Core course:8 - Unit 1
TECHNOLOGY OF CEREALS
(PART 2)---WHEAT

by
Dr Vasudeva Singh
Emeritus Medical scientist(ICMR)
DOS in Food Science & Nutrition
University of Mysore,Mysore-570006
Former HOD, Scientist- G (Retd) CSIR-CFTRI-570020

Technology of wheat

Introduction

Wheat is one of the important staple cereal. Its production is around 700 Million Tonnes in World. Our country produces around 90 M T. It contains highest protein. Sorghum, maize, millet and oats all have high fat content than wheat. Brown rice contains high fat content than polished rice. The grains having hulls (barley, millet, oats and rice) show a lower content of soluble carbohydrates, and have higher content of fibre and ash than does wheat. White flour represents the endosperm. Commercial germ represents the embryo. Bran consists of mainly pericarp, seed coats and aleurone layer. However, commercial flour contains small amounts of ground embryo and bran. Commercial germ contains some endosperm and bran. Commercial bran contains small amount of endosperm and embryo. Different parts of the wheat grain is clear from the following figure:

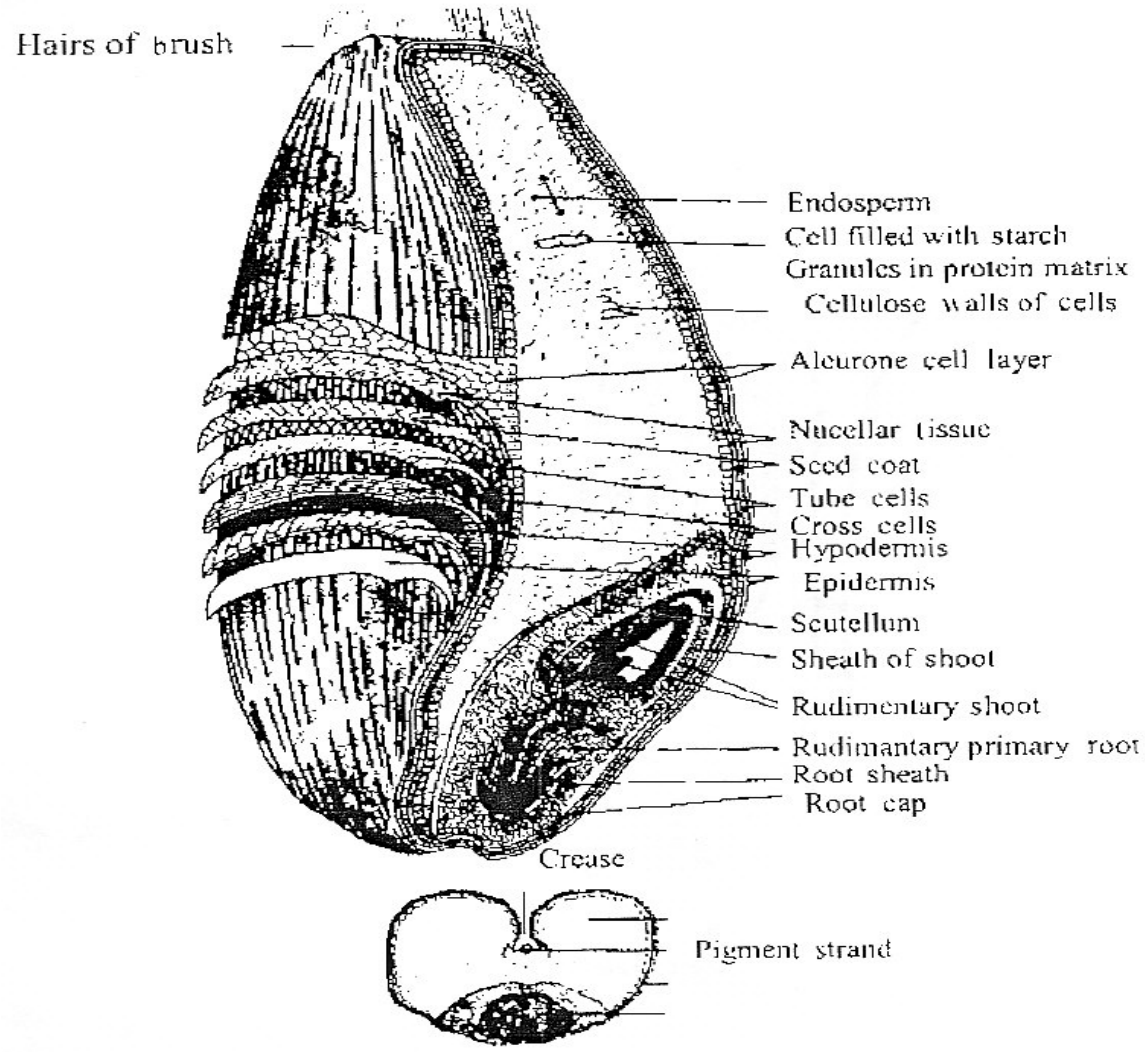

Fig. 1 Diagrammatic illustrations of wheat structure. (From Lasztity, 1999.)

Wheat types and Classes of wheat

Wheat types

There are 17 varieties of wheat consisting of 3 species of wheat *Triticum aestivum, T. Compactum and T. Durum , amino acids were not different in these, almost all were uniform.*

Wheat types may be classified as hard or soft and strong or weak. Hardness and softness are the milling characteristics relating to the way, the endosperm breaks down.

In hard wheat, fragmentation of endosperm tends to occur along the lines of cell boundaries. Whereas the endosperm of soft wheat fractures in random way.

This phenomena suggests a pattern of area of mechanical strength and weakness in hard wheat.

But fairly uniform mechanical weakness in soft wheat.

Hardness is related to the degree of adhesion between the starch granules and surrounding protein. Hard wheat yield coarse, gritty flour, free flowing and easily sifted consists of regular shape particles.

Soft wheat gives very fine flour, consists of irregular shape fragments of endosperm cells with some flattened particles which becomes entangled and adhere together sift with difficulty and tend to clog the apertures of sieves.

The degree of mechanical damage to starch granules produced during milling is greater for hard wheat than for soft wheat.

Hardness effects the ease of detachment of endosperm from the bran. In hard wheat, the endosperm cells comes away more cleanly, whereas in soft wheat the endosperm cells tend to fragment.

Depending upon the degree of hardness, the principle wheat of the world are classified into :-

Extra hard ex: durum, some algerium varieties

ii). Hard varieties- Manitoba, American hard red spring wheat, Australian prime hard

iii). Medium hard – Russian varieties, American Hard seed winter wheat & some European varieties

iv). Soft: American soft red winter wheat, American soft white variety

Strong and weak wheat

Wheats yielding flour which has the ability to produce the bread of large loaf vol, good crumb texture and good keeping qualities generally has high protein content and these types are called as strong wheats.

Whereas the wheat yielding flour from which only a small loaf vol with coarse open crumb texture having low protein content are generally categorized as weak flour / weak wheat. The flour from the weak wheat is ideal for biscuits and cakes

The main types of wheat are classified according to their *baking* strength are as

follows:

1) Strong wheat Ex: CWRS (Canadial Wester Red spring wheat) called as Manitoba.
2) American HR’s, Russian spring type and some Australian varieties.

Medium types: American Hard red winter wheat, some European varieties and some Australian varities.

Weak wheat: American soft red winter wheat, American soft white verities.

*Wheat berry***:** It is a raw, unprocessed wheat kernel containing bran, germ, and endosperm. These kernels double in volume when cooked in water and have a nutty taste, with a chewy but tender texture.

Bulgar wheat **:** Wheat is parboiled (or even roasted**)** and from this is small portion of bran is removed and it is ground into granular meal , with good keeping quality . Parboiling is carried out by boiling wheat with little water and then dried or the grain is soaked and water is removed, tempered for about 2h and then steamed for about 10 min. and afterwards it is dried. Bran is removed by tempering the grain for about 30 min. after sprinkling the water on the wheat grain. Steaming helps in seeping of the nutrients into the endosperm as a result of which these are not lost through bran removal or polishing.

Farina is coarsely ground wheat endosperm. It is used as a breakfast cereal and as a baby food cereal. Cream of wheat is popular commercial farina product.

Peeled whole wheat: The wheat is boiled in alkali partially, such that the wheat is easy to cook.

Wheat malt extract: Wheat is soaked in water, next germinated, afterwards it is dried. This is rubbed in a cloth, the sprouts are removed, and then ground, the flour is named as malt. This malt is used for the preparation of beverages.

Classes of Wheat

Wheat can be divided into 6 classes and thousands of wheat varieties. It is classified according to the time of year it is planted, the hardness of the kernels and the colour of the kernels.

The classes of wheat are 1. Hard red winter 2. Hard red spring 3. Soft red winter 4. Hard white winter 5. Soft white wheat and 6. Durum.

Winter a wheat is planted in the fall and harvested in the spring and summer; spring wheat is planted in the spring and harvested in late summer or early fall. Hard red winter wheat is the dominant wheat grown and used in the United states.

The hard wheats, including durum wheat, are higher in protein and lower in starch than the soft wheats. Therefore, the harder types of wheat especially hard red winter and hard red spring – are used for making bread to provide good structure.

Durum **–** the hardest type of wheat is used to make semolina., the flour used to make pasta products such as spaghetti, macaroni and egg noodles. The soft, low protein types of wheat are used for cakes, biscuits, some noodle products, pastries, and other baked products that require a soft and render crumb .

Following information is about the proximate composition of whole wheat flour and maida viz. wheat flour

1. Proximate composition of whole wheat flour and wheat flour

	Wheat (%)	Wheat flour (%)
Moisture	9-18	13.0 – 15.5
Protein (Nx5.7)	8-15	8.0 – 13.0
Fibre (cellulose)	2.0 – 2.5	trace – 0.2
Fat or oil	1.5 – 2.0	0.8 – 1.5
Ash	1.5 – 2. 0	0.3 – 0.6
Sugars	2- 3	1.5 – 2.0
Starch (difference)	60-68	65 – 70

2. Wheat milling

Wheat is consumed mostly in the form of flour obtained by milling the grain,
while a small quantity is converted into breakfast foods such as wheat flakes and puffed wheat. Indian wheats are hard and the moisture content is usually 8-10%.

Various steps are involved in making the flour. Figure 2-c gives the different steps.

The traditional procedure for milling wheat in India has been stone grinding to obtain whole wheat flour.

In modem milling the wheat is subjected to cleaning to remove various types of impurities together with damaged kernels. Following diagram indicates the various steps involved in making a whole wheat flour.

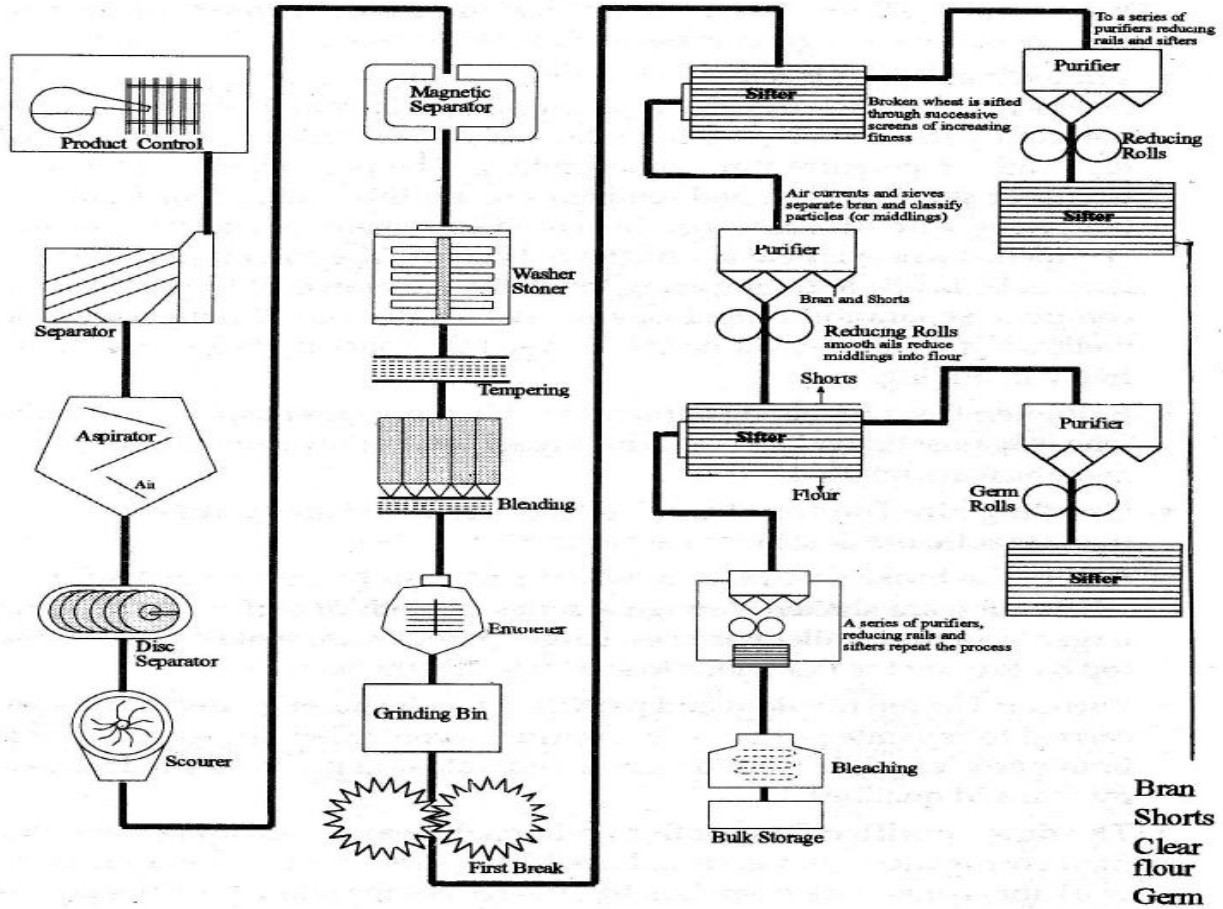

Figure 2-c: Milling of wheat

The process is repeated over and over again. Sifters, purifiers reducing rolls until the maximum amount of flour is separated consisting of at least 72% of wheat.

Following are schematic steps in the milling of Wheat

Vibrating screen → Aspirator → Disc separator → Scourer → Magnetic separation → Tempering → Entoleter → Grinding bin → Sifter → Purifier →

The down purifier

Different forms of wheat products

Milling can be used to produce several different types of flours. Refined white flours from any of the wheat varieties are graded based on the streams of millings included in the final flour product. The highest grade of flour is **short-patent** , which contains refined flour from ~50% of the streams of endosperm, especially the middle portion of the endosperm, and is high in starch and low in protein.

Medium-patent flour includes about 90% of the streams and is higher in protein and lower in starch than short-patent flour. *Long-patent flour* contains nearly all the flour streams and is the highest in protein and lowest in starch.

Whole wheat flour : Ground bran, germ and endosperm all present. It is high in fat and hence sometimes turns rancid under inappropriate storage conditions. It is also high in fiber due to the bran component. It produces baked products that have a denser texture and a lower volume due to the bran and germ's interference with gluten development.

Enriched flour: It is white flour produced from just the endosperm, with the B vitamins thiamin, riboflavin, niacin and folic acid and the mineral iron added based on federal standards.

All purpose flour: It is a flour produced from blend of wheat varieties. It is used to make quick breads. It contains enough protein to make homemade yeast breads and some cakes, but it has too much protein for delicate cakes. It is the most common type of flour sold in the retail market.

Self rising flour: is all purpose flour to which a leavening agent and salt have been added. The leavening agent is baking powder in the form of monocalcium phosphate (an acid salt) combined with sodium bicarbonate (baking soda). One cup of this flour generally contains 1.5 teaspoons of baking powder and 0.5 tsp of salt.

Bread flour : It is long-patent flour produced from a blend of hard wheat varieties. It contains more protein than all purpose flour. Because of higher protein, the loaf volume will be high. Bread flour produces excellent yeast breads and is used by commercial bakers.

Cake flour : It is short-patent flour prepared from finely milled soft wheat varieties. It is a high starch, low protein flour. This flour will produce delicate, fine-textured cakes. Cake flour is usually bleached with chlorine to inhibit gluten development and to allow starch to easily absorb water—desirable characterstics while making cakes.

Similarly there are still different types of wheat flour which finds practical application in baking industry.

Refined flour (Maida): Bran and germ are removed. Very fine texture, bland and easily digested.
Semolina (Suji) : Coarse ground endosperm. Granular in touch

*Amylase rich food (ARF***):** Made from germinated cereal flours. Have high amounts of alpha-amylase enzyme, which cleaves long carbohydrate chains into dextrins and this aids in digestion. It can reduce the dietary bulk of viscous gruels and so it is ideal to feed weaning children with it to provide energy-rich but low viscosity food.

Macoroni products **:** Popular name is pasta. It is made from semolina (prepared from durum wheat) and water, where a stiff dough is prepared. The dough is extruded to get different shapes of macaroni. Durum wheat is amber coloured , with a nut flavor and has a firm texture.

By-products

Gluten is a byproduct of Wheat starch industry. Even we can inform **wheat starch** is a byproduct of wheat industry. Wheat starch is produced from the carbohydrates in wheat endosperm. It is useful thickner, but it does not have the thickening power of corn starch.

The germ component of wheat appears as tiny, crumb like grains. Wheat germ has a nutty taste and is used in hot cereals and breads. It can also be sprinkled over yogurt and salads.

Wheat bran can be used in baking, as an ingredient in meatloaf, and stirred into hot cereals. Bran from all cereals can be used as a fiber supplement.
Following table indicates the proximate composition of germ and bran of wheat in general.

Proximate composition of wheat germ and wheat bran

	Germ	Bran
Moisture	9.0 – 13.0	14.0
Protein (N x 5.7)	22 - 32	15.5
Fibre (cellulose)	1.8 – 2.5	9.6
Fat or oil	6.0 – 11.0	3.5
Mineral matter (ash)	4.0 – 5.0	5.4
Carbohydrates	35.0 – 45.0	52.0

Moisture content varies mainly with different degrees of humidity, where wheats were grown,
Harvested and stored.

In cereals, that too in wheat, starch is the highest and next is protein content. Generally soluble sugars (carbohydrates) and the fibre (cellulose) are somewhat > 2%. While the fat and mineral matter are less than 2 % in whole grain.

The data for flour , germ and bran show clearly that the main chemical constituents of the wheat grain are distributed unevenly in the grain. Practically all of the starch is in the endosperm. The carbohydrates in embryo are mainly soluble sugars. Carbohydrates in husk are cellulose and hemicelluloses. Cellulose is most abundant in the bran and lowest in endosperm. Proteins, fats, nutrient minerals are mostly concentrated in embryo along with its scutellum and least in the endosperm. The bran coats have a higher mineral content than the embryo partly because they have a relatively high content of silicon.

Enrichment of Flour

Nutrients which are lost while milling are added externally. These are Thiamine, riboflavin, niacin and iron. In Great Britain, by law white flour is enriched with thiamine, nicotinic acid and iron, which are to a specified limit. Similarly in US and in Canada, by law the flour is enriched with above mentioned items. Australia, Brazil, Chile and Sweden also follow these. In some countries Vitamin D is added and Ca in the form of Chalk. Calcium is added in U K in the form of Chalk and in Newfoundland both Ca and P are added in the form of bone meal. Discussions are in progress to add some of EAA to the flour.

Chemical additions to the flour

In milling of wheat, in many countries, minute quantity of some chemical substances are added to the flour to improve it in various ways such as ageing (maturing), bleaching or enriching.

Ageing

Bread prepared from fresh milled flour is generally inferior w.r.t loaf volume, texture and colour compared to that prepared from flour stored for several months.

The property of gluten changes while storage as well as the starch property changes during storage where natural ageing or maturing process occurs.

The same effect is now obtained by addition of minute quantity of some chemicals like Potassium bromate in minute quantity. They are known as “Improving agents” which has been proved harmless to the human body. Recently Potassium bromate has been removed from the list of improving agents as it causes cancer, almost every one have removed all over the world this chemical as an improving agent.

By this , the fresh flour is satisfactorily matured in a few hours after the addition of the chemical.

Bleaching

Normal flour is often yellowish and produces yellowish bread, because of the pigment xanthophylls which are present in wheat varieties. Therefore the flour is bleached with minute quantities of bleaching agent such as nitrogen peroxide.

Combined ageing and bleaching

This is achieved by careful addition of nitrogen trichloride (Agene). Quantity should be carefully controlled.

Conclusion

Wheat is an important staple cereal. It is consumed as whole wheat flour as well as wheat maida or wheat flour. Generally wheat flour is used for preparation of bakery products. Germ is an important byproduct of wheat having high amount of fat and protein. Bran is another byproduct which contains high amount of dietary fiber. There are different kinds of flour like short patent, long patent, medium patent flour have some differences in their starch and protein contents. Similarly we have cake flour, bread flour, self rising flour etc. Milling of wheat is an interesting phenomenon. We find various steps of cleaning, removal of stones, magnetic impurities, rollers with various types of grinding. There are different classes of wheat, which informs about red winter wheat, hard wheat , soft wheat, durum wheat, which have different applications in bakery products. Even we find enrichment of flour, where we add different type of minerals, vitamins to enrich the wheat flour. Even sometimes the wheat flour is bleached with some nitrogen compounds in order to bleach the colour or to improve the colour of the wheat flour. Even sometimes the wheat flour is aged by addition of some of the additives like potassium iodate, by which the quality of the bakery products could be improved.