



# FOOD CHEMISTRY

Course No.-DTC-321, Credit Hours – 3 (2+1)



## Legumes

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# Legumes

- ❖ important food crops => humans and other animals.
- ❖ generally low in fat and high in protein,
- ❖ important micronutrients - folate, iron, magnesium and potassium.
- ❖ food additives, such as gums (for thickeners) - gum arabic, guar gum and tragacanth gum are derived from legumes.
- ❖ Soybean derivatives (soybean lecithin) are used extensively in processed foods

- ❖ essential for healthy ecosystems and agriculture → because of ability to ‘fix’ nitrogen.
- ❖ accomplished through a symbiotic relationship between the legume plant and special bacteria → live in nodules on the roots of the plant.
- ❖ **convert atmospheric nitrogen** into a form that is usable by other plants.

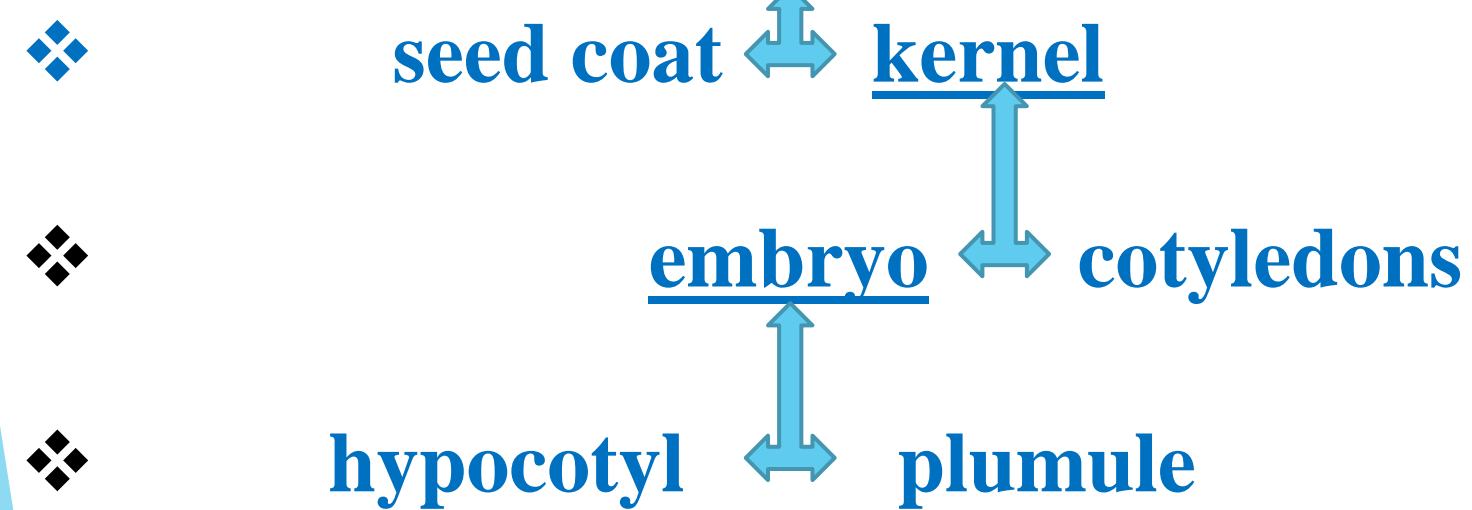
- ❖ legumes (pulses), complement cereals and make an ideal combination => provide protein quality matching that of animal products.
- ❖ Legumes => a major portion of lysine in the vegetarian diet.
- ❖ fairly good sources of vitamins => thiamine, niacine and riboflavin and much needed iron.
- ❖ poor source of calcium and Sulphur containing amino acids.

- ❖ Legumes are classified in the family **Fabaceae**, which can be further divided into three sub-families :
- ❖ **Faboideae,**
- ❖ **Mimosoideae and**
- ❖ **Caesalpinioideae.**
- ❖ The sub-families (or families) are based → form of the flowers, specifically the **petal shape.**

# Structure

- ❖ grains → similar in structure.
- ❖ differ → size, shape, colour and thickness of the seed coat.

❖ seeds (two major parts)



- ❖ On an average, pulses contain
- ❖ 11 percent seed coat,
- ❖ 2 percent embryo and
- ❖ 87 percent cotyledons.

- ❖ **seed coat** (Pigeon pea, chickpea, black gram, green gram and horse gram) accounting → **12-15** percent of the total weight.
- ❖ **seed coat** (lentils, French bean, kidney bean, pea, soybean and cowpea) → **8-11** percent .
- ❖ **embryo** → rich in **lysine, threonine** and **tryptophan** but contributes → **2 %** of their total quantity.
- ❖
- ❖ **cotyledons** account for → **93 percent** of **lysine, threonine** and **tryptophan** of the whole seed.
- ❖ **seed coat** → **poorest** in these amino acids.

proteins → two types :

- ❖ Storage proteins (70-80 percent) occur within the cells in discrete protein bodies.
- ❖ structural proteins (20-30 percent) → responsible for cellular activities including **synthesis** of structural and storage proteins.
- ❖ **deficient** → **methionine and cysteine**
- ❖ carbohydrates → **starch**.
- ❖ appreciable amount of **crude fiber** → Cellulose and hemicellulose.
- ❖ 80-90 percent of crude fiber → in the **seed coat**.



# Chemical Composition

- ❖ vary → governed by → cultivar, geographical location and growth conditions.
- ❖ rich → protein, carbohydrates and oil.
- ❖ good amount → dietary fiber and mineral.
- ❖ **grain legumes :**
  - ❖ **1. pulses** → low oil (1-5 percent), high protein (20-30 %) and carbohydrates (50 % and more)
  - ❖ **2. oilseeds** → high oil (30-50 percent), low protein (20-30 percent) .
  - ❖ **Soybean** and **groundnut** → two most cultivated legumes of the world.

## Proteins:

- ❖ classified into **three** basic groups:
- ❖ **globulins (70 percent),**
- ❖ **albumins (15 percent), and**
- ❖ **glutelins (15 percent)**
- ❖ These protein fractions include **essential** and **nonessential** amino acids.
- ❖ All legume proteins have **less** than optimal content of **sulphur amino acids** → **cystine** and **methionine** and in some **tryptophan** is also deficient.
- ❖ Amino acid deficiency can be met → large amount / mixture of legumes / high sulphur amino acid cereals and legumes.
- ❖ Cereals → **7-14** percent protein whereas legumes → **20-40** percent.

- ❖ **Cereals** → **Lysine** (first limiting essential a a), **tryptophan** (second limiting a a) in maize and **threonine** in other cereals.
- ❖ **Legumes** → **methionine** and **cysteine**.
- ❖ overall protein quality of cereal – legume mixtures > either protein source alone → **complementary nature** of their amino acid profiles
- ❖ **Digestibility** of legume proteins → **poor** → presence of **protease inhibitors**, deficiency of **sulphur amino acid**, presence of **polyphenols** and other **anti-metabolites** .
- ❖ can be improved through heat-treatments - cooking, autoclaving, roasting, etc.
- ❖ important → this less than optimal digestibility of legume be taken into consideration when one is attempting to meet nutritional requirements of humans with diets which are **essentially legume-based**.

- ❖ Legumes contain **high protein** content.
- ❖ ranges between **17-25 %** → proteins are chiefly **globulins**.
- ❖ **Albumins** are also present in a few species.
- ❖ **quality** of legume proteins is lower than most other classes of proteins.
- ❖ grain legumes are rich in protein → their nutritive value is limited → deficiency of **Sulphur containing amino acid**.
- ❖ **Low digestibility** is another factor → their **poor nutritive value**.

## Carbohydrates:

- ❖ contains → 60 percent of carbohydrate.
- ❖ Starch → principal carbohydrate.
- ❖ Minor amounts of lower molecular weight carbohydrates such as sucrose and sucrosyl oligosaccharides are present.
- ❖ oligosaccharides - raffinose, stachyose and verbascose → associated with flatulence.
- ❖ major hindrance → large-scale acceptance of legumes as food.
- ❖ Digestible energy coefficient → most legumes as well as mixed diets containing legumes → between 85-90 percent of the gross energy of the dry legume seed whereas metabolizable energy values → 75-85 percent.
- ❖ Soybean contains a considerable amount of carbohydrate such as galactans, pentoses, and hemicelluloses → poorly utilized.

- ❖ good sources → **dietary fibers**.
- ❖ **Low dietary fiber** intake → increased incidence of cancer of the colon and rectum, diverticular disease, coronary heart disease, diabetes and gallstone in affluent societies of the West.
- ❖ concentrated source of dietary fiber from soybean is obtained by processing de-hulled and defatted soy flakes → **65-75 percent** dietary fiber.
- ❖ Only **13 gm of soy fiber** → **10 gm of dietary fiber** in food whereas it takes **23 gm of wheat bran; 58 gm of oat bran; 502 gm of apple; and 735 gm of lettuce** → **10 gm of fiber**.

- ❖ physiological **benefits** of soy fiber and other dietary fiber sources
  - **increased fecal bulk** and its moisture;
- ❖ **reduced plasma cholesterol** and
- ❖ positive influence on blood **glucose and insulin** concentration.
- ❖ **hypocholesterolemic** effect is attributed to the dietary fiber (high content of pectins, gums and galactants).
- ❖ Dietary fiber also absorbs **bile salt**.
- ❖ It is aided by **saponins**.
  
- ❖ **Fat:**
  - ❖ fat content → between **1 and 2 percent**.
  - ❖ fats → rich in **essential fatty acids**

## Other nutrients:

- ❖ small amounts of **provitamin A** (50 to 300 IU of vitamin A / 100g).
- ❖ Fresh legumes → more vitamin A activity.
- ❖ **thiamine** content → 0.3 and 1.0 mg per 100 g.
- ❖ **little riboflavin** → 0.1 to 0.4 mg per 100g.
- ❖ **niacin** → 2.0 mg per 100 g.
- ❖ good sources of **folic acid**.
- ❖ Dry legumes → **devoid** of ascorbic acid.
- ❖ Undecorticated legumes → **vitamin E** → larger amounts than whole cereals.
- ❖ considerably richer in **calcium** → 100 mg per 100 g.
- ❖ **phytic acid** → affect the **absorption and utilization of their calcium**
- ❖ **iron** → 2 to 10 mg per 100 g.



## Anti-nutritional Factors:

- ❖ contain → wide variety of anti-nutritional factors or toxic principles → trypsin inhibitor and others.
- ❖ anti-nutritional factors → heat labile → destroyed during cooking.
- ❖ chemical substances → non-toxic → generate adverse physiological responses and interfere with the utilization of nutrients.
- ❖ protease inhibitors, lectins, goitrogens, antivitamins and phytates, saponins, oestrogens, flatulence factors, allergens and lysinoalanine.
- ❖ Some other anti-nutritional factors → cyanogens, favism factors, lathyrism factors, amylase inhibitors, tannins, aflatoxins and pressor amines.
- ❖ Although only a few legumes → contain all these anti-nutritional factors, many contain a few of them.

- ❖ Heat stable compounds → polyphenols and phytates → not easily removed by simple soaking and heating → could be reduced → germination and/or fermentation.
- ❖ Tannins → anti-nutrients due to their adverse effects on protein digestibility.
- ❖ nowadays, there is considerable interest → antioxidant activity of these compounds and their potential health benefits → prevention of cancer and cardiovascular disease.
- ❖ Dark colored legumes → red kidney beans, black beans, black gram and soybean have higher amount of these polyphenolic compounds.

## Chemical Composition of Pulses and Legumes (g/100g of edible portion)

	Moisture	Protein	Fat	Carbohydrate	Crude Fibre	Minerals
Bengal Gram (whole)	9.8	17.1	5.3	60.9	3.9	3.0
Bengal Gram (dhal)	9.9	20.8	5.6	59.8	1.2	2.7
Black Gram (dhal)	10.9	24.0	1.4	59.6	0.9	3.2
Cow Pea	13.4	24.1	1.0	54.5	3.8	3.2
Field Bean (dry)	9.6	24.9	0.8	60.1	1.4	3.2
Green Gram (whole)	10.4	24.0	1.3	56.7	4.1	3.5
Green Gram (dhal)	10.1	24.5	1.2	59.9	0.8	3.5
Horse Gram (whole)	11.8	22.0	0.5	57.2	5.3	3.2
Khesari (dhal)	10.0	28.2	0.6	56.6	2.3	2.3
Lentil	12.4	25.1	0.7	59.0	0.7	2.1
Moth Beans	10.8	23.6	1.1	56.5	4.5	3.5
Peas (green)	72.9	7.2	0.1	15.9	4.0	0.8
Peas (dry)	16.0	19.7	1.1	56.5	4.5	2.2
Rajmah	12.0	22.9	1.3	60.6	4.8	3.2
Red Gram (dhal)	13.4	22.3	1.7	57.6	1.5	3.5
Soyabean	8.1	43.2	19.5	20.9	3.7	4.6

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

**THANKS**

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