Core Course 8

UNIT 2 TECHNOLOGY OF CEREALS AND MILLETS

Introduction:

Throughout the world, there is a great variety of types and amounts of grain products that are consumed by individuals. The *nutritional* importance of grains has a foundation of a good diet. Cereals form the staple food of the human race. In India wheat, rice, maize (corn), oats, sorghum (jowar), ragi and bajra are the common cereals and millets used. Cereals are an important and economic source of energy. Hundred grams of cereals supply 340kcals of energy. Cereals are also a significant source of proteins (8–11%). Millets are hardy plants capable of growing where most other grain cereals would fail. They are mostly grown in areas with low rainfall, poor irrigation facilities and low fertility. These are well suited for "dry farming". In this chapter, the variety of cereals and millets milling and byproducts are presented.

Thorough study of this unit you will be able to understand milling aspects, byproducts and uses of the following cereals and millets

- ✓ Corn
- ✓ Barley
- ✓ Oats
- ✓ Sorghum and millets
- ✓ Rye and triticale

1. Corn

Maize (*Zea mays*), known as "corn", is utilised in more diversified ways than any other cereal. With its high percentage of carbohydrate, lipid and protein, it is nutritious for human consumption. A high percentage of maize grown in developing countries is used for food. In developed countries, maize is used as an animal feed. Maize is also used for the manufacture of starch, sugar (corn sugar, dextrin), syrup (corn syrup) and industrial alcoholic beverages.

1.1 Milling

Maize is milled by a dry or wet process. In both processes, the germ is separated from the grain in order to extract and recover germ oil. After degermination,

the dry milling employs roller mills and the process is somewhat similar to wheat milling. Wet milling involves a steeping stage and complete disintegration of the endosperm in order to recover starch and protein.

1.1.1. Dry Milling:

In dry milling, the grains are cleaned and conditioned by addition of cold/hot water/steam, which results in the loosening of and toughening of the germ and bran. The endosperm is moistened to an ideal moisture content such that the yield of grits is maximum. The conditioned grain is passed through a suitable machine to separate bran and germ. The stock after degermination is dried to 15-50% moisture content and then sifted to produce a number of fractions. The large, medium and finer fractions (hominy) are finished grits, meal (corn meal is a product somewhat smaller than grits, but still much coarser than corn flour) and flour are sifted. The yield of products in dry maize milling is as follows: grits-40; coarse meal-20; fine meal-10’ flour-5; germ-14 and hominy feed-11%.

1.1.2. Wet Milling:

In wet milling, maize is milled to obtain starch, oil, cattle feed and the products of starch hydrolysis, viz, liquid and solid glucose and syrup. The first step in wet milling is steeping. The cleaned maize is steeped for 48 hours in warm water (50°C) containing sulphur dioxide. Steeping in water softens the kernel and assists separation of the hull, germ and fibre from each other. After steeping, the steeped water is drained off, and the maize is coarsely ground in degerminating mills to free the germ from the grain. Then the ground material flows down separating troughs in which hulls and grits settle, while the germ overflows. The germ is then separated, dried and oil extracted by hydraulic pressing or by using a solvent. The degerminated material in the separating troughs is then finely ground in a bhur or attrition mill. The hulls and fiber, which are not reduced so much in size, can then be separated from the protein and starch by sieving. The suspensions of starch and protein from wet screening is adjusted to a specific gravity of 1.04 by dewatering over string filters and the starch is separated from the protein by continuous centrifugation. Finally, the starch is filtered and dried. The protein in the steep water is recovered by vacuum evaporation and dried as “gluten feed” for animal feeding.

1.2. Corn flour:

First, dried maize is soaked in a solution of water with lime, often with ashes mixed in. The grain is then cooked, steeped, drained, and rinsed multiple times. The grain is then ground to make a wet dough from which tortillas are formed or allowed to dry into flour.

1.3. Flaked maize cereal (Corn flakes):

Corn flake is a ready-to-eat breakfast cereal that only requires the addition of milk. The basic objective in making flaked cereals is to obtain grain grits from the whole grain that would each produce a flake.

2. Barley:

Barley is one of the world's oldest cultivated cereals. It was used as a bread grain in early times. Nowadays, barley is extensively used as food, cattle feed and for malting and brewing. Barley is by far the most important cereal grain for malting because of its specific physical and chemical properties.

2.1. Milling:

Barley is milled to make blocked barley, pearl barley, barley graots (grits), barley flakes and barley flour. The sequence of operations is as follows.

Barley is cleaned and conditioned, *i.e.*, its moisture content is adjusted by drying or damping. The conditioned barley is next subjected to blocking (shelling) and pearling (rounding). Both blocking and pearling are abrasive processed differing in degree of the removal of the superficial layers of the grain. Blocking removes part of the husk, and pearling the remainder of the husk and part of the endosperm. Aspiration of the blocked or pearled grain removes the abraded portions. The grain is then cut into portions known as grits. The grits are graded by size and then rounded in a pearling machine and polished.

Pearl barley has had the bran removed and has been steamed and polished. It comes in three sizes-coarse, medium and fine-and can be used as an ingredient in soups, stews and salads. While pearl barley is much more tender and quicker to cook than the whole grain variety, it is also slightly lower in nutrients.

Barley flakes are made from pearl barley by steaming and flaking on a smooth large diameter roller.

Pearl or blocked barley is converted to **barley flour** in roller mills. Barley flour can also be milled from whole barley. The flour is also a byproduct of the cutting, pearling and polishing processes.

3. Oats

Oat is an important cereal crop fed to animals such as horses and sheep and also used by humans. It is valued for its high protein content. It is an important cereal crop which be used as oatmeal, bran, flakes in breakfast cereals. It appears as white covered coat.

3.1. Milling:

The processing of oats in mills is different from that of wheat because of the difference in the structure and composition between two cereals. In milling, cleaned oats are subjected to klin-drying to inactivate lipase. This process is known as stabilization. Stabilization also reduces moisture content and facilitates the subsequent shelling of the oats. The klin-dried oats are then shelled resulting in the splitting off the husk. The shelled graots are then polished and after removal of **oat dust**, they are transversely cut so that each kernel gives about four to five pieces (pinhead meal). This is subjected to further grinding when **oatmeal** is obtained.

Oat flour is the milled, flour product from hulled oats and is used in baked products, granola bars and ready-to-eat breakfast cereals. It is especially valuable in infant foods due to the high nutritional value and low allergenicity and pleasant flavour. It is widely uses as one of the first solid foods introduced to babies or as thickener in various commercial infant products.

Oat flakes or rolled oats are manufactures from pinhead meal (or from whole uncut groats) by cooking the pinhead meal in a steamer, rolling the cooked product while hot, moist and plastic, between heavy rollers and drying the flakes so formed.

4. Sorghum and Millets

Millet is the general name for small seed grass crops. The crops are harvested for food or animal feed. Apart from maize and sorghum, the major millet crops of

India are pearl millet (*Pennisetum* typhoideum) called **bajra** and finger millet (*Eleusine* coracanca) known as **ragi**. A number of other minor millets are grown and they are; the proso (the most common), foxtail, and kodo. Millet is related to sorghum. Sorghum is a special type of millet with large seeds.

4.1. Sorghum:

Sorghum grain is known as **jowar** and constitutes an important article of food, after rice and wheat. The whole grain or broken grain may be cooked like rice or the whole grain ground to flour and used to make chapathis. In Africa, sorghum is used as food in various forms as porridge, gruel, and parched, popped or malted grain. From a blend of wheat flour, baked products like muffins, bread and cakes can be produced. In advanced countries, the grin is used chiefly as an animal feed. Sorghum grain is used as a source of starch in the fermentation industry for producing industrial alcohol and solvents.

4.1.1. Milling:

Sorghum grains are processed by dry milling and wet milling. The products of milling are chiefly starch and feed products. However, very few processed products of sorghum are commercially produced. Dry milling is used to obtain products low in fibre, fat and ash, and wet milling to make starch and its derivatives. The residue from wet milling is used as a feed.

4.1.1.1. Dry milling

The dry milling process starts with the cleaning of grains. The cleaned grain is conditioned, by addition of water, to soften the endosperm, and milled by the conventional roller mills to separate endosperm, germ and bran from each other. The endosperm is recovered in the form of grits, with the minimum production of flour. yields of various fractions from the dry milling process are grit-76.7, bran-1.2, germ-11, fibre-10%. Bran and germ are further processed, as in the case of maize, by dry milling for the preparation of oils and feeds.

4.1.1.2. Wet milling

Wet milling of sorghum is carried out by methods similar to that of maize wet milling. However, the milling of sorghum is more difficult than that of maize because

of the small size and spherical shape of the sorghum kernel and the dense high-protein peripheral endosperm layer. Manufacture of starch is the main purpose of wet milling. However, some of the pigments of the pericarp and subcoat of the grain leach out and stain the starch.

4.2. Millets:

Pearl millet is a native of Africa and is successfully cultivated in India. The processing of this millet for industrial purposes has not yet been developed. More commonly, it is ground into flour and made into chapathies. It is also made into thin porridge. The grain is sometimes eaten after it is parched, the product being similar to popcorn. The grain is suitable for the preparation of malt.

Finger millet is so called because of the ear (head of grain) consists of five spikes which radiate, sometimes in a curving manner, from a central point, rather as the fingers attached to the palm of the hand. Finger millet or ragi is another important millet cultivated in India. Ragi can be milled by wet conditioning. It can be steamed followed by milling in a hammer or plate mill or a roller flourmill. Ragi is usually converted into flour and a variety of preparation like ragi balls, chapathi, dosa and porridge. The grain is also malted and the flour of the malted grain is used as a nourishing food for infants and geriatrics. Malted ragi flour is called ragi malt, and is used in the preparation of milk beverages. A fermented drink or beer is also prepared from the grain in some parts of the country.

5. Rye and Triticale:

Rye is richer in lysine than wheat but has a relatively low gluten-forming potential, and therefore, does not contribute as good a structure to dough as does wheat. It frequently is used in combination with wheat flour in breads and quick breads and is made into crackers. There are three types of rye—dark, medium, and light—often baked into bread. Rye may be sprouted, producing malt or malt flour.

Triticale is a *wheat* and *rye* hybrid, first produced in the United States in the late 1800s. Work for the introduction of triticale as a cereal grain in India is being carried out since 1974. As a crop, it offers the disease resistance of wheat and the hardiness of rye. It has more protein than either grain alone, but the overall crop yield is not high, so its use is not widespread. Triticale was developed to have the baking

property of wheat (good gluten-forming potential) and the nutritional quality of rye (high lysine).

5.1. Milling:

The processes of rye milling are similar to wheat milling and comprises of cleaning, conditioning and the milling process proper. The products of rye milling are flour for soft breads, coarse rye meal for hard breads and rye flakes for hot breakfast cereals.

6. Health Benefits of Millets

Being economically feasible and high nutritious diet, millets also comprise other essential health benefits. Its outstanding composition makes it an effective food for the treatment of cancers, anaemia, diabetes, constipation, non-communicable diseases and allergies. Millets contain several nutrients that supports in potential health benefits and thus accepted as functional and nutraceutical food. Few Millets contains high amount of Iron but many non-nutrient components are responsible for decreasing the bio accessibility of iron. By the use of household processing technologies, such as germination and fermentation, the amount of non-nutrient components can be reduced and can support the cure of anaemia. The high fiber content of millets is helpful for those people who are dealing with the problem of obesity and constipation. Millets are good source of fibre and can be used to prepare healthy foods. Millet grains are rich in antioxidants and phenolics so they can contribute to antioxidant activity important in health, aging, and metabolic syndrome. Phenolic compounds have also anticancer property. These compounds are concentrated in the pericarp and testa. Flavonoid, a phenolic compound, helps to inhibit tumor development and reduce the risk of breast cancer. Gluten intolerance, is a physiological and lifelong disorders affecting humans in many areas of the world. Being a gluten free grain, millets are useful for those people who are suffering from celiac disease. Millet diet considerably decreases blood glucose levels. Various millet-based food products have a lower glycemic index than those based on wheat. Low glycemic index of foods are useful because it improves the metabolic control of blood pressure and low density lipo protein cholesterol levels.

7. Conclusion

The nutritional importance of grains has a foundation of a good diet. Cereals form the staple food of the human race. Millets are hardy plants capable of growing where most other grain cereals would fail. In India wheat, rice, maize, oats, sorghum, ragi and bajra are the common cereals and millets consumed. Maize is utilised in more diversified ways than any other cereal. Maize is used for the manufacture of corn flakes, starch, sugar, syrup, industrial alcohol and alcoholic beverages. Maize is milled by both dry or wet process. Barley is by far the most important cereal grain for malting because of its specific physical and chemical properties. Barley is milled to make blocked barley, pearl barley, barley graots, barley flakes and barley flour. Oat is valued for its high protein content. It is an important cereal crop which can be used as oatmeal, bran, flakes in breakfast cereals. Apart from maize and sorghum, the major millet crops of India are pearl millet and finger millet. Sorghum grain are processed by dry milling and wet milling. Pearl millet and finger millets are used in the preparations of chapathies, thin porridge, parched, malted; and like ragi ball, chapathi, dosa and porridge, malted forms respectively. Rye is richer in lysine than wheat but has a relatively low gluten-forming potential. Triticale is a wheat and rye hybrid. The processes of rye milling are similar to wheat milling and the products are flour, coarse rye meal and rye flakes. Being economically feasible and high nutritious diet, millets are having outstanding nutritional composition which makes an effective food for the treatment of cancers, anaemia, diabetes, constipation, non-communicable diseases and allergies. Therefore, Millets are accepted as functional and nutraceutical food.

Table 1: Nutrient Content of Cereals and Millets per 100gms of edible portion

Sl. No	Name of the Cereal/Millet	Moisture (gm)	Protein (gm)	Fat (gm)	Minerals (gm)	Fibre (gm)	Carbohydrates (gm)	Energy (kcal)	Calcium (gm)	Phosphorus (mg)	Iron (mg)	Carotene (µg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)
1.	Corn	14.9	11.1	3.6	1.5	2.7	66.2	342	10	348	2.0	90	0.4	0.10	1.8	0
2.	Barley	12.5	11.5	1.3	1.2	3.9	69.6	336	26	215	3.0	10	0.47	0.20	5.4	0
3.	Oats	10.7	13.6	7.6	1.8	3.5	62.8	374	50	380	3.8	0	0.98	0.16	1.1	0
4.	Sorghum	11.9	10.4	1.9	1.6	1.6	72.6	349	25	222	5.8	47	0.37	0.13	3.1	0
5.	Pearl Millet	12.4	11.6	5.0	2.3	1.2	67.5	361	42	296	5.0	132	0.33	0.25	2.3	0
6.	Finger Millet	13.1	7.3	1.3	2.7	3.6	72.0	328	344	283	6.4	42	0.42	0.19	1.1	0

Source: Gopalan et al. (2014). Nutritive Value of Indian Foods. National Institute of Nutrition, ICMR, Hyderabad.