

Adoption of hygienic meat production and handling practices among value chain stakeholders of chevon and carabeef in Kerala, India

Abstract

This study investigated the adoption of hygienic practices in Kerala's chevon and carabeef value chain, focusing on production and handling methods. Using a stratified multistage sampling approach, the research examined three stakeholder groups: farmers (producers), traders, and retailers. For farmers, the assessment covered hygiene practices in feeding, environmental management, livestock health, and biosecurity. For traders and retailers, evaluation parameters included animal welfare standards, handling protocols, transportation compliance, regulatory adherence, traceability systems, slaughter hygiene, packaging methods, and waste management practices. Demographic analysis revealed that participants were predominantly middle-aged males with secondary education and substantial industry experience. The findings indicated moderate adoption of hygiene practices across all stakeholder categories. The domain-specific analysis highlighted critical areas requiring improvement: antimicrobial resistance management, residue monitoring, biosecurity protocols, and general hygiene practices throughout the value chain. For meat traders and retailers specifically, the study identified regulatory compliance, product traceability, personal and environmental hygiene, and waste management as key areas needing enhancement. These findings underscore the necessity for targeted interventions to improve hygiene standards across Kerala's red meat value chain.

Keywords: Carabeef; Chevon; Red meat stakeholders; Hygienic practices; Kerala.

1. INTRODUCTION

Culinary taste is reported to be an important attribute affecting the consumption of red meat (1). Apart from this, nutritional qualities such as high biological value protein, essential amino acids, long-chain omega-3 polyunsaturated fats, bioavailable micronutrients like vitamin D, riboflavin, pantothenic acid, heme-iron, zinc, calcium and selenium which have efficient absorption from the diet, are other unobserved attributes of red meat that are of interest to potential consumers (2). Among the red meats, carabeef and chevon have been widely accepted by consumers, and carabeef is available to the consumers at cost less than half of the price of chevon, carabeef is widely consumed in Kerala state.

Various actors involved in carabeef and chevon value chains are farmers, aggregators, sub-traders, traders, retailers, restaurants and consumers. Each actor has engaged in specific activities in this value chain (3). Despite the increasing demand for animal-sourced foods along with significant economic contribution and cash inflows from meat sector, this sector still remains highly neglected, unorganized, facing numerous social, ecological, cultural, and environmental constraints, characterized by poor infrastructure.

Foodborne diseases (FBDs) pose a significant public health challenge, particularly in low- and middle-income countries such as India, where their impact is more pronounced (4, 5). The economic burden of FBDs in India is estimated at \$28 billion (Rs. 1,78,100 crore) annually, emphasising the substantial financial stress on the nation's healthcare and economic systems (6). Notably, animal-source foods account for approximately 21 per cent of India's total FBD burden (7). A comprehensive study analysing the data from June 2009 to December 2018 identified 58 outbreaks associated with meat, poultry, and eggs. This highlights the critical role of food safety measures in mitigating risks associated with animal-derived foods (8). Due to the highly perishable nature of meat, it is essential to adopt hygienic practices in the entire meat value chain from the production point up to consumption. Due to numerous factors like illiteracy, socio-economic, religious and policy-related constraints the standards for hygienic meat production remain notably underdeveloped.

In recent years, the demand for quality meat for human consumption has increased significantly worldwide. Therefore, the adoption of hygienic practices in meat production and processing is of great importance for stakeholders to achieve high quality and safe meat production that would further enhance and supplement human nutrition. Therefore, this study will valorize the aspects of primary production practices including hygiene in feeding and environment, animal health management and biosecurity measures among farmers. The results of the present study will promote the adoption of hygienic production and handling practices in all segments of the red meat value chain.

2. METHODOLOGY

The study was conducted among different actors of chevon and carabeef value chain located in six districts of Kerala state by applying stratified multistage sampling technique. The districts of the state were divided into three strata, viz., southern Kerala, central Kerala and northern Kerala. In the first stage of sampling, district in each stratum having the highest

buffalo/goat populations as per the twentieth livestock census (9) was selected for the study. Accordingly, for carabeef value chain, Malappuram, Thrissur and Kollam districts was selected, whereas for chevon value chain, Malappuram, Palakkad and Thiruvananthapuram districts were selected respectively from the northern, central and southern Kerala.

In the second stage of sampling, from the selected districts, 10 value chains each of chevon and carabeef was mapped and selected thus making it to a total of 30 chevon and 30 carabeef value chain (10). The study considered the three actors namely farmers, traders and retailers in the value chains of carabeef and chevon, and hence the studied sample consisted of 30 farmers, 30 traders and 30 retailers from both sectors thus the total sample size was 180 respondents. Further, key informant sampling was used to identify first-stage informer actors (informer actors) (11). These informer actors were used as part of the exponential discriminative snowball sampling procedure to create sampling frames for each category of actors (12)(13). In the third stage of the sampling, simple random sampling technique was used to select the respondent actors in each category of sampling frame. Hence 180 respondent actors were selected and they were interviewed with a pretested interview schedule developed for this study.

The methodology used scales developed by the researcher for the study, according to the procedure followed by George (1999) (14), while the adoption of hygiene practices among retailers was studied using the scale developed by Greeshma (2023) (15).

The adoptions level was measured using a scoring system, where the responses to the above-selected statements were obtained from the respondents of the study on a three-point continuum viz. adopted, partially adopted and non-adopted, with corresponding scores of 3, 2, and 1 respectively. The adoption score of different domains was added to explore the adoption level of hygienic meat production and handling practices among value chain actors

The Adoption Mean Score (AMS) of respondents was calculated using the following formula:

Adoption Mean Score (AMS) = (Respondent's total obtained score) ÷ (Maximum possible score)

The numerator represents the total responses given by all respondents. The denominator, which is the maximum possible score, represents the total number of respondents in the study (30*3=90), denominator remains unchanged. The Average of Adopted Mean Score (AAMS), was calculated for adoptions which fell under different

domains. Based on values of Average of Adopted Mean Score (AAMS), domains were classified from most adopted to least adopted.

3. RESULTS AND DISCUSSION

Table 1. Distribution of value chain actors based on their socio-economic profile

Socio-economic profile	Category	Farmers f (%) (n=60)	Traders f (%) (n=60)	Retailers f (%) (n=60)	Total f (%) (n=180)
Age (In years)	Young (< 35)	7 (11.67)	8 (13.33)	15(25.00)	30 (16.67)
	Middle (35-50)	24 (40.00)	31 (51.67)	29 (48.33)	84 (46.67)
	Old (> 50)	29 (48.33)	21 (35.00)	16 (26.67)	56 (36.67)
Gender	Male	49 (81.67)	60 (100.00)	59 (98.33)	168 (93.33)
	Female	11 (18.33)	-	1 (1.67)	12 (6.67)
Education	Non formal	2 (3.33)	1 (1.67)	3 (5.00)	6 (3.33)
	Primary	14 (23.33)	10 (16.67)	7 (11.67)	31 (17.22)
	Secondary	27 (45.00)	31 (51.67)	36 (60.00)	94 (52.22)
	Higher secondary	8 (13.33)	13 (21.67)	12 (20.00)	33 (18.33)
	Graduate	9 (15.00)	5 (8.33)	1 (1.67)	15 (8.33)
	Post-graduation	-	-	1 (1.67)	1 (0.56)
Experience (In years)	Least experienced (< 01)	1 (1.67)	1 (1.67)	1 (1.67)	3 (1.67)
	Less experienced (01-05)	5 (8.33)	2 (3.33)	3 (5.00)	10 (5.56)
	Experienced (05-10)	13 (21.67)	8 (13.33)	13 (21.67)	34 (18.89)
	Highly experienced (>10)	41(68.33)	49 (81.67)	43 (71.67)	133 (73.89)
Training attended	Yes	18 (30.00)	-	1 (1.67)	19 (10.55)
	No	42 (70.00)	60 (100.00)	59 (100.00)	161 (89.44)
Social category	Hindu	26 (43.33)	10 (16.67)	5 (8.33)	41 (22.78)
	Muslim	24 (40.00)	47 (78.33)	49 (81.67)	120 (66.67)
	Christian	10 (16.67)	3 (5.00)	6 (10.00)	19 (10.56)
Primary occupation	Agriculture	7 (11.67)	-	1 (1.67)	8 (4.44)
	Animal Husbandry	16 (26.67)	-	-	16 (8.89)
	Animal trading	3 (5.00)	47 (78.33)	5(8.33)	55 (30.56)
	Meat retailing	-	4 (6.67)	45 (75.00)	50 (27.78)
	Wage employment	16 (26.67)	-	1 (1.67)	17 (9.44)
	Salaried class	2 (3.33)	1 (1.67)	1 (1.67)	4 (2.22)
	Business	8 (13.33)	1 (1.67)	2 (3.33)	11 (6.11)
	Self employed	2 (3.33)	3 (5.00)	-	5 (2.78)
Others	6 (10.00)	4 (6.67)	5 (8.33)	15 (8.33)	

Socio-economic profile of red meat value chain actors

It was observed from the above table that nearly half of the red meat producing farmers were belongs to old age, whereas similar share of studied traders and retailers were

middle aged. Considering their gender more than nine tenth of actors in these value chains were males, looking particularly in to traders and retailers, it is completely male dominant sector, whereas among buffalo and chevon farming sector, only about one-fifth of the female involvement (18.33%) could be recognised. With respect to educational qualification of actors, just more than half of them had secondary level of education, whereas involvement of graduates in this sector was found to be meagre and it is observed to be in descending manner among farmers (15.00%), traders (8.33%) and retailers (1.67%).

A study on the experience of actors revealed that nearly three-fourths of them have extensive experience (more than 10 years) in their profession. Approximately three-tenths of farmers attended training on various aspects of livestock rearing. However, none of the traders received training on hygienic meat production and processing, and only a negligible portion of retailers attended such training. The study also found that just over four-tenths of farmers are Hindu, followed by Muslims (40.00%) and Christians (16.67%). Among traders, more than three-fourths belong to the Muslim community, followed by Hindus (16.67%) and Christians (5.00%). Similarly, among retailers, over eight-tenths are Muslim, followed by Christians (10.00%) and Hindus (8.33%). Regarding the primary occupation of actors, slightly more than one-quarter of buffalo and goat farmers engage equally in animal husbandry and wage employment. In contrast, animal trading and meat retailing are the primary occupations for three-fourths of animal traders and meat retailers.

Similar observation was studied by (16) (17) (18) and (19) regarding age, gender, education and rearing purpose among farmers respectively, whereas divergent results observed from regarding age and education of farmers (20). Studies conducted by (21) (22) and (23) were found similar results with age, education and trade experience among traders of value chain respectively, whereas results observed from studies of (22) (21) and (23) depicts contrast results with gender, primary occupation and social category. Studies conducted by (24) (25) (26) and (27) revealed similar results among meat retailers with respect to socio-economic profile of age, gender, education status and social category, whereas contrast results were observed from (28) on gender, ethnicity, social category and retailing experience.

Table 2. Distribution of farmers based on adoption of scientific and hygienic meat production practices

Sl. No	Category	Carabeef farmers f (%)	Chevon farmers f (%)	Total f (%)
1	low (51-73.3)	5 (16.66)	3 (10.00)	8 (13.30)
2	Medium (73.31-95.60)	16 (53.33)	16 (53.33)	32 (53.33)
3	High (95.61-118)	9 (30.00)	11 (36.66)	20 (33.33)
	Total	30 (100.00)	30 (100.00)	60 (100.00)

The adoption of scientific and hygienic meat production practices among red meat producing farmers (Table 2) revealed that more than half of the farmers demonstrated a moderate level of adoption. This was followed by approximately one-third of producers exhibiting a high level of adoption, while just over one-tenth fell into the low-adoption category. Studies conducted by (29) and (30) on beef cattle and dairy farms similarly observed that the majority of farmers belonged to the category of moderate adopters. These findings highlight a trend of partial but growing acceptance of improved meat production practices within the sector.

Table 3. Domain wise mean score on adoption of scientific and hygienic meat production practices

Sl. No	Domain	Carabeef farmers		Chevon farmers		Compiled	
		AAMS	Rank	AAMS	Rank	AAMS	Rank
1	Primary Production: Basic animal welfare	0.82	2	0.83	1	0.83	1
2	Primary Production: General livestock management practices	0.85	1	0.74	3	0.80	2
3	Hygiene of feeding stuffs and water	0.63	3	0.66	5	0.65	3
4	Livestock health management	0.47	6	0.78	2	0.63	4
5	Antimicrobial resistance and residues	0.59	5	0.58	6	0.59	5
6	Hygiene of the environment	0.60	4	0.55	7	0.58	6
7	Carcass handling and disposal	0.43	7	0.69	4	0.56	7
8	Primary Production: Personal hygiene of animal handlers	0.40	8	0.47	8	0.44	8
9	Biosecurity	0.39	9	0.42	9	0.41	9

An analysis of domain-wise mean scores for the adoption of scientific and hygienic meat production practices (Table 3) among red meat producing farmers revealed that basic animal welfare emerged as the most adopted domain, with an Average of Adopted Mean Score (AAMS) of 0.83. This was followed by general livestock management practices (AAMS = 0.80), hygiene of feeding stuffs and water (AAMS = 0.65), livestock health management (AAMS = 0.63), antimicrobial resistance and residues (AAMS = 0.59), hygiene of the environment (AAMS = 0.58), and carcass handling and disposal (AAMS = 0.56), with adoption levels decreasing sequentially. In contrast, biosecurity (AAMS = 0.41) and personal hygiene of animal handlers (AAMS = 0.44) were identified as the least adopted domains.

Findings from (29) and (32) similarly indicated higher adoption levels in hygiene practices related to feedstuff management, whereas feeding practices of green fodder and concentrates were found similar with the findings of Hasan *et al.* (2022) (19). Additionally, Nyokabi *et al.* (2024) (30) reported that factors such as herd size, farmer education, dairying expertise, and participation in the formal milk value chain positively influenced the adoption of food safety measures. These results highlight the variation in adoption levels across different domains, emphasizing the need to strengthen biosecurity and personal hygiene practices within the red meat production sector.

Table 4. Distribution of traders based on adoption of scientific and hygienic meat processing practices

Sl. No	Category	Carabeef traders f (%)	Chevon traders f (%)	Total f (%)
1	low (79-86)	14 (46.66)	13 (43.33)	26 (43.33)
2	Medium (86.1-93)	13 (43.33)	9 (30.00)	21 (35.00)
3	High (93.1-100)	3 (10.00)	8 (26.66)	11 (18.33)
	Total	30 (100.00)	30 (100.00)	60 (100.00)

The assessment of scientific and hygienic meat handling practices among red meat traders (Table 4) indicated that over above four tenth of traders exhibited a low level of adoption. This was followed by 35 per cent representing a medium level of adoption, while 18.33 per cent showed a high level of adoption. A study conducted by Nyokabi *et al.* (2023) (31) reported similar findings within the Ethiopian meat value chain, highlighting comparable patterns in the adoption of hygienic practices. These results underscore the need for targeted interventions to improve the adoption of best practices among red meat traders, particularly those with lower engagement in food safety measures.

Table 5. Domain wise mean score on adoption of scientific and hygienic meat processing practices

Sl. No	Domain	Carabeef traders		Chevon traders		Compiled	
		AAMS	Rank	AAMS	Rank	AAMS	Rank
1	Hygiene of feeding stuffs and water	0.79	1	0.76	2	0.78	1
2	Livestock health management	0.65	6	0.78	1	0.72	2
3	Basic animal welfare at lairage	0.71	3	0.69	5	0.70	3
4	General livestock management practices	0.66	5	0.70	4	0.68	4
5	Vehicle design and floor space	0.73	2	0.62	6	0.67	5
6	Hygiene of the lairage environment	0.58	7	0.75	3	0.66	6
7	Transportation acts and rules	0.68	4	0.62	7	0.65	7
8	Personal hygiene of animal handlers	0.44	8	0.60	8	0.52	8
9	Regulatory compliance	0.43	9	0.46	9	0.45	9
10	Animal traceability	0.33	10	0.33	10	0.33	10
11	Training and education	0.33	11	0.33	11	0.33	11

The present study (Table 5) revealed that the hygiene of feeding stuffs and water was the most adopted domain (AAMS = 0.78) concerning scientific and hygienic meat handling practices among red meat animal traders. This was followed by livestock health management (AAMS = 0.72), basic animal welfare (AAMS = 0.70), general livestock management practices (AAMS = 0.68), vehicle design and floor space (AAMS = 0.67), hygiene of the lairage environment (AAMS = 0.66), transportation acts and rules (AAMS = 0.65), personal hygiene of animal handlers (AAMS = 0.52), and regulatory compliance (AAMS = 0.45), with adoption levels decreasing sequentially. Conversely, animal traceability (AAMS = 0.33) and training and education (AAMS = 0.33) were identified as the least adopted domains. These findings highlight the areas requiring greater attention and intervention to improve overall meat handling practices among red meat traders. Regarding traceability system in value chain, significant proportion of livestock farmers were preferred it, whereas also adopted it by few, hence need of streamlining it among other stakeholders like traders and retailers (33). Also, the various challenges in adoption of hygienic practices among meat value chain, with special emphasis in retailers' sector was mentioned by Government of Kerala (34).

Table 6. Distribution of retailers based on adoption of scientific and hygienic meat processing practices

Sl. No	Category	Carabeef retailers f (%)	Chevon retailers f (%)	Total f (%)
1	Low (49-69)	8 (26.66)	3 (10.00)	11 (18.33)
2	Medium (69-89)	18 (60.00)	18 (60.00)	36 (60.66)
3	High (89-109)	4 (13.33)	9 (30.00)	13 (21.66)
	Total	30	30	60

The analysis of scientific and hygienic meat handling practices among red meat retailers (Table 6) revealed that six tenth of respondents demonstrated a medium level of adoption. This was followed by 21.66 per cent exhibiting a high level of adoption, while 18.33 per cent reported a low level of adoption. When analyzed by individual value chains, a similar adoption trend was observed within the chevon value chain, reflecting the overall pattern. However, in the carabeef value chain, the adoption trend differed, following a medium-to-low-to-high pattern, which deviated from the compiled adoption levels.

Insufficient knowledge and low adherence to food safety practices among beef sellers are critical factors contributing to the cross-contamination of raw beef, significantly increasing the risk of beef-borne diseases (25). Similar findings were reported in the studies conducted by (24) and (35), whereas significance of hygienic meat handling among retailers was well documented with supporting works (36). These results highlight the urgent need to enhance food safety awareness and promote the adoption of proper meat handling practices to mitigate the health risks associated with beef consumption.

Table 7. Domain-wise mean score on adoption of scientific and hygienic meat processing practices

Sl. No	Domain	Carabeef retailers		Chevon retailers		Compiled	
		AAMS	Rank	AAMS	Rank	AAMS	Rank
1	Packaging processes	0.98	1	0.99	1	0.99	1
2	Pre-slaughter processes	0.64	2	0.73	2	0.69	2
3	Post-slaughter processes	0.57	7	0.70	3	0.64	3
4	Personal hygiene of fresh meat retail entrepreneurs	0.61	3	0.65	4	0.63	4
5	Slaughter processes	0.603	4	0.643	5	0.623	5
6	Environmental hygienic in and around the meat stall	0.60	5	0.642	6	0.621	6

7	Scientific waste management practices	0.58	6	0.49	7	0.54	7
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The analysis of scientific and hygienic meat handling practices among red meat retailers (Table 7) indicated that packaging processes (AAMS = 0.99) were the most adopted domain, followed by pre-slaughter processes (AAMS = 0.69), post-slaughter processes (AAMS = 0.64), and personal hygiene of fresh meat retail entrepreneurs (AAMS = 0.63). Conversely, scientific waste management practices (AAMS = 0.54), environmental hygiene in and around the meat stall (AAMS = 0.621), and slaughter processes (AAMS = 0.623) were identified as the least adopted domains. These findings align with the observations of (26) and (27) who reported similar trends in practices such as wearing protective clothing, washing hands before and after meat handling, displaying carcasses, and cleaning equipment. The results underscore the need to improve less adopted domains to ensure comprehensive adherence to hygienic meat handling practices across all stages of the retail process.

Conclusion

An analysis of the socio-economic profile of actors revealed that the majority of farmers were of older age, raising concerns about the long-term sustainability of the production sector. The observed male dominance within these sectors highlights the need for policy formulation and the creation of conducive environments to promote greater female participation. Regarding the educational qualifications and training participation of actors, the findings suggest an urgent need to enhance awareness of hygienic practices, with a particular focus on meat handlers. Although the adoption of hygienic meat production practices among farmers remains suboptimal, it is comparatively higher than that observed among meat handlers. Therefore, greater emphasis should be placed on promoting the adoption of hygienic meat handling practices among traders and retailers. Priority areas for improving hygienic meat production and handling practices include antimicrobial resistance and residues, environmental hygiene, carcass handling, personal hygiene, and biosecurity measures among farmers. For meat traders, key domains requiring attention are hygienic animal handling, regulatory compliance, and animal traceability. Among red meat retailers, critical focus areas include personal hygiene, slaughtering processes, environmental hygiene within and around meat stalls, and scientific waste management practices. These insights

underscore the need for targeted interventions across various domains to enhance overall food safety and ensure the sustainable development of the meat production and handling sectors.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Consent

As per international standards or university standards, respondents' written consent has been collected and preserved by the author(s).

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