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(RESEARCH ARTICLE)

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Bacterial contamination of syrups in households found in squatter settlements of Mwanza city, Tanzania: A health threat to the community

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Abstract

Bacterial contamination of syrups due to improper handling or poor adherence to storage conditions cause spoilage of the products which might lead to serious clinical hazardous problems. Data on the microbiological quality of different syrups at community pharmacy and hospital level is well established. However, there is paucity of data (globally) on microbial contamination of syrups at household level. Therefore, the present study aimed at establishing the magnitude of bacterial contamination in syrups obtained from households and associated factors. About 292 of syrup samples of different types were taken to the microbiology laboratory for analysis as per established protocols. Data were analysed using STATA version 13 following the objectives of the study. A total of 292 syrups were sampled with average of 3.29 syrup type per household. Households found with contaminated syrups were 12 out of 89 (13.5%), whereas the total number of contaminated syrups in these households was 15 (5.1%). The most common bacterial species found as contaminant was *Pseudomonas aeruginosa* 4 (36.4%) followed by *Enterobacter cloacea* 2 (18.2%) and *Klebsiella pneumoniae* 2 (18.2%). A sufficient amount of syrups stored at households were presumably bacteriologically contaminated. The general public needs to be educated on proper handling and storage of liquid pharmaceutical products as a key aspect in eliminating cross-contamination of these products.

Keywords: Bacteriological contamination; Syrups; Households; Tanzania

1. Introduction

Oral liquids such as syrups have been extensively used in the treatment of many diseases in pediatric patients. Contamination is the undesired introduction of impurities (chemical or microbiological or foreign matter) onto a starting material, intermediate product or finished product during production, packaging, storage or transportation [1]. Following that, non-sterile preparations are required to pass bioburden tests [2]. Despite the inclusion of preservatives in syrups, still many cases of bacterial contamination have been reported and contaminants range from true pathogens such as *Clostridium* species to opportunistic pathogens such as *Pseudomonas aeruginosa* [3]. The contamination of these preparations with potentially pathogenic organisms constitute serious threat to children because their immune system is poorly developed [4]. Bacterial contamination of syrups can cause the spoilage of the products and lead to serious clinical hazardous problems [5]. Metabolic activities of bacteria may lead to the changes in physicochemical properties of the ingredients found in these products [6, 7]. Syrups are required to be free of *E. coli* and other coliforms, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and other pathogens whereas permissible bacteria (non-pathogenic bacteria) must not exceed 10^3 CFU/ml of syrup [8]. The major health concern arises when microbial growth in syrups exceeds the limit for non-pathogenic bacteria or there is contamination with pathogenic bacteria [9]. Microbial contamination of syrups may be due to inappropriate composition of preservatives, improper handling and poor adherence to storage conditions [9, 10]. Contamination of syrups with different pathogens can lead to secondary

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bacterial infections in children, increase in the number of resistant bacterial species, toxicity, wastage and decrease in effectiveness of these products (as a result of physicochemical changes) in the treatment of the respective diseases [4, 8, 11, 12].

Many studies on the microbiological quality of many different syrups sold in pharmacies and hospitals have been conducted [11, 13, 14], but little is known for the microbiological quality of these products at the level of household in Mwanza City and many other places where self-medication prevails. It must be emphasized that, majority of cases of medicine related infections are not reported or recorded [15] and poor storage of medicines at homes is a source of contamination [16]. Therefore, this study will evaluate the magnitude of bacterial contamination of syrups from households in Mwanza city so as to inform stake holders for appropriate safety interventions.

2. Material and methods

2.1. Study site and sample collection

This cross-sectional study was conducted in the squatter settlements (Kirumba, Igogo and Mbugani) of Mwanza city. In the current study squatters were defined according to UN-HABITAT as areas that have inadequate access to safe water and sanitation, poor structural quality of housing, overcrowding, insecure residential status and missing good infrastructure [17, 18]. Respondents were informed in details about the study and then requested to voluntarily participate. Socio-demographic and clinical information were collected using questionnaires. Syrup samples were collected aseptically into a sterile screw capped container for laboratory analysis. Different samples of syrup of different brand names were collected from different households in Mwanza city, Tanzania.

2.2. Preparation of sample dispersions

The head of the family were requested for the small amount of the syrup (1mil to the sterile vacutainer tubes) for microbiological isolation and quantification of bacteria. The sample was transported to the microbiology laboratory within 4 hours of collection in 4-8 degrees of centigrade. Two mls of each syrup sample were added separately in 8mls of sterile normal saline to make the volume of 10mls with gentle agitation. The dispersions formed were then left to settle for approximately five minutes so as to dislodge possible microbial cells.

2.3. Isolation and identification of bacterial contaminants

A total of 20µl from each of the dispersions made was taken and spread onto blood agar and MacConkey agar and then incubated at 35-37^{0}C for 18 – 24 hours so as to support the growth of bacteria cells. Identification of bacteria isolates based on gram stain reaction, hemolysis on blood agar, catalase, coagulase, bacitracin (BA), optochin (OP), trimethoprim/sulfamethoxazole (SXT), CAMP test and Bile esculin tests (for gram positive bacteria) and gram stain reaction, lactose fermentation on MacConkey agar, oxidase, urease, citrate, sulfur indole and motility (SIM) and triple sugar iron (TSI) tests for gram negative bacteria [19] .

2.4. Data Analysis

Data was entered into excel sheet for consistence check and then exported to the STATA software for analysis. Continuous variables were described as mean (+/-standard deviation) or median (interquartile range). Categorical variables were described as proportion and were analyzed to compare the significance of difference in distribution of syrups contamination with variables using chi-square test or Fisher's exact test where appropriate. The difference in distribution was considered significant if p-value will be less than 0.05 at 95% level of confidence interval.

3. Results

3.1. Baseline information of the study respondents

The study included 89 households where by among respondents (head of the family responsible to give medicine to the children) males accounted for 44 (49.4%) and females 45 (50.6%). Majority of respondents resided at Kirumba ward 34 (38.2%) and were primary school leavers 47(52.8%).

Table 1 Baseline information of the study respondents

Social demographic		frequency	percentage
Sex	Male	44	49.4
	Female	45	50.6
Education	Illiterate	1	1.2
	Primary	47	52.8
	Secondary	35	39.3
	College	6	6.7
Residence	Igogo	29	32.6
	Kirumba	34	38.2
	Mbugani	26	29.2

3.2. Proportion of the contaminated syrups in the households

The most common syrup collected was paracetamol, 42 (14.4%) and Mucolyn, 37 (12.7%) (Table 2). Households found with the contaminated syrups were 13.5% (12/89); whereas the total number of contaminated syrups in these households was 5.1% (15/292). Metronidazole (fragyl) was the most contaminated syrup 14.3% (Table 2).

Table 2 Types of syrups collected from households and their contamination

Type of syrup	Collected N (%)	Contamination N (%)
Paracetamol	42 (14.4)	1(2.4)
Mucolyn (ammonium chloride)	37 (12.7)	2(5.4)
Coldril	16 (5.5)	1(6.3)
Zentuss	15 (5.2)	0(0.0)
Fragyl (metronidazole)	14 (4.8)	2(14.3)
Others*	168 (57.4)	9(5.4)
Total	292 (100)	15 (5.1)

3.3. Bacterial species found as contaminants

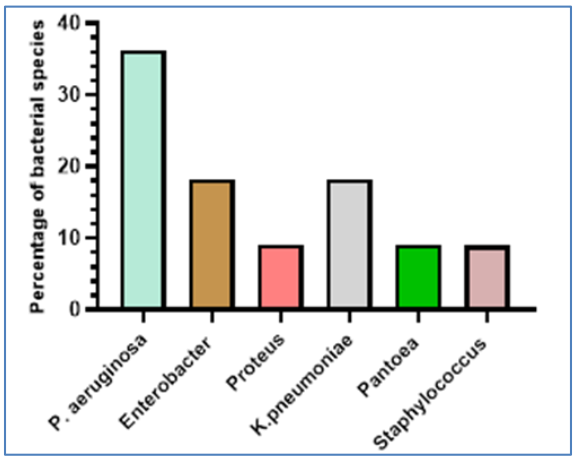

Figure 1 Bacterial species contaminating syrups from households in Mwanza city

The most common bacteria found as contaminants was *Pseudomonas aeruginosa* 4 (36.3%). Other bacteria isolated as contaminants were *Enterobacter cloacea* 2 (18.2%), *Proteus* species 1 (9.1%), *Klebsiella pneumoniae* 2 (18.2%), *Pantoea* species 1 (9.1%) and *Staphylococcus aureus* 1 (9.1%) (Figure 1).

3.4. Risk factors associated with the contamination of syrups

Syrups from igogo households were more likely to be contaminated (20.7%) compared to Kirumba (8.8%) and Mbugani (11.5%), although the difference was not statistically significant (p-value=0.394). Residence area, educational status, the use of expired drugs and sharing of syrups between households were not associated with contamination (p values=0.394, 0.441, 0.592 & 0.592 respectively) (Table 3).

Table 3 Risk factors associated with the contamination of syrups

Variable		Households contamination (N=89)		P-value
		N (%)	Yes (%)	
sex	male	39(86.7)	6(13.3)	0.967
	female	38(86.4)	6(13.6)	
Education	Illiterate	1(100)	0	0.441
	Primary	38(80.9)	9(19.1)	
	Secondary	32(91.4)	3(8.6)	
	College	6(100)	0	
Expiry date usage	No	72(86.8)	11(13.2)	0.592
	Yes	5(83.3)	1(16.7)	
Syrup sharing	No	72(86.8)	11(13.2)	0.592
	Yes	5(83.3)	1(16.7)	

Table 4 Description of storage syrups and practice among households

SNo.	Description	n/N (%)
1	Presence of syrup at households	89/89(100)
2	Mean number of syrups at households	3.29
3	Use of prescribed syrup	81/89(91.0)
4	Mean storage days	525.8
5	Households keeping expired syrups	81/89(91.0)
6	Households confirm to use expired syrups	6/89(6.8)
7	Sharing of syrups among households	6/89(6.8)

4. Discussion

Most studies report microbiological contamination at community pharmacy and hospitals level [11, 13, 14]. However, global data on the microbiological quality of these products at the level of household is scanty and this was the basis for this study to be carried. Findings from the present study have shown that a significant proportion of syrups from households were bacteriologically/microbiologically contaminated. The most common bacterial species isolated as contaminant in the syrups for under five children was *Pseudomonas aeruginosa* as opposed to *Klebsiella* and *Bacillus* which were established from a study involving samples sold in the market in another part of the country [11]. All these bacteria are normal flora of the gastrointestinal tract and therefore their likelihood of contaminating syrups if hygienic measures are not strict is high. The detection of *Pseudomonas aeruginosa* in the sampled syrup is a major health concern since this pathogen is often associated with severe infections and resistance to clinically available antimicrobial agents at the study site and other areas [8, 20-22].

Other bacteria isolated as contaminants were *Enterobacter cloacea*, Proteus species, *Klebsiella pneumoniae*, *Pantoea* species and *Staphylococcus aureus*. Isolation of *Staphylococcus aureus* is a serious concern because this pathogen secretes toxins which cause gastrointestinal distress [11, 19]. Isolation of *Klebsiella spp* and *Enterobacter spp* is a public concern since these pathogens have been established to be predominant species in the study area and have been associated with outbreak at Bugando Medical Centre which is located in the city [23, 24] and were the most common isolated species contaminating traditional liquid herbal medicinal products in the study area [25].

The recorded microbial contamination of syrups in this study may be due to improper handling of the syrups using unwashed hands, microbial contamination of refrigerators and poor adherence to storage conditions which could result to loss of preservatives activity [9, 10, 26, 27]. Our previous study reported that most medicines are stored on cupboards/shelves [28] which may expose syrups to direct sunlight and high temperature thus facilitating microbial contamination [12]. Generally, isolation of pathogens may suggest that, these pathogens are able to tolerate the preservatives contained in the syrups. It is worth noting that, *Escherichia coli* which isolation indicates recent fecal contamination [25] was not isolated in any household sample.

Residence area, educational status, the use of expired drugs and sharing of syrups between households was not associated with contamination. Further studied are need in other part of the country for the purpose of obtaining a broader picture of the microbial quality of pharmaceutical products at household level.

Limitations of the study

The susceptibility pattern of each bacterial isolates to commonly used antimicrobial agents was not done. However, our study is unique in its own, this study is the first in the country and one of the very few studies globally which have assessed the bacterial contamination of pharmaceutical products at household level.

5. Conclusion

A sufficient amount of syrups stored at households were presumably bacteriologically contaminated. The general public needs to be educated on proper handling and storage of liquid pharmaceutical products as a key aspect in eliminating cross-contamination of these products.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that they have no competing interests.

Statement of ethical approval

This research sought ethical clearance from the Catholic University of Health and Allied Sciences (CUHAS)/Bugando Medical Centre (BMC) institutional review board. The permission to conduct research was asked from relevant authorities whereas permission to use Multipurpose Laboratory at CUHAS was requested from the head of department of microbiology and immunology. Informed written consent was requested from each study respondent. The name respondent and the station point where the sample was taken was anonymously coded.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

Authors' contributions

KJM participated in conception, the design of the study, field work, data analysis and manuscript drafting. NAH participated in proposal writing, data collection and analysis. MFM participated in supervision of the research group, revising and approving the manuscript for submission.

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