Bacteriological Quality of Fresh Beef Sold Within Eldoret Municipality

Koech Edwin*, Rono Salinah and Kiprop Ezekiel
Department of Biological Sciences, School of Science, University of Eldoret, P.O. Box 1125, Eldoret, Kenya

***Corresponding author:** edukoch85@gmail.com

Abstract

Meat is the primary source of proteins in many parts of Africa. In many cases however, it is major point of entry of many zoonotic diseases. Further, due to the long procedures involved in the meat industry, it is also implicated with many diseases associated with poor hygiene. The study was done to assess the bacteriological quality of (beef and mutton) sold at the Eldoret Municipality in Uasin Gishu county in particularly the bacteriological load of meat collected from selected sites. The study sought to assess the bacterial load of the meat in five major abattoirs in major peri-urban centres of Eldoret Municipality, Kenya; Kaburwo (Langas), Maili Nne, Cyrus (Munyaka), Eldoret main, and Teresia ((Moiben) and butcheries. Five butcheries in Eldoret town were also randomly selected for inclusion in the study. Eldoret is currently among the fastest growing town in Kenya with 475,716 people according to 2019 Kenya Population and Housing Census. It's the economic hub for North Rift Region and neighboring counties; Nandi, Elgeyo Marakwet and sections of Baringo, Kakamega, Bungoma, and Trans-Nzoia. Slum households comprise the majority of Eldoret city's inhabitants. The slaughterhouse within Eldoret municipality supplies approximately 80% of the town with meat and slaughter an average of 30 cattle and 150 shoats (sheep and goats) per day making it the largest in the Region. Meat samples were aseptically collected and taken in sterile bags and kept at 4˚C prior to processing using standard microbiological techniques. One gram of each meat sample was mixed with 0.4 ml of 0.1% of buffered peptone water for 2 minutes. Serial dilutions were carried out and followed by culture via pour plate technique. The plates were incubated for 24 hours at 37 ˚C after which total plate count was done to determine the bacterial load of the meat samples. The data analysis was done using Ms excel 2013. The means from different slaughter houses and Butcheries were done. The highest bacterial load was found in the carcasses in the butchery with an average of 19.8 cfus while the lowest was from the Maili Nne abattoir with an average of 4.9 cfus. Among the abattoirs, Teresia had the highest bacterial load of 9.2 cfus. Both Slaughter houses and butchery isolates recorded high counts exceeding the acceptable maximum limits prescribed by Meat HACCP (Scotland) regulations citing accepted ranges > 3.0 and > 5.0 cfu/g respectively indicating poor bacteriological quality. More public health education on the appropriate hygienic practices ought to be rolled out to help achieve a better microbiological quality status of the meat sold around Eldoret Municipality. The research work will help highlight the areas that need improvement during the distribution of beef carcasses to avoid and reduce contamination with pathogens. The results will inform the policy makers on areas that need reinforcement with regulations and an appropriate action plan that will reduce the microbial contamination of beef before, during and after slaughtering processes.

Keywords: Zoonotic, abattoir, colony forming unit, carcasses, bacteriological quality

INTRODUCTION

The bacteriological quality of locally processed beef is remains poor despite increased hygienic regulations (Kimindu *et al*., 2021). Due to its pH, temperature, water activity, and nutritional content, meat and meat products are especially prone to bacterial development (Jeffer *et al*., 2021). Meat surfaces exposed to ambient air during cutting are ideal breeding sites for the majority of germs (Adu-Gyamfiet al., 2012). Therefore, it is very important that slaughtered animals are cut according to hygiene rules in slaughterhouses. Carcasses naturally have a low level of microbial flora and can be regarded to be sterile immediately after slaughtering (Gürbüz et al., 2018). It is necessary that slaughtered animals are cut according to hygiene rules in slaughterhouses. After slaughtering, carcasses naturally have a low level of microbial flora and can be regarded to be sterile immediately after slaughtering. Microbial contamination can occur in slaughtered animals in most of the stages throughout the slaughtering process and handling (Gürbüz et al., 2018). The European Union legislation declared that the Aerobic colony count (ACC) forms the hygiene criteria throughout the slaughtering process and that measures should be taken if the values increase above the criteria for slaughtered animals during the slaughtering process (Barco et al., 2015). The legislation required monitoring of the above bacterial groups as process hygiene criteria for cattle, sheep and other slaughtered animals and were declared to be Hazard Analysis and Critical Control Point (HACCP) indicators for an acceptable food processing system (EC No 2073/2005.According to the legislation, the ACC and Enterobacteriaceae limits for carcasses of cattle and sheep declared as minimum (m) and maximum (M) values to be >3.5 log CFU/g and > 5.0 log CFU/g respectively.

Red meat's shelf life may be extended if handled and kept properly, for instance by using the appropriate packaging (Ekmekcioglu *et al*., 2018). The assurance of wholesomeness and the provision of high-quality meat marketed to consumers are the main goals of a meat hygiene and safety program (Kademi *et al*., 2019). In the ante-mortem and post-mortem examinations, the presence of a meat inspection system looks for grossly obvious abnormalities but misses' complex microbial contamination, which could later result in serious risks to public health and financial loss due to food poisoning and meat spoilage (Ahmed *et al*., 2002).

The major factor for the emergence of food borne illness is eating habits of the community, poor handling, unsanitary slaughterhouse facilities, unsafe food storage conditions, and transportation (Kebede et al., 2014). The effects that microbial contaminants cause spoilage of the meat, food poisoning and condemnation of carcasses, which results into reduction of income to farmers as well as meat sellers. *Staphylococcus* food poisoning, *streptococcosis,* tetanus, tuberculosis and *yersiniosis* is caused due to poor handling of food animals and meat (Adeyemo, 2002; Pal, 2007; Pal et al.,2013).

The majority of people consume meat regularly, and its safety depends on the implementation of efficient control procedures at each level of the production chain, or "farm to fork," in other words. Cooperation between farmers, feed manufacturers, livestock market operators, livestock haulers, abattoir co-operatives, and workers in food processing plants is necessary to accomplish this crucial goal (Mazhangara *et al*., 2019. However, during the slaughter process, they may be spread to the surface of the meat by infected hands, equipment, or feces on the coats of unclean animals. Therefore, several more carcasses might get contaminated by microbes from a single diseased animal. Slaughterhouses are required to put in place mechanisms that lessen the chance of contamination. For instance, a Clean Livestock Policy was developed in 1997 in response to *E. coli* O157 outbreaks, and it mandates that any livestock that does not reach the necessary standard of cleanliness be rejected for slaughter (Davies *et al*., 2000). By using conventional meat inspection techniques, it is possible to remove meat from carcasses that have disease lesions that are apparent from the food chain (Alvseike *et al*., 2018). It is easy to think that this will be enough to guarantee the safety of the corpses that pass inspection, and that will be the end of the problem (Pal *et al*., 2018). This is untrue, though, as significant risks to human health result from clinically healthy animals carrying dangerous microbial organisms like *Campylobacter* and *Salmonella* (Buncic *et al*., 2019).

Only a fully integrated approach to food safety at all phases of production, processing, and distribution, which includes hazard analysis critical control point (HACCP) and comparable safety plans, can manage these hidden dangers (Minor *et al*., 2020).It is crucial that everyone working in the meat business be aware of this since cooperation is the only way to make progress toward guaranteeing that all meat and meat products marketed to the general public are healthy and safe (Yunusov & Achilov, 2022). Meat and other foods that spoil quickly offer ideal circumstances for the development of dangerous germs. Fresh meat's quality can be affected by microbial infection, which can also reduce its shelf life and pose a health risk (Zdolec, & Kiš, 2021). The microbial population that comes into touch with fresh meat during slaughter, dressing, and processing is a difficult issue for the meat business. Therefore, to produce sanitary and wholesome meat and to protect the safety of the public's health, continuous monitoring and intermittent microbiological tests are required (Koffi-Nevry *et al*., 2011). Thus, the present study was done to determine the bacterial load on meat obtained from selected sites within Eldoret Municipality, Uasin Gishu County. The County governance is divided into 3 Constituencies and 13 wards. There are three peri-urban areas that lie within different constituencies; Huruma in Eldoret North, Munyaka in Eldoret East and Langas in Eldoret South (Kenya Economic Report, 2013).

MATERIALS AND METHODS

The study was done in Eldoret Municipality located at 0˚ 31ˈ N (latitude) and 35˚ 17ˈ E (longitude) in Uasin Gishu County. The governance of the county is divided into six constituencies and 27 wards. Major peri-urban areas around Eldoret are Langas to the south, Munyaka to the East, and Hururma to the north of Uasin Gishu Municipality. The slaughter houses selected for this study were Kaburwo in Langas (0.47 ˚ N 35.26 ˚E), Maili nne around Huruma area (0.57 ˚N 35.28 ˚E), Cyrus in Munyaka (0.52 ˚N 35.31 ˚E), Eldoret Main very close to the town (0.53 ˚N 35.2 ˚E) and Teresia in Kuinet (0.65 ˚N 35.3 ˚E) (Fig 1). All the three main peri-urban centres were represented in the selected slaughter houses as one is present in each. The additional two, Eldoret main is the major one serving the town while Teresia is relatively an outskirt abattoir. Eldoret Municipality. It is currently among the fastest growing town in Kenya with 475,716 people according to 2019 Kenya Population and Housing Census. (Kenya National Bureau of Statistics (KNB). The slaughterhouse supplies approximately 80% of the town with meat and slaughters an average of 30 cattle and 150 shoats (sheep and goats) per day this is according to Uasin Gishu County Executive Committee Member (CECM) for Agriculture 2021 report. Eldoret is a cosmopolitan city in Uasin Gishu County and the foremost administrative, socio-economic and political capital of northwestern Kenya. It is a major transit point for long-distance trucks that ferry goods to neighboring countries of Uganda, Rwanda, Burundi, and the Democratic Republic of Congo. The city is served by an international airport. In addition, the city is home to numerous educational institutions including primary and secondary schools, middle-level colleges, institutes of science and technology, polytechnics and universities. Eldoret is also the industrial heart of the north-rift valley with a number of nationally recognized manufacturing concerns, factories, business premises and trade enterprises located. (Ochieng' 2012)

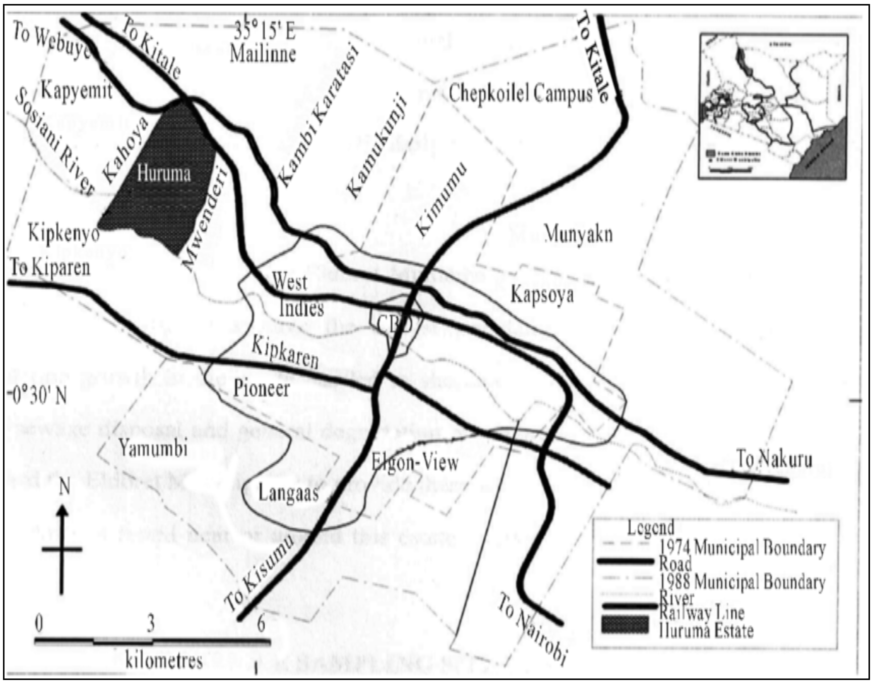

Figure 1: Uasin Gishu County Map (Department of Geography Moi University)

Methods

During the slaughter and dressing processes, all fresh meat becomes infected with germs; some of these bacteria may include pathogens (these are microorganisms that cause food illness). Microbiological testing is a component of the Hazard Analysis Critical Control Points (HACCP) system. In order to confirm the approach utilized for managing microbiological contamination of goods, testing is employed to study the microbiological impacts of the operations inside or influencing any process (Brown *et al*., 2000). The enumerator and indicator organism are required for HACCP microbiological testing.

Methods for sample collection

A destructive sample collecting procedure was adopted recommended by Hazard Analysis and Critical Control Point regulations (2002) and Gürbüz et al. (2018). This was accomplished by removing a 5cm^2 portion of tissue from the cadaver. The sample was used as a template and placed in sterile tins that were labeled. Individual beef, sheep, and goat samples were gathered in each killing slab and butchery. The tissues taken were; Cattle: neck, brisket, flank, and rump, and Sheep, goat: flank, thorax lateral, brisket, and breast.

Sample collection

At the slaughterhouse and butchers, meat samples were aseptically collected and placed in sterile plastic bags. These were then brought to the University of Eldoret laboratory for examination and processing. Appropriate tagging of the samples with the type, of sample, collecting locations and the date of collection was recorded.

Sample Processing

One gram of the meat samples was mixed for 2 minutes in 0.4ml of 0.1 percent buffered peptone water (diluent). Serial dilutions were made by adding 1ml of the preceding dilution to 9 ml of the sterile diluents was done. The pour plate method was used, and the samples were incubated at 37 °C for 24 hours. Rumeration of colonies was done as colony forming.

Table 1: Acceptable ranges of bacterial counts on meat sample

Daily log mean Values (cfu/cm^2)	***Acceptable Range***	***Marginal range (>m but •M)***	***Unacceptable range (> M)***
Total Viable Counts (TVC)	Cattle/sheep/ Goat < 3.5 log	Cattle/pig/sheep/goat 3.5 log (pig: 4.0 log) – 5.0 log	Cattle/pig/sheep/goat > 5.0 log
Total Viable Counts (TVC)	< 3.5 log	1.5 log (pig: 2.0 log) – 2.5 log (pig:3.0 log)	> 2.5 log (pig > 3.0 log)

Values for the number of colonies for testing of surfaces

Acceptable range	**Unacceptable range**
Total viable Counts (TVC) 0 – 10/ cm^2	> 10/ cm^2
Enterobacteriaceae 0 – 1/ cm^2	> 1/ cm^2

Data analysis
The analysis was done using Ms excel 2013. The means from different slaughter houses and Butcheries were done.

RESULTS AND DISCUSSION

From the study, the bacterial load obtained from the carcasses had higher number of Colony Forming Units (cfus) than the required threshold that permits meat's quality. The acceptable range is <3.5cfu/g for slaughter slab and <5cfu/g for butchery. As reflected from the permitted ranges, the highest bacterial load was obtained from the Butcheries carcasses mean (CFU; 19.8). This was way above the rest. Maili 4 had the lowest count of 4.9 cfus while Teresia had the highest number in the second category with 9.2 CFUs.

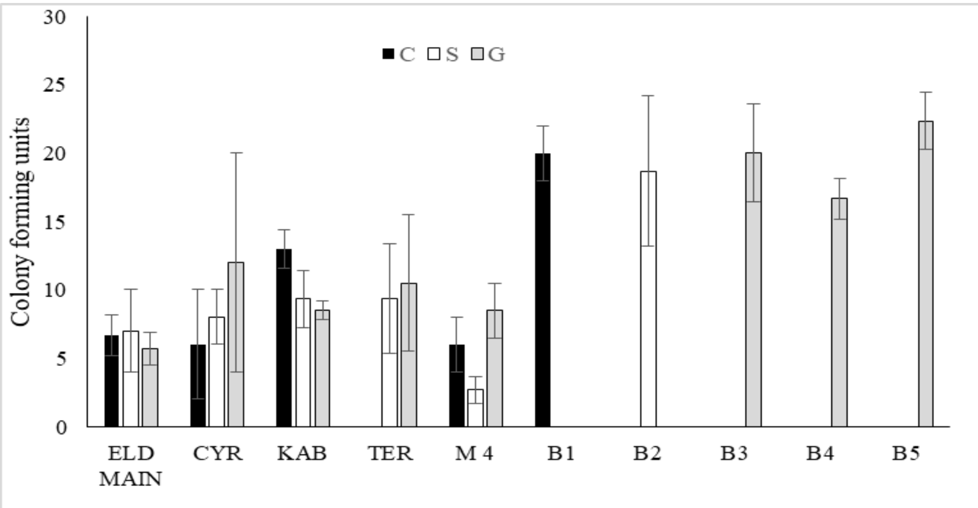

Figure 1: Bacterial loads obtained from the different meat points within Eldoret municipality

Key: S;Sheep, G;Goat, C;Cow Eld main; Eldoret Main slaughter house, CYR;Cyrus, KAB;Kaburwa, TER;Teresia, M 4;Maili Nne, B;Butchery

Bacterial loads obtained from the different meat points within Eldoret municipality. Butchery stands out with having significantly high number of Colony Forming Units (CFUs). The bacterial loads in the meat obtained from all the sampling sites were higher than the recommended levels. The most microbe infested was the meat in the butchery while on the other hand, the meat obtained from Maili 4 abattoir had the least bacterial load. This study revealed that fresh meat products available in local markets are seriously contaminated with variety of microorganisms. The acceptable range is <3.5cfu/g for slaughter slab and <5cfu/g for butchery. The presence of higher number of organisms makes meat more prone to spoilage and may serve as a tool for the transmission of pathogenic strains. The diseases of gastrointestinal tract are very common in this part of the world and they are mainly transmitted through contaminated food and water. It is largely due to improper handling, unhygienic conditions, and lack of awareness and ignorance of regulatory authorities.

CONCLUSION

The study established that bacterial load in the meat obtained from all the sampling sites were higher than the recommended levels. The most microbe infested was the meat in the butchery while on the other hand, the meat obtained from Maili 4 abattoir had the least bacterial load.

RECOMMENDATION

The study recommends the creation of awareness of butcher shop workers regarding meat hygiene, enforcing of mandatory meat inspections by veterinary professionals before and after slaughtering and before the meat is distributed to the public, maintenance of high levels of personal hygiene and meat handling practices should be followed strictly by butchers and personnel selling the meat.

Further research and studies are needed to assess knowledge, attitude and behaviors of worker in slaughters and meet butchers regarding food hygiene and safety. Policy makers should implement more safety and hygiene policy to promote good hygiene.

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