Academic Journal of Life Sciences
ISSN(e): 2415-2137, ISSN(p): 2415-5217
Vol. 7, Issue. 1, pp: 17-21, 2021
URL: https://arpgweb.com/journal/journal/18
DOI: https://doi.org/10.32861/ajls.71.17.21

Academic Research Publishing Group

Original Research | Open Access

Particulates Distribution Around Smallholder *Gari* Production Facilities in the Niger Delta, Nigeria

Glory Richard
Department of Community Medicine, Faculty of Clinical Sciences, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria
Email: richieglo63@gmail.com

Article History
Received: February 2, 2021
Revised: February 26, 2021
Accepted: March 1, 2021
Published: March 3, 2021

Abstract

This study evaluated the distribution of particulates (PM1, PM 2.5, PM 4, PM 7, PM 10, and TSP) around smallholder gari production facilities in the Niger Delta, Nigeria. The particulates were evaluated at 3 distances (3.05, 7.62, and 15.24 m) from emission source in the dry season (November, January, and March) and wet season (May, July, and September) in Delta, Bayelsa, Rivers, and Abia states. A mini-volume air sampler was used to assess the concentration of particulates, while health risk was assessed following standard protocol using median and geometric mean as reference values. The particulates ranged from 11.54 – 14.99 µg/m3, 18.70 – 22.34 µg/m3, 26.12 – 36.04 µg/m3, 37.00 – 52.26 µg/m3, 46.91 – 72.49 µg/m3 and 57.94 – 99.49 µg/m3 for PM1, PM2.5, PM4, PM7, PM10 and TSP, respectively. There were statistical variations ($p<0.05$) across months, distances, and locations of study and their interactions. The particulates correlates positively at $p<0.01$ with higher concentrations recorded for the dry season as opposed to the wet season, (indication of seasonal influence). The health risk assessment indicated a slight to moderate pollution in both seasons across the study area, which should be taken into advisement when considering long-term exposure to sensitive groups. Hence, there is a need to adopt a sustainable management of emissions due to gari production from cassava tuber.
Keywords: Air quality; Environmental health; *Gari* processing; Particulates; Pubic health.

1. Introduction

In Nigeria, there has been extensive industrialization and urbanization as population growth continuous at an outrageous pace compared to that of the past century. Since most human activities take place within the environment, the rate of environmental degradation has alarmingly, increased resulting in a noticeable threat to sustainability. Continuous environmental degradation has influenced the characteristics of various ecosystems including air [1-4] , soil/ land [5-7] and water resources [8, 9].

The Niger Delta region of Nigeria has several tributaries of River Niger, which is one of the important rivers in Nigeria. According to Abam [10], River Niger drains large section of West Africa and discharges its waters and sediments into the Atlantic Ocean through several tributaries leading to the formation of a complex and fragile delta with divergent biodiversity. The hydrology of the area is dominated by a unidirectional flow which is predominant in the upper region of the Niger Delta; bidirectional tidal flow common in coastal areas and the brackish water zones; and a mixed flow [10]. The marine ecosystem of the area is dominated by a daily rise and fall in water level with varying ranges spanning between 1.8 m in the west and 2.75 m in the east [10]. The fluctuation in river system is often complimented by cyclic changes in water quality. This is attributed to mixing of sea water with freshwater [10].

The major source of environmental (water and soil) degradation in the Niger Delta emanates from oil and gas activities including oil spills, gas leakage, well blowouts, canalization and discharge of wastes and effluents [11]. For instance, artisanal refining continues to endanger human and environmental health, whilst also posing a threat to fish survival and fishing activities. Fish remains a major protein source for the indigenous people of the coastal or riverine towns [12].

Apart from oil and gas activities, agriculture is intensively carried out in the area, which is mostly dominated by smallholders who use rudimentary equipment for soil tillage and processing of produce into finished products. Some of the finished product resulting from agricultural activities is *gari* produced from cassava tuber and palm oil produced from fresh fruit bunch of oil palm. During the processing of oil palm and cassava, several steps are involved requiring human inputs. Specifically, during the processing of *gari* from cassava tuber by smallholder in the Niger Delta region of Nigeria, 7 steps (peeling, washing, grating, bagging, dewatering/ fermentation, sieving and frying) are involved before *gari* can be produced [13].

Several studies have been conducted with respect to cassava processing and how it affects the environmental components especially soil [5-7] and receiving surface water [14]. However, information on the impact on air quality due to cassava processing activities is scanty in literature. Notable environmental pollutants include heavy metals, bioaersols, particulates and noxious gases as well as high density of microbes in the ambient environment arising from various anthropogenic activities [15]. There is paucity of information on the role of *gari* processing activities on ambient air quality, hence this study focused on the distribution of particulates around *gari* processing facilities in the Niger Delta region of Nigeria.

2. Materials and Methods

2.1. Study Area

The study area is made up of four (Delta, Bayelsa, Rivers, Abia) out of the Nine states that make up the Niger Delta region of Nigeria. The other States include Ondo, Edo, Imo, Cross Rivers and Akwa-Ibom. The region is characteristically located in the southern part of the country. It has three major structural basins or formations including Akata, Benin and Agbada. The area has two distinct seasons viz: wet season (April to October; making up 7 months) and dry season (November to March of the following year; making up 5 months) [5]. The relative humidity and temperature of the area is between 50 - 95% and 28 ± 8ºC, respectively throughout the year [2, 5] .

2.2. Sample Measurement

A mini-volume air sampler (model: AEROCET 531, Manufactured by Met-one instrument, USA) with a pre-weighed membrane filter (45µm) was used to measure the particulate matter:(PM_1, $PM_{2.5}$, PM_4, PM_7, PM_{10}) and TSP at a distance of 3.05m, 7.62m and 15.24m from the gari production facility in four states in the Niger Delta, viz: Location A, Bayelsa; Location B, Rivers; Location C, Delta and Location D Abia. Sampling was carried out between November 2016 and September 2017 cutting across the two predominant seasons viz: dry season (November, January and March) and wet season (May, July and September).

3. Data Analysis

3.1. Health Risk Assessment

The health risk assessment was carried out using geometric and median mean values for the various scenarios following the method previously described by Richard, *et al.* [1], Richard, *et al.* [2]. The Background values were adopted from risk assessment of toxicants in the environments such as soil [5] and water [16]. The index for calculating the health risk were presented by ACT Government [17] and modified by Richard, *et al.* [2]. While the criteria for assessment presented by Richard, *et al.* [1], Richard, *et al.* [2] was adopted for the study.

3.2. Statistical Analysis

Statistical Package for Social Sciences software version 20 was used to carry out the statistical analysis. The particulates data obtained were subjected to three-way analysis of variance at $\alpha = 0.05$, and Duncan multiple range test statistics was used to separate the means. Determination of significant relationship between particulates was carried out using Spearman Rho correlation matrix.

4. Results and Discussion

Particulates around *gari* processing facility in 4 Niger Delta states, Nigeria was carried out on a bimonthly, spatial-temporal and at varying distances from emission, and results presented in Table 1, 2 and 3 respectively.

The concentration of PM_1 in the various months of study in a smallholder cassava processing plant in the Niger Delta ranged from 12.30 – 14.02 µg/m^3, being significantly different at $p<0.05$ among the various months studied (Table 1). The spatial-temporal distribution of PM_1 ranged from 11.54 – 14.99 µg/m^3. There was significant variations at $p<0.05$ across the various locations of study (Table 2). PM_1 concentration ranged from 9.51 – 16.83 µg/m^3 based on distances and decreased significantly at $p<0.05$ further away from emission source (Table 3). Significant variations at $p<0.05$ for PM_1 occurred between distances, months, locations and their interactions.

Particulate matter 2.5 ($PM_{2.5}$) concentrations from smallholder cassava processing environment across the various months studied in the Niger Delta ranged from 20.30 – 22.34 µg/m^3. There was significant variations at $p<0.05$ among the months studied (Table 1). The spatial-temporal distribution of $PM_{2.5}$ in this study ranged from 18.70 – 24.09 µg/m^3 (Table 2), and from 15.36 – 27.04 µg/m^3 based on distances. Concentration showed significant decline at $p<0.05$ as distances away from the emission source increased (Table 3). The interactions of $PM_{2.5}$ on distances and months, months and locations, locations and distance, and months, distances and locations show significant differences at $p<0.05$.

The concentration of particulate matter 4 (PM_4) in the months of study ranged from 28.94 – 33.33 µg/m^3, being significantly different at $p<0.05$ among the various months studied (Table 1). The spatial-temporal distribution of the PM_4 ranged from 26.12 – 36.04 µg/m^3, also being significantly different at $p<0.05$ among the various locations (Table 2). Based on distance the concentration ranged from 20.56 – 43.00 µg/m^3, and showed significant decline at $p<0.05$ in concentration as distances move away from emission source (Table 3). Significant differences at $p<0.05$ with distances and months, months and locations, locations and distance, and months, distances and locations was observed.

Particulate matter 7 (PM_7) concentrations across the months of study ranged from 41.56 – 47.58 μg/m^3. There was significant variations at $p<0.05$ among the various months studied (Table 1). The spatial-temporal distribution ranged from 37.00 – 52.26 μg/m^3. There was significant variations at $p<0.05$ among the various locations (Table 2). The concentration ranged from 29.87 – 63.41 μg/m^3 based on distance but showed significantly declined at $p<0.05$ as distances move away from the source of emission (Table 3). The interactions of PM_7 on distances, months and locations showed significant variations at $p<0.05$.

Particulate matter 10 (PM_{10}) concentrations in the months of study ranged from 55.74 – 61.87 μg/m^3. There was significant difference at $p<0.05$ among the months studied (Table 1). The spatial-temporal distribution of PM_{10} ranged from 46.91 – 72.49 μg/m^3. Based on locations there was significant variations at $p<0.05$ among the various points under consideration (Table 2). The concentration of PM_{10} ranged from 40.15 – 84.24 μg/m^3 based on distances and decline significantly at $p<0.05$ further away from emission source (Table 3).

The concentration of total suspended particulate (TSP) ranged from 71.66 – 82.57 μg/m^3, being significantly different at $p<0.05$ among the various months studied (Table 1). The spatial-temporal distribution of TSP in the cassava processing environment ranged from 57.94 – 99.49 μg/m^3 (Table 2). The concentration ranged from 50.01 – 113.21 μg/m^3 based on distances and significantly declined at $p<0.05$ as the distances from the emission source increased (Table 3). The interactions of TSP on distances and months, months and locations, locations and distance, and months, distances and locations show significant differences ($p<0.05$).

The spearman rho correlations matrix of the various particulates is presented in Table 4. The particulates showed high positive significant relationship among each other. This suggests that they are from common source with mutual dependence [2]. The trend observed is in consonance with the report of Richard, *et al.* [2] on particulates from waste dumpsite.

The different air particulates (viz: PM_1, $PM_{2.5}$, PM_4, PM_7, PM_{10}, and total suspended particulates) presents varying level of toxicity to humans. Of these PM_1 and $PM_{2.5}$ are often regarded as fine particulates because they easily readily penetrate the respiratory tract, while the PM_{10} is seen as coarse particulate. PM_4 to PM_{10} is regarded as coarse particulates because they do not easily penetrate into the bronchi and cause diseases. However, the values reported in this study were within the Federal ministry of environment limit of 250 μg/m^3 for total suspended particulates [18]. This suggests no notable effects due to exposure, but prolonged exposure may give rise to an adverse health impact. Authors have reported on certain adverse effects attributable to particulates to include emphysema, pneumonia, bronchitis, asthma and respiratory tuberculosis [2, 4, 19-21]. The effect could be linked to the concentration and dispersal rate of particulates [2]. Again the significance difference suggests the influence of climatic conditions across the various months, anthropogenic activities in the various locations and distances from emission.

Table-1. Bimonthly distribution of particulates from gari processing area in the Niger Delta region of Nigeria

Parameters	Months					
	November	January	March	May	July	September
PM 1, μg/m^3	14.02e	12.78b	13.15d	12.97c	12.89bc	12.30a
PM 2.5, μg/m^3	22.34d	21.33c	21.00b	20.91b	20.77b	20.30a
PM 4, μg/m^3	33.33e	32.05d	29.39ab	29.83b	30.46c	28.94a
PM 7, μg/m^3	47.58e	46.26d	41.56a	43.89bc	44.77c	43.36b
PM 10, μg/m^3	61.87d	60.21c	56.18a	55.74a	58.71b	56.10a
TSP, μg/m^3	82.57d	78.32c	72.20a	71.66a	73.95b	73.78b

Means (36) with Different letters across the row indicate significant difference at $p<0.05$ according to Duncan multiple range test statistics

Table-2. Spatial distribution of particulates from gari processing area in the Niger Delta region of Nigeria

Parameters	Locations			
	A	B	C	D
PM 1, μg/m^3	14.99d	11.54a	13.24c	12.29b
PM 2.5, μg/m^3	24.09d	18.70a	21.24c	20.40b
PM 4, μg/m^3	36.04d	26.12a	31.24c	29.27b
PM 7, μg/m^3	52.26c	37.00a	44.85b	44.16b
PM 10, μg/m^3	72.49d	46.91a	58.13c	54.99b
TSP, μg/m^3	99.49d	57.94a	73.12c	71.10b

Means (54) with Different letters across the row indicate significant difference at $p<0.05$ according to Duncan multiple range test statistics

Table-3. Distance distribution of particulates from gari processing area in the Niger Delta region of Nigeria

Parameters	Distance, meter		
	3.05	**7.62**	**15.24**
PM 1, µg/m^3	16.83c	12.72b	9.51a
PM 2.5, µg/m^3	27.04c	20.92b	15.36a
PM 4, µg/m^3	43.00c	28.43b	20.56a
PM 7, µg/m^3	63.41c	40.43b	29.87a
PM 10, µg/m^3	84.24c	50.01b	40.15a
TSP, µg/m^3	113.21c	63.02b	50.01a

Means (72) with Different letters across the row indicate significant difference at $p<0.05$ according to Duncan multiple range test statistics

Table-4. Spearman's rho of particulates in gari processing area in the Niger Delta region of Nigeria

Parameters	PM 1	PM 2.5	PM 4	PM 7	PM 10	TSP
PM 1	1.000					
PM 2.5	.974**	1.000				
PM 4	.974**	.977**	1.000			
PM 7	.964**	.973**	.974**	1.000		
PM 10	.956**	.965**	.970**	.981**	1.000	
TSP	.939**	.947**	.962**	.956**	.974**	1.00

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N=218

The health risk assessment of the particulate matter (PM_1, $PM_{2.5}$, PM_4, PM_7, PM_{10}, and total suspended particulates) is presented in Table 5. The health risks for the particulates ranged from no pollution (HRA≤50) to dense pollution (150<HRA≤200). In Location A, moderate pollution was the predominant feature across all the particulates in both seasons and background considerations. The values in Location B were dominated by slight pollution across both seasons and background scenarios. For Location C and D, slight pollution is the most occurring feature across all the particulates. The health risk did not favor a particular season, suggesting that deviation in particulates content due to human activities occurred in both seasons. From the air quality index, sensitive group of people could be unpleasantly affected due to exposure over a prolong period.

Since the extreme health risk occurred mostly in one of the background scenarios apart from Location A, then it may not have been considered true impact. This trend have been reported and emissions from dumpsites in the Niger Delta with respect to particulates [2], noxious gases [1] and volatile organic compounds [3].

Table-5. Air quality index of particulates from gari production in the Niger Delta region of Nigeria

Locations	Mean consideration	PM1		PM2.5		PM4		PM7		PM710		Total	
		Dry	Wet	Dry	Wet	Dry	Dry	Wet	Dry	Wet	Wet	Dry	Wet
A	Geometric	115.24	114.39	115.35	113.70	121.47	18.24	121.47	129.38	145.78	147.45	154.85	162.05
	Median	118.74	116.50	117.76	115.38	117.90	119.69	118.14	127.96	147.73	150.45	159.79	168.88
B	Geometric	92.17	90.57	90.72	90.57	86.27	86.67	77.89	75.65	70.63	70.64	68.75	66.97
	Median	94.97	92.24	92.28	91.91	86.75	87.78	75.76	74.83	71.58	72.08	70.94	69.71
C	Geometric	98.88	98.00	99.12	97.34	101.10	99.14	102.48	99.20	103.82	100.54	96.71	100.06
	Median	110.88	99.82	101.43	109.93	101.67	100.36	99.67	98.11	105.21	102.58	99.79	104.15
D	Geometric	95.29	98.43	96.32	99.78	97.82	98.40	103.17	247.39	93.54	95.47	97.11	92.08
	Median	98.18	100.25	98.57	101.24	98.36	99.61	100.34	101.89	94.79	97.42	100.21	95.84

HRA≤50 (No pollution); 50<HRA≤100 (Slightly polluted); 100<HRA≤150 (Moderately polluted); 150<HRA≤200 (Significantly/Densely polluted); 200<HRA≤250 (Hazardous); HRA>250 (Very Hazardous)

5. Conclusion

With increased human activities the rate of atmospheric pollution has increased. Several human activities have the tendency to influence ambient air quality. This study investigated the distribution of particulates in *gari* production facility by smallholders in the Niger Delta. The study showed that particulate distribution is influenced by distances, locations and period (month) of study. The health risk assessment indicates that *gari* processing causes an alteration in the atmospheric particulate distribution, suggesting that sensitive group of people may be at risk when exposed over prolong period.

References

[1] Richard, G., Nwagbara, M. O., and Weli, V. E., 2019. "Public health implications of seasonality in noxious gases from dumpsites in some Niger Delta States, Nigeria." *Intern. J. Res. Studies. Biosci.*, vol. 7, pp. 1-14.

[2] Richard, G., Weli, V. E., and Nwagbara, M. O., 2019. "Seasonality in particulates distribution from dumpsites in the Niger Delta region of Nigeria: A health risk assessment approach." *Intern. J. Res. Environ. Sci.*, vol. 5, pp. 7-15.

[3] Richard, G., Weli, V. E., and Nwagbara, M. O., 2019. "Effects of seasons in the distribution of volatile organic compounds across dump sites in some selected Niger Delta States, Nigeria." *BAOJ Biotechnol.*, vol. 5, p. 042.

[4] Seiyaboh, E. I. and Izah, S. C., 2019. "Impacts of soil pollution on air quality under Nigerian setting." *Journal of Soil and Water Science*, vol. 3, pp. 45-53.

[5] Izah, S. C., Bassey, S. E., and Ohimain, E. I., 2017. "Assessment of heavy metal in cassava mill effluent contaminated soil in a rural community in the Niger Delta region of Nigeria." *EC Pharmacology and Toxicology*, vol. 4, pp. 186-201.

[6] Izah, S. C., Bassey, S. E., and Ohimain, E. I., 2017. "Geo-accumulation index, enrichment factor and quantification of contamination of heavy metals in soil receiving cassava mill effluents in a rural community in the Niger Delta region of Nigeria." *Molecular Soil Biology*, vol. 8, pp. 7-20.

[7] Izah, S. C., Bassey, S. E., and Ohimain, E. I., 2017. "Assessment of pollution load indices of heavy metals in cassava mill effluents contaminated soil: a case study of small-scale cassava processing mills in a rural community of the Niger Delta region of Nigeria." *Bioscience Methods*, vol. 8, pp. 1-17.

[8] Aghoghovwia, O. A., Miri, F. A., and Izah, S. C., 2018. "Impacts of anthropogenic activities on heavy metal levels in surface water of nun river around gbarantoru and Tombia Towns, Bayelsa State, Nigeria." *Annals of Ecology and Environmental Science*, vol. 2, pp. 1-8.

[9] Ogamba, E. N., Charles, E. E., and Izah, S. C., 2021. "Distributions, pollution evaluation and health risk of selected heavy metal in surface water of Taylor creek, Bayelsa State, Nigeria." *Toxicology and Environmental Health Sciences*, Available: http://DOI: 10.1007/s13530-020-00076-0

[10] Abam, T. K. S., 2001. "Modification of Niger Delta physical ecology: the role of dams and reservoirs." In *Proceedings of Workshop HW2 held at Birmingham, UK. IAHS Publication.* pp. 19-29.

[11] Emoyan, O. O., Akpoborie, I. A., and Akporhonor, E. E., 2008. "The oil and gas industry and the Niger Delta: implications for the environment." *J. Appl. Sci. Environ. Manage.*, vol. 12, pp. 29-37.

[12] Ezekwe, C. I. and Edoghotu, M. I., 2015. "Water quality and environmental health indicators in the Andoni River estuary, Eastern Niger Delta of Nigeria." *Environ. Earth Sci.*, vol. 74, pp. 6123-6136. Available: http://DOI:10.1007/s12665-015-4635-9

[13] Izah, S. C., 2018. "Estimation of potential cassava mill effluents discharged into Nigerian environment." *Environmental Analysis and Ecology studies*, vol. 2, pp. 189-195.

[14] Seiyaboh, E. I. and Izah, S. C., 2018. "Mortality rate of juvenile heterobranchus bidorsalis exposed to cassava mill effluents." *Annals of Review and Research*, vol. 4, p. 555628.

[15] Seiyaboh, E. I. and Richard, G. I., S. C., 2020. "Time impact on spatio -temporal density of microbial air contaminants in the dewatering zone of smallholder gari processing facility in the Niger delta region of Nigeria." *Open Access Journal of Environmental and Soil Science*, vol. 4, pp. 559-563.

[16] Bhutiani, R., Kulkarni, D. B., Khanna, D. R., and Gautam, A., 2017. "Geochemical distribution and environmental risk assessment of heavy metals in groundwater of an industrial area and its surroundings, Haridwar, India." *Energyn, Ecology and Environment*, vol. 2, pp. 155-167.

[17] ACT Government, 2018. "What is an air quality index?" Available: http://health.act.gov.au/public-information/public-health/act-air-quality-monitoring/air-quality-index-aqi.

[18] Federal Environmental Protection Agency, 1991. *National interim guidelines and standards for industrial effluents, gaseous emissions and hazardous wastes*. Lagos, Nigeria: Environmental Pollution Control Handbook.

[19] Efe, S. I., 2008. "Spatial distribution of particulate air pollution in Nigerian cities: Implications for human health." *J. Environ. Health Res.*, vol. 7, pp. 107-116.

[20] Ohimain, E. I., Izah, S. C., and Abah, S. O., 2013. "Air quality impacts of smallholder oil palm processing in Nigeria." *Journal of Environmental Protection*, vol. 4, pp. 83-98.

[21] Ossai, E. K., Iniaghe, G. O., Osakwe, S. A., and Agbaire, P. A., 1999. *Pollution problems and environmental effects of Chemicals, reading in general studies: History and Philosophy of Science*. Abraka General Studies Dept. Pub., pp. 83-86.