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

pots. Twenty days old papaya seedlings were taken in four groups, each containing 25 seedlings. The seedlings of the first group were inoculated with the neutral phosphate buffer to serve as control. The second and the third groups of seedlings were inoculated with PMMV and PLDV respectively, while those of the 4th group were subjected to viruliferous (PLCV) white flies. The method of preparation of inoculum and the inoculation were followed according to Rao *et al*[1]. Carborundum powder (600 mesh) was used as abrassive. Leaf samples were collected separately from healthy and virus-infected plants on the 60th day after inoculation, when the symptoms of all the viruses were quite prominent.

For the measurement of ATPase activity, the fresh leaves of papaya from healthy and virus-infected plants were first crushed with activated charcoal which adsorbed the chloroplast of green leaves. This was filtered and the filtrate centrifuged. The clean supernatant was then taken for enzyme activity measurement. The assay procedure involved the incubation of ATP with leaf cytosol followed by the determination of the released phosphate using the method of Boyer *et al*[2] as modified by Woolfolk *et al*[3]. Phosphate was estimated by the method of Farnden and Robertson[4]. Enzyme activity was measured in terms of $MgPO_4\ g^{-1}$ fresh weight of the leaf. Each estimation was made in triplicate and the average value is presented. All the virus experiments were performed under glass house conditions. The results are presented in table 1.

ADP/ATP ratio is a pace maker reaction and controls the respiration rate, the latter depending upon ADP availability. ATPase enzyme is well-known to be involved in the production of energy by breaking ATP into ADP and the inorganic phosphate[5]. The increased ATP concentration in virus-infected tissues[6] implies more ATP generation from ADP during oxidative phosphorylation. The rapid ATP turnover results in the enhanced respiration of the infected tissues[7–9]. This might be the main reason for the increase in ATPase activity in the virus-infected leaves of papaya during the present investigation.

Table 1 *Effect of three different papaya viruses on the ATPase activity of papaya leaves*

Virus strains	ATPase activity ($MgPO_4\ g^{-1}$ fr. wt)
Control	5.196
PMMV	6.200
PLCV	12.450
PLDV	13.200

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PRE-SOWING HYDRATION OF MAIZE SEEDS FOR STIMULATION OF LOW-TEMPERATURE GERMINATION AND ITS EFFECTS ON PHOSPHOLIPID CHANGES IN THE EMBRYOS

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THE research interest in pre-sowing treatments for improving seed performance has yielded information of both intrinsic and applied value[1–3]. Pre-sowing hydration treatments of seeds can be effective in accelerating the rate and reducing the spread of germination[2]. Such treatments allow the seeds to imbibe partially and undergo considerable metabolic activity but without radicle emergence.

The maize crop needs a high optimal temperature for germination and growth and belongs to the