

mined, six samples harboured *A. flavus* and five of these were toxigenic. Among the 12 unrefined groundnut oil samples examined, two samples and of the seven ration oil samples examined three samples, had toxigenic *A. flavus*. All the seven refined oil samples were free from *A. flavus*.

Such incidence of *A. flavus* in unrefined groundnut and ration oil samples which are consumed by a large section of community was alarming and indicated that oil-seeds infested with *A. flavus* were used for extraction of the oil. Thus, oils could become carrier of *A. flavus* and hence hazardous. Since no aseptic precautions are followed during the extraction of oil from oil-seeds, the presence of *A. flavus* in unrefined groundnut and ration oil samples, thus indicated the origin of the fungus through infested oil-seeds. Absence of *A. flavus* in the refined oil samples indicated that the process of refining eliminates *A. flavus* and makes it safe for the consumption. The present investigation thus suggests that the oil-seeds should be treated to eliminate microorganisms including *A. flavus*.

When the ability of the isolates to produce aflatoxin in sterile groundnut oil was tested, the results showed that the strain did not produce any aflatoxin in sterile groundnut oil over a period of three months. The fact that the strain produced aflatoxin B₁ in nutrient medium, but not in groundnut oil indicated the requirement of sufficient moisture and nutrients for growth and toxin production. Oil alone does not satisfy these requirements and hence the organism could not produce aflatoxin in oil. Thus, it is the oil-seed which produces the aflatoxin and hence it should be suitably treated.

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CYTOPLASMIC VESICLES CONTAINING SECONDARY METABOLITES IN THE ROOT OF *COLEUS FORSKOHLII* (WILLD.) BRIQ.

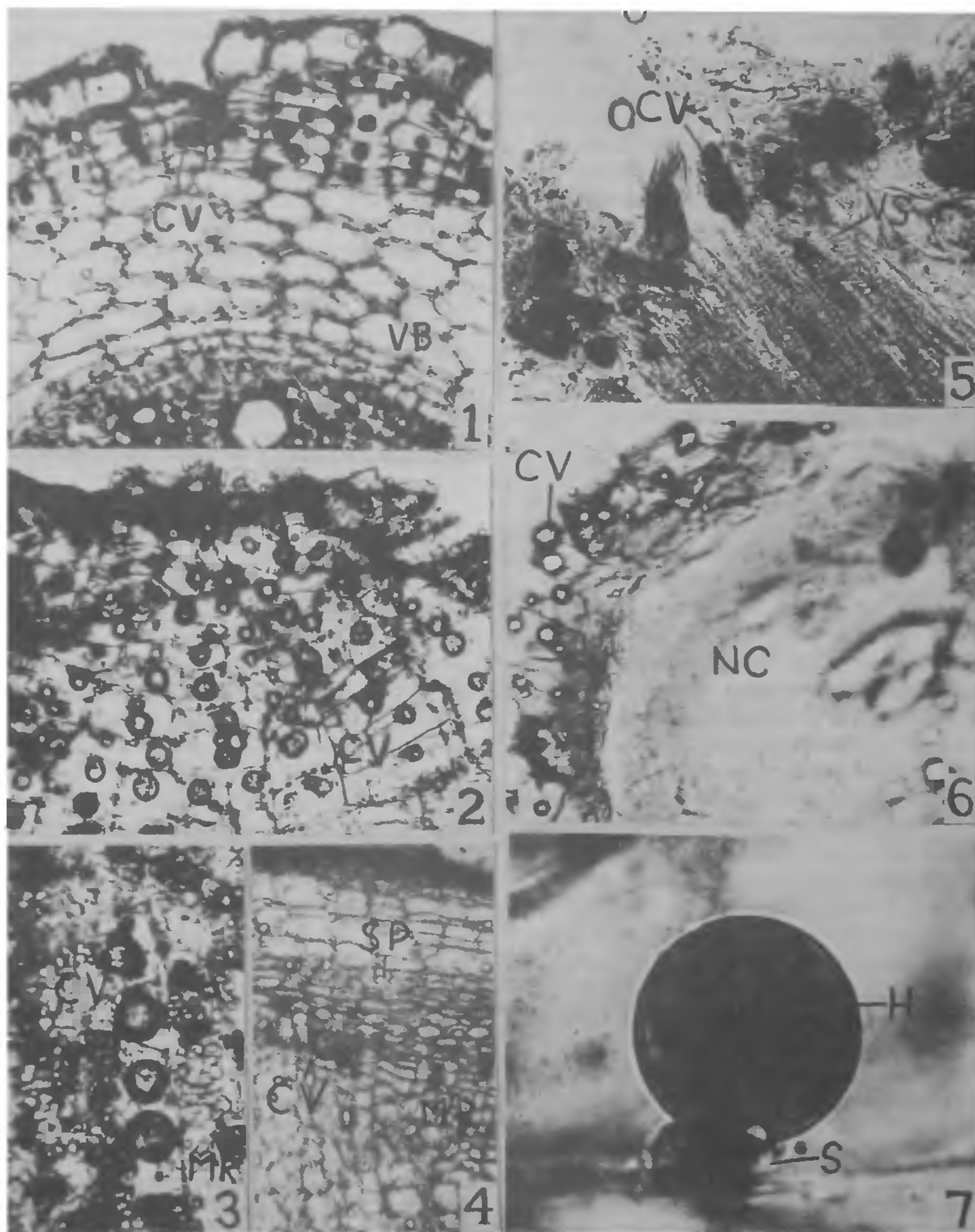
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COLEUS FORSKOHLII (Willd.) Briq. Syn. *C. barbatus* (Andr.) Benth. (Lamiaceae) is a perennial aromatic herb, growing wild from Simla eastwards to Nepal, in the hills of Bihar, Gujarat and peninsular India (600–2500 m). It is common on dry barren hills and is cultivated in Maharashtra and Gujarat for edible roots, which are often used as pickles¹. Recently, biologically active terpenoids were isolated from the roots^{2–7}. The plant is valued for its hypotensive activity, the chief active principle being forskolin/coleonol^{8,9}. Forskolin also acts as bronchodilator^{10,11}, stimulates adenylate cyclase activity^{12,13}, and acid and pepsinogen secretion by gastric glands¹⁴. Both these compounds (forskolin/coleonol) are identical in nature¹⁵. Other terpenoids, barbatusin and cyclobutatusin are found to be active against mouse Ehrlich ascites tumour cells⁷.

The terpenoids are found in almost all the parts of the plant but roots are the main source³. Forskolin is present in amounts of ca 0.05% of the dry weight of the whole plant and ca. 0.1% of the dry weight of the roots¹⁶. The present study has been undertaken to localize the part of root wherein the terpenoids and other metabolites are stored.

Plants collected from Kuridimalai, Tamil Nadu (4514) and Marayur, Kerala (4773) were grown in the glass house/farm of the Central Institute of Medicinal and Aromatic Plants, Lucknow. Free hand sections of fresh roots were cut and observed. Photographs were taken with the help of Optiphot-pol-camera attached light microscope.



Figures 1-7. Anatomy of root of *Coleus forskolii*. 1. TS of young root ($\times 40$); 2. Cork region of mature root ($\times 100$); 3. Medullary ray cells ($\times 100$); 4. Secondary phloem region of mature bark ($\times 40$); 5. Cytoplasmic vesicles near vascular supply to rootlets ($\times 100$); 6. Cells containing cytoplasmic vesicles, surrounding the nematode infected cavity ($\times 100$), and 7. Enlarged cytoplasmic vesicle ($\times 1000$). [CV, Cytoplasmic vesicle; H, Head; MR, Medullary ray; S, Stalk; SP, Secondary phloem; VB, Vascular bundle; VS, Vascular supply.]

Transverse section of both fibrous and tuberous roots of *C. forskohlii* showed yellowish to reddish brown globular structures in the cork cells (figures 1 and 2). Under high magnification, these structures in the cytoplasm were found to be surrounded by a thin membrane (figure 7) appearing like a vesicle containing terpenoids and other secondary metabolites. These cytoplasmic vesicles, in mature cork cells, measure 5–12 μm in diameter. These were found attached with the outer wall of the cork cells by a membranous stalk, which is usually rectangular (figures 1, 2 and 7). The stalk also contains yellowish to brown contents of secondary metabolites.

Cytoplasmic vesicles are mainly concentrated in the cork cells of the root but a few are also found in the cells of medullary ray and phloem. The number of these per cell is mostly one but may be more in the cells of medullary ray (figure 3). Other tissues do not possess these vesicles. Vesicles are also seen readily in sections of dried material.

In young root, cytoplasmic vesicles appear as small globules, each surrounded by cytoplasm. During the development of the plant, secondary metabolites get accumulated in the central vacuole of the cell and as root mature, the globules enlarge in size diminishing the surrounding cytoplasm gradually. In the mature root, the cork cells lack cytoplasm but possess enlarged cytoplasmic vesicles containing secondary metabolites/terpenoids. The stalk of the vesicle may possibly be formed by the disintegrating membranes of cytoplasm.

The concentration of vesicle containing cells is more in the regions where the vascular bundle branch for supply in the rootlet (figure 5). These cells also surround the nematode infected portions of the root (figure 6) indicating that secondary metabolites may have some role in the protection of plant.

In the leaves of Lamiaceae (including *Coleus* spp), essential oils, terpenoids and other secondary metabolites, however, accumulate in the specialized glands. These glands are formed outside the epidermis and are uni- to multi-cellular in structure. In *C. forskohlii*, terpenoids and other secondary metabolites are stored mainly in the cytoplasmic vesicles of cork cells of both fibrous and tuberous roots. The contents are enclosed in cytoplasmic membrane and have globular head and rectangular stalk. This type of vesicles is not reported in any other member of angiosperms and are of diagnostic importance for this drug plant.

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ATPASE ACTIVITY AS INFLUENCED BY PAPAYA VIRUSES

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PAPAYA (*Carica papaya* L.) was used as host plant for different papaya viruses [papaya mild mosaic virus (PMMV), papaya leaf curl virus (PLCV) and papaya leaf distortion virus (PLDV)] for a systemic multiplication. The test plants were grown in clay