Liu *et al.*, 2013). This research aimed to investigate the links between water quality and microbiological loads on fresh fruit and leafy vegetables.

Methodology

Experimental area: This study was carried out in Minna metropolis, Minna occupies a land area of about 6,784 square kilometers, which is a fraction of the entire Niger State, Nigeria; with a mean annual rainfall of 1300mm. Due to the all year-round high demand of vegetables and lack of appropriate storage facilities, irrigation is employed to enhance farming of vegetables during the dry season.

Laboratory preparation: Prior to sampling, necessary laboratory preparations were done. All glass wares materials used which include test tubes, syringe and needle (10 ml and 2 ml), vials, flasks, cylinder, conical flasks, glass plates were soaked in standard washing detergent overnight, thoroughly washed and sterilized by either dry heating at 160 °C for 2 hours or by autoclaving at 121°C for 15 minutes and later oven dried at 50 °C and stored at the same oven temperature. Similarly, disposable plastics went through autoclaving for sterilizing.

Sampling: Six different farms located within the Minna metropolis were considered for this study. Farm 1: El-Ameen Farms, Farm 2: Rural farm at Al-Bishri, Farm 3: Rural farm at Morris fertilizer area, Farm 4: Rural farm at Kangiwa Chanchaga, Farm 5: Rural farm near IBB Specialist Hospital Chanchaga and Farm 6: Upper River Basin and Development

From the farms, four leafy vegetables and four fruit vegetables were sampled in 3 replicates (Table 1 and Figure 1). Sterile polythene zip bags were used for sample collection, transported to the laboratory and processed within 6 hours with no significant temperature change. This is to maintain all necessary microbial analyses standards. The water being used for irrigation were also sampled from each of the farms. The samples collected were transported to the Department of Microbiology in the School of Life Sciences, Federal University of Technology, Bosso campus, Minna,

Figure 1: Picture representatives of the sampled vegetables.

113 DETERMINATION OF DRY SEASON IRRIGATION WATER QUALITIES FOR VEGETABLE PRODUCTION IN MINNA, NIGERIA

[1] Adesina, O. A [2] Ajikobi, H. A [3] Adegbite A. Adesipo
[1]Department of Horticulture, Federal University of Technology, Minna, Niger state.
[2]Department of Crop Production, Federal University of Technology, Minna, Niger state.
[3]Brandenburg University of Technology, Cottbus Germany
[1]Corresponding author: adolwak@gmail.com

Abstract

This research was carried out to determine microbial loads in irrigation water and vegetables under dry season production in Minna. Irrigation water, fruits and leafy vegetables were collected from six farms. The samples were collected and checked in the laboratory. The results revealed that all the sampled farms have the presence of bacteria and fungi loads. However, the irrigation water used for irrigating the plants has high bacteria counts and low fungi counts. The high bacteria count in the irrigation water can be best thought to be from the source of water, which makes the leafy vegetables has high bacteria count. The fungi count on the vegetables were higher than the irrigation water, which have resulted from the manure used as fertilizers or the hygiene level of the area. It is recommended that consumers should ensure the produce are hygienic before eating especially the vegetables that are eaten raw. It is also recommended that farmers should ensure the use of quality water for irrigating their farms in dry season. To meet the all year-round demand of vegetable and fruits in the middle-belt region of Nigeria, irrigation with any available source of water is a common practice by the local farmers.

Introduction

Fruits and leafy vegetables are exceptional dietary source of nutrients, micronutrients, vitamins and fibre for human beings hence vital for health and fitness (Tsado *et al.*, 2013). Foods rich in fruits and vegetables, are especially valuable for their ability to prevent deficiencies of vitamin C and vitamin A and also reduce the risk of several diseases (Kalia and Gupta, 2006; Nwachukwu and Chukwu 2013; Sobukola *et al.*, 2010; Ijabadeniyi, 2010). Regular intake of fruits and vegetables has been associated with low incidence of chronic diseases such as osteoporosis, cancer, chronic obstructive pulmonary and cardiovascular diseases. (Pem and Jeewon, 2015). Leriet *et al.* (2006) reported that nutritional and other benefits of a regular intake of vegetables and fruits are well documented internationally. In contrast to the health and economic benefits of fruits and vegetables, there is much concern about their contamination by human pathogens, after they have been consumed fresh, or moderately cooked (Iyoha and Agoreyo, 2015; Mahmoud, 2019). Production of vegetables is always a difficult task during dry season because of limited water availability. Consumption of fresh vegetables and fruits has increased mainly because of awareness of the benefits of a healthy diet and dry season vegetables has always met the fine need of consumer. However, limited attention have been paid to water quality used for irrigation of the vegetables produced in this period. There has been an increasing outbreak of food infection associated with the consumption of raw vegetables and fruits (Orji *et al.*, 2016; Miraglia *et al.*, 2009;

Table 1: The sampled plants

English Name	Botanical Names	Farms sampled
	Leafy vegetables	
Bitter-leaf	*Vernonia amygdalina*	Farm 1, Farm 2,
Fluted-pumpkin	*Telifairia occidentalis*	Farm 3
Spinach	*Amaranthus cruentus*	Farm 1, Farm 2
Water-leaf	*Talinum triangulare*	Farm 2, Farm 3
	Fruit vegetables	
Bell-pepper	*Capsicum spp*	Farm 5, Farm 6
Chilli-pepper	*Capsicum annuum*	Farm 4, Farm 5
Okra	*Abelmoschus esculentus*	Farm 4, Farm 6
Tomatoes	*Solanum lycopersicum*	Farm 5, Farm 6

Microbial analyses

Media Preparation All media used were of analytical reagent grade. For the microbial analyses, two different media were considered; (1) Nutrient Agar (NA) for bacterial estimation and (2) Saboraud Dextrose Agar (SDA) for enumeration of fungal organisms. The methods of preparing the media are differently elucidated below.

Nutrient Agar (NA): 28 g of Nutrient Agar was suspended in a well prepared flask containing 1000 ml of cold distilled water. This was subjected to heat briefly to ensure that the medium was dissolved completely. It was afterwards sterilized by autoclaving. The medium was then poured into each prepared petri-dish and stored for further use. For assurance of sterility, the samples were incubated at 37°C overnight

Saboraud Dextrose Agar (SDA): 65 g of Saboraud Dextrose Agar was suspended in a prepared flask containing 1000 ml of cold distilled water, heated briefly for 1 minute to dissolve the medium completely. After dispensing and dissolving in distilled water, it was sterilized by autoclaving for 15 minutes at 15 lbs pressure (121 °C). It was afterwards cooled to about 45 – 50 °C and dispensed into each well-prepared petri-dishes and test tubes. The sterility was ensured and used under its refrigerated storage at 4 °C.

Preparation of the Diluent: Each sampled plant was crushed and thoroughly homogenised. The mortar and pestle used was carefully washed prior to each use and disinfected to avert any cross contamination. The homogenates were preserved in well labelled sterile bottles stored until needed. For each use, aliquots of the samples were serially diluted, each diluent of the buffered solution was afterwards inoculated on to its respective media. This procedure was observed in an aseptically order for both bacterial inoculation and the fungi inoculation. The pour plate count method was used for the total organism count (bacterial and fungi).

Describe this Item | FUT | ARTICLE 14 Adediran, C | ARTICLE 14 Adediran, C | Proceedings of the | EFFECT OF MILLED GRC | PROXIMATE COMPOSIT
file:///C:/Users/hp/Desktop/Proceedings%20of%20the%202nd%20ICAAT%202022%20Revised%20Edition.pdf
Find on page ajikobi 1 of 1 Options

Proceedings of the 2nd ICAAT, 2022

For the bacterial count, after pouring and allowing to solidify, they were incubated for 24 hours at 37 °C, while incubation for the fungi count was for 5 days at 28 ± 2 °C. The grown colonies counted were each expressed as colony forming units (cfu/ml) for the water samples and cfu/g for the vegetables. Repeated sub-culturing was employed to obtain pure cultures of isolates, the cultures were maintained on agar slants for further identification.

Characterization and Identification of Isolates: Bacterial and fungi isolates were characterized using microscopic appearance, colonial morphology and biochemical test. Identification of the isolates were confirmed in comparison to the known taxa.

Statistical tool: All obtained data were subjected to statistical Analysis of Variance (ANOVA) test using SPSS. Prevalence of both bacterial and fungal isolates were presented in descriptive statistics. For the cfu/g values obtained, statistical significance relations were tested between each sampled vegetable and the isolated pathogens.

Results

Differences in Bacteria and Fungi loads found in the water sample from the 6 farms

Bacterial count in the water sample: Results of the bacterial loads on water samples from the six considered farms within Minna metropolis are presented in Figure 2. The results show significant differences ($p<0.05$) among the means. Water samples from Farm 2 shows the highest bacterial load of 112.50×10^2 cfu/ml, followed by that of Farm 1 with 72.50×10^2cfu/ml and the water sample with the least bacterial load from Farm 6 with 5.00×10^2 cfu/ml.

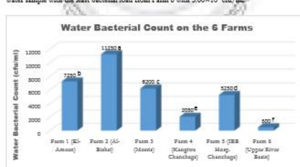

Figure 2: Differences in Bacteria load found in the water sample from the six farms

Fungi count in the water sample: The obtained results of the fungi load in water samples from the six considered farms in Minna metropolis are shown in Figure 3. Unlike the bacterial load results, there were no significance differences ($p<0.05$) in all water samples from the farms.

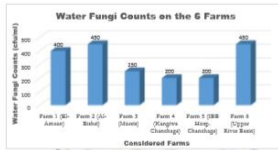

Figure 3: Differences in Fungi loads found in the water samples from the six farms

Differences in Bacterial &Fungi load found in leafy vegetables

As presented in Figure 4, the microbial load count for bacterial is higher than fungi count. For the bacterial count, the result shows significant differences among the means. Water leaf in farm 2 (Al-Bishri) has the highest bacteria count but was not significantly different from the bacterial count in spinach and bitter leaf on the same farm, as well as Spinach on Farm 1. On the other hand, Water-leaf on Farm 3 recorded the lowest bacteria count and significantly different from others except Bitter-leaf on Farm 1 and Fluted-pumpkin on Farm 3.

Describe this Item | FUT ARTICLE 14 Adediran, C ARTICLE 14 Adediran, C Proceedings of the EFFECT OF MILLED GRC PROXIMATE COMPOSIT
file:///C:/Users/hp/Desktop/Proceedings%20of%20the%202nd%20ICAAT%202022%20Revised%20Edition.pdf
Find on page ajikobi 1 of 1 Options

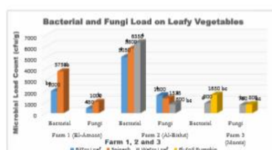

Figure 4: Differences in Bacteria and Fungi load found in leafy vegetables from Farm1 to 3

Differences in Bacteria and Fungi loads on Fruit Vegetables for Farm 4 to 6

The microbial load count for both bacterial and fungi found on sampled fruit vegetables are presented in Figure 5 below. Results obtained for the bacteria count showed significant difference ($p<0.05$) among the means. Chilli pepper on Farm 5 recorded the highest bacteria count and has no significant difference ($p<0.05$) from Tomato and Bell-pepper on the same farm. Similarly, the Bell-pepper from Farm 5 has no significant difference ($p<0.05$) from Bell-pepper and Tomato on Farm 6.

For the fungi load count, results obtained showed significant difference ($p<0.05$) among the means. Okra fruit on Farm 6 Okra and Chilli-pepper on Farm 5 recorded the highest fungi counts which shows no significant difference ($p<0.05$). However, Okra fruit on Farm 4 recorded the least fungi count but no significant difference ($p<0.05$) from Bell-pepper and Tomato fruits on the same farm 5. Contrary, it shows significant difference ($p<0.05$) from Chilli-pepper fruit on Farm 4.

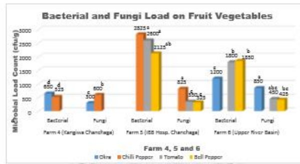

Figure 5: Differences in Bacteria load found on Fruit Vegetables from Farm 4 to Farm 6

Isolated Bacterial and Fungi

Bacterial organisms isolated from the water, leafy vegetables and fruit vegetables samples as presented in Table 2 belong to the genera ***Escheria coli, Staphylococcus aureus, Bacillus subsdlis, Streptococcus feacalis and Staphylococcus epidermidis***. The isolated Fungal organisms, as presented in Table 3 include ***Aspergillus niger, Aspergillus flavus, Saccharomyces cervicea, Penecillium species and Trychophyton specie***.

Describe this Item | FU1 | ARTICLE 14 Adediran, C | ARTICLE 14 Adediran, C | Proceedings of the | EFFECT OF MILLED GR(| PROXIMATE COMPOSI1
file:///C:/Users/hp/Desktop/Proceedings%20of%20the%202nd%20ICAAT%202022%20Revised%20Edition.pdf
Find on page ajikobi 1 of 1 Options

Table 2: Showing Bacteria Isolated from each of the farms.

Sampled area	*Escheria coli*	*Staphylococcus aureus*	*Bacillus subsdlis*	*Streptococcus feacalis*	*Staphylococcus epidermidis*
Farm 1	All samples	Bitter-leaf, Spinach	Bitter-leaf	-	-
Farm 2	Water	Water-leaf	Spinach	Water-leaf, Spinach	Bitter leaf
Farm 3	Water	Fluted-pumpkin	Water	-	-
Farm 4	Water	Okra	Okra	Water	Chilli-pepper
Farm 5	Water, Bell-pepper	-	Bell-pepper, Chilli-pepper	-	Tomato
Farm 6	Water, Tomato	Bell-pepper, Tomato	Tomato, Okra	Tomato	-

Table 3: Showing Fungi isolated from each of the farms.

Sampled area	*Aspergillus niger*	*Aspergillus flavus*	*Saccharomyces cervicea*	*Penecillium species*	*Trychophyton species*
Farm 1	Bitter-leaf, Spinach	Spinach	Water	Bitter-leaf	-
Farm 2	Spinach	-	Bitter-leaf, Water	Water-leaf, Bitter-leaf	-
Farm 3	-	Water-leaf	Fluted-pumpkin	-	Water-leaf
Farm 4	Chilli-pepper	Okra	Water	Okra	-
Farm 5	All samples	-	-	Tomato, Bell-pepper	Chilli-pepper
Farm 6	-	-	Water	Tomato	Okra, Chilli-pepper

Discussion

The results show that bacteria and fungi are present in the leafy vegetables, fruit vegetables, and the water used for irrigation in dry season in each of the sampled area in Minna metropolis. This corresponds with previous studies within this region (Tsado *et al.*, 2013). However, the bacteria counts are more prominent in the water used for irrigation than the vegetables in all farms except Farm 6, which has bacteria count for irrigation water as low as 5×10^{3} cfu/ml while the vegetables high count up to 12×10^{4} (Okra), 18.5×10^{4} (Tomato) and 18.5×10^{4} (Bell pepper). It could also be observed that leafy vegetables have higher bacteria count than the fruit vegetables.

The high bacteria count on the water could be attributed to the source of water used for the irrigation. A related reason is the waste water some farms used to augment their irrigation water during dry season (Tsado *et al* 2013).

The fungi count in the irrigation water was observed to be lower than the fungi count found in the vegetables. It was also observed that leafy vegetables have greater fungi count than the fruit. Since the fungi count in the irrigation water is lower than the vegetables fungi count, it could be deduced that the higher fungi count on the vegetables could be due to the manure used for organic fertilizer or presence of soil borne pathogens or the hygiene level of the area where the vegetables were grown.

Conclusions

Microbial control is very essential in food crops, to prevent its related health hazards potentials. Vegetable samples obtained from all the considered farms show the presence of bacterial and fungi, which are within the standard satisfactory thresholds. The high bacterial count on the leafy counts is due to the high bacterial count from the irrigation water. This is vice versa compared to fungi with lower counts. It is recommend that all year production of vegetable within Minna Metropolis and the country at large. However, it should be under adequate management of the irrigation process. The farmers should ensure the use of quality, hygienic and standard satisfactory water in irrigating their farms. In addition, the final consumers of the vegetables should ensure adequate washing of their vegetables using water containing chlorine or very clean running water.

References

Ijabadeniyi, O. A. (2010.) ***Effect of irrigation water quality on the microbial safety of fresh vegetables (Ph.D. thesis)***, Pretoria University of Agricultural and Food sciences, Johannesburg, South Africa.

Iyoha O, Agoreyo F. (2015) Bacterial contamination of ready to eat fruits sold in and around ugbowo campus of university of Benin (Uniben), Edo State, Nigeria. Br J Med Med Res. 2015;7:155-60. DOI:10.9734/bjmmr/2015/15356.

pg. 794

Proceedings of the 2nd ICAAT, 2022

Kalia A, Gupta R.P (2006). Fruit Microbiology, in Hui Y.H, J.,Cano, M.P., Gusek, W., Sidhu, J.W., Sinha, N.K.Handbook of Fruit and Fruit processing. 1st Edition, Blackwell publishing, pp 3-28.

Lerici C. R, Nicoli M. C, and Anese **M. "The weight" given to food processing at the "Food and Cancer Prevention III" symposium,** ***Italian Journal of Food Science***, vol. 12, no.1, pp.3-7, 2000.

Liu C., Hofstra N. & Franz, E. (2013). Impacts of climate change on the microbial safety of pre-harvest leafy green vegetables as indicated by Escherichia coli O157 and

Mahmoud B. Science-based recommendations for the production of safe fruits and vegetables in developing countries. Food Safety Magazines FSM eDigest, 2019. https://www.foodsafetymagazine.com/enewsletter/sciencebased-recommendations-for-the-production-of-safe-fruits-and-vegetables-in-developingcountries/. Accessed April 4, 2019.

Miraglia, M., Marvin, H.J.P., Kleter, G.A., Battilani, P., Brera, C., Coni, E., Cubadda, F., Croci, L., De Santis, B., Dekkers, S., Filippi, L., Hutjes, R.W.A., Noordam, M.Y., Pisante, M., Piva, G., Prandini, A., Toti, L., vanden Born, G.J. & Vespermann, A. (2009). Climate change and food safety: An emerging issue with special focus on Europe. ***Food and Chemical Toxicology*** 47(5), 1009-1021.

Nwachukwu E, Chukwu CM. Effect of chemical treatments on the microbial load of fruits and vegetables. IJAMBR. 2013;1:16-19.

Orji JO, Orinya C, Okonkwo E (2016). The microbial contamination of ready-to-eat vended fruits in Abakpa Main Market, Abakaliki, Ebonyi State, ***Nigeria. J Pharm Biologic Sci. 2016;11:71-80.***

Pem D, Jeewon R. Fruit and Vegetable Intake: Benefits and progress of nutrition education interventions- narrative review article. Iran J Public Health. 2015;44:1309-21. PMID:26576343.

Sobukola OP, Adeniran OM, Odedairo AA. Heavy metal levels of some fruits and leafy vegetables from selected markets in Lagos, Nigeria. AJFST. 2010;4:389-93.

Tsado E. K., Adesina O. A. and Oyeleke S. B. "A Survey on the Bacterial Load of Selected Fruits and Leafy Vegetables in Minna Metropolis of Niger State, Nigeria". ***J Anim Prod Adv*** 2013, 3(1):6-11