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Effect of Gas Flaring on the Phytochemical and Nutritional Composition of *Treculia africana* and *Vigna subterranean*

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Authors' contributions

This work was carried out in collaboration between all authors. Authors COU and FNU, designed the study. Authors COU and LAN, performed the statistical analysis, authors COU and DCB, wrote the protocol, and the first draft of the manuscript. Authors COU and FNU, managed the analyses of the study and managed the literature searches. All authors read and approved the final manuscript

Research Article

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ABSTRACT

Aims: The effect of petroleum exploration and exploitation activities on the phytochemical and nutritional composition of African breadfruit (*Treculia africana*) and Bambara groundnuts (*Vigna subterranean*) harvested from polluted and unpolluted environment were studied.
Study Design: Plant samples were collected from Izombe, an environment highly polluted by gas flaring and Eziobodo, an environment not known for gas flare exposures. Both locations are within the (Niger-Delta) rain forest region of Imo State, Nigeria.
Methodology: The processed samples were subjected to proximate and phytochemical screening. The vitamins, micro and macro minerals contents were determined using standard biochemical methods and equipment.
Results: Some of the phytochemicals and nutritional contents showed varying levels of significant difference ($P<0.05$) in samples from the two localities. Bambara groundnuts from polluted area was significantly lower ($P<0.05$) in moisture, ash, protein and carbohydrate when compared to samples from unpolluted environment. The concentrations of antinutrients such as oxalate, phytate, tannin and cyanogenic glycoside were significantly higher ($P<0.05$) in samples from polluted areas when compared to

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samples from unpolluted areas. The results showed increased accumulation of microminerals and reduced macrominerals in samples from polluted environment. Riboflavin, vitamins A, C and E were also significantly higher (P<0.05) in samples obtained from unpolluted environment.
Conclusion: Data obtained revealed that *T. africana* and *V. subterranean* are highly nutritious and their nutrient composition are responsive to pollution due to gas flaring.

Keywords: Gas flaring; pollution; petroleum; oxidative stress; phytochemicals, nutrients, photosynthesis.

1. INTRODUCTION

Since the earliest times in most parts of Nigeria, varieties of plants have been utilized as food because they are cheap sources of nutrients. It provides populations with limited access to meat or fish, a rich source of proteins. It contains macro and micronutrients essential for pregnant and lactating mothers, as well as children. Plant nutrients provide nourishment which is able to establish and sustain structures and functions of organs and systems. When food stuffs are properly combined in the diet, it ensures good nutrition and high grade of physical efficiency and health in human beings [1]. Much attention has been given to the *leguminaceae* Bambara groundnuts (*Vigna subterranean*) and African breadfruit (*Treculia africana*) because of their high protein and reduced sugar contents [2,3]. These two plant foods are widely cultivated in the Niger-Delta region of Nigeria. The Niger-Delta is replete with petroleum pollution from crude oil exploration and gas flaring. The resulting pollutants could alter the nutrient composition in these plant foods [4,3].

Gas flare alternatively known as flare stack, is a gas combustion device used in industrial plants such as petroleum refineries, chemical plants, natural gas processing plants at oil or gas production sites having oil wells, gas wells, offshore oil and gas rigs and landfills [5]. In this area of the world that lacks pipelines and other gas transportation infrastructure, vast amounts of gas are commonly flared as wastes or unstable gas. Such flaring constitutes hazard to plant's well-being as it can affect soil composition and thus pose threat to plants metabolism by altering their nutrient composition [6,7]. For example, too high temperatures due to excess CO_2 released can be accompanied by high rates of evapotranspiration from the soil and this can affect plant metabolism [8]. Flared gases constituents are mainly methane, volatile organic compounds (VOC), hydrogen sulfide, CO_2, CO, oxides of nitrogen and sulfur. It also contains heavy metals and black carbon soot [9]. These pollutants cause stress in plants and contaminate surface soil layers, leading to accumulation of heavy metals.

The African breadfruit is commonly grown in Western and Eastern States of Nigeria [10]. The seeds are called '*afon*' and '*ukwa*' by the Yorubas and Igbos respectively. The grains have excellent polyvalent dietetic value and its biological value exceeds that of soy beans. Breadfruit flour can be used to produce a variety of baked foods. Other parts of the plant are very medicinal. The root decoction is used as an anthelmintic and febrifuge. The caustic sap of male African breadfruit is applied on carious teeth. The bark decoction is used to treat common and whooping cough. The ground bark when mixed with oil and other plant parts is used to massage swelling. It is also used as a laxative and in the treatment of leprosy [11].

In Nigeria Bambara groundnut is called '*okpa'* by Igbos and '*gurujia'* by Hausas. It is highly nutritious and the high protein value makes it important food for people who cannot afford expensive animal proteins [12]. It can be cooked with the pods and eaten as snack or cooked with soup and eaten as a main meal. The high lysine content can complement the low lysine content in other cereals when combined [13]. The seeds are used as beverage and the protein contents are easily digestible [14].

This study evaluates the effect of flare gases on the phytochemical and nutritional composition of these plant foods which serve as staples in the polluted Niger-Delta environment of Nigeria. It is expected to update and improve available information on the nutritional potentials of *Vigna subterranean* and *Treculia africana.*

2. MATERIALS AND METHODS

2.1 Collection, Identification and Preparation of Samples

Samples of African breadfruit and Bambara groundnuts were obtained at Izombe in Oguta Local Government Area (LGA). In this locality flaring of gases have being on for over three decades and it is termed, polluted environment. Eziobodo, a village in Owerri LGA served as the unpolluted environment. Gas flaring activities were not observed here and it is about hundred kilometers away from Izombe. Samples of African breadfruit and Bambara nuts were collected in Eziobodo and it is termed, unpolluted environment. Both localities are in Imo State, Nigeria. Plant samples were identified at the Federal University of Technology, Owerri by a plant taxonomist. The seeds of African bread fruit were extracted from the pulpy fruit head in flowing water with sand, sponge and basket until the slimness of the husk was reduced considerably. Seeds of Bambara groundnuts were sorted to remove extraneous materials and immature seeds. Samples were oven-dried, macerated to powder and stored until used.

2.2 Analysis of Proximate Composition of Bambara Groundnuts and African Breadfruit

Moisture content was determined by oven-dry method [15,16]. Ash content was determined by the method described in A.O.A.C [16]. Crude fiber was determined by Weede methods [17,18]. Fat content was determined by soxhlet and gravimetric method [19] and protein by Kjeldahl method [16]. Total carbohydrate was estimated as the remainder after accounting for moisture, ash, crude fiber, protein and fats [20,18].

2.3 Quantitative Analysis of Phytochemicals in Bambara Groundnuts and African Breadfruit

Alkaline precipitation gravimetric method [21] was used for the determination of alkaloids. Flavonoids, cyanogenic glycoside, oxalate and phytate were determined using the method described by harborne [21]. Tannin content was determined by Folin-denis colorimetric method [22]. Saponin was determined by double solvent extraction gravimetric method [21].

2.4 Determination of Minerals

Mineral contents of processed samples were determined following the dry ash extraction methods [17,22]. Calcium and magnesium were determined by Versanate EDTA titrimetric method [23]. Phosphorus in test sample was determined by Molybdo vanadate colorimetric method [17]. Sodium and potassium was determined by flame photometry. Microminerals (Selenium, Copper and Iron) were determined using atomic absorption spectrophotometer [17] after ashing and extraction of elements.

2.5 Determination of Vitamins

Vitamin A, C and E contents in the samples were determined by the methods described by Association of Vitamin Chemist [22].

2.6 Data Analysis

Data obtained were expressed as mean ± standard deviation (SD) and One Way Analysis of Variance (ANOVA) was used to compare obtained means. Values with $P \leq 0.05$ were considered statistically significant.

3. RESULTS AND DISCUSSION

3.1 Results

The phytochemicals in Bambara nuts and African breadfruit from polluted environment are shown in Table 1. Oxalate, alkaloid, tannin and phytate contents of Bambara nuts from polluted area were significantly higher ($P<0.05$) than samples from unpolluted environment. Saponin and flavonoid concentrations did not vary significantly when samples from the two sites were compared. Cyanogenic glycoside content in Bambara nuts from polluted area were higher ($P<0.05$) than those in nuts from unpolluted environment. In African breadfruit, oxalate, saponin, tannin and cyanogenic glycoside contents were higher ($P<0.05$) in seeds from polluted environment. Alkaloid, flavonoid and phytate contents in samples from polluted environment did not vary significantly ($P>0.05$).

Proximate compositions (Table 2) showed that moisture and ash were higher ($P<0.05$) while protein and carbohydrate contents were lower ($P>0.05$) in nuts from polluted site when compared to unpolluted. Fibre and fats contents of nuts from unpolluted site though higher in value but did not vary significantly. Fats, protein and carbohydrate contents in breadfruit were higher ($P<0.05$) in samples from unpolluted environment but the moisture and ash contents were higher ($P<0.05$) in polluted environment. Fiber content showed no significant difference ($P<0.05$) in both samples.

Table 1. Phytochemical composition (%) of African breadfruit and Bambara nuts from polluted and unpolluted

Samples	Oxalate	Saponin	Alkaloid	flavonoid	tannin	Cyanogenic glycoside	phytate
Bambara groundnut (*Vigna subterranean*)							
Unpolluted	0.38±0.04[a]	0.24±0.02[a]	0.15±0.02[b]	0.17±0.01[a]	0.16±0.01[b]	4.42±0.03[a]	3.25±0.03[b]
Polluted	0.41±0.01[a]	0.49±0.01[a]	0.23±0.02[a]	0.23±0.06[a]	0.92±0.02[a]	1.1±0.16[b]	5.25±0.01[a]
African breadfruit (*Treculia africana*)							
Unpolluted	0.22±0.06[b]	0.18±0.02[b]	0.09±0.02[a]	0.25±0.01[a]	0.15±0.01[b]	4.23±0.03[b]	0.44±0.02[a]
Polluted	3.05±0.08[a]	0.28±0.01[a]	0.13±0.02[a]	0.29±0.04[a]	0.91±0.01[a]	5.41±0.06[a]	0.76±0.01[a]

**Values = mean ± SD of triplicate determinations. Values with different superscripts per column are significantly (P<0.05) different.*

Table 2. Proximate composition (%) African breadfruit and Bambara nuts from polluted and unpolluted environments

Samples	Moisture	Fibre	Fat	Ash	Protein	Carbohydrate
Bambara groundnut (*Vigna subterranean*)						
Unpolluted	8.60±0.35[b]	5.01±0.01[a]	5.81±0.07[a]	3.45±0.01[b]	21.12±0.20[a]	56.02±0.20[a]
Polluted	11.66±0.3[a]	4.64+0.36[a]	4.07±0.11[a]	5.80±0.01[a]	20.49±0.01[b]	53.33±0.01[b]
African breadfruit (*Treculia africana*)						
unpolluted	9.23±0.06[b]	1.33±0.08[a]	13.19±0.20[a]	2.13±0.13[b]	13.07±0.16[a]	61.04±0.16[a]
polluted	13.01±0.02[a]	1.33±0.08[a]	12.58±0.03[b]	4.91±0.01[a]	12.33±0.28[b]	56.25±0.28[b]

**Values = mean ± SD of triplicate determinations. Values with different superscripts per column are significantly (P<0.05) different.*

The macromineral contents (Table 3); calcium, sodium, magnesium, potassium and phosphorus in Bambara nuts were appreciable and significantly higher (P<0.05) in samples from unpolluted area. In Breadfruit; calcium, sodium, potassium, magnesium, and phosphorus contents were significantly lower (P>0.05) in samples from polluted environment. Except for potassium, African breadfruits had higher concentration of all macrominerals studied.

Micromineral contents are shown in Table 4. It showed that variations in concentration of iron and selenium were not significant (P<0.05). However, zinc, copper and manganese contents in Bambara nuts from polluted area were higher (P<0.05). The micromineral contents of breadfruits from polluted environment were significantly higher (P<0.05) than those from unpolluted environment. Also, Bambara nuts from polluted area had higher micromineral contents than breadfruits from polluted environment.

Table 5 showed the vitamin contents. Except thiamin which varied non significantly in concentration, the vitamins- riboflavin, niacin, vitamin E, vitamin A and vitamin C were significantly higher (P<0.05) in Bambara nuts from unpolluted area. Similar results were obtained in Breadfruit. However niacin and thiamin showed no significant difference in concentration in both environments.

Table 3. Macrominerals (mg/100g) of Bambara nuts and African breadfruit from polluted and unpolluted environments

Samples	Calcium	Sodium	Magnesium	Potassium	Phosphorus
Bambara groundnut (*Vigna subterranean*)					
Unpolluted	85.50 ± 2.31^a	6.20 ± 0.02^a	8.00 ± 1.39^a	237.33 ± 0.46^a	7.43 ± 0.14^a
Polluted	31.53 ± 1.10^b	5.66 ± 0.31^b	4.83 ± 0.21^b	$203+51 \pm 5.80^b$	5.06 ± 0.10^b
African breadfruit (*Treculia africana*)					
unpolluted	92.18 ± 2.31^a	25.07 ± 0.51^a	12.8 ± 1.39^a	185 ± 0.46^a	30.47 ± 0.46^a
Polluted	82.21 ± 0.61^b	20.49 ± 0.64^b	9.14 ± 1.56^b	151.53 ± 1.33^b	28.90 ± 0.69^b

**Values = mean ± SD of triplicate determinations. Values with different superscripts per column are significantly (P<0.05) different.*

Table 4. Microminerals (mg/100g) in Bambara nuts and African breadfruit from polluted and unpolluted environments

Samples	Zinc	Iron	Copper	Selenium	Manganese
Bambara groundnut (*Vigna subterranean*)					
unpolluted	2.36 ± 5.21^b	4.57 ± 0.56^a	1.25 ± 0.17^b	5.08 ± 0.13^a	1.96 ± 0.06^b
Polluted	5.21 ± 0.01^a	5.00 ± 0.01^a	4.94 ± 0.04^a	5.06 ± 0.11^a	4.32 ± 1.14^a
African breadfruit (*Treculia africana*)					
unpolluted	0.34 ± 0.04^b	1.20 ± 0.02^b	0.21 ± 0.01^b	1.31 ± 0.01^b	0.09 ± 0.01^b
Polluted	0.92 ± 0.02^a	2.14 ± 0.12^a	0.60 ± 0.06^a	3.68 ± 0.28^a	0.21 ± 0.01^a

**Values = mean ± SD of triplicate determinations. Values with different superscripts per column are significantly (P<0.05) different.*

Table 5. Vitamin composition (mg/100g) of Bambara nuts and Breadfruit from polluted and unpolluted areas

Samples	Riboflavin	Niacin	Vitamin E	Vitamin A	Vitamin C	thiamin
Bambara groundnut (*Vigna subterranean*)						
Unpolluted	0.15±0.06^{a}	2.10±0.06^{a}	3.18±0.15^{a}	26.05+0.14^{a}	1.17±0.20^{a}	0.03±0.01^{a}
Polluted	0.03±0.01^{b}	0.12±0.03^{a}	1.99±0.01^{b}	20.00±0.00^{b}	0.09±0.02^{b}	0.02±0.30^{a}
African breadfruit (*Treculia africana*)						
Unpolluted	0.49±0.06^{a}	0.57±0.03^{a}	5.76±0.1^{a}	9.23±0.25^{a}	20.18±0.27^{a}	0.02±0.01^{a}
Polluted	0.04±0.02^{b}	0.14±0.03^{a}	3.40±0.1^{b}	7.50±0.99^{b}	18.67±0.29^{b}	0.01±0.01^{a}

**Values = mean ± SD of triplicate determinations. Values with different superscripts per column are significantly (P<0.05) different.*

3.2 Discussion

Studies on nutritional and phytochemical composition of edible plant samples from polluted and unpolluted environments provides nutritional efficiencies of plant food, insight on the effects of pollutants on metabolism of a whole plant as well as effects it could possibly have on those who consume them.

Results obtained from this study showed that Bambara nuts and Breadfruit contains appreciable amounts of oxalate, saponin, cyanogenic glycoside, alkaloid, tannin and phytate. These secondary metabolites are used by some plants for defense and protection [24]. They are beneficial chemicals with predator and parasite repelling effects. In humans and most animals, alkaloids and flavonoids have been observed to posses antidiuretic, antispasmodic, anti-inflammatory and analgesic effects [25]. However, they inhibit certain mammalian enzymatic activities such as those of phosphodiesterase, prolonging the action of cyclic AMP. These phytochemicals can induce actions of glucagons and thyroid stimulating hormone even when it is not needed [26].

The concentrations of phytate and cyanogenic glycosides were non-toxic. Phytate is an antinutrient that chelates minerals in the body and makes their bioavailability impossible. Phytate forms insoluble complexes with calcium, zinc, iron and copper [27]. Cyanogenic glycoside of Breadfruit was 4.23±0.03%. This is higher than 3.12% reported by Akubor et al. [28]. Cyanogenic glycosides are toxic and when hydrolysed releases hydrogen cyanide (HCN) which has been reported to cause marked weight change [29]. They have ability of linking with metals (Fe^{++}, Mn^{++} and Cu^{++}) which are functional groups of many enzymes. HCN linkage with metals could inhibit processes like the reduction of oxygen in cytochrome respiratory chain, electron transfer in photosynthesis, and the activities of enzymes like catalase and oxidase [30,31]. Concentrations of antinutrients can be significantly reduced by boiling, heating or soaking [32], these are major processing methods of Breadfruit in Southeastern Nigeria. A reduced concentration of tannin was also observed. Tannins are polyphenols which have shown appreciable antimicrobial actions [33].

Pollution due to oil exploration and gas flaring has definitely affected the Niger Delta ecosystem. This assertion is supported by the significant changes observed in the phytochemistry of plants studied. The plants may have been affected by atmospheric pollutants especially oxidants and acid soil due to acid rain. Percy et al. [34] reported that plants grown under enriched atmospheric CO_2 and volatile organic compounds (VOCs) typically showed phytochemical changes. This is because some phytochemicals such as flavonoids, flavanols and polyphenols are important in relieving oxidative stress. It has been reported that certain phytochemicals play important roles in antioxidant defense systems of vegetative plants [35]. Pollution by gas flaring results in absorption of pollutants within cells or tissue of plants leading to generation of free radicals in plants growing the in surrounding environment [6]. Thus, it is expected that such plant will have increased synthesis of its antioxidant defense compounds.

Moisture content of Breadfruit and Bambara nuts were observed to be 9.23±0.06% and 8.60±0.35% respectively in samples from unpolluted areas. Nwokolo et al. [36] reported 11% moisture in Breadfruit. There were increased moisture contents in the samples from polluted areas (13.01±0.02% for breadfruit and 11.66±0.30% for Bambara nuts). The moisture content of any food can be used as a measure of its keeping quality. Hence, increased moisture may be explained by the fact that moisture favours increased enzymatic reactions due to presence of water which leads to degradation of vitamins, protein denaturation, starch gelatinization and retrogradation [37]. Prolonged storage is also not assured.

Ash content in breadfruit and Bambara groundnuts from unpolluted area were less than that reported by Omoikhoje [38], but within the value reported by Akubor et al. [28]. The ash content is an indicator of product quality and nutritional value of food [22]. The increased ash content in Breadfruit and Bambara nuts samples from polluted area suggests presence of elevated levels of inorganic residues. Fat content of breadfruit from unpolluted area was higher than the 4.23% reported by Nwokolo et al. [36]. Breadfruits have higher content of fat when compared to Bambara that has 5.81±0.07%. Caroline [3] reported an average fat content 4.9 - 7.24% in Bambara nuts. Dietary fats provide energy through oxidation of their constituent free fatty acids. They can serve as carriers of fat soluble vitamins and provitamins like carotenes. The reduced fat values of samples from polluted area may be attributed to the deleterious effects of reactive oxygen species. This results in depletion of cellular lipids and peroxidation of polyunsaturated fatty acids [39]. Crude fiber contents are appreciable and it encompasses all plant cell wall components that cannot be digested by human digestive enzymes. Plant fibre aids water retention during passage of food along the gut and adds bulk to faeces which induces peristalsis. Soluble fibers from legumes lower blood cholesterol by binding bile acids and dietary cholesterol. Thus, dietary fiber consumption is associated with reduced incidence colon cancer and atherosclerosis.

From the results, Bambara nuts had more protein than breadfruit. This indicates that consumption of Bambara nuts can ameliorate protein energy malnutrition in places where protein rich foods are in limited supply. Bambara nuts contain essential amino acids- methionine and lysine whereas Breadfruit lacks sufficient amount of methionine. The combination of these foods will present a reliable source of protein nutrition. Good protein nutrition presents all essential amino acids together and simultaneously to organisms for utilization in protein synthesis. Hexoses (glucose, fructose etc.) and carbohydrates that yield monosaccharides on digestion are energy producer to the body. Pentoses (ribose, deoxyribose etc.) obtained from HMP-shunt, required for nucleic acid synthesis, form very small fraction of total dietary carbohydrate. The percentage carbohydrate in Breadfruit and Bambra nuts are commendable with Breadfruit having higher content as shown. These carbohydrates when combined may contribute significantly to daily requirement which is 55 to 65 % of total food calories. Undue restriction of carbohydrate affects fats and protein metabolism. The decrease in total carbohydrates in plants from polluted area could be the effect of photosynthetic inhibition or the stimulation of respiratory rate and low starch export from the mesophyll to storage organs [40]. Zugler and Nudge [41] reported reduction in carbohydrate content following acute exposure to oxidants which forces chloroplasts into an excessive excitation energy level. These suggest a possible positive correlation of toxic effects of air pollutants to photosynthetic rate.

Tables 3 and 4 showed that Bambara nuts and African breadfruits are rich in minerals. These results shed light on the reason for the elevated levels of ash residue. Minerals are known to play important metabolic and physiologic roles in living systems [33]. Iron, selenium, zinc and manganese strengthen the immune system as antioxidants [42]. Magnesium, zinc and selenium similarly prevent cardiomyopathy, muscle degeneration, growth retardation, impaired spermatogenesis, congenital malfunctions and bleeding disorders [43]. The calcium which is low in polluted samples on consumption may bind to oxalate since oxalate concentration is very significant, thus preventing its availability. Phytate may also chelate the minerals and inhibit their bioavailability when consumed. Constant pollution of the environment by gas flare can create chemical and biological conditions which may be harmful to plants and soil microorganisms. Such condition may reduce the capacity of plants to absorb cations [44]. Our results showed reduced concentration of calcium, sodium, potassium and magnesium in samples from polluted area. These observations could be linked to the acidic nature of the soil (due to acid rain) which does not favour cation uptake [40]. These minerals are essential for normal plant growth. Crops grown in soil with low mineral contents exhibit various forms of mineral deficiencies. Low mineral contents in Bambara nuts and Breadfruits from polluted environment can be attributed to toxic gases released into air. Generally, minerals assist in body functions such as producing energy, growing, and healing. Minerals are required for fluid balance, blood and bone development, maintaining a healthy nervous system, and regulating muscles, including heart muscles. Minerals, like vitamins, function as coenzymes. They participate in all enzyme reactions in the body and help in assimilation and use of vitamins and other nutrients. The observed fluctuations in mineral contents in plants from the two locations may affect consumers.

The plants studied showed significantly high contents of vitamins especially vitamins A, E and C, riboflavin and niacin in samples obtained from unpolluted area when compared to polluted area. These vitamins are involved in intermediary metabolism in plants and animals. Vitamins act as part or whole coenzyme to some specific enzyme system. It plays important role in both enzymatic and non-enzymatic oxidative stress defense systems. Vitamin C have essential role in several physiological processes in plants, including growth, differentiation and metabolism. Vitamin C functions as a reductant for many free radicals, thereby minimizing the damage caused by oxidative stress. When consumed in diet, vitamin A helps to maintain good sight and prevents diseases of the eye. Vitamin C, on the other hand, has anti-infective properties, promotes wound healing and strong immune system [45]. The significantly reduced vitamin contents observed in plants from polluted environment will definitely deny consumers the benefits derivable from vitamins abundant in plant tissues. Vitamins are essential nutrients that promote growth, development, reproduction, digestion, disease reduction, and overall health and life maintenance. Since each vitamin has its own role. If the body is deficient in any vitamin it is prone to risk for a host of diseases and disorders.

4. CONCLUSION

The phytochemical and nutritional composition in Bambara groundnuts and African breadfruit could be considered satisfactory. Owing to the protein factor in nutrition, Bambara groundnut has more protein, contain reduced carbohydrate when compared to breadfruit, making it more adequate for consumers requiring reduced carbohydrate intake. It follows that the reduced nutrients and increased concentration of some phytochemicals in samples from polluted areas indicates oxidative and metabolic stress due to flared gases and associated activities. The higher concentration of microminerals in samples from polluted environment may affect metabolic and physiological characteristics of plants. This could lead to impairment of functions and metabolic processes in the ultimate consumers.

So many plant foods grow in the Niger- Delta region of Nigeria where gas flaring and venting are unregulated. Among the numerous plants, two were analysed. So it is recommended that further research is carried out using other plant species that serve as food for the populace. Environmental scientists and government officials should corroborate to bringing to an end these unwholesome practices used in getting rid of unwanted gases during crude oil refining and other industries processes.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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