UtahStateUniversity
COOPERATIVE EXTENSION

Home Storage of Wheat

By ***Ralph E. Whitesides***, Extension Agronomist

June 1995 FN-371

CONTENTS

Page

Types of Wheat 2

Selection of Wheat 3

Wheat Quality 4

Moisture and Temperature Levels for Home Storage 7

Preparing and Storing Wheat 8

Home-Stored Grain Insect Control 9

Answers to Frequently Asked Questions 10

(Originally published as Utah State University Extension Publication EC 371; original circular authored by D. R. McAllister and R. S. Roberts; revised July 1989 and June 1995.)

Utah State University is an Equal Opportunity/Affirmative Action Institution
Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert L. Gilliland, Vice President and Director, Cooperative Extension Service, Utah State University. (EP/06-95/DF)

TYPES OF WHEAT

There are several species of cultivated wheat and numerous wild grasses that are closely related to wheat. To aid in plant characterization and marketing, wheat has been separated into several commercial classes based on color, hardness of the kernel, and growing season. Some common types of wheat include: hard red spring, hard red winter, soft red winter, soft white spring, and soft white winter. The color of the wheat kernel depends upon the wheat type and may be amber, red, purple, or creamy white. Red and white wheats are the most common in the United States.

The hard wheat classes are produced in areas that have dry-temperate climates. The kernels are usually small, red, have a hard texture, and a strong gluten. Gluten is a substance that gives wheat flour its cohesive strength and allows it to stretch and expand while retaining gases as the fermenting dough expands. Wheat that does not have strong gluten allows gases to escape and makes poor quality bread because the dough cannot rise. Gluten can be purchased and added to poor quality flour in order to produce good/better quality bread.

The white wheat classes are usually produced in areas where winters are relatively mild and there is adequate moisture. White wheat kernels are more plump and larger than red wheat kernels, have a softer texture than hard wheats, but are usually poor in gluten strength.

Hard Red Spring Wheat

Hard red spring wheat is planted during the spring of the year and harvested in the late summer in areas where the winter is too severe to permit the production of winter wheat. Hard red spring wheat has strong gluten and is generally considered to be the standard for bread flour.

Hard Red Winter Wheat

Hard red winter wheat is produced in areas where normal annual rainfall is less than 35 inches and the winter precipitation can be used to help produce the crop. Hard red winter wheat varieties are excellent for bread flour.

Soft Red Winter Wheat

Soft red winter wheat has the same kernel color as the hard red wheats but is softer in texture and lower in protein. The soft red winter wheat class is not good for bread flour unless it is blended with hard red wheat flour and is generally used for cake, biscuit, cracker, and pastry flours.

Soft White Spring Wheat

Soft white spring wheat is seeded in the spring and harvested in the late summer. It has poor gluten qualities, makes poor bread, and is used for pastry flours and breakfast foods.

Soft White Winter Wheat

Soft white winter wheat is planted in the fall and harvested the following summer. Soft white winter wheat generally yields significantly more than soft white spring wheat. The grain is used in cakes, pastries, cookies, crackers, and breakfast foods in much the same way as soft white spring wheat.

SELECTION OF WHEAT

Red Wheat Varieties

Hard red wheat varieties grown in Utah and other states are desirable for home storage and bread making. Some of the spring-planted and fall-planted hard red wheat varieties commonly grown in the Intermountain States are listed below.

Spring-planted varieties

1. Bannock
2. Borah
3. Fremont
4. McKay
5. Pondera
6. Rick
7. Vandal
8. WB 936

Fall-planted varieties

1. Bonneville
2. Garland
3. Hansel
4. Manning
5. Promontory
6. Ute
7. Weston

Soft White Wheat Varieties

White wheats may be stored in the home for use in pasta, pastries, cookies, crackers, and breakfast cereal. The protein content of white wheat is commonly lower (9-12 percent) than hard red wheats (11-15 percent). Bliss, Centennial, Fieldwin, Owens, Penewawa, Treasure, and Whitebird are common spring-planted soft white wheat varieties. Daws, Hill-81, Lewjain, Nugaines, and Stephens are fall-planted soft white wheats frequently grown in Utah and other western states. The triticales (wheat-rye crosses) are not widely grown in Utah and are not recommended for home storage.

Hard White Wheat Varieties

Recently some new varieties, considered in a new category known as hard white wheat, have been developed. They are suitable for making bread and some people feel that these grains are more acceptable in whole wheat bread than red wheats. Most hard white wheats are spring planted, but some new varieties of hard white winter wheats are being developed. Golden 86 and Klasic are two varieties of hard white spring wheats that may be commercially available.

WHEAT QUALITY

Kernel Description

A plump, well developed kernel of wheat, free of contaminants and other crop seeds is most easily stored and processed. A pound of wheat can contain 8,000 to 24,000 kernels depending upon kernel size and density. Shriveled and shrunken wheat kernels may be the result of adverse weather conditions during a critical stage of grain development and will definitely influence the number of kernels per pound of grain. The legal test weight of a bushel of wheat is 60 pounds; however, the weight of a bushel can vary from a high of about 67 pounds to a low of 40 pounds, depending upon individual kernel size and weight. A low test weight, for example, usually implies small, poorly developed kernels that often have a high protein but a low gluten content.

Protein Content

Hard red wheats produced in Utah usually contain from 11 to 15 percent protein. A protein content of 12 percent and above is most desirable. Wheats with a protein content greater than 12 percent may be available nationally at higher prices, plus freight, but are not necessary to make quality bread or cereal. Shriveled wheat, due to drought or frost, may have an abnormally high protein content, but may make poor bread because of lower gluten content. Wheat with an unusually high protein content may be of interest in the international wheat market where the wheat may be used as an important source of protein for human consumption.

For protein analysis of wheat, submit a one cup (8 ounces) sample to:

Utah State University Analytical Laboratory
Utah State University
Logan, UT 84322-4830

or

Utah Department of Agriculture
Grain Inspection
P.O. Box 1519
128 17th Street
Ogden, UT 84402

Hard red wheats with a high percentage of yellow berry usually have a lower protein content than more desirable dark, hard (flinty and unyielding) vitreous (resembling glass in brittleness) wheat. Yellow berry is defined as the presence of chalky, yellow kernels, or portions of kernels, in a normally flinty wheat. Yellow berry is not harmful and the occurrence of some yellow kernels in a “lot” of seed is not objectionable.

Mixtures of hard and soft wheats are not objectionable, provided the mixture suits individual needs. Mixtures may be more difficult to mill than hard or soft wheat milled separately. In mixtures, the presence of a soft wheat will lower the protein content of the final product.

Contaminants in Wheat

Wheat may be purchased:

Field-run from the producer—harvested with a combine and sold shortly thereafter,

Field-run from storage—harvested with a combine and stored commercially or on a farm for some time before being sold,

Pre-cleaned—harvested with a combine and then cleaned by passing through screens, sieves, or fans to remove chaff and foreign material and stored in bulk, or

Pre-cleaned and pre-packaged—harvested with a combine and then cleaned by passing through screens, sieves, or fans before being packaged in bags or other containers for sale.

Each category of wheat has advantages and disadvantages, but the price will normally increase with each additional handling or processing. Pre-cleaned wheat is usually free of most contaminants, while field-run wheat requires more work prior to storage.

Contaminants commonly found in wheat may include any or all of the following: (1) smut balls, (2) ergot bodies, (3) mouse droppings, (4) chaff, (5) weed seeds, (6) dirt and rocks, (7) insect parts, and (8) other crops.

1. Smut balls—Wheat plants infected with smut fungi produce smut balls in the head instead of healthy kernels. Fully developed smut balls are approximately the same size and weight as wheat kernels and are difficult to completely remove from wheat by either screening or fanning. The ball consists of the seed coat of a wheat kernel with the internal parts replaced by millions of black smut spores. The spores are not dangerous to health but discolor flour when the grain is milled. Smut balls can be easily crushed between the fingers. When present in considerable quantity, the spores impart a fish-like odor to the wheat and greatly reduce the market value.

2. Ergot bodies—Ergot is a fungal disease which affects only the flowering parts of many members of the grass family. Ergot bodies are hard, spurlike, purplish-black structures that replace the kernel on the grain head. These bodies vary in size and may be the length of a wheat kernel or as much as several times that length. They are not easily crushed; however, when fractured, the inner broken faces are off-white, yellow, or tan.

These fungal bodies contain alkaloids that can cause poisoning in humans if they are present in the grain when it is converted to flour. When taken in large dosages, the ergot alkaloids cause constriction of blood vessels in the limbs or extremities. The effects of ergot poisoning are cumulative and lead to numbness of the appendages, shrinkage, and finally dropping off. Ergot bodies are very rarely found in wheat, but are more commonly found in some lots of rye.

3. Mouse droppings—Mouse droppings are black and may resemble ergot bodies. However, when broken the interior is black and does not resemble the lighter color of ergot bodies. Droppings are of various shapes and sizes but are often roughly cylindrical. They are not poisonous but are difficult “to stomach” once they have been identified. Droppings are usually found in wheat which has been stored for some time.

4. Chaff—Chaff consists of broken wheat, plant parts, and the glumes (papery bracts) which enclose the kernels. Chaff pieces are usually easy to remove by fanning and/or screening except where the kernels are enclosed by the glumes.

5. Weed seeds—A large number of weeds may grow in wheat fields and many of their seeds may be found in field-run wheat. If the weed seeds are approximately the same size and weight as wheat kernels, they may be present in wheat that has previously been screened or fanned.

6. Dirt and rocks—Pieces of dirt and broken rocks may be found in wheat, particularly when grown on rough, uneven, or rocky ground. Dirt and rocks are most commonly found in field-run wheat.

7. Insect parts—Fragments of insects, such as grasshopper legs and body parts may be included in field-run wheat. These parts are light in weight and are easily fanned out of contaminated wheat seed.

8. Other crops—It is not uncommon to find kernels of barley in wheat. Due to their enclosure in rough glumes and different milling qualities, barley kernels are undesirable.

Rye frequently grows as a weed in fall-sown wheat fields and some kernels of rye may be included in the harvested wheat. Rye kernels are commonly bluish-grey in color, somewhat more slender than wheat kernels, and are pointed on one end and blunt on the other. Rye varies considerably in color and some kernels may be the same color as wheat kernels. Because rye kernels are approximately the same size and weight as wheat kernels, they are difficult to remove from wheat. Rye imparts an undesirable color and flavor to wheat flour and most millers discount or reject rye-infested wheat for milling purposes. Rye is not a health hazard.

The grain from rye plants frequently contains approximately one percent less protein than wheat. Rye bread in the United States constitutes a relatively small percentage of the U.S. bread market and usually contains at least 25-50 percent wheat flour. The wheat flour provides the gluten which retains the yeast fermentation gases and permits the dough to rise.

MOISTURE AND TEMPERATURE LEVELS FOR HOME STORAGE

The moisture content of the grain to be stored and the temperature of the storage facility greatly influence the effective storage life of grains. Although storage conditions may vary, depending upon the type of grain stored, some general principles can be used as guidelines.

Storage Moisture Level—Grains (barley, corn, millets, oats, rice, rye, sorghum, triticale, and wheat) containing 12 percent moisture or less and pulses (beans, broadbeans, chickpeas, lentils, and dry peas) plus soybeans containing 10 percent moisture or less can be safely stored for food purposes indefinitely. The ability of stored seeds to germinate will decline with time but food value is only slightly reduced. The grain must be protected from insects, rodents, and external moisture to be effectively stored for a long period.

A high moisture content (greater than 12%) in grain causes damage because it promotes diseases. The outer layer of each kernel of grain may bear several thousand spores of fungi and bacteria which are inactive at low moisture levels. At 13½ to 15 percent moisture some fungal spores grow, while other species of fungi require 16 to 23 percent moisture in stored grain before they can grow. Aerobic (oxygen requiring) bacteria require 20 percent moisture for multiplication. When grain is stored at high moisture levels, the combined respiration of the grain, the fungi, and the bacteria release heat and water vapor which stimulates additional microbial activity. This results in spoiled grain unfit for use and could cause fire if the heat generated by respiration reaches the level sufficient to cause combustion.

To determine the moisture content of grain at home, place 20 ounces of grain (taken from the middle of the bag or bin) in a large baking dish so the grain does not exceed 1 inch in depth. Heat in oven at 180º F for 2 hours with occasional stirring. Reweigh when cool. A 1

ounce loss in weight indicates roughly 5 percent moisture, 2 ounces = 10 percent, 3 ounces = 15 percent, etc.

Storage Temperature—Storage at 40-60º F is optimal for most home stored grains but is usually impractical in most homes except during winter months. Freezing or sub-zero temperatures do not damage stored grains or pulses. Storage at temperatures above 60º F causes a more rapid decline in seed viability (ability to germinate) but only a slightly faster loss in food value. All nuts (including peanuts) and ground, whole wheat ***flour*** should be refrigerated in closed containers to prevent the development of off flavors and rancidity.

PREPARING AND STORING WHEAT

Commercial Cleaning—Commercially cleaned wheat is excellent for home storage but is not always completely free of contaminants. Precleaned and bagged wheat should be stored "as is" in a cool and dry location until ready for use.

Home Cleaning—Wheat may be cleaned by "fanning" when contaminants are lighter weight than the wheat. Drop the wheat slowly through the air stream of a home fan into a clean, high-sided box, bucket, or garbage can. The high sides reduce the amount of bouncing out that occurs when the grain hits the bottom of the container. Fanning will remove most of the broken kernels, chaff, smut balls, small wheat kernels, etc. If too much good wheat is blown out with the contaminants, select a lower fan setting or move the fan a greater distance from the falling wheat. The wheat may be fanned as many times as necessary to obtain clean grain.

After fanning, "hand picking" will remove the remaining contaminants. "Sieving" or "screening" is also effective for cleaning fanned wheat and is much less time consuming than hand picking if a large volume of wheat must be cleaned. Sieve the fanned wheat through a "wheat scalper" sieve having round perforations measuring 3/16 inch in diameter onto a "large chess" sieve with slot perforations that measure 4½/64 inches wide by ½ inch long. The sieved wheat should fall into a bottom pan designed to fit the sieves or into a high-sided box, bucket, or garbage can.

Do not wash wheat prior to storage. After washing or rinsing, dry wheat immediately in the oven and grind. A conventional oven will effectively dry wet wheat if the grain is placed no deeper than ½ to 1 inch and is maintained at 150º F for ½ hour. Stir occasionally to facilitate drying.

The use of a microwave oven for drying is not recommended. Attempts to speed the drying process by increasing the heat in the conventional oven frequently lead to scorched wheat with a distinct "off taste" in the flour.

Home Storage—Regardless of the type of storage container selected, grain should be stored in materials approved for food storage. Many plastic bags, some plastic buckets or cans, some metal buckets or cans are suitable for storage of dry grain. However, some plastic materials have an odor that can be transferred to the wheat stored in them. Some metal containers are lined with plastic that can also impart an odor or flavor to the wheat. Plastic garbage bags are not suitable for food storage unless the label on the container so specifies.

Wheat that is stored in 10-15 pound bags is easy to manipulate, facilitates rotation, allows easy inspection of the grain, and compartmen-talizes the grain so contamination of one lot does not expose large quantities of stored grain to contamination. Clear polyethylene bags, 8 x 4 x 21 inches and 2.0 mil allow for suitable storage.

Place 10-15 pounds of fanned and picked wheat in a clear plastic food storage bag, exhaust as much air as possible and close with a twist tie. Place the tied bag into a second,

similar bag, exhaust the air and tie. Colored bags, or bags with a colored design, are suitable for storage but make it difficult to inspect for weevil and other pests.

After the cleaned wheat is double bagged, place bags in an approved clean metal or plastic container and cover to exclude rodents, insects, and moisture. Mice will not usually eat through heavy plastic buckets but they will eat through plastic bags if the bags are not protected. Containers should have a tight lid, preferably air-tight, but it is not necessary to vacuum pack the wheat inside the container. Metal containers should be placed on wooden slats or shelves to prevent moisture accumulation on the bottom as frequently occurs when stored on a cement floor.

On monthly intervals, for a period of 3 months, each bag should be inspected. If weevil activity is seen in some bags, contaminated lots may be recleaned and used immediately, treated for the control of grain insects, or discarded.

HOME-STORED GRAIN INSECT CONTROL

Insecticides (insect killing chemicals) that will effectively control stored-grain pests are registered by the Environmental Protection Agency (EPA). However, most of these pesticides are fumigants (gas producing) and are “restricted use pesticides” that are highly toxic, can be dangerous, and can only be purchased and used by certified and licensed applicators. In almost every case, home storage does not represent a significant enough market to interest commercial fumigators; therefore, acceptable alternatives need to be considered.

Some alternatives to commercial fumigation include heating, freezing, vacuum sealing, and compressed gases. While all methods are effective, only limited quantities of wheat can be handled at one time. In small samples of grain (1-10 pounds), insects can be effectively controlled by oven heating at 130-140° F for ½ to 1 hour.

When heating wheat there is a delicate balance between adequate heat and too much heat. This balance is difficult to maintain, which renders this method almost impractical for the homeowner with any volume of grain to treat.

To control insects by freezing, 1-15 pounds of grain should be placed in a medium to heavy plastic bag or double bagged and stored in a freezer for 2-3 days. Eggs of insect pests, if present, will not be affected by freezing. After removing the bag from the freezer, leave it in a warm room for 24 hours to permit drying of condensation that will occur on the outside surface of the bag. Freezing requires a warm-up period between each freeze cycle and is a very time-consuming and laborious practice even when a freezer of adequate size is available. Multiple freeze cycles are required until no further insect activity is observed in the sample.

Vacuum sealing, where the atmospheric air is removed prior to sealing the container, is effective but usually impractical for the homeowner. Compressed gases, such as carbon dioxide and nitrogen, effectively control insects when they replace the oxygen within the container. Gases are not registered by the EPA for such uses and in most cases are not available to the homeowner in a quantity or container that is manageable.

The single most effective recommendation for acceptable long-term wheat storage is to start with clean wheat placed in clean containers. Earlier descriptions of storage in plastic bags assumes the grain to be uninfested with stored grain insects and stored in an insect-free container that is not easily contaminated.

Clean grain stored in clean containers is most likely to be acceptable for use without later sanitation efforts. Insect infested grain can be successfully fumigated to kill the insect pests, but the cocoons, pupal cases, insect bodies, fecal material, and off colors, odors, and flavors caused by the insects remain after fumigation.

Dry Ice Fumigation—When storing grain that is suspected of being contaminated with insects or when storing bulk grain (for example, loose grain placed in 5-gallon plastic buckets) treatment with dry ice may improve storage life of the grain. Dry ice is not the most effective fumigant for controlling pests in stored grain, but if used carefully, it is a safe technique for home use.

To fumigate wheat stored in 5-gallon containers, spread approximately 2 ounces of crushed dry ice on 3 to 4 inches of grain in the bottom of the container. After the ice is added, fill the container to the desired depth with cleaned grain. If larger quantities of grain are fumigated with dry ice, use ½ pound of dry ice for each 100 pounds of grain or 1 pound of dry ice for each 30 gallons (approximately 200 pounds) of stored grain.

The fumes from the vaporizing dry ice are carbon dioxide and are heavier than air and readily replace the existing air in the container. Allow approximately 30 minutes (time varies depending upon temperature) for the dry ice to vaporize (evaporate) before placing the lid tightly on the container. It is acceptable to place the lid ajar over the container during the 30 minute evaporation phase.

After the oxygen in the container has been replaced by the carbon dioxide from the vaporizing dry ice, the lid should be placed firmly on the container to eliminate any further exchange of gases within the container. The lid to the container must fit air-tight if this system is to remain effective. The dry ice replaces atmospheric air with carbon dioxide to inhibit insect growth and development.

Dry ice will control most adult and larval insects present, but usually will not destroy eggs or pupae. When a high level of carbon dioxide is maintained for a long period of time in the container some eggs and pupae may be killed.

When practical, the addition of dry ice to a container should be made in a dry atmosphere to reduce the condensation of moisture in the bottom of the container.

If properly applied, a single treatment with dry ice is sufficient for long-term storage. Annual dry ice treatments are not necessary unless an infestation is recognized in the stored grain. Use gloves when handling dry ice. Treating grain with dry ice does not reduce its ability to sprout or its food value.

ANSWERS TO FREQUENTLY ASKED QUESTIONS

Question: How do weevils get into my stored grain?

Answer: Weevils do not exist as a contaminant in wheat as it is harvested in the field. Grain may become infested with weevils during exposure to contaminated equipment such as combines, trucks, railroad cars or in an elevator, mill, or granary, and many times in the home.

Question: Can I add bay leaves or salt to my stored grain to protect it from insects?

Answer: The addition of bay leaves, chewing gum (mint flavored or otherwise), 10-penny nails, or salt will not prevent contamination of grain by insects. The inclusion of many of these items and a host of others has been construed as preventing stored grain insect contamination when, in many cases, the product was never exposed to stored grain insects and thus would have remained insect-free regardless of the treatment.

Question: Can flour be stored like unmilled wheat?

Answer: Flour cannot be stored as long as wheat and should never be stored near apples, onions, potatoes, etc., as they will cause the flour to have an odor or flavor.

Whole wheat or white flour stored for more than 5 years results in off flavored bread and reduced loaf volume. Whole grain wheat stored for 23 years and then milled yielded

excellent loaf volume and flavor. Whole wheat flour includes the wheat germ and cannot be stored as long as white flour without developing a rancid taste.

Question: What kind of containers can be safely used for grain storage?

Answer: Unbagged grain should be stored only in containers identified on the label as acceptable for food storage. Dry wheat purchased in plastic food bags and stored in the bags in galvanized cans is unlikely to present a hazard to safety from the chemicals used in the galvanizing process.

Question: Is it safe to use wheat that has been chemically treated to improve storage life?

Answer: Wheat that is chemically treated to improve storage life may or may not be harmful, depending upon the nature of the treatment. Treated wheat should not be eaten in any form until the chemical treatment has been identified and the safety verified by the manufacturer or the Environmental Protection Agency (EPA).

Question: Is it safe to use chemically treated seed wheat for home storage?

Answer: Do not store or use treated seed wheat. The materials used to treat seed wheat are poisonous and are designed to kill pests that attack wheat plants during germination.

Question: Should I wash my wheat prior to storage?

Answer: Normally, washing and oven drying are practices that occur immediately prior to milling. Washed wheat can be stored safely if it is dried to 10 percent moisture, or less, before bagging.

Question: Will weevils infest wheat that is stored at a very low moisture content?

Answer: It has been reported that wheat containing less than 10 percent moisture will not harbor weevils. This is not correct. Low moisture content in wheat may slow the rate of weevil increase and thus appear to resolve the problem, but it may also extend the time interval during which the insect exists in any one of its stages of life and, therefore, simply delay the problem.

ROTATE YOUR SUPPLY OF WHEAT; DO NOT ATTEMPT TO STORE THE SAME GRAIN INDEFINITELY. Develop a program to utilize stored wheat on a systematic basis. As stored wheat is used, replace it with containers of new wheat. Identify each container for market grade or variety and storage date.

References

Brennand, C., and D. Hendricks. 1988. “Food Storage in the Home.” USU Extension Circular 257, Logan, Utah. 16 p.

Cuperus, G. (coordinator). 1989. Wheat Pest Management, a Guide to Profitable and Environmentally Sound Production. Extension Service/United States Department of Agriculture, The Wheat Industry Resource Committee, and The National Association of Wheat Growers Foundation. 59 p.

Hilfliger, E. (editor). 1980. Wheat-documenta: CIBA-GEIGY, Technical Monograph. CIBA-GEIGY Ltd., Basle, Switzerland. 95 p.

Martin, J. H., W. H. Leonard, and D. L. Stamp. 1976. Principles of Field Crop Production, 3rd edition. Macmillan Publishing Company, Inc., New York. 1118 p.