

## Original Research Article

# Survey of salmonella species isolated in ready-to-eat fruits vended in Bukuru market, Jos South, Plateau State

Comment [D1]: Can consider reframing the topic

### Abstract:

**Background:** Despite control measures to curtailed salmonella fruit contamination over the years, pathogenic disease outbreaks caused by the ingestion of Salmonella contaminated fresh-cut-fruits pose a significant problem to human health by the consumption of fresh and minimally processed fruits. **Aims:** This study aimed to enumerate and determine the prevalence of Salmonella species isolated in ready-to-eat fruits vended in Bukuru Market Jos South, Plateau state.

**Methodology:** A total of seventy-eight ready-to-eat vended fruit samples were purchased and cultured for the enumeration of bacterial isolates according to National Food Safety Standard for Microbiological Examination. Pulp pH value of each fruit was obtained by immersing litmus paper into the pulp and results recorded. Results: Of the 78 fruits specimen, 22 (28.2%) were Salmonella positive. The prevalence rates of salmonella isolated were found to be higher (22.7%) in both coconut and avocado followed by watermelon (18.2%) and sweetmelon (13.6%) as compared with other fruits in the study area. Lower rates of 4.5% were found in banana, pawpaw, and dates with a rise in apple with 9.1% respectively.

**Conclusion:** The study showed a high  $p < 0.05$  (7.811) prevalence of pathogenic Salmonella species isolated in ready-to-eat fruits in the study area revealing that the spread of salmonella is not independent of fruits thereby suggestive of contamination made available by fruit vendors in this part of the world. Thus, epidemiological traceability and significant measures must be taken to check the safety of these vended products before consumption.

**Keywords:** Enumeration, Ready-to-eat fruits, Salmonella spp, Isolation, Bukuru-Market, Salmonella contamination

### INTRODUCTION:

Disease outbreaks caused by the ingestion of contaminated fresh cut fruits pose a significant problem to human health as source of contamination of these food products is linked to Salmonellosis [1,2], however, in some cases the higher incidence is attributed to vegetables than other food products [3,4]. Fruits comprise an essential part of human diet as one of the major sources of dietary nutrients of great importance. However, over the years fruit has a dramatic increase in outbreaks of food-borne illness caused primarily due to salmonella by the consumption of fresh and minimally processed fruits [5-7]. The

Comment [D2]: Is it only salmonella linked to FBD from fresh-cut? Need to update more on other pathogenic organism too.

consumption of street foods has been suggested to potentially increase the risk of foodborne diseases as street foods are readily contaminated from different sources as there is no proper safety, quality and hygiene practices during preparation [8]. In Nigeria, mostly the North – Central Nigeria and at different parts of the world have indicated the pollution and contamination of common fruits and vegetables by salmonella species where small-scale farmers cultivate vegetables and fruits generally marketed at different markets within the respective local communities [9].

Comment [D3]: Food safety

## MATERIAL AND METHODS

A total of seventy-eight (78) ready-to-eat vended fruit samples from 13 different fruits (apple, avocado, sweetmelon, coconuts, sliced watermelon, pawpaw, orange, mango, African cherry, dates, banana, pineapple and cashew) comprising of six (6) samples each were purchased from the Bukuru market and packaged in polyethene bags then transported to the Bingham University Multipurpose Laboratory Jos campus for enumeration of bacterial isolates. In the laboratory, 25g of each sample was weight, blended and homogenized with agitation for 3 minutes and pre-enriched in 225ml of buffered peptone water (BPW) incubated at 37°C for 18 hours according to National Food Safety Standard for Microbiological Examination thereafter a 10µl was streaked on a section of xylose lysin deoxycholate (XLD) medium for 24hrs at 37°C and second isolation was done on SSA medium for 24hrs at 37°C respectively. For the enumeration of Salmonella specie in food myriads and products, the method by Luo *et al.*, [1] was followed. Pulp pH value of each fruit was obtained by immersing the litmus paper into the pulp and results recorded.

Comment [D4]: Method for confirmation for other GNB missing

## RESULTS AND DISCUSSION

Comment [D5]: Results and Discussion should be separated. Follow authors guide

The results showed that out of the 78 fruits specimen collected, 22 (28.2%) specimens were Salmonella positive. In this, only 8 fruits group had Salmonella spp. (38.6%) and 5 fruits group had (61.4%) growth of other gram-negative bacteria isolated in the study area. This concurs with a study conducted by Lukasz *et al.*, [11] in Poland who reported a 25% prevalence rate of salmonella isolated in samples of plant origin such as fruits, vegetables and spices and Iveren *et al.*, [9] in Makurdi revealed that all the sampled fruits and vegetables sold in the markets were contaminated with pathogenic bacteria. However, high prevalence (66.7%) rate of Salmonella spp. was reported by Orji *et al.*, [12] in Ebonyi revealed that isolated organisms from the vended fruits contamination occurred due to poor hygiene and environmental factors like contaminated air. These bacteria isolated were *Escherichia coli* (19.3%), *Proteus spp* (14.0%), *Shigella spp* (28.1%) as seen in tables 1 and 2. In Gram's staining, the organism appeared as gram negative, short rod-shaped bacteria, arranged in single and paired under light microscope, these characteristics correspond to *Salmonella spp.* as described by Bae *et al.*, [13].

Comment [D6]: Gram

Comment [D7]: These bacterial from which source (literature or current study)? There is no link with previous sentence

Comment [D8]: This finding is interesting and concerning. Need more details

Comment [D9]: Gram

Comment [D10]: This characteristic are similar to many GNB. So this Gram stain features can be used as preliminary reporting only and not for confirmation.

In table 2, the prevalence rates of salmonella isolated were found to be higher (22.7%) in both coconut and avocado followed by watermelon (18.2%) and sweetmelon (13.6%) as compared with other fruits in the study area. Lower rates of 4.5% were found in banana, pawpaw, and dates with a rise in apple with

Comment [D11]: Why is this? Need to mention the reasons for such high rate of contamination. Is the contamination due to use of contaminated knife shared? Or water contamination? Any data on this?

9.1% respectively. This implies that the acidic contain in other fruits could not permits the growth of salmonella isolates. This is in consonance with the findings of Pui *et al.*, [14] who reported that the growth of salmonella is completely inhibited at pH <3.8, the water activity of <0.94 and temperatures of <7°C. Additionally, Keerthirathne *et al.*, [15] revealed that *Salmonella typhimurium* has a regulated response to further protect itself from acid stress by the process called the acid tolerance response (ATR) that protects *Salmonella* spp. at pH levels of 3.0–4.0, but is activated when environmental pH values are between 5.5 to 6.0 (Fig. 1)

**Comment [D12]:** Is this the same species of salmonella isolated from fresh-cut fruits? Did the researcher do species identification, as it is not mentioned anywhere in the article.

Apart from Salmonella organisms isolated, several pathogenic bacterial species are primarily responsible for the contamination of ready-to-eat fruits and stand as a threat. Having been evidenced in this study by the isolation of these species from various fruits such as *E. coli*, *Shigella* spp. and *Proteus* spp., this concurs with the report of Balali *et al.*, [16], who revealed that sources of contamination and type of pathogenic agents isolated from fresh fruits and veggies are *E. coli* O157:H7, *Listeria monocytogenes*, *Salmonella* spp., *Shigella* etc. Moreso, researchers reported in their work that other isolates can be identified in ready-to-eat fruits as seen in studies conducted in Kwara state [17], in Ogun state [18], in Kogi state [19] and in India Tambeker *et al.*, [20] as seen in table 3.

**Table 1. Enumeration rates of Salmonella spp. from vended fruit samples in the study area**

**Comment [D13]:** Table 1 and table 3 can be combined

Samples	No. examined (N=78)	No. of positive for Salmonella spp. (N=22)	Percentage (%)
B	6	1	4.5
M	6	0	0
A	6	2	9.1
Av	6	5	22.7
Pw	6	1	4.5
Wm	6	4	18.2
Sm	6	3	13.6
O	6	0	0
Ca	6	0	0
P	6	0	0
Ac	6	0	0
Cn	6	5	22.7
D	6	1	4.5
		<b>28.2%</b>	<b>100</b>

**Keys:** B=Banana, M=Mango, A=Apple, Av=Avocado, Pw=Pawpaw, Wm=Watermelon, O=Orange, Sm=Sweetmelon, Cn=Coconut, D=Dates, Ca=Cashew, P=Pineapple, and Ac=African cherry

**Table 2. Gram-negative bacteria isolated from different fruits in the study area**

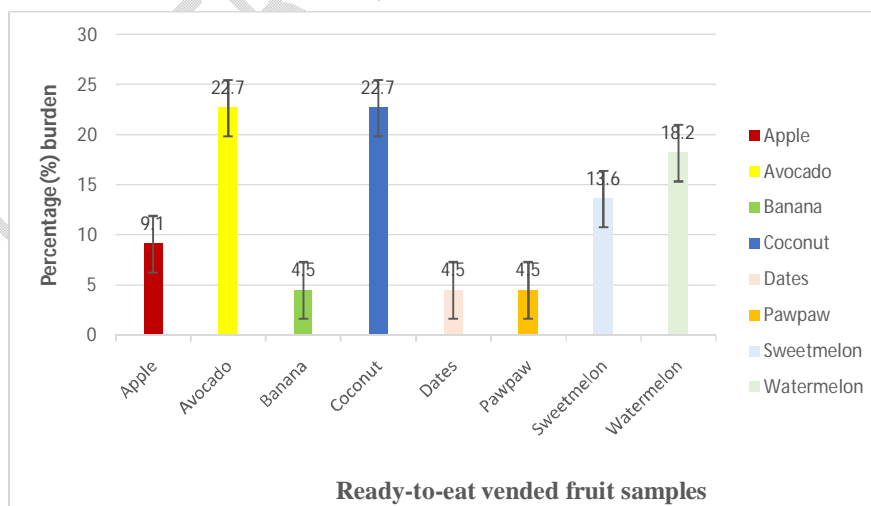
Organisms	B	A	Av	M	Pw	Wm	Sm	Cn	D	O	Ca	P	Ac	Total (%) *	(X <sup>2</sup> )
<i>Salmonella spp.</i>	1	2	5	0	1	4	3	5	1	0	0	0	0	22 (38.6)	7.81
<i>E. coli</i>	0	1	0	3	2	0	0	0	0	2	1	0	2	11 (19.3)	1.55
<i>Shigella spp.</i>	2	2	1	1	1	1	3	0	0	1	0	3	1	16 (28.1)	3.99
<i>Proteus spp.</i>	3	0	0	2	0	0	0	0	0	2	0	1	0	8 (14.0)	1
<b>Total</b>	<b>6</b>	<b>5</b>	<b>6</b>	<b>6</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>5</b>	<b>1</b>	<b>5</b>	<b>1</b>	<b>4</b>	<b>3</b>	<b>57 (100)</b>	<b>(p&lt;0.05)</b>

Key: B=Banana, M=Mango, A=Apple, Av=Avocado, Pw=Pawpaw, Wm=Watermelon, O=Orange, Sm=Sweetmelon, Ca=Cashew, P=Pineapple, and Ac=African cherry  
\*Percentages in parenthesis

Table 3. Pulp pH value of ready-to-eat fruits in the study area

S/No	Fruit sample(s)	pH values
1	Apple	3.0
2	Avocado (Pea)	6.0
3	Banana	5.0
4	Cashew	6.0
5	African Cherry	4.0
6	Coconut	7.0
7	Dates	7.0
8	Mango	5.0
9	Orange	4.0
10	Pawpaw	7.0
11	Pineapple	3.0
12	Sweetmelon	6.0
13	Watermelon	6.0

Key: B=Banana, M=Mango, A=Apple, Av=Avocado, Pw=Pawpaw, Wm=Watermelon, O=Orange, Sm=Sweetmelon, Ca=Cashew, P=Pineapple, and Ac=African cherry



Comment [D14]: The information here is provided in table 1. This graph can be omitted

**Figure 1. Percentage (%) burden and Distribution of Salmonella isolates in the study area**

## CONCLUSION

The present study shows that  $p < 0.05$  (7.811) thus the spread of salmonella is not independent of fruits. This consequently suggests contamination of the ready-to-eat fruits made available by fruit vendors in this part of the world. Though, most ready-to-eat fruit contaminated with pathogens are either from the environment or vendors through processing and handling that could potentially cause diseases. Thus, epidemiological traceability is difficult for fruits as carriers of foodborne pathogens but significant measures must be taken to check the safety of these vended products before consumption.

**Comment [D15]:** How has this value come here. It has been never mentioned in main text.

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