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CONSUMER MEAT SAFETY KNOWLEDGE AND HYGIENE PRACTICES IN A VETERINARY DISEASE-CONTROLLED AREA OF SOUTH AFRICA

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ABSTRACT

Consumers' practices and knowledge play a significant role in ensuring meat safety and hygiene application. This is important in an environment where the slaughter and release of such meat is restricted and not always controlled and monitored. This could have been contributed by the lack of slaughter facilities; the controlled movement of live animal restrictions applicable in a typical veterinary diseases-controlled area. The aim of this investigation was to identify meat hygiene practices and general meat safety knowledge applied by consumers of central Bushbuckridge, South Africa. Structured interviews (n=81) were conducted with consumers observed purchasing meat from local meat supply centres. Data analysis was achieved by SAS Statistical software (Version 26) SAS and graphs were drawn using MS Excel 2020. The majority (84.2%, σ=29.4) of the consumers indicated that meat supplied in the region were from registered facilities. The general belief amongst the consumers was that routine hygiene inspection was conducted by authorities at all meat distributing or butchery facilities (74.1%, σ=39.7). None of the facilities or/and butcheries in the study area was registered and therefore, no formal regulated practices could have been conducted. Slaughter and distribution of meat within the area were seen as a good business by 78.6%, σ=18.9 of the consumers, and as a result, the consumers did not have a problem with widespread slaughter and release of this meat to the public outside of those facilities. The extent of hygiene application practices at household level varied. These included the assurance that perishable products were properly handled after purchase (84.1%, σ=8.3), and the handling or transportation of sourced meat did not comply with cold chain management prescripts (39.9%, σ=44.9). The likelihood of consumers feeling the same about meat hygiene concerns and practices is undoubtedly low as represented by a high standard deviation (σ) of the responses. These results show that consumers were relying on authorities for meat safety assurances. This ought to caution authorities on consumer practices and needed interventions such as animal movement policies enforcement. The adoption of such policies by consumers lies with the development and rollout of consumer awareness and meat safety assurances training programs.

Key words: abattoir, consumer practices, illegal slaughter, meat safety, meat hygiene

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INTRODUCTION

Article 11(1) of the Covenant of the United Nations (2012) affirms that everybody has a right to access sufficient and safe food including meat [1]. This resolution clarifies that the government will have to ensure that food is available for consumers from farm to fork, though this commitment is purely on the belief that governments must create an environment conducive for self-provision of food [2]. The responsibility of monitoring, and testing whether food is safe for human consumption lies with the authorities or agencies [3]. In the context of meat production, measures must be put in place to ensure that meat provided meets the minimum safety requirements such as the provision that the meat is free from microbiological (pathogens), chemical and physical hazards that could render it unsafe for human consumption and that consumers are able to make sound decisions on its handling and quality [4]. A number of developing countries are not immune to challenges of safe meat production, these would include the control of meat animal slaughter, provision of meat inspection, development and implementation of controlled processes, as well as identification, evaluation and elimination of meat hazards [5]. In these countries, animal slaughter is mainly controlled in formal markets and within the meat supply chain, thus leaving substantial quantities of meat sourced from informal processes being distributed to an unsuspecting public [6]. While this could be linked to the high costs related to running a registered abattoir daily, other contributors are the abundance of domestic livestock especially cattle in these communities. This results in farmers and livestock owners being able to slaughter and provide such meat to different communities without hindrances, thus increasing the risks of food borne illnesses in communities and increased numbers of the availability of illegally slaughtered meat [7]. Illegal slaughter or informal slaughter is defined as slaughter of meat animals at unregistered facilities for meat distribution [8]. These practices have been experienced for a long time, and they unfortunately present a high risk of food poisoning and diseases spreading from animals to consumers [9].

Animal slaughter in controlled zones

Bushbuckridge (in South Africa) with its three districts (Rolle, Orinoco and Agincourt) is partly located within the foot and mouth diseases (FMD) control zone, and this requires an extensive role to be played by farmers and consumers to prevent the occurrence and spread of FMD and other veterinary controlled diseases. Like other areas with cloven hoof animals' movement control, Figure 1 shows the dynamics that exist in Bushbuckridge [10]. In these areas, domestic meat animals are free roaming within communities and are sometimes reported to be grazing with wild animals from the neighbouring Kruger National Park (KNP), a result of porous borders between the communities and the KNP [6,11].

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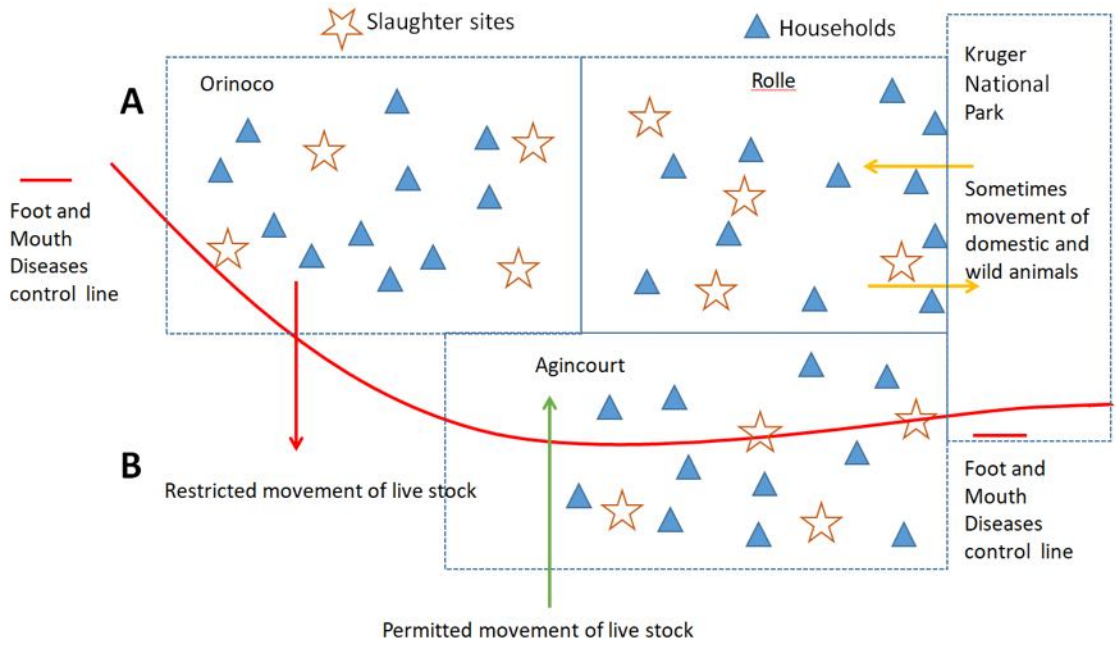

Figure 1: Situation of Bushbuckridge study area, where animals farmed inside the red line must be slaughtered within the line. The movement of animals for slaughter and farming is not permitted from A to B

It can be seen from Figure 1, that cloven hoof animals reared within area "A" are expected to be traded and slaughtered inside the same area. However, animals or raw meat products from these areas cannot be moved to areas in "B", unless movement protocols have been met [12]. This encourages the slaughter and trading of meat within the restricted areas. While slaughter practices in FMD controlled areas are standard practices, for that meat to be sold to the public it must still undergo normal slaughter compliances. Such animals must have been slaughtered in a registered abattoir under hygienic conditions and such meat is certified safe for human consumption [13, 14, 15]. To mitigate against possible risks of contamination, consumers are expected to follow a number of hygiene prescripts termed "five keys" to safer food production [16, 17].

Consumer practices and expectations

Consumers' practices that are in contrast with hygiene compliance are documented in the informal food supply chain. Although known (this information is documented) [18,19], it has not been extensively investigated due to a lack of data from informal practices. It was concluded by Nicoletti [20], that informal slaughter in its nature could lead to the release of contaminated meat, which may be contributed by the use of conventional slaughter methods, poor slaughter techniques, lack of meat inspection and poor hygiene compliances including cold

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chain management. In this regard, a significant amount of pathogenic and spoilage organisms could be cross- transferred from dirty surfaces to other meat surfaces subsequently posing a risk to consumers [21, 22, 23].

As reported above, the World Health Organization (WHO) has developed "five Keys to safer food" that must be followed to reduce the risk of food borne illnesses occurring at consumer levels. It is Imperative to note that the "five Keys" are dependent on the consumers' ability to maintain food safety practices by: (1) keeping handlers, surfaces and equipment clean; (2) separating raw and cooked foods, (3) cooking food thoroughly, (4) keeping food at safe temperatures, and (5) using safe water and raw materials at all times [25]. Researchers such as Odeyemi *et al.* [26,27] argued that, in developing countries, a majority of consumers may not be aware of the risks associated with practices construed as normal. Thus, an opportunity to add a hurdle or a step that may remove a hazard or reduce it to lower levels at households is missing [28, 29].

As a result, consumer linked practices including sourcing from uncertified outlets (un-certifiable meat), improper storage, poor hygienic handling practices post purchase, during preparation, and consumer behaviours such as the consumption of undercooked meat remains risky practices [30, 31, 32].

This paper investigated consumer meat safety practices and expectations, at an area where uncontrolled slaughter and the release of such meat is continuous. It was hypothesised that while meat safety risks are documented, most consumers are generally not aware of the safety risks associated with meat from informally slaughtered animals. The objective of this paper is to evaluate consumer behaviour, and their knowledge of adoptable practices to ensure clean meat handling practices from butcheries to fork, in an area where the movement of animals and raw animal products is "controlled".

MATERIALS AND METHODS

Data collectors were stationed outside six (6) raw meat points of sale premises or butcheries. This area represented a typical developing country rural community, where animal slaughter is normal, handling and distribution of the resultant meat is generally uncontrolled [33]. The investigation was conducted in the 3 sub-districts of Bushbuckridge, South Africa namely: Agincourt (n=10), Orinocco (n=33), and Rolle (n=38). Researcher administered questionnaire developed from local, international legislation and the WHO "5 keys to safer food" code of practice was used to interview (n=81) consumers identified buying meat. This study was approved by Tshwane University of Technology's ethical committee (REC2012/07/003).

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Persons buying raw meat from butcheries, informal markets and retailers were approached and conveniently requested to take part in the study. Prior to an interview, each respondent was informed about the nature and aim of the study and requested to provide consent for participating. Participants had a choice to answer or not to answer questions that they were uncomfortable with, as a result, not all questions were answered by all consumers and thus the n-values of the variables will differ. The frequencies observed within the categories of each question were tested for even distribution by a 1:1 ratio using the Chi-square test. In cases where there was strong evidence against a 1:1 ratio, regrouping was done for even distribution of frequencies in categories. Furthermore, 2 x 2 contingency tables were constructed from meaningful combinations and a Chi-square test for independence (association or pattern) was performed [34]. Significant probability value ($P<0.05$) of the results are presented in bar charts and frequency tables. All data analyses were done using SAS Statistical software (Version 26) SAS [36] and graphs were produced using MS Excel 2020.

RESULTS AND DISCUSSION

The results highlight aspects of consumer practices and knowledge that directly or indirectly contribute to the unhygienic preparation of unsafe meat in a veterinary controlled area in South Africa. In communities where the movement of animals to registered facilities is restricted, it could be expected that private slaughter would be rife, unless there is an abattoir registered within the restricted area. These practices are expected in areas such as wildlife conservation camps [36, 37]. As seen in Figure 1, to prevent the spread of diseases, domestic animals reared in these communities must be slaughtered or traded within the same communities [38]. In these cases, for such meat to be certified safe for human consumption, it requires that such animals are slaughtered at registered facilities, where meat inspection takes place and general hygiene application has been complied with during slaughter [39]. In areas where there is a risk of zoonotic diseases to spread, it is even more fitting to control this slaughter and meat production [40]. This may ensure diseases' monitor from primary processing, meat inspections and consumers capacitating on ways of ensuring extended safer meat handling practices, preparation and serving. Hence, the development and compliance to five keys of safer food production as a response to safer meat practices could be a needed intervention strategy at consumer level.

Globally, in instances where the World Health Organisation's five keys to safer food were not followed, evidence of increased food poisoning had occurred. These were linked to the poor hygiene during handling, storage and serving at consumer level [41]. Badrie *et al.* [42] stated that even though many consumers categorise

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food safety as important, most do not apply the principles of safe food handling when preparing at home as is the case in this study.

Sourcing of meat

Consumers purchase meat from available sources with affordability being a major consideration. The majority of consumers, for example n=70 (84.2%), indicated that they purchase meat from formal premises, followed by 8.7% from informal markets and 7.1% consume the offal from animals that they slaughter themselves. Although there are several "butcheries" housed in built structures, which may be regarded by the consumers as "formal" in the three regions evaluated, none of them are registered under regulation 638 of the Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972 (South Africa) [44]. About 67.9% of consumers reported that they trust the premises where they were buying meat from complied with minimum regulatory requirements; 12.3% indicated that they do not trust the meat facilities and 19.8% were unsure of their trust.

Majority (n=81, 74.1%) trusted that authorities were routinely conducting inspections and believed that non-conformances at facilities were dealt with accordingly. This emphasised the consumer trust towards governments and food safety institutions. Interestingly, 8.6% reported that they knew that authorities did not inspect meat premises and that knowledge was not a deterrent to purchasing meat from those facilities. It was evident that many consumers pay little attention to meat sourcing practices when purchasing meat or even eating out. The results show that meat consumers were not aware of the differences between formal and informal facilities and as a result, they perceived all butcheries and slaughter facilities to be formal and to be registered under standing regulations and inspected by authorities for compliances to regulation [5]. This study showed that, while consumers expected meat from these regions to be safe and free from hazards, it was clear that they were not aware of the different meat safety aspects linked with sourcing meat from uncontrolled facilities. This was further magnified by the lack of knowledge of other factors that may improve meat safety at end user point.

Consumer beliefs and practices

On a virtual analogue scale, consumers were prompted to indicate the extent of agreement with statements regarding general knowledge, beliefs and practices pertaining to meat handling at home. The results are presented in Table 1. Averages between 0 - 50 represent levels of disagreement and 51 – 100 represent levels of agreement. An important feature from Table 1 is that the responses of consumers between the different sub-districts did not differ ($p>0.05$) for any of the questions. The probability of consumers feeling the same about the hazards in meat is undoubtedly low and, therefore, the results show that the answers of the

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consumers were not precisely reproduced. In fact, the answers were widely spread as indicated by the standard deviation (σ) of the responses. It is important to note that most consumers from all three the sub-districts believed that beef was an important element of their diet (82.7%, σ=29.4) and they would regularly eat beef with friends and guests (7.5%, σ=39.7).

In general, consumers agreed (78.6%; σ=40.1) that they do not have a problem with the slaughter of cattle outside an approved abattoir, with consumers from Agincourt having the highest level of agreement (90%). Only 51.4% (σ=46.9) of the consumers were interested in finding out how the animal was slaughtered, and the meat processed (37.2%; σ=40.1). Regarding the eating of beef, there was a high level of agreement (84.6%; σ=29.4) that it "tastes great" trailed by lesser levels of agreement regarding the availability of it throughout the year (58.8%; σ=35.4), its nutritional value (58.6%; σ=32.6), humane slaughter of animals (56.6%; σ=42.5), meat is free of hormones and antibiotics (55.8%; σ=42.0), part of the Bushbuckridge tradition (54.2%; σ=42.2) and that the meat is cheap for what it offers (39.0%; σ=34.2).

On meat hygiene and safety practices at household level, consumers agreed (84.1%; σ=8.3) that when they purchase frozen meat, they will always ensure that the meat was properly frozen and that they will allow it to thaw before cooking it (76.6%; σ=18.9). Noteworthy is that the latter two aspects were the ones with the smallest variation in the responses, which is an indication that the consumers were more in agreement with one another. Of concern is that consumers disagreed with statements on good meat hygiene practices, which are an indication of poor knowledge at household level. This relates to reheating of left-over meat prior to eating it at a later stage (54.7%; σ=36.1), thawing of meat in a fridge (40.2%; σ=46.7), ensuring that the meat is ready for consumption just in time for the meal (45.1%; σ=38.9), keeping of left-overs in a fridge (39.1%; σ=41.5), discarding left-overs after re-heated meat (36.3%; σ=32,0), checking of temperatures when cooking (33.4%; σ=34.8) and the transport of purchased meat in a cooler bag (31.9%; σ=44.9). Consumers did not entirely believe that the animals were slaughtered in a humane manner (Table 1). 'Humane' refers to a quick and painless death during slaughter. The practice of using free bullets to kill bovine intended for human consumption has been practiced by slaughter operators in central Bushbuckridge and possibly perceived by consumers as a normal way of killing bovine [6]. Though, the Red Meat Regulation of South Africa [13], European Regulation No 853/2004 [15] recognises the use of a captive bolt, electrical claps or any method of stunning approved by the responsible authorities, these processes are abattoir based. In an uncontrolled slaughter plant, other stunning procedures could be conducted. Noteworthy is that consumers did not regard the

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slaughter of animals and the release of such meat in unregistered facilities as a problem. This could be ascribed to the fact that the animals are mostly free roaming in human spaces and their trading and slaughter is seen as normal, consumers put a high premium of trust on authorities for meat safety protection [6].

Aspects of concern to consumers

During the study, consumers were observed purchasing meat from outlets that were dilapidated, without water, no meat inspection conducted and where the general hygiene practices followed were poor. It must be noted that in a developing country such as South Africa, where animal slaughter is done for cultural, religious and traditional practices, it would be expected that issues related to animal slaughter are widely accepted. In the context of an African system of informal and formal or illegal and legal slaughter, the fine line between the two could be emphasised and general focus must be the compliances to all regulative transcripts during slaughter and the safety of products of the final products. Consumers were asked to indicate whether they were concerned about the deficiencies in structural requirements and hygiene practices that could exist with informal meat markets; Figure 2 illustrates the “NO” responses of the central Bushbuckridge consumers to the question for the respective aspects of hygiene requirements.

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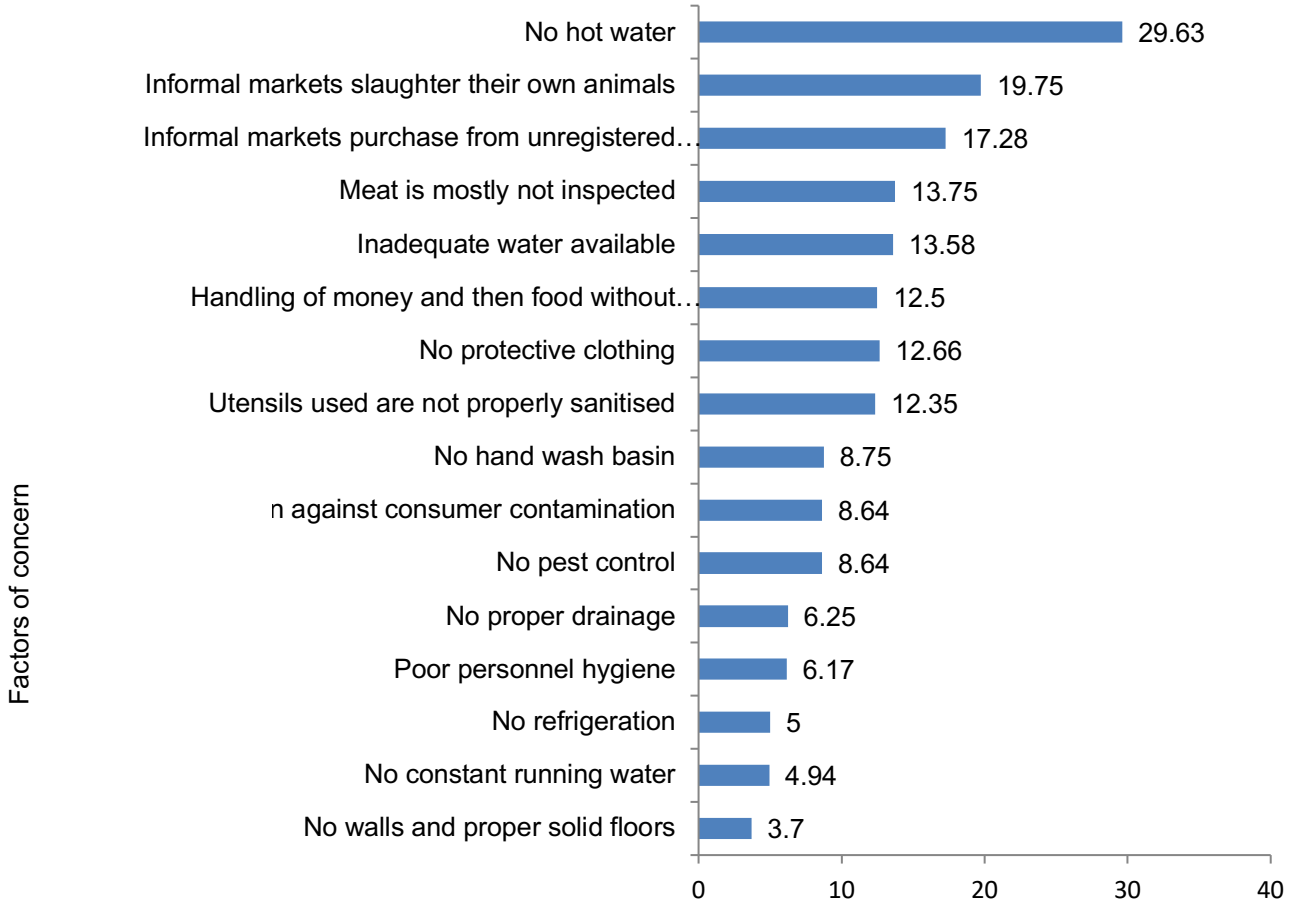

Figure 2: "No" responses (%) on concern of the central Bushbuckridge consumers (n=81) regarding structural and hygiene practice deficiencies that could exist with informal meat markets

Consumers were mostly concerned about the unavailability of walls and proper solid floors (96.3%), followed by no constant running water (95.1%), no immediate refrigeration of the meat (95%), poor personal hygiene (93.8%), no proper drainage facilities (93.7%), no pest control (91.4%), no hand wash basins (91.2%), utensils not properly sanitised (87.6%), handling of money and then the meat (87.5%), inadequate water availability (86.4%) and no protective clothing worn by food handlers (87.3%). Of particular interest to this study is that 80.2% of consumers were concerned about the fact that the animals were slaughtered informally by the informal markets themselves (not at abattoirs) and 86.4% were concerned that no meat inspection was carried out. The one factor of least concern was the inadequate availability of hot water (70.4%).

On aspects of concern regarding health risks associated with beef (Table 2), the responses of consumers (n=81) between the different sub-districts did not differ

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(p>0.05) for any of the questions with the exception of: (1) the receiving and handling of bovine meat in a butchery / processing plant that was not approved for human consumption (79.4%; $\chi^2_{(df=2)}$ =16.696, p=0.033) and (2) the presence / absence of hormones and growth stimulants (29.4%; $\chi^2_{(df=2)}$ =20.584, p=0.008). Consumers' attitudes towards food safety and their concern may vary widely and therefore, a high standard deviation (σ) can be expected.

Most consumers (>60%) were concerned about the absence or presence of physical contaminants in meat from processing equipment and utensils (81%; σ=16.70), wrapping material that can lead to choking (81.9%; σ=21.7), receiving and handling of bovine meat in a facility that was not approved for human consumption (79.4%; σ=28.2), foreign material from animal origin (78.6%; σ=23.0), toxic substances in feed from microbial actions (74.8%; σ=32.03), the level of fat and the related hazard of high cholesterol (62.5%; σ=41.9), colorants in processed products (61.7%; σ=34.6), zoonotic diseases (60.5%; σ=26.1) and bone splinters as a result of shooting damage and processing (60.1%; σ=36.5).

Interestingly, consumers were less concerned (<60%) about the presence of bullet particles in the meat as a result of shooting (57.8%; σ=34.5), internal parasites in meat (49.2%; σ=42.0), the use of genetically modified feeds (47.7%; σ=40.2), cleaning chemical residues (46.8%; σ=38.9), pesticides from contaminated feed (45.9%; σ=40.2), antibiotics (44.8%; σ=40.2), hormones and growth stimulants and preservatives in processed products (25.2%; σ=34.6).

During the slaughter of animals, meat could be contaminated by linked processes. This is especially prominent at uncontrolled slaughter facilities, poor slaughter practices, slaughter without water for cleaning and sanitation of facilities, poor hygiene application, slaughter at areas that are exposed to environmental imputers (no walls and roofs) and use of contaminated equipment during slaughter. When consumers are less cautious about these mentioned aspects, unsafe meat may be made available to an unsuspecting public. A large proportion of the consumers were aware that meat must be inspected by a meat inspector prior to distribution. However, because Bushbuckridge does not have any registered abattoirs, meat inspection was not conducted and, therefore, could not be the basis of discarding meat ordinarily seen as the norm in formal supply chains [5]. The absence of meat inspection at informal slaughter facilities increases the possibility of consumers being exposed to various zoonotic diseases. Not only is the lack of meat inspection during slaughter a cause for concern, but also the lack of hygiene application and compliance to other requirements such as structural compliances, and cross contamination that may play a role in increasing the risk of microorganism proliferation.

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Consumer awareness of meat hygiene and safety issues

The level of consumer awareness regarding meat hygiene and safety issues often influences consumer choices. Consumers' (n=81) awareness levels regarding aspects associated with meat hygiene and safety are presented in Figure 3. As pertaining to the legislative aspects of meat safety control and assurance on meat sources as well as meat outlets, it was evident that consumers' knowledge and awareness of relevant legislations remained below 53%. These included South African meat related legislations, Animals Diseases Act (40.7%), Meat Safety Act (42%) and Foodstuffs, Cosmetics and Disinfectants Act (52.5%). Interestingly most consumers were aware that; meat must be inspected before being sold to the public (69.1%), that environmental health practitioners (EHPs) inspect registered meat outlets (67.9%), that slaughter animals are often shot with a rifle, pistol or revolver (60.5%).

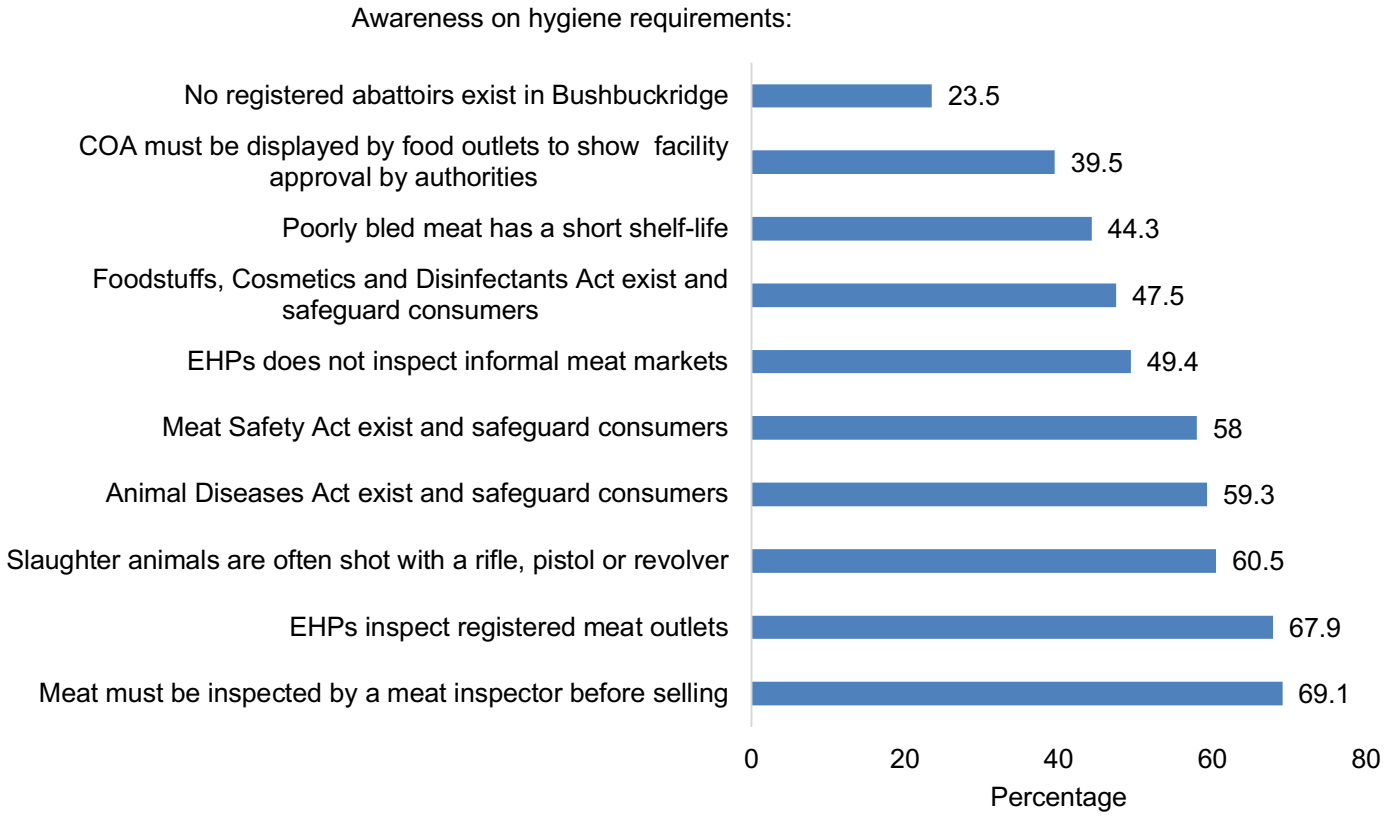

Figure 3: Consumer awareness on meat safety practices

Notes on Figure 3:

- COA refers to a Certificate of Acceptability that is issued by the health department of the Bushbuckridge Local Municipality as proof that the facility (excluding abattoirs) complies with the requirements of Regulation 631 of 2018 promulgated under the Foodstuffs, Cosmetics and Disinfectants Act of South Africa
- EHP refers to an Environmental Health Practitioner registered under the Health Professions Act 56 of 1974 (of South Africa) and who is in the service of District Municipal Health or Veterinary Service at Provincial Level

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On the contrary, consumers were not aware that EHPs do not inspect informal meat markets (49.4%), that the Foodstuffs, Cosmetics and Disinfectants Act exists and safeguards consumers (47.5%), that poorly bled meat has a short shelf-life (44.3%) and that all meat handling facilities must be issued with a Certificate of Acceptability (COA) and this certificate must be displayed by all facilities (39.5%). Significant to this study is that n=81 (76.5%) of consumers were not aware of the compliance registration status of meat slaughter facilities at the study area. Figure 4 suggests the possible *scenario* in a situation where livestock movement is restricted. This figure highlights the need to develop policies that control the slaughter of animals for meat purposes. These policies must be adopted and endorsed by communities that exist within the veterinary disease-controlled zones (Figures 1 and 2).

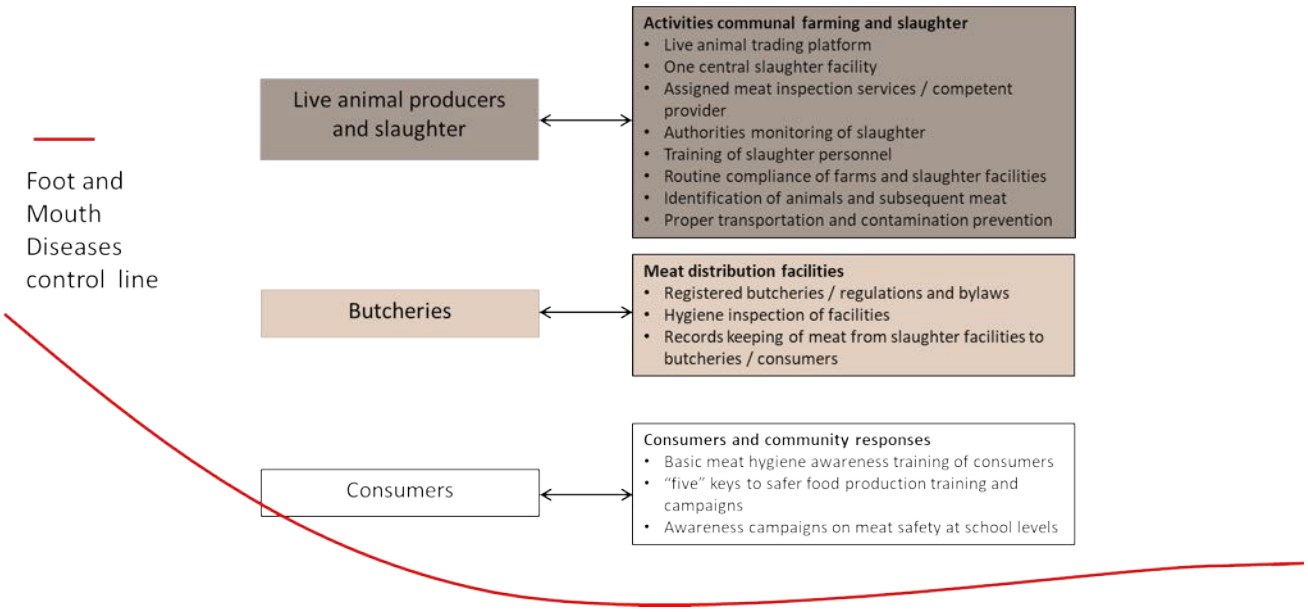

Figure 4: Suggested animal slaughter for meat provisions at areas of veterinary diseases control

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

In veterinary disease-controlled areas, the movement of cloven hoof animals to slaughter facilities and the provisions of safer meat must always be monitored. As part of these monitoring plans, a number of actions that can be taken by authorities and subsequent consumers to prevent the scourge of meat safety risks and related hazards include the registration and compliance assurances of all slaughter facilities, assurances that all animals are slaughtered in a humane manner and that meat inspection is provided. The responsibility to ensure reduced meat hazards should also be passed onto the consumers. Governments and meat safety

agencies must also provide consumers with enough knowledge and awareness on important aspects of meat safety assurance. This will not only facilitate knowledge transfer but will also ensure that other meat safety threats are eliminated by consumers. These actions are designed to ensure a safer final product and contamination prevention at consumer level. While these actions are basic and could be applicable throughout the various processes of meat production, most of these actions are knowledge and information distribution linked. To ensure better consumer information flow and good utilization of such information, targeted responses such as slaughter policy development, adherence to guidelines, training and meat safety consumer awareness must be implemented. This must be added to the role and benefits of five keys to safer food handling practices at consumer levels and the one health principle application at community level. It is important to note that these measures are in nature designed to reduce the number of food-borne illnesses or contamination and should be more strongly emphasised at areas where less compliance of food facilities to regulations is observed. In turn, authorities can thus focus on other intervention strategies as building blocks of meat safety control during and throughout specific points of the meat supply chain.

Ethics statement

The Tshwane University of Technology (TUT), Faculty of Science Committee for Research Ethics granted ethical approval (Reference number REC2012/07/003).

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AUTHORS' CONTRIBUTIONS

DVN conducted the research as part of his Master's degree programme in Environmental Health. This study was supervised by JLB and LCH. All authors commented on early and final versions of the manuscript

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Availability of data

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Competing interests

The authors declare that there is no conflict of interest

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Table 1: Comparison of consumer, beliefs and practices regarding meat at central Bushbuckridge

STATEMENTS	Agincourt n=10 Mean%	Rolle n=38 Mean%	Orinoco n=33 Mean%	Total mean% in agreement	σ	$^{1}\chi^{2}_{(df=2)}$	P-values
I believe that beef is an important element of my diet	82.5	83.5	82.1	82.7	29.4	2.513	0.961
I believe that beef can form an important part of my total meat consumption	65.0	61.8	62.5	63.1	42.3	6.529	0.769
I regularly eat beef when I am with friends or guests	68.7	70.4	72.3	70.5	39.7	3.572	0.894
I do not have a problem with the illegal slaughter of cattle outside an approved abattoir	90.0	77.3	68.6	78.6	40.1	3.872	0.694
Before I purchase beef, I would like to know how the meat was produced on the farm of origin	52.5	53.3	48.5	51.4	46.9	4.161	0.842
Before I purchase beef, I would like to know how the animals were slaughtered and the meat processed	47.5	31.9	32.2	37.2	40.1	1.674	0.947
If and when I eat beef slaughtered informally it will be because:							
It tastes great	87.5	81.9	84.5	84.6	29.4	5.907	0.823
It is readily available throughout the year	60.0	57.6	58.7	58.8	35.4	4.012	0.947
It is nutritious	60.0	54.3	61.4	58.6	32.6	2.667	0.988
I believe that the slaughtering of cattle is done in a humane manner	58.8	60.2	50.7	56.6	42.5	7.403	0.687

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STATEMENTS	Agincourt n=10 Mean%	Rolle n=38 Mean%	Orinoco n=33 Mean%	Total mean% in agreement	σ	$^{1}\chi^{2}_{(df=2)}$	P-values
I believe that the beef is free of hormones and antibiotics	56.3	60.5	50.7	55.8	42.0	2.560	0.862
It is part of Bushbuckridge's tradition	57.5	55.9	49.2	54.2	42.2	2.862	0.826
It is cheap for what it offers	36.3	39.1	41.7	39.0	34.2	3.108	0.979
If and when I purchase frozen meat. I always ensure that the meat was properly frozen	86.2	82.9	83.3	84.1	8.3	5.515	0.068
I will normally allow frozen meat to thaw totally before cooking it	73.7	82.6	73.5	76.6	18.9	5.031	0.284
On consuming leftover meat at a later stage, I will normally reheat it prior to consumption	41.2	69.1	53.8	54.7	36.1	10.374	0.110
When cooking meat, I will normally ensure that the meat is ready for consumption just in time for the meal	51.2	47.0	37.1	45.1	38.9	4.100	0.663
I will normally allow frozen meat to thaw in the fridge	31.2	53.9	35.6	40.2	46.7	9.786	0.134
If there is meat left over after a meal, I normally keep it in the fridge	33.7	50.0	34.1	39.2	41.5	4.378	0.357
If any leftover meat from the reheated meat, I will normally discard of it as it was already reheated once	37.5	33.9	37.5	36.3	32.0	11.868	0.157
When reheating meat, I will normally heat all of the meat and then dish out the amount that I want to consume	35.0	33.9	34.1	34.3	31.4	1.350	0.853

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STATEMENTS	Agincourt n=10 Mean%	Rolle n=38 Mean%	Orinoco n=33 Mean%	Total mean% in agreement	σ	$^1\chi^2_{(df=2)}$	P-values
I normally check the temperature that the meat I cook is cooked at	50.0	17.1	33.3	33.4	34.8	10.275	0.114
If and when I purchase meat, I always transport in it a cooler bag from the point of purchase to my house	35.0	36.6	24.2	31.9	44.9	12.381	0.054

$^1\chi^2$= Chi Square test for equal proportions
σ= standard deviation
P= probability value significant at P<0.05

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Table 2: Extent of consumer (n=81) concerns about health risks associated with beef

HAZARDS IN MEAT Indicate the extent to which you are concerned about the:	Agincourt n=10 Mean%	Rolle n=38 Mean%	Orinoco n=33 Mean%	Total mean% in agreement	σ	$^{1}\chi^{2}_{(df=2)}$	P-values
Presence / absence of physical matter e.g. metal / plastic from processing equipment and utensils	75.0	83.9	84.1	81.0	16.7	4.258	0.642
Presence of transparent (non-visible) wrapping material that can lead to choking	80.0	83.2	82.6	81.9	21.7	2.028	0.917
The receiving and handling of bovine meat in a butchery / processing plant that was not approved for human consumption	67.5	83.6	87.1	79.4	28.2	16.696	0.033
Presence / absence of foreign material from animal origin e.g., hair	75.0	80.9	79.9	78.6	23.0	3.537	0.739
Presence / absence of toxic substances produced by certain organisms in the feed and absorbed into the meat	62.5	73.0	89.0	74.8	32.0	19.496	0.147

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HAZARDS IN MEAT Indicate the extent to which you are concerned about the:	Agincourt n=10 Mean%	Rolle n=38 Mean%	Orinoco n=33 Mean%	Total mean% in agreement	σ	$^{1}\chi^{2}_{(df=2)}$	P-values
The absorption of lead from the bullet particles during the cooking process	85.0	68.4	72.3	75.2	28.4	13.978	0.600
The level of fat and related hazard of high cholesterol	43.7	70.7	73.2	62.5	41.9	12.639	0.125
Presence / absence of colorants in processed products e.g., Vienna's	56.3	61.5	67.4	61.7	34.6	15.160	0.367
Presence / absence of animal diseases that can be transferred to the consumer	52.5	60.2	71.2	60.5	26.1	2.618	0.627
Presence / absence of bone splinters as a result of shooting damage and processing	58.7	59.9	61.7	60.1	36.5	8.172	0.772
Presence / absence of internal parasites	30.0	50.3	67.4	49.2	42.0	20.124	0.065
Feeding of cattle with genetically modified crop	47.5	48.7	46.9	47.7	40.2	2.618	0.624
Presence / absence of cleaning chemical residues	46.3	47.4	46.6	46.8	38.9	9.414	0.493

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HAZARDS IN MEAT Indicate the extent to which you are concerned about the:	Agincourt n=10 Mean%	Rolle n=38 Mean%	Orinoco n=33 Mean%	Total mean% in agreement	σ	$^1\chi^2_{(df=2)}$	P-values
Presence / absence of pesticide absorbed from contaminated feed	35.0	46.7	56.1	45.9	40.2	8.997	0.532
Presence / absence of antibiotics	31.3	39.8	63.3	44.8	43.6	13.792	0.087
Presence / absence of hormones and growth stimulants	12.5	22.0	53. 8	29.4	40.3	20.584	0.008
Presence / absence of preservatives in processed products e.g., wors (sausages)	16.3	25.7	33.7	25.2	34.6	7.169	0.519

$^1\chi^2$ = Chi Square test for equal proportions
σ= standard deviation
P= probability value significant at P<0.05

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