



FOOD CHEMISTRY

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Cereal and Cereal products

proteins, lipids, carbohydrates and vitamins
in cereals flour and their relationship in
dough making

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Generally **cereals** belong => species of the **wild grasses**

Major cereals => wheat, rye, rice, barley, millet and oats

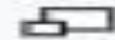
Cereal products => staple foods of mankind

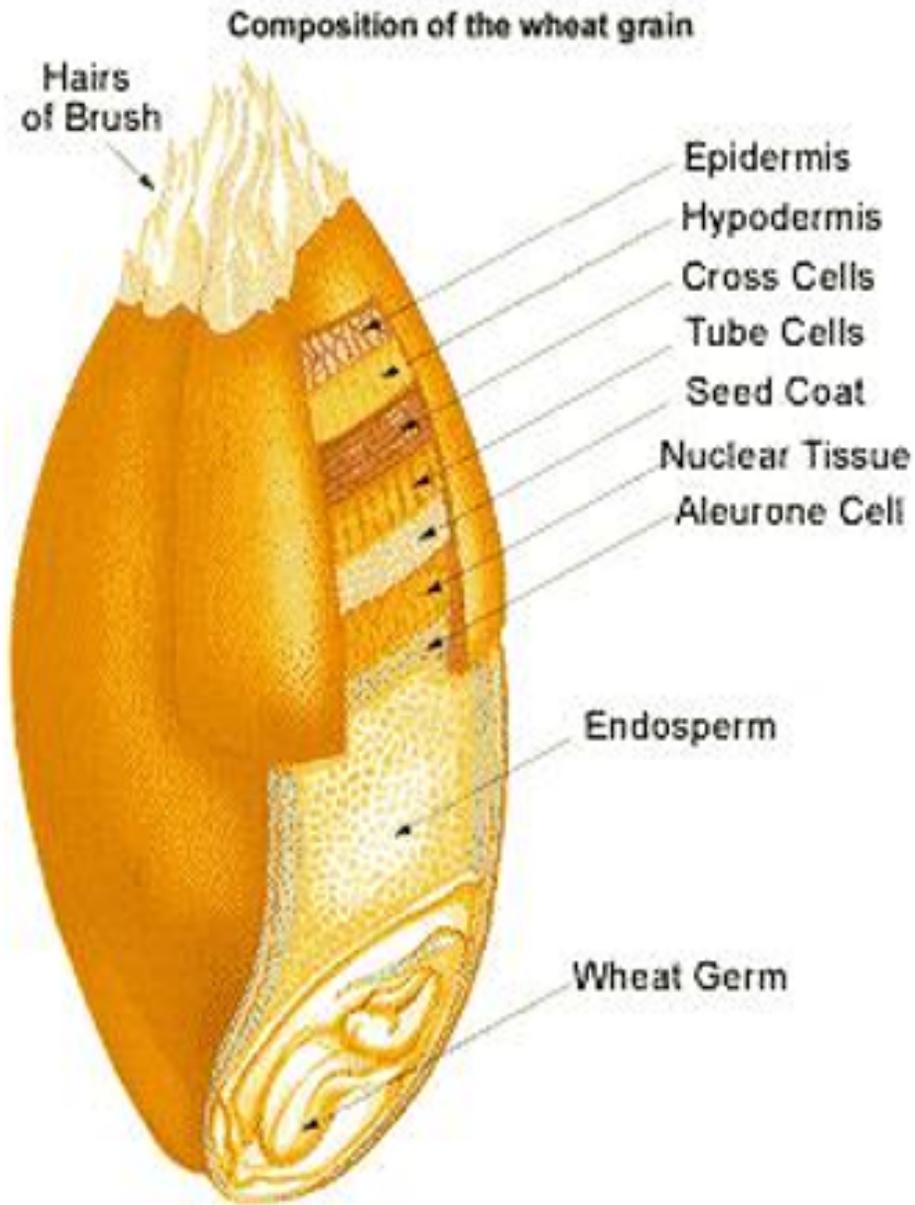
Wheat and rye have a special role since only they are => suitable for **bread-making**

in industrial countries => bread consumption => 50% of the daily requirement of **carbohydrates**, one third of the **proteins** and 50–60% of **vitamin B, minerals and trace elements**



Wheat is used in a wide variety of foods.





There are several layers of bran => protect the seed, and by being partly waterproof, ensure that the seed will not start to grow again immediately after harvest.

At one end of the grain is the germ; that is the young plant that will grow when the grain is put into the soil and given the right conditions of moisture and warmth.

The aim of the miller in making **white flour** is to obtain the greatest possible amount of the whitish interior of the grain, the endosperm (the grain's food supply), with the least possible contamination by bran and germ.

Bran is not wanted mainly because of its' colour and texture.

Germ is not wanted because of its high fat content which reduces the keeping quality.

Structure of Cereal Grains

1. The embryo or germ:

- embryo is small and attached to the base of the seed.
- root and leaf of the new plant are formed.
- rich in lipids and high in total nitrogen and ash.

2. Endosperm:

- makes up the **major portion** of the seed.
- supplies the **sprouting embryo** with **food** in the period before the root and leaf begin to function.
- endosperm cells consist of mainly => **starch** and **proteins**.
- The starch is form of spherical granules embedded in a matrix of protein.
- It is the main source of **white flour** and **semolina**.

3. Bran:

- dark coloured and consists of several layers of fiber.
- layer of cells surrounding the endosperm is known as aleurone.
- In milling the aleurone layer separates with the bran.
- bran has unusually high percent of crude fiber and ash.
- Crude fibre includes => cellulose, hemicelluloses and lignins.

Composition of Cereal Grains

- varies depending on => variety, geographical and other conditions.
- major **compositional features** :
- 80% of the dry matter of cereals => **carbohydrates** => mainly starch and dietary fibers.
- generally contain 10-12% of **protein** (found in all tissues of cereal).
- **Lysine** => low in all cereals.
- **Methionine** => low, particularly in wheat, rice, barely and corn.

- **Lipids** => 1-2% in wheat and rice
- 3% in maize
- 5.7% in oat
- More lipids => present in **germ** and **bran**.
- **Linoleic acid** => predominant fatty acid in cereal lipids.
- About 95% of the **minerals** => **phosphates** and **sulphates** of **potassium** and **magnesium**.
- Cereals => poor sources of **calcium** and **iron**.

- Whole grain cereals => important sources of **B vitamins**
- most of these vitamins are in the **bran** => refining or polishing => grains => **reduces** vitamin B content
- contain => **many enzymes**:
 - amylases,
 - proteases,
 - lipases and
 - oxido-reductases
- importance in **cereal processing**.

Individual constituents of wheat and their importance in baking

Proteins:

- T. B. Osborne (1907) **separated** wheat proteins => solubility => **four fractions** :
- Albumins: as leukosin 14.7 %
- Globulins: as edestein 7.0 %
- Prolamins: as gliadin 32.6 %
- Glutelins : as glutenin 45.7 %

Wheat flour contains **soluble** and **insoluble** protein fractions

soluble proteins => comprise **20%** of total proteins => include **albumins** and **globulins** and certain minor **glycoproteins**.

These proteins => **do not contribute** to **dough** forming properties of wheat flour.

- **insoluble** wheat proteins => **prolamins** and **glutelins** => exist in ratio **2:3**.
- also referred => as **gluten proteins** => major **storage protein** in wheat.
- It is **heterogeneous** mixture of **gliadin** and **glutenin**.
- **Gluten** is formed => when **water flour** mixture is **kneaded** to form dough.
- **Gluten** proteins => responsible => formation of **viscoelastic** dough => capable of **entrapping gas** during **fermentation**

- **Both fractions** of insoluble wheat pr. in hydrated forms have different effect => on **rheological characteristics** of the dough
- **prolamins** => responsible => **viscosity**
- **glutelins** => responsible => **elasticity**
- **gluten proteins** in association with **lipids** => responsible for **cohesive** and **viscoelastic** flour properties of dough => suitable for making **bread** and other **bakery products**
- Gluten consists of **90% of protein**, **8% lipids** and **2% carbohydrates**

Mechanism of Dough and Gluten Formation

- Several physical and chemical transformations take place during **mixing** and **kneading** of \Rightarrow mixture of water and **wheat flour**.
- Under the applied shear and tensile forces \Rightarrow gluten proteins absorb water and **partially unfold** \Rightarrow facilitates **hydrophobic interactions** and **sulphydryl-disulfide interchange reactions** that \Rightarrow result in formation of **thread like polymers**.
- These linear polymers in twin \Rightarrow interact with each other presumably via **hydrogen bonding**, **hydrophobic association** and **disulfide links** \Rightarrow to form **a sheet like film** \Rightarrow capable of **entrapping gas**.
- Therefore **optimum ratio** of **prolamins** and **glutelins** \Rightarrow necessary to form a **visco-elastic dough**

Lipids:

- Cereals => low lipid content
- Germ and bran => higher conc. of fat than other parts
- In wheat kernels,
 - germ and aleurone cells => rich in **triglycerides**
- Endosperm => **phospholipids and glycolipids**

- On an average, the wheat
- **germ** contains => 6 to 11 % of the lipids,
- **bran** => 3 to 5% and
- **endosperm** => 0.8 to 1.5%

- **flour** contains 1.5 to 2.5% lipids depending on **milling extraction rate**.

- flour lipids are **differentiated** by their **solubility**

Non-starch bound lipids => 75% of total lipids of the flour.

starch bound lipids => 25% of total lipids.

non-starch and starch bound lipids **differ** in their **composition**

non-starch bound lipids => **triglycerides** and **glycolipids**

starch bound lipids => **lysophosphatides**

- non-starch lipids => further **fractionated** into => **free** and **bound** form by solvent extraction
- both **free and bound lipids** contain non-polar **glycolipids** and **phospholipid**
- **free lipids** fractions contains
 - 90% of the total nonpolar lipids and
 - 20% of total polar lipids of wheat flour.

- By **kneading** the flour => dough ,
- **glycolipids** becomes completely bound with gluten, while binding of **other lipids** is => only 70 to 80 % => resulting in a **starch-protein-lipid** complex matrix.
- Non-starch lipids affect => rheological properties of dough.
- Starch bound lipids affect => properties of the baked products.

- lipids are enclosed within the amylose helices => lipids complexed within the starch granules => **retard** swelling and **increase** their gelatinization temperatures => thus they influence the **baking behaviour** of cereals and => **properties** of baked product.
- Polar lipids positively influence the gas holding capacity of the doughs and **baking volume**, while
- non-polar lipids generally negatively influence the baking results.

Carbohydrates

1) Starch:

- Starch => **major storage form** => occurs only in endosperm cells.
- consist of **25%** amylose and **75%** amylopectin.
- Starch granules **swell** => when heated in **water suspension**.
- At the end of swelling => they **lose** their native structural form and arrangement => i.e. they are **gelatinized**.
- Starch contributes => **viscoelastic strength** of the semi rigid structure formed along with gluten => during baking.
- Lipids and proteins are **heterogeneous constituents** of starch granules.

2) Other polysaccharides:

- contain polysaccharides other than starch => but in endosperm their content is **less** than that of starch.
- include **hemicelluloses, pentosans, cellulose, β -glucans and glucofructans.**
- primarily **constitutents of cell wall** and are more abundant in the **outer portions of the kernels.**

3) Pentosans:

- Its content in wheat flour is 2-3%.
- A portion of pentosans is water soluble => absorb 25 times more water and => form highly viscous solution.
- insoluble form of pentosans swells extensively in water => increases crumb juiciness and chewability of baked products.
- play an important role => in baking quality since they also participate in gluten formation.

4) β -glucan:

- β -glucan content in wheat flour is **only 0.5-2%**.
- linear **polysaccharides** with D glucopyranose units linked by β (1 \rightarrow 3) and β (1 \rightarrow 4) linkages.
- polysaccharides are known as **lichenins**.
- They are slightly **mucous** \Rightarrow provide high **viscosity** to water solution.

Sugars:

- include **mono-, di- and trisaccharides** as well as other **low molecular weight degradation products** of starch.
- occur in relatively **low concentrations** but are **important** for **dough leavening** in the presence of yeasts.

Enzymes:

- Cereal grains contain many enzymes
- amylases,
- proteinases,
- lipases and
- oxidoreductases
- play => an important role in cereal processing.

Amylases:

- α - and β -amylases are \Rightarrow in all cereals.
- Their optimum activities \Rightarrow desirable in dough making in presence of yeast.

Proteinases:

- Acid Proteinases are present in wheat flour.
- involved in cleavage of gluten bonds => thereby affecting the softening or mellowing of gluten during baking.

Lipases:

- responsible for => the fatty acids appearing during the storage of cereals and their products.

Chemical Composition of Cereal Grains and Products

	Mositure	Protein	Fat	Carbohydrate	Crude Fibre	Minerals
Wheat (whole)	12.8	11.8	1.5	71.2	1.2	1.5
Wheat flour (whole)	12.2	12.1	1.7	69.4	1.9	2.7
Wheat flour (refined)	13.3	11.0	0.9	73.9	0.3	0.6
Wheat bread (brown)	39.0	8.8	1.4	49.0	1.2	-
Wheat bread (white)	39.0	7.8	0.7	51.9	0.7	-
Bajra	12.4	11.6	5.0	67.5	1.2	2.3
Barley	12.5	11.5	1.3	69.6	3.9	1.2
Jowar	11.9	10.4	1.9	72.6	1.6	1.6
Italian Millet	11.2	12.3	4.3	60.9	8.0	3.3
Maize	14.9	11.1	3.6	66.2	2.7	1.5
Ragi	13.1	7.3	1.3	72.0	3.6	2.7
Rice parboiled milled	13.3	6.4	0.4	79.0	0.2	0.7
Rice raw milled	13.7	6.8	0.5	78.2	0.2	0.6

(Source: Nutritive value of Indian Foods, National Institute of Nutrition (NIN), Indian Council of Medical Research (ICMR), Hyderabad, 1994)

THANKS

The background features abstract, overlapping geometric shapes in various shades of pink and purple, primarily concentrated on the right side of the frame. The shapes are semi-transparent, creating a layered effect. The overall aesthetic is modern and clean.