic, Jamod, Tal. Jalgaon Jamod, Buldhana, Maharashtra, India
***Corresponding Author**: Kishor Sheshrao Rathod, drkishorrathod79@gmail.com

ABSTRACT:
Background: The hygiene conditions of retail meat shops may influence the quality and safety of chevon offered to consumers. The present study evaluated the physicochemical, microbiological, and sensory quality of raw chevon sold through retail meat shops graded under different Food Safety and Standards Authority of India (FSSAI) hygiene grades in Nagpur, Maharashtra, India.
Methods: A total of 99 fresh chevon samples were collected from Grade A, B, and C retail meat shops, with 33 samples per grade. The samples were analysed for pH, water-holding capacity (WHC), water activity (aw), total plate count (TPC), and coliform count. Sensory evaluation was performed using a five-point hedonic scale.
Results: The mean pH values of chevon samples from Grades A, B, and C were 5.88±0.08, 6.05±0.07, and 6.08±0.04, respectively. WHC differed significantly among grades, with values of 58.93±0.61, 61.99±0.63, and 62.42±0.59, respectively. Water activity also varied significantly, ranging from 0.97±0.003 in Grade A to 0.91±0.004 in Grade C. Microbiological analysis revealed significantly lower TPC and coliform counts in Grade A samples 3.87±0.42 and 0.80±0.34 (log_{10}CFU/g), respectively) than in Grades B and C. The mean TPC and coliform counts in Grades B and C exceeded the FSSAI limits cited in the study. Sensory scores for colour, odour, and overall acceptability also varied among the grades.
Conclusion: The findings indicate an association between FSSAI hygiene grade and selected physicochemical and microbiological characteristics of retail chevon. The lower microbial counts observed in Grade A samples highlight the importance of hygienic meat handling, sanitation, and appropriate storage practices in retail outlets. Strengthening hygiene management and routine monitoring of meat shops may contribute to improved chevon quality and safety.

KEYWORDS: Chevon, FSSAI, Retail Meat Shops, Physicochemical Quality, Microbial Quality, Sensory Evaluation

INTRODUCTION

Environmental Chevon is an important source of high-quality animal protein and contributes to food and nutritional security in India. It is widely consumed across the country owing to its dietary, cultural and economic significance. According to Basic Animal Husbandry Statistics 2025, India produced 10.50 million tonnes of meat during 2024–25, of which goat meat accounted for approximately 15.06%, highlighting its substantial contribution to the country's meat sector (BAHS, 2025). Ensuring the quality and safety of chevon throughout the supply chain is therefore important for consumer health, market confidence and the sustainability of the meat industry. The quality and safety of fresh meat may be influenced by several factors along the slaughter, handling, transportation and retail chain. Inadequate sanitation, contaminated equipment and meat-contact surfaces, poor personal hygiene, environmental exposure and improper temperature management may contribute to microbial contamination and deterioration of meat quality. Retail meat shops are particularly important in this regard, as meat may be exposed to repeated handling and environmental contamination before reaching consumers. Assessment of physicochemical, microbiological and sensory attributes can provide useful information about meat quality and help identify potential concerns associated with retail handling and storage practices.

In India, the Food Safety and Standards Authority of India (FSSAI) has introduced the Hygiene Rating Scheme to encourage food businesses to maintain appropriate hygiene and food safety standards and to help consumers make informed choices. The scheme applies to meat retail shops and evaluates food businesses against specified hygiene and food safety requirements through an audit-based rating process. It also encourages food business operators to identify deficiencies and improve their hygiene practices. Although hygiene ratings provide a structured assessment of food premises, the rating of a retail outlet does not, by itself, establish the microbiological or physicochemical quality of the meat sold there. Evaluating meat quality alongside shop-level hygiene ratings can therefore provide complementary evidence on the relationship between hygiene compliance and the quality of retail meat. In a previously published survey of 100 retail chevon shops in Nagpur, Rathod et al., (2026) reported that 54% of the shops were classified as Grade B and 44% as Grade C, while only 2% received Grade A; no shop was classified as A+. The study also identified deficiencies in several hygiene-related domains, including facilities, sanitation, food-handler training and record keeping. While these findings characterized the hygiene status of retail chevon shops, the corresponding quality attributes of the meat sold through these outlets were not directly established.

Therefore, the present study was undertaken to evaluate the physicochemical, microbiological and sensory quality of retail chevon across FSSAI hygiene-rated meat shops (Grades A, B and C) in Nagpur, India. By examining selected meat-quality attributes across these hygiene-rating categories, the study aimed to determine whether retail chevon quality differed according to the hygiene rating of the shops and to generate evidence that may support hygiene improvement and food-safety practices in the retail chevon value chain.

MATERIALS AND METHODS

2.1. Study area and classification of retail meat shops

The study was conducted in Nagpur, Maharashtra, India. Retail chevon meat shops had previously been graded using the Food Safety and Standards Authority of India (FSSAI) hygiene-rating checklist, as described by Rathod et al., (2026). In the earlier survey, 100 retail chevon shops were assessed across five zones of Nagpur city. Based on their hygiene-rating scores, 2%, 54% and 44% of the shops were classified as Grades A, B and C, respectively, while no shop received Grade A+. For the present study, fresh chevon samples were collected from retail meat shops representing Grades A, B and C and evaluated for physicochemical, microbiological and sensory attributes. The samples were categorized according to the hygiene grade assigned to the respective retail meat shop.

2.2. Collection and preparation of chevon samples

A total of 99 fresh chevon samples were collected, comprising 33 samples each from Grade A, Grade B and Grade C retail meat shops. Approximately 250 g of fresh chevon was collected aseptically in pre-sterilized, self-locking low-density polyethylene (LDPE) pouches. The samples were transported under chilled conditions using ice packs to the Department of Livestock Products Technology, Nagpur Veterinary College, for further analysis. Precautions were taken during sample collection and transportation to minimize the risk of contamination.

2.3. General laboratory procedures

Borosilicate glassware was soaked overnight in a detergent solution, washed thoroughly with running tap water, rinsed with deionized water and air-dried. The glassware was then packed and sterilized in a hot-air oven at 160°C for 1.5 h. Plastic laboratory ware, including micropipette tubes, was sterilized by autoclaving at 121°C and 15 psi for 15 min. Gamma-irradiated sterile Petri dishes (90 mm; ABDOS, Lot No. M111121A11) were used for microbiological analysis.

2.4. Physicochemical analysis

2.4.1. pH

The pH of chevon samples was determined according to the method described by Trout et al., (1992). Briefly, 10 g of meat was mixed with 50 mL of distilled water to prepare a homogeneous suspension. The glass-combination electrode of a digital pH meter (HM HiMedia pH-80 Hydrotester, Model No. HTG3C00073) was immersed in the suspension, and the pH value was recorded.

2.4.2. Water-holding capacity

The water-holding capacity (WHC) of chevon was determined according to the method of Wardlaw et al., (1973), with minor modifications. Briefly, 20 g of minced meat was mixed with 30 mL of chilled 0.6 M NaCl in a centrifuge tube. The mixture was stirred for 1 min using a glass rod and maintained at 4°C for 15 min. The sample was subsequently centrifuged at 5,000 rpm for 15 min using a REMI R-24 centrifuge. WHC was calculated based on the amount of liquid retained by the meat following centrifugation and expressed as a percentage.

2.4.3. Water activity

Water activity (aw) was measured using a Rotronic HygroPalm HP23-AW water activity meter. Approximately 1 g of meat sample was placed in the sample cup, and the water activity value was recorded after 1 min of measurement at 25°C.

2.5. Microbiological analysis

The total plate count (TPC) and coliform count of chevon samples were determined following the standard procedures described by APHA (1984).

2.5.1. Preparation of serial dilutions

For microbiological analysis, 10 g of meat sample was aseptically transferred to a sterile mortar using sterilized forceps and scissors. The sample was mixed with 90 mL of sterile 0.1% peptone water and homogenized using a sterile pestle for 2 min to obtain the initial 10^{-1} dilution. Subsequent decimal dilutions were prepared by transferring 1 mL of the preceding dilution into 9 mL of sterile 0.1% peptone water, followed by thorough mixing. Further dilutions were prepared as required for microbial enumeration.

2.5.2. Total plate count

The total plate count was determined using the pour-plate technique. Plate Count Agar (23.5 g) was suspended in 1 L of distilled water, heated to dissolve completely and sterilized by autoclaving at 121°C and 15 psi for 15 min.

An aliquot of 1 mL from an appropriate serial dilution was transferred into sterile Petri dishes in duplicate. Approximately 20 mL of molten Plate Count Agar, cooled to 45°C, was added to each plate and mixed thoroughly. After solidification, the plates were incubated at 37±1°C for 24 h. Plates containing 30–300 colonies were selected for enumeration. The mean colony count was multiplied by the reciprocal of the corresponding dilution factor, and the results were converted to $\log_{10}$CFU/g of meat.

2.5.3. Coliform count

Coliform counts were determined using MacConkey agar. Briefly, 1 mL of an appropriate serial dilution was transferred into sterile Petri dishes in duplicate. Approximately 10–15 mL of sterile molten MacConkey agar, cooled to 45°C, was added to each plate and mixed thoroughly. The agar was allowed to solidify at room temperature, and the plates were incubated at 35°C for 18–24 h. Following incubation, characteristic pink colonies were counted, and the coliform count was expressed as $\log_{10}$CFU/g of meat.

2.6. Sensory evaluation

Sensory evaluation of raw chevon samples was conducted by a panel of five semi-trained members comprising academic staff and students from the Department of Livestock Products Technology, Nagpur Veterinary College. The samples were evaluated for appearance and colour, smell, juiciness, palatability and overall acceptability using a five-point hedonic scale, as described by Dzomba et al., (2014). The scale ranged from 1 (dislike extremely) to 5 (like extremely). Scores were recorded for each sensory attribute and overall acceptability.

2.7. Statistical analysis

Quantitative data for physicochemical, microbiological and sensory parameters were summarized as mean ± standard error (SE). The data were analysed using a completely randomized design (CRD), as described by Snedecor and Cochran (1989), with WASP 2.0 (ICAR, Goa) and SPSS software. Statistical significance was considered at $P < 0.05$.

RESULTS AND DISCUSSION

3.1. Physicochemical characteristics of chevon

The physicochemical characteristics of raw chevon samples collected from retail meat shops classified as Grades A, B and C are presented in Table 1.

3.1.1. pH

The mean pH values (mean ± SE) of raw chevon meat from Grades A, B, and C were 5.88 ± 0.074b, 6.05 ± 0.071a, and 6.08 ± 0.037 a, respectively, with significant differences observed among the grades. These variations may be attributed to differences in the time elapsed between slaughter and sample collection. The observed pH values were comparable to those reported by Capan and Bagdatli (2021) and Kuncara et al., (2020), who documented pH values of 6.36 and 6.2–6.7 in chevon meat, respectively. Meat pH is an important quality parameter, as variations in pH can influence shelf life, water-holding capacity, and cooking loss (Allen et al., 1998).

3.1.2. Water-holding capacity

The water-holding capacity (WHC) of raw chevon meat differed significantly among the grades, with mean values (mean ± SE) of 58.93 ± 0.61b, 61.99 ± 0.63a, and 62.42 ± 0.59a for Grades A, B, and C, respectively. An increasing trend in WHC was observed alongside higher mean pH values (Table 4.9). These findings were comparable to those of Rathod et al., (2022), who reported a WHC of 66.14% in fresh chevon meat collected in Nagpur. WHC is one of the key functional properties of raw meat and plays an important role in determining its tenderness (Mir, 2017). Meat with a lower pH is generally associated with reduced WHC, which may consequently affect tenderness (Barbut, 1993).

3.1.3. Water activity

The mean water activity (aw) values (mean ± SE) of raw chevon meat from Grades A, B, and C were 0.97±0.003a, 0.95±0.006a, and 0.91±0.004b, respectively, with significant differences observed among the grades ($p < 0.05$). These findings were in agreement with Rathod et al., (2022), who reported a water activity value of 0.97 in fresh meat samples collected in Nagpur.

Table 1. Physicochemical analysis of meat samples from different graded meat shops in Nagpur city.

Parameter	Grade A	Grade B	Grade C	P value
pH	5.88 ± 0.08^{b}	6.05 ± 0.07^{a}	6.08 ± 0.037^{a}	0.055
WHC (%)	58.93 ± 0.61^{b}	61.99 ± 0.63^{a}	62.42 ± 0.59^{a}	0.000
a_w	0.97 ± 0.003^{a}	0.95 ± 0.006^{a}	0.91 ± 0.004^{b}	0.000

N=33 and P < 0.05.

3.2. Microbiological quality of raw chevon

The total plate count (TPC) and coliform count of raw chevon samples collected from Grade A, B and C retail meat shops are presented in Table 2. Both microbial parameters differed significantly among the shop grades. Grade A samples exhibited lower mean microbial counts than Grades B and C.

3.2.1. Total plate count

The total plate count (TPC) of raw chevon meat varied significantly among the grades, with mean values (mean ± SE) ranging from 3.87±0.42b to 6.43±0.01a log_{10}CFU/g. Grade A samples exhibited significantly lower TPC than those from Grades B and C, while Grade C samples recorded the highest microbial counts. These findings were consistent with previous studies by Gupta and Gupta (2009), Saikia and Joshi (2010), Yammine and Karam (2020), Kumar et al., (2020), Dhanze et al., (2012), and Jerry et al., (2015). Similarly, Tafesse et al., (2014) and Erdem et al., (2014) reported total viable counts of 6.8 and 8.3 log_{10}CFU/g, respectively, in chevon obtained from hygienically maintained retail shops. The comparatively higher TPC observed in Grades B and C may be associated with inadequate storage conditions and poor hygienic practices in retail outlets, which can promote microbial proliferation. Based on the FSSAI limit of 6 log_{10}CFU/g cited in the study, Grade A samples were within the specified limit, whereas the mean TPC values for Grades B and C exceeded it.

3.2.2. Coliform count

The coliform counts of raw chevon meat differed significantly among the grades, with mean values (mean ± SE) ranging from 0.80±0.34b to 4.24±0.43a log_{10}CFU/g. Grade A samples exhibited significantly lower coliform counts than those from Grades B and C, while Grade C samples recorded the highest count. The elevated coliform levels in Grades B and C may be attributed to inadequate hygiene during slaughtering, meat handling, and storage. These findings were comparable to those of Kumar et al., (2020) and Siddiky et al., (2022), who reported coliform counts of 4.98 and 4.87 log_{10}CFU/g in chevon samples collected from retail shops in Hyderabad and wet markets in Dhaka, respectively. Similar counts were documented by Kumar et al., (2012) and Abu-Ruwaida et al., (1994), with values of 4.96 and 4.89 log_{10} CFU/g, respectively. In contrast, lower coliform counts, ranging from 1 to 4 log_{10}CFU/g, were reported by Saikia and Joshi (2010), Mawia et al., (2012), Azage and Kibret (2017), and Sengupta et al., (2011). Conversely, higher counts (5.7–7.6 log_{10} CFU/g) were observed by Kumar et al., (2020), Bhandari et al., (2013), Erdem et al., (2014), and Vaidya et al., (2016) in meat samples obtained from roadside slaughtering stalls. According to the FSSAI limit of 2 log_{10} CFU/g cited in the study, the mean coliform count of Grade A samples (0.80±0.34b log_{10}CFU/g) was below the specified limit, whereas the mean counts in Grades B (4.17±0.45a log_{10}CFU/g) and C (4.24±0.43a log_{10}CFU/g) exceeded it.

Table 2. Microbial analysis of meat samples from different graded meat shops in Nagpur city.

Parameter	Grade A	Grade B	Grade C	P value
TVC (log_{10} CFU/g)	3.87 ± 0.42^{b}	6.28 ± 0.02^{a}	6.43 ± 0.01^{a}	0.000
Coliform count (log_{10} CFU/g)	0.80 ± 0.34^{b}	4.17 ± 0.45^{a}	4.24 ± 0.43^{a}	0.000

N=33 and P < 0.05

3.3. Sensory attributes of raw chevon

The sensory attributes of chevon samples obtained from retail meat shops classified under different FSSAI hygiene grades are presented in Table 3.

Colour: Colour is an important sensory attribute that influences the visual appeal, presentation, and consumer acceptability of meat (Bekhit et al., 2019; Cao et al., 2022). Significant differences (P<0.05) in colour scores were observed among chevon samples from different grades. The scores varied across the grades, with Grade A samples receiving favourable colour ratings, indicating better sensory appeal.

Odour: Significant differences (P<0.05) in odour scores were observed among the grades, with samples from Grades A and B receiving higher scores than those from Grade C. The comparatively lower odour scores in Grade C may be associated with microbial activity and the development of undesirable odours during meat storage. Baston (2010) reported that meat odour deteriorates over time due to microbial activity, which can generate volatile sulphur- and ammonia-containing compounds. Similarly, Bleicher et al., (2022) associated the ammoniacal odour of goat meat with the formation of volatile organic compounds.

Overall acceptability: Overall acceptability scores differed significantly (P<0.05) among the chevon samples from the three grades, ranging from 3.667 to 4.333. These variations indicate differences in the overall sensory perception of the samples. Keskin et al., (2012) reported that goat meat exhibits favourable overall acceptability compared with other types of red meat.

Table 3. Sensory evaluation of meat samples from different graded meat shops in Nagpur city.

Parameters	Grade A	Grade B	Grade C	P-value
Colour	4.15 ± 0.09^{a}	4.03 ± 0.12^{a}	4.33 ± 0.10^{a}	0.001

Odour	3.91 ± 0.12[a]	4.03 ± 0.13[a]	4.12 ± 0.10[a]	0.031
Overall Acceptability	3.57 ± 0.09[b]	3.63 ± 0.13[b]	3.66 ± 0.11[b]	0.000

N=33 and P < 0.05

CONCLUSION

The present study demonstrated variations in the physicochemical, microbiological and sensory quality of raw chevon sold through retail meat shops classified under different FSSAI hygiene grades in Nagpur city. Although pH values did not differ significantly among the grades, significant differences were observed in water-holding capacity (WHC) and water activity (a_v). Microbiological analysis revealed significantly lower total viable count (TVC) and coliform count in chevon obtained from Grade A shops compared with Grades B and C, indicating comparatively better microbiological quality in meat from Grade A outlets. Based on the FSSAI limits cited in the study, the mean microbial counts of Grade A samples were within the specified limits, whereas those of Grades B and C exceeded them. Sensory evaluation also revealed significant differences in colour, odour and overall acceptability scores among the hygiene grades, suggesting variation in the sensory attributes of retail chevon. Overall, these findings highlight the importance of hygienic handling, effective sanitation and appropriate storage practices in maintaining chevon quality and safety at the retail level. Strengthening hygiene practices, providing regular training to meat handlers, improving shop infrastructure and sanitation facilities, and ensuring routine monitoring by regulatory authorities may help improve the microbiological quality and consumer acceptability of chevon sold in retail markets.

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