Cytological studies on vicia faba and allium cepa plants as affcted by chemical extracts of some naturally growing plants in Egypt

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The present study represents the first that comprises the cytological effectsof the phytochemically analysed plant extracts of Cleome droserifolia andPortulaca oleracea on Allium cepa root meristem and Viciafaba flowerbuds, as observed by light microscopy. In addition, tracing those effectson the ultramicroscopic level was carried out.The results of the work can be summarized in the following : -Phytochemical screening of the aerial parts of C.droserifolia and P. oleracea plants, and the seieciion•o(a. . -: __ ,; -~.::. ~.-.>substance from each plant to isolate, purify and”p). :. e~r~·io be~ ’ .• ’•.. :;,·_.,,,_ . I ’tested for its cytological effects. The experiments .it!V((aJ:OO·that ?: ·. 1:·• ·.,.; • ~ .. ’ • ·”... __ ...the two plants contain tannins, sterols, terpenes, glycosid¢s,!m.a I ofcarbohydrates, alkaloids and mucilage; C. droserifolia containsflavonoids and saponins in addition. A mucilaginous substancewas isolated in a pure form from each plant; Compound (1)(C12Hzo010)n isolated from C. droserifolia and Compound (2)(C~toOs)n from P. oleracea. Their structures were confirmedby paper chromatography, infra red and mass spectrum analyses.Light microscopic examination of A. cepa root tip cells toinvestigate effects of the tested material on the mitotic activity,percentages of phases, induction of abnormalities, thenucleoplasmic index, and the recovering ability of the inducedeffects after 24 hours immersion of the treated tissue in water.Cleome extract was tested at concentrations of 0.25%, 0.5%, 1%and 3%, while Portulaca extract at concentrations of 1%, 5% and100/o; treatment durations were for 4, 8 and 24 hours. The isolatedcompounds, Compound (1) and Compound (2), were applied ataqueous solutions of 100, 300 and 500 J,J.g/ml. In all the conductedcytological experiments control treatments using tap water, insteadof the tested solution, were carried out The observations provedthe following : -a- Both of Cleome and Portulaca extracts and the isolated compoundsinduced statistically significant, dose-dependent reductions in themitotic index. These reductions were recoverable in all theextracts treatments but those of the highest concentrations andlongest durations, where complete arrest at interphase wasinduced.b- Very weak or no effect of the plant extracts and the isolatedchemicals on the percentages of the mitotic phases was observed.c- Effects on the percentage of total abnonnalities induced by the twoextracts were highly significant, with more recovery aftertreatment with Portulaca extract than Cleome extract. The mostaffected stage after direct treatment with either extract seemed tobe

prophase. Treatment with Compound (1) and Compound (2)resulted in highly -significant, dose-dependent increase in thepercentage of total abnormalities. Ana telophase seemed to be themost affected stage by treatment with either compound. Stickinessof chromosomes was induced by all the tested materials with veryhigh percentages amounting to l 00% of the induced abnonnalitiesm some treatments. Much lower percentages of spindledisturbance, chromosome bridge, irregular prophase andchromosome despiralization were induced by direct and recoverytreatment of Cleome and Portulaca extracts. In addition tostickiness, Compound (1) and Compound (2) induced very lowpercentages ofbridges and spindle disturbance, respectively.d- Statistically significant reductions in the nucleoplasmic index wereinduced by Cleome and Portulaca extracts, specially after highconcentration and long duration treatments, which could notrecover after treatment with Portulaca extract. This may reflectthe existence of a relation between mitotic index decline andnuclear volume reduction.Light microscopic examination of poUen mother cells andpoUen grains in V. faba flower buds to test effects of the twoplants extracts on the induction potential of meiotic irregularities(their total percentages, distribution in the 1st and 2nd divisions,and types), in addition to effects on pollen grain viability. Cleomeextract solutions were applied at concentrations of 1% and 3% andthose of Portulaca at 2.5% and 10%. Flower buds were coveredwith cotton wool pieces moistened with the extract solution for 3hours, then removed. The flower buds were left intact and twogroups were gathered after 24 and 48 hours of treatment. The datashowed that : -a- The two extracts induced highly significant increases in thepercentage of total abnormalities which were negatively correlatedto the treatment concentrations.b- The induced percentages of total abnormalities were diminishedafter elapse of 24-48 hours following treatments, meanwhilepercentages of abnormalities of the 1st division were higher thanthose of the 2nd one. These observations point to recovery ofP,Ollen mother cells from the induced aberrations.c- Five types of abnormalities were induced by both plant extracts;namely, chromosome stickiness (which was the dominant type asin mitosis), bridges, un-oriented chromatin material andchromosome lagging, spindle disturbance, and multinucleate cells.It is obvious that most of the scored abnormalities in meiosisresemble those observed in mitotic cells.d- Aberrant spore tetrads were abnormally arranged after treatmentwith C/eome extract, while after Portulaca extract treatments theywere sticky or deformed. Aberrant pollen grains were deformedafter C/eome extract -treatments, whereas those induced byPortulaca extract were either deformed, un stained or sticky. Itwas suggested that the induced abnormalities may negativelyaffect pollen grains viability.Electron microscopy of V. faba root meristem treated with0.5%, I% or 3% C/eome extract, or 1%, 5% or 10% Portulacaextract, to investigate ultrastructural changes induced in thecytoplasm. The study showed the following changes in : -a- Mitochondria : which appeared disrupted after Cleome extracttreatments and slightly deformed after those of Portulaca, thusdisturbance of the cells energetics could be expected.b- Dictyosomes : appeared with enlarged vesicles after C/eomeextract treatments, whereas Portulaca extract treatments causeddecrease in volwne of the vesicles accompanied by increases innwnber, length and electron-density of dictyosomal cisternae,specially after high

concentration treatments.c- Most treatments of Cleome or Portulaca extracts induced thefonnation of autophagic vacuoles, which points to injury of thetreated cells.d- The endoplasmic reticulum cisternae appeared destructed afterCleome extract treatments, while those of Portulaca extractinduced the formation of whorls which may inclose somecytoplasmic organelles and acting as autophagic areas.from the obtained results it was concluded that four main effects wereinduced by the tested materials, these are : [1] Reduction of the mitoticactivity, [2] high percentages of abnormal mitotic and meiotic figures, [3]diminution of the nuclear volwne, and [4] disturbed metabolic energeticsexpressed as malfonned mitochondria, dictyosomes and endoplasmicreticulwn.