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Genotoxic and Cytotoxic Activities of Cornhusk Extract of *Zea mays* and Leaf Extract of *Sacharum officinarum*

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Abstract

Zea mays husk and *Saccharum officinarum* have been used for years in ethnomedicine for their antimalarial, anti-inflammatory, antipyretic, antidiabetic, and antiphlogistic activities. The cytotoxic and genotoxic effects of *Zea mays* husk and *Saccharum officinarum* leaf extracts on the root meristem cells of *Allium cepa* were investigated. Onion bulbs were exposed to 2.5 mg/ml, 5mg/ml, and 10 mg/ml concentrations of the extracts for macroscopic and microscopic analysis. Tap water was used as a negative control and Methotrexate (0.1 mg/ml) was used as a positive control. There was statistically significant ($p < 0.05$) inhibition of root growth depending on concentration by the extracts when compared with the negative control group. All the tested extracts were observed to have cytotoxic effects on cell division in *A. cepa*. The extract induced chromosomal aberrations and micronuclei (MNC) formations in *A. cepa* root tip cells were significant ($p<0.05$) when compared with the control group. The extracts treatment further induced cell death, ghost cells, cells membrane damage, and binucleated cells. The *Zea mays* husk extract was found to exhibit higher cytotoxic and genotoxic potential than *Saccharum officinarum* leaf extract. These results suggest that *Zea mays* husk and *Saccharum officinarum* leaf extracts possess cytotoxic and genotoxic effects on *A. cepa*.

Keywords: *Allium cepa*; Cytotoxic; Genotoxic; Medicinal plants; *Zea mays* husk; *Sacharum officinarum*.

Abbreviations: ANOVA (Analysis of Variance), Completely Randomized Design (CRD), polymorphonuclear leukocytes (PMNs)

INTRODUCTION

A number of green plants contain phytoconstituents, which may exert cytotoxic and genotoxic activities due to their effects within a biological system. Research has also shown that a number of plants which are utilized as food or medicine traditionally have mutagenic effects as well as cytotoxic and genotoxic effects *in vitro* and *in vivo* (Higashimoto *et al.*, 1993; Schimmer *et al.*, 1994; Kassie *et al.*, 1996; As *et al.*, 2007; Ikechukwu *et al.*, 2024; Magnus *et al.*, 2024). Plants with potential mutagenic and carcinogenic substances (Ames, 1986; de Sá Ferreira & Ferr˜ao Vargas, 1999) which are used as food or medicine have been correlated with a high rate of tumour formation in some human populations (Wynder *et al.*, 1983; Nagao *et al.*, 1986; Nguyen *et al.*, 1989; Brito *et al.*, 1990). This reveals potential toxic hazards that may result from prolonged use of such plants, especially those used as herbs in the treatment of various diseases traditionally. The husk of *Zea mays* (maize) and leaves of *Sacharum officinarum* (sugarcane) are commonly used in the treatment of various diseases by the Ibibios of the Niger Delta region of Nigeria.

Saccharum officinarum (Family-Poaceae), also called sugarcane, thrives throughout tropical and subtropical regions worldwide. In traditional medicine, it is used in the treatment of diarrhoea, dysentery, eyes, fever, arthritis, bedsores, boils, cancer, colds, cough, opacity, skin sores, sore throat, hiccups, inflammation, laryngitis, spleen, tumours, and wounds (Hartwell, 1967-1971). the leaf extract possesses some biological activities such as antibacterial and anthelmintic (Palaksha *et al.*, 2013), anti-hyperglycaemic, anti-hyperlipidaemic (Ojewunmi *et al.*, 2013), antioxidant (Ojewunmi *et al.*, 2013; Sun *et al.*, 2014), diuretic and antiurolithiatic (Palaksha *et al.*, 2015), antidepressant and anticonvulsant (Okokon *et al.*, 2019a), analgesic (Okokon *et al.*, 2021a) and antimalarial (Okokon *et al.*, 2022), antioxidative stress and hepatoprotective (Edem *et al.*, 2022), anti-inflammatory and antipyretic (Edem *et al.*, 2023) activities. SAABMAL®: a polyherbal preparation containing *S. officinarum* is utilized as a malarial remedy in Nigeria

(Obidike *et al.,* 2015). The leaves are employed in Ghana for the local treatment of malaria (Asase *et al*., 2010). Phytochemical screening of the leaf extract of *Saccharum officinarum* revealed the presence of glycosides, phytosterols, saponins, tannins, and flavonoids (Palaksha *et al.,* 2013; Singh *et al*., 2015). Some flavones and phenolics, as well as their derivatives from the leaves of *S. officinarum,* have been identified (Coutinho *et al*., 2016; Okokon *et al.,* 2022).

Zea mays L. (Poaceae), commonly called maize or corn, is a grass and food plant cultivated for human and animal benefits. The plant is tall and bears ears that are enclosed in modified leaves known as husks (Simmonds, 1979). In addition to its nutritive values, various parts of the plants are used in ethnomedicine for the treatment of several ailments such as diabetes (Foster & Duke, 1990; Gill, 1992; Abo *et al.,* 2008; Brobbey *et al*., 2017; Okokon *et al.,* 2017a), cough (Gill, 1992), inflammatory diseases (Okokon *et al.,* 2016), pains and arthritis (Owoyele *et al.,* 2010) and ulcer (Jadhav, 2016). Reported pharmacological properties of the husk extract include analgesic, anti-inflammatory (Owoyele *et al.,* 2010), antioxidant (Dong *et al.,* 2014), antidepressant (Okokon *et al*., 2016), antimalarial and antiplasmodial (Okokon *et al.,* 2017a), hepatoprotective (Okokon *et al.,* 2017b; Okokon *et al.,* 2020; Udobang *et al.,* 2019), antidiabetic and hypolipidemic (Okokon & Mandu, 2018) and nephroprotective (Okokon *et al.,* 2017c; Okokon *et al.,* 2019b), antiulcer (Okokon *et al.,* 2018), antiobesity (Okokon *et al.,* 2021b) and alpha glucosidase and alpha amylase inhibitory (Okokon *et al*., 2021c) activities. Isolated compounds from the husk extract include; arabinoxylan (Ogawa *et al.,* 2005), phenolic compounds (gallic acid, protocatechuic acid, chlorogenic acid, cafes acid, ferrulic acid, rutin, resveratrol, and kaempferol) (Dong *et al.,* 2014), anthocyanins (Li *et al.,* 2008) and stigmasterol, stigmasteryl stearate and stigmasterol palmitate (Okokon *et al.*,2021b). The medicinal potentials of these plants have been widely reported, but there is paucity of information on their toxicological potential, therefore this investigation.

MATERIALS AND METHODS

Collection and Identification of Plant Material

The plant materials, husks of *Zea mays* and leaves of *Saccharum officinarum,* were both collected from farms and compounds within Uyo metropolis, Akwa Ibom State, Nigeria in May 2023. The plants were identified and authenticated by a taxonomist, Dr. Margaret Bassey, of the Department of Botany and Ecological Studies, University of Uyo, Uyo, Nigeria.

Extraction procedure

The plant materials were each washed and shade-dried for two weeks. The dried plant materials were further chopped into small pieces and reduced to powder. The powdered materials were individually soaked in 70% ethanol. The liquid filtrates were concentrated and evaporated to dryness in vacuo at 40ºC using a rotary evaporator. The crude extracts were stored at -4 degrees Celsius until used.

Macroscopic Evaluation

The two plant extracts were prepared by dissolving 20 g of each extract in 200 mL of distilled water to obtain a stock solution of 10% each. Afterwards, each stock solution was filtered using a filter paper to remove any particulate matter. The stock solutions were diluted to concentrations of 2.5 mg/mL, 5 mg/mL, and 10 mg/mL respectively.

Allium cepa Test

Small bulbs of the common onion, *A. cepa* were, procured from Jos in the Northern region of Nigeria. Prior to initiating the test, the outer scales of the bulbs and the dry bottom plate were removed without destroying the root primordia using a small sharp knife without destroying the root primordia and collected in a jar of water.

Test concentrations of the plants' extracts (*Zea mays* husk and *Saccharum officinarum* leaves*)* were prepared at 2.5 mg/mL, 5 mg/mL, and 10 mg/mL respectively. For each test concentration of *Zea mays* husk and *Saccharum officinarum* leaf extracts, 15 mL beakers were arranged in a series of 5 per test concentration and filled up for each concentration. One *A. Cepa* bulb was placed on top of each beaker, with the root primordia downward toward the liquid. Tap water was used as a negative control and 0.1mg/ml Methotrexate was used as a positive control.

After 24 hours, the test samples were changed in the controls and all test concentrations and photographs of the growing *A. cep*a roots were captured. This continued until 72 hours, after which the roots were counted per beaker in all the tested concentrations and the mean root number was calculated. Similarly, the roots' lengths were measured using a meter rule and the mean root length was calculated. These were also done for the control. Several root tips were cut at a length of 10mm from the bulbs at 8:00 am, 8:30 am and 9:00 am, respectively and fixed in 3:1 (v/v) ethanol: glacial acetic acid and 1N HCL before putting them in sample bottles and storing them in a refrigerator until use.

Microscopy

The root tips was each placed in a test tube with 1N HCL and heated at 50ºC for 6 minutes to fix and macerate them. After that, the root tips were placed on microscopic slides on a blank background with a-forceps and were cut off at terminal tips. Two drops of 2% (w/v) orcein stain was added and mixed with the rootlets properly by knocking and stirring with a stirring spatula.

Then, a cover slip was placed at 45º to avoid air bubbles. After that, the cells were squashed by placing a filter paper on the cover slip and pressing slightly with a thumb. The coverslip was sealed with a-clear fingernail polish (Grant, 1982; Okokon *et al.,* 2024) and each slide was examined using a Light Microscope at a magnification of x40. Microphotographs were taken to show chromosomal aberrations. The mitotic index and frequency of chromosomal aberration were calculated based on the number of aberrant cells per total cell scored at each concentration of each sample (Bakare *et al.,* 2000). The mitotic inhibition was determined using the following formula:

$$\text{Mitotic index} = \frac{Number\ of\ dividing\ cells}{Total\ number\ of\ cells} \text{ x } 100$$

$$\%\text{Aberrant cells} = \frac{Number\ of\ Aberrant\ cells}{Total\ number\ of\ cells} \text{ x}100$$

$$\%\text{root growth of control} = \frac{Overall\ mean\ root\ length\ of\ test\ solution}{Overall\ mean\ root\ length\ of\ control} \text{ x } 100$$

Analysis

The following parameters were used for determination of cytotoxicity and genotoxicity: (i) the mitotic index (MI was calculated as the ratio between the number of mitotic cells and the total number of cells scored and expressed as percentage and (ii) chromatin aberrations (stickiness breaks and polar deviation) were used as endpoints for determination of cytogenetic effects and micronuclei (MNC) were scored in interphase cells per 1000 cells.

Statistical Analysis

Data obtained from this work were analysed statistically using one–way ANOVA followed by Tukey-Kramer multiple comparison test using Instant GraphPad software, (San Diego, USA). Differences between means were considered significant at a 5% level of significance i.e., $p \leq 0.05$.

RESULTS AND DISCUSSION

Physicochemical Characterization.

The effects of extracts of *Z. mays* husk and *Sacharum officinarum* leaves on levels of the physicochemical parameters (root number and root length) are presented in Table 1. These results show that all tested concentrations of *Z. mays* husk and *S. officinarum* leaf extracts exerted significant root growth inhibition in comparison to negative control and positive control. The inhibition of root number and root length increased with increasing concentrations of the leaf extracts. The average root length in negative and positive control (methotrexate) groups were 4.66±1.26 and 0.10±0.01 cm, respectively. However, average root lengths in 10 mg/mL treatment groups of the two extracts were 0.42±0.03 and 0.46±0.09 cm, respectively, for *Z. mays* husk and *S. officinarum* leaves extracts. These observed decreases were significant ($p<0.05$) when compared to that of the negative control (Table 1). The average root lengths in treatment groups of the extracts were found to decrease with increasing concentrations. *Z. mays* husk exhibited higher inhibition of the root growth than *S. officinarum* leaf extracts, and this was significant ($p<0.05$) when compared to the negative control. The root morphology of the negative control group appeared to be normal, while the 2.5 mg/mL treatment groups of the two extracts appeared yellowish brown. The morphology of roots from 5 and 10 mg/mL treatment groups of the two leaf extracts appeared brownish (Table 1).

Cytogenetic Analysis.

Table 2 shows the effects of *Zea mays* husk and *Saccharum officinarum* leaf extracts on cytogenetic parameters of *Allium cepa* roots. Cytogenetic analysis carried out showed that the two extracts caused concentration-dependent and significant ($p<0.05$) decreases in the mitotic index when compared to that of the negative control. The extracts of *Z. mays* husk and *S. officinarum* leaves at 10 mg/mL had mitotic indices of 17.20±2.56 and 19.20±3.27 respectively, as compared to 60.40±8.24 recorded in the negative control group (Table 2). This showed that *Z. mays* husk was more cytotoxic than *S. officinarum.*

Table 1. Cytotoxicity of *Zea mays* husk and *Sacharum officinarum* leaf extracts on growing roots of Onion (*Allium cepa*).

Treatment group	Concentration of extract (mg/mL)	Average root Number ± SEM	Average root length (cm) ± SEM
Negative control	Tap water	35.80±2.41	4.66±1.26
Methotrexate	0.1	2.10±0.02[a]	0.10±0.01[a]
Zea mays husk extract	2.5	31.20±3.55[a]	1.00±0.07[a]
	5.0	11.40±1.20[a]	0.80±0.13[a]
	10.0	8.40±1.40[a]	0.42±0.03[a]
Saccharum officinarum leaf extract	2.5	22.00±1.87[a]	1.26±0.15[a]
	5.0	6.20±0.73[a]	0.66±0.16[a]
	10.0	4.40±0.67[a]	0.46±0.09[a]

Values are expressed as mean ±SEM (n=5). Significant at $p<0.05$ when compared to negative control, SEM: Standard Error of Mean.

Table 2. Dividing and total cells counted under microscopic observations and mitotic values in control and treatment concentrations.

Treatment group	Concentration of extract (mg/mL)	Total Number of cells	Dividing cells	M.I (%) ± SEM
Negative control	Tap water	500	302	60.4±8.24
Methotrexate	0.1	500	15	3.00±0.68[a]
Zea mays husk extract	2.5	500	188	37.60±2.77[a]
	5.0	500	141	28.20±3.26[a]
	10.0	500	86	17.20±2.56[a]
Saccharum officinarum leaf extract	2.5	500	224	44.80±2.65[a]
	5.0	500	126	25.20±4.13[a]
	10.0	500	96	19.20±3.27[a]

Values are expressed as mean ±SEM (n=5). Significant at $p<0.05$ when compared to negative control, SEM: Standard Error of Mean.

Cytogenetic alterations caused by the two extracts are shown in Table 3. Chromosome and cytological alterations were observed in the negative control, methotrexate, *Z. mays* husk and *S. officinarum* leaf extracts-treated groups, as depicted in Table 3. Various chromosome aberrations were observed according to the analysis carried out, including bridge formations, which were observed mostly in *Z. mays* husk extract-treated groups, especially in the group treated with 2.5 mg/mL. (Table 3) (Figure 1A). Chromosome fragmentations or clastogenic breaks were observed mostly in *S. officinarum* leaf extract (5 mg/mL) and were of chromosome type (Table 3) (Figure 1(B). This depicts the clastogenic effect of the extract. This was significant ($p<0.05$) when compared to the negative control group. Sticky metaphase and telophase were also observed in the two extracts- treated groups. These abnormalities were found to increase generally with increasing concentrations of the extracts. The number of aberrant cells (aberrant cells include chromosome breaks, stickiness and polar deviation) was found to be concentration-dependent and statistically significant ($p<0.05$) when compared to the negative control (Table 3). However, the highest value of aberrant cells was observed in the methotrexate-treated group (positive control) (Table 3). The extracts further demonstrated genotoxic potentials by inducing micronuclei in the root tip meristem cells of *A. cepa.* This was not concentration-dependent (Figure 1(B)). Also, cells with membrane damage (Figure 1(C)) and nucleus damage (Figures 1(C, D and F), binucleated cells (Figure 1(E)), ghost cells 1(G)) and apoptotic cells (Figure 1(E)) were found in various frequencies in the groups treated with the two extracts.

Table 3. Chromosomal and mitotic aberrations in the root meristematic cells of *Allium cepa* after treatment with *Zea mays* husk and *Sacharum officinarum* leaf extracts.

Treatment group	Concentration of extract (mg/mL)	Chromosome breaks (%) ± SEM	Stickiness (%) ± SEM	Polar deviation (%) ± SEM	Aberrant cells (%) ± SEM	MNC (%) ± SEM
Negative control	Tap water	-	0.04±0.02	-	4.00±0.34	-
Methotrexate	0.10	2.34±1.23 [a]	21.34±5.38 [a]	10.55±2.28 [a]	45.13±4.22 [a]	2.28±0.86 [a]
Zea mays husk extract	2.5	0.02±0.01[a]	2.39±1.06[a]	-	22.14±1.45[a]	1.35±0.14[a]
	5.0	-	5.04±0.36[a]	-	30.27±2.45[a]	1.05±0.01[a]
	10.0	-	18.15±3.18 [a]	-	43.44±3.75[a]	0.20±0.02[a]
Saccharum officinarum leaf extract	2.5	-	2.01±0.92 [a]	-	21.48±4.28[a]	0.06±0.01[a]
	5.0	1.22±0.40[a]	3.12±1.34[a]	-	32.19±2.10[a]	2.29±0.35[a]
	10.0	-	14.23±2.15 [a]	-	37.12±3.11[a]	1.14±0.31[a]

Values are expressed as mean ±SEM (n=5). Significant at $p<0.05$ when compared to negative control, SEM: Standard Error of Mean.

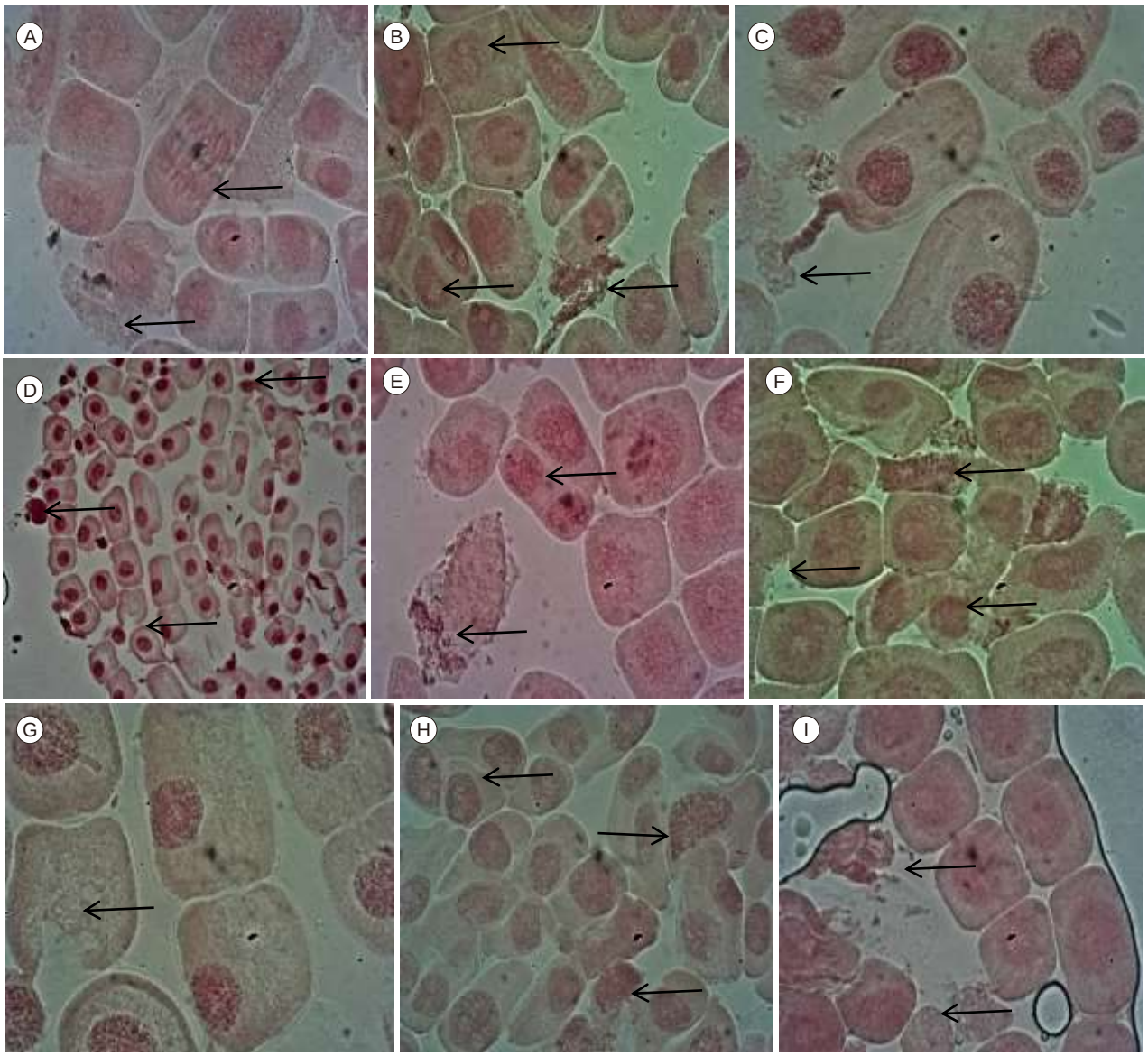

Figure 1. Photomicrograph showing the mitotic and chromosomal aberrations of *Allium cepa* root meristem cells after *Zea mays* husk and *Saccharum officinarum* leaf extract treatments under light microscope X40 magnification. Arrows indicate (A) Bridge and nuclear damage, (B) Chromosomal fragmentation, binucleated cells and nuclear damage, (C) nuclear and cell wall damage, (D) Nuclear and membrane damage, (E) Binucleated cells and apoptotic bodies, (F) membrane and nuclear damage, (G) dead cells, (H) sticky metaphase and binucleated cells, (I) Nuclear damage and fragmentation.

Discussion

In this study, the toxic effects of *Zea mays* husk and *Saccharum officinarum* leaf extracts were evaluated by analyzing root growth and root morphology of Allium cepa. Various concentrations of the extracts employed in the study were observed to cause inhibition of root growth, and these inhibitions were statistically significant when compared to control group. In addition, the two extracts caused colour changes in the root tips of *Allium cepa* depending on the concentration. This colouration ranged from yellowish light brown to dark brown colouration of the roots. Cyto- and genotoxicity were assessed by observing cytological parameters such as the mitotic index and number of chromosome abnormalities, including chromosome breaks, stickiness, and polar deviations. The mitotic index (MI) of *A. cepa* meristematic cells treated with methotrexate (0.1 mg/mL) decreased significantly when compared to control. Also, significant inhibition in the onion roots treated with the *Z. mays* husk resulted in mitotic indices of 37.60%, 28.20% and 17.20% for 2.5, 5.0 and 10.0 mg/mL, respectively. In comparison, *S. officinarum* leaf extract had mitotic indices of 44.80%, 25.20% and 19.20%, respectively, for 2.5, 5.0 and 10.0 mg/mL compared to the negative control (Table 2). The inhibition of root growth was found to be dependent on the decrease in the mitotic Index. The decline of the mitotic index below 22% in comparison to negative control can have lethal impact on the organism (Antonsie-Wiez, 1990), while a decrease below 50% usually has sublethal effects (Panda & Sahu, 1985) and is called cytotoxic limit value (Sharma, 1983). The mitotic index measures the proportion of cells in the M-phase of the cell cycle and its inhibition could be interpreted as cellular death or a delay in the cell proliferation kinetics (Rajas *et al*., 2001). Reduction in the mitotic activity could be due to inhibition of DNA synthesis or a blocking in the G2 phase of the cell cycle, preventing the cell from entering mitosis (Sudhakar *et al*., 2001). Mitodepressive effects of some herbal extracts, including the ability to block the synthesis of DNA and nucleus proteins, were reported earlier (Mercykutty & Stephen, 1980; Schulze & Kirschner, 1986). Several other herbal extracts have been reported to inhibit mitosis (As *et al*., 2006; As *et al*., 2007; Akinboro & Bakare, 2007). The decreased mitotic indices in *A. cepa* roots treated with *Z. mays* husk and *S. officinarum* leaf extract were probably due to either disturbances in the cell cycle or chromatin dysfunction induced by extracts-DNA interactions. The results of this study suggest that the tested extracts concentrations have inhibitory, mito-depressive effects on root growth and cell division of *A. cepa* and it can prevent DNA synthesis and the reduction in the number of dividing cells in roots produced by the cytotoxic effects of compounds found in the extracts. The observation of sticky metaphase demonstrated the toxic effect of the extracts and this was common in all groups treated with the two extracts. Metaphases with sticky chromosome lose their normal appearance, and they are seen with a sticky "surface," causing chromosomes agglomeration (Babich *et al*., 1997). Stickiness has been attributed to the effect of pollutants and chemical compounds on the physical-chemical properties of DNA, protein or both, on the formation of complexes with phosphate groups in DNA, on DNA condensation or formation of inter- and intra chromatid cross links (Gömürgen, 2005; Türkoğlu, 2007). Chromosomal aberrations (CA) are changes in chromosome structure resulting from a break or exchange of chromosomal material. Most of the CA observed in cells are lethal, but many related aberrations are viable and can cause genetic effects, either somatic or inherited (Swierenga *et al*., 1991). The presence of chromosome fragments is an indication of chromosome breaks and can be a consequence of anaphase/telophase bridges (Sharma & Sen, 2002). Fragments were observed in this study especially in the treated groups of *S. officinarum* leaf. These extracts used were found to not only interfere with the cell cycle, but also affect chromatin organization or DNA replication, causing chromosome breaks. Polar deviation was not observed in the study. Frequencies of total chromosome aberrations increased significantly following exposure to the extracts which indicated clastogenic activity (Table 3). These were more frequent aberrations in the groups treated with the *Z. mays* husk extract. The two extracts significantly induced the formation of MNC in *A. cepa* root cells at 2.5–10 mg/mL concentrations. Frequencies of MNC were found to be higher in the groups treated with 5.0 and 10.0 mg/mL of *S. officinarum* leaf extract. However, MNC frequency decreased in *A. cepa* roots treated at the highest concentration of the extracts (10 mg/mL) due to high cytotoxicity. The frequency of cells with micronuclei is a good indicator of the cytogenetic effects of tested chemicals. Micronuclei (MN) often result from the acentric fragments or lagging chromosomes that fail to incorporate into the daughter nuclei during telophase of the mitotic cells and can cause cellular death due to the deletion of primary genes (Albertini *et al*., 2000; Krishna & Hayashi, 2000). Previous studies have suggested the MNC-induced effect of various plant extracts such as *Lavandula stoechas* and *Ecballium elaterium* (As *et al*., 2007; As *et al*., 2009), *Azadirachta indica* (Soliman, 2001) *Psychotria* species (Akinboro & Bakare, 2007).

In this study, membrane damage cells were observed in groups treated with various concentrations of the extracts 2.5, 5.0 and 10.0 mg/mL but mostly in the *Z. mays* husk extract-treated groups. These results show that the extracts over certain concentrations may cause cytotoxicity as they cause membrane damage. These results suggest the cytotoxic potentials of the two extracts, especially *Z. mays* husk. Multinucleated and binucleated cells have been observed in extracts-treated groups. This is due to the prevention of cytokinesis or

cell plate formation. Microtubules have been implicated in cell plate formation and the extraction process, resulting in the inhibition of cytokinesis. A ghost cell is a dead cell in which the outline remains visible but whose nucleus and cytoplasmic structures are not stainable (As *et al*., 2009). Some ghost cells were observed in various frequencies in this study in the two extracts but mostly in *Z. mays* husk extract (10 mg/mL) treated groups (Figure 1). This could have resulted from the activities of the phytochemical constituents of the extracts leading to nucleus damage and prevention of cytoplasmic structures, thus resulting in ghost cells. In addition, the extracts also induced DNA damage cell death and apoptosis in various frequencies in this study. In this study, high concentrations (5 mg/mL and 10 mg/mL) of the extracts were found to cause the induction of cell death and apoptosis. Cell death is a basic biological process of living organisms. Cell death is induced by high concentrations of such toxins, stress, heavy metals, chemicals and others.

The results of this study show that the extracts of *Z. mays* husk and *S. officinarum* can induce cytogenetic alterations (cytoplasmic shrinkage, nuclear condensation, DNA fragmentation, membrane blebbing, cytoskeleton alterations and appearance of apoptotic bodies) and cell death in root tips of *A. cepa* (Figures 1(a), 1(b), 1(c), and 1(d)), suggesting cytotoxic and genotoxic activities of the extracts.

Eight phenolic compounds (gallic acid, protocatechuic acid, chlorogenic acid, cafeic acid, femlic acid, rutin, resveratrol, and kaempferol) have also been detected in ethanol extract of Z. mays husk (Dong *et al*., 2014). Coutinho *et al*. (2016) identified some flavones and phenolics as well as their derivatives, from the leaves of *S. officinarum*. Other phenolic, compounds such as caffeic acid, cis-p-hydroxycinnamic acid, quercetin, apigenin, albanin A, australone A, moracin M, and 5'-geranyl-5,7,2',4'-tetrahydroxyflavone have been identified from the leaves (Xu *et al*.,2018). The high phenolic and flavonoid contents of the two extracts may have been responsible for the observed effects in this study. Flavonoids such as quercetin have been reported to demonstrate mutagenic and genotoxic potentials in various studies (Ping *et al*., 2017). The high phenols and flavonoid contents in the extracts must have contributed to the observed cytotoxic and genotoxic activities in this study.

CONCLUSIONS

This study revealed that *Zea mays* husk and *Saccharum officinarum* leaf extracts possess cytotoxic and genotoxic effects, as seen in the effects elicited by all test concentrations of the two plant extracts on the root number, root length, and root morphology of the *Allium cepa* meristems after exposure. The degree of chromosomal aberrations (based on increasing extract concentration), the inhibition of cellular mitotic processes, and the general abnormalities observed in all root bulbs treated with test samples further indicate cytotoxic potentials of *Z. mays* husk and *S. officinarum* leaf extracts.

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