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Original Article

PREVALENCE OF PATHOGENIC BACTERIA IN COOKED, RAW MEAT AND VEGETABLES FROM SELECT MARKETS OF ENTEBBE MUNICIPALITY IN WAKISO DISTRICT, UGANDA. A CROSS-SECTIONAL STUDY.

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Abstract

Background

Although meat consumption is highest in high-income countries and lowest in low-income countries. The study aims to assess the prevalence of pathogenic bacteria in cooked, raw meat and vegetables from select markets of Entebbe municipality in Wakiso district, Uganda.

Methodology

A descriptive cross-sectional study was carried out in common food markets of Entebbe municipality that is; Katabi, Abayita, Kawuku, Kasatiro, and Namulanda between November 2021 and January 2022. Susceptibility patterns were analysed using susceptible, resistant, and intermediate proportions of isolates per antibiotic used.

Results

Staphylococcus aureus and Corynebacterium spp had the highest number of isolates, 3 each (23.1%). Serratia, mycobacterium, and shigella spp had 1 (7.7%) isolate of each. For raw chicken from all the five select markets, staphylococcus aureus and corynebacterium were the most prevalent with 10 and 8 isolates respectively (43.5 and 34.8%). enterococcus (17.4%), and Citrobacter (4.3%). For cooked meat, 4 isolates of Corynebacterium spp (44.4%), mycobacterium spp, E. coli, and salmonella had the least number of isolates with only 1 isolate of each (11.1%), enterococcus was also isolated (22.2%). corynebacterium 3(18.3%), enterococcus 2(12.5) and Citrobacter spp 4(25.0%). 20 isolates were identified from the raw cabbages, Neisseria spp were the most prevalent, 12 (60%) and Citrobacter & corynebacterium were the least prevalent, 1 isolate of each (5.0%). 6 Moraxella spp were also identified (30%).

Conclusion

Staphylococcus aureus and Corynebacterium species were the most prevalent isolates. The prevalence of coliforms was lower than the other bacterial pathogens from all five markets.

Recommendations

The government should establish a stringent regional microbiological hazard surveillance system and later a national one to assess the safety of food staff, especially the street foods before selling.

***Keywords**: Prevalence of pathogenic bacteria, Cooked Raw meat, Select markets of Entebbe municipality in Wakiso district.*
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Background

Although meat consumption is highest in high-income countries and lowest in low-income countries, the demand for meat is increasing in Africa and its consumption may be a status symbol, especially in low-income countries (Etinosa et al,2021). Foodborne infections related to meat are a global health concern because of the high risk of bacterial contamination of meat by several bacterial pathogens (Tesson et al, 2020). However, food products like meat and some plant-based foods are generally cooked and it is expected that all microbes including the harmful ones are killed (Madoroba et al 2021). In some food habits and traditional recipes, meat may be consumed raw or partially cooked which presents a variety of potential pathogenic bacteria threatening the safety and quality of food (Hippolyte, 2020). Even though some pathogenic and spoilage bacteria may be killed by heat, some still produce heat-stable toxins that present severe symptoms when ingested for example the Shiga-like toxin of enterotoxigenic E. coli (Pena et al 2014).

Organisms like S. aureus, salmonella species, Campylobacter species, L. monocytogenes, and E. coli are some of the major zoonotic bacterial pathogens responsible for food-borne illness and mortality in the world as a result of contamination of animal products. Toxins and constitutional virulent factors are

responsible for the pathogenesis of these microorganisms. They cause human infections which present gastrointestinal symptoms including nausea, vomiting, diarrhea, and abdominal cramps, among others. Some bacteria may cause severe complications. Good hygiene, sanitation in operating procedures, and implementation of standardized HACCP and pasteurization procedures are effective methods for control and prevention. Currently, the emergence of multidrug-resistant zoonotic bacteria associated with the consumption of contaminated animal products is a great concern for public health, and there should be coordinated surveillance and monitoring systems for food-borne bacterial pathogens, particularly in developing countries including Uganda (Eshetie, Hussien, Teshome, & Mekonnen, 2018) In the quest for healthy lifestyles, there has been an increase in the consumption of salad vegetables which are also eaten without any heat treatment and most times minimal cleaning with water (Chileshe et al 2018). The contaminated meat and vegetables act as vehicles for the transmission of the pathogens that lead to food-borne illnesses/diseases. The study aims to assess the prevalence of pathogenic bacteria in cooked, raw meat and vegetables from select markets of Entebbe municipality in Wakiso district, Uganda.

Methodology

Research Design

This was a descriptive cross-sectional study that was carried out in common food markets of Entebbe municipality that is; Katabi, Abayita, Kawuku, Kasatiro, and Namulanda between November 2021 and January 2022.

Study Area

The study was conducted in a few selected raw meat, vegetables (cabbages) and cooked (roasted) vending stalls of Katabi, Abayita, Kawuku, Kisubi, and Namulanda. It will be from such stalls that the respective meat and vegetable samples will be collected (purchased).

Study setting

Katabi

Katabi Central market is in Wakiso district, Entebbe municipality near The National Water and Sewage Corporation treatment plant. The final results of the 2002 population census put Entebbe Municipality at a total of 55,086 people of whom 27,135 are males and 27,951 females (United Nations Human Settlements Program, 2003) and as of 2021-2022, the population of the city of Entebbe, Uganda is - 67,271 people (Allpopulations.com, 2022). The increase in population over the years suggests a corresponding increase in the number of people visiting the market. Katabi Central market operates once a week every Saturday.

Abayita

Abayita Ababiri is located in Kyaddondo South Constituency, Wakiso District, Central Uganda. Abayita Ababiri's main market is a local communal marketplace. The market is situated between Kasenyi Road and

Abayita, Ababiri bus stop along Entebbe Express highway, opposite Abayita Ababiri Police Station (Google Maps, 2022). As of 2014 and to date, the population is unknown (Wikiwand, 2021) but the marketplace is busiest once a week every Friday.

Kawuku

Kawuku market is in Kawuku, Wakiso District (Central Region), Uganda about 12 miles (or 20 km) south of Kampala, the country's capital city. It is situated along Kampala-Entebbe Road, about 3.8km from the main road next to Mt. Zion Church Kawuku, (Google maps, 2022). The Kawuku communal market operates seven days a week but attracts bigger numbers on Saturdays.

Kisubi

Kisubi local market, indigenously known as “Kasatiro” is located in Kisubi, Central region of Uganda along Kampala-Entebbe Road. It is located just after the University of Kisubi, formerly known as Kisubi Brothers University College coming from Kampala. Kasatiro market operates seven days a week attracting numbers from other businesses and travelers around.

Namulanda

Namulanda is a village in Central Uganda and it is situated east of Buzzi, and south of Kasali. Namulanda market, next to Kibungo Fishing village just like Kisubi and Kawuku operates daily but attracts bigger numbers on Thursdays. It is a local communal market with a variety of goods.

Study Materials.

Autoclaves and hot air ovens were used for the sterilization of all materials used during analysis e.g sample collection containers and bags, tubes, loops, plates e.t.c. Sterile normal saline was prepared in sterile bottles in which the cut sample pieces were immersed

on reception. Selective media i.e. MSA, XLD, MAC, and BEA agar was prepared for primary culture growth.

Nutrient agar base for sub-culturing from the peptone culture broth, rabbit plasma (coagulase test), TSI, Simmon's citrate agar, oxidase strips, hydrogen peroxide, SIM media were prepared for all the necessary biochemical tests. MHA, antibiotic discs, and AST international guideline booklet. Microcentrifuge tubes, microcentrifuge, TENT buffer solution, cold ethanol, and cryo-vials for the extraction of and banking genomic DNA of the isolates. Electrophoresis unit for the visualization of extracted DNA. Spectrophotometer for purity testing and determination of the DNA concentration.

Sampling Strategy

Different samples from randomly selected vending stalls totaling n=50 was collected in sterilized sample collection bags.

The sample size was then calculated using Fischer's method (Charan et al 2013);

$$\frac{n=Z2P(1-P)}{d2}$$

Where; n= Sample size

Z= level of confidence P= Expected prevalence d= precision

P was determined from a pilot study with a smaller sample from the population to determine the Prevalence of contaminated food (beef, chicken, and vegetables) from all the 5 sampling areas.

Determination of n

Z= 0.95 (CI), P= 0.8333, d= 0.05

$$n= \frac{0.952(0.8333)(1-0.8333)}{0.052}$$

n=50.140

A sample space of 50 samples was handled.

Isolation, Identification, Antibiotic Susceptibility Testing (AST), and extraction of DNA of identified Bacterial Pathogens from the collected food samples.

These were aggregated into 4 stages i.e., sample collection, preparation, culture and sensitivity, and extraction.

Collection of Samples from Sampling Sites.

Sample collection bags were sterilized using an autoclave before sample collection. The sample bags were triple packaged in more sterile bags ensuring minimal or no contamination of the samples. On sample collection, proper disinfection of hands was done to minimize contamination of the samples. The sample was then placed in a disinfected cool box with ice packs and immediately transported to the laboratory for examination.

Preparation of collected food samples.

In the laboratory, the samples were cut into small pieces and immersed in sterile normal saline in sterile containers.
Covering the containers with loosely tight lids to prevent contamination, these were incubated in a shaking incubator overnight (24hrs) at 37ºC.

Antimicrobial Susceptibility testing of isolates obtained.

The samples were then inoculated on selective media the following day to get primary cultures.
The primary cultures were sub-cultured on NA recovering colonies on which biochemical tests were done to confirm the different isolates.
Using Kirby Bauer's disc diffusion method, AST with selected antibiotic classes was done on all the identified bacteria (Cheesbrough, 2005).
The isolates were stored in 70%BHI and 30%glycerol for future reference.

Extraction and banking of DNA from the isolates.

The boiling method was used to release the bacterial DNA into the surrounding TENT buffer. The buffer had been prepared before extraction the previous day (Hassanzadeh et al., 2016).
The extracted DNA was visualized by electrophoresis and the purity was determined by the spectrophotometric method (Optic density) (Hassanzadeh et al., 2016).
The purest DNA was stored at -20ºC for future use.

Data Analysis

Ms-Word and Ms-Excel were used to organize the collected data into tables. The prevalence of all the

isolated bacterial pathogens by nature of the food (cooked and raw), and area (Katabi, Kasatiiro, Abayita, Kawuku, and Namulanda) was determined. This data was then presented in bar graphs. Susceptibility patterns were also analysed using susceptible, resistant, and intermediate proportions of isolates per antibiotic used.

QA and QC

Pre-analysis

Sterilization of all equipment including sample bottles, collection bags, normal saline, and plates was done etc. to prevent bacterial contamination of the samples.
Samples were immediately transported to the laboratory to maintain the viability of the pathogens while also minimizing contamination.
Proper labelling of the samples with specific identification codes of the collection site, nature of the sample (raw or cooked), and sample type (beef, chicken, or vegetables) was done.

Analysis

The samples were immediately prepared on arrival to the laboratory minimizing contamination and maintaining viability of possible pathogens.

Careful sample verification procedures were followed.
While analyzing the samples, all microbial aseptic techniques were vehemently observed.
Frequently used equipment like the incubators were maintained on a daily, weekly, and monthly basis e.g., careful temperature monitoring using the daily temperature maintenance logs. Adherence to procedural SOPs.

Post-analysis

Inconclusive or unclear results were troubleshot before recording.
Test results were double-verified before recording.
Results were recorded in both hard and soft copies for proper data management.
Reports were written for proper documentation of result discussions.

Results

Prevalence of isolates from all the five select markets.

A total of 81 isolates equating to 11 species of bacteria were obtained from all the samples collected from the five markets. Generally, more isolates were obtained from the raw samples, 59 (72.8%) than the cooked, 22 (27.2%). staphylococcus aureus and Corynebacterium had the highest number of isolates, 19 each (23,5%) while isolates of Serratia, E. coli, salmonella, and shigella had the least number of isolated identified 1 each (1.2%).

By sample type, staphylococcus aureus isolates were found highest in raw foods (meat and chicken) with 16 (84.2%) isolates and mycobacteria as the least with 1(33.3%) isolate. Whereas in cooked food corynebacterium spp was highest with 7(36.8%) isolates and isolates of Serratia, E. coli, salmonella, and shigella with 1 each as the least. See.

All isolates of Serratia, E. coli, salmonella, and shigella were found in cooked foods only with the lowest number while Moraxella and Neisseria isolates were only found in raw foods.

Prevalence of isolates from Cooked Chicken from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

A total of 13 isolates were obtained from cooked chicken samples from all the five markets. Of these, staphylococcus aureus and corynebacterium spp had the highest number of isolates, 3 each (23.1%). Serratia, mycobacterium and shigella spp had the least number of isolates with only 1 (7.7%) isolate of each.

Prevalence of isolates from Raw Chicken from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

A sum of 23 isolates were obtained from raw chicken from all the five select markets of Wakiso district, Uganda. staphylococcus aureus and corynebacterium were the most prevalent with 10 and 8 isolates respectively (43.5 and 34.8%). enterococcus was also isolated (17.4%), Citrobacter was the least prevalent of the isolates with 1 isolate (4.3%).

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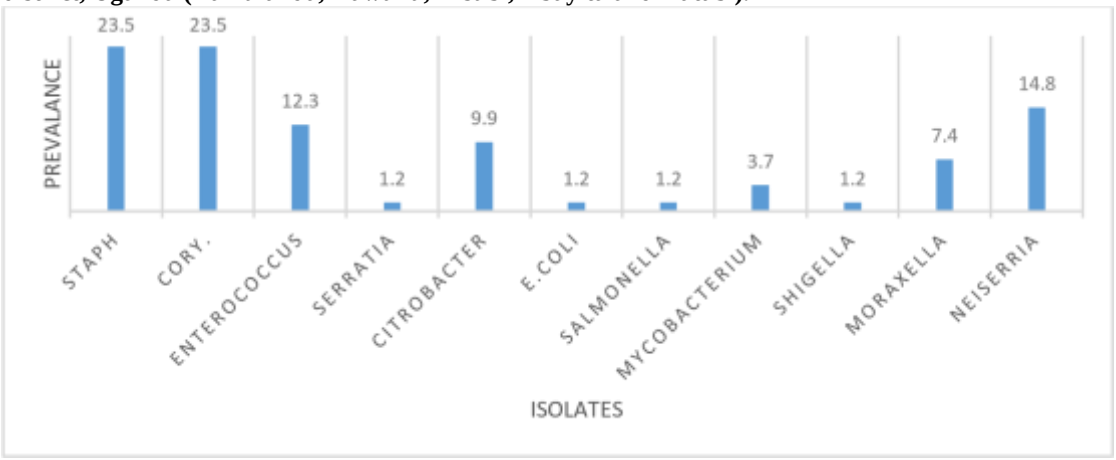
Table 1: Number and Prevalence of Isolates from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

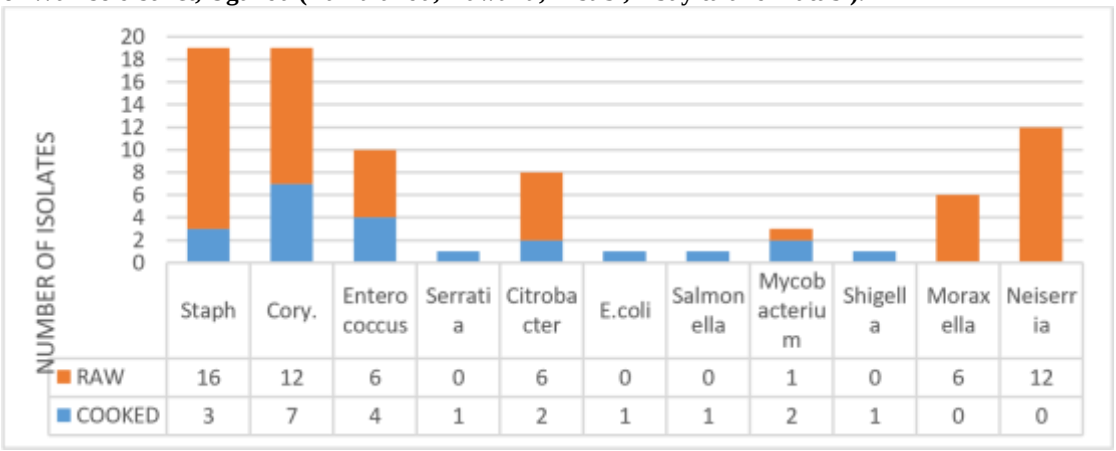
	COOKED	COOKED (P)	RAW	RAW (P)	TOTAL ISOLATE COUNT	TOTAL ISOLATE (P)
Staph	3	15.8	16	84.2	19	23.5
Cory.	7	36.8	12	63.2	19	23.5
Enteroco	4	40.0	6	60.0	10	12.3
serratia	1	100.00	0	0	1	1.2
Citro	2	25.0	6	75.0	8	9.9
E. coli	1	100.0	0	0.0	1	1.2
salmonella	1	100.0	0	0.0	1	1.2
Myco	2	66.7	1	33.3	3	3.7
shigella	1	100.0	0	0.0	1	1.2
moraxella	0	0.0	6	100.0	6	7.4
Neisseria	0	0.0	12	100.0	12	14.8
TOTAL	22	27.2	59	72.8	81	100

Figure 1: Prevalence of all the isolates from all the samples collected in the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).



Key: Staph- staphylococcus aureus, Cory- corynebacterium spp, E. coli- Escherichia Coli

Figure 2: Number of isolates from all the cooked and raw samples collected from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

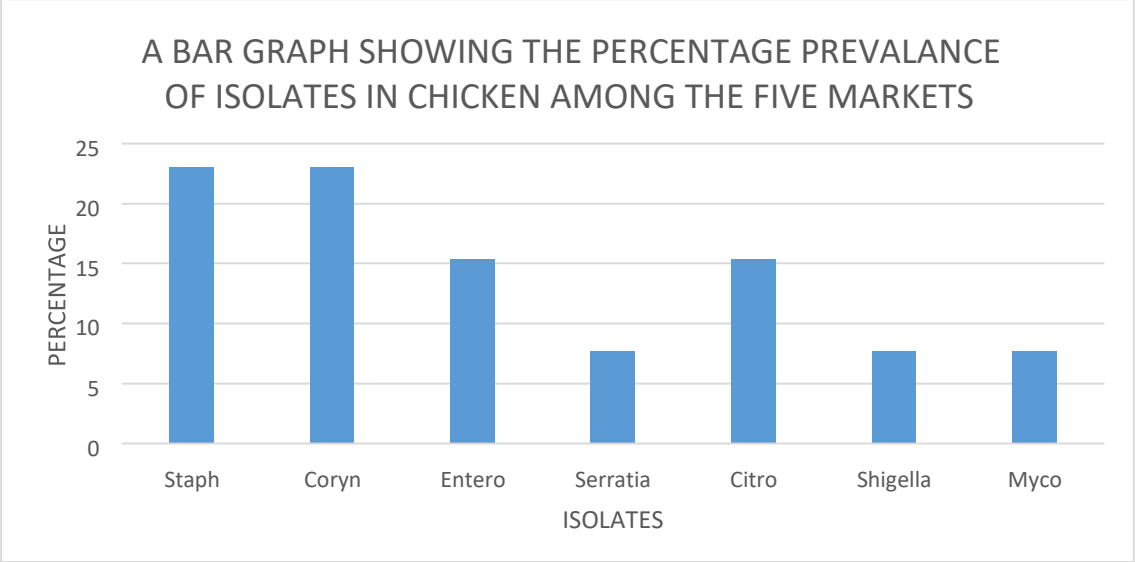


Key: Staph- staphylococcus aureus, Coryn- corynebacterium

Table 2: Number and prevalence of isolates from cooked chicken collected from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

ISOLATE	PERCENTAGE	NUMBER
Staph	23.1	3.0
Coryn	23.1	3.0
enterococcus	15.4	2.0
serratia	7.7	1.0
citrobacter	15.4	2.0
shigella	7.7	1.0
Mycobacteria	7.7	1.0
TOTAL	100	13.0

Figure 3, Prevalence of isolates from cooked chicken collected from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).



Key: Staph-staphylococcus aureus, Coryn-corynebacterium , Entero- enterococcus, Citro-citrobacter & Myco-mycobacterium spp

Table 3, Number and prevalence of isolates from raw chicken collected from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

ISOLATE	PERCENTAGE	NUMBER
Staphylococci	43.5	10
corynebacterium	34.5	8
enterococcus	17.4	4
citrobacter	4.3	1
Total	100	23

Key: Staph-Staphylococcus, Coryn- corynebacterium, Entero- enterococcus, Citro-citrobacter

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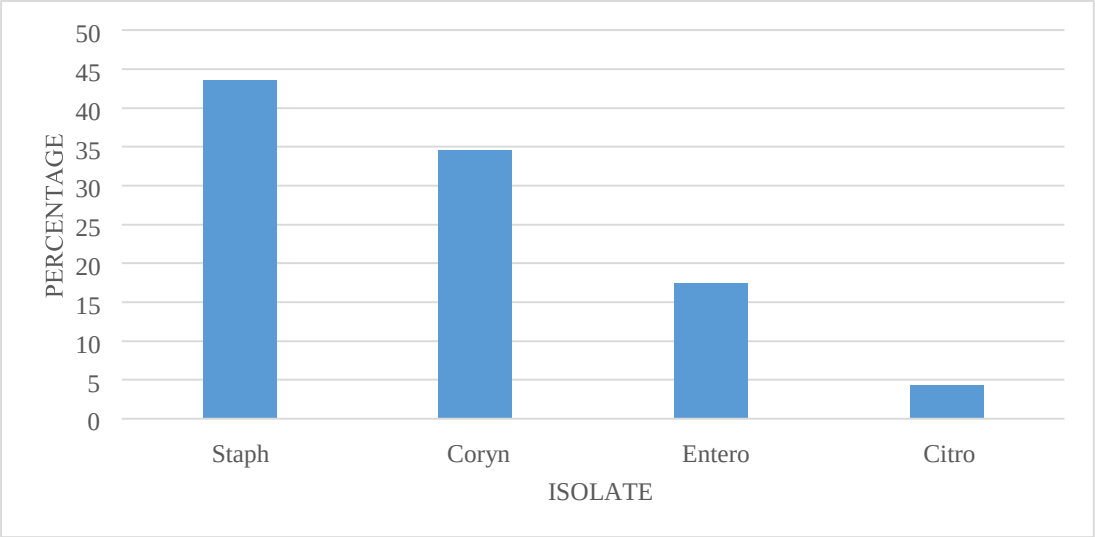
Figure 4, Prevalence of isolates from raw chicken collected from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

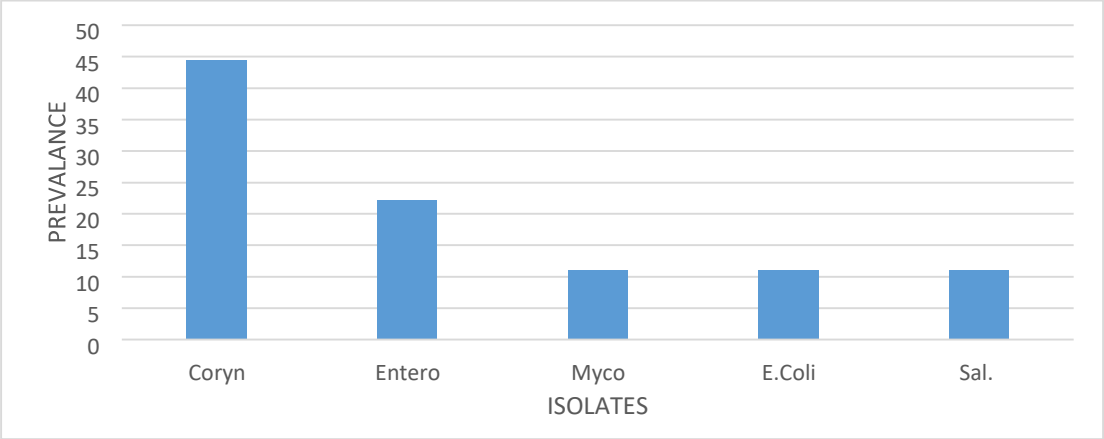


Key: *Staph - Staphylococcus, Coryn - coryneba cterium , Entero -* enterococcus, Citro-citrobacter

Table 4, Number and prevalence of isolates from cooked meat collected from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

ISOLATE	PERCENTAGE	NUMBER
Coryn	44.4	4
enterococcus	22.2	2
Mycobacteria	11.1	1
E. coli	11.1	1
salmonella	11.1	1
Total	100	9

Figure 5, Prevalence of isolates from cooked meat collected from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).



Key: Coryn-corynebacterium, Entero-enterococcus, Myco-mycobacterium, E.coli- Escherichia Coli, Sal-salmonella

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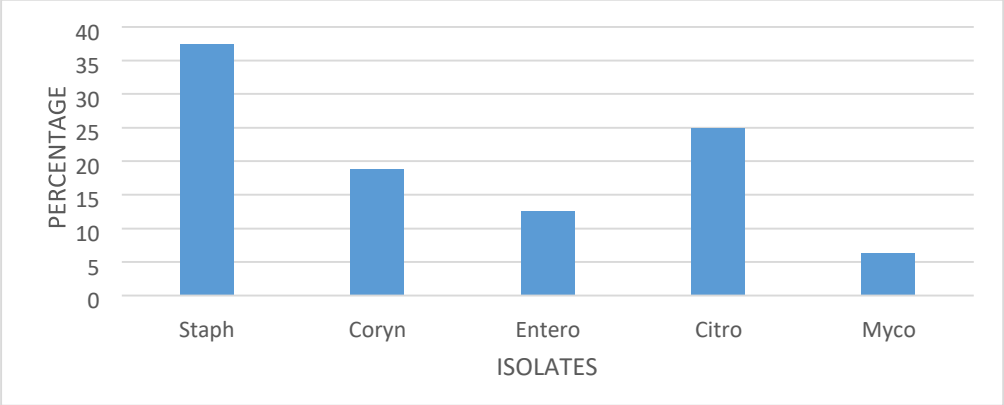
Table 5, Number and prevalence of isolates from raw meat collected from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

ISOLATES	PERCENTAGE	NUMBER
Staphylococcus	37.5	6
corynebacterium	18.8	3
enterococcus	12.5	2
citrobacter	25	4
Mycobacteria	6.3	1
TOTAL	100	16

Figure 6, Prevalence of isolates from raw meat collected from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).



Key: Staph-Staphylococcus, Coryn-corynebacterium, Enteroenterococcus, Citro-citrobacter, Myco-mycobacterium

Prevalence of isolates from cooked meat from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

9 isolates were obtained from cooked meat from all the five select markets. 4 isolates of corynebacterium spp (44.4%) were obtained from all the cooked meat samples. This was the most prevalent isolate in the cooked meat. mycobacterium spp, E. coli and salmonella had the least number of isolates with only 1 isolate of each (11.1%). enterococcus was also isolated (22.2%)

Prevalence of isolates from raw meat from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

From the raw meat samples, 16 isolates of pathogenic bacteria were identified and of these, staphylococcus aureus was the most prevalent with 6 isolates (37.5%) and mycobacterium spp being the least prevalent, 1 isolate (6.3%) corynebacterium 3(18.3%), enterococcus 2(12.5%) and citrobacter spp 4(25.0%) were also isolated. see table 4.5 and graph 4.5

Prevalence of isolates from vegetables (raw cabbages) from all the five selected markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

A total of 20 isolates were identified from the raw cabbages that were collected from all the five selected markets. Neisseria spp were the most prevalent, 12 (60%) and Citrobacter & corynebacterium were the least prevalent, 1 isolate of each (5.0%). 6 Moraxella spp were also identified (30%).

Prevalence of isolates in each of the five select markets of Wakiso district, Uganda.

All the markets had isolates identified, however NAMULANDA market had the highest percentage of isolates identified (24%), KATABI market had the least percentage (16%), whereas KISUBI had (23%), KAWUKU had (20%) and ABAYITA had (17%).

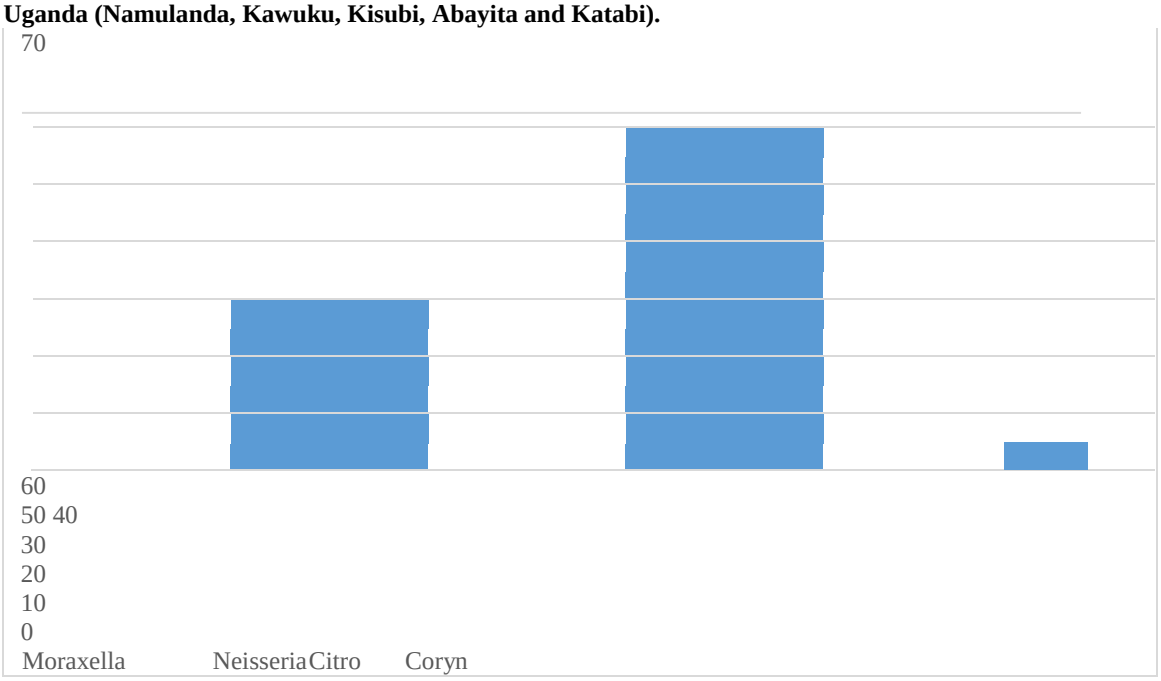
Prevalence of isolates per sample type (Chicken, meat or vegetables) in each of the selected five markets.

Amongst the chicken sample type, highest percentage of isolates was identified in KAWUKU market (50%) and the least in ABAYITA market (37.7%).
In the meat samples, ABAYITA market had the highest percentage of isolates (37.7%) and KATABI market had the least (21.4%) isolate.
whereas for the vegetable samples, KATABI had the highest percentage of isolates (35.7%) identified and NAMULANDA had the least isolates identified (21.1%).

Table 6 Number and prevalence of isolates from vegetables collected from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).

ISOLATES	PERCENTAGE	NUMBER
moraxella	30	6
neisseria	60	12
corynebacterium	5	1
TOTAL	100	20

Figure 7, Prevalence of isolates from vegetables collected from all the five select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita and Katabi).



Key: Citro-citrobacter, Coryn-corynebacterium

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Figure 8, Percentage Prevalence of Total Isolates Per market

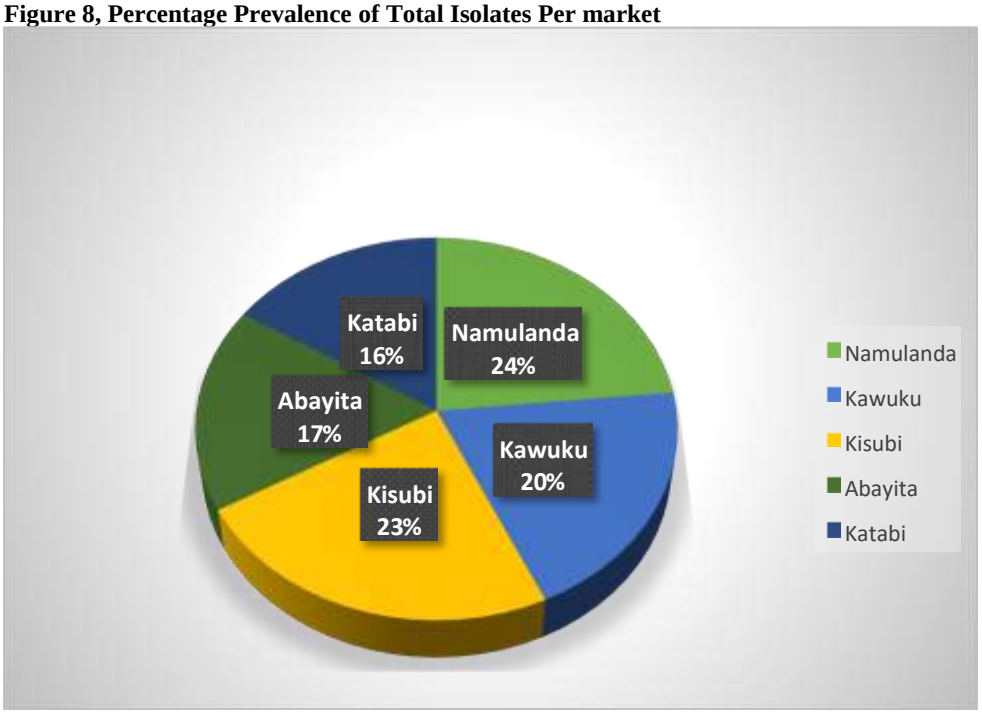
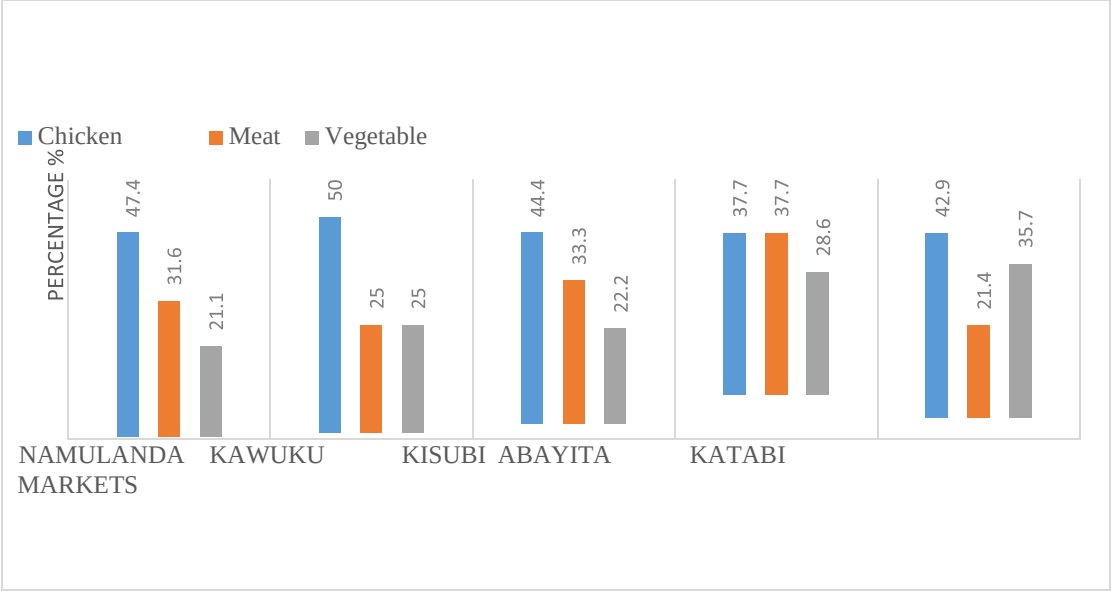


Figure 9, Percentage of Isolates Identified per Sample in Each of the Five Markets.



DISCUSSION

Prevalence of isolates in cooked, raw (chicken and meat) and vegetables (cabbage) from select markets of Wakiso district, Uganda (Namulanda, Kawuku, Kisubi, Abayita, and Katabi)

The results from the study indicated that Staphylococcus aureus and Corynebacterium spp had the highest prevalence (23.5%) while Serratia, E. coli, salmonella, and shigella had the least prevalence (1.2% each). To some extent, this was relatively in line with Eleonora's study (2021) since staphylococcus aureus was reported as one of the most common isolates from food samples yet to a greater extent there is a contradiction since, salmonella, E. coli, and shigella

were also listed as equally as high as staphylococcus aureus. Furthermore, there were barely any studies reporting the prevalence of Corynebacterium spp in meat, chicken, or vegetables even though this genus was equally prevalent to staphylococcus aureus from our study.

Despite both isolates' high prevalence, they were least isolated from cooked samples. Although the nature and design of the research limit the generalizability that cooking reduces the number of these pathogens, it does give an insight into the possibility because, in addition to this, raw samples generally had the highest prevalence of all isolates (72.8%) compared to the cooked samples (27.2%).

Chicken from all the five select markets.

From all the five markets, staphylococcus aureus spp was the most prevalent while enterococcus, mycobacterium spp, and serratia were the least prevalent. This was contrary to Alekhya et al (2021) who reported that salmonellarather than staphylococcus aureus was the most dominant isolate in chicken samples obtained from vendors in India. It portrays the factor of the contribution of the environment in contamination of food, let alone chicken. Coliforms were obtained only from samples of Namulanda, Kawuku, and Katabi hence giving an insight into the possibility of fecal contamination. corynebacterium spp was found in all chicken samples from the five markets.

Meat from all the five markets.

Staphylococcus aureus was the most prevalent isolate in meat though it was isolated from only three of the five markets i.e., Namulanda, Kawuku, and Kisubi. These three markets follow each other in the order stated and there is a possibility that they have similar practices when handling the meat before selling. The mycobacterium in the meat samples was more prevalent than that in the chicken samples. Coliform contamination was only detected in Namulanda, Abayita, and Kisubi. This suggests possible fecal contamination of unknown sources and due to the study design and methodology, thus data wasn't collected therefore future studies may address the possible sources of contamination of meat samples with all the identified pathogens.

Vegetables from the five markets.

All the vegetable samples from the five markets had Moraxella and Neisseria with neisseriadominating. This was contrary to previous studies like Vignesh et al (2018) where no Moraxella or Neisseria spp were isolated from any vegetable samples. The only third isolate from cabbage samples was Citrobacter spp from the Katabi central market.

Conclusion

Staphylococcus aureus and Corynebacterium species were the most prevalent isolates.
The prevalence of coliforms was lower than the other bacterial pathogens from all five markets.

Recommendations

The government should establish a stringent regional microbiological hazard surveillance system and later a national one to assess the safety of food staff, especially the street foods before selling.

Study limitations

The main limitation of the study was the lack of molecular characterization techniques for identifying the pathogenic bacteria to a strain level, a procedure that requires a qualitative PCR and specific primers.

Some important antibiotics under certain drug classes were also not available which narrowed AST to fewer drugs/antibiotics hence making it difficult to determine multi-drug resistance.

Acknowledgment

We'd like to acknowledge our guardians and everyone who supports us in every way. A special acknowledgment goes to Mr. Lujjimbirwa Fortunate, our research supervisor for being so helpful, considerate, and very supportive in every way possible.

List of abbreviations and acronyms

AST : Antimicrobial Susceptibility Testing
BEA : Bile Esculin Agar
DNA : Deoxyribose Nucleic Acid
MAC : MacConkey
MHA : Muller Hinton Agar
MSA ` : Mannitol Salt Agar
Ms-Word Excel: Microsoft-Word Excel
NA : Nutrient Agar
P. aeruginosa : pseudomonas aeruginosa
QA : Quality Assurance
QC : Quality Control
QTY : Quantity
S. aureus : staphylococcus aureus
SIM : Sulphur Indole Motility
SOPs : Standard Operating Procedures
TSI : Triple Sugar Iron
WHO : World Health Organisation

XLD : Xylose Lysine Deoxycholate
MRSA : Methicillin Resistant staphylococcus aureus
CA-MRSA : Community Associated MRSA
LA-MRSA : Livestock Associated MRSA

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