



Identifying disease risk hotspots in buffalo meat (Carabeef) value chain

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ABSTRACT

The study was carried out to quantitatively map and analyse buffalo meat value chains in Uttar Pradesh state of India. The chain actors identified were farmers, peri-urban and urban dairies, aggregators, traders/sub-traders, retailers, restaurants/ roadside stalls and export-oriented abattoirs. Mapping exercise shows that aggregators constitute the main link between farmers and live animal markets and account for 72% of the total flow of buffaloes to livestock markets. Sub-traders/traders ship the bulk of the flow from markets to abattoirs. Of the total meat produced, 87% is shipped directly to importing countries and the rest (12%) to retailers (local and from other districts). The results of quantitative value chain mapping along with the risk pathways in the value chain (as identified by the research team) were presented to a panel of experts for rating of each risk factor on two dimensions, viz. 'likelihood of risk factor causing unwanted outcome' (introduction of pathogenic organism) and 'impact of unwanted outcome' (quality deterioration and adverse health implications for consumers of final meat products), each on a three-point continuum (low, medium and high). The ratings were then used to prepare a two-dimensional risk matrix having total of nine cells. The above exercise identified total of seven major disease risk hotspots in buffalo meat value chain. Overall, this study provided qualitative evidence of importance of adopting value chain approach in disease risk mitigation, by identifying structural deficiencies and vulnerabilities.

Keywords: Buffalo, Disease risk, Value chain

Livestock value chain includes the full range of activities by different people that are required to bring a product (e.g. live animal, meat, milk, egg, day old chick, feed, medicine, leather, fiber, manure) to final consumers passing through the different phases of production, processing and delivery. With growing importance of high-value agriculture in developing countries and its consequent complexity, efficient value chain management is crucial to deliver products in a safe and timely manner (Rich K M and Narrod C A 2005). The challenge is to properly map and quantify a value chain to identify value drivers and determine factors and key challenges that significantly affect/improve competitiveness and sustainability (Spies D C 2011).

Rushton J (2009) has given three main objectives of livestock value chain analysis as used for risk assessment, viz. (i) to identify the main people in the value chain; (ii) to identify and map the different routes to market the livestock and livestock products and (iii) to assess how well the marketing chain works. Literature on Indian meat value chains, both in the organized and unorganized sectors, is scarce. FICCI (2013) and Bardhan *et al.* (2019) Studies

had earlier been carried out carried out on comparative evaluation of value chains for domestically consumed and export-oriented Indian buffalo meat (carabeef) (FICCI 2013, Bardhan *et al.* 2019). But, scant research attention has been given on integrating livestock value chains with disease risk assessment.

The present study addresses the above crucial research gaps in the case of buffalo meat value chain. The objectives of the study were to quantitatively map buffalo meat (carabeef) value chains and to carry out risk analysis to identify the disease risk hotspots in the value chains.

MATERIALS AND METHODS

Study area: The study was carried out in 2018–19 in the state of Uttar Pradesh, as the state has the highest buffalo population in the country (33.05 million heads), accounting for 30% of the country's buffalo population (GoI 2019). Meat production is also highest in the state (624.32 thousand tonnes in 2017–18) (GoI 2018), accounting for 8.1% of the country's meat production. The number of buffaloes slaughtered in the state (4,277.27 thousand numbers) for meat purpose is also highest in the country. The highest number of buffalo meat exporting units in the country is also situated in Uttar Pradesh.

The study focussed on carabeef supply in Bareilly city (28°10' N 78°23' E/28.167°N 78.383°E, situated at a height of 250 metres from mean sea level) of Bareilly division in

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Uttar Pradesh, with the focus on analyzing details of the value chains that supply buffalo meat to the city both for the domestic and export-oriented sectors. Bareilly has a humid subtropical climate with hot summers and cool winters. The average temperature for the year is 25°C. June, with an average temperature of 32.8°C is the warmest month, while the coolest month of the year is January, with an average temperature of 15°C. Bareilly receives 1,038.9 mm precipitation for the year on average. The total human population in the state is 4.47 million, with the share of Muslim population at 34.5%, being one of the highest amongst all the districts in the state. There are two export-oriented slaughter houses in the district, viz. Marya Frozen Agrofoods Pvt. Ltd. and Marya Frozen Agrofoods Products Pvt. Ltd. While the former is exclusively focussing on exports (with a capacity of 1,000 buffaloes per day), the later has been recently established under public-private partnership mode, where-by they have the capacity of slaughtering 600 buffaloes (per day) with the additional mandate to supply 100 buffalo carcasses (per day) for the domestic sector.

Sampling: The study has covered 19 rural buffalo owners, 8 aggregators (who collect animals from the villages and sell them at livestock markets), 5 sub-traders, 1 trader (out of 5 registered traders/ suppliers in Bareilly city), 13 buffalo meat retailers, 18 peri-urban and urban dairies, rearing buffaloes and 13 restaurants/ road-side stalls selling food items in which carabeef is a major component. A total of 7 livestock markets, transacting in sale and purchase of buffaloes for slaughter purposes, were visited to hold discussion with market functionaries regarding the functioning of such markets and identifying different stakeholders. Out of these 7 markets, 5 are located nearby Bareilly city (viz. Rithora, Faridpur, Saidpur and Devchaura in Bareilly district and Katra in Shahajampur district). Two livestock markets in Uttar Pradesh, but located at distant centres from Bareilly city, were also covered, viz. Jubairganj in Faizabad district and Khalilabad in Sant Kabir Nagar district as buffaloes transacted in these markets are also supplied to Bareilly city.

Data: Primary data was collected by interviewing the above mentioned key value chain stakeholders in the buffalo meat sector by developing a structured comprehensive interview schedule.

Risk analysis: The framework of this study on value chain and risk analysis was based on practical field applications of approaches given in a FAO working paper (FAO 2011). Overall, the approach in this study was qualitative in nature. In this approach, the following features were considered:

- (i) Identification of hazard - Probability of an event (resulting in the value chain being prone to introduction of pathogenic organism at any point) occurring.
- (ii) Identification of specific risk pathways and description of the main factors affecting the risk probability at each step of the risk pathway (in the

form of a table detailing the factors, comments on the factors and a qualitative risk estimate).

The information in regard to the above two aspects, viz. risk pathways and relevant remarks on each pathway, were provided by the research team which carried out this study, based upon their observation of functioning of the value chain, behaviour of personnel engaged in different activities across the chain and discussion with various stakeholders of the chain, including market functionaries, Veterinary Officers, para-veterinarians and abattoir personnel. Based upon the risk factors and observations/ discussion, the research team rated each risk pathway step on a three point continuum, i.e. low, medium and high (Table 1). In the next step, the same was presented to a panel of experts, along with the results of quantitative value chain mapping, for their aid in rating of risks.

- (iii) Rating of risk - Risks along different pathways were rated by a panel of 15 experts comprising of Scientists from ICAR-Indian Veterinary Research Institute, Izatnagar and ICAR-National Research Centre (Meat), Hyderabad, with specialization in Livestock Products Technology (Meat Science), Veterinary Public Health and Veterinary Epidemiology. The scientists were asked to rate each risk factor on two dimensions, viz. likelihood of risk factor causing unwanted outcome (introduction of pathogenic organism) and impact of unwanted outcome (quality deterioration and adverse health implications for consumers of final meat products). These two aspects were rated by the experts on a three-point continuum (low, medium and high). In addition, the experts also gave an overall risk score for each risk factor on a five-point continuum (very low, low, medium, high and very high).

RESULTS AND DISCUSSION

Mapping of buffalo meat value chain pertaining to Bareilly city: The carabeef value chain was mapped utilizing information from key informants and group discussions and following published framework (Alarcon *et al.* 2017). Farmers and local peri-urban and urban dairies were the main suppliers of buffaloes for meat (Fig. 1). Male calves and unproductive female buffaloes were sold by farmers mostly to aggregators who, in turn, sold these in local livestock markets. A major share of the market arrivals happened through aggregators, and the rest by farmers. There were 150–250 aggregators in Bareilly city. About 18 animals were brought by an aggregator each week to a market. Farmers and aggregators agreed to a price based solely on the body weight of animals. There were 350–450 peri-urban and urban dairies in and around Bareilly city and male buffalo calves and unproductive dairy animals were sold directly by them to abattoirs. On an average, 1–2 animals per month were supplied by each dairy to the abattoirs. Price settlement was based on body weight. There were 200–250 sub-traders who operated on behalf of the five registered traders. Animals were procured by sub-

Table 1. Risk pathways

Risk pathways steps	Risk factors (Factors influencing probability)	Relevant information	Probability of the event (1) occurring (Qualitative)
Animals are not vaccinated/dewormed	Depends upon sources/ villages	Animals are mostly brought from villages without history of vaccination	High
Multiple pickups of animals by aggregators from different villages/ sources	Depends on locations/ villages/ markets	There are no restrictions on multiple pickups	High
Non-cleaning of vehicles by aggregators/ traders and sub-traders for transport of animals and by retailers for transport of carcasses	Depends upon area/ location	Mostly vehicles cleaned with water, not disinfectants	High
Lack of market facilities—like holding area, watering/cleaning facilities	Depends upon markets	Only present in large markets	Medium
Lack of AM examinations of animals	Depends upon markets	Only present in large markets	Medium
Animals transported without health certificates	For long distance markets (Jubairganj/ Khalilabad), health certificates are provided. Health certificates are not present when animals transported from local livestock markets Depends upon markets	No health certificates checking during movement (from local markets) by concerned authorities	Medium
Intermingling of animals from different sources at markets	Animals for domestic markets slaughtered in export-oriented abattoirs	More prevalent in large markets with rapidly turning changing populations	High
Non-inspection of presence of pathogens in carcasses meant for domestic purposes		Lack of clarity about the extent of implementation of FSSAI regulations for meat cuts meant for domestic markets	Medium
Lack of cold storage for carcasses/ animals slaughtered during night and available for retailers early morning	For carcasses meant for domestic markets, carcasses stored in AC rooms. Due to time lag from slaughter, meat quality deteriorates	For carcasses meant for export, chiller rooms are used/ available	High
Unhygienic packaging of carcasses by retailers while transporting	Widely prevalent throughout the Value Chains	Lack of checking/ supervision from government authorities	High
Sharing of same vehicles by retailers	Widely prevalent throughout the Value Chains	Lack of checking/ supervision from government authorities	High
Lack of areas for separation of sick animals/ lack of holding places	Mostly prevalent in smaller markets	Stringent inspection/ supervision lacking	Medium
Mixing of stocks from different sources	Prevalent/ mostly during festival season	Inspection/ supervision lacking	Medium

traders from markets and transported directly to abattoirs. Animals were brought by most of them directly from markets to abattoirs. A small share of the buffaloes, that

sub-traders procured from markets, were sold in other livestock markets too; other sub-traders procured these for transfer to abattoirs. About 20 animals on an average were

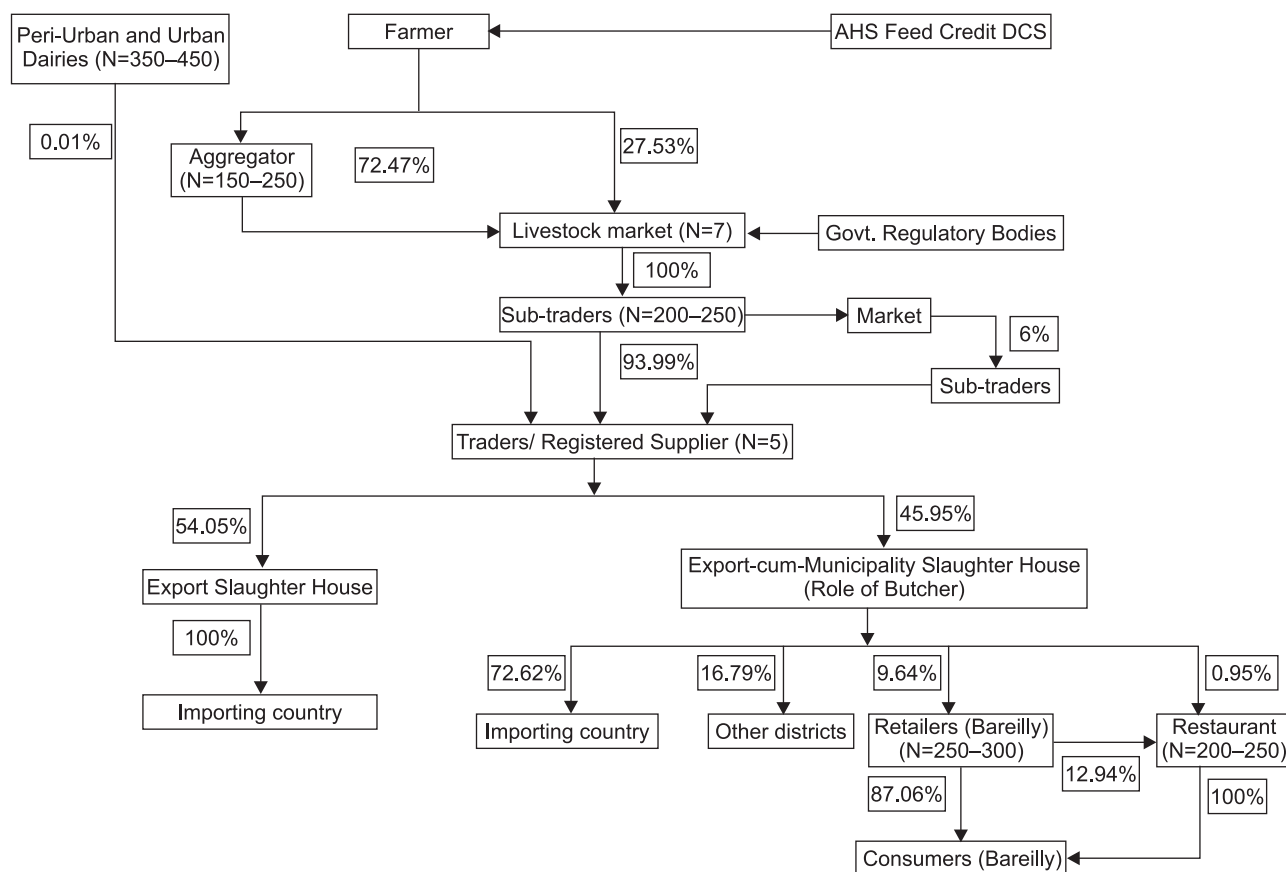


Fig. 1. Mapping of buffalo meat value chain.

procured by each sub-trader per trip on each visit to the market. Price was determined mainly on the basis of the live body weight of animals. About 900 to 1,500 animals, on an average, per day per trader were received by each abattoir. About 54% of the animals were brought to the export-oriented abattoir and 46% to the export-cum-domestic abattoir. Frozen, boneless meat (pack sizes of 18, 20, 25 and 28 kg) was the main item of export to Algeria, Egypt, Saudi Arabia, Vietnam, Syria, Iraq, Mauritius, Jordan, Muscat, the UAE, Yemen and Kyrgyzstan. For supply to domestic markets, the animals were slaughtered in the night and the carcasses were hung in air-conditioned rooms; these were then sold to retailers the following morning. Prices were negotiated with traders (sellers) at the abattoir. On an average, 50 kg of meat per day from the abattoir was procured by each retailer. A single vehicle was rented by 3–4 retailers for transporting the carcass to their retail outlets. About 36 kg of meat, on average, was sold by each retailer and the leftover meat was stored in refrigerators. Most of the fresh meat was sold to consumers and the rest to restaurants/ roadside stalls that made and sold carabeef biryani, minced meat curry and meat curry. Meat was also procured directly from the slaughter houses by these restaurants. There were about 200–250 restaurants and 50 roadside food stalls in Bareilly city. On average, about 27 kg of meat was procured by each restaurant daily from a slaughterhouse and about 11 kg from retailers. Most (75%) of the restaurants sourced their raw meat from

retailers, while the rest procured directly from abattoirs.

Seasonal variations in flow (volume) across the value chain: No seasonal variations were found in the flow of volume of animals/carabeef across the value chains. Only during the festival seasons, the flow increased (Table 2). Percentage increase in procurement of animals than that in normal times in case of aggregators and traders were 53% and 63%, respectively. The percentage increase in procurement of carcasses/ meat cuts by retailers was about 71%.

Table 2. Temporal variation in flow along the value chain

Stakeholder	Procurement of during normal season (per market)	Procurement of during festivals (per market)	Percentage increase in procurement during festivals (%)
Aggregator (No. of animals)	9	14	52.78
Traders (No. of animals)	20	32	63.26
Retailers (kg)	50	85	70.76

Spatial dimension of the value chain: Fig. 2 presents geographical routes through which live animals were supplied to the slaughterhouses in Bareilly. These were transported from livestock markets as far as Sant Kabir Nagar and Faizabad districts. Along this route lied the other



Fig. 2. Geographical route for transfer of buffaloes to Bareilly.

major livestock markets—Rithora, Katra and Faridpur. The geographical route for supply of carcasses / meat cuts from slaughterhouses to various retail outlets is shown in Fig. 3. The distance from slaughterhouses to retail outlets in Bareilly averages 15 km.

Identification of risk hotspots in buffalo meat value chain: The panel of 15 experts was presented with a total of 27 risk factors under four major areas of concern, viz. ‘Disease introduction to value chain/area’, ‘Exposure of local animals to diseases’, ‘Spread of disease within value chain/to consumers’ and ‘Spread of disease to other areas / districts’. Each of the risk factors was rated by the experts on two dimensions, viz. ‘likelihood of risk factor causing

unwanted outcome’ and ‘impact of unwanted outcome’. The specific risk factors and average ratings on the above dimensions to each risk factor are presented in Table 3. The ratings were then used to prepare a risk matrix, measuring the likelihood of unwanted outcome on the Y-axis and the impact of unwanted outcome on the X-axis. Some risk factors were rated high on one dimension, while low on another. The risk factors in the matrix were represented in terms of their respective codes as mentioned in Table 3. Given, there were total of 27 risk factors to be rated by the experts on two dimensions, there are 54 entries of specific codes in the risk matrix. Those risk factors, which scored high on both the dimensions, indicated the disease risk hotspots in buffalo meat value chain. Seven risk hotspots were identified, viz. lack of provision for mandatory ante-mortem examination in local livestock markets before transactions; lack of measures for pre and post movement isolation and testing; transportation of animals for long distances without health certificates; absence of cleaning and disinfection of vehicles by aggregators and traders and sub-traders after each trip; lack of hygienic practices at retail outlets; lack of measure for check of pathogens in meat meant for domestic consumption; and use of contaminated meat cutting wooden slabs (Fig. 4).

Overall, the study showed how the major carabeef value chains – domestic chains for fresh meat and value-added cooked meat products, and the chains for international markets, function. However, all the chains originated from the same, highly fragmented back end – smallholder, mixed-crop farming systems and peri-urban and urban dairies. The results of this quantitative mapping supplemented the qualitative identification of risk hotspots along the value

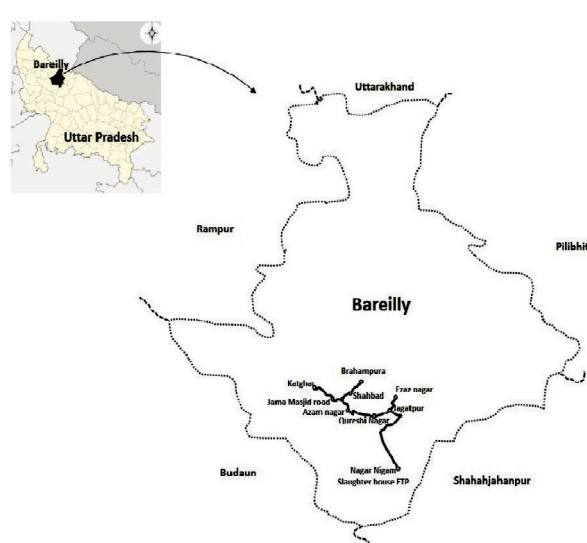


Fig. 3. Geographical route for transport of carcass/meat-cuts from slaughterhouse to retail hubs in Bareilly.

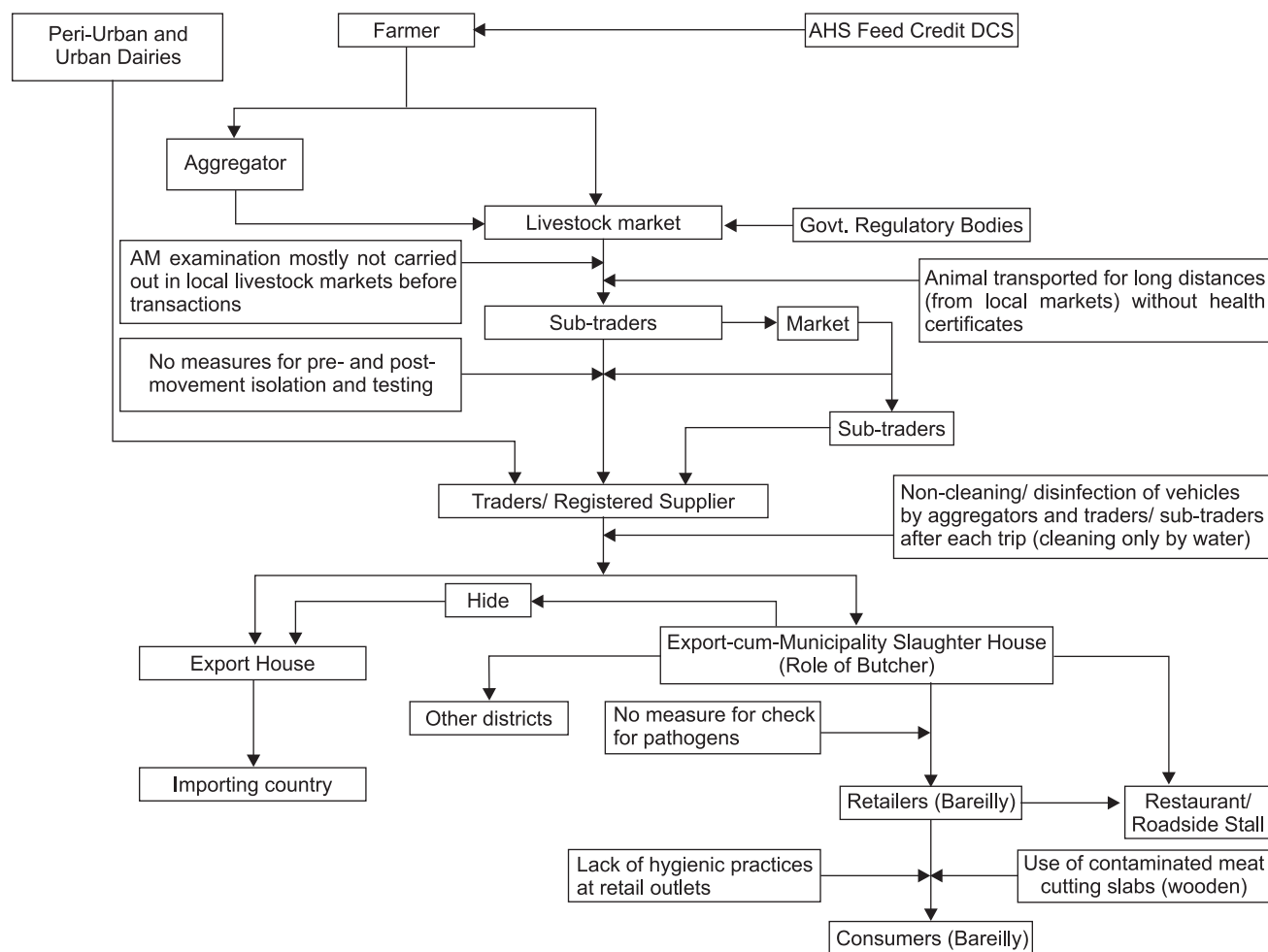


Fig. 4. Disease Risk Hotspots in Buffalo meat value chain.

Table 3. Preliminary risk assessment

Area of concern	Type of carrier	Code	Factors affecting risk	Likelihood of risk factor (3) causing unwanted outcome [#] (qualitative)	Impact of unwanted outcome [#] (qualitative)	Comments on likelihood and impact of unwanted outcome
(1)	(2)		(3)	(4)	(6)	(7)
A Disease introduction to value chain/ area	A1 Live animals	A1.1	Animals mainly arrive at Bareilly abattoirs from local livestock markets where in turn, animals are brought by local aggregators from nearby villages. Urban and Peri-urban dairies (in and around Bareilly city) also supply animals directly to abattoirs.	2.15	2.07	Intermingling of animals sourced from different farms and regions pose a threat to food safety management. If facilities are good at abattoirs, then the probable risk can be minimized.
		A1.2	Multiple pickups by aggregators from villages while transporting animals to livestock markets.	2.21	2.14	Big challenge in containing the diseases. Quality of meat may be affected.
		A1.3	History of vaccination of animals against priority diseases are not available.	2.36	2.50	Disease outbreaks may increase.
		A1.4	AM examination mostly not carried out in local livestock markets before transactions.	2.71	2.71	AM examination is one of the critical control point in meat production, ensuring humane treatment of animals and also preventing zoonotic infection.

(Table 3 contd...)

Area of concern	Type of carrier	Code	Factors affecting risk	Likelihood of risk factor (3) causing unwanted outcome [#] (qualitative) (4)	Impact of unwanted outcome [#] (qualitative) (6)	Comments on likelihood and impact of unwanted outcome (7)
(1)	(2)		(3)			
B Exposure of local animals to diseases	Products A2 Fomites A3	A1.5	Overstocking of vehicles by traders/ sub-traders and aggregators while transporting animals.	2.21	2.29	Animals are physically and physiologically affected. In addition to animal welfare, quality of the meat also affected. More of a physical risk than disease risk.
		A1.6	No measures for pre and post movement isolation and testing.	2.63	2.73	Lack of veterinary inspection (pre-transportation) to screen the health of animal poses serious threat to food safety management. Free movement of diseased animals will obviously lead to spread of diseases.
		—	—	—	—	—
		A3.1	Non-cleaning/ disinfection of vehicles by aggregators and traders/sub-traders after each trip (cleaning only by water).	2.64	2.50	Improvement in the market infrastructure is the need of the hour to address this issue. May have impact on other disease outbreak and on carcass quality. Transport regulations need to be implemented strictly.
		B1.1	Animals are also brought over from distant livestock markets, as far as Jubaiganj and Khalilabad and also sometimes from other states like Punjab.	1.86	1.86	Long distance travel of meat animals is a common phenomenon across the world. Long distance travel per se is not a risk. But transportation without following standard procedure is a problem.
	B1	B1.2	Markets in Jubaiganj/ Khalilabad are large with rapidly turning changing population.	1.79	1.41	Low risk.
		B1.3	Animals transported for long distances (from local markets) without health certificates.	2.53	2.50	Lack of veterinary inspection has serious consequence on safety of meat. Transportation without pre examination poses serious threat to the animal and the other animals which are transported together. No health certificate or certificate issued casually—both pose risk.
		B1.4	Intermingling of animals brought from different regions (local and distant) and ages/ sexes at livestock markets/ abattoirs.	2.21	2.63	—
		B1.5	During festivals, movements of animals from distant areas increase.	1.93	2.00	—
		Products B2 Fomites B3	—	—	—	—
B3.1	Non-cleaning/disinfection of vehicles after each trip while transporting animals (cleaning only by water).	2.57	2.71	Disease risk to animal and man both.		

(Table 3 contd...)

Area of concern	Type of carrier	Code	Factors affecting risk	Likelihood of risk factor (3) causing unwanted outcome [#] (qualitative)	Impact of unwanted outcome [#] (qualitative)	Comments on likelihood and impact of unwanted outcome
(1)	(2)		(3)	(4)	(6)	(7)
C Spread of disease within VC/ consumers	Live animals –	–	–			
	C1					
	Products	C2.1	Lack of hygienic practices at retail outlets.	2.79	2.64	Meat is directly exposed to hazards from environment, personnel and other carcasses. High temperature cooking cannot substitute for hygienic handling. Basic hygienic requirements should be made as mandatory to retail meat. Critical risk area.
	C2					
	C3	C3.1	Non-inspection of presence of pathogens in carcasses meant for domestic consumer market.	2.71	2.57	Post-mortem examination is critical control point in meat production. Poses risk to consumers directly.
	Fomites	C3.2	Lack of cold storage facilities for carcasses (meant for domestic use) at abattoirs.	2.36	2.43	Awareness need to be created among traders and consumers on the importance of cold chain maintenance. Usually meat is sold on same day. It is critical control point in large scale abattoirs. In small scale marketing practices, not a major risk due to hot meat consumption practice.
		C3.3	Animals slaughtered in night and available for retailers early next morning—Thus time lag in slaughtering and procurement of carcasses by retailers leading to quality deterioration.	2.21	2.36	As temperature is generally low in early mornings, not a major risk.
		C3.4	Waste products are managed by export-oriented slaughter houses.	1.40	1.32	Low
		C3.5	Intermingling of animals from different sources at livestock markets/ abattoirs.	2.14	2.14	–
		C3.6	Lack of hygienic packaging of carcasses/ meat cuts.	2.36	2.57	Usually consumers carry in fresh polythene bags. Public health risk.
		C3.7	Non-cleaning/disinfection of vehicles (cleaning only with water).	2.36	2.43	–
		C3.8	Sharing of same vehicles by retailers while transporting meat cuts from abattoirs.	2.41	2.29	If done in such way for long distance it will be a high risk. Short distance or shorter time—Medium risk.
		C3.9	Use of contaminated meat cutting slabs (wooden).	2.64	2.71	Usually wooden slabs are scraped before beginning the day's work. Awareness on microbial contamination need to be created among traders.

(Table 3 contd...)

Area of concern	Type of carrier	Code	Factors affecting risk	Likelihood of risk factor (3) causing unwanted outcome [#] (qualitative)	Impact of unwanted outcome [#] (qualitative)	Comments on likelihood and impact of unwanted outcome
(1)	(2)		(3)	(4)	(6)	(7)
D Spread of disease to other areas / districts	Live animals	–	–			
	D1 Products	D2.1	Carcasses/meat cuts collected and transported to nearby districts (long distance transport).	1.43	2.07	Awareness need to be created among traders on the importance of cold chain maintenance. High chances of spoilage of meat.
	D3 Fomites	D3.1	No measure for check for pathogens.	2.20	2.37	–
		D3.2	Lack of hygienic packaging of carcasses/ meat cuts.	2.36	2.57	Public health risk.
		D3.3	Non-cleaning/ disinfection of vehicles (cleaning only with water).	2.29	2.29	Awareness on microbial contamination need to be created among traders.

#High, Medium, Low. * 1, Very low; 2, Low; 3, Medium; 4, High; 5, Very high.

chain. In this process, this study has validated the process of risk analyses in value chains and identified the risk hotspots for intervention to mitigate health concerns from consumption of meat. Overall, this study provided qualitative evidence of importance of adopting value chain approach in disease risk mitigation, by identifying structural deficiencies and vulnerabilities.

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