Journal of Advances in Microbiology

5(4): 1-6, 2017; Article no.JAMB.34532
ISSN: 2456-7116

Salmonella and *Listeria* Associated with Street Vended Watermelon and Pawpaw Sold in Calabar Metropolis

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMB/2017/34532
Editor(s):
(1) Adekunle Sanyaolu, Epidemiology Division, Nigeria Center for Disease Control, Federal Ministry of Health, Abuja, Nigeria.
(2) Foluso O. Osunsanmi, Department of Biochemistry and Microbiology, University of Zululand, South Africa.
Reviewers:
(1) V. Sudershan Rao, National Institute of Nutrition, India.
(2) Igbaver Isaac Ieren, Ahmadu Bello University, Nigeria.
(3) Abdelsalam Tidjani, University of N'Djamena, Chad.
Complete Peer review History: http://www.sciencedomain.org/review-history/21178

Original Research Article

Received 31st May 2017
Accepted 17th July 2017
Published 1st October 2017

ABSTRACT

Fresh cut street vended watermelon and pawpaw was analyzed for possible contamination with *Salmonella* and *Listeria* species was understudied using standard microbiological techniques. A total of twenty samples, (10) of pawpaw and (10) of watermelon were obtained from four different vendors located in Etta-Agbo, Watt, Goldie and Marian market. These were analyzed using the Compact Dry Plate, chromogenic media for the direct detection of these organisms selectively. The results revealed a high contamination level of the samples with *Salmonella* spp whereas all the pawpaw and watermelon samples analyzed were free of *Listeria* spp. The mean *Salmonella* spp count ranged between $2.1X10^3$ to $5.7x10^5$ cfu/g. The presence of this organism in the samples analyzed is a reflection of unwholesomeness and gross contamination of the fruits and are therefore unsafe for human consumption.

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Keywords: Watermelon; pawpaw; contamination; street vended fruits; Salmonella; Listeria.

1. INTRODUCTION

Street vended fruits are freshly cut or sliced fruits packaged and sold within street corners to offer consumers a take in their nutritive value in terms of their freshness and their vitamin content at affordable prices [1]. With the rapid increase in the demand for fresh cut fruits and vegetables and the proliferation of street vended products, there is the likely hood of contamination of these products with pathogenic microorganisms. [2] isolated *Salmonella* spp and *Shigella* spp at an incidence rates of 77% and 55% respectively from fresh fruits and vegetables. Packaged for immediate consumption are sliced fruits like pineapple, cucumber, carrot, pawpaw, and water melon among others [2]. They are well known for their high nutritive value [3]. This minerals and vitamins are taking in directly through consumption of food substances such as the various fruits that thus exist. Oranusi and Olorunfemi [4] reported that fruits are extraordinary source of nutrients, micronutrients, vitamins and fibre essential for health and well - being of humans. Like vegetables, the consumption of fruits has increased over the years [5].

Watermelon (*Citrullus lanatus*) belongs to the cucumbitaceae family. On geographical spread in Nigeria, it is found in the northern region [6]. Water melon has reddish or yellowish mesocap with seeds. While the exterior of the fruits has smooth hard rind, with dark green stripes or yellow spots. It contains lycoprene, phytofluene, phytoene, beta carotene, Lutein and nuerosprene, which are mainly from carotenoids. The carotene from water melon has antioxidant activity and free scavenging characteristics that helps in minimizing cancer risk, cardiovascular diseases such as artericlerosis, while the cucurbitacin E contain triterpene an anti-inflammatory phytonutrient and citruline. However, water-melon is rich in vitamins A and C, potassium, magnesium, sodium, fatty acids and amino acids [7]. Watermelon contains about 6% sugar and 91% water [8].

On the other hand, Pawpaw (*carica papaya*) belongs to the *Caricaceae* family with several varieties. Apart from the shape, the colour of the endocarp can be used as distinguishable feature of some varieties. Some of the common noticeable colour of the endocarp include red, orange, yellow etc. like water melon, pawpaw is rich in vitamin A and C mainly and other nutrients such as potassium, calcium and iron. Pawpaw contains sugar (10-13%), protein (0.6%), moisture (85%), and has found application in canned food production such as jam [7]. It has also been reported to have some medicinal values [5] melon and pawpaw show that they have considerable health benefits; and as such several people including old and young folks consume these fruits in both rural and urban areas. In some cities in Nigeria, the price of this fruits in refined (that is, fruit juice) or a whole fruit is high and as such, these fruits vendors often wash, peel and slice at reduce prices. As a result, slicing of fruits before selling has gained prominence. This could be due to their easy accessibility, convenience, nutrition and cost [6]. Oranusi and Olorunfemi [4] attributed the consumption of sliced fruits to economic factor, like majority living on less than one dollar a day.

The slicing of fruits often increases surface area thereby exposing the fruits to contamination. Microbes are known to be a ubiquitous; and on sugary substrate, some microbes aid in fermentation processes. Fruits are known to harbor natural non-pathogenic micro-organisms, but contamination occurs from the environment during preparation and handling processes. Food monitoring and regulatory agencies have not considered these ready to eat fruits sold in Nigeria as potential sources of food borne disease [5]. Typically, food borne diseases cause gastrointestinal tract disorder and are transmitted through consumption of contaminated food or drink [9].

1.1 Justification of the Study

Cross contamination of street-vended fruits (water melon and pawpaw) are increased by unsanitary processing and preservation methods. The use of dirty utensils as well as the open display of the edible wares encourages sporadic visits by flies, cockroaches, rodents and dust. Packaging sliced fruits that require no further processing before consumption at ambient temperature during rainfall maintain the temperature at optimum temperature for proliferation and invasion of mesophiles. Bacteria like *Salmonella* enter sliced fruits through contact with sewage and contaminated water [10].

In Nigeria, several studies have been purportedly carried out with regards to microbial qualities of ready-to-eat fruits in different regions including

Kano metropolis [5] Ota, Ogun State [4] Owerri metropolis, Imo state [6] and Bida, Niger State [11]. But ironically, information about the microbial qualities of sliced and packaged fruits is scanty. Information on incidence of foodborne diseases related to street-vended fruits in Asian, European, American and some African countries has revealed increased bacterial pathogens in fruits [12]. In view of this threat posed by bacterial pathogens in fruits and the increasing demands for such street-vended food, the present study is undertaken to survey incidence of *Salmonella* and *Listeria* contamination of street-vended pawpaw and watermelon in Calabar metropolis to ascertain their food safety and standard. This will help in setting guidelines for hygienic production and preparation of these fruits. The overall aim of this study is to determine the level of *Salmonella* and *Listeria* contamination of street vended pawpaw and watermelon in Calabar.

2. MATERIALS AND METHODS

2.1 Sample Collection

Convenience sampling method was employed in the sample collection. A total of 20 samples comprising of ten each of ready to eat sliced watermelon and pawpaw were purchased from four different vendors (Etta-Agbo, Watt, Marian and Goldie markets) in Calabar Metropolis. They were then aseptically transported to the laboratory for analysis. No statistical analsis was required for the study.

2.2 Sample Analysis

2.2.1 Isolation of *Listeria* using compact dry LS medium

The pawpaw and watermelon samples were aseptically weighed and added to 9 ml of buffer solution and homogenized by stomacher; after which 1 ml of the specimen was paid on the middle of the compact dry plate. The specimen diffuses automatically and evenly into the sheet, and transforms the dried sheet into a gel within seconds. The cap of the plate was then put back and necessary information was written on the memorandum section. The capped plates were turned over and incubated at 37% for 24 h. After incubation, the numbers of colored colonies underneath the plates were counted. *Listeria* species forms light blue/blue colonies of 1-2 mm in diameter by chromogens contained in the medium.

2.2.2 Isolation of *Salmonella* using compact dry SL medium

The samples (pawpaw and water melon) was weighed into 9 ml of buffer peptone water and homogenize with stomacher for about 1 mm. The specimen was then incubated for 18 hours at 37% for pre-enrichment. After the pre-enmeshment, 0.1 ml of the enriched specimen was dropped on the dry sheet (approximately 1cm far from the edge of the plate) gently. After the inoculation of the enriched specimen, 1 ml of sterilized water was gently dropped at the opposite point where the specimen has been dropped. The water diffused automatically and the sheet was wet uniformly. The cap of the compact dry plate was put back and the plate turn over for incubation for 24-48 hours at 41-43°c, after incubation, the plates with positive *Salmonella* growth (appearance of black to green colonies on the sheet) were counted and recorded.

3. RESULTS AND DISCUSSION

Fruits are good dietary source of nutrients, micronutrients, vitamins and fiber for human; hence they are very essential for the overall well-being of man. The present study however investigated the presence of *Salmonella* and *Listeria* in pawpaw and water melon.

Table 1. Incidence of *Salmonella* and *Listeria* in ready to eat watermelon and pawpaw

Sample	*Listeria*	*Salmonella*
P_{w1}	-	+
P_{w2}	-	+
P_{w3}	-	-
P_{w4}	-	+
P_{w5}	-	-
P_{w6}	-	+
P_{w7}	-	+
P_{w8}	-	+
P_{w9}	-	-
P_{w10}	-	-
W_{m1}	-	-
W_{m2}	-	+
W_{m3}	-	-
W_{m4}	-	+
W_{m5}	-	+
$_{m6}$	-	-
W_{m7}	-	+
W_{m8}	-	-
W_{m9}	-	+
W_{m10}	-	+

The result from Table 1 shows that 75% of the samples were contaminated with *Salmonella* however, non-of the sample was contaminated with *Listeria*. This agrees with the work of Mahale, [12], Edward et al. [13], Rashed, [14] and Nichols, et al. [15] where they isolated *Salmonella* and other organisms from fresh fruits. This result confirms that fruits are highly susceptible to microbial contamination. The presence of *Salmonella* calls for concern as this organism is frequently associated with poor sanitary practices and could be a pointer to danger of possible foodborne infection. *Salmonella* has been implicated in numerous foodborne diseases [16].

Table 2. Mean count of *Salmonella*

S/N	Sample code	Mean *Salmonella* counts (cfu/g)
1	P_{w1}	$2.1X10^3$
2	P_{w3}	$1.1x10^5$
3	P_{w5}	$2.9x10^4$
4	P_{w7}	$2.4x10^3$
5	P_{w8}	$1.8x10^4$
6	W_{m2}	$4.5x10^3$
7	W_{m4}	$3.8x10^3$
8	W_{m5}	$4.8X10^4$
9	W_{m7}	$5.7x10^5$
10	W_{m9}	$1.6x10^5$
11	W_{m10}	$4.1x10^3$
12	W_{m11}	$2.8x10^3$

Key: P_w = Pawpaw, W_m = Watermelon

Direct observation studies showed that majority of these vendors operated stalls located very close to the main road exposing the fruits to dust and other physical contaminants. About 20% of the vendors had access to hand washing facilities. Washing of hands, utensils and dishes were often done in open spaces. Also, personal hygiene of the vendors serves as a contributing factor to the presence of this organism. The high *Salmonella* counts observed in the ready-to-eat pawpaw and watermelon samples analyzed were similar to that observed in other studies [17,18] and thus warrants further investigation of the conditions of preparation. Use of contaminated utensils, lack of potable water and personal hygiene of the vendors are likely sources of contamination of these fruits [19].

Contamination of street vended fruits with *Salmonella* had also been reported in other countries with incidence rate of 27% in Malaysia, 40% in Mexico and 16% in Adds Ababa, Ethiopia [20,21]. The incidence of virulent strains of *Salmonella* has been attributed to the differences in hygiene condition during food handling, processing and storage.

Results from Table 2 show the extend of *Salmonella* contamination of water melon and pawpaw understudied. The values of *Salmonella* obtained in this study are less than those reported by Edward, et al. [13] in a similar study in Port Harcourt, Nigeria. The differences might be due to disparity in the processing method and the situation of the production area as well as the personal hygiene of the vendors. It is commonly observed that these fruits (pawpaw and water melon are displayed on the ground by vendors for a long time prior to their preparation. Such exposure of the fruits might permit entry of microorganisms and their subsequent internalization in the fruit tissue. Therefore, ordinary washing of the surface of the fruit is not sufficient to completely eradicate microbial contaminants [22].

The outcome of this study shows that street vended pawpaw and water melon pose serious health risk to consumers as they contain high level of *Salmonella*. Since pawpaw and water melon are eaten without further proper processing, and adoption of strict aseptic techniques and good personal hygiene should be adhered to by vendors during the preparation stage in order to reduce microbial load and eliminate contamination of the final product. A major limitation of the study is the non probability method employed in the sampling collection which perhaps could lead to bias in statistical analysis. Further studies will aim at including the shortcomings in this study.

Table 3. Biochemical test results

	Lac	Cat	Glu	Mal	Mot	Ind	Man	H2S	Grm rxn	VP	Oxd	MR
Salmonella	-	+	+	+	+	+	+	+	-	-	-	+
Salmonella ATCC 19114	-	+	acid	+	+	+	+	+	-	+	-	-

Key: Lac = lactose, Cat = catalase, Glu = glucose, Mal = maltose, Mot = motility, Ind = indole, Man = mannitol, Grm rxn = Gram reaction, VP= Voges Proskauer, Oxd= Oxidase, H2S= Hydrogen sulfite, MR= Methyl red

4. CONCLUSION

Watermelon and pawpaw sold in the city of Calabar pose a great risk of infection given their high level of *Salmonella*. There is need for comprehensive risk assessment of *Salmonella* from fruits sold in Calabar. The presence of *Salmonella* in these fruits poses threat of contamination. Therefore, there is need to identify pathogenic strains of *Salmonella* in various street vended fruits. The loads and incidence rates of this pathogen on these produce show the contamination levels of these produce. The findings of this study show that most fruits and vegetables consumed in this part of the country are grossly contaminated with *Salmonella* spp which are involved in food borne disease.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/21178