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Socio-demographic evaluation of odour annoyance from cassava wastewater treated with an sfws-v

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Abstract
The study on odour annoyance of wastewater from Garri, Akpu and Starch process methods was carried out in Makurdi using a laboratory scale SFWS-v and evaluating the performance by removal efficiency of odour. Structured questionnaire on seven rated odour annoyance level was used to evaluate the levels of odour annoyance by rourty respondent within the vicinity of cassava processing plants. Descriptive statistics of mean, StDev, correlation and multivariate statistic was used to attest the degree of variation and similarities that exist between tested process methods, there was 100% response by the respondent comprising 37,5% male and 62.5% female. The odour annoyance was skewed toward increasing rating of annoyance for non-treated wastewater and skewed toward decreasing rating for treated wastewater, the treatment facilities have reduced the percentage response to annoying (25%) and quite annoying (35) of non- treated water to below 5% of treated wastewater for the three cassava processes. In consequence, response to not annoyed and very little annoyed was increased from below 5% for non-treated water to 20% for not annoyed and 45% for very little annoyed on the average for treated water.

Keywords: Cassava processing, garri, akpu, starch, wastewater, odour annoyance

Introduction

Environmental pollution caused by the effluent and the other associated wastes during cassava processing has been reported by Ubalua, (2007) [19] to poses aesthetic nuisance thereby reducing the value of the final product in the value added chain. Odour annoyance among residence within cassava processing has been acknowledged by Sam *et al.* (2017) [17] to be a critical factor limiting the values on final products. Oiamo *et al.*, (2015) [16] posited that odour annoyances are important considerations in research on health effects of air pollution. He further stated that cumulative exposures can occur via several chemical hazards or a combination of chemical and stressor-based hazards, and related health outcomes can be generalized as manifestations of physiological and/or psychological stress responses. A major research challenge in this field is to understand the combined health effects of physiological and psychological responses to exposure. Ubalua, (2007) [20] posited that cassava wastewater transformation offers the possibility of creating marketable value-added products. According to Greenway, (2005) [8] constructed wetland technology is a viable option that not only reduces nutrients but it performs the function of disinfection and removing the odour from wastewater hence rendering the treated wastewater a resource to irrigate crops, playing arenas, gardens or golf courses. Constructed wetlands are achieving prominence as an active and low cost alternative for treatment of wastewater in both the developed and developing world.

Cassava wastewater according to Ehiagbonare *et al.*, (2009) [4] is typically known to cause bad odour which are generally considered unhealthy annoyance to be removed from the air. It can be perceived as far as 90.3-102.3m of its source. In a developing country like Nigeria, air quality studies is still at infant stage and government agencies have not seen food processing sectors like cassava processing as a major area for which limits need to be established. During cassava processing, odour emanates from the decomposition of nutrients and this could be highly offensive (Nosa and Okponmwense, Undated).Odours may affect the wellbeing of people by eliciting unpleasant sensations, by triggering possibly harmful reflexes and other physiological reactions and by modifying olfactory functions. Unfavourable responses include breathing and coughing, upsetting of sleep, stomach and appetite, irritation of the eyes, nose and throat, reduction in the enjoyment of home and external environment, disturbances; annoyance, depression and sometimes a decrease in beat rate and constriction of blood vessels of the skin and muscle (Derek, 1992). Accoerding to Akinbade and Mamodu (2013), about 73 % of women involved in direct production of garri could be at risk of early death or disability-adjusted life years from the mentioned diseases. Odour emanating from cassava waste water results from the decomposition of the constituting nutrients and this can be extremely offensive. The offensive odour can lead to the deterioration of personal and community pride. Odour from cassava also interferes with human relation, discourage capital investment, lower socio-economic status and thus deter the growth of the economy. Odour annoyance forms the main source of environmental stress in residents living in the proximity of cassava processing. Full implementation of strict environmental controls too quickly can have negative consequences, forcing the industry to forfeit its competitiveness. Dealing with environmental problems resulting from processing is generally regarded as a necessary expense with no direct return. Hence lack of effective and implementable cassava waste management policies in Nigeria makes it difficult for the peasant and smallholder farmers to realize the link between waste treatment cost effectiveness and value added benefit of cassava waste management. The aim of this study is to develop and evaluate the performance of a laboratory scale wetland model (SFWS-v) in terms of odor annoyance of wastewater from cassava processing plants

Materials and Methods

The study area

This study was conducted on wastewater from three cassava processing plants producing three different products (Garri, Akpu, and Starch) in Makurdi. The research was conducted at the Soil and Water Engineering Laboratories, Department of Agricultural and Environmental Engineering, Joseph Sarwuan Tarka University Makurdi. It is located between latitude 7°38'N - 7°50'N, and longitude 8°24'E and 8°38'E. in the Benue valley in the North Central region of Nigeria. It is traversed by the second largest river in the country, the River Benue. The relief is generally low-lying ranging from below 90 to 150 m on the average. The River Benue is the main drainage channel traversing the town. Makurdi town is basically composed of sedimentary rocks, which sandstones are the dominant rock type. Lowlying areas like Wadata are overlain by shale (Kogbe, 1989). The sandstone is divided into micaceous and feldsphatic sandstones. Some of these are exposed in parts of the town. Soils in the area reflect the geology. It is also significant to mention that human activities have affected the nature of soils in Makurdi town through farming, construction and reclamation. The rainy season lasts from April to October, with 5 months of dry season (November to March). Annual rainfall in Makurdi town is consistently high, with an average annual total of approximately 1173 mm (Abah, 2012). Temperature in Makurdi is however, generally high throughout the year, with February and March as the hottest months. Temperature in Makurdi varies from a daily of 40°C and a maximum of 22.5°C (Ologunorisa and Tor, 2006). The vegetation of Makurdi is the guinea savannah type however; artificial vegetation has replaced natural secondary vegetation. Makurdi town is inhabited by many tribes with a population of 297,398 to 157,295 males and 140,103 females (FGN, 2007) [6].

Setting up Procedure

Coarse and fine gravels were collect, weighed and place up to 2cm respectively on each of the SFWS-v system tank sedimentation tank as adopted by Vymazal (2010) [21] the treatment media (soil) was place up to 6cm on top of the gravel layer in each of the SFWS-v system as recommended by Zhang *et al,* (2014) [22]. 10L (10000cm^3) of wastewater were collected and emptied into the respective sedimentation tank and allowed to sediment for 24 hours in accordance with Guo *et al*. (2017) [9], Plate 1 is the experimental set up of the system. The wastewater sample were evaluated for ordour annoyance response from sample population of 40 persons living within the processing plant, The control valve was carefully adjust to allow gentle and uniform flow of wastewater from sedimentation tank to the SFWS-v system without scouring of soil in the SFWS-v system, Water plants (Macrophytes) were collected and place in equal population on each of the SFWS-v system according ton Kataki *et al*.. (2021) [10], The treated water was collected from each the SFWS-v system after two weeks according to Sezerino et al. 2015) [18] and odour annoyance evaluation performed by the same respondents that evaluated the non treated water.

Plate: Experimental set up

Analytical Methods

Odour annoyance before and after treatment

The structuring and implementation of the questionnaire survey followed the instructions of the New Zealand Ministry for the Environment (2003. [14] The questions aimed at: a) characterize the respondents (proportion of men/women and age) while maintaining their anonymity; b) identify the source of odour; and c) identifying odour annoyance level. The sampling size was based on residence withib the radius of 120m as opined by Ehiagbonare *et al.*, (2009) [4] and number of questionnaire was based on the tolerable error of 5% according to Barbetta, (2001) [2]

Survey respondents were also asked about annoyance levels they experience from odour. Responses were classified according to the scale in Table 1. The key statistic used from odour surveys is the 'percent at-least annoyed'

category, which is made up of the responses ranging from annoyed to extremely annoyed as approved by New Zealand Ministry for the Environment (Leathwick *et al*., 2003) [11].Only the odour nuisance level associated with the cassava processing industry was assessed for environmental compliance.

The model questionnaire is of closed type with multiple choice questions, with its application performed in a structured way. Therefore, the respondent verbally answered the interviewer's questions that transcribed for the record. The poll is based on olfactory memory (past experiences) of the interviewee, reflecting their experience in relation to perceived odours, and not its current condition at the time of interview. Thus, mechanisms of exclusion of respondents (e.g. flu, allergy, smoking) were not applied.

The questionnaire was developed based upon a number of prior investigations (Miedema *et al.*, 2000) [12] and consisted of two main sections. The first part included general socio-demographic data (i.e., age and gender), while the second part referred to environmental stressors. Regarding the

unpleasant smells of cassava wastewater, the questions included: degree of perceived odour annoyance (estimated using the 7-point scale,in Table 1

Table 1: Annoyance levels for odour community surveys.

Rating score	Response to odor annoyance
0	Definitely not annoying
1	Very little annoyance
2	Little annoyance
3	Some annoyance
4	Annoying
5	Quite annoying
6	Very annoying
7	Extremely annoying

Sourcw: Leathwick *et al* (2003).

Statistical Analysis

Descriptive statistics such as minimum, maximum, mean, standard deviation of all test questions for type of wastewater was performed

Results

Socio-demographic composition

Table 2 shows socio-demographic composition and their responses to test question from the structure questionnaire by the sampled population. From the Table there were 15 male and 25 female that responded to the test questions and this is represented as 37.5% and 62.5 % respectively. 23 of the respondent were of age class between 20yre – 30yre, 2 were of 30yrs to 40yrs while 15 were above 40yrs. The age classifications are represented as 57.5%, 5%, and 35.5% respectively.

Table 2: Frequency distribution and socio-demographic characteristics of the participants stratified by non- treated and treated cassava wastewater

	Sex			Age group				
	Male	**Female**	**Total**	**10-20**	**20-30**	**30-40**	**>40**	**Total**
NTW	15	25	40	-	23	2	15	40
Percentage (%)	37.5	62.5	100	-	57.5	5	35.5	100
TW	15	25	40		23	2	15	40
Percentage (%)	37.5	62.5	100		57.5	5	35.5	100

NTW = Non treated wastewater; TW= Treated wastewater

Odour Annoyance response

Table 3 presents the results for the prevalence of odor annoyance expressed as the percentage (%) and number (N) of respondents for the three sampled cassava processed wastewater. The odor annoyance were ranked as; Not annoyed (score = 0); Very little Annoyed (score = 1); little annoyed (score = 2); Some annoyance (score = 3); Annoying (score = 4); Quite Annoying (score = 5); Very annoyed (score = 6); Extremely annoyed (score = 7). Their respective response in terms of male and female respondent were (0,0); (1,0); (3,1); (3,4); (5,5); (7,6);(4,0); and (1,0) before treatment and (5,4); (14,5); (2,3); (2,2); (1,0); (2,0);(0,0); and (0,0) after treatment respectively for wastewater from Garri processing

That of waste water from Akpu process were (0,0); (1,0); (2,1); (2,2); (5,5); (5,4);(4,2); and (4,2) before treatment and (5,4); (14,5); (2,3); (2,2); (1,0); (2,0);(0,0); and (0,0) after treatment respectively while that of starch process were (0,0); (1,0); (3,1); (3,4); (5,5); (7,6);(4,0); and (1,0) before treatment and (16,4); (4,5); (2,3); (2,2); (1,0); (0,0);(0,0); and (0,0) after treatment respectively.

Table 3: Prevalence of odor annoyance expressed as the percentage (%) and number (N) of Male and Female respondents on wastewater

		Not annoyed (score = 0)	**Very little annoyed (score = 1)**	**little annoyed (score = 2)**	**Some annoyance (scoew = 3)**	**Annoying (scoew = 4)**	**Qyuite Annoying (scoew = 5)**	**Very annoyed (score = 6)**	**Extremely annoyed (score = 7)**
		No (%}	No (%)	No (%)	No (%)	No (%)	No (%)	No (%)	No (%)
Garri	Before	M0(0.0)	M1(2.5)	M3(7.5)	M3(7.5)	M5 (12.5)	M7 (17.5)	M 4(10.0)	M1(2.5)
	treatment	F0(0.0)	F0(0.0)	F1(2.5)	F4(10.0)	F5(12.5)	F6(15.0)	F0(0.0)	F0(0.0)
	After	M5(12.5)	M14(35.0)	M2(5.0)	M2(5.0)	M1(2.5)	M2(5.0)	M0(0.0)	M0(0.0)
	treatment	F4(10.0)	F5(12.5)	F3(7.5)	F2(5.0)	F0(0.0)	F0(0.0)	F0(0.0)	F0(0.0)
Akpu	Before	M0(0.0)	M1(2.5)	M2(5.0)	M2(5.0)	M5 (12.5)	M5 (12.5)	M 4(10.0)	M4(10.0)
	treatment	F0(0.0)	F0(0.0)	F1(2.5)	F2(5.0)	F5(12.5)	F4(10.0)	F2(5.0)	F2(5.0)
	After	M5(12.5)	M14(35.0)	M2(5.0)	M2(5.0)	M1(2.5)	M2(5.0)	M0(0.0)	M0(0.0)
	treatment	F4(10.0)	F5(12.5)	F3(7.5)	F2(5.0)	F0(0.0)	F0(0.0)	F0(0.0)	F0(0.0)
Starch	Before	M0(0.0)	M1(2.5)	M3(7.5)	M3(7.5)	M5 (12.5)	M7 (17.5)	M 4(10.0)	M1(2.5)
	treatment	F0(0.0)	F0(0.0)	F1(2.5)	F4(10.0)	F5(12.5)	F6(15.0)	F0(0.0)	F0(0.0)
	After	M16(40.0)	M4(10.0)	M2(5.0)	M2(5.0)	M1(2.5)	M1(2.5)	M0(0.0)	M0(0.0)
	treatment	F4(10.0)	F5(12.5)	F3(7.5)	F2(5.0)	F0(0.0)	F0(0.0)	F0(0.0)	F0(0.0)

M – Male; F- Female

Discussion

Socio-demographic composition

Survey results through the structured questionnaire confirmed the problem of odor nuisance from all the processes of cassava in the study. The descriptive analysis of the age of respondent indicated that 100% of respondents were of age above 20 years and believed that odour nuisance is associated with non-treated wastewater from garri processing. Prevalence of odor annoyance expressed as the percentage (%) and number (N) of Male and Female was 60% male that were rated between very little annoyed to extremely annoyed on descriptive scale while 40% female rated their annoyance between very little annoyed to quite annoyed.

Odour Annoyance

Generally the annoyance responses were skewed towards increasing order of annoyance rating as demonstrated in Figure 1. None of the female responded attested to very annoyed and extremely annoyed, representing 0%., this could be attributed to the fact that they are conversant with the odour from Garri in their kitchen (Figure 1).

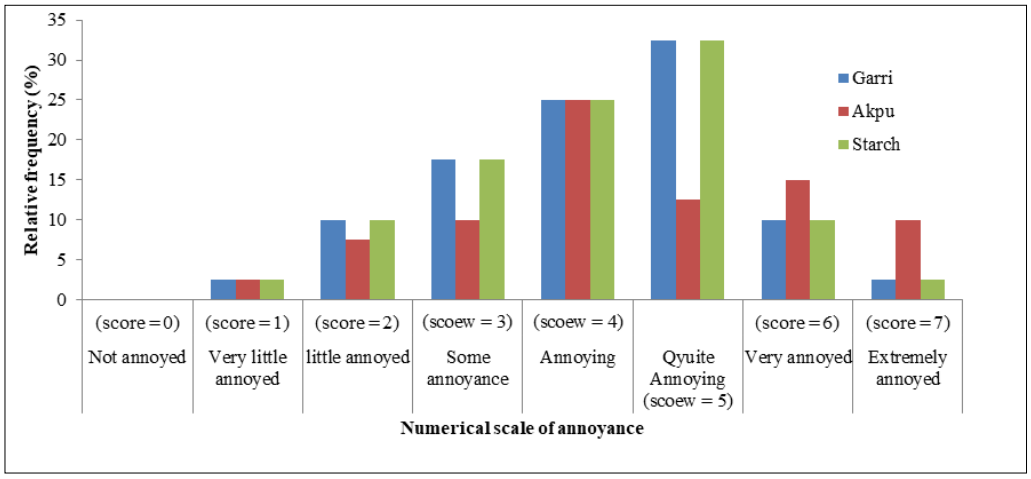

Fig 1: Comparison of odor annoyance expressed felt by respondent before treatment on a numerical scale

While 12.5 % and 10% of male and female respectively respondent attested to not annoyed with treated wastewater from garri processing 52.5% of Male attested to odour prevalence from treated wastewater from garri process at lower odour rated scale between very little to quite annoyed. 25% female attested to very little, little and some annoyance odour from treated garri processing. No female attested to annoying, quite annoying, very annoyed and extremely annoyed with odour from treated wastewater from garri processing (Figure 2)

Similarly, there was no attestation to not annoyed by both male and female for non-treated Akpu wastewater, however 57.5% male and 42.5% female attested to various scale of odour annoyance from non-treated Akpu wastewater (Figure 2). The general responses were skewed towards decreasing order of annoyance rating roe the treated wastewater.

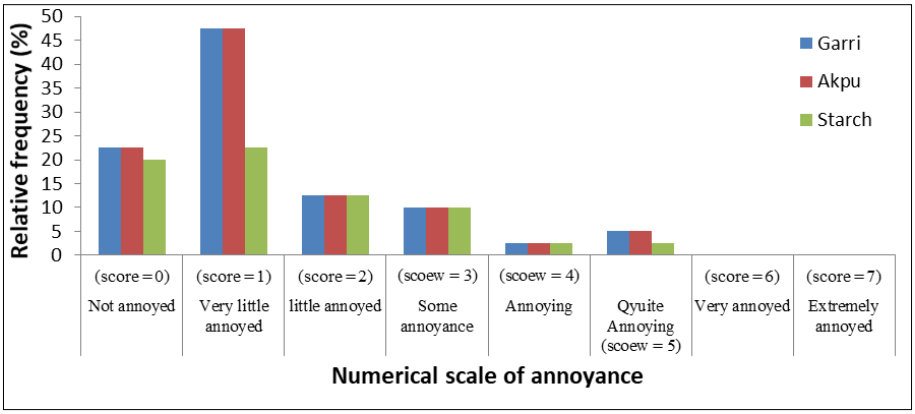

Fig 2: Comparison of odor annoyance expressed on a numerical scale felt by respondent after treatment

Similar trend of 12.5 % and 10% of male and female respectively respondent attested to not annoyed with treated wastewater from Akpu processing, no male was very annoyed nor extremely annoyed while no female was annoyed, quite annoyed, very annoyed nor extremely annoyed with the ordour from treated Akpu wastewater (Figure 2)

The same trends followed for non-treated wastewater from starch however highest response was achieved for not annoyed with treated water from starch process at 49% male and 19% female. Male are always with the use starch and could probably be comfortable with little or no ordour from starch (Figure 2)

Conclusion

This study critically designed and constructed a laboratory scale SFWS-v system for treatment of wastewater from Garri, Akpu and Starch processes, that system has three chamber sedimentation tank and three chamber treatment tank. They were loaded with equal amount of waste water and the same volume of soil as treatment media, planted with equal amount of mycrophant. The experiment lasted for 16 days and the result showed that the treatment facilities have reduced the percentage response to annoying (25%) and quite annoying (35%) of non- treated water to below 5% of treated wastewater for the three cassava processes. In consequence, response to not annoyed and very little annoyed was increased from below 5% for non-treated water to 20% for not annoyed and 45% for very little annoyed on the average for treated water.

Recommendations

Odour in wastewater from cassava processing has affected the value chain of the products. This system has achieved

the reduction in ordour and increase wastewater quality but did not exploit potentials of different treatment media. It is therefore recommended that; 1) different soil type be investigated to identified the best performing media; 2) 2 Also ilot scale systems be advocated to remove the burial on value chain of this products; 3) Further investigation should be carried out to recommend the potential uses of the treated wastewater

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