Lesson- 32 Condition of environment inside storage.

32.1 Environmental Factors Influencing Grain Quality

The quality of stored grain depends on four important factors: (a) initial condition of the grain; (b) environmental conditions during the period of storage; (c) biotic factors, such as insects, rodents, and microorganisms; and (d) various treatments applied on the grain during the storage period (e.g., aeration, drying, fumigation, controlled atmospheres, and grain protectants).

32.1.1 Initial Condition of the Grain

The storage properties of the grain are likely to be affected even before reaching the storage premise. Environmental conditions during growth and maturation of grains, the degree of maturity at the time of harvest, harvesting methods, and the method of handling grain in the farms influence the storage quality. Fungal and insect pest activity can start in the field itself. High temperatures and humidity during maturation of corn are conducive to aflatoxin formation. The level of infection by the storage fungi has been linked to the amount of kernel damage as a result of combined harvesting and handling. Insects such as the larger grain borer Prostephanus truncatus and the maize weevil Sitophilus zeamais, which are active flyers, infest the grain in the field itself. It is not uncommon for the maize and paddy crops to be harvested at high moisture levels of more than 15%, which is not suitable for storage as such. It needs drying artificially or by sunlight (8). The sanitary condition or physical state of the newly harvested grain (i.e., moisture content, cleanliness, and specific weight) will affect the storage quality. Therefore, it is necessary to conduct quality tests on the grain before binning or taking into storage. These tests include determination of moisture content, bulk density, germination tests (glutamic acid decarboxylase activity or tetrazolium tests), amylase activity (Hegberge test), free fatty acids, nonreducing sugar contents, detection of insect infestation, and mold counts. Indices of fungal load can also be assessed by chitin and ergosterol assays. These details will help assess the shelf life potential of the grain; hence, assessment of grain quality is an important storage strategy (6). Among the quality parameters the water activity or moisture content of the grain is the most significant because it has an influential effect on the multiplication of insect pests and growth of other spoilage organisms. The moisture content will not be uniform in bulk storage and is likely to vary between farms, between truck loads or grain lots, and in bag storage between peripheral and inner bags, and in bulk storage between top layer and periphery or in depth. The highest moisture prevailing in any part of the grain bulk has more practical importance than the average moisture content.

32.1.2 Physical Factors

Because pest activity is dependent on temperature, the latter plays an important role during grain storage. The optimum temperatures for the growth and multiplication of insects, fungi, and mites in stored grains are 25–32, 30, and 25°C, respectively. Development of insects and mites is decreased, respectively, at temperatures less than 15° and 5°C. The mold growth, however, is affected only at 0°C or below. As the temperature rises, the rate of respiration of the grain and the pests in it increases. Furthermore, the enzymatic activity of grains goes up. This enhanced biological activity leads to rapid quality deterioration at higher temperatures. Another interrelated factor is the moisture or water activity of the grain. Moisture content in the range of 12–14% is favorable for insect development. When the water activity is 0.9 or more, mold and other microorganisms thrive. When the water activity is low, the pest activity is automatically reduced. Temperature and moisture together largely determine the length of safe storage life. Respiration of grain and the pests leads to the consumption of oxygen and release of carbon dioxide during storage. Composition of the intergranular atmosphere influences the type of metabolism of the microorganisms and the grain. It also affects nonenzymatic reactions and certain enzymatic reactions. Oxygen and carbon dioxide levels also affect insect population and mold growth. Interactions of the physical factors along with the biological process in the grain storage ecosystem lead to changes in the grain composition and its functional properties. Free fatty acids and glycerol are formed when grain lipids are broken down by lipases. The free fatty acid content of grain is a sensitive indicator of deterioration during storage (9,10). Changes in carbohydrates include decreases in the amounts of nonreducing sugars and total sugars. Considerable loss in vitamin A activity in yellow corn and sorghum, decreases in water-soluble B vitamins, and an increases in the level of phosphorus compounds in grains during storage have been reported (10). Functional properties such as bread-making quality of wheat, milling and cooking quality of rice, malting quality of barley, and starch separation in corn are also likely to be affected during storage (9,10). Storage of rice leads to aging and aged rice is preferred in some regions in Asia. Decreased levels of 2-acetyl-1-pyrroline, an aroma principle in aromatic rice following storage of rice, have been observed. Reductions in the content of free amino acids, nonreducing sugars, and albumin have been noted in ordinary rice (9).

32.1.3 Biotic Factors and Treatment Effects

Biotic factors such as insects, mites, rodents, birds, and microorganisms are responsible for quantitative and qualitative losses of the stored grains. They are also responsible for the contamination, heating, and associated storage problems, and in extreme cases may pose health hazards. The biotic factors are discussed in detail in Sec. 3, and the effects of treatments, such as aeration, drying, fumigation, and protectants, are discussed in Sec. 4.

References :

1. Grain Storage: Perspectives and Problems by Somiahnadar Rajendran - (Central Food Technological Research Institute, Mysore, India)