Annals of Ecology and Environmental Science
Volume 3, Issue 4, 2019, PP 27-35
ISSN 2637-5338

Influence of Season on the Distribution of Volatile Organic Compounds from Small-Holder Cassava Processing Facility in the Niger Delta Region of Nigeria

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ABSTRACT

Seasonal influence on the distribution of volatile organic compounds from small-holder gariprocessing facility in the Niger Delta region of Nigeria was studied,using measurement at 3 distances (3.05 m, 7.62 m and 15.24 m) in 4 states (Bayelsa, Rivers, Delta and Abia) across the two major seasons (wet and dry) withportable multi-probe AEROQUAL meter.Meteorology indices (wind speed, temperature and relative humidity) were also measured the stations. The resultant data were subjected to 3-way analysis of variance and the health risk index calculated using median and geometric mean as reference background values. The overall values of volatile organic compounds in the wet and dry season were in the range of 7.50 – 10.58ppm and 9.37 – 12.07ppm at 10 feet distance, 4.25 – 6.96ppm and 4.94 – 6.57 ppm at 25 feet distance, and 2.57 – 4.36ppm and 1.62 – 2.25ppmat 50 feet distancerespectively. The meteorological indicators in the dry and wet season ranged from 30.93 – 31.97°C and 28.56 – 30.24 °C, respectively (temperature), 58.67 – 64.00% and 65.33 – 76.33%, respectively (relative humidity), and 0.73 – 1.08m/s and 0.42 – 1.20m/s, respectively (wind speed). The values of volatile organic compounds showed significant variations ($p<0.05$) across months, location, distances and interactions. In addition,meteorological data showed significant difference ($p<0.05$) across months, locations and distances except for distance value of wind speed. This suggests seasonal and spatio-temporal influence on volatile organic compounds emitted from gari processing mill in the Niger Delta. Public health risk index revealed slight to moderate pollution, which suggest that infants, children, elderly and immune-compromisedindividuals could be at risk over prolonged exposure.

Keywords:Air quality, Gari processing, public health, volatile organic compounds.*

INTRODUCTION

Environmental degradation is one of the major challenges of global environmental sustainability (Richard et al., 2019a-c). Several natural and anthropogenic activities contribute to this; however, man-made activities appear to trigger other natural disasters and account for a significant proportion of environmental problems. In developed countries, much attention is focused on the environment just as in the energy sector, whereas in developing countries like Nigeria the focus is less on environmental degradation by anthropogenic activities despite multiple environmental agencies. In recent times, the world has experienced several natural disasters including earthquake, desertification, flooding, and land change pattern as well as climate change.

Several activities contribute to climate pattern currently been observed in Nigeria including unsustainable agricultural practices, mining, dredging, use of fossil fuel, and more importantly crude oil and natural gas exploration. Tawari and Abowei (2012) stated that air pollution is the introduction of chemicals, particulate matter, or biological materials that cause discomfort to biotic and non-biotic components in the environment. In Nigeria, air pollution is typically caused by bush burning, combustion of fossil fuel, gas flaring, improper disposal of domestic and industrial wastes; pollution through oil spillage; car exhausts, unsanitary and unsafe housing, etc (Ogwu et al., 2015).

Besides oil and gas, emissions are also generated from coal and nuclear power plants, combustion of fossil fuel for transportation purposes, activities of manufacturing and production sector including cement, iron and steel, fertilizer; food processing including flour, sugar, maize, rice; cassava mills, breweries, wineries and distilleries.

Unlike oil and gas activities, emission from agricultural processes like oil palm and cassava processing often go unchecked. Little or no attention is shown in non-oil and gas related sector in Nigeria, however, air pollution is a threat to human life. Researchers have associated several disease conditions to air pollution with severity of disease determined by dosage inhaled, exposure duration and constituents of the pollutants. Nearly all Nigerians are vulnerable to different forms of air pollution, basically, emitted from human activities. The World Health Organization (WHO) has estimated that approximately 2.4 million people worldwide (including about 93,700 Nigerians) die annually from air pollution related disease conditions (WHO, 2002).

During oil palm processing for instance, gaseous emissions are released into the environment which has been documented by Ohimain et al. (2013a) and Ohimain and Izah (2013). Apart from oil palm processing, emission is also generated during cassava processing. The major wastes streams include cassava waste water (liquid), seviates and peels (solid) and gaseous emissions. Basically, Nigeria is the world leading producer of cassava accounting for about 20% of total cassava production (Izah et al., 2017a-e; Ohimain et al., 2013b). The cassava is processed in a combined operation by small-holder processers that use rudimentary equipment. The waste water is discharged into the environment where they decompose through the activities of microbes and cause offensive odour. In addition, during *gari* frying emissions are also generated.

Among the pollutant gases is volatile organic compound whose distribution s could be influenced by season. Richard et al. (2019a) reported that temperature and sunlight is essential for biosynthesis and volatility of volatile organic compounds. Hence this study focused on the influence of season on the distribution of volatile organic compounds from smallholder cassava processing facility in the Niger Delta region of Nigeria.

Materials and Methods

Study Area

Niger delta region of Nigeria has two predominant seasons comprising five months' dry season (November to March of the preceding year) and seven months of wet season (April to October) (Richard et al., 2019a,b). The temperature and relative humidity of the area is 28 ±8 ºC and 50 - 95% all year round. The region has been reported to contain vast useful bio-resources and the centre of oil and gas processing in Nigeria. The area is among the notable biodiversity hotspot in Africa. The area is presently under intense threat due to human activities. Surface water resources that harbor several fish species, planktons abound in the area. Cassava processing is among the major source of livelihood to several families in the Niger Delta (Izah et al., 2017a-d).

Measurement ofvolatile Organic Compounds

In this study, volatile organic compounds were measured with a portable multiprobe AEROQUAL meter.Aeroqual Limited Auckland, New-Zealand-Series 300 with probe detection range of 0 – 25ppm from four cassava processing facilities in the Niger Delta States of Delta, Rivers, Abia andBayelsa states. The volatile organic compounds were monitored at 3 distances (3.05 m i.e 10feet, 7.62 m i.e. 25 feet and 15.24 m i.e 50ft).

Meteorological Measurement

The temperature, relative humidity and wind speed were monitored with meteorological station (Kestrel model: 4500 NV manufactured by Nielsen-Kellerman CO, Boothywn, USA).

Statistical Analysis

Statistical analysis was carried out with SPSS software version 20. Three factorial was carried out at α = 0.05, and Duncan multiple range test statistics was used to discern source of variation. Spearman rho correlation matrix was used to show relationship between the meteorologicalindicatorsand volatile organic compounds.Charts were plotted with Microsoft excel. The charts (expressed as mean ± standard error) using Graph-Pad software.

Health Risk Assessment

Health risk assessment was carried out for two scenarios (geometric mean and median mean) based on the approach previously applied by Richard et al. (2019a-c). The assessment was carried out using the value for 3.05m (10 feet) distance. The geometric and median mean value was 9.61 and 10.37, respectively for dry season, and 10.69 and 10.76 respectively for the rainy season.The values were classified as; HRA≤50 (no pollution), 50<HRA≤100 (Slight pollution), 100<HRA≤150 (moderate pollution), 150<HRA≤200 (Significant/Dense pollution), 200<HRA≤250 (Hazardous), HRA>250 (Very Hazardous) (Richard et al., 2019a-c).

Results and Discussion

The concentration of volatile organic compounds across the months of study in a small-holder cassava processing plant in the Niger Delta ranged from 5.25 – 6.79. Basically, there was significant difference at $p<0.05$ among the various months studied (Table 1). The spatio-temporal distribution of volatile organic compounds also differs significantly at $p<0.05$ ranging from 5.45 – 6.45 ppm (Table 2). The concentration ranged from 2.43 – 10.22 ppm based on distances and showed significant decline at $p<0.05$ based on distances away from the emission source (Table 3).It showed significant interactions at $p<0.05$ between months and distance, distance and location, and months, distance and locations, months and locations (Table 4).

Table1. *Bimonthly distribution of Volatile organic compounds and meteorological indicators in smallholder gari processing area in the Niger Delta region of Nigeria*

Parameters	Months					
	Nov	Jan	Mar	May	July	Sept
VOC, ppm	6.54d	6.27c	5.25a	5.77b	5.95b	6.79e
Wind speed, m/s	0.89bc	0.91bc	0.85abc	0.78ab	0.93c	0.74a
Temperature, ℃	31.64e	31.52d	31.09c	28.46a	29.82b	29.80b
Relative humidity, %	60.61b	60.08a	63.08c	75.83e	70.36d	69.97d

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

Table2. *Spatial distribution of Volatile organic compounds and meteorological indicators in smallholder gari processing area in the Niger Delta region of Nigeria*

Parameters	Locations			
	A (Bayelsa)	B (Rivers)	C (Delta)	D (Abia)
VOC, ppm	6.17b	5.45a	6.45c	6.31bc
Wind speed, m/s	0.75a	0.92b	0.79a	0.94b
Temperature, ℃	30.64c	30.29b	30.86d	29.76a
Relative humidity, %	65.07b	67.41c	63.741a	70.41d

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

Table3. *Distance distribution of Volatile organic compounds and meteorological indicators in smallholder gari processing area in the Niger Delta region of Nigeria*

Parameters	Distance, meter		
	3.05	7.62	15.24
VOC, ppm	10.22c	5.63b	2.43a
Wind speed, m/s	0.83a	0.84a	0.88a
Temperature, ℃	30.38a	30.38b	30.41a
Relative humidity, %	66.31a	66.78b	66.89b

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

Table4. *P-values of Volatile organic compounds and meteorological indicators in smallholder gari processing area in the Niger Delta region of Nigeria*

Parameters	Months	Locations	Distances	Interaction of months and location	Interaction of months and distance	Interaction of distance and location	Interaction of months, locations and distance
VOC, ppm	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wind speed, m/s	0.017	0.001	0.407	0.000	0.000	0.000	0.000
Temperature, ℃	0.000	0.000	0.502	0.000	0.932	0.974	0.423
Relative humidity, %	0.000	0.000	0.001	0.000	0.000	0.087	0.000

Values greater than 0.05 indicates no significant difference

Based on seasons, values for volatile organic compounds for both dry and wet seasons were 10.58 and 10.24 ppm (Bayelsa), 7.5 and 9.37ppm (Rivers), 10.27 and 11.27ppm, (Delta), and 10.47 and 12.07ppm, (Abia) respectively for 3.05m (10 feet) distance; 5.68 and 4.94 ppm, (Bayelsa), 6.96 and 5.74 ppm (Rivers), 4.74 and 6.14ppm, (Delta), and 4.26 and 6.57 ppm, (Abia) respectively for 7.62m(25 feet) distance; 2.57 and 1.79 ppm, (Bayelsa), 2.83 and 1.62 ppm (Rivers), 4.36 and 2.00ppm, (Delta), and 4.26 and 2.25 ppm (Abia), respectively for 15.24 m (50 feet) distance (Figure 1). At 10 feet distance, the value was generally lower during the dry season compared to wet season across the states studied. This was not the case for 25 and 50 feet distance which showed fluctuation in seasonal pattern. These fluctuating patterns could be due to other anthropogenic activities in the area.

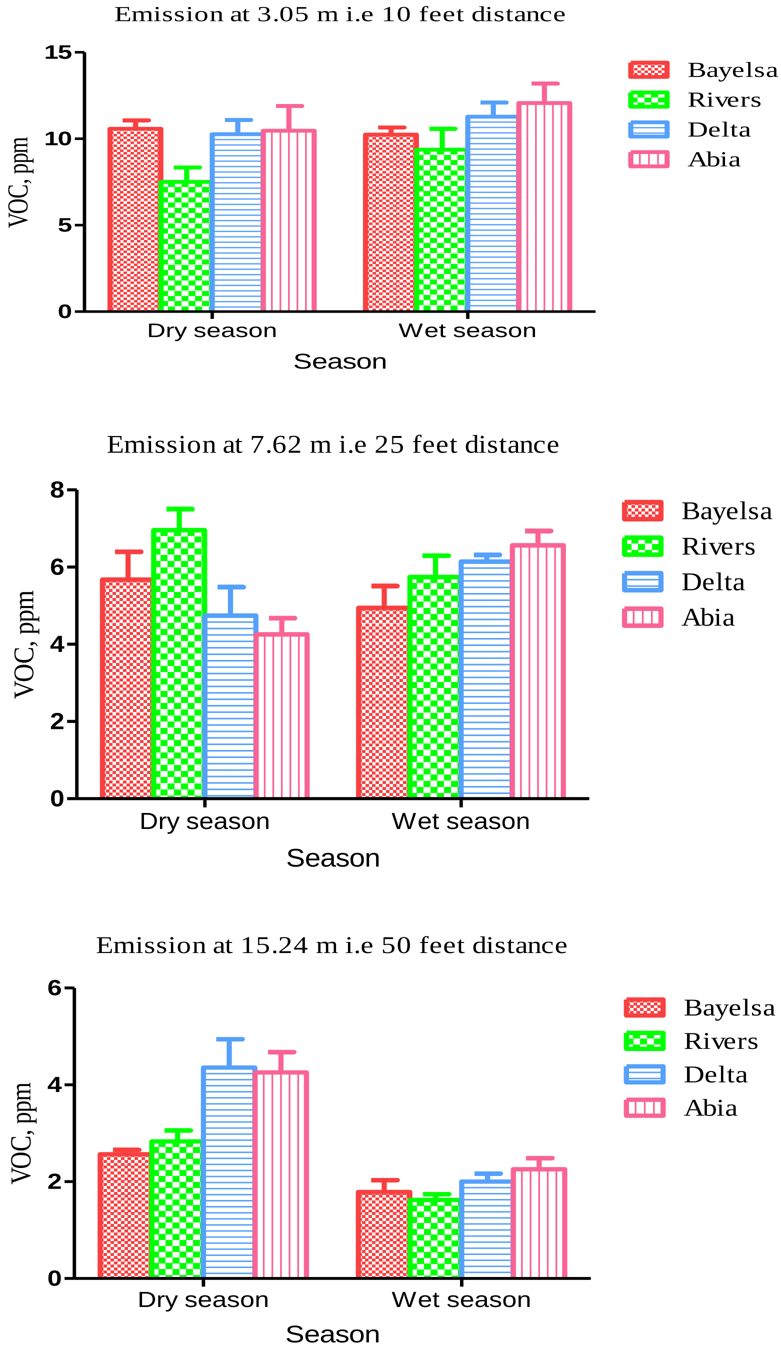

Figure1. *Distribution of volatile organic compounds in smallholder gari processing facilities*

The wind speed from smallholder cassava processing mills across the various months of study ranged from 0.74 – 0.93 m/s, being significantly different at $p<0.05$ (Table 1). The spatio-temporal distribution of wind speed ranged from 0.75 – 0.92 m/s (Table 2). Based on distance, the wind speed ranged from 0.83 – 0.88, not significantly different at P>0.05. Based on interaction, there was significant variation between location and months, location and distance, and month, location and distances (Table 4). Wind speed based on variation of distance ranged from 0.87 – 1.08m/s (dry season) and 0.42 – 0.70 m/s (wet season) at 10 feet, 0.86 – 0.97m/s (dry season) and 0.56 – 1.04 m/s (wet season) at 25, and 0.73 – 0.92m/s (dry season) and 0.67 – 1.00 m/s (wet season) at 50 feet respectively (Figure 2).

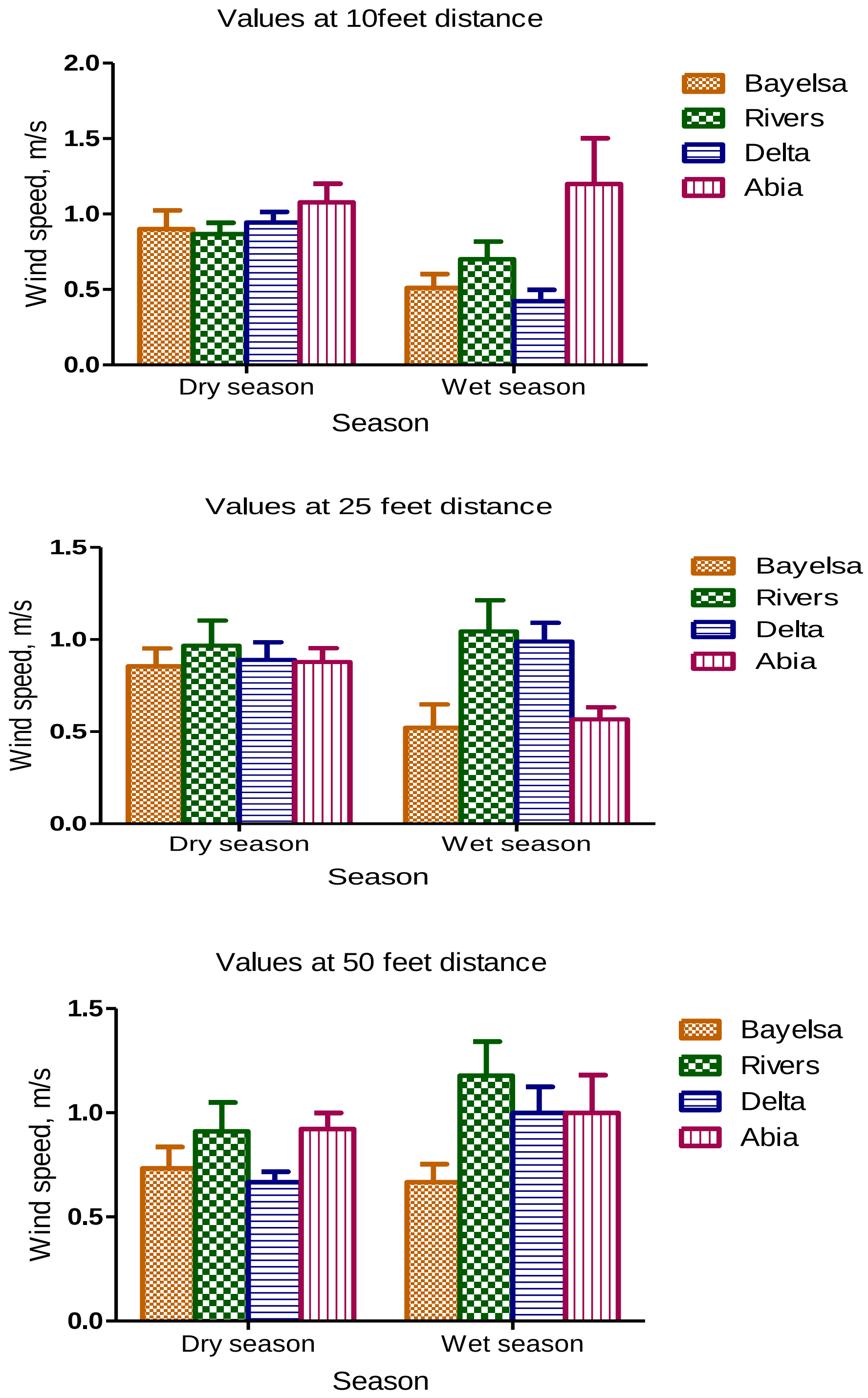

Figure2.*Distribution of wind speed in smallholder gari processing facilities.*

Atmospheric temperature around cassava processing mills in the various months of study ranged from 28.46 – 31.64 ºC, being significantly different at p<0.05 (Table 1). The spatio-temporal distribution of temperature ranged from 29.76 – 30.86 ºC (Table 2) and 30.38 – 30.41 ºCbased on distance, (not significantly different) at p>0.05 (Table 3). Temperature revealed significant interactions at $p<0.05$ on months and location, and no significant variation at $p>0.05$ between months and distances, distances, and locations and distances, months and locations respectively (Table 4). Based on variation of distance, the temperature ranged from 30.93 – 31.56ºC (dry season) and 28.56 – 30.00 ºC (wet season) at 10 feet, 31.16 – 31.90 ºC (dry season) and 28.84 – 30.18(wet season) at 25 feet, and 31.10 – 31.97 ºC (dry season) and 28.83 – 30.24 ºC (wet season) at 50 feet (Figure 3).

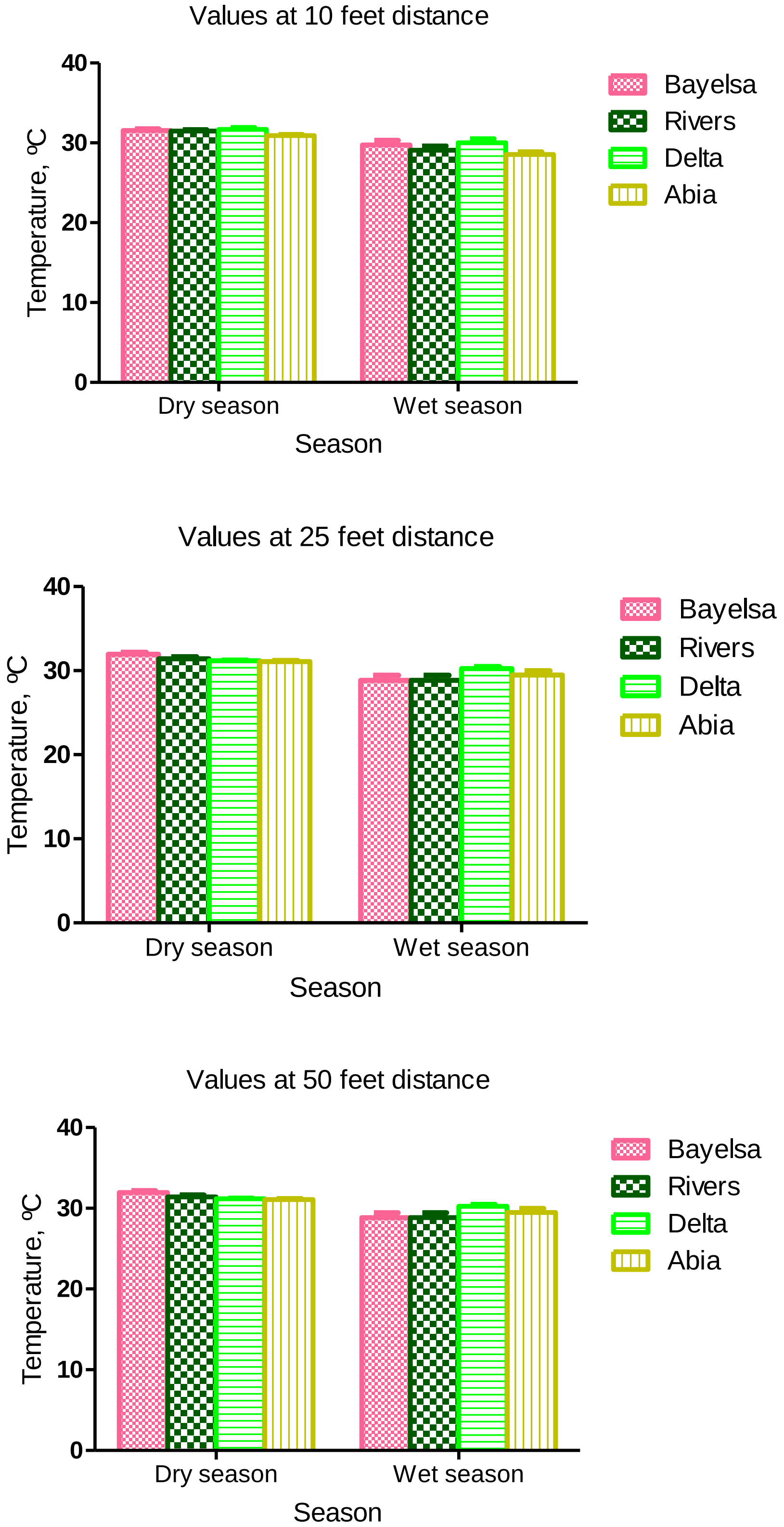

Figure3. *Distribution of temperature in smallholder gari processing facilities.*

The relative humidity around small-holder cassava processing mills in the various months studied ranged from 60.08 – 75.83 %, being significantly different at $p<0.05$ (Table 1). The spatio-temporal distribution of relative humidity ranged from 63.74 – 70.41 %. Typically, there was significant variation at $p<0.05$ across the different locations (Table 2).

Relative humidity Based on distances ranged from 66.31 – 66.89 %, being statistically different at $p<0.05$ across the various distances (Table 3). Relative humidity showed significant interactions at $p<0.05$ on distances, months and locations (Table 4). Across varying distances, the relative humidity ranged from 59.44 – 64.00% (dry season) and 67.55 – 69.89% (wet season) at 10 feet, 58.67 – 63.44% (dry season) and 67.44 – 75.00% (wet season) at 25 feet, and 50.89 – 63.44% (dry season) and 64.44 – 78.00% (wet season) at 50 feet (Figure 4).

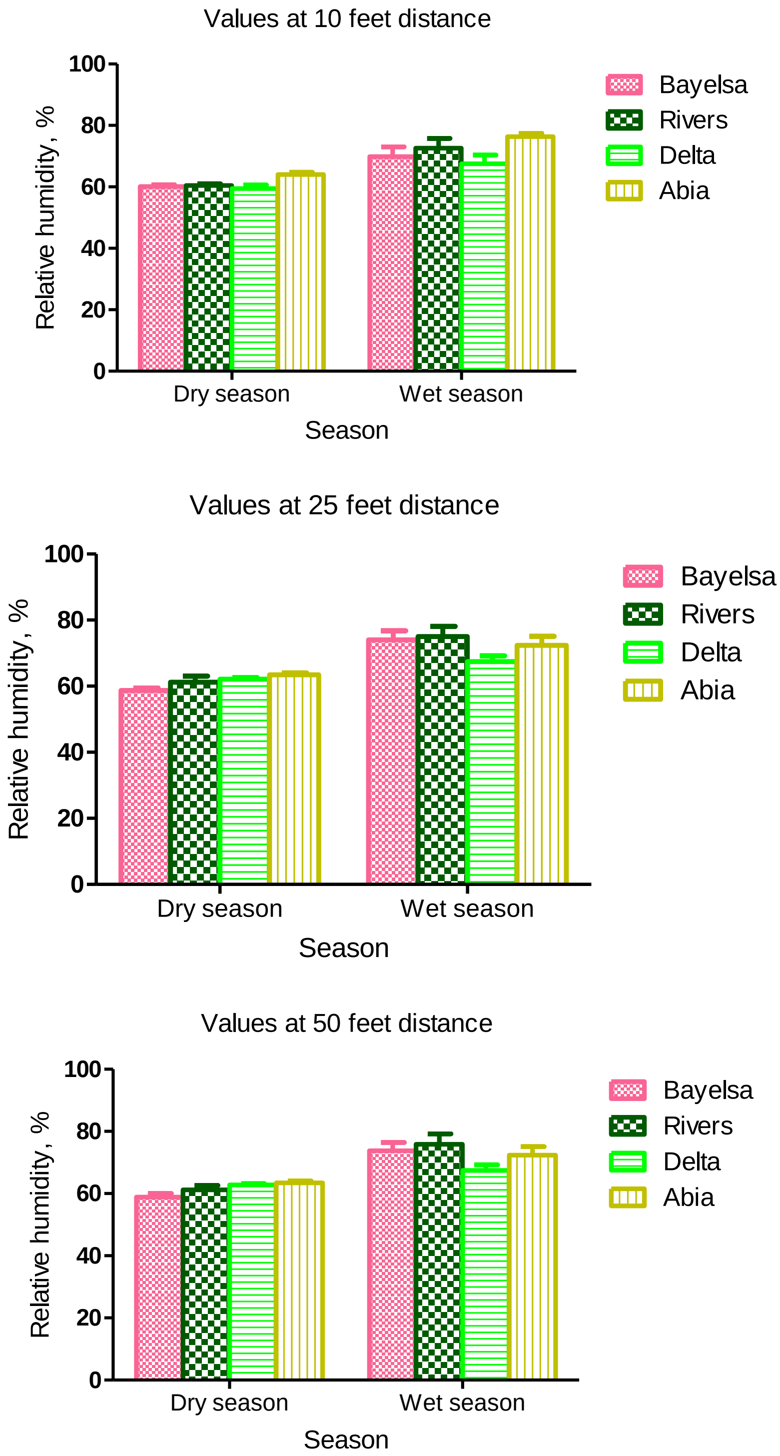

Figure4.*Distribution of relative humidity in smallholder gari processing facilities.*

The air quality index of volatile organic compounds in smallholder cassava processing in the Niger Delta region of Nigeria is presented in Table 5. The air quality index showed slight pollution (50<HRA≤100) to moderate pollution (100<HRA≤150). In nearly all cases, the values in the wet season were considerately higher compared to dry season. This may be associated with the moisture content that enhances degradation processes of the cassava waste water during decomposition processes. Again the volatile organic compounds showed no significant relationship with the meteorological indicators (temperature, wind speed and relative humidity) (Table 6). This suggests that distribution of volatile organic compounds in the area is influenced by other factors. The result shows that sensitive group (including infants, children and elderly over a short period of time, and immune compromised patients over prolonged period of are vulnerable (Richard et al., 2019a). According to Wolkoff and Kjærgaard (2007), Ohimain*et al.* (2013), Richard et al. (2019a), high concentration of volatile organic compounds could cause irritation in some sensory organs such as eyes, nose and throat.

Table5. *Air quality index of volatile organic compounds in smallholder cassava processing in the Niger Delta region of Nigeria*

Locations	Mean consideration	*Gari* processing	
		Dry	Wet
A (Bayelsa)	Geometric	110.09	95.79
	Median	102.03	95.17
B (Rivers)	Geometric	78.04	87.65
	Median	72.32	87.08
C (Delta)	Geometric	106.87	105.52
	Median	99.04	104.83
D (Abia)	Geometric	108.95	112.91
	Median	100.96	112.17

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)

Table6.*Spearman's rho of the Volatile organic compound and meteorology of selected gari processing area in the Niger Delta region of Nigeria*

Parameters	VOC	W/S	TEMP	RH
VOC	1.000			
W/S	-.005	1.000		
TEMP	-.099	.012	1.000	
RH	-.009	-.095	-.874**	1.000

***. Correlation is significant at the 0.01 level (2-tailed).*

**. Correlation is significant at the 0.05 level (2-tailed).*

N=218 (months =6, Location =4, distance = 3, replicate=3)

Conclusion

This study evaluated the influence of season of the distribution of volatile organic compounds from smallholder cassava processing facility in the Niger Delta region of Nigeria. The values showed significant variations across the distances, interactions between locations and months, locations and distance, months, location and distances, and no significant difference (p>0.05) in the monthly distribution as well as the distances. The health risk showed that infants, children, elderly and immune-compromisedindividuals could be affectedover prolonged exposure resulting from cassava processing. There was slight variation in the associated health risk across the seasons

References

[1] Izah, S.C., Bassey, S.E., and Ohimain, E.I. (2017a). 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,* 4(5): 186-201.

[2] Izah, S.C., Bassey, S.E., and Ohimain, E.I. (2017b). 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,* 8(1): 1-17.

[3] Izah, S.C., Bassey, S.E., and Ohimain, E.I. (2017c). Changes in the treatment of some

physico-chemical properties of cassava mill effluents using *Saccharomyces cerevisiae, Toxic*, *5*(4) 28; doi:10.3390/toxics5040028. PMID:29051460.

[4] Izah, S.C., Bassey, S.E., and Ohimain, E.I. (2017d). Cyanide and Macro-Nutrients Content of *Saccharomyces cerevisiae* Biomass Cultured in Cassava Mill Effluents, *International Journal of Microbiology and Biotechnology*, 2(4): 176-180.

[5] Izah, S.C., Bassey, S.E., and Ohimain, E.I. (2017e). Removal of Heavy Metals in Cassava Mill Effluents with *Saccharomyces cerevisiae* isolated from Palm Wine. *MOJ Toxicology*, 3(4): 00057. DOI: 10.15406/mojt.2017.03.00058.

[6] Ogwu, F.A., Peters, A.A., Aliyu, H.B. and Abubakar, N. (2015).An Investigative Approach on the Effect of Air Pollution on Climate Change and Human Health in the Niger Delta Region of Nigeria. *International Journal of Scientific Research and Innovative Technology*, 2(5): 37- 49.

[7] Ohimain, E.I., Izah, S.C. and Abah, S.O. (2013a). Air quality impacts of smallholder oil palm processing in Nigeria. *Journal of Environmental Protection*,4: 83-98.

[8] Ohimain, E. I., Silas-Olu, D. I., and Zipamoh, J. T. (2013b). Biowastes generation by small scale cassava processing centres in Wilberforce Island, Bayelsa State, Nigeria. *Greener Journal of Environmental Management and Public Safety*, *2* (1): 51 – 59.

[9] Ohimain, E.I. and Izah, S.C. (2013). Gaseous emissions from a semi-mechanized oil palm processing mill in Bayelsa state, Nigeria. *Continental Journal of Water, Air and Soil Pollution*, 4 (1): 15 – 25.

[10] Richard G, Nwagbara MO., and Weli VE (2019a). Effects of Seasonsin the Distribution of Volatile Organic Compounds across Dump Sites inSome Selected Niger Delta States, Nigeria BAOJ Biotech. 5: 042.

[11] Richard G, Nwagbara MO., and Weli VE (2019b). Public Health Implications of Seasonality in Noxious Gases from Dumpsites in Some Niger Delta States, Nigeria. International Journal of Research Studies in Biosciences, 7(5): 1-14.

[12] Richard G, Nwagbara MO., and Weli VE (2019c). Seasonality in Particulates Distribution from Dumpsites in the Niger Delta Region of Nigeria: A Health Risk Assessment Approach. International Journal of Research in Environmental Science, 5(2): 7-15.

[13] Tawari, C.C., and Abowei, J.F.N. (2012).Air Pollution in the Niger Delta Area of Nigeria.*International Journal of Fisheries and Aquatic Sciences*, 1(2): 94-117.

[14] Wolkoff, P., and Kjærgaard, S.K., (2007). The dichotomy of relative humidity on indoor air quality. *Environment International*, *33*, 850–857

[15] World Health Organization (WHO) (2002). Estimated Deaths and DALYs attributable to selected environmental risk factors by WHO member state, 2002.http://www.who.int/entity/quantifying_ehimpacts/countryprofilesebd.xls. Accessed 30th November 2012.

Citation: *Glory Richard.“Influence of Season on the Distribution of Volatile Organic Compounds from Small-Holder Cassava Processing Facility in the Niger Delta Region of Nigeria”.Annals of Ecology and Environmental Science 3(4), pp.27-35*