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Microbiological Comparison of Effluents from Some Bakery Factories Companies in Delta State on their Soils

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Abstract: Soil is the loose material on the earth's surface, composed of a mixture of mineral particles, organic matter, air and water which supports plants life and also serves as a habitat for microorganisms but a bad soil has a poor drainage, compaction and nutrients deficiencies often leading to stunted plants growth, discoloration, presence of weeds and pathogens. Most soils in Nigeria have been subjected to different kinds of pollutants and untreated bakery effluents (UBE) have emerged as the major threatening factor to the quality of Nigerian agricultural soils. This study was carried out to X-ray the effects of UBE on the soil microbiological characteristics. UBE samples were collected from five major bakery factories (B1, B2, B3, B4 and B5) in Delta State, Nigeria, and these samples were analyzed for microbiological properties using instrumentation and gravimetric techniques. Standard plate technique, morphological and biochemical characteristics were employed for the microbial analysis. UBEs showed pronounced inhibitory activities against the microbes, of which UBE B4 showed the highest activities against the microbes. There were increase in heavy metals (Arsenic, Cadmium, Cobalt, Nickel, Lead) and decrease in nutritive (proteins, carbohydrates, fats) values of Zea mays seeds harvested from UBE polluted sites, and these were significant ($P<0.05$) in 100L/9m^2 UBE-polluted sites. This study has suggests that the microbiological properties and number of soil nutrient cycling microbes were significantly reduced, but the heavy metals levels increased in UBE-polluted sites, mostly in some polluted site.

Keywords: Soil, Effluents, Microbes, Chemicals, Crops

Introduction

Over the last three decades, there has been increasing global concern over the public health impacts attributed to environmental pollution, in particular, the global burden of disease. The World Health Organization estimates that about a quarter of the disease facing mankind today occur due to prolonged exposure to environmental pollution (WHO, 2014). Most of these environment-related diseases are however, not

easily detected and may be acquired during childhood and manifest later in adulthood. The discharge of industrial effluent into water bodies is one of the main causes of environmental pollution and degradation in many cities, especially in developing countries. Many of these industries lack liquid and solid waste regulations and proper disposal facilities, including harmful waste. Such waste may be infectious, toxic and radioactive (Nwakoby et al., 2021).

The National Environmental Standard Regulation and Enforcement Agency (NESREA) stipulated that industrial effluents are to be properly treated in order to reduce pollutants to the barest minimum before disposal (Ezeogo et al., 2021).

Trace amounts of Bakery effluents in the soil for longer duration may cause substantial undesirable effects to plants health and even aquatic life when discharged to rivers. There is currently no Bureau of Standards Limiting the levels of Bakery effluents in the environment. It has been found that these compounds reach the environment and can be considered as environmental pollutants (Nwakobyet al., 2022).

Several bakery factories were found to be sources of much higher environmental concentrations than those caused by the application of drugs. They are generated through a wide mixture of deeds in a shopping facility, including supermarkets and local village markets. There are a number of different options available for the treatment and management of waste containing Bakery, which include minimization, re-use, reutilizing, energy recovery and disposal (Nwakobyet al., 2022).

Moreover, these effluents may enter the environment by diverse routes such as discharge of treated wastewater, seepage from dump landfills sites, sewer lines, runoff from animal waste (Oledibeet al., 2022).The bakery industry is very important to the economy of every country and confectionaries are so priceless that no nation can survive without them. Studies have revealed the presence of many active ingredients of confectionaries in surface and ground waters at level of consequence to safety in the environment especially the soil. Many reports have been published that prove the widespread occurrence of these pollutants in waste water, surface water and ground water (Nwakobyet al., 2024). Bakery industries suffer from inadequate effluent treatment due to the presence of recalcitrant substances including oil and grease. In most developing countries, like Nigeria, most industries dispose their effluents without treatment. These industrial effluents have hazard effects on water quality, habitat quality and complex effects on flowing waters.

When these chemicals are introduced into the soil, they have a tendency to accumulate there for a longer time period. Some can be taken up by plants and then they can accumulate in various plant tissues, however, the concentrations increased in proportion to their concentrations in manure used as fertilizer. The highest concentrations of these compounds have been described in the tissues of maize, akidi, lettuce and potatoes (Pang etal., 2019). The results of this research carried out

showed a low risk of exposure to these substances through the consumption of the crops. However, the risk may be important in the case of compounds whose daily acceptable dose is very low, or those that produce subtle effects over a longer period of time, or when their consumption occurs from various sources simultaneously (Tang et al., 2018). The mechanism of detoxification of the green algae in question permits to take advantage of the species for bio indication in the environment risk assessment, whereas from an ecological viewpoint, it showed the potential for sulfathiazole bioaccumulation, which with the role of macroalga as the main producer in the trophic network, poses a risk of bio magnification (Nkoom etal., 2019).

Materials and Methods

Sample Collection

Collection, Handling and transportation of bakery effluents and soil samples: The samples used for this study were untreated bakery effluents, collected from five notable bakery factories in Asaba, Delta State. The bakery factories were Bake and Take Bakery, Turner Modern Bakery, Sunset Bakery, Bonsaac Bakery and Fresh grains Bakery. Samples were taken from the sampling sites in triplicates. The effluent samples were collected with sterile containers. The containers were thoroughly washed with detergent, rinsed with water, and then rinsed with 70% ethanol and final rinsed three times with distilled water. During collection, the containers were placed inverted in order to drain the water inside them. The container was placed on the discharged point, then, placed vertically for the effluent sample to refill the sample container. This sample was covered immediately and kept in a cooler containing ice block. Similarly, soil samples were collected at the site of discharge of the effluent using a soil auger at the depth of 10 cm. Samples were collected at 5 cm distance apart and the samples were mixed together to formulate a composite sample and were put in a clean polyethene material. Also, cobs of maize and Akidi were purchased at Eke Awka Market and put in a clean polyethene material. All the samples were transported to the laboratory for immediate analysis.

Microbiological analysis

Determination of Total Bacterial Counts (TBC): One milliliter (1.0 ml) sample was aseptically transferred into a sterile test tube (Pyrex) containing 9.0 ml of the diluent (sterile normal saline) and from this; ten-fold serial dilutions were made up to 10^{-3}. One milliliter of the diluted sample (10^{-3}) was plated on Petri dishes (60 mm OD × 55 mm ID × 13mm high) containing Nutrient agar medium (NA/Biotech) using pour plate method. All the plates in triplicates were incubated inverted at 37±2˚C for 24 h.

The total bacterial counts were determined after incubation using an electric colony counter and colonies counted were expressed at CFU/ml as described by APHA (2012). The procedure was repeated for other samples.

Determination of Total Coliform Counts (TCC): One milliliter (1.0 ml) sample was aseptically transferred into a sterile test tube (Pyrex) containing 9.0 ml of the diluent (sterile normal saline) and from this; ten-fold serial dilutions were made up to 10^{-3}. One milliliter of the diluted sample (10^{-3}) was plated on Petri dishes (60 mm OD × 55 mm ID × 13mm high) containing MacConkey agar medium (MA/Biotech) using pour plate method. All the plates in triplicates were incubated inverted at 37±2˚C for 24 h. The total coliform counts were determined after incubation using an electric colony counter and colonies counted were expressed at CFU/ml as described by APHA (2012). The procedure was repeated for other samples.

Determination of Total Faecal Coliform Counts (TFC): One milliliter (1.0 ml) sample was aseptically transferred into a sterile test tube (Pyrex) containing 9.0 ml of the diluent (sterile normal saline) and from this; ten-fold serial dilutions were made up to 10^{-3}. One milliliter of the diluted sample (10^{-3}) was plated on Petri dishes (60 mm OD × 55 mm ID × 13mm high) containing Eosin Methylene Blue agar medium (EMB/Biotech) using pour plate method. All the plates in triplicates were incubated inverted at 44.5˚C for 24-48 h. The total coliform counts were determined after incubation using an electric colony counter and colonies counted were expressed at CFU/ml as described by APHA (2012).

Total Mold Counts (TMC): One milliliter (1.0 ml) sample was aseptically transferred into a sterile test tube (Pyrex) containing 9.0 ml of the diluent (sterile normal saline) and from this; ten-fold serial dilutions were made up to 10^{-3}. One - tenth milliliter of the diluted sample (10^{-3}) was plated on Petri dishes (60 mm OD × 55 mm ID × 13mm high) containing Sabouraud Dextrose agar medium (SDA/Biotech) using pour plate method. All the plates in triplicates were incubated at inverted position at 30±2˚C for 5-7 days. The total mold counts were determined after incubation using an electric colony counter and colonies counted were expressed at CFU/ml as described by APHA (2012).

Total Yeast Counts (TYC): One milliliter (1.0 ml) sample was aseptically transferred into a sterile test tube (Pyrex) containing 9.0 ml of the diluent (sterile normal saline) and from this; ten-fold serial dilutions were made up to 10^{-3}. One-tenth milliliter of the diluted sample (10^{-3}) was plated on Petri dishes (60 mm OD × 55 mm ID × 13mm high) containing Sabouraud Dextrose agar medium (MA/Biotech) using pour plate method. All the plates in triplicates were incubated inverted at 37±2˚C for 24 h. The total yeast counts were determined after incubation using an

electric colony counter and colonies counted were expressed at CFU/ml as described by APHA (2012). The procedure was repeated for other samples. The CFU/ml was further converted log CFU/ml.

Estimation of Total Heterotrophic Bacterial Counts (THBC): The prepared samples were aseptically introduced (1.0 mL) into Petri dishes (90 mm X 15 mm) containing sterile prepared nutrient agar (BIOTECH) as described in the study published by Frank and Robert (2015). These were placed in electric incubator in vertical positions at 35±°C for 24 h. THBC were enumerated by counting the number of colonies in each plate after 24 h, and the mean counts were calculated and presented in form of mean ± standard deviation.

Estimation of Lipolytic Bacterial Counts (LBC) : The prepared samples were aseptically cultured on sterile poured plates (90 mm x 15 mm) containing Tributyrin agar (TA) as described in the study published by Agboli et al. (2017). The plates were incubated in inverted position in electric incubator (STXB128) at 30±2°C for 24 – 48 h. LBC was enumerated by counting the number of colonies surrounded by the clear zones.

Estimation of Phosphate Solubilizing Bacterial Count (PSBC): The prepared samples were aseptically cultured on sterile poured plates (90 mm X 15 mm) containing National Botanical Research Institute's Phosphate Growth Medium (NBRIP) which comprises 10 g glucose, 5 g $Ca(PO_4)2$, 5 g $MgCl_2.6H2O$, 0.25 g $MgSO_4.7H_20$, 0.2 g KCl and 0.1 g $(NH_4)_2SO_4$ in 1000 mL of distilled water as described in the study published by Agboli et al. (2017). These were placed in electric incubator (STXB128) in vertical positions at 30±2°C for 24 – 48 h. PSBC were enumerated by counting the number of colonies in each plate after 24 – 48 h, and the mean counts were calculated and presented in form of mean ± standard deviation.

Estimation of Nitrifying Bacteria Counts (NBC) : The prepared samples were aseptically cultured on sterile poured plates (90 mm X 15 mm) containing Glucose Nitrogen Free Mineral Medium (GNFMM) which comprises 1.0 g K_2HPO_4, 1.0 g $CaCl_2$, 0.5 g NaCl. 0.25 g $MgSO_4.7H2O$, 0.01 g $FeSO_4.7H2O$, 0.1 g $Na_2MoO4.2H_2O$, 0.01 g $MnSO_4.5H_2O$ and 7.0 g glucose in 1000 mL distilled water as described in the study published by Zaw et al. (2020). These were incubated in vertical positions at room temperature (30±2°C). The NBC were enumerated after 48 h.

Results

Microbiological qualities of the bakery effluents

The microbiological qualities of the bakery effluents (B1, B2, B3, B4 and B5) are shown in Table 1. The physicochemical qualities of the bakery effluents collected from discharge points of five bakery factories (B1, B2, B3, B4 and B5) in Delta State

are presented in Table 2. The study revealed that the total bacterial counts (TBC), total yeast counts (TYC) and total mold counts were within the WHO stipulated limited. The total coliform counts (TCC) and faecal coliform counts (FCC) deviated from the WHO stipulated limits. The study further revealed that TBC of the effluents were significantly ($P<0.05$) higher than the TCC, FCC, TYC and TMC as shown in Table 1 and B4 recorded the highest microbial counts.

Table 1: Microbial qualities of the Bakery effluents

Effluents Source	TBC ($x10^2$ CFU/ml)		TCC ($x10^2$ CFU/ml)	FCC ($x10^2$ CFU/ml)	TYC ($x10^2$ CFU/ml)	TMC ($x10^2$ CFU/ml)
B1	53.33±0.21		11.52±0.01	5.33±0.61	8.78±0.06	2.39±0.17
B2	78.11±0.23		1727±0.10	7.25±0.13	11.21±0.07	5.22±0.05
B3	91.21±0.61		34.27±0.12	6.83 ±0.01	6.58±0.22	7.69±0.08
B4	91.31±0.14		53.33±0.16	7.47±0.13	18.21±0.07	8.31±0.03
B5	84.42±0.13		13..84±0.07	6.17±0.01	8.18±0.03	2.45 ±0.02
WHO	10	-	0	0	-	-

TBC – Total Bacterial Counts; ; TCC – Total Coliform Counts; FCC – Faecal Coliform Counts; TYC – Total Yeast Counts; TMC – Total Mold Counts; WHO – World Health Organization

Table 2: Microbial qualities of the unpolluted soil samples

Parameter ($X10^6$ CFU/g)	Value
TBC	14.10±0.10
LBC	11.50±0.10
PSBC	1.60±0.07
NBC	2.70±0.03
TYC	2.40±0.07
TMC	0.70±0.03

TBC – Total Bacterial Counts
LBC – Lipolytic Bacterial Counts
PSBC – Phosphate Solubilizing Bacterial Counts

NBC – Nitrifying Bacterial Counts
TYC – Total Yeast Counts
TMC – Total Mold Counts
CFU/g – Colony Forming Unit per gram

Effects of the untreated bakery effluents on the soil microbes

Tables 3-7 showed the effects of the untreated bakery effluents on the soil microbes. There was significant ($P<0.05$) decrease in the microbial counts of soil microbes from month 1 to month 4, and the decrease was mostly pronounced after the third month mostly for Total Bacterial Counts (TBC), Lipolytic Bacterial Counts (LBC), Phosphate Solubilizing Bacterial Counts (PSBC) and Nitrifying Bcaterial Counts (NBC). A decrease in Total Yeast Counts (TYC) and Total Mold Counts (TMC) was also observed from month 1 to month 4, but the decrease was not pronounced and were statistically not significant ($P>0.05$) more especially for the TMC.

The study revealed that there was deviation in the Physicochemical properties of the bakery effluent-polluted soil samples as shown in Tables 10-14. There was significant ($P<0.05$) decrease in the pH of the soil samples from month 1 to month 4, and the decreased became severe after the third month. There was increase in the electrical conductivity from month 1 to month 3, and the increase became significant ($P<0.05$) after the third month. The sulphate contents showed slight increase from month 1 to month 3, but later decreased after the third month. Also, deviation occurred in the appearance of the soil samples.

Table 3: Microbiological qualities of the bakery effluent-polluted soil from Bake and Take Bakery

Parameter ($x10^6$ CFU/g)	Month 1	Month 2	Month 3	Month 4
TBC	9.68±0.07	4.69±0.02	2.44±0.03	3.08±0.01
LBC	9.88±0.04	4.49±0.05	3.64±0.02	1.23±0.01
PSBC	2.31±0.01	0.44±0.01	0.24±0.03	0.47±0.01
NBC	3.72±0.05	2.23±0.03	1.26±0.01	0.45±0.01
TYC	1.42±0.01	1.81±0.01	0.73±0.01	0.83±0.01
TMC	1.47±0.01	0.94±0.01	0.51±0.01	0.75±0.01

TBC – Total Bacterial Count; LBC – Lipolytic Bacterial Count; NBC – Nitrifying Bacterial Count; PSBC – Phosphate Solubilizing Bacterial Count; TYC – Total Yeast Count; TMC – Total Mold Count.

Table 4: Microbiological qualities of the bakery effluent-polluted soil samples from Turner Modern Bakery

Parameter ($x10^6$ CFU/g)	Control	Month 1	Month 2	Month 3	Month 4
TBC	15.10±0.10	9.52±0.01	2.54±0.07	1.02±0.03	0.11±0.01
LBC	1.47±0.10	3.10±0.01	2.25±0.01	0.42±0.03	0.14±0.01
PSBC	1.20±0.03	2.31±0.03	1.38±0.01	0.55±0.01	0.12±0.01
NBC	2.48±0.10	1.87±0.03	1.95±0.01	0.22±0.01	2.54±0.01
TYC	2.85±0.07	2.35±0.01	1.18±0.01	0.74±0.01	0.71±0.01
TMC	0.45±0.03	0.65±0.01	0.67±0.01	0.75±0.01	0.74±0.01

TBC – Total Bacterial Count; LBC – Lipolytic Bacterial Count; NBC – Nitrifying Bacterial Count; PSBC – Phosphate Solubilizing Bacterial Count; TYC – Total Yeast Count; TMC – Total Mold Count.

Table 5: Microbiological qualities of the Bakery effluent-polluted soil from sunset bakery

Parameter	Month 1	Month 2	Month 3	Month 4
TBC ($x10^6$ CFU/g)	6.66±0.01	3.24 ±0.01	1.84±0.01	0.28±0.00
LBC ($x10^6$ CFU/g)	0.50±0.01	2.74 ±0.01	0.63±0.01	1.62±0.00
PSBC ($x10^6$ CFU/g)	3.54 ±0.01	0.65±0.03	2.41 ±0.01	0.06±0.00
NBC ($x10^6$ CFU/g)	1.74±0.033	1.98 ±0.01	0.06±0.01	0.03±0.00
TYC ($x10^6$ CFU/g)	0.54±0.01	1.50±0.01	3.74 ±0.01	0.49±0.01
TMC ($x10^6$ CFU/g)	1.30 ±0.01	1.34±0.01	0.64±0.01	0.73±0.01

TBC – Total Bacterial Counts; LBC – Lipolytic Bacterial Counts; NBC – Nitrifying Bacterial Counts; PSBC – Phosphate Solubilizing Bacterial Counts; TYC – Total Yeast Counts; TMC – Total Mold Counts.

Table 6: Microbial qualities of untreated bakery effluent-polluted soil samples from Bonsaac Bakery

Parameter ($x10^6$ CFU/g)	Control	Month 1	Month 2	Month 3	Month 4
TBC	22.10±0.10	5.77±0.07	7.79±0.02	6.94±0.03	2.38±0.01
LBC	1.60±0.10	7.18±0.5	3.54±0.02	2.17±0.03	0.26±0.03
PSBC	3.40±0.03	2.16±0.01	1.78±0.01	1.67±0.03	0.33±0.01
NBC	2.70±0.10	2.37±0.03	1.63±0.01	1.52±0.01	0.88±0.01
TYC	1.60±0.07	1.19±0.01	3.48±0.01	2.41±0.01	0.24±0.01
TMC	1.50±0.03	1.84±0.01	0.64±0.01	0.64±0.01	0.75±0.01

TBC – Total Bacteria Count; LBC – Lipolytic Bacterial Count; NBC – Nitrifying Bacterial Count; PSBC – Phosphate Solubilizing Bacterial Count; TYC – Total Yeast Count; TMC – Total Mold Count.

Table 7: Microbial qualities of untreated bakery effluent-polluted soil samples from Freshgrains Bakery

Parameter ($x10^6$ CFU/g)	Control	Month 1	Month 2	Month 3	Month 4
TBC	13.10±0.10	7.68±0.01	3.47±0.05	1.88±0.03	0.72±0.01
LBC	1.24±0.10	1.00±0.7	0.22±0.02	2.65±0.03	1.34±0.01
PSBC	1.30±0.03	1.77±0.07	0.34±0.01	1.12±0.05	2.85±0.03
NBC	3.80±0.10	1.58±0.05	2.54±0.03	0.11±0.01	0.340±0.03
TYC	1.45±0.07	2.11±0.01	1.47±0.01	0.41±0.02	0.42±0.01
TMC	1.95±0.03	2.14±0.01	0.47±0.01	0.70±0.01	0.95±0.01

TBC – Total Bacteria Count; LBC – Lipolytic Bacterial Count; NBC – Nitrifying Bacterial Count; PSBC – Phosphate Solubilizing Bacterial Count; TYC – Total Yeast Count; TMC – Total Mold Count.

Characteristics and Identities of the Bacterial and Fungal Isolates from the Samples

The cultural and morphological characteristics of the bacterial isolates from the effluent and soil samples are shown in Table 8. The isolates; A, B, C, D, E and F exhibited varying characteristics culturally and microscopically. Isolates B, C, D and F were Gram negative rods, circular colonies with varied appearance on nutrient agar plates. Isolates D was yellow in color, with entire margin, non-capsulated and motile. Isolate C was colorless with smooth margin, raised elevation, non-capsulated

and motile. Isolate D was colorless and mucoid on nutrient agar plate, raised colonies with smooth margin, capsulated and non-motile. Isolate F exhibited pale yellow colonies initially and later turned white, which also fluorescence when exposed to direct sunlight. The colonies were convex with entire margin, non – capsulated and motile. Isolate A was Gram positive rod, endospore positive, motile with flat or concave colonies. The colonies were milkish white, irregular shaped with filamentous margin. Isolate E was yellow on nutrient agar plates, circular colonies, non-motile Gram positive cocci bacterium. The isolates were catalase positive and utilized glucose. Isolate B, E and F were oxidase positive. They exhibited varied degree of utilizing sugar molecules as shown in Table 9.

Table 8: Cultural and morphological characteristics of the bacterial isolates from the effluent and soil samples

Parameter	A	B	C	D	E	F
Appearance on NA	Milkish white	Yellow	Colorless	Colorless	Yellow	Pale yellow, later white
Shape of colony	Irregular	Circular	Circular	Circular	Circular	Circular
Elevation	Flat/Concave	Convex	Raised	Raised	Raised	Convex
Margin	Filamentous	Entire	Smooth	Smooth	Smooth	Entire
Gram Reaction	Positive	Negative	Negative	Negative	Positive	Negative
Cell Morphology	Rods	Rods	Rods	Rods	Cocci	Rods
Endospore	Positive	Negative	Negative	Negative	Negative	Negative
Capsule	Negative	Negative	Negative	Positive	Negative	Negative
Motility	motile	motile	Motile	Non-motile	Non-motile	Motile
Possible Bacterium	Bacillus	Burkholderia	Enterobacter	Klebsiella	Micrococcus	Pseudomonas

Table 9: Biochemical characteristics of the bacterial isolates

Parameter	B	D	E	M	N	P
Catalase	+	+	+	+	+	+
Oxidase	_	+	_	_	+	+
Citrate	+	+	+	+	_	+/_
Indole	_	_	_	_	_	_
Methyl Red	+	_	_	_	_	_
Voges Proskauer	+	_	+	+	+/_	_
Urease	+	_	_	+	+/_	_
Hydrogen sulphide	–	–	–	–	–	–
Glucose	+	+	+	+	+	+
Maltose	+	_	+	+	_	_
Lactose	+	_	+	+	_	_
Mannitol	+	+	+	+	_	_
Mannose	+/_	+	+	+	_	_
Sorbitol	+/_	_	+	+	_	_
Bacterium	Bacillus	Burkholderia	Enterobacter	Klebsiella	Micrococcus	Pseudomonas

Discussion

The uncontaminated soil samples' physicochemical and microbiological characteristics fell within the Environmental Protection Agency's (EPA) and WHO's established bounds. According to numerous researchers, the nitrifying bacterial counts (NBC), lipolytic bacterial counts (LBC), total bacterial counts (TBC), and phosphate solubilizing bacterial counts (PSBC) were all within the allowed ranges of nutrient-enriched soil intended for agricultural use (Less et al., 2016). The present study's observations of the Untreated bakery-polluted soil's physicochemical properties deviated from those of Lalwani et al. (2020).

Only the treatment methods, human use, and heavy metal components of soil contaminated by bakery effluents were the subject of Kumar et al.'s (2019) reports. There were declines in the number and loads of nutrient enriched soil microorganisms such as NBC, PSBC, and LBC in Untreated bakery-polluted soil. Numerous researchers noted similar findings (Gworek et al., 2021). Additionally, Ezeogo et al. (2021) noted that the loss of beneficial microbes in the soil was caused by the presence of contaminants in the form of heavy metals. Therefore, the substantial decrease seen in this study may be explained by the loss or reduction of important nutrient-cycling microorganisms brought on by prolonged exposure to high concentrations of untreated bakery effluent, which also causes the nutrients and soil structure to decompose.

The findings of Zhi et al. (2019) were corroborated by the discovery of heavy metals such arsenic, cadmium, cobalt, chromium, copper, nickel, lead, and zinc in the edible portion of corn and akidi crops. Heavy metals were found in crops grown in

untreated bakery -polluted areas, according to certain researchers who documented their presence there. According to studies, the majority of the elements found in untreated bakery-polluted soil and the crops grown there were nickel (Tang et al., 2018), copper (Kumar et al., 2019; Pobi et al., 2019), lead (Sousa et al., 2018), cadmium (Shahmahidi et al., 2020), chromium (Zhu et al., 2018), cobalt, and zinc.

The decrease in the nutritional qualities of both fresh and dried maize samples taken from the UPE-polluted soil could be attributable to a range of critical elements in the polluted soil.

The migration of contaminants down into the soil profile depends on the strength of their sorption on the soil solid phase particles. The bioavailability and durability of active ingredients in the soil environment are influenced by the sorption intensity. Thus, a key factor in the exposure of living things to contamination is the soil's sorption capacity (Barbara et al., 2021).

Because of their movement and degradation mechanisms, soil sorption qualities play a crucial role in regulating the fate and behavior of chemicals in soils.

In three distinct soils, Nwakoby et al. (2024) investigated the sorption and breakdown processes of carbamazepine, gemfibrozil, octylphenol, triclosan, and bisphenol. The Freundlich equation was used to characterize the absorption isotherms of every chemical present in the soil. Gemfibrozil and carbamazepine showed very little sorption, while triclosan and octylphenol showed a moderate to severe sorption. Chemicals in the soil had half-lives ranging from 9.8 to 39.1 days.

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