

Chapter 1

Properties of Grains

A grain is a living biological product that germinates as well as respire. The respiration process in the grain is externally manifested by the decrease in dry weight, utilization of oxygen, evolution of carbon dioxide, and release of heat. The rate of respiration is dependent upon moisture content and temperature of the grain. The rate of respiration of paddy increases sharply (at 25°C) from 14% to 15% moisture content, which may be called the critical point. On the other hand, the rate of respiration increases with the increase of temperature up to 40°C. Above this temperature, the viability of the grain as well as the rate of respiration decreases significantly.

Structure

Wheat and rye consist mainly of pericarp, seed coat, aleurone layer, germ, and endosperm, whereas oats, barley, paddy, pulses, and some other crops consist not only of the aforementioned five parts but also an outer husk cover. The husk consists of strongly lignified floral integuments. The husk reduces the rate of drying significantly.

The embryo or germ is the principal part of the seed. All tissues of the germ consist of living cells that are very sensitive to heat. The endosperm that fills the whole inner part of the seed consists of thin-walled cells, filled with protoplasm and starch granules and serves as a kind of receptacle for reserve foodstuff for the developing embryo. The structures of a few important grains are shown in Figures 1.1 through 1.4.

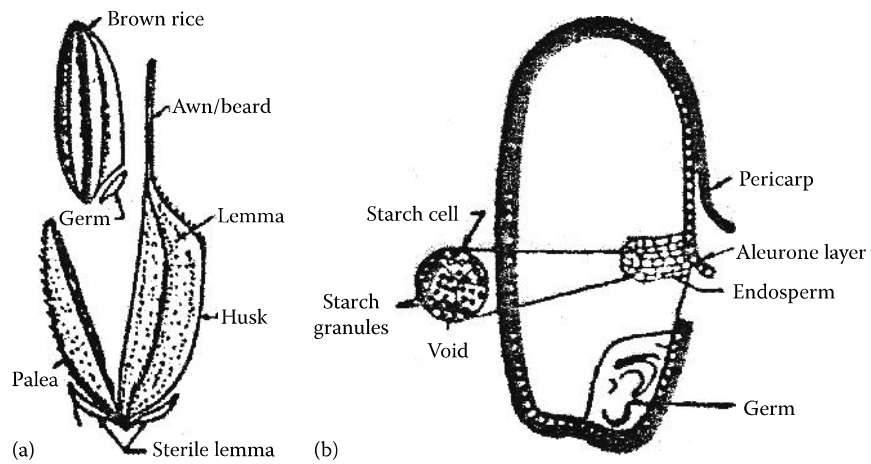


Figure 1.1 (a) Different parts of paddy. (b) Structure of brown rice kernel (longitudinal section).

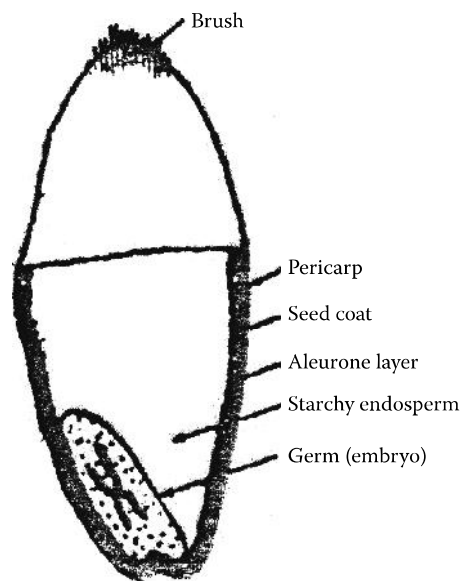


Figure 1.2 Structure of wheat.

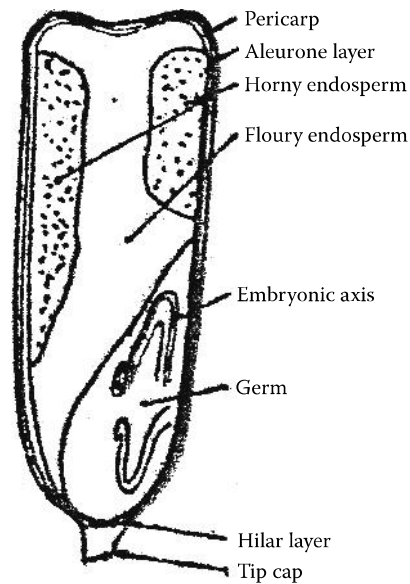


Figure 1.3 Structure of shelled corn (longitudinal section).

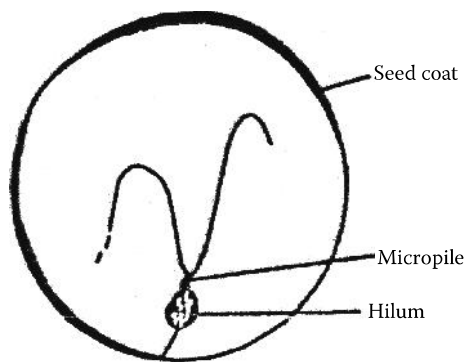


Figure 1.4 Whole arhar pulses (*Cajanus cajan*).

Chemical Composition

The grain is composed of both organic and inorganic substances, such as carbohydrates, proteins, vitamins, fats, ash, water, mineral salts, and enzymes. Paddy, corn, wheat, and buckwheat seeds are especially rich in carbohydrates, whereas legumes are rich in proteins and oilseeds in oils.

Generally, pericarp and husk contain cellulose, pentosan, and ash. The aleurone layer contains mainly albumin and fat. The endosperm contains the highest amount of carbohydrate in the form of starch, a small amount of reserve protein, and a very little amount of ash and cellulose, whereas the germ contains the highest amount of fat, protein, and a small amount of carbohydrate in the form of sugars and a large amount of enzyme.

Effects of Temperature on the Quality of Grain

Proteins

The proteins present in cereal grains and flour are hydrophilic colloids. The capacity of flour proteins to swell plays an important role in the preparation of dough. At temperatures above 50°C, denaturation and even coagulation of proteins take place. As a result, the water-absorbing capacity of the proteins and their capacity for swelling decrease.

Starch

Starch is insoluble in cold water but swells in hot water. Up to a temperature of 60°C, the quality of starch does not change appreciably. With a further increase in temperature, particularly above 70°C, and especially in the presence of high moisture in the grain, gelatinization and partial conversion of starch to dextrin take place. In addition, a partial caramelization of sugars with the formation of caramel may take place, which causes deterioration in color of the product. These effects will be discussed in detail in Part III on Parboiling and Milling.

Fats

Fats are insoluble in water. Compared to albumins and starch, fats are more heat-resistant. But at temperatures above 70°C, fats may also undergo a partial decomposition resulting in an increase of acid numbers.

In the range of temperatures from 40°C to 45°C, the rate of enzymatic activity on fats increases with the increase of moisture and temperature. With a further rise of temperature, the enzymatic activity begins to decrease, and at temperatures between 80°C and 100°C the enzymes are completely inactivated.

Vitamins

The heat-sensitive B vitamins present in the germ and aleurone layer are destroyed at high temperature.

The details of the structures and compositions of wheat, rice, corn, and pulses/legumes can be found in Pomeranz (1971), Potter (1986), and Kadam et al. (1982).