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Microbial Quality of Traditional Banana Alcoholic Beverages in Arusha, Tanzania

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Abstract
The objective of this study was to asses the microbial quality and hygienic practices of banana alcoholic beverages produced at Arusha region. The qualitative data were obtained by survey and laboratory analysis. The results from survey which involve interviewing the production attendant selected at random from 12 small scale processing industries showed that out of 12 respondents 66.7% were male and the majority of respondents 75% had primary education level (grade school) and large number of respondents 91.7% were not have any knowledge about food handling. Wine filling is done manually by 75% of all processors. Although all production attendants wash hands before wine fillings but 83.3% use normal soap instead of disinfectant.
Total count and coliforms was found ranging from 113-253 × 10^3cfu/ml, 92-254× 10^3cfu/ml and 0.075-3.8 × 10^3cfu/ml, 0.0015-0.77× 10^3cfu/ml for prebottled and bottled banana alcoholic beverages respectively. Confirmatory test was done for the presence or absence of E-coli and some samples confirmed to have E-coli. No Samonella was detected in any sample. The unhygienic processing and bottling of banana alcoholic beverages lead to serious bacterial contamination. Consuming such contaminated product may cause a public health problem.
Keywords: traditional banana alcoholic beverages, microbial quality, hygienic practices

INTRODUCTION

Banana *(Musa acuminate)* is the name given to a group of commodities that includes dessert bananas, cooking bananas and beer bananas. It not only represents the sweet dessert fruits, but is also a staple food of 400 million people in the underdeveloped and developing economies (Subbaraya *et al.,* 2006).

Bananas are staple food in most tropical countries where they are well grown and they are fourth important crop produced in the world after rice, wheat and maize (Jitrajoen, 2007).They are cultivated in more than 120 tropical countries in five continent of the world.

The estimated world banana production of banana is 106 millions tones and it ranks fourth in agricultural production. Bananas make the largest production of fruits and the largest international trade more than apple and melon (Jain and Priyadarshan, 2008).

In Tanzania, about 30-30% of the total population depends on bananas as a staple food. In the areas where banana farming system is practiced like Kilimanjaro, Arusha, Mbeya, Kagera and part of Morogoro and Tanga, 70-95% grow bananas and they depend on this crop as food or cash crop (Smale and Tushemereirwe, 2007).

Banana processing aims in reducing the post harvest loss, spoilage and increasing the income of households (Flores *et al.,* 2008). The government favors small scale processing industries which add values to the products including bananas (Mgenzi *et al.,* 2008). Banana can be processed in different forms and many value added products from bananas such as banana alcoholic beverages which is the type of bananas wine have been available commercially (Foure and Frison 1999).

Home made banana alcoholic beverages although they are made illegally are consumed in many parts of Africa including Tanzania, and many farmers and households depend on it as the main source of income (Pillay and Tenkouano, 2011). However unhygienic processing of varieties of brands has threaten the consumer health.

The African continent is rich with numerous traditional alcoholic beverages for example *burukutu*, *pitokaffir beer*, *buzaa* (maize beer), *malawa beer* , Zambian opaque beer, *28erissa*, *seketeh*, *bouza, talla* and *kishk* (Marshall and Mejia, 2011). In Tanzanian, some beers include *mbege* and *komoni* made from fermented bananas and maize respectively. Also, some traditional wines include *mnanasi*, *wanzuki*, *mofru* and *mnazi* also known as *tembo* and palm wine which is confined to the coast of Tanzania (Mwambete *et al., 2007*).

Unavailability of literature on these beverages, particularly regarding their production, consumption and quality is a major constraint against industrial production (Laswai *et al.,* 2007). The simple idea of commercializing tradition local drinks had profoundly impacted the community.

High rate of uncontrolled production and consumption of unsafe hygienically banana alcoholic beverage is associated with the low income. Lack in quality control and regulations of locally produced alcoholic beverages in most countries of Africa may possibly relate to health consequences. Possible sources of contamination in traditional brews include the wild yeast, bacteria from processing environment and

untreated water that may introduce pathogenic microbes, which may survive in alcoholic beverages with low alcohol content (Saria *et al.,* 2012)

Microbial contaminations associated with other local alcoholic beverages in Tanzania have been reported in different studies (Mwambete *et al.,* 2007; Shayo *et al.,* 2000). The aim of this paper is to asses the microbial quality and hygienic practices during processing and bottling of banana alcoholic beverages.

MATERIALS AND METHODS

Samples of bottled and pre-bottled banana alcoholic beverages were collected randomly from different producers in Arusha city, Northern part of Tanzania. In the collection of pre-bottled banana alcoholic beverages, 250mls bottles were sterilized in anautoclave at 121^0C for 15 minutes, prior to aseptic packaging in their respective bottles and sealed and kept in cool box cushioned with ice bags. After collection of one production attendant was selected randomly for interview.

After bottling, the bottled wines were collected immediately after released to the market and kept in the cool box cushioned with ice bags. All the samples were taken from the site while kept in the cool box and stored temporary in the refrigerator at 4^0C before analysis.

Microbiology analysis of banana alcoholic beverages

Determination of Total Count

This was done according to International standards (ISO, 2003) where twenty five milliliters (25mls) of wine was measured using a sterile measuring cylinder, and transferred into the bottle containing 225mls of pre-sterilized buffered peptone water and stirred to mix for one minute. This was referred as 10^{-1} dilution.

The aseptic transfer of 1ml of 10^{-1} dilution mixture was done to the bottles containing 9mls of buffered peptone water followed by serial dilution of the second bottle containing 9mls of buffered peptone water.

Following dilutions aseptic transfer of 1ml from each dilution to the sterile petri dishes was done followed by pouring 20-25 ml sterile plate count agar pre-cooled to 40^0C stirred to mix the contents then left to cool and solidify in the lamina flow followed by labeling according to dilutions made. After complete solidification all the petri dishes were incubated at 28-30^0C for 24-72 hours.

Following incubation petri dishes containing 30-300 colonies were counted and the results were recorded and presented as cfu/ml.

Determination of Total Coliforms

The international standards (ISO, 2006), was used in coliform determination in banana alcoholic beverages where five way most probable number (MPN) was opted. In the set three tubes (3 tubes) filled with 10mls of double strength selective enrichment media lauryl sulphate broth (LSB) and the other five sets of 5 test tubes were filled with 9mls of single- strength selective enrichment media (LSB) with durham tubes inside. All the test tube filled with the media, loosely caped and autoclaved at 121^0C at 15 minutes, and allowed to cool.

Four (4) serial dilutions were prepared from,(25mls of sample in 225mls) buffered peptone water (BPW) (10^{-1}), Under aseptic condition, 10mls of the initial dilution (10^{-1}) were transferred in the first three tubes containing the double strength selective enrichment media and caped.

Using a fresh sterile pipette, 1mls of the initial suspension (10^{-1}) was transferred in the second set of each test tube containing single-strength enrichment media and caped. This was also done for the remaining four (4) dilutions respectively. All inoculated tubes of the double- strength selective enrichment media lauryl sulphate broth (LSB) were incubated the incubator set at 37^0C for 24h to 48 hours.

Following incubation, 3 consecutive dilutions which showed good results were selected i.e.(showed gas formation and cloudness) counted and the numbers obtained were used for getting MPN values from MPN tables. The total *coliforms* were reported in cfu/ml in the sample.

Determination of *E-coli*

This was done by detection method according to international standards (ISO, 2005). The 25mls of sample was diluted in 225mls of BPW and thoroughly mixed. This makes a dilution of 10^{-1}.

Using a fresh sterile pipette, 1mls of the initial suspension (10^{-1}) was transferred in test tube containing double-strength enrichment media and caped. The inoculated media was incubated at 37^0C for 24h±2hrs.

The test tubes which show gas formation were used for *E- coli* detection where by 1mls of the sample was used to inoculate in *E-coli* broth and incubated at 44^0C for 48hrs±2hrs.

Following incubation, I mls of incubated sample were added in the sterile indole free peptone followed by addition of 0.5mls of Kovaacs reagents after 2 days of incubation, mixed well and examined after 1 minute. A pink colored ring indicates the presence of E-coli in the incubated sample.Results were presented

as presence or absence of *E-coli* in 1ml of a sample

Determination of *Salmonella*

The international standard (ISO, 2002) was opted for determination of *Samonella* in banana alcoholic beverages. The 25mls of sample was diluted in 225mls of BPW and thoroughly mixed. This makes a dilution of 10^{-1}.

Using a fresh sterile pipette, 1mls of the initial suspension (10^{-1}) was transferred in test tube containing double-strength enrichment media and caped followed by incubation at 37^0C for 48hours

The inoculated tubes were used to inoculate Salmonella enrichment media by transferring 1ml from enrichment media and incubated at 37^0C for 48hrs ±2hrs.

The rapid salmonella strips (coated with salmonella antibodies) were used to determine the presence of Salmonella by immersing the strip in the test tube with *Salmonella* enrichment media.

The appearance of one red line (control) on the strip indicates negative results, while the appearance of two red lines on the strip indicates positive results.

RESULTS

Hygienic practices during banana alcoholic beverages processing

The results of survey presented this section are divided into three sections; section one is reflecting the demographic and social characteristics, section two shows response on hygienic practices from food handlers/production attendants and last section general observation of the layout of equipment and other facilities processing.

Demographic characteristics

Table 1 shows demographic and social characteristics of the respondents from different locally processed banana alcoholic beverages industries who were involved in the study. The demographic characteristic included sex while social characteristic involved in the study was level of education. Out of 12 respondents eight (66.7%) and four (33.3%) were male and female respectively.

The majority of respondents 75% had primary education level (grade school) where by 8.3% attended high school and 16.7% had college/university education. The results showed that 8.3% of production attendants were having the knowledge of food handling while 91.7% were not have any knowledge about food handling.

Variable	Categories	n	%
Sex	Male	8	66.7
	Female	4	33.3
Education	Grade school	9	75.0
	High school	1	8.3
	College	2	16.7
Knowledge of food handling	Yes	1	8.3
	No	11	91.7

Table 1 *Demographic and Social Characteristics of Production Attendants Involved in the Study* (N=12)

Hygienic practices adopted in banana alcoholic beverages processing

The results revealed that 100% of the production attendants wear protective clothes and gear. However, 50% do not remove them when they go outside the processing area. Also, (50%) of the processors use water from well followed by (33.3%) and (16.7%) of the processors who use tape and springs water respectively.

About water treatment, it was found that 75% of processors wash bottle with unboiled and untreated water. As far as hygienic manual is concerned (91.7%), banana alcoholic processors, do not have hygienic instruction manual in the processing areas. Only 58% pasteurize the bottles after washing and only 40% understand the pasteurization temperature, two respondents had no idea. Wine filling is done manually by 75% of all processors. Although all production attendants wash before wine fillings but 83.3% use normal soap instead of disinfectant.

Variable	Category	n	%
Washing hands after visiting to toilet	Yes	10	83.3
	No	2	16.7
Type of soap used	Normal	10	83.3
	Disinfectant	2	16.7
Use of protective clothes and gear	YES	12	100.0
	No	0	0
Going outside processing area with protective clothes and gear	Yes	6	50.0
	No	6	50.0
Source of water	Tape water	4	33.3
	Wells	6	50.0
	spring water	2	16.7
Water treatment	Yes	4	33.3
	No	8	66.7
Availability of hygienic instruction manual	Yes	1	8.3
	No	11	91.7
Washing bottle with unboiled and untreated water	Yes	3	25
	No	9	75
Bottle pasteurization after washing	Yes	7	58.3
	No	5	41.7
Understanding pasteurization temperature	Yes	2	40
	No	5	60
Wine filling	Manually	9	75.0
	Machine	2	16.7
	both	1	8.3
Washing hands before filling wine in the bottle manually	Yes	12	100
	No	0	0
Kind of soap used for washing hands	Normal	10	83.3
	Disinfectant	2	16.7

Table 2 Hygienic Practices Adopted During Processing of Banana Alcoholic Beverages

Layout of processing equipments and other facilities

In the designing of the processing area, 58.3% designed in such a way that there was a direct flow of raw materials to the finished product which minimizes the possibility of cross contamination.

Microbiological analysis results

The processing of banana alcoholic beverages involves mainly four principal steps: Banana ripening, cooking of peeled ripe banana, juice extraction and fermentation. After juice extraction process, the subsequent steps do not involve the heating or cooking process and if enough precautions are not taken contaminations are likely to occur rendering the final product unfit for human consumption.

The microbial count were found ranging from 83-275 $\times 10^2$cfu/m and 47-283 $\times 10^2$ cfu/ml in pre-bottled and bottled banana alcoholic beverages (Table 1 and 2). No Samonella was detected in any brand; however 20.8% and 33.3% of pre-bottled and bottled banana alcoholic beverages respectively were detected to have *E-coli*. Total coliforms were found ranging from 0.075-3.8$\times 10^3$cfu/ml and 0.0015-0.77$\times 10^3$cfu/ml in pro-bottled and bottled banana alcoholic beverages respectively.

Producer	Sample replication	Total count ($\times 10^2$) cfu/ml	*Escherichia coli*	*Salmonella*	Total coliform($\times 10^{3)}$ cfu/ml
1	1	148	-	-	-
	2	94	-	-	-
2	1	114	+	-	3.8
	2	112	-	-	-
3	1	186	-	-	-
	2	131	-	-	-
4	1	143	-	-	
	2	207	+	-	2.05
5	1	128	-	-	
	2	201	-	-	3.15
6	1	173	-	-	
	2	253	-	-	
7	1	152	-	-	
	2	133	+	-	3.4
8	1	115	-	-	
	2	251	-	-	0.075
9	1	130	-	-	
	2	83	-	-	
10	1	207	+	-	2.65
	2	192	-	-	
11	1	179	-	-	
	2	256	+	-	2.4
12	1	231	-	-	
	2	275	-	-	

Table 3: Microbial Results of Pre-bottled Banana Alcoholic Beverages

Producer	Replication	Total count ($\times 10^2$) cfu/ml	*Escherichia coli*	*Salmonella*	Total coliform($\times 10^{3)}$ cfu/ml
1	1	112	-	-	
	2	275	-	-	
2	1	145	+	-	0.35.
	2	202	-	-	
3	1	261	-	-	
	2	247	-	-	
4	1	135	-	-	
	2	209	+	-	0.06
5	1	173	+	-	0.37
	2	215	+	-	0.155
6	1	121	-	-	
	2	119	-	-	
7	1	227	-	-	
	2	233	+	-	0.77
8	1	123	-	-	
	2	144	-	-	
9	1	68	+	-	0.37
	2	116	-	-	
10	1	207	+	-	0.06
	2	257	-	-	
11	1	47	-	-	
	2	157	+	-	0.015
12	1	283	-	-	
	2	174	-	-	

Table 4: Microbial Results for Bottled banana Alcoholic Beverages
+/- Presence or absence of *E-coli*

Sample	Mean cfu/ml(10^2) pre-bottled banana alcoholic beverages	Mean cfu/ml(10^2) bottled banana alcoholic beverages
1	121.00 ± 27	193.50 ± 81.5
2	113.00 ± 1.0	173.50 ± 28.5
3	158.50 ± 27.5	254.00 ± 7.0
4	175.00 ± 32	172.00 ± 37
5	164.50 ± 36.5	194.00 ± 21
6	213.00 ± 40	120.00 ± 1.0
7	142.50 ± 9.5	230.00 ± 3.0
8	183.00 ± 68	133.50 ± 10.5
9	106.50 ± 23.5	92.00 ± 24
10	199.50 ± 7.5	232.00 ± 25
11	217.50 ± 38.5	102.00 ± 55
12	253.00 ± 22.0	228.50 ± 54.5

Table 5 Mean Total Count for Bottled and Pre-bottled Banana Alcoholic Beverages

Discussion

The processing methods of banana alcoholic beverages in most industries are remarkably similar. Many processors learned from the neighbor industry or start their own industry after being employed in these small industries regardless of their education only what matters is experience gained. Also many employees' workers are employed regardless of their education and the males are highly preferred to females because they can manage to use the manual filling machine. Lack of education on the part of food handlers has resulted in negligent practices, especially relating to sanitation and hygiene, during and post-production of indigenous traditional products (Lyumugabe *et al.,* 2010).

Hygienic Practices During Banana Alcoholic Beverages Processing

Hygienic Adopted

Large percentages of aspects which are related with hygienic practices are not practiced in locally processed banana alcoholic beverages. Many processors and production attendants do not have the enough education to ensure production of the product under hygienic condition. Also, the operations of these industries are at elementary level so the limitations of fund hinder the implementation of hygienic programs such as training and purchasing of equipments and disinfectants for cleanliness. Studies have revealed that unhygienic handling, external contamination, contaminated water and inferior quality of raw material, of many fermented foods may get contaminated by bacteria such as *Escherichia coli*, *Salmonella*, and many other pathogens (Roy *et al.,* 2007). Although high percent of respondent (83.1%) Wash hands after visiting latrines before entering the processing area, they use the normal soap instead of disinfectant which is capable in killing microorganisms. Fawz *et al.,* 2009 reported that people in the food production and foodservice industries should be well trained and motivated to follow good personal hygiene practices, to use correct hand washing procedures and to follow these procedures while working in order to prevent the spread of infection.

Fifty percent of the production attendants misuse the working clothes and protective gears. Also, the findings have revealed that (50%) of the processors use water from well followed by (33.3%) and (16.7%) of the processors who use tape and springs water respectively.

Gloves are one of physical barrier which reduce the transfer of pathogens to the food surface from the hands of a food worker, other foods, or from the environment. Work clothes should be strictly for work wearing it outdoors can carry undesirable microorganisms, including pathogens (Todd *et al.,* 2010). The habit of wearing the aprons outside processing area might be the source of contamination of banana alcoholic beverages.

Water treatment in the processing banana alcoholic beverages industries is not a common practice. It was found that 75% of processors wash bottle with unboiled and untreated water. Many small scale processing industries (91.7%) do not have hygienic instruction manual in the processing areas. According to Kirby *et al.,* 2003, water like food, is a vehicle for the transmission of many agents of disease and continues to cause significant outbreaks of disease in developed and developing countries world-wide. So, the untreated water may be the source of contamination of banana alcoholic beverages.

Only 58% pasteurize the bottles after washing and only 40% understand the pasteurization temperature, two respondents had no idea. Pasteurization is important in order to prolong the shelf life and assure the stability of the foods and drinks Kourtis and Arvanitoyannis 2001). Negligence of bottle pasteurization in small scale banana producing industry make quality of this product questionable because contamination may occur during bottling..

Wine filling is done manually by 75% of all processors. Greig *et al.,* (2007), reported that bare hand of food handlers direct in contact with food is likely the source of contamination which may lead to food born diseases. Although all production attendants wash before wine fillings but 83.3% use normal soap instead of disinfectant. Washing hands using plain soap or normal domestic soap with water can physically remove a certain level of microbes, but antiseptic agents are necessary to kill microorganisms (Pittet, 2001).

Observation of Layout of Processing Equipments and Other Facilities

In the designing of the processing area, 58.3% designed in such a way that there was a direct flow of raw materials to the finished product which minimizes the possibility of cross contamination. According to Reij and Den Aantrekker, (2004), the correct hygienic design and proper maintenance of equipment are crucial to avoid recontamination through. Poor designing of equipment and other facilities observed in some banana alcoholic beverages industries may be the source of contamination.

Microbiological Analysis

Total Count

From table 3 the pre-bottled banana alcoholic beverages contain high microbial counts ranging from 83-275 $\times 10^2$cfu/ml, however the number was found lower after bottling ranging from 47-283 $\times 10^2$ cfu/ml (Table 4). Similar results were obtained by Obaedo and Ikenebomeh, (2009), where by bacteria counts increased during the early days of fermentation and thereafter decreased during the production of banana wine. Also, results agreed with that found by (Sanni *et al.,* 1999). The reduction in the microbial population was obtained in the deteriorating beverages *pito,seketen* and *burukutu.*

The high counts in prebottled banana alcoholic beverages could be attributed to a possibility of the growth of different micro-organisms present in banana alcoholic beverages because it acts as a non-selective media. However, high microbial metabolites and nutrient depletion contributed to the decrease of microbial load in the bottled banana alcoholic beverages.

The standard established by Tanzania Bureau of standards for microbial requirements for microbial requirements in banana alcoholic beverages is1×10^4 cfu/ml. For the bottled and pre-bottled banana alcoholic beverages (N=24), 91.67% of both samples exceed the established standards. The presence of large number of bacteria count in food is an indicator of improper food hygiene. Two pre-bottled and bottled brands of banana alcoholic beverages meet the required specification this may be attributed to the possibility of proper and good manufacturing practices from the production line.

Measuring total plate count is a convenient tool in assessing the general microbial contamination of foods and beverages (Simango and Rukure, 1992). The high total count uncounted in pre-bottled and bottled banana alcoholic beverages (Table 3 and 4) could have resulted from contamination from handlers during fermentation and post-fermentation especially the habit of not washing hands and addition of raw water in subsequent process.

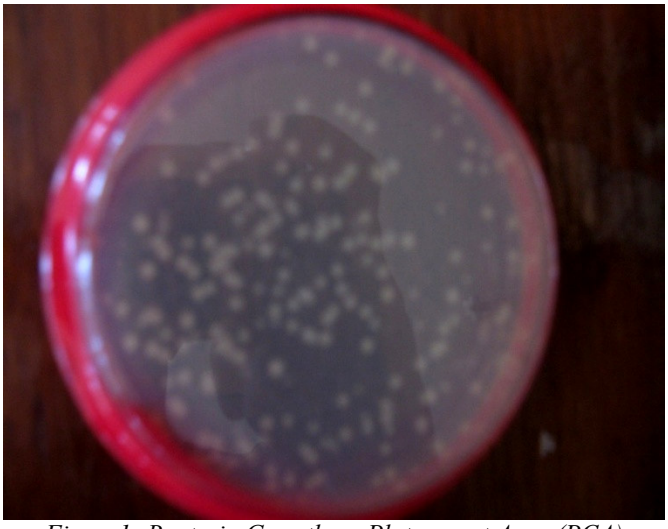

Figure1: Bacteria Growth on Plate count Agar (PCA)

Salmonella

The results in table 3 and 4 shows no *Salmonellas* were detected in pre-bottled and bottled banana alcoholic beverages. The study done by Sugita-Konishi, *et al.,* (2001), revealed that red and white wines decreased the

bacteria count of *Samonella enteridis* and *E-coli* from 10^5 cfu/ml to undetectable level within 30 minutes. Also, in the microbial analysis of two brands of banana alcoholic beverages produced in Rwanda, *no Samonellas* were detected in either brand (Shale*, et al.,* 2012).

The study on survival of strains of bacterial enteric pathogens was investigated in two traditional fermented foods (mahewu and sour porridge) and in unfermented porridge produced in Zimbabwe (Simango and Rukure, 1992). The *Samonellas* were not found 4 h after inoculation in either fermented foods.

Also, effect of fermentation of sorghum flour on the survival of a single strain of *Salmonella typhimurium* revealed that the fermented sorghum flour and porridge inhibited the growth of *Salmonella typhimurium* (Mensah*,* 1997). This shows that *Salmonella species* do not survive in fermented foods and beverages.

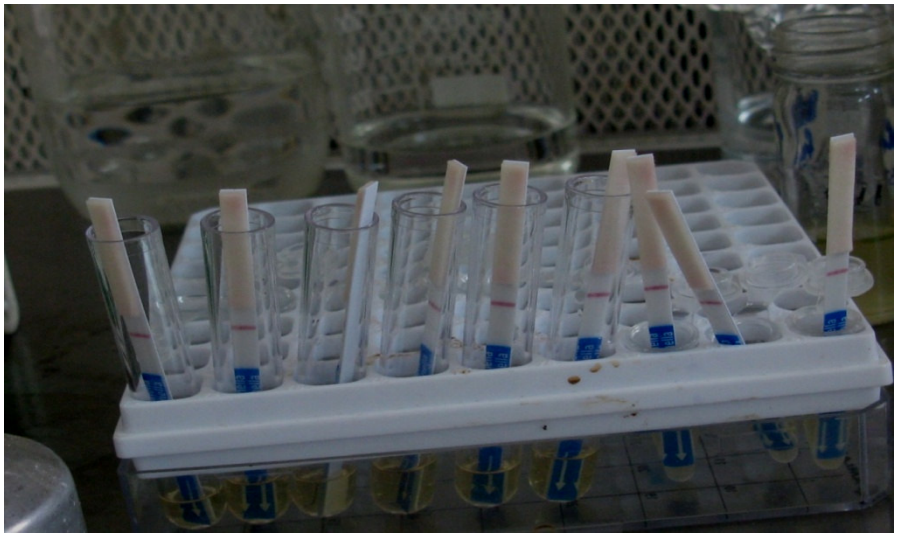

Figure 2: Negative results for Salmonella (Two Red Strip Means Positive Test)

***E-coli* Detection**

Escherichia coli were detected in both pre-bottled and bottled banana alcoholic beverages in 5 samples (20.8%, N=24) and 8 samples (33.3%, N=24) respectively. Three banana alcoholic beverages were contaminated with *E-coli* during packaging, because they were found to contain *E-coli* after bottling. The study made by Mensah, (1997), revealed that *Escherichia coli* appears to survive for longer periods in fermented food products such as fermented maize dough.

The similar study was done in Rwanda, where Samples of traditional sorghum beer *Ikigage*_were subjected to microbial analysis and found to contain *E-coli* (21.90 x 10^3 cfu/ml). The presence of *E. coli* indicates a contamination of fecal origin (Lyumugabe *et al.,* 2010) According to Tanzania Bureau of Standards, (2003), food intended for human consumption should not contain *coliform* hence *E-coli* as a coliform group should not found in foods.

Large percentage 80.2 %,(N=24) and 66.7% (N=24) of pre-bottled and bottled banana beverages respectively were free of *E-coli*. Wines made from fruits other than apples show antimicrobial activity (Bish, 2011). At 40% fruit wine concentration, numbers of all foodborne pathogens including *Escherichia coli* tested were significantly reduced compared to a 0% wine solution control.

The absence of *E-coli* in large number of banana alcoholic beverages might be caused by inability to survive in high concentration of banana alcoholic beverages. Although the *E-coli* have existed in some banana alcoholic beverages, they are likely to disappear after a long period of fermentation as they have reported to decrease to undetectable level within 30 minutes in red and white wines (Sugita-Konishi *et al.,* 2001).

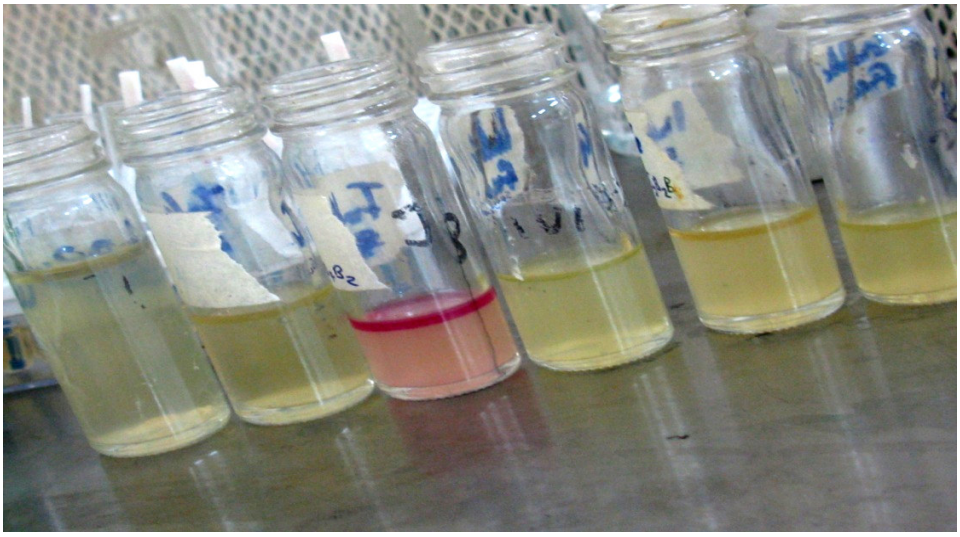

Figure 3: One of the Positive test for E- coli after Addition of Kovaacs Reagent (Bottle with Pink Ring Means Positive Results).

Total Coliform Enumeration

The coliforms decreased as the pH decreased after bottling. Mensah, 1997, report the work of Mbugua who obtained similar results in fermented maize product which showed complete inhibition of all coliforms after 24h when the pH of the maize slurry had decreased. Large number of Coliforms (32.30 x 10^3 cfu/ml) were obtained in traditional sorghum beer Ikigage (Lyumugabe *et al.,* 2010), however their trend of survival in this fermented product was not explained in the study.These results disagree with the results of the current study.

The decrease in Coliforms is associated with fall in pH (increase of total acidity).There was a decrease in pH in bottled banana alcoholic beverages. The rate of growth of pathogenic microorganism is likely contributed to the fall in pH, as a result of fermentation which continue further after fermentation.

The results from the study of *orubis* a traditional alcoholic beverage in the north-western region of Tanzania, showed the presence of high number of total coliforms 1.18×10^2 cfu/ml (Shayo *et al.,* 2000). The presence of high number of coliforms renders the food product unsuitable for human consumption as well as endangers the public health.

According to Tanzania standards wine should be free from, coliforms and other pathogenic microorganisms (Tanzania Bureau of Standars, 2003). The presence of coliforms in banana alcoholic beverages is probably due to untreated water used for processing, poor personal hygiene, improper handling of raw materials, fermenting vessels, storage containers and utensils and lack of direct processing flow which is crucial in processing industry in elimination of contamination.

Conclusion

In Arusha, the majority of people consume banana alcoholic beverages. The food attendants are not well educated and many lack education on hygienic and food handling. Not only that but also they do not apply hygienic practices during banana alcoholic beverages processing. This may lead to high contamination of the banana alcoholic beverages. The presence of high total bacteria count,*E-coli* and total coliforms in pre-bottled and bottled banana alcoholic beverages represent high risk associated with consumption of contaminated banana alcoholic beverages.

In order to reduce the healthy risk associated with the consumption of contaminated banana alcoholic beverages hygienic practices should be observed during processing of banana alcoholic beverages and training the production attendants about proper food handling procedures so as to prevent contamination and achieve high quality standard of the products

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References

Bish, T. J. (2011). Inactivation of foodborne pathogens by fruit wines. University of Missouri--Columbia.

Fawzi, M., Gomaa, N. F., & Bakr, W. (2009). Assessment of hand washing facilities, personal hygiene and the bacteriological quality of hand washes in some grocery and dairy shops in alexandria, egypt. *The Journal of the Egyptian Public Health Association, 84*(1-2), 71.

Flores, W., Gonzales, I., Akinyemi, S., Staver, C., Ngoh, G., Junkin, R., et al. (2008). *musa processing businesses their contribution to rural development.* Paper presented at the International Conference on Banana and Plantain in Africa: Harnessing International Partnerships to Increase Research Impact 879.

Fouré, E., & Frison, E. (1999). *Bananas and food security*: Bioversity International.

Greig, J. D., Todd, E. C., Bartleson, C. A., & Michaels, B. S. (2007). Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 1. Description of the problem, methods, and agents involved. *Journal of Food Protection®, 70*(7), 1752-1761.

ISO. (2002). *Microbiology of food and animal feeding stuffs-Horizontal method for detection of Salmonella spp*: International Organization For Standardization.

ISO. (2003). *Microbiology of food and animal feeding stuffs-Horizontal method for the enumeration of microrganisms-Colony-count techniques* (Vol. ISO 4833:2003(E)): International Organization for Standardization.

ISO. (2005). *Microbiology of food and animal feeding stuffs-Horizontal method for detection and enumeration of presumptive Escherichia coli-Most probable number techniques* (Vol. ISO 4833:2003(E)): International Organization for Standardization.

ISO. (2006). *Microbiology of food and animal feeding stuffs-Horizontal method for detection and enumeration of coliforms-Most probable number techniques* (Vol. ISO 4831:2006): Internation Organization for Standardization.

Jain, S. M., & Priyadarshan, P. (2008). *Breeding plantation tree crops: tropical species* (Vol. 1): Springer.

Jitjaroen, W. (2007). *Influence of yeast strains and nutritive supplements on enological characteristics of tropical fruit wines*: Cuvillier Verlag.

Kirby, R. M., Bartram, J., & Carr, R. (2003). Water in food production and processing: quantity and quality concerns. *Food control, 14*(5), 283-299.

Kourtis, L., & Arvanitoyannis, I. (2001). Implementation of hazard analysis critical control point (HACCP) system to the alcoholic beverages industry. *Food Reviews International, 17*(1), 1-44.

Laswai, H., Wemdelin, A., Kitabatake, N., & Mosha, T. (1997). The Under-Exploited Indigenous Alcoholic Beverages of Tanzania: Production, Consumption and Quality of the Undocumented" Denge". *African Study Monographs, 18*(1), 29-44.

Lyumugabe, F., Kamaliza, G., Bajyana, E., & Thonart, P. (2010). Microbiological and physico-chemical characteristic of Rwandese traditional beer" Ikigage". *African Journal of Biotechnology, 9*(27), 4241-4246.

Marshall, E., & Mejia, D. (2011). *Traditional fermented food and beverages for improved livelihoods*: FAO.

Mensah, P. (1997). Fermentation—the key to food safety assurance in Africa? *Food control, 8*(5), 271-278.

Mgenzi, S., Mshaghuley, I., Staver, C., & Nkuba, J. (2008). *Banana (Musa spp.) Processing Businesses: Support Environment and Role in Poverty Reduction in Rural Tanzania*. Paper presented at the International Conference on Banana and Plantain in Africa: Harnessing International Partnerships to Increase Research Impact 879.

Mwambete, D., Justin-Temu, M., Mashurano, M., & Tenganamba, O. (2007). Microbial Quality of Traditional Alcoholic Beverages Consumed in Dar es Salaam, Tanzania. *East and Central African Journal of Pharmaceutical Sciences, 9*(1), 8-13.

Obaedo, M., & Ikenebomeh, M. (2009). Microbiology and Production of Banana (Musa sapientum) Wine. *Nigerian Journal of Microbiology, 23*(1), 1890-1895.

Pillay, M., & Tenkouano, A. (2011). *Banana breeding: progress and challenges*: CRC Press Inc.

Pittet, D. (2001). Improving adherence to hand hygiene practice: a multidisciplinary approach. *Emerging infectious diseases, 7*(2), 234.

Reij, M., & Den Aantrekker, E. (2004). Recontamination as a source of pathogens in processed foods. *International Journal of Food Microbiology, 91*(1), 1-11.

Roy, A., Moktan, B., & Sarkar, P. K. (2007). Microbiological quality of legume-based traditional fermented foods marketed in West Bengal, India. *Food control, 18*(11), 1405-1411.

Sanni, A., Onilude, A., Fadahunsi, I., & Afolabi, R. (1999). Microbial deterioration of traditional alcoholic beverages in Nigeria. *Food research international, 32*(3), 163-167.

Saria, J. A., Kyobe, J. W. M. P., & Donnat, M. (2012). Tanzanian Local Alcoholic Beverages: Quality and Health Risks. *TaJONAS: Tanzania Journal of Natural and Applied Sciences, 3*(1), 489-494.

Shale, K., Mukamugema, J., Lues, R., Venter, P., & De Smidt, O. (2012). Microbiota associated with commercially produced traditional banana beer in Rwanda. *Scientific Research and Essays, 7*(47), 4037-4046.

Shayo, B. K., A. AB Gidamis,AB. SAM Nnko, N. (2000). Aspects of manufacture, composition and safety of orubisi: a traditional alcoholic beverage in the north-western region of Tanzania. *International journal of food sciences and nutrition, 51*(5), 395-402.

Simango, C., & Rukure, G. (1992). Survival of bacterial enteric pathogens in traditional fermented foods. *Journal of Applied Microbiology, 73*(1), 37-40.

Smale, M., & Tushemereirwe, W. (2007). *An economic assessment of banana genetic improvement and innovation in the Lake Victoria region of Uganda and Tanzania* (Vol. 155): International Food Policy Research Inst.

Subbaraya, U., Lutaladio, N. B., & Baudoin, W. O. (2006). FARMERS'KNOWLEDGE OF WILD MUSA IN INDIA. *Food and Agriculture Organization of the United Nations*, 33-36.

Sugita-Konishi, Y., Hara-Kudo, Y., Iwamoto, T., & Kondo, K. (2001). Wine has activity against entero-pathogenic bacteria in vitro but not in vivo. *Bioscience, biotechnology, and biochemistry, 65*(4), 954-957.

TBS. (2003). *Fruit wine specification* (Vol. TZS 664:2003). Dar-es-salaam.

Todd, E. C., Michaels, B. S., Greig, J. D., Smith, D., Holah, J., & Bartleson, C. A. (2010). Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 7. Barriers to reduce contamination of food by workers. *Journal of Food Protection®, 73*(8), 1552-1565.

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