Chapter VI
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DISCUSSION

Some of the main conclusions are as follows:

The storage life of foodstuff including fruits and vegetables is considerably affected by onset of fungi, bacteria and actinomycetes. The problem assumes considerable importance not only of loss of foodstuff as reported in the storage chambers causing food unfit for human consumption but also of deleterious effects of the spoiled foodstuff on plant and animal life. Of the fungi, mostly belonging to the genera *Penicillium*, *Aspergillus*, *Mucor*, *Helminthosporium* and *Fusarium* are predominantly frequent colonisers on the foodstuff in the storage chambers.

Christensen and Kaufmann (1968) have stressed the importance of fungi in particular in maintaining the quality of foodstuff. The sources of origin of the fungi are being investigated to find out if the fungi had gained entrance from the field into the storage chambers and proliferated in the atmosphere. In that case aerobiological studies of the chamber giving a quantitative estimate will have to account for the rapid decay of the foodstuff. The aerospora of the local godowns, mills and bakeries were studied at random. The most common and responsible fungi present were *Aspergillus flavus* and *Penicillium notatum* (Table 3). This finding is in conformity with the observation of Miyaki et al (1970), Lim (1971), Wogan (1972) and Mehrotra and Basu (1975).
Although *Aspergillus flavus* and *Penicillium notatum* were found to be common storage fungi, yet they were specific to their host substrate. *Penicillium notatum* shows poor growth as compared to *Helminthosporium sativum* which gives luxuriant growth on rice; *A. flavus* shows highest growth in all the substrates, viz., rice, wheat and corn (Fig. 1, 2 and 3; Pl. 1A, B & C). Similar study conducted by Schade (1940) showed specificity of *Leptomitus lacteus* only on fatty acids.

Relative humidity of the storage atmosphere has been found to be an important factor in the spoilage of foodstuffs in storage. If the commodity is stored in an atmosphere which is not moisture proof or if the foodstuff itself has a high moisture content the vapour pressure of the storage atmosphere of the commodity tends to equilibrate with the atmosphere with which it is in contact. A higher humidity thus encourages infection and spoilage of stored foods (Mossel and Ingram, 1955).

The results of the present investigation also show that the higher the relative humidity, the heavier is the growth of fungi. At 93% RH, foodstuff and grains were found to be contaminated from the second day of onset of the experiment. Christensen and Kaufmann (1965) gave abundant evidences that storage fungi, specially *A. flavus* group require relative humidity of 83 to 85% to invade starchy cereal grains. On the other hand, Christensen and Mirocha (1976) pointed out that stored products became hazardous for consumption when infected by *A. flavus* at 75% RH. Their findings are quite in agreement with the present work (Pl. 2A, B,C,D,E,F).
Moisture content of cereal grains has a very important role in the growth of fungi in storage condition. In the present work it was observed that higher the moisture content the greater is the infection by fungi. Due to the humid climate of Assam, infection of the cereals particularly rice and wheat were brought about within 1 month of storage, when the moisture content of these grains were above 12.1 and 14.1 per cent respectively; but corn grains never got infected till 75 days even with the moisture content of 16.5 per cent. Papavizas and Christensen (1960) found that germinability was retained in wheat and corn by storing at lower moisture content even after inoculating with *Aspergillus candidus*. Christensen and Mirocha (1965) found that the lowest limit of moisture content for the invasion of storage fungi in the cereal food were 17.5 to 18 per cent. Indudharaswamy et al (1971) also found that stored samples with 16.5 and 18 per cent moisture content showed mould growth. The difference between the present observation and those of the authors mentioned above might be due to the atmospheric variation with high humidity in Assam (Table 5 & 5A).

The development of fungi particularly *A. flavus* showed luxuriant growth at temperatures ranging from 30° to 40°C which is in conformity with the observation of Hellberg and Kolk (1972) (Fig. 5C). Mossel and Ingram (1955) however have shown that most spoilage microorganisms develop at temperatures within the range of -5 to +70°C and that the effect of temperature is reflected in the storage life of the commodity.
The pH of the infected foodstuff such as rice, wheat and corn flour stored at room temperature showed changes after the sixth day of onset of the experiment (Fig. 4). The fungi were characteristically tolerant to low pH around 5.0 to 6.0. Alsopp (1973) also recorded marked effect in the changes of pH in the deteriorated foodstuffs. Nagar et al (1977) too observed fall in pH when wheat is infected by storage fungi like A. niger, Rhizopus sps. and A. tereus.

The reducing sugar of the cereal foodstuff infected with A. niger increased from 3rd day of incubation till 12th day and gradually began to decline. Iwaki et al (1967) observed increase in reducing sugar in stored rice.

The flour, corn flour and rice grain after one month storage in humid atmosphere, apparently did not show any mycelial growth; but on isolation revealed the presence of A. flavus, P. notatum and H. sativum.

Another aspect of this work was to study the effect of toxic metabolites of the fungi on some experimental plants and animals which has occupied the attention and studies of several investigators during the last two decades (Blount, 1961; Allcroft et al, 1961; Allcroft and Carnaghan, 1963; and Hesseltine et al, 1966). The toxic effect of crude extracts of A. flavus, P. notatum and H. sativum had been studied on germination of pollen grains, seeds on growth of seedlings and lethal effect on embryonated eggs and day-old chick (Table 9, 10, 11, 12, 13). Among the three fungal extracts, A. flavus
proved to be most toxic (Pl. 3, 4, 5, 6A, B, C and 7A, B, C; Table 13). Compared to the control group Aflatoxin B and G showed an average loss of weight ranging from 43 g. to 57 g. in the chicken (Table 15 and Pl. 9A & 9B). In the albino mice comparison to the control group revealed minimal loss of weight in the test group; those mice fed with crude extract showed 0.3 to 0.5 g. loss whereas those fed with purified extract lost 0.6 to 1.2 g. (Table 16 and Pl. 11A & 11B). Feeding experiments on chicks and mice and subsequent microscopic examination of tissues of the dead or killed specimens showed congestion, haemorrhage and degeneration particularly of the liver (Pl. 10A & 10B). Joffe (1969) reported similar histopathological changes caused by aflatoxins. There is also evidence of inhibitory effect of aflatoxins on gram-positive and gram-negative bacteria (Pl. 12A, B).

The problem, therefore, resolves into not only finding out the extent of loss of foodstuff during storage but also determining the factors influencing onset and spread of infection and the effects of the metabolites elaborated by the fungi on different substrates on plant and animal life.