

Lesson 10: Processing of Grain Crops

Since the beginning of time, people have enjoyed eating grain crops. Crops like corn, rice, wheat, oats, and barley have been a steady supplier of complex carbohydrates. Leguminous crops supply protein to the diet. This lesson will focus on the processing of these grain crops.

Steps in Processing Grain

Before becoming human food, most grains are processed. They are processed to improve their digestibility, flavor, texture, and storage qualities.

Grain must be harvested and transported to the appropriate processing plants. Transporting grain is accomplished by rail, barge, or truck. Once at the processing plant, the procedures vary depending on the type of grain.

Cereal grains undergo milling. There are two types of milling: dry and wet. Dry milling includes the removal of any foreign seeds and soil; conditioning the grain to the proper moisture level (17% for wheat, 21% for corn); and loosening and separating the germ, bran (hull), and endosperm. The germ, bran, and endosperm are separated after they have been passed through a roller. The flakes of bran and the flattened, semi-plastic germ are separated from the small, brittle particles of endosperm by the sieves under the rollers. The pulverized endosperm is now in the form of grits or meal and may be further processed into flour.

Wet milling is a process used mostly by corn processors. It involves steeping the corn in large tanks of warm water that contain acid and sulfur dioxide (SO₂). The soft kernels are passed through a grinder to break up the kernels. The result is a paste that is pumped into water-filled settling troughs. The germ, which has the lowest density, can be skimmed off the top. It is then pressed for oil. The slurry passes through screens to separate the bran from the endosperm. High speed centrifuges separate the remaining starch and protein fragments found in the endosperm. The starch is dried to yield corn starch and corn sugars. The dried protein becomes corn gluten.

Malting is primarily a process used for barley. The barley seed is germinated to activate dormant enzymes. The swollen grain is gently kilned to dry the seed without destroying the enzymes. The dry malt is then storage-stable.

Oil seeds must be roasted to remove the oil. The seed is steamed and crushed to rupture the cellular structure and expose the free oil. The oil is extracted by high pressures, or dissolving the oil in solvents such as hexane or liquified carbon dioxide. The remaining meal or flakes are high in protein and may be further processed into flour.

Food Science and Technology-Unit II

Enrichment and fortification are used to improve the nutritional characteristics of some processed grains to meet U.S. nutrient standards. Wheat and rice often undergo processing procedures that unintentionally remove nutrients. These nutrients are often added back into the food product. These products are enriched. Some nutrients are added to products to help ensure good nutrition in an entire population. These products are fortified.

Extrusion is a process that combines several operations, including mixing, kneading, shearing, heating, cooling, shaping, and forming. Extrusion compresses the food into a semisolid mass and forces it through a restricted opening. The moisture in the food turns instantly to steam, causing the product to expand or puff. Many breakfast cereals and snack foods, macaroni, textured food products, and confections have been extruded.

Preserving Grain Products

Nature, in the form of sun rays, will dry grain to about 14 percent moisture. At this moisture level, spoilage is usually not a problem. Grain processors eliminate spoilage problems by drying meal, flour, pasta, and grain to below 14 percent moisture, (3-5 percent). Very few grain products contain an added preservative. Insects pose the greatest spoilage threat. Thus, packaging in insect-proof containers is vital. Insects along with molds and bacteria can be destroyed by irradiation treatments of flour, cornmeal, etc.

A second method to preserve grain products can be accomplished by regulating osmotic pressure. Corn syrup contains sufficient nutrients to promote bacterial growth. Growth of microbes is prevented, however, because of the high osmotic pressure found in syrup due to its sugar concentration.

A third technique used to preserve grain in Europe and Russia is irradiation. High energy atomic particles are used to bombard the grain and destroy insects, molds, and bacteria. The irradiated grain must be protected from future contamination by proper packaging.

Grain Inspection

The quality of a food product can only be as good as the raw materials. The laws that govern grain inspection today were initiated by the Grain Standards Act of 1916. Grain is inspected to determine its quality, thus influencing its price.

Grading Grain

There are several factors to consider when grading grain. These include test weight, moisture, damaged or split grains, heat damaged grains, foreign material, and diseased or treated kernels. These variables carry the potential to alter a grain's food value. Variances in test weight can affect density, moisture levels affect storage life, damaged grain may hinder the germ-endosperm-hull ratio, and excess heat can reduce enzyme activity and protein content.

Some grains have different classes or subclasses. Each class is also graded. Corn is divided into three color classes: yellow, white, and mixed. Soybeans are also classified by color, however, in only two classes: yellow and mixed. Wheat is extensively classified into eight areas: hard red spring, hard red winter, soft red winter, Duram, hard white, soft white, unclassified wheat, and mixed wheat.

Corn and wheat are graded into U.S. Grade 1, U.S. Grade 2, U.S. Grade 3, U.S. Grade 4, U.S. Grade 5 and U.S. Sample grade. U.S. Grade 1 is the highest quality grade.

Oats and soybeans may be graded as: U.S. Grade 1, U.S. Grade 2, U.S. Grade 3, U.S. Grade 4 or U.S. sample grade. The higher the sample quality, the closer to U.S. Grade 1.

Barley and oats do not have any classes or subclasses.

How Grades of Grain are Used

Grading grain is essential for fair trade. It provides information in an understandable language for buyers and sellers. It facilitates selling/buying grain without personal inspection.

U.S. Grades 1 and 2 grain are primarily used for food production. U.S. Grades 3, 4, 5, and U.S. sample grade grains are normally processed or exported for animal feed. This is not to say, however, that it cannot be upgraded by mixing U.S. Grade 1 or 2 grain with it. If the grain contains too many cobs or cockleburs, these can be cleaned out and the grain upgraded. On the other hand, if a mold (aflatoxin) is present, no amount of mixing would be permissible.

Food Grain Industry

The food grain industry is diverse in size, ranging from small locally owned processors to multi-million dollar corporations. This industry also includes contract growers (raise specific varieties for contracted mill), independent growers, and corporate production sites. The Kansas City Board of Trade plays a significant role in the world's wheat trade while the Chicago Board of Trade deals with the buying and selling of many different grains.

Summary

Most grains are processed to improve their flavor, texture, storage quality, and digestibility. Following harvest, grains are transported to processing mills. Dry milling separates the bran, germ, and endosperm with a series of rollers and sieves. Wet milling is useful for corn processors. This involves swelling the grain with moisture, rolling it into a paste, and then separating the constituents by density. Malting, roasting, fortification and enrichment are other means used to process grain. Oil-seed grains must be roasted to remove and process the oil. Extrusion is a process that compresses a semi-solid mass and reforms it as it passes through a restricted opening.

Grain products rely on a low moisture content or a high sugar concentration to prohibit microbial invasion. Grain inspection and standards identify grain quality, and thereby, are essential for fair trade. Grades for corn and wheat are similar. Grades for oats and soybeans are very much alike. Test weight, moisture, damaged kernels, heat damage, foreign material, color, variety, and evidence of diseased or treated kernels all contribute to grain grades. The US grain industry is very diverse in structure and organization.

Credits

Hui, Y.H. *Encyclopedia of Food Science and Technology*. 1st ed. New York: Wiley-Interscience, 1991.

Jelen, Panel. *Introduction to Food Processing*. 1st ed. Reston, VA: Prentice-Hall, 1985.

Potter, Norman N. *Food Science*. 4th Ed. Westport, CT: AVI Publishing Co. Inc., 1986.

Schoeff, Robert W.; Tim Herrman. *U.S. Grain Grading Handbook*. Manhattan: Kansas State University, 1993.