Full Length Research Paper

Compliance with food safety standards by beef vendors at butcheries in Kamuli district, Uganda

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Butcheries are the leading retailers of beef in Uganda and their level of compliance with food safety standards is unknown. The aim of this study was to determine the compliance by beef vendors in Kamuli district with the US 736:2019 standard for hygienic requirements for butcheries. A survey questionnaire and observation checklist on sanitation, hygiene, and beef handling were used to collect data from 60 butcheries. More than 75% of beef vendors complied with the inspection, storage, and some sanitation and hygiene requirements, however, many violated the transportation and construction requirements. Self-reported surveys revealed that 96.7% of vendors sold inspected beef, 83.3% of butchery facilities were inspected at least once a month and all vendors stored beef for less than 36 hours. Beef vendors (76.7%) reported washing beef handling tools with water and soap whereas 96.7% cleaned butcheries every day. Sixty percent (60%) of vendors transported beef using motorcycles, and 23.3% used tricycles. All beef vendors observed had short hair, short fingernails, and did not wear jewelry. Only 15% of vendors wore protective clothing when handling beef. Butcheries had wooden walls (71.7%), and their floors were either wooden or bare ground (65%). This study demonstrated a need for food safety interventions to emphasize sanitation and personal hygiene practices, safe transportation of beef, and the hygienic construction of butchery facilities.

Key words: Beef butcheries, compliance, food safety, beef handling.

INTRODUCTION

Beef is the number one meat consumed in Uganda and Kamuli district (Agriterra, 2012; Ikendi, 2019). The demand

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For beef in Uganda is likely to increase due to the rapidly growing population estimated at an annual growth rate of 3.3% (World Population Review, 2022). Roadside and market stall butcheries are the main retailers of raw beef to consumers at both household level and retail food establishments, contributing 75 to 80% of sales in the industry (Agriterra, 2012). Despite its high nutritional value, beef in Uganda has been reported to be contaminated with pathogenic microorganisms (Bogere and Baluka, 2014; Lujujimbwa et al., 2022). Recently, beef has been implicated in gastrointestinal anthrax outbreaks in Uganda (Nakanwagi et al., 2020; Musewa et al., 2022). Beef vendors at butcheries must protect raw beef from contamination before it is sold to the final consumer for further handling, processing, and cooking.

In order to protect public health, the Uganda National Bureau of Standards (UNBS) and the Ministry of Agriculture Animal Industry and Fisheries (MAAIF) have provided hygiene requirements for butcheries in the standard US 736:2019, released in 2019 (UNBS, 2019). This standard provides requirements before opening a butchery, requirements for construction, equipment, operation, personal hygiene, storage of meat, inspection of meat and butcheries, and requirements for transportation of meat. The standard requires personnel operating butcheries to be trained in food and personal hygiene practices before starting to work and to understand the hygiene and safety requirements. Compliance with food safety requirements is important for protecting the public from foodborne illnesses. Compliance is in part fostered through using a collaborative approach when conducting inspections, whereby food business operators form partnerships with inspectors and work with them to learn about best practices and solve food safety issues at their facilities (Buckley, 2015). Additionally, compliance can be encouraged by designing educational interventions that identify and address barriers experienced by food business operators (Chen et al., 2021).

According to the population census of 2014, 18.6% of the populations in Kamuli district were children under the age of four years (UBOS, 2017). Children in this age group, especially after six months are susceptible to foodborne illnesses, since their immune systems are not yet fully developed (CDC, 2022) to fight against pathogens that may be introduced through ingesting foods other than breast milk. Diarrhoea is one of the common signs of foodborne illness and can lead to dehydration and death among children below five years (Talbert et al., 2019). Busoga region, where Kamuli district is located, had the second highest prevalence of diarrhoea according to the Uganda Demographic and Health Survey of 2016 (UBOS and ICF, 2018). Nabongo et al. (2014) also reported that diarrhoea is the third leading cause of death among children below five years in this region.

Improper handling of highly perishable foods such as beef can lead to cross contamination of ready-to-eat foods and food contact surfaces and can contribute to these diarrhoea related diseases and death. Although in Uganda beef is typically cooked before consumption (Asada, 2019), it is important that vendors sell raw beef with the lowest microbial load possible to minimize subsequent contamination with other food contact surfaces during preparation by consumers at home. The aim of this study was to determine if beef vendors in Kamuli district follow the hygienic requirements set out in Uganda Standards for butcheries (US 736:2019) and to identify services available to support vendors to meet the requirements.

**MATERIALS AND METHODS**

This cross-sectional study was conducted in the Kamuli district in Uganda from October to December of 2021, following approval from Iowa State University’s Institutional Review Board (IRB ID - 21-125), and the Makerere University School of Social Sciences Research Ethics Committee (MUSSS-2021-87).

**Survey questionnaire development**

A survey questionnaire and observation checklist was used to collect data in this study. The survey questionnaire and observation checklist designed to reflect the minimum hygiene requirements for butcheries in the standard US 736:2019, included both multiple choice questions and open-ended questions, and adopted and modified questions from previous studies by Mirembe et al. (2015) and Chepkemoi et al. (2015). A draft of the survey questionnaire and observation checklist was evaluated for content validity by six food safety experts at Iowa State University and Makerere University. Experts evaluated whether the different aspects of the standard US 736:2019 were represented in the questionnaire and observation checklist and provided feedback on the organization of the different sections in the questionnaire. A revised questionnaire and observation checklist were piloted with six beef butcheries in Butansi sub-county in Kamuli district to verify that content was easy to understand and to determine if both the face-to-face interviews and observations could be completed within one hour or less. Vendors who participated in the pilot test were not recruited in the research study and their data was not used in generating the results presented in this paper. The final survey questionnaire had a total of 29 questions, categorized into five sections which were butchery operation-related questions (10), sanitation (five questions), personal hygiene (four questions), storage practices (two questions), and demographics (eight questions). The observation checklist covered construction, hygiene, sanitation of personnel and surroundings at the butchery.

**Participants and inclusion criteria**

Researchers contacted personnel at the Kamuli district’s Veterinary and Public Health departments, and two people (one from each department) consented to participate in the study. These individuals are involved in ensuring that beef sold at butcheries is safe for human consumption.

Sixty-two vendors at beef butcheries operating at the time of this study were contacted, and 60 (96.8%) were allowed to participate in the study. These vendors’ butcheries were located in Kamuli district, with 48 (80%) in Kamuli town and 12 in Butansi sub-county.
Municipal Council, and in five out of 12 rural sub-counties which included Namasagali, Balawoli, Namwendwa, Bugulumbya and Nawanyago. The rural sub-counties and municipal council were from all three counties (Bugabula County North, Bugabula County South, and Buzzaaya County) of Kamuli district.

Only adults of 18 years and above who sold raw beef in Kamuli district were allowed to participate in the study. Participants were given a consent form with information about the study or verbally given the same information in Lusoga language (for vendors), and only those who agreed to participate were interviewed. According to the IRB requirements, participants were informed about their freedom to stop participation at any time and to skip any questions they did not want to answer.

Survey questionnaire administration

For beef vendors, the survey questionnaire and observation checklist were administered on the same day and by the same researcher to ensure the consistency of administration of the survey tool. Face-to-face interviews were conducted in the local Lusoga language to help minimize misinterpretation of questions and to allow respondents who were unable to read or write in English to participate in the study. Interviews were conducted on the butchery premises to allow for observations to be taken with permission from the respondent.

In-depth interviews with personnel from the Veterinary and Public Health departments of Kamuli district were conducted on their office premises and guided by pre-developed questions about services available to assist beef vendors to comply with food safety requirements. In-depth interviews were conducted in English and audio-recorded with permission from the respondent.

Data analysis

Data from surveys and observation checklists were entered into Microsoft Excel and exported to JMP Pro, version 16 statistical software for analysis. Descriptive statistics of percentages and frequencies were calculated. Responses to open-ended questions were content-analyzed for common themes. Vendors’ beef handling practices were compared to the requirements in the standard US 736:2019, and any gaps where vendors did not comply with the standard were identified. Audio-recorded in-depth interviews were transcribed into Microsoft Word, and information about services available to assist beef vendors in complying with food safety requirements was color-coded in Microsoft Word and extracted. It should be noted that the limited number of food safety personnel (n = 2) who participated and the lack of representation from the Ministry of Agriculture, Animal Industry and Fisheries may negatively impact some of the results discussed in this paper.

RESULTS AND DISCUSSION

Supportive services to beef vendors in complying with requirements.

The in-depth interviews showed that the Department of Public Health and the Veterinary Department of the Kamuli district work together to provide various services to support beef vendors within the district and to ensure that beef sold to the general public is safe for human consumption. Table 1 shows the services provided to beef vendors.

The services provided either directly or indirectly promote beef vendors’ compliance with food safety requirements of the standard US 736:2019. Although a number of services were provided, personnel participating in in-depth interviews noted that hygienic packaging and transportation of beef from the slaughterhouse to the butchery was still a challenge. Personnel also added that slaughter facilities were not enough during festive seasons, so some animals were slaughtered in open fields, exposing beef carcasses to environmental contamination.

Government inspection of small food facilities is key in ensuring compliance with food safety standards, as it gives inspectors an opportunity to build relationships with facility operators, and learn the challenges experienced while trying to follow requirements and provides a platform for inspectors to share information about best practices to minimize food contamination (Buckley, 2015). Barnes et al. (2022) also added that inspection encourages positive behavioral change both when interacting with business operators and when results from inspections are disclosed to the public. Food safety inspectors are better prepared for their job when they are trained, and their proficiency increases with experience (Barnes et al., 2022). This present study did not inquire about inspectors’ training or experience and did not obtain details about the results of butchery inspections.

Demographic characteristics of beef vendors

A total of sixty beef vendors from Kamuli Municipal council, and five rural sub-counties participated in this study. All beef vendors (100%) were male with 71.2% being Muslims. A majority of the beef vendors (40.7%) were between 18 and 30 years of age. The most commonly spoken language (98.3%) by the beef vendors was Lusoga. Almost sixty-four percent (63.8%) had completed primary education and above with highest level being Uganda Certificate of Education (UCE). Beef vendors (49.2%) had experience running a beef butchery business for greater than 10 years. Table 2 shows demographic characteristics of beef vendors in this study.

The beef butchering business in Kamuli district is dominated by men, like other butcheries in other parts of Uganda (Mirembe et al., 2015; Heilmann et al., 2015; Jeffer et al., 2021), Ethiopia (Zerabruk et al., 2019), Nigeria (Alimi et al., 2022), and Ghana (Adzitey et al., 2020). The level of education among beef vendors in this present study is similar to that reported by Zerabruk et al. (2019) and Tegegne and Phyo (2017) among Ethiopian butchers whereby a majority (85 and 52.7%) had studied up to an elementary level. Lamunu et al. (2022) also reported that 50.7% of beef vendors in Wakiso district in Uganda had not studied beyond the primary level. In this present study, the vendors’ level of education is lower compared to that reported by Mirembe et al. (2015) and
Table 1. Supportive services to beef vendors in Kamuli district.

<table>
<thead>
<tr>
<th>Service</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movement permits</td>
<td>These permits are required for inter-district movement of animals and are issued following examination of animals by the veterinary officer. Movement permits contain information about the owner of the animal, the district where the animal is departing from, and the district where the animal is to be taken. This ensures that only healthy animals are transported between districts and minimizes spread of diseases</td>
</tr>
<tr>
<td>Issue licenses</td>
<td>Licenses allow vendors to open and operate butcheries. When issuing licenses, beef vendors are informed about the hygiene and health requirements and are told what facilities they must have at their butchery.</td>
</tr>
<tr>
<td>Slaughter facilities</td>
<td>These facilities include roofed and enclosed slaughterhouses, open slaughter slabs, and open shades. Management provides clean water to use at the slaughter facilities. During festive seasons, temporary locations are designated to meet the additional demand for slaughtering more animals</td>
</tr>
<tr>
<td>Inspection of beef at the slaughterhouse</td>
<td>At the slaughterhouse, veterinary officers inspect animals before and after slaughter to ensure that the beef to be distributed will not compromise the health of consumers or that of other animals within the community. Beef that passes postmortem inspection is stamped as a sign to distinguish it from any beef that is not inspected in the market. Beef that does not pass postmortem inspection is condemned and discarded. Personnel must also ensure that beef from the slaughterhouse is packaged and transported with minimal contamination.</td>
</tr>
<tr>
<td>Inspection of butcheries</td>
<td>Inspection at butcheries involves monitoring the health and hygiene of beef vendors, sanitation of butchery premises, and verifying that beef sold was inspected and stored properly for not more than two days. Inspectors also check whether beef vendors wear protective gear including an overcoat and gumboots or closed-toe shoes. Through inspection, inspectors also respond to calls from the public about potentially suspicious beef at butcheries.</td>
</tr>
<tr>
<td>Medical forms showing vendors’ health status</td>
<td>Beef vendors are tested by health professionals at the district hospital to confirm that they are free from communicable diseases. Beef vendors must have the medical form during inspections, and the form must be renewed every six months. Occasionally, the management at the slaughterhouses demands that beef vendors present their medical forms before they receive any beef.</td>
</tr>
<tr>
<td>Capacity building</td>
<td>Occasionally, Kamuli district works together with non-government organizations to organize workshops that empower the butchery community. The respondent gave an example that in 2021 Kamuli district co-organized a workshop with the International Livestock Research Institute (ILIRI). This workshop was focused on preventing tapeworms and was attended by several stakeholders including veterinary officers, public health officers, extension agents, and beef handlers from slaughterhouses and butcheries in Kamuli district. Inspectors also remind beef vendors about safe beef handling practices during inspections.</td>
</tr>
</tbody>
</table>

Extracted from in-depth interviews with personnel from the Public Health (n = 1) and Veterinary (n = 1) departments.

Kunyanga et al. (2021) in Kampala and Kenya, where 57.5 and 60% of butchers, respectively, had obtained secondary education or higher. The low level of education among beef vendors in Kamuli district could be one of the hindering factors for vendors to comply with the requirements. Food safety educators should consider the simplification and translation of food safety standards to languages understood by vendors. Additionally, pictorial presentation of the standard and culturally appropriate visuals with minimal text about safe beef handling practices can be utilized during training to support compliance by the beef vendors (Nabwire et al., 2022).

The beef butchering business in Kamuli district is fairly stable, with 49.2% of vendors having been in business for greater than 10 years. Similarly, Kunyanga et al. (2021) in Kenya, and Alimi et al. (2022) in Nigeria reported that 54%, and 67.6% of meat handlers in their studies had greater than 10 years of experience in the meat butchering business, respectively. Food safety educators should use strategies that encourage all beef vendors to use safe meat handling practices regardless of their level of experience in the butchering business. Additionally, refresher training can be incorporated into food safety training programs to reinforce food safety practices among returning beef vendors (McFarland et al., 2019) and the train-the-trainer model leveraging vendors’ experience in using safe practices can be adopted in the future (Warner et al., 2014).

Youth and Muslims dominate the beef butchery business in Kamuli district as in Wakiso district, where
Table 2. Demographic characteristics of beef vendors at butcheries in Kamuli district.

<table>
<thead>
<tr>
<th>Demographic variable</th>
<th>Number of respondents (n)</th>
<th>Percentage of respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender (n = 60)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Female</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Age (n = 59)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-30</td>
<td>24</td>
<td>40.7</td>
</tr>
<tr>
<td>31-40</td>
<td>20</td>
<td>33.9</td>
</tr>
<tr>
<td>41-50</td>
<td>11</td>
<td>18.6</td>
</tr>
<tr>
<td>51 and above</td>
<td>4</td>
<td>6.8</td>
</tr>
<tr>
<td><strong>Language (n = 59)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lusoga</td>
<td>58</td>
<td>98.3</td>
</tr>
<tr>
<td>Luganda</td>
<td>1</td>
<td>1.7</td>
</tr>
<tr>
<td>English</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Religion (n = 59)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muslim</td>
<td>42</td>
<td>71.2</td>
</tr>
<tr>
<td>Christian</td>
<td>17</td>
<td>28.8</td>
</tr>
<tr>
<td><strong>Level of education (n = 58)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not go to school</td>
<td>3</td>
<td>5.2</td>
</tr>
<tr>
<td>Below primary seven</td>
<td>18</td>
<td>31</td>
</tr>
<tr>
<td>Primary seven</td>
<td>15</td>
<td>25.9</td>
</tr>
<tr>
<td>Some ordinary level classes</td>
<td>10</td>
<td>17.2</td>
</tr>
<tr>
<td>Senior four – UCE</td>
<td>12</td>
<td>20.7</td>
</tr>
<tr>
<td><strong>Years in butchering business (n = 59)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 1 year</td>
<td>2</td>
<td>3.4</td>
</tr>
<tr>
<td>1.5 to 5 years</td>
<td>17</td>
<td>28.8</td>
</tr>
<tr>
<td>6 to 10 years</td>
<td>11</td>
<td>18.6</td>
</tr>
<tr>
<td>Greater than 10 years</td>
<td>29</td>
<td>49.2</td>
</tr>
</tbody>
</table>

*October to December, 2021; participants included persons who were 18 years or older involved in selling raw beef in Kamuli district in Uganda.

55.2% of butchers were between 18 and 35 years of age, and 61.2% were Muslims (Lamunu et al., 2022).

**Beef vendors’ compliance with hygienic requirements for butcheries**

In this study, beef vendors complied with some requirements in the US 736:2019 standard while violating others. Table 3 shows the percentage of beef vendors complying with or violating different requirements in the standard.

**Meat and meat products sold at butcheries**

Eighteen percent (n = 11) of vendors sold only beef, whereas the remaining sold beef and meat from other species, including goat (57%, n = 34), turkey (1.7%, n = 1), and sheep (1.7%, n = 1). No vendor sold pork probably because the highest percentage (71.2%) of vendors identified as Muslim. In addition to selling different meat types, 80% (n = 48) of vendors sold offals including bovine or goat intestines, liver, or lungs. Twenty percent of vendors (n = 12) also sold heads and legs of goats and cattle at their butcheries. Vendors separated offals from skeletal muscle meat using separate sisal ropes (50%, n = 24 of 48), separate metallic hooks (18.8%; n = 9), leaving space between meat and offals placed on the same table (14.6%; n = 7), using separate tables (10.4%; n = 5), displaying meat and offals in different shades (4.2%; n = 2), and putting the offals in a separate plastic bucket (2.1%; n = 1). In this study, although beef vendors endeavoured to separate offals from muscle meat, the practice of using ropes and spacing meat and offals on the same table as reported at 64.6% of butcheries, may lead to cross-contamination if surfaces are not thoroughly cleaned and sanitized between uses (Fasanmi et al., 2010; Kirchner et al., 2021). The results of this study are similar to those reported by Bogere and Baluka (2014) and Jeffer et al.
Table 3. Percentage of beef vendors (%) complying with or violating different hygiene requirements of the standard (US 736:2019) at butcheries in Kamuli district.

<table>
<thead>
<tr>
<th>Category used for research purposes</th>
<th>Section in Standard US 736: 2019 (UNBS, 2019)</th>
<th>Number of vendors</th>
<th>Percentage of vendors complying with requirements</th>
<th>Percentage of vendors violating or using inadequate practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products sold at butcheries</td>
<td>Section 5.3: Meat vendors must construct a separate area dedicated to handling offals.</td>
<td>48&lt;sup&gt;a&lt;/sup&gt;</td>
<td>35.4</td>
<td>64.6</td>
</tr>
<tr>
<td>Source of beef carcass and inspection of meat and butcheries</td>
<td>Section 10.3: All meat sold at butcheries must be slaughtered from an approved abattoir.</td>
<td>60</td>
<td>95</td>
<td>13*</td>
</tr>
<tr>
<td></td>
<td>Section 10.1 and 12: All meat sold at butcheries must be inspected and declared fit for human consumption by an authorized meat inspector.</td>
<td>60</td>
<td>96.7</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>Section 12.1: Butcheries must be inspected by an authorized inspector.</td>
<td>60</td>
<td>98.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Packaging and transportation of beef</td>
<td>Section 11: Beef vendors must transport meat to butcheries using a clean closed vehicle or container that has smooth surfaces made of non-absorbent material for easy cleaning. The packaging container used must protect meat from flies and dust during transportation</td>
<td>60</td>
<td>16.7</td>
<td>83.3</td>
</tr>
<tr>
<td>Displaying meat at butcheries</td>
<td>Section 7.1: Meat at butcheries must be suspended using metallic hooks that can be washed without corrosion.</td>
<td>60</td>
<td>51.7</td>
<td>76.7*</td>
</tr>
<tr>
<td>Storage of meat at butcheries</td>
<td>Section 9: In absence of cold storage services, meat can be stored by hanging to allow aeration around it for a maximum of 36 hours.</td>
<td>59</td>
<td>98.3</td>
<td>5.1*</td>
</tr>
<tr>
<td>Cleaning meat handling tools</td>
<td>Section 6: Vendors must clean all tools used for handling meat at butcheries.</td>
<td>60</td>
<td>76.7</td>
<td>23.3</td>
</tr>
<tr>
<td>Cleaning of butchery premises</td>
<td>Section 7.5: Vendors must remove waste from butcheries and dispose it of daily.</td>
<td>60</td>
<td>96.7</td>
<td>3.3</td>
</tr>
<tr>
<td>Construction materials for floors and walls of butcheries</td>
<td>Sections 5.6: Butchery walls must be constructed with cleanable, and non-absorbent materials.</td>
<td>60</td>
<td>8.3</td>
<td>96.7*</td>
</tr>
<tr>
<td></td>
<td>Sections 5.7: Butchery floors must be constructed with cleanable, and non-absorbent materials.</td>
<td>60</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>Flies and methods of controlling them</td>
<td>Sections 7.1 and 5.11: Beef vendors must protect meat from flies and must use fly-proof screens at their butcheries.</td>
<td>60</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Section 8.11: Beef vendors must wash hands regularly with clean water and soap, and dry them using disposable towels</td>
<td>60</td>
<td>54</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Sections 8.6, 8.8, 8.7, and 8.13: Beef vendors must not wear jewelry, must have short fingernails, short or covered hair, and must cover injuries on hands if present</td>
<td>60</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>
(2021) where butchers mixed beef with offals. The gastrointestinal tract (GIT) of cattle can harbour many microorganisms including pathogenic strains of *Escherichia coli* (Sapountzis et al., 2020). Mixing meat and offals may lead to cross-contamination with foodborne pathogens. Beef handlers at butcheries should ensure meat/beef and offals are separated from each other to prevent the contents of the GIT from spilling onto muscle meat during the display at the butchery and that the materials or surfaces used to separate them are cleaned and sanitized between batches.

### Source of beef carcass and inspection of beef and butcheries

Ninety-five percent (*n* = 57) of vendors in this study obtained meat and meat products from slaughterhouses, and 13% (*n* = 8) sold meat slaughtered from tree shades or their backyards. Ninety-six percent (*n* = 58) of vendors reported that they sold beef that had been inspected and stamped before transporting it to their butcheries. Eighty-three percent (*n* = 50) of vendors received additional inspection at their butcheries at least once a month, 15% (*n* = 9) were inspected less than five times a year, and one (1.7%) had never been inspected. From the in-depth interviews, personnel from the Veterinary and Public Health departments confirmed providing inspection services at approved slaughterhouses and butchery premises, which enabled 95% of beef vendors in this study to comply with the inspection requirements. Similar to this study, Kyayesimira et al. (2019) reported 100% compliance with antemortem inspections at approved slaughterhouses in Kampala district but only 25% compliance in Mbale and Mbarara districts in Uganda. The percentage of butcheries inspected once a month (83%) in this study is similar to the 71.6% reported by Lamunu et al. (2022) among butchers in Wakiso district in Uganda. However, this percentage (83%) is several times higher than the eight percent of butcheries reported by Jeffer et al. (2021) in Kampala district. Similarly, Adzitey et al. (2020) reported that 70% of meat sellers in Tamale Metropolis of Ghana obtained meat from designated abattoirs and 30% sold meat slaughtered from the backyards.

### Packaging and transportation of beef

In this study, beef vendors used a variety of ways to package and transport beef from slaughterhouses to their butcheries. Before transportation, 50% (*n* = 30) of vendors packaged beef in woven polypropylene bags, 36.7% (*n* = 22) used wooden boxes, 13.3%, (*n* = 8) used cardboard boxes, and 1.7% (*n* = 1) used a plastic bucket. Fourteen beef vendors (23%) reported covering beef with black polythene bags (18.3%), tarpaulin (3.3%), and paper (1.7%). Two vendors (3.3%) tied beef carcasses on tree logs. Twenty-eight (46.7%) of the vendors either hired or shared packaging materials with other butcheries. Ten vendors (17%) reused woven polypropylene bags and polythene bags, washing them between uses and replacing them after two rounds of using them or on a weekly or monthly basis. This practice can result in cross-contamination if the bags are not washed and sanitized properly. To transport beef, 60% (*n* = 36) of vendors used motorcycles, 23.3% (*n* = 14) used tricycles with carrier compartments, 16.7% (*n* = 10) used closed vehicles, seven percent (*n* = 4) used wheelbarrows, 1.7% (*n* = 1) used bicycles, and eight percent (*n* = 5) walked with the beef to their butcheries. Beef vendors (21%, *n* = 13) individually owned the means of transportation whereas 78.3%, (*n* = 47) either hired or shared transportation with neighboring butcheries. In order to observe packaging and transportation of beef, a slaughterhouse in Kampala district was visited during their working hours. It was observed that the wooden box had a metallic lining that had cracks and needed replacing for it to be cleaned.

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*Table 3. Contd.*

<table>
<thead>
<tr>
<th>Category used for research purposes</th>
<th>Section in Standard US 736: 2019 (UNBS, 2019)</th>
<th>Number of vendors</th>
<th>Percentage of vendors complying with requirements</th>
<th>Percentage of vendors violating or using inadequate practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal hygiene</td>
<td>Section 8.5: Beef vendors must wear protective clothing</td>
<td>60</td>
<td>15</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Sections 8.3 and 8.12: Butcheries must have a separate person to handle money</td>
<td>29</td>
<td>42.4</td>
<td>57.6</td>
</tr>
<tr>
<td></td>
<td>Section 8.9: Vendors must not eat food from inside the butchery</td>
<td>29</td>
<td>54.2</td>
<td>57.6*</td>
</tr>
<tr>
<td></td>
<td>Section 8.12: Vendors must not store personal items inside the butchery</td>
<td>29</td>
<td>56.7</td>
<td>43.3</td>
</tr>
</tbody>
</table>

*48 is the number of beef vendors selling offals. *Total percentages are greater than 100 because some vendors provided multiple responses, some of which complied with requirements and others did not.
effectively. During transportation from the slaughterhouse to the butchery, beef carcasses in the wooden box and tricycle were left exposed to the environment and could become contaminated. It was also noticed that the wooden box and the tricycle made more than one trip from the slaughterhouse, delivered beef to at least four butcheries in each trip, and were not cleaned between trips which could lead to cross-contamination between batches. Bogere and Baluka (2014) reported that microbial contamination of meat increased from the slaughterhouse to the butchery. Contamination could come from containers that are not cleaned properly, and from dust and flies that may come in contact with the meat that is not covered during transportation. Jeffer et al. (2021) and Kyayesimira et al. (2019) also reported that polypropylene bags and wooden boxes were common packaging materials used and were shared by butchers in Kampala, Mbale, and Mbarara districts. Additionally, Jeffer et al. (2021) and Kyayesimira et al. (2019) reported that meat was transported using motorcycles at 84.2 and 54% of butcheries respectively. The use of motorcycles to transport beef was also reported among butcheries in Meru (59.8%), Kitui (60.8%), Nairobi (31%) and Isiolo (39%) counties in Kenya (Kunyanga et al., 2021; Chepkemoi et al., 2015). Kunyanga et al. (2021), however, reported that less than 12% of butcheries in Meru, Kitui, and Tharaka Nithi counties in Kenya used wooden boxes to transport beef.

To reduce contamination risks during packaging and transportation of beef in Kamuli district, beef vendors should be educated on the food safety requirements outlined in the standard and emphasis should be put on cleaning and sanitization schedules for transportation and packaging materials used. Single-use, waterproof plastic linings could be placed inside the wooden box and the lining discarded after use. A lid for the wooden box should be designed and used to cover the box during the transportation of beef carcasses. Cleanable plastic bins with lids can be used as primary packaging for beef carcasses transported on tricycles. Persons in charge should not allow any beef not hygienically packaged to exit the slaughterhouse.

**Displaying meat at butcheries**

During the day, beef vendors displayed meat by hanging it inside the butchery using woven sisal ropes (70%), or metallic hooks (51.7%) and placing beef on wooden tables (6.7%), three of which were covered with cardboard boxes. One vendor used a rusted metallic hook, whereas 88% (n = 37 of 42) used visibly dirty ropes to hang beef. Displaying beef by hanging was also observed at nearly all butcheries in Meru, Kitui, and Tharaka Nithi counties in Kenya (Kunyanga et al., 2021), in Kampala, Mbale, and Mbarara districts in Uganda (Kyayesimira et al., 2019), and in Ethiopia (Zerabruk et al., 2019). In contrast to this study’s results, in Ghana, 48% of meat sellers displayed meat by placing it on open tables (Adzitey et al., 2020). In this present study, sisal ropes, which are rough and difficult to clean, were the most common item used to hang beef and other meat products. The practice of using ropes to hang/display beef at the butchery should be avoided since they cannot be cleaned properly and can lead to contamination of the beef. Non-degrading metallic hooks as recommended by the standard should be encouraged for displaying beef at butcheries, as they may be cleaned more effectively. Vendors should also be informed about the tenderization benefits of hanging raw beef as opposed to placing it on tables (Ramanathan et al., 2020).

**Storage of beef at butcheries**

Storage conditions and storage time are critical when handling raw meat. Only 10.2% (n = 6) of beef vendors in this study reported selling out all beef on the same day it is brought to the butchery. Eighty-eight percent (n = 53) of beef vendors occasionally took up to two days (from the morning of the first day to the afternoon of the second day) to sell all the beef. When beef remains at the end of the first day, 67.9% (n = 36) of beef vendors indicated leaving the beef hanging inside the butchery overnight, 26.4% (n = 14) stored it in a refrigerator, 5.7% (n = 3) covered it in a cardboard box inside the butchery, and 3.8% (n = 2) either gave it out or took it home to feed their family. Although all beef vendors complied with the storage requirement because they had beef at the butchery for less than 36 hours and hung it during storage, the beef can accumulate foodborne pathogens (Bogere and Baluka, 2014) which can cause consumers foodborne illnesses. In this study, the percentage of vendors holding meat at their butchery for more than one day was more than twice the 34.2% reported by Jeffer et al. (2021) among butcheries in Kampala district. Kampala district (N = 1,507,080) has three times the population of Kamuli district (N = 486,319) (UBOS, 2016) and so beef vendors in Kampala can sell higher quantities of beef within the same amount of time since the demand is higher. Jeffer et al. (2021) and Mirembe et al. (2015) also report that 78 and 65.8% of butchers respectively stored leftover beef by hanging it inside their butcheries. Hanging meat is used as a storage method at 82.8 and 46.5% of butcheries in Nairobi and Isiolo counties in Kenya (Chepkemoi et al., 2015) respectively. On the contrary, all butcheries in Kasama district in Zambia used deep freezers or walk-in cold rooms to store meat until it was all sold (Hanyinza et al., 2020). Adzitey et al. (2020) also reported that all meat sellers in Tamale Metropolis of Ghana stored leftover meat in a refrigerator. Beef vendors in Kamuli district should be encouraged to use cold storage or discouraged from stocking more beef than they can sell the same day it is brought to the
butchery. Vendors should also consider increasing marketing efforts and identifying restaurants and/or businesses that can purchase beef for cooking if stock remains after a day of storage.

Although cold storage is the appropriate form of storing raw meat (FDA, 2018), as it reduces the rate of microbial growth, its availability continues to be low, at less than 40% of butcheries in Uganda (Jeffer et al., 2021; Kyayesimira et al., 2019), Ethiopia (Zerabruk et al., 2019), and Kenya (Chepkemoi et al., 2015). Five beef vendors reported that their refrigerators stored beef alone, whereas two mentioned that they created space between beef and other items in the refrigerators. Storage of raw beef with other food items in the same refrigerator was also reported by Mirembe et al. (2015) among butcheries in Kampala. Beef vendors in Uganda are allowed to display and store meat by hanging it inside butcheries which are located in a warm tropical climate with temperatures ranging from 64°F (18°C) to 86°F (30°C), and humidity ranging from 66 to 85% (World Weather, 2023).

Keeping beef at such temperatures for 36 hours allows multiplication of microorganisms already present on the beef. In fact, Bogere and Baluka (2014) reported that meat samples collected from butcheries in Kampala were contaminated with Staphylococcus aureus (10^5 CFU/g), E. coli (10^5 CFU/g), and coliforms (10^5 CFU/g), all of which were above the maximum allowable limits for beef carcasses and cuts. Although meat in Uganda is typically thoroughly cooked before consumption (Asada, 2019), pathogenic microorganisms such as Staphylococcus aureus (10^6 CFU/g) can produce toxins that are not destroyed by heat (Regenthal et al., 2017). The 36-hour allowance in the US 736: 2019 standard to hang/hold raw meat at butcheries in the absence of cold storage should be reduced to 10 hours following slaughter to protect consumers from potential bacterial toxins. This recommendation is based on the findings that Staphylococcal toxins are detectable after 10 hours of exposing raw beef to warm temperatures of 37°C, or after 48 hours of exposure to 20°C temperatures (Grispoldi et al., 2019).

**Cleaning beef handling tools**

Seventy-six percent (n = 46) of beef vendors used water and soap to clean knives and pangas used for chopping beef at their butcheries, whereas 23.3% (n = 14) did not use soap during cleaning. Additional materials used for cleaning were sand (53.3%, n = 32), a piece of woven polypropylene bag (38.3%, n = 23), and steel wire (steel wool) (3.3%, n = 2). Twenty-six percent (n = 16) of beef vendors reported sharpening tools using a file or a stone, and 23.3% (n = 14) wiping tools with reusable towels after washing them or between serving customers. The cleaning methods used by vendors in this study were also reported by other authors. Kyayesimira et al. (2019) reported that 50% of meat handlers used cold water without soap, 27% used cold water with soap, 17% used hot water and soap, and 6% used sand to clean butchering tools in Kampala, Mbale, and Mbarara districts in Uganda. The percentage of butcheries using water and soap to clean utensils in the present study is much higher than that reported by Chepkemoi et al. (2015) among butcheries in Nairobi (30%) and Isiolo (7%) counties in Kenya. However, the percentage of butcheries using reusable cloths in this present study is much lower than that reported among butcheries in Nairobi (33.8%) and Isiolo (59.9%) counties in Kenya (Chepkemoi et al., 2015).

Although the US 736: 2019 standard requires cleanliness, it does not specify what materials can or cannot be used to clean tools used for handling meat. Some cleaning practices used by beef vendors may pose physical or biological hazards to consumers. Twenty-three percent of beef vendors did not use soap to clean tools. Soap acts as a surfactant, reducing surface tension so that soil and microorganisms (3.53 log reduction) are more easily removed from food contact surfaces (Marriott et al., 2018; Man and Heacock, 2018). Therefore, cleaning tools without soap as observed in this present study may leave pathogens which could be transferred to beef subsequently sold to the consumers. From the results of this study, it is recommended that the standard discourages the use of reusable towels to wipe tools because if they are not cleaned and sanitized on a regular basis, they can harbor microorganisms (Sukumaran and TR, 2021) and contribute to cross contamination. The use of steel wool to clean tools should also be discouraged as it might leave small steel pieces which when ingested can lead to hospitalizations (Abbsia lou and Ahmadipour, 2020). Beef vendors should wash beef handling tools with soap and water and sanitize them regularly whenever they become contaminated and allow them to air-dry rather than re-contaminating them with reusable towels.

**Cleaning of butchery premises**

Ninety-six percent (n = 58) of beef vendors reported cleaning their butchery every day, one (1.7%) cleaned it once a month, and the other one (1.7%) twice a month. Cleaning by sweeping was reported at 98.3% (n = 59) of butcheries and this was followed by mopping (38%, n = 23), replacing cardboard boxes on display tables (11.7%, n = 7), painting walls (8.3%, n = 5), washing display tables (6.7%, n = 4), and wiping tables with damp towels (3.3%, n = 2). After sweeping, 85% (n = 51) of vendors disposed of trash in a pit, a garden, or a bush that was outside their butchery whereas 15% (n = 9) put trash in a covered woven polypropylene bag that was kept outside the butchery to be removed for dumping in a communal
trash collection site. Results obtained are in agreement with those reported by Mirembe et al. (2015) and Kunyanga et al. (2021). These authors reported that 75.3 and 100% of butcheries cleaned their facilities daily using sweeping and mopping methods. Although 96% of beef vendors in the present study reported cleaning their butcheries every day, it was observed that only 10% (n = 6) of butcheries had clean walls, and 90% (n = 54) had visibly dirty walls, which suggested that the cleaning methods used by vendors were not effective at removing stains from walls, or that it was not clear to vendors that butchery walls were among the surfaces that needed to be cleaned regularly. Cleaning and sanitizing of butchery premises including meat contact surfaces, floors, walls and the surrounding should be completed on a daily basis to reduce the accumulation of soil.

Construction materials for floors and walls of butcheries

The butcheries whose floor was constructed out of wood were 41.7% (n = 25), whereas 35% (n = 21) had cement or concrete floors. Butcheries with bare ground floors accounted for 23.2% (n = 14). Butchery walls were made of wood (71.7%, n = 43), cement or concrete (5%, n = 3), glass (1.7%, n = 1), or metal (1.7%, n = 1). Eleven butcheries (18.3%) were partially open and located on verandas of buildings, four butcheries (6.7%) were completely in the open without any walls whereas 83.3% lacked clear separation between beef and customers. Additionally, 96.7% of butcheries had a roof to protect beef from rain and 98.3% had sufficient lighting for clear illumination of the butchery. Materials used for the construction of butcheries in this study are different from those reported by Jeffers et al. (2021) and Lamunu et al. (2022). These authors reported that 87 and 56.7% of butcheries in Kampala and in Wakiso districts in Uganda respectively had cleanable smooth surfaces and floors. Oyirwoth (2021) reported that 51.2% of butcheries had bare ground floors whereas 48.8% had concrete floors in Nebbi district in northern Uganda. Wood is likely to absorb water and break down faster when washed with water which may explain why 98.3% of vendors opted for cleaning methods that involved using little to no water. The Public Health and Veterinary Departments of Kamuli district should inspect butcheries and only give or renew licenses for those butcheries with walls, floors, and rooves constructed with cleanable material. Additionally, education and resources should be provided to vendors on where they can purchase materials that are cleanable to utilize in their establishments.

Chopping surfaces at butcheries

The standard US 736: 2019, Section 7.4 requires vendors to cut meat on clean food-grade surfaces and to clean those surfaces regularly. All butcheries studied had a wooden stump on which beef was chopped, and it was observed that the chopping surface was rough. In addition to the wooden stump, 38.3% (n = 23) of vendors chopped beef on the wooden display table which was covered with cardboard boxes. These observations were done during working hours when stumps and tables were being continuously used to chop beef, so it was difficult to ascertain whether vendors cleaned them regularly. Chopping meat on a wooden stump is a common practice in several butcheries in Uganda (Mirembe et al., 2015; Heilmann et al., 2015; Bogere and Baluka, 2014), but it should be used with caution since it can lead to cross-contamination of meat as they can harbor microorganisms such as E. coli O157 (Kago, 2015). Wooden chopping surfaces are porous, become rough over time, and accumulate nutrients and bacteria providing a conducive environment for the survival of microorganisms, some of which can produce biofilms that make cleaning with traditional methods of scraping and rinsing challenging and inefficient (Sekoai et al., 2020). The use of cutting saws should be encouraged as these are less likely to be contaminated as compared to wooden chopping surfaces (Kago, 2015).

Flies and methods of controlling them

Fly infestation is a general problem for meat butcheries in Uganda. Heilmann et al. (2015) and Mirembe et al. (2015) indicated that 80% of pork butcheries and 78% of beef butcheries in Kampala had been infested by flies. Flies can carry pathogenic microorganisms such as Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Enterococcus faecium, and Staphylococcus aureus which are linked to human infections and animals (Monyama et al., 2022; Heilmann et al., 2015) and so must not be in contact with food or food contact surfaces. In the present study, flies were observed and present at 80% (n = 48) of butcheries. Only one butchery (1.7%) had a fly screen. Beef vendors used different strategies and techniques for controlling flies at their butcheries. Thirty-eight percent (n = 23) endeavored to sell fresh beef, 35% (n = 21) chased flies as they came, 28.3% (n = 17) maintained cleanliness, 5% (n = 3) sprayed with insect repellent, 3.3% (n = 2) smoked wood or charcoal, 3.3% (n = 2) smoked mosquito coils, 1.7% (n = 1) smeared beef with cooking oil, and 3.3% (n = 2) did not use anything to control flies. From the in-depth interviews, food safety personnel reported that beef vendors did not use the required structures with flyproof screens, as they prevented customers from noticing that beef is available for them to buy. Although beef vendors used several means to control flies, these were not effective because flies were still present and could get in contact with beef. The use of fly screens is not yet adopted by most butchery in Uganda (Bogere and Baluka et al., 2014; Jeffers et al., 2021; Kyayesimira et al., 2019).
Vendors from six of the twelve butcheries that did not have flies at the time the study was conducted indicated that selling fresh beef prevented flies from staying around the butchery. The remaining six butcheries either smoked wood, charcoal, mosquito coils, or maintained cleanliness at the butchery. These strategies should be further investigated to identify affordable methods of keeping flies away from raw meat without reducing customers’ ability to see the displayed meat.

**Personal hygiene**

Ninety-eight percent \((n = 59)\) of beef vendors in this study reported always washing their hands after visiting the toilet, and 41.7% \((n = 25)\) after disposing of garbage. Table 4 shows the frequency of handwashing before or after performing different activities at the butchery.

More than 50% of vendors either always or often washed their hands after visiting the toilet, after disposing of garbage, and after touching beef. Twenty-eight percent of vendors either rarely or never washed their hands before or after touching beef, which could lead to cross-contamination. All vendors \((100\%)\) in this study reported washing their hands using soap and water. Water was contained in either a hand-held jerrycan \((98.3\%)\) or a bottle \((1.7\%)\). Two vendors used sanitizers after washing their hands. Forty-six percent \((n = 27)\) of vendors dried washed hands using reusable towels, overcoats, or handkerchiefs. Beef vendors in this study complied with the requirement to wash their hands regularly with clean water and soap, however, 46% did not dry their hands as required and hence could cross-contaminate hands with microorganisms from the reusable drying materials used (Sukumaran and TR, 2021). Similar to these results, Jeffer et al. (2021) reported that 95% of butchers surveyed in Kampala washed their hands. Kyayesimira et al. (2019) also noted that 97.9% of butchers washed their hands after using the toilet, but only 0.33% of butchers washed their hands before touching beef. Mirembe et al. (2015) reported a lower percentage of beef vendors in Kampala washing their hands after visiting the toilet \((41\%)\) and before touching beef \((11\%)\). A study conducted in Kenya, also reported that 40 and 18% of butchers in Nairobi and Isiolo counties, respectively, washed their hands before handling meat (Chepkemoi et al., 2015). In Ethiopia, 40.7% of meat handlers reported washing their hands before and after handling meat (Tegegne and Phyo (2017). In Ghana Tamale Metropolis, Adzitey et al. (2020) reported a much higher percentage \((96\%)\) of meat sellers always washing their hands before touching meat. The practice of washing hands after using the toilet and before touching beef seems to have improved over the years among beef vendors in Uganda. This study was conducted in 2021 when there were hand-washing campaigns for reducing the spread of COVID-19, which could have contributed to the high hand-washing frequencies reported. It should be noted that although 45% of vendors reported washing their hands before touching beef, on a few occasions when a customer came to buy beef from the butchery, it was observed that some vendors did not wash their hands before serving them, which was different from what was reported. Visual reminders about handwashing should be posted in butcheries, and handwashing stations should be conveniently designed and positioned to simplify performance of this hygienic practice.

The beef vendors were asked the reasons for washing their hands. Seventy-six percent \((n = 45)\) wanted to maintain cleanliness, 25.4% \((n = 15)\) wanted to prevent diseases with four vendors mentioning COVID-19 as one of the diseases, 22% \((n = 13)\) wanted to remove the smell, fat, and blood of beef from their hands, 16.9% \((n = 10)\) wanted to avoid germs, and 3.4% \((n = 2)\) wanted to prevent flies. One respondent mentioned that handwashing was good behavior and four vendors indicated that money was dirty. Beef vendors in Kampala were also reported to wash their hands to maintain cleanliness and to remove germs from their hands (Mirembe et al., 2015). From the results, it was revealed that beef vendors understand that hand washing can be used as a method to prevent diseases.

The standard US 736: 2019, Section 7.2, requires that the water used for hand washing at the butcheries is potable, and for butcheries to have access to hot water for cleaning food contact surfaces. Water used to perform

### Table 4. Percentage of beef vendors (%) washing hands at butcheries in Kamuli district.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>After visiting the latrine</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.7</td>
<td>98.3</td>
</tr>
<tr>
<td>Returning from outside the butchery</td>
<td>0</td>
<td>18.3</td>
<td>60</td>
<td>20</td>
<td>1.7</td>
</tr>
<tr>
<td>Before touching beef</td>
<td>1.7</td>
<td>26.7</td>
<td>26.7</td>
<td>38.3</td>
<td>6.7</td>
</tr>
<tr>
<td>After touching beef</td>
<td>1.7</td>
<td>23.3</td>
<td>25</td>
<td>41.7</td>
<td>8.3</td>
</tr>
<tr>
<td>After disposing of garbage</td>
<td>0</td>
<td>1.7</td>
<td>23.3</td>
<td>33.3</td>
<td>41.7</td>
</tr>
</tbody>
</table>

Washing hands at different frequencies before or after performing different activities at the butchery \((n = 60)\). October and December 2021; participants included persons who were 18 years or older involved in selling raw beef in Kamuli district in Uganda.
sanitation and hygiene activities at butcheries in this study was collected from boreholes (66.7%, \( n = 40 \)) and/or piped (city/treated) water (36.7%, \( n = 22 \)). Only 13.3% (\( n = 8 \)) of vendors used hot water to clean tools, and four of them got it from nearby restaurants. Eighty-six percent of vendors violated the requirement to clean food contact surfaces with hot water. These results differ from those reported by Mirembe et al. (2015) who noted that the main water source for 91.8% of butcheries in Kampala was piped water. Piped water continues to be limited in several parts of Kamuli district, as 85.6% of households use borehole water for drinking (UBOS, 2017).

All beef vendors (100%) in this study had short hair, did not wear jewelry, and did not have wounds on their hands, 98.3% (\( n = 59 \)) had short fingernails, all of which were in line with requirements. Eighty-five percent (\( n = 51 \)) of vendors, however, violated the requirement to wear personal protective coats. Six of those who did not wear protective coats had hung them inside their butcheries. Only one butcher had a first aid kit to use in case of an injury and the rest indicated that they ran to a nearby clinic or pharmacy in case of injury. Beef butcheries were located in trading centers where other businesses including clinics and pharmacies were also located. These results are consistent with those reported by Mirembe et al. (2015) that 89% of butchers in Kampala had short fingernails and 31.5% wore protective clothing. Kyayesimira et al. (2019) also reported that only 22.2% of butchers in Kampala, Mbale, and Mbarara districts wore protective clothing while working. In Nebbi district, Oyirwoth (2021) reported that 83% of butcher operators did not wear protective coats. The results obtained in this present study are similar to those of butchers in Nairobi and Isiolo counties in Kenya, where more than 70% of them did not wear protective clothing (Chepkemoi et al., 2015). Adzitey et al. (2020) and Tegegne and Phyo (2017) also reported that 58% of meat sellers in Ghana Tamale metropolis and 55% of meat handlers in Jijiga town in Ethiopia did not wear protective clothing when handling meat respectively. On the contrary, 84% of butchers in Meru, Kitui, and Tharaka Nithi counties in Kenya wore protective clothing when handling meat at the butchery (Kunyanga et al., 2021). Additionally, Alimi et al. (2022) reported that 54% of butchers wore protective clothing, whereas 79% wore jewelry while handling beef at the butchery in Nigeria. Beef vendors in Kamuli district should be educated on the importance of wearing protective clothing and encouraged to wear them when handling beef at their butcheries.

Fifty-four percent (\( n = 32 \)) of vendors in this study reported that they had their meals from inside the butchery whereas 57.6% (\( n = 34 \)) ate outside the butchery. From observations, plates and cups were noted inside of butcheries (21.7%, \( n = 13 \)), and 43.3% (\( n = 26 \)) had personal belongings such as wallets and clothing inside butcheries. Twenty-eight percent (\( n = 17 \)) of beef vendors reported that their butcheries were run by one person, whereas 71.7% (\( n = 43 \)) were run by two or more people. At the time of this study, it was observed that 56.7% (\( n = 34 \)) of butcheries had only one person present. The practice of having one person to handle money and serve meat to customers is common at more than 67% of butcheries in Uganda (Lamunu et al., 2022; Jeffer et al., 2021; Kyayesimira et al., 2019), at greater than 85% of butcheries in Nairobi and Isiolo counties in Kenya (Chepkemoi et al., 2015), and at 75% of butcher shops in Ethiopia (Zerabruk et al., 2019). Money has been reported to carry spoilage and pathogenic microorganisms (Ejaz et al., 2018); hence there is a risk of contaminating beef if the hands of individual beef vendors are not washed properly between activities. Butchery owners should be required to have at least two people at any time the butchery is operating such that responsibilities of cutting beef and handling money are divided, to reduce the risk of contamination of beef.

**Beef handlers’ knowledge of food safety standards**

In this study, 96.6% (\( n = 57 \)) of beef vendors had received some form of training about handling meat. Seventy-six percent (\( n = 45 \)) had been trained by veterinarians or health assistants from the sub-county, district, or town council offices in Kamuli district. Eight percent (\( n = 5 \)) had learned beef handling from their relatives and five percent (\( n = 3 \)) had learned from fellow butchers or their supervisors at work. From the in-depth interviews, food safety personnel also confirmed that health assistants, inspectors, and veterinary officers trained beef handlers and emphasized the meat handling requirements when issuing them licenses, when conducting routine inspections at butcheries, and during occasional meetings held at slaughterhouses and seminars organized by the district, sub-county, or town council. These results are consistent with those obtained from a study conducted in Kampala by Jeffer et al. (2021) where 94% of butchers reported that they had received training. However, these authors indicated that no government body provided or facilitated any training. In the present study, the veterinary doctors, extension officers, and health assistants who shared information about meat handling requirements with vendors are employed under the different Kamuli administrative units (district, town councils, and sub-counties) of the government. The percentage of trained butchers (96.6%) in the present study is much higher than the 56.7% reported by Lamunu et al. (2022) in Wakiso district, the 31% by Kunyanga et al. (2021) in Meru, Kitui, and Tharaka Nithi counties in Kenya, the 62.5% by Zerabruk et al. (2019) in Ethiopia, and the 30.6 and 14.1% reported by Chepkemoi et al. (2015) in Nairobi and Isiolo counties in Kenya respectively.

To understand if the information disseminated to
vendors covers the US 736:2019 standard’s requirements, the vendors were asked what they knew about the food safety requirements or requirements to run a butchery. Sixty-nine percent (n = 41) emphasized that personal hygiene was a requirement for operating a butchery. This was followed by sanitation at the butchery (32.2%, n = 19), medical forms (32.2%, n = 19), permits or documentation such as letters or licenses from authorities (23.7%, n = 14), tools and approved weighing scales (20.3%, n = 12), beef inspection (10.2%, n = 6), customer care (6.8%, n = 4), slaughtering by designated people (6.8%, n = 4), ensuring that beef is fresh (5.1%, n = 3) and that it is packaged properly (5.1%, n = 3), separating meat products sold at the butchery (1.7%, n = 1), displaying beef in a net (1.7%, n = 1), and not receiving beef returned by customers (1.7%, n = 1). These results contradict the findings by Jeffer et al. (2021) who reported that only 2% of meat handlers in Kampala were aware of the requirements for operating a butchery business. At least one-third of beef vendors in this study were aware of requirements for personal hygiene (Section 8), sanitation (Sections 6 and 7), and possession of a medical form (Section 4C). However, none of the vendors mentioned requirements for construction (Section 5), and less than 8.3% mentioned using a net or fly-proof screen (Section 7.1.1), separating meats of different kinds (Section 7.1.2), and selling fresh meat (Section 9.4). The limited knowledge of the vendors about food safety requirements can explain the low compliance levels noted. Although personal hygiene and sanitation of premises were mentioned by more than 32% of beef vendors, there is still a need for improvement especially with the use of personal protective coats, having more than one person at the butchery, keeping flies away from beef during transportation and display at butcheries.

CONCLUSION AND RECOMMENDATIONS

This study aimed to determine if beef vendors in Kamuli district in Uganda complied with the minimum food safety requirements of US 736:2019 standard and to identify supportive services available to beef vendors in complying with these requirements. Overall, beef vendors complied with the requirements to sell meat that has been inspected (Section 10.1), obtain meat from an approved slaughterhouse (Section 10.3), store meat by either refrigeration or hanging it inside the butchery for less than 36 hours (Section 9.4), clean butcheries every day (Section 9.5), and have short or covered hair, short fingernails and no jewelry (Sections 8.6, 8.7 and 8.8). ‘Vendors’ compliance could be attributed to the fact that the recommended practices were affordable and to the efforts of the Public Health and Veterinary departments of Kamuli district, who provided inspection services at the slaughterhouses and at the butcheries, and informed vendors about food safety requirements on different occasions.

However, beef vendors violated the requirements to protect beef from flies during transportation and display at the butchery (Section 7.1.1), wear protective clothing (Section 8.5), construct butchery walls and floors using non-absorbent material (Section 5), not eat food from inside the butchery (Section 8.9), and have a separate person to handle money at the butchery (Section 8.3). Violations of the food safety standards could have resulted from limited knowledge of those specific parts of the standard, limited understanding of why safe food handling practices are important, and the extra financial expenses incurred to follow requirements. The violations reported in this study compromise the safety of beef, increase the risk to public health, and could have contributed to the high diarrhoea disease outcomes reported within the Busoga region (UBOS and ICF, 2018). Violations could be mitigated through providing culturally appropriate food safety educational interventions covering food safety requirements in the US 736:2019 standard, and the importance of following the recommended practices. Educational interventions should be designed to use more visuals and demonstrations such that vendors with limited education and speaking Lusoga language can understand the safe meat handling practices. A waterproof coating could be added to the wooden walls and floors of butcheries to make them cleanable with water and soap for vendors who may not afford smooth cemented surfaces. Since vendors are already practicing sharing of resources, a district-owned refrigerated truck can be adopted for cold transportation and distribution of beef from the slaughterhouse to the butcheries, starting with the Municipal council which has the highest number of butcheries in Kamuli district.

Based on the fly control findings from this study, future research can investigate the effectiveness of selling only fresh meat, smoking wood, charcoal, or mosquito coils, maintaining cleanliness, and using the recommended fly screens to keep flies away from raw meat at butcheries, while making sure customers can see the displayed meat. Other techniques that serve the same purpose of inexpensively and safely controlling flies at butcheries also could be investigated.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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