**Original Research Article**

**Chemical Composition, Genotoxic and Cytotoxic Activities of Methanol Fruit Extract of African Spice *Tetrapleura tetraptera***

**ABSTRACT**

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| --- |
| *Tetrapleura tetraptera* is a medicinal plant in most West Africa communities with a widespread medicinal use such as inflammation, convulsions, leprosy, asthma, hypertension, schistosomiasis, and malaria, antimicrobial, neuromuscular and anti-ulcerative activities. This study investigated the phytochemical composition as well as the genotoxic and cytotoxic effects of methanol extract from the fruit of *T. tetraptera* on the root meristem cells of *Allium cepa* (onion). Onion bulbs were treated with extract concentrations of 2.5, 5.0, and 10 mg/mL, while tap water served as a negative control and Methotrexate (0.1 mg/mL) as a positive control. Results revealed a statistically significant (p < 0.05), concentration-dependent inhibition of root growth compared to the negative control. Cytological analysis indicated that all tested concentrations of the extract exerted cytotoxic effects, as evidenced by a reduction in mitotic index and the presence of chromosomal abnormalities, including micronuclei (MNC), chromatin bridges, binucleated cells, membrane damage, ghost cells, and cell death. Phytochemical screening identified the presence of flavonoids, alkaloids, saponins, tannins, and cardiac glycosides. Gas Chromatography-Mass Spectrometry (GC-MS) analysis revealed major constituents such as 4H-pyran-4-one, 3,3-dihydro-3,5-dihydroxy-6-methyl (26.85%), 5-hydroxymethylfurfural (18.13%), 3-O-methyl-D-glucose (16.52%), and 1,3-propanediol, 2-(hydroxymethyl)-2-nitro- (5.20%). These findings suggest that the bioactive constituents of *T. tetraptera* fruit extract possess significant cytotoxic and genotoxic potential in *A. cepa* root meristem cells. |

***Keywords****: Tetrapleura tetraptera* fruit extract; chemical composition; genotoxicity; cytotoxicity; *Allium cepa*.

**1. INTRODUCTION**

Phytochemicals are naturally occurring secondary metabolites produced by plants, many of which have been shown to possess significant nutritional, therapeutic, and pharmacological potential (Bhatti et al., 2022; Nwozo et al., 2023). These compounds contribute to the plant’s defense and ecological interactions and occur in diverse chemical classes namely: alkaloids, flavonoids, phenolics, tannins, saponins, and steroids (Koche et al., 2016; Awuchi, 2020).

In traditional medicine systems, they display a wide array of bioactivities such as antioxidant, antimicrobial, anti-inflammatory, anticarcinogenic, and antimutagenic effects (Patra 2012; Roy et al., 2019; Wani et al., 2023). Such pharmacological properties support the historical use of medicinal plants and highlight the importance of investigating traditional remedies to identify novel therapeutic agents.

*Tetrapleura tetraptera* (Schum. & Thonn.) Taub. (Fabaceae) is a deciduous tree native to the West African region. The plant is widely used in African ethnomedicine and culinary traditions. Its fruit, which contains aromatic, oily seeds, is employed both as a spice and for its medicinal attributes (Adesina et al., 2016; Kemigisha et al., 2018; Bonsou et al., 2022). In various West African communities, different parts of the plant such as fruit, seeds, and flowers are utilized for their therapeutic properties in treating a range of ailments such as inflammation, convulsions, leprosy, asthma, hypertension, schistosomiasis, and malaria (Adesina et al., 2016; Sikam et al., 2022). Other reported ethnopharmacological uses include antimicrobial, hypoglycaemic, neuromuscular, molluscicidal, trypanocidal, and anti-ulcerative (Kuate et al., 2015). The plant is also used postpartum to promote uterine involution and is incorporated in the preparation of soups and herbal infusions for fever, gastrointestinal disorders, and constipation (Addo-Beatson, 2018).

The continued reliance on *T. tetraptera* in traditional healthcare across West Africa underscores the need for systematic ethnopharmacological evaluation. Its widespread use and reported bioactivities suggest the presence of potent phytochemicals that warrant detailed phytochemical and pharmacological investigations. In this study, we examine the phytochemical composition, genotoxic and cytotoxic activities of the fruit methanol extract to understand its biological effects.



**Figure 1: Photo of *Tetrapleura tetraptera* fruit**

**2. material and methods**

**2.1 Plant collection**

*Tetrapleura tetraptera* fruits waspurchased from a local market in Uyo metropolis, Akwa Ibom State of Nigeria, in July 2023. The plant was identified and authenticated by the Department of Botany and Ecological Studies, University of Uyo, Nigeria.

**2.2** **Preparation of extract**

The sample was washed, dried in the shade, and ground using a laboratory mill. Extraction was carried out following a standard method (Umeh et al., 2005). Sixty grammes (60 g) of the powdered material was extracted in methanol for 48 hours. The mixture was filtered and evaporated to dryness to obtain the methanol extract. The extracts were weighed, and the percentage yield was calculated.

**2.3** **Phytochemical Analysis**

Preliminary phytochemical screening for the detection of flavonoids, alkaloids, saponins, tannins and cardiac glycosides were conducted according to standard procedures (Ouandaogo et al., 2023)

**2.4 *Allium cepa* test.**

The *Allium cepa* test was carried out according to the method of Grant (1994) and Ikechukwu *et al.,* (2024). Small onions bulbs*, A. cepa*, were procured from Itam metropolitan market, Itu in Akwa Ibom State, Nigeria. The bulbs were processed for the study by scarifying the bulbs and bottom base without destroying the root primordia using a small sharp knife. Distilled water (200 mL) was used to dissolve each of the extract (20 g) which were thereafter diluted to different concentrations (2.5, 5.0 and 10 mg/mL) respectively from the stock solution. Test concentrations of the fruit extract at 2.5 mg/mL, 5 mg/mL, and 10 mg/mL concentrations were prepared in 50 mL beakers and arranged in a series of 5 per test 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 negative control and Methotrexate (0.1 mg/mL) was used as positive control. After 24 hours, the test samples were changed in the controls and all test concentrations and photographs of the growing *A. cepa* roots were taken. This continued for 72 hours, after which the roots were counted per beaker in all the tested concentrations and mean root number was calculated. Similarly, the roots’ lengths were measured using a metre rule and the mean root length was calculated. These were also done for the control groups. Several root tips were cut at a length of 10 mm from the bulbs at 8:30 am, and respectively fixed in 3:1 (v/v) ethanol: glacial acetic acid and 1N HCl before putting them in sample bottles and storing in a refrigerator until use.

**2.5 Microscopy**

The root tips were each placed in a test tube with 1N HCl and heated at 50ºC for 6 minutes in order to fix and macerated them. Thereafter, the root tips were placed on microscopic slides on a blank background with a forcep 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 pressed lightly with a thumb. The cover slip was sealed with a clear finger nail polish 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 cells counted at each concentration of the test extract (Bakare *et al.,* 2000; Magnus *et al.,* 2024). The mitotic inhibition was determined using the following formula:

The following indices were considered for evaluation 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, bridges, breaks and polar deviation) were used as endpoints for assessment of cytogenetic effects and micronuclei (MNC) were scored in interphase cells per 500 cells.

**2.6 Gas Chromatography-Mass Spectrometry Analysis**

A Gas Chromatography-Mass Spectrometry (GC-MS), model number QP2010SE, Shimazu Japan was used for the analysis of the sample. This instrument applied a column length of 30 m; thickness, 0.25 m; and diameter, 0.25 mm. Helium was the carrier gas at 1 mL/min and a sample injection volume of 1µL was at split ratio (10:1). The oven temperature was taken from 60 °C, with an increase of 5 °C/min, to 180 °C and subsequently, a ramp of 20 ˚C/min to 250 ˚C. The ion source temperature was adjusted to 230 °C, and the ionization voltage was set at 70 eV. The GC-MS data interpretation utilized the National Institute of Standards and Technology (NIST) (Kadhim et al., 2016).

**2.7 Statistical Analysis**

Data obtained from this work were analyzed statistically using one –way ANOVA followed by Tukey-Kramer multiple comparison test using Instat Graphpad software, (San Diego, USA). Differences between means were considered significant at 5% level of significance i.e., p≤ 0.05.

**3. results and discussion**

**3.1****Plant Extraction**

The methanol extraction of 60 grammes of *Tetrapleura tetraptera* fruit afforded 16.2 grammes, indicating a 26.8 percentage yield.

**3.2****Preliminary Phytochemical Screening**

The results of the preliminary phytochemical screening of *Terapleura tetraptera* methanol extract indicated the presence of alkaloid, flavonoid, tannins, saponins and cardiac glycosides in both extracts.

**3.3 Physicochemical Characterization**

The effect of *Tetrapleura tetraptera* fruit extract on levels of the physicochemical parameters (root number and root length) are presented in Table 1. This result show that all tested concentrations of *Tetrapleura tetraptera* fruit extract caused significant inhibition in the growth of roots in comparison to negative and positive control groups. The inhibition of root number and root length was greater with increasing concentrations of the fruit extract with the highest concentration of the fruit extract exerting complete inhibition of root growth. The average root length in negative and positive control (methotrexate) groups were 4.36±0.24 and 0.10±0.01 cm respectively. However, average root length in 5.0 mg/mL treatment group decreased significantly compared to that of the negative control; 2.12±0.06 cm with no root growth in 10.0 mg/mL concentration (Table 1). Average root lengths in treatment groups were decreased depending on concentration, significantly (p<0.05) when compared to negative control. The root morphology was almost normal during the negative control treatment, but at 2.5 mg/mL and 5 mg/mL of *Tetrapleura tetraptera* extract, the roots appeared slightly yellow and the roots had brownish tips. (Table 1).

**Table 1: Cytotoxicity of *Tetrapleura tetraptera* fruit extract on growing roots of Onion (*Allium cepa*)**

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment group | Concentration of extract (mg/mL) | Average root Number ± S. D | Average root length (cm)± S. D |
| Negative control | Tap water | 26.40±3.82 | 4.36±0.24 |
| Methotrexate | 0.1 | 2.10±0.02a | 0.10±0.01a |
| Extract | 2.5 | 20.16±2.24a | 3.16±0.94a |
| 5.0 | 10.30±1.02a | 2.12±0.06a |
| 10.0 | 0.00±0.00a | 0.00±0.00a |

Values are expressed as mean±SEM (n=5). Significant at p<0.05 when compared to negative control

**3.4 Cytogenetic Analysis**

Table 2 shows the effects of *Tetrapleura tetraptera* fruit extract on cytogenetic parameters of *Allium cepa* roots. Cytogenetic analysis performed showed that the fruit extract caused concentration-dependent and significant (p<0.05) decreases in the mitotic index when compared to that of negative control. The fruit extract of *Tetrapleura tetraptera* at 10 mg/mL had mitotic index of 0.00±0.00 as compared to 70.80±3.22 recorded in the negative control group (Table 2).

**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 (%)± S. E |
| Negative control | Tap water | 500 | 354 | 70.80±3.22 |
| Methotrexate | 0.1 | 500 | 14 | 2.80±0.10a |
| Extract | 2.5 | 500 | 66 | 13.20±0.87a |
| 5.0 | 500 | 47 | 9.40±1.22a |
| 10.0 | - | - | - |

Values are expressed as mean±SEM (n=5). Significant at p<0.05 when compared to negative control

Cytogenetic alterations caused by the extract are shown in Table 3. Chromosome and cytological alterations were observed in negative control, methotrexate, *Tetrapleura tetraptera* extract-treated groups as depicted in Table 3. Analysis of chromosome aberrations observed showed that there were bridges of chromosomes and nuclear damage detected in the different concentration treatments especially in the highest concentration (Table 3) (Figure 2(A). This was significant (p<0.05) when compared to negative control group. No fragments or clastogenic breaks of chromosomes were observed in all concentrations of fruit extract(Table 3). Sticky metaphase was also observed (Figures 2(B) in the extract-treated groups but were more frequent in the group treated with the lowest concentration of the extract (2.5 mg/mL). It was generally observed that these abnormalities increased with increasing concentrations of the extract. A concentration-dependent and statistically significant (p<0.05) increase in total aberrant cells (aberrant cells include bridge, laggard and stickiness) as compared with the negative control (Table 3) was observed. However, the highest value of aberrant cells was observed in methotrexate-treated group (positive control) (Table 3). Genotoxic activities of the extract were further demonstrated by the induction of micronuclei in the root tip meristem cells of *A. cepa.* Micronucleus formation in 500 cells per slide (%MNC value) was not concentration-dependent as the groups treated with methotrexate and 2.5 mg/mL of *Tetrapleura tetraptera* had high numbers of cells with micronuclei in the test compared to negative control, which were statistically significant (*p<* .05) (Figure 2(D)). In addition, cells with membrane damage (Figure 2(A and C)), binucleated cells (Figure 2(C and D)), and nucleus damage (Figures 2C, E and F) were found in various frequencies. Also, apoptotic cells (Figure 2(D, E and F)) were detected in the group treated with the fruit extract*.*

**Table 3: Chromosomal and mitotic aberrations in the root meristematic cells of *Allium cepa* after treatment of fruit extract**

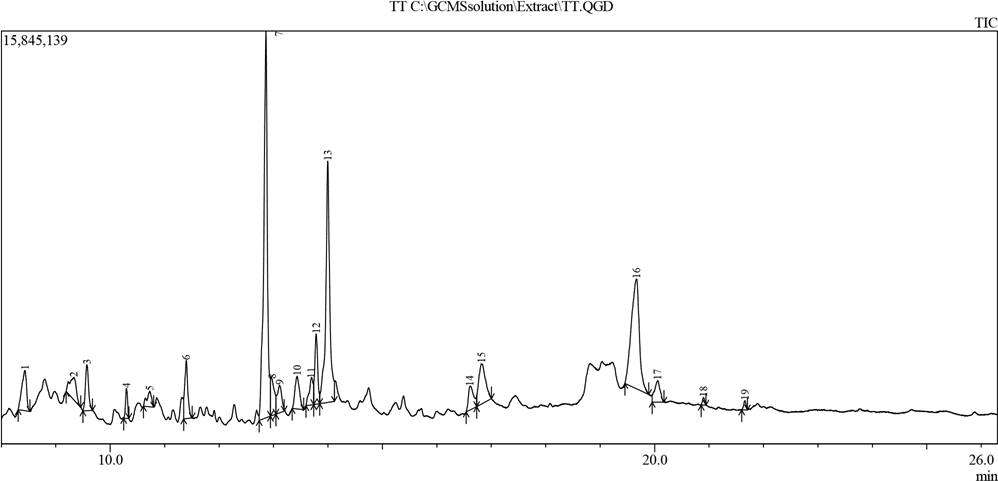
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Treatment group | Concentration of Extract (mg/mL) | Chromosome breaks (%±S.E) | Stickiness (%)±S.E | Polar deviation (%)±S.E | Aberrant cells (%)±S.E | MNC (%)±S.E |
| Negative control | Tap water | - | 0.28±0.02 | 0.15±0.01 | 2.03±0.13 | - |
| Methotrexate | 0.10 | 3.23±1.38a | 34.12±2.38a | 15.23±2.34a | 51.12±3.42a | 3.12±0.56a |
| Extract | 2.5 | - | 4.19±0.33a | - | 22.31±2.18a | 2.01±0.22a |
| 5.0 | - | 8.28±0.34a | - | 35.42±3.16a | 0.89±0.01a |
| 10.0 | - | 10.17±2.34a | - | 52.38±4.28a | 0.02±0.01a |

Values are expressed as mean±SEM (n=5). Significant at p<0.05 when compared to negative control

**Figure 2: Photomicrograph showing the mitotic and chromosomal aberrations of *Allium cepa* root meristem cells after *T. tetraptera* fruit extract treatments under light microscope X40 magnification. Arrows indicate (A) Bridge, sticky chromosome and nuclear damage (B) sticky metaphase (C) bridge, laggard, cell wall damage, binucleated cells (D) Nuclear and membrane damage, apoptotic cells, binucleated cells (E) Nuclear and membrane damage, dead cells and apoptotic bodies (F) dead cells, membrane and nuclear damage**

**3.5 Gas Chromatography-Mass Spectrometry Analysis**

The Gass Chromatography-Mass Spectrometry analysis of methanol extracts of *Tetrapleura tetraptera* revealed nineteen compounds its chromatograph (Figure 2). Values of their retention time (minutes), concentration (%), and molecular weight (g/mol) are shown (Table 4). These compounds were: 2-Furanmethanol, dl-Glyceraldehyde dimer, cyclohexanone, 2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one, 2-Hydroxy-gamma-butyrolactone, 2,5-Dimethyl-4-hydroxy-3(2H)-furanone, 4H-pyran-4-one, 3,3-dihydro-3,5-dihydroxy-6-methyl, glyceraldehyde, 2(3H)-Furanone, dihydro-4-hydroxy, 1,6-Diazabicyclo(3.1.0)haxane-5-carboxylic acid-, methyl ester, 1,2-Ethanediol, 1-(2-furanyl)-, N-Aminopyrrolidine, 5-Hydroxymethylfurfural, tetrahydro-4H-pyran-4-ol, 1,3-propanediol, 2-(hydroxymethyl)-2-nitro-, 3-O-Methyl-d-glucose, di-n-octyl phthalate, 1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester, 7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione

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**Figure 3:GC-MS Chromatogram of *Tetrapleura tetraptera* Fruit Extract**

**Table 4: GC-MS Analysis of Methanol Fruit Extract of *Tetrapleura tetraptera***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Peaks** | **RT** | **Name** | **MF** | **MW** | **Area %** |
| 1 | 8.434 | 2-Furanmethanol | C5H602 | 98 | 3.57 |
| 2 | 9.330 | dl-Glyceraldehyde dimer | C6H12O6 | 180 | 2.73 |
| 3 | 9.573 | Cyclohexanone | C6H10O | 98 | 2.74 |
| 4 | 10.300 | 2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one | C6H8O4 | 144 | 1.13 |
| 5 | 10.726 | 2-Hydroxy-γ-butyrolactone | C4H6O3 | 102 | 1.35 |
| 6 | 11.398 | 2,5-Dimethyl-4-hydroxy-3(2H)-furanone | C6H8O3 | 128 | 3.36 |
| 7 | 12.860 | 4H-pyran-4-one, 3,3-dihydro-3,5-dihydroxy-6-methyl | C6H8O4 | 144 | 26.28 |
| 8 | 12.975 | Glyceraldehyde | C3H6O3 | 90 | 2.59 |
| 9 | 13.113 | 2(3H)-Furanone, dihydro-4-hydroxy | C4H6O3 | 102 | 2.37 |
| 10 | 13.435 | 1,6-Diazabicyclo(3.1.0)haxane-5-carboxylic acid-, methyl ester | C6H10N2O2 | 142 | 2.79 |
| 11 | 13.690 | 1,2-Ethanediol, 1-(2-furanyl)- | C6H8O3 | 128 | 2.11 |
| 12. | 13.784 | N-Aminopyrrolidine | C4H10N2 | 86 | 3.79 |
| 13 | 13.996 | 5-Hydroxymethylfurfural | C6H6O3 | 126 | 18.13 |
| 14 | 16.605 | Tetrahydro-4H-pyran-4-ol | C5H10O2 | 102 | 2.38 |
| 15 | 16.819 | 1,3-propanediol, 2-(hydroxymethyl)-2-nitro- | C4H9NO4 | 151 | 5.20 |
| 16 | 19.664 | 3-O-Methyl-d-glucose | C7H14O6 | 194 | 16.52 |
| 17 | 20.054 | Di-n-octyl phthalate | C24H38O4 | 390 | 2.21 |
| 18 | 20.897 | 1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester | C16H22O4 | 278 | 0.31 |
| 19 | 21.661 | 7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione | C17H24O3 | 276 | 0.43 |

RT = retention time; MF = molecular formular; MW = molecular weight.

**4. DISCUSSION**

In this study, toxic effects of *Tetrapleura tetraptera* fruit extract was evaluated by analyzing root growth and root morphology. Varying concentrations of the methanol extract were observed to cause inhibition of root growth and these were statistically significant when compared to control group. In addition, the extract induced slightly yellow, slightly brown and brownish coloration of the roots. Cyto- and genotoxicity were estimated 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 (2.80%) was significantly decreased when compared to control. Significant inhibition in the onion roots treated with the *Tetrapleura tetraptera* fruitextract compared to the negative control was observed (Table 2). The inhibition of root growth was found to be dependent on decrease of Mitotic Index (MI). The decline of 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 (Šiviková & Dianovský, 2000) and is called cytotoxic limit value (Sharma, 1983). 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 (Rojas *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, have been reported (Mercykutty & Stephen, 1980). Several other herbal extracts have been reported to inhibit mitosis (Liman et al., 2012; Akinboro & Bakare, 2007). The decreased mitotic index in *A. cepa* roots treated with *Tetrapleura tetraptera* fruit extract is probably due to either disturbances in the cell cycle or chromatin dysfunction induced by extracts-DNA interactions. The results herein suggest that the tested extract 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 number of the dividing cells in roots produced by the cytotoxic effects of compounds found in the extract. The observation of sticky metaphase reinforces the hypothesis of the toxic effect of the extract. Metaphases with sticky chromosome, loses their normal appearance, and they are seen with a sticky “surface,” causing chromosome 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 on formation of inter- and intra-chromatid cross links (G’’om’’urgen, 2005). 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 there are many related aberrations that are viable and that 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 and Sen, 2002). Fragments were observed in this study in all the extract concentrations- treated groups. The extract was found to not only interfere with the cell cycle, but also affect chromatin organization or DNA replication, causing chromosome breaks. Frequencies of total chromosome aberrations increased significantly following exposure to the extract which indicate clastogenic activity (Table 3). The extract did not induce the formation of MNC in *A. cepa* root cells at the tested concentrations,2.5–10 mg/mL.

In this study, membrane damaged cells were observed in all the treated groups, which indicated the potential of the extract to exert cytotoxic effect over certain concentrations such as cause membrane damage. Multinucleated and binucleated cells were observed in extract treated groups, perhaps due to the prevention of cytokinesis or cell plate formation. Microtubules have been implicated in cell plate formation and the extract inhibited this process, resulting in inhibition of cytokinesis. Ghost cell is a dead cell in which the outline remains visible, but whose nucleus and cytoplasmic structures are not stainable (Çelik & Aslantürk, 2009). Some ghost cells were observed in various frequencies in 2.5 -5.0 mg/mL treated groups. This could have resulted from the activities of the phytochemical constituents of the extract leading to nucleus damage and prevention of cytoplasmic structures, thus resulting in ghost cells. In addition, theextract also induced DNA damage and cell death and/or apoptosis in various frequencies in this study. Cell death is a basic biological process of living organism. The cell death is induced by high concentrations of such as toxin, stress, heavy metals, chemicals and others.

Several studies have reported that some classes of flavonoids, saponins, tannins and glycosides exhibit mutagenic and genotoxic effects. Manly, organic compounds of nitroaromatics, aromatic amines, aromatic ketones, polycyclic aromatic hydrocarbons and hydroxy compounds have been reported for these activities (Rashwan et al., 2021; Beltzig et al., 2024). Results of our preliminary phytochemical analysis revealed that *Tetrapleural tetraptera* fruit extract contained flavonoids, alkaloid, saponins, cardiac glycosides and tannins. Moreover, spectroscopic information from GC-MS analysis showed the presence of heteroatomic compounds of different nature like alcohol and ketones (e.g., 2-Furamethanol and glyceraldehyde), ketones (e.g., 2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one and cyclohexanone), cyclic and aromatic ketones, bicyclic amine compounds (e.g., 4H-pyran-4-one, 3,3-dihydro-3,5-dihydroxy-6-methyl and N-Aminopyrrolidine), aldehyde (e.g., 5-Hydroxymethylfurfural), ethers (e.g., tetrahydro-4H-pyran-4-ol) and esters (e.g., 1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester and Di-n-octyl phthalate). We suggest that the presence of these compounds in the extract may be responsible for the observed cytotoxic and genotoxic activities in this study.

**4. Conclusion**

The results of this study show that the fruit extract of *Tetrapleura tetraptera* can induced 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*, suggesting cytotoxic and genotoxic activities of the extract. As such, caution is advised when using this plant in traditional medicine, and high doses should be avoided due to possible harmful effects. The observed toxicity is likely linked to the phytochemical constituents present in the extract. We recommend further research involving bioassay-guided fractionation and isolation of key compounds to identify the specific agents responsible for these effects.

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