

## Proximate and phytochemical constituents of four medicinal plants and their cytogenotoxic effects using *Allium cepa* assay

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### Abstract

Many people in Nigeria rural areas use plants for the treatment of ailments without adequate information on associated consequences. The proximate and phytochemical constituents of the leaves of *Cymbopogon citratus*, *Tridax procumbens*, *Mitracarpus scaber* and *Polyalthia longifolia* (medicinal plants) were evaluated. The cytogenotoxic effects of 1.0, 2.5, 5.0, 10.0, 20.0 and 40.0% of their aqueous leaf extracts were also tested using *Allium cepa* assay. Proximate constituents and phytochemicals were detected in varying proportion in plant leaves. The leaf extracts showed significant inhibition of cell division with the mitotic index (10, 20 and 40% of *C. citratus*, only 10% in *M. scaber* and *P. longifolia*) lower than half of the control. Complete cell arrest was observed at 20 and 40% of *P. longifolia*. The observed order of cytotoxicity was *P. longifolia* > *C. citratus* > *T. procumbens* > *M. scaber*. The plants are potential candidates for anticancer drugs, especially *P. longifolia* which exhibit complete cell arrest.

**Keywords:** cytogenotoxicity, medicinal plant, *Allium cepa*, extract, chromosome, phytochemicals

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### 1. Introduction

Medicinal plants are used in the treatment of infections caused by fungi, bacteria, viruses, parasites and certain clinical conditions (like cancer) occurring naturally or resulting from exposure to environmental contaminants. Over 60% of people in Nigeria rural areas depend on traditional medicine for the treatment of ailments [1]. Report has shown that despite the various advances in modern medicine, larger proportion of the world's population still relies completely on raw herbs and unrefined extracts as medicines [2, 3]. Different plants have been used as a source of inspiration in the development of novel drugs [4]. Plant derived medicine are widely used because

they are readily available, cheaper and relatively safer than the synthetic alternatives [5]. In the past years, many plant species have been evaluated for their antimicrobial activities [6, 7] and since then the effectiveness of many medicinal plants in the treatment of many other diseases have been put to test in many laboratories either alone [8] or in combination with salts of metals to produce nanoparticles which have been found to be very effective as antimicrobial agent [9-11].

*Cymbopogon citratus* Stapf (*Poaceae*), *Tridax procumbens* Linn. (*Asteraceae*), *Mitracarpus scaber* (*Rubiaceae*) and *Polyalthia longifolia* (*Annonaceae*) commonly referred to as lemon grass, tridax, 'irawo

ile [12] and masquerade tree, respectively are widely used medicinal plants in Nigeria. . These plants are widely spread in Africa, Asia, Australia, tropical America and India. Reports showed that they contain phytochemicals like terpenes, carotenoids, tannins, alcohols, ketones, aldehyde, esters, alkaloids, flavonoids and saponins among others [13-16] at different concentrations which may be influenced by their geographical location and content of soil on which the plants are grown.

These plants have pharmacological activities such as antimicrobial [17,18], antibacterial, antiamoebic, antidiarrhoea, antifilarial, antifungal and anti-inflammatory properties. They also have antimalarial, ant mutagenicity [19], antimycobacterial [20], anticoagulant [21], anti-inflammatory [22], analgesic [23], hepatoprotective [23, 24] properties among others. Despite the reported wide usage of these plants (*Cymbopogon citratus*, *Tridax procumbens*, *Mitracarpus scaber* and *Polyalthia longifolia*) as materials for treatment of different ailments, there is paucity of knowledge on their potential toxicity especially to the end users. Different bioassays have been reported to be very effective in evaluation of the toxicity of chemicals released into the environment. The use of higher plant bioassays for the detection of mutagens have been in existence for many years and are now well established systems for screening and monitoring environmental chemicals for cytogenic aberrations and gene mutations [25]. Among the plant species, *Allium cepa* ( $2n = 16$ ) has been used to evaluate DNA damages such as chromosome aberrations and disturbances in the mitotic cycle. The *Allium cepa* test also enables the evaluation of different endpoints. Among the endpoints, chromosome aberrations have been the most used to detect genotoxicity over the years. *Allium cepa* test system provides important information to evaluate action mechanisms of an agent about its effects on the genetic material [26]. Besides its sensitivity, it is cost effective and as reliable as other methods for evaluation of chromosome aberrations [27] and can be easily used to assess toxicity via effective concentration determination [28].

The study thus aimed to evaluate the proximate and phytochemical constituents of the leaves of *Cymbopogon citratus*, *Tridax procumbens*,

*Mitracarpus scaber* and *Polyalthia longifolia*. Also, to explore the cytogenotoxic potentials of their aqueous leaf extracts using *Allium cepa* assay

## 2. Materials and Method

### 2.1 Collection of plant materials and leaf extracts preparation

Fresh leaves of the four medicinal plants employed for this study (*Cymbopogon citratus*, *Tridax procumbens*, *Mitracarpus scaber* and *Polyalthia longifolia*) were collected within the premises of Ladoke Akintola University of Technology, Ogbomoso, and identified at the Herbarium of Department of Pure and Applied Biology. The leaves were rinsed to remove dust particles and aqueous extracts of the plant materials were prepared by boiling 50 grams of each of *C. citratus*, *T. procumbens*, *M. scaber* and *P. longifolia* leaves separately in 1000 mL of bore-hole water for 30 minutes. Physicochemical parameters of the borehole had been reported in previous study [29]. The resulting extracts were filtered to remove the shaft and residue, while the filtrates were transferred into sterile bottles and kept in refrigerator for further analyses.

### 2.2 Proximate and Phytochemical Analyses

Air dried leaves (10g) were used for evaluation of moisture, protein, fat, ash and crude fibre [30], while carbohydrate was calculated by percentage differences. Quantitative determination of the phytochemicals in the leaf samples of the selected medicinal plants was carried out. The parameters such as saponins, alkaloids, terpenoids, phenolics, flavonoids, oxalates, phytates, anthocyanins, cyanogenetic glycosides, thiamin, riboflavin, steroids, carotenoids, tannins and ascorbic acid were determined using the method of AOAC [31] with the absorbance measured using spectrophotometer.

### 2.3 *Allium cepa* assay:

Modified *Allium cepa* (L) assay was adopted using the methods of Fiskesjo [32], Rank and Neilson [33] and Yekeen et al [34, 35]. The cytogenotoxic potentials of the medicinal plant aqueous extracts were evaluated using onion bulbs obtained at the Sabo market, Ogbomoso, Nigeria. The onion bulbs were sun dried for 3 weeks with the dried outer scales carefully removed leaving ring of root primordial

exposed and intact. Six concentrations (1%, 2.5%, 5%, 10%, 20% and 40%) of each plant extract were prepared from their respective stock solution with borehole water used as diluents and control [29]. Twelve onion bulbs were planted per concentration using 50ml capacity beaker and were kept in dark planting chamber at room temperature (25±1°C). The concentrations were renewed at every 24 h to supply fresh nutrient to the sprouting onion bulb roots.

## 2.4 Microscopic evaluation

Root tips from five out of twelve onions per concentration were harvested at 48 h of growth, fixed separately in ethanol-ethanoic acid (ratio 3:1) fixative and stored at 4 °C for slide preparation. The fixed root tips were first hydrolyzed in 1N HCl and further treated as previously described [34,35]. Two root tips were teased on a clean glass slide using a pair of needles. Two drops of aceto-orcein stain was added to the homogenized root tips and left for 10 minutes. Thereafter, excess stain was drained; cover slip was placed on macerated root tip and sealed with nail polish. Five slides were prepared per concentration and a total of 5000 cells were scored for chromosomal aberrations.

## 2.5 Macroscopic evaluation

Root length from another set of 5 onion bulbs per concentration were measured at 72 h, to determine growth inhibition by the extracts as previously described [36-39].

## 2.6 Statistical analyses:

SPSS software version 15 was used for data analysis. The data obtained from proximate and phytochemical compositions, as well as the mitotic indices of the treated groups and the control were compared using one way analysis of variance (ANOVA) and their means were separated using Duncan's multiple range test. The difference between the control and treated groups was considered significant at  $p \leq 0.05$ . Root lengths of treated onion bulbs at different plant extract concentrations and control were calculated and compared using student T-test.

The mitotic index was determined by counting the number of dividing cells relative to total number of cells scored, while mitotic inhibition was calculated as difference between mitotic index of control and treated relative to control.

$$\text{Mitotic index (MI)} = \frac{\text{Number of dividing cells} \times 100}{\text{Total number of cells scored}}$$

$$\text{Mitotic inhibition} =$$

$$\frac{(\text{Mitotic index of control} - \text{Mitotic index of treated}) \times 100}{\text{Mitotic index of control}}$$

## 3. Results and discussion

### 3.1 Proximate analysis of the leaf extracts

Comparative evaluation of the proximate components of the four medicinal plants (Table 1) revealed that moisture content was highest in *M. scaber* which was significantly different from all other plants, while the least value was obtained for *C. citratus*. Protein and fat contents were highest in *T. procumbens* and *C. citratus*, while the least value was observed for *C. citratus* and *T. procumbens* respectively. The values recorded for ash and crude fibre in the four medicinal plant leaves were highest in *M. scaber* and *C. citratus*, while the least values were obtained for *C. citratus* and *M. scaber* respectively. Significant variation was obtained for carbohydrates with highest value in *C. citratus*, while *T. procumbens* had the least value.

Although, *C. citratus*, *T. procumbens*, *M. scaber* and *P. longifolia* are commonly used as medicinal plants, it is evident from the present study that their usage might also be beneficial to the user as sources of nutrients. High values of proximate composition were observed for these plants which are comparable to other studies. For instance, protein content (24.47%) in *T. procumbens* is comparable to the reported value (26%) by Verma and Gupta [13] while the value obtained for carbohydrate is higher than 39% reported by the same authors. The variation in the proximate composition among different plant and even plant of the same species is a common phenomenon as observed in this study and may be attributed to various factors such as; differences in species, mineral component of the soil, age of the plants as well as geographical location.

### 3.2. Phytochemical parameters

There were significant variations in the concentrations of phytochemical parameters evaluated for the medicinal plants except for Phytates. Highest values were observed for most of the parameters in *T. procumbens* compared to other plants (Table 2). *C. citratus* had the highest values for alkaloid and Terpenoid only, *M. scaber* recorded highest value for Flavonoids, while *P. longifolia* had highest value for phenol, steroids and tannins. Thiamin and riboflavin were generally very minute in the four medicinal plants used for the study while cyanogenetic glycosides were not detected. The phytochemical test carried out on the leaves of the plants indicates the presence of antioxidant agents such as ascorbic acid and flavonoids among others. The presence of antioxidants confirms the medicinal potential of the four plants. Ingestion of natural antioxidants has been associated with reduced risks of cancer, cardiovascular diseases, diabetes, and other diseases associated with ageing [40, 41]. High values of alkaloids were observed for the plants with the least value in *T. procumbens*. The presence of high levels of alkaloids and other compounds like flavonoids in *T. procumbens* make it widely employed as medicinal plant and also as livestock and poultry feed [42].

These plants also contained phenolics, flavonoids and terpenoids that are well known for their antioxidant and anticarcinogenic activities [43-45] and therefore can be recommended for relevant drugs. Furthermore, the plant extracts contained saponins which produce inhibitory effect on inflammation [46] and steroids which are found to be very important due to their relationship with compounds such as sex hormone [47]. In addition, the presence of phenolic compounds used in the preparation of some antimicrobial compounds such as dettol and cresol [48] in these plants contributed to their antioxidative properties. This probably enhanced their usefulness in herbal medicament. At present, the trend worldwide is towards the use of the natural phytochemicals present in herbs, oil-seeds, beans, fruits and vegetables among others [49] rather than their synthetic analogues. As such, information on the phytochemical constituents of plants becomes very relevant and valuable. Although there are many

positive effects of herbal medication in the treatment of many ailments, most plants employed for this purpose produce hazardous secondary metabolites which primarily form parts of their defensive mechanisms. As a result, several reports have indicated the toxicity of some medicinal plants used in traditional medicines if consumed above certain concentrations despite their potential to cure various diseases [50, 51].

### 3.3. Toxic effects of plant extracts on *A. cepa*

Cytotoxic effects of the leaf extracts of *C. citratus*, *T. procumbens*, *M. scaber* and *P. longifolia* on *A. cepa* root cell are shown in Tables 3. The numbers of dividing cells obtained for *A. cepa* treated with different concentrations of the leaf extracts were lower than that of the control except at 1% of *P. longifolia*. The reduction in dividing cells observed was only dose dependent in *A. cepa* treated with *C. citratus* leaf extract. Significant reduction in the dividing cells was observed at 5.0, 10.0, 20.0 and 40.0 % of *C. citratus* and *T. procumbens* leaf extracts, while reduction was observed only at 5 and 40.0 % for *M. scaber*, and 5 as well as 10% for *P. longifolia* leaf extracts. Cell arrest was only observed for *A. cepa* treated with 20 and 40% of *P. longifolia* leaf extract. The mitotic index and inhibition values obtained for the four plant leaf extracts also varied (Table 3). The mitotic index obtained for *C. citratus* revealed that values obtained at 10, 20 and 40% were less than half of the value obtained for the control with highest percentage inhibition obtained at 40% suggesting their cytotoxicity. Similar observation was observed for *P. longifolia* only at 10% while the mitotic index at all concentrations of *T. procumbens*, and *M. scaber*, though lower than that of the control but more than half of the control's value (Table 3). Previous studies had revealed that mitotic index of treated plant that is less than half of the mitotic index of control indicates high toxicity [39, 52].

Study on chromosomal aberrations revealed normal cells at different stages of cell division for the control (Figure 1), while some of the concentrations of the plant extracts showed different aberrations (Table 3). The aberrations observed include chromosome bridge, fragmentation, c-mitosis, vagrant chromosome, stickiness and chromosome lag. However, none of the observed aberration was predominant in the study (Figure 1).

**Table 1.** Proximate analysis of aqueous extract of *C. citratus*, *T. procumbens*, *M. scaber* and *P. longifolia*.

PARAMETERS (%)	<i>C. citratus</i>	<i>T. procumbens</i>	<i>M. scaber</i>	<i>P. longifolia</i>
Moisture Content	8.67 <sup>c</sup> ±0.12	9.13 <sup>b</sup> ±0.15	9.43 <sup>a</sup> ±0.15	8.93 <sup>b</sup> ±0.15
Protein	12.37 <sup>a</sup> ±0.21	24.47 <sup>a</sup> ±0.25	23.57 <sup>b</sup> ±0.25	21.37 <sup>c</sup> ±0.15
Ether Extract (Fat)	5.33 <sup>a</sup> ±0.15	3.47 <sup>c</sup> ±0.06	3.53 <sup>c</sup> ±0.15	4.37 <sup>b</sup> ±0.21
Ash	6.87 <sup>c</sup> ±0.15	7.53 <sup>b</sup> ±0.06	8.27 <sup>a</sup> ±0.15	7.73 <sup>b</sup> ±0.15
Crude Fibre	11.17 <sup>a</sup> ±0.15	8.40 <sup>c</sup> ±0.10	7.27 <sup>d</sup> ±0.15	8.67 <sup>b</sup> ±0.15
Carbohydrates	55.60 <sup>a</sup> ±0.53	47.00 <sup>c</sup> ±0.10	48.60 <sup>b</sup> ±0.35	48.93 <sup>b</sup> ±0.21

Mean values with different superscript alphabets are significantly different (p < 0.05) using ANOVA and Duncan multiple range tests

**Table 2.** Phytochemicals analysis of aqueous extract of *C. citratus*, *T. procumbens*, *M. scaber* and *P. longifolia*

PARAMETERS	<i>C. citratus</i>	<i>T. procumbens</i>	<i>M. scaber</i>	<i>P. longifolia</i>
Saponins	83.33 <sup>d</sup> ±2.89	228.33 <sup>a</sup> ±7.64	180.00 <sup>b</sup> ±13.23	111.67 <sup>c</sup> ±2.89
Alkaloids	346.67 <sup>b</sup> ±15.28	126.67 <sup>c</sup> ±7.64	143.33 <sup>c</sup> ±2.89	373.33 <sup>a</sup> ±7.64
Terpenoids	568.33 <sup>a</sup> ±7.64	93.33 <sup>d</sup> ±7.64	278.33 <sup>b</sup> ±7.64	238.33 <sup>c</sup> ±7.64
Phenolics (GAE/g)	7.57 <sup>a</sup> ±0.15	15.63 <sup>c</sup> ±0.38	14.70 <sup>b</sup> ±0.00	25.50 <sup>a</sup> ±0.26
Flavonoids	75.00 <sup>a</sup> ±0.00	220.00 <sup>b</sup> ±0.00	265.00 <sup>a</sup> ±0.00	138.33 <sup>c</sup> ±7.64
Oxalates	11.67 <sup>c</sup> ±2.89	43.33 <sup>b</sup> ±2.89	25.00 <sup>a</sup> ±5.00	13.33 <sup>c</sup> ±2.89
Phytates	25.00 <sup>a</sup> ±5.00	28.33 <sup>a</sup> ±2.89	20.00 <sup>a</sup> ±5.00	21.67 <sup>a</sup> ±2.89
Anthocyanins	5.00 <sup>b</sup> ±0.00	13.33 <sup>a</sup> ±2.89	11.67 <sup>a</sup> ±2.89	5.00 <sup>b</sup> ±0.00
Cyanogenetic Glycosides	ND	ND	ND	ND
Thiamin	0.03 <sup>c</sup> ±0.01	0.11 <sup>a</sup> ±0.01	0.08 <sup>b</sup> ±0.01	0.04 <sup>c</sup> ±0.01
Riboflavin	0.02 <sup>b</sup> ±0.01	0.03 <sup>a</sup> ±0.01	0.01 <sup>b</sup> ±0.01	0.03 <sup>a</sup> ±0.01
Steroids	20.00 <sup>c</sup> ±5.00	30.00 <sup>b</sup> ±0.00	23.33 <sup>c</sup> ±2.89	46.67 <sup>a</sup> ±2.89
Carotenoids	758.33 <sup>c</sup> ±7.64	928.33 <sup>a</sup> ±10.41	818.33 <sup>b</sup> ±10.41	368.33 <sup>d</sup> ±7.64
Tannins	73.33 <sup>c</sup> ±2.89	53.33 <sup>d</sup> ±7.64	86.67 <sup>b</sup> ±2.89	146.67 <sup>a</sup> ±2.89
Ascorbic acid	16.30 <sup>a</sup> ±0.36	25.57 <sup>a</sup> ±0.31	21.37 <sup>b</sup> ±0.35	18.47 <sup>c</sup> ±0.25

All parameter were measured in mg/100g except Phenolic (GAE/g); \*GAE= Gallic Acid Equivalent

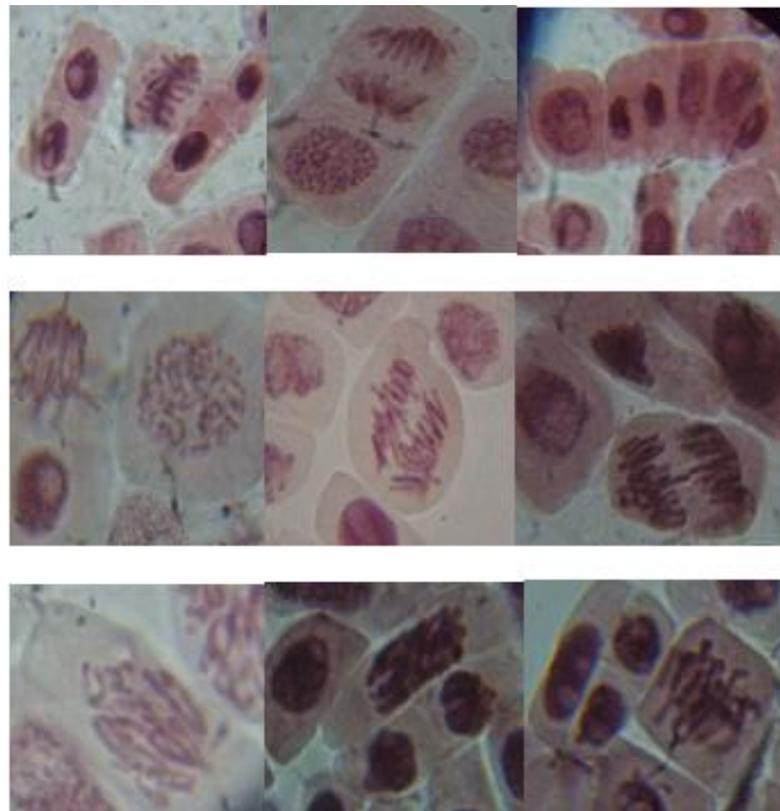
Mean values with different superscript alphabets are significantly different (p < 0.05) using ANOVA and Duncan multiple range tests

**Table 3.** Root inhibition and cytogenotoxic effects of aqueous leaf extract of the selected medicinal plants on *Allium cepa* root cells

	Concentration (%)	Mean Root length	% Inhibition	Dividing cell	Mitotic index	Mitotic inhibition	Chromosome bridge	Fragmentation	C-mitosis	Vagrant Chromosome	Stickiness	Laggard Chromosome	Total aberration	% frequency
Control	0	4.15±0.54	-	115	2.30	-	-	-	-	-	-	-	-	-
Cc	1	3.26±0.67	21.45	100	2.00	13.04	-	-	-	1	-	-	1	0.02
	2.5	2.67*±0.48	35.66	97	1.94	15.65	-	-	-	-	-	-	-	-
	5.0	2.05*±0.61	50.60	68	1.36	40.87	2	1	-	3	1	-	7	0.14
	10.0	1.50*±0.65	63.86	43	0.86	62.61	-	-	-	-	-	-	-	-
	20.0	1.06*±0.40	74.46	47	0.94	59.13	-	-	-	-	-	-	-	-
	40.0	0.50*±0.10	87.95	8	0.16	93.04	-	-	-	-	-	-	-	-
Tp	1	2.46*±0.95	40.72	106	2.12	7.83	-	-	-	-	-	-	-	-
	2.5	2.59*±0.63	37.59	109	2.18	5.22	2	2	-	2	-	-	6	0.12
	5.0	2.65*±0.73	36.14	88	1.76	23.48	3	-	-	-	-	-	3	0.06
	10.0	1.80*±0.93	56.63	58	1.16	49.57	1	-	-	1	-	-	2	0.04
	20.0	1.68*±0.31	59.52	69	1.38	40.00	-	-	-	-	-	-	-	-
	40.0	1.01*±0.26	75.66	60	1.20	47.83	1	1	1	1	2	-	6	0.12
Ms	1	3.20±0.54	22.89	96	1.92	16.52	-	-	-	1	-	-	1	0.02
	2.5	2.77*±0.37	33.25	90	1.80	21.74	1	-	-	1	-	-	2	0.04
	5.0	2.50*±0.35	39.76	71	1.42	38.26	-	-	-	3	1	-	4	0.08
	10.0	2.53*±0.58	39.04	83	1.66	27.83	1	-	-	-	1	1	3	0.06
	20.0	1.62*±0.33	60.96	64	1.28	44.34	1	-	-	-	-	-	1	0.02
	40.0	1.23*±0.22	70.36	61	1.22	46.96	-	1	-	-	-	-	1	0.02
Pl	1	3.16±0.24	23.86	132	2.64	-14.78	1	-	-	-	-	-	1	0.02
	2.5	2.25*±0.41	45.78	90	1.80	21.74	-	1	-	-	-	-	1	0.02
	5.0	1.09*±0.38	73.73	68	1.36	40.86	-	-	-	-	-	-	-	-
	10.0	0.60*±0.31	85.54	54	1.08	53.04	-	1	1	4	-	-	6	0.12
	20.0	0.32*±0.04	92.29	-	-	-	-	-	-	-	-	-	-	-
	40.0	0.23*±0.03	94.46	-	-	-	-	-	-	-	-	-	-	-

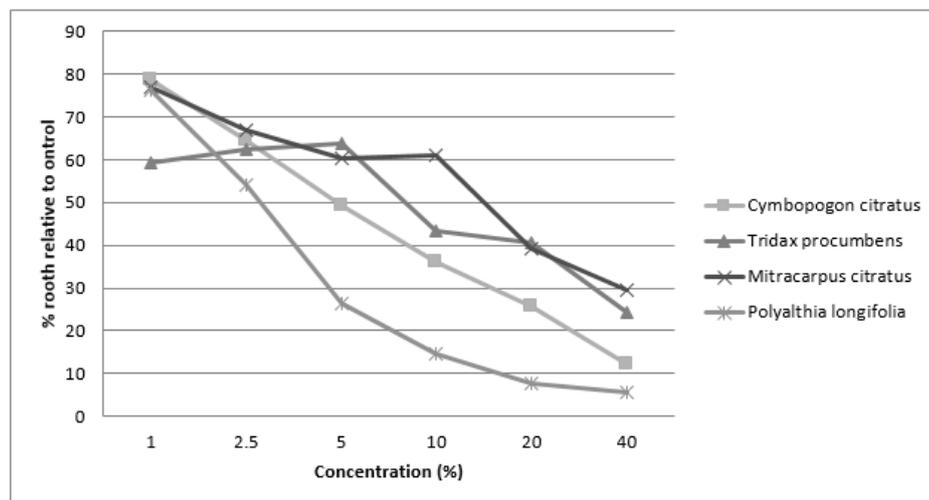
Cc: *Cymbopogon citratus*; Tp: *Tridax procumbens*; Ms: *Mitracarpus scaber*; Pl: *Polyalthia longifolia*

\*= Value significantly different from control as indicated by T-test (P<0.05); 5000 cell were scored per concentration.



(a) Interphase (b) prophase (c) metaphase (d) anaphase (e) telophase (f) Chromosome bridge (g) fragmentation (h) chromosome lag (i) C-mitosis (j) Sticky chromosome (k) vagrant chromosome

**Figure 1.** Normal cell stages and aberrant cells observed for *A. cepa* root cells treated with medicinal plant leaf extracts (x5000)



**Figure 2.** The root growth toxicity of aqueous medicinal plants leaf extracts on *Allium cepa*

The induction of chromosomal aberrations showed potential of the plant extracts to be genotoxic.

However, the frequency of occurrence of chromosomal aberrations across the concentrations for each of the plant extracts was not very high, though none was observed in the control.

Chromosome bridge is formed by breakage and fusion of chromosomes and chromatids, the stickiness of chromosome and subsequent failure of free anaphase separation, and unequal translocation or inversion of chromosome segments [53]. The occurrence of c-mitosis indicates that spindle formation was adversely affected [54] while vagrant chromosome is a weak form of c-mitosis. Stickiness of chromosome may be due to physical adhesion of the proteins of the chromosome [55].

Permjit and Grover [56] attributed laggard chromosomes to the delayed terminalization, stickiness of chromosome ends or the failure of chromosomal movement. Growth response of *A. cepa* root to the leaf extracts of *C. citratus*, *T. procumbens*, *M. scaber*, *P. longifolia* manifested variation in root length and inhibition (Table 3). A dose dependent significant reduction in the mean root length was observed for all concentrations of *C. citratus* and *P. longifolia*, except at 1%. The root length obtained for *T. procumbens* and *M. scaber* at all concentrations were significantly different from that of the control, except 1% of *M. scaber*, though not dose dependent. For all treated onion bulbs, least root length was observed for each of the plant at their highest concentration (40%). The EC<sub>50</sub> values of 2.65, 5.0, 8.9, and 16.8 % were respectively obtained for *P. longifolia*, *C. citratus*, *T. procumbens* and *M. scaber* (Figure 2).

Significant growth inhibition observed in this study corresponds to the observation for the microscopic evaluation. The reduction in root length of treated onion bulbs compared to the control indicates the toxic effects of the plant extracts on the root. The order of the medicinal plant extracts toxicity to *A. cepa* (*P. longifolia* > *C. citratus* > *T. procumbens* > *M. scaber*) as shown by the EC<sub>50</sub> values was consistent with the result obtained for mitotic index in the microscopic evaluation. The suppression of mitotic activity is often used in tracing cytotoxicity [57] and this might be attributed to inhibition of DNA synthesis [58]. Reports have shown that whenever there is root growth inhibition in the *A. cepa*, there is always reduction in the number of dividing cells [29, 59]. Similar observation on reduction in mitotic index, induction of aberrant cells and inhibition of root growth had been reported for *A.*

*cepa* roots treated with the extract of different vegetables [29, 34,35] and medicinal plants [60, 61].

Inhibition of growth induced by the extract of the tested medicinal plants could be linked to the presence of some bioactive compounds found in the sample. Report had shown that bioactive compounds that are anti-carcinogenic in nature may act in a way that could be cytotoxic in cells through mitotic suppression [62]. Flavonoids known to have wide range biological and pharmacological activities have been implicated to induce DNA mutations in the mixed-lineage leukemia (MLL) gene in *in vitro* studies [63, 64]. Arising from the above, metabolites such as saponin, flavonoids, steroids among others that are found in the tested medicinal plants might be responsible for the root growth inhibition observed. This can be further corroborated with the reports of khandewal [65] and Kokate [66] that the presence of these metabolites brought about growth inhibition.

#### 4. Conclusion

The results of this study have shown that phytochemical components of the aqueous leave extracts of the four medicinal plants have antioxidant property thereby making them a prospect in drug production. Ability of the extracts to inhibit growth makes them a potential candidate for anticancer drugs, especially *P. longifolia* which exhibit a complete cell arrest at two consecutive higher concentrations. The potential of the aqueous extracts of these plants to induce chromosomal aberrations of different types connotes that individual using them must be cautious to prevent similar induction of chromosomal aberrations as demonstrated in this study. Further work is hereby recommended on the plants potential as anticancer agent.

**Compliance with Ethics Requirements.** Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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