Contact information:

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- Pharmaceutical Chemistry Dept.
- Office hours:
  - Tuesdays and Thursdays: 10:00 am–12:00 pm
- E-mail: ss_ebada@mutah.edu.jo
# Course Outline:

**Level III**

**Course Title:** Pharmacognosy  
**Course Code:** 1702363  
**Prerequisite:** Pharmaceutical Organic Chemistry (1703216)  
**Semester:** Summer 2018-2019 (1st Teaching day: 09.06.2019 / last Teaching day: 08.08.2019)  
**Credit Hours:** Weekly 4 hrs Lecture (Sunday-Wednesdays 9:00 -10:00 am)  
**Total Grade:** 100 pts.  
- **First Exam:** 25 pts.  
- **Second Exam:** 25 pts.  
- **Final Written:** 50 pts. (2 hrs.)

**Lecture Schedule and Content:**

<table>
<thead>
<tr>
<th>Sun. 09.06 - Wed. 12.06</th>
<th>Sun. 16.06 - Wed. 19.06</th>
<th>Sun. 23.06 - Wed. 26.06</th>
<th>Sun. 30.06 - Wed. 03.07</th>
</tr>
</thead>
</table>
| Introduction to Pharmacognosy.  
  a. Definition of Pharmacognosy.  
  b. Factors affecting plant growth.  
  c. Adulteration.  
  d. Secondary metabolites.  
  Introduction to Medicinal Leaves.  
  a. Senna leaf.  
  b. Digitalis leaf.  
  Solanaceous leaves. | Introduction to Medicinal flowers.  
  a. German chamomile.  
  b. Pyrethrum.  
  c. Santonica.  
  d. Clove.  
  e. Hibiscus.  
  Introduction to Medicinal woods and barks.  
  a. Cinchona.  
  b. Cinnamon/Cassia.  
  c. Cascara/Frangula.  
  d. Salicis.  
  e. Gualacum wood. | Introduction to Medicinal seeds.  
  a. Linseed.  
  b. Foenugreek.  
  c. Cardamom.  
  d. Black/White mustard.  
  e. Psyllium.  
  Introduction to Medicinal fruits.  
  a. Fennel/Anise.  
  b. Capsicum.  
  c. Poppy.  
  d. Senna.  
  e. Ammi visnaga/majus. | **First Exam** |
| Introduction to Medicinal herbs.  
  a. Mentha/Thyme.  
  b. Lobelia.  
  c. Ergot.  
  d. Ephedra.  
  Introduction to Medicinal Subterranean organs.  
  a. Ginger/Curcuma.  
  b. Liquorice.  
  c. Rhubarb.  
  d. Garlic. | Introduction to Medicinal Unorganized drugs.  
  a. Colophony.  
  b. Myrrh.  
  c. Gum Acacia.  
  d. Gum tragacanth.  
  e. | Introduction to Medicinal Unorganized drugs (Continued).  
  a. Agar.  
  b. Gelatin.  
  c. Aloes.  
  d. Opium. | **Second Exam** |
| Sun. 04.08 - Wed. 07.08 | Sun. 11.08 - Wed. 14.08 | | **Final Exam** |
Lecture Outline

- Introduction to seeds.
  a. Linseed.
  b. Foenugreek.
  c. Cardamom.
  d. Black/White mustard.
  e. Psyllium
Introduction to seeds

SEEDS

Definition: The seed is a mature fertilized integumented ovule inside a mature fertilized ovary (fruit). They are surrounded by the ovary wall, which develops to form the pericarp.

Function of seeds: it is constructed to facilitate transportation and its purpose is to ensure the continuation and distribution of the individual.

- Structure of the ovule:
  A typical mature ovule consists of:
  1. Integuments or coats of the ovules: They have a protecting function for the ovule; composed of either one coat (testa) or two (outer called testa and inner called tegmen). A micropyle (pore) is present at the apex through which the pollen tubes begin their way to embryo sac.
  2. Nucellus: A collapsed mass of parenchyma, in some mature seeds it is bigger in size forming the perisperm e.g. cardamom.
  3. Embryo sac or Megaspore: A large sac in the nucellus containing the ovum. After fertilization, it will form the embryo sac (a zygote), a primary endosperm nucleus and three antipodal cells. The zygote divides and develops to form the embryo, with its cotyledons, radicle and plumule.
1- Nucellus.
2- Micropyle.
3- Integuments.
4- Embryo sac.
5- Funicle.
6- Chalasa.
7- Raphe
• Types of ovules:
  1. **Atropous (orthotropous):** The ovule is erect and the funicule, nucellus and micropyle are on a straight line. The micropyle is at the opposite side of the hilum. There is no raphe. This type is not very common e.g. Piperaceae.
  2. **Anatropous:** The stalk grows adherent to one side of the ovule and has grown so rapidly that it completely inverts the ovule on its stalk (180°) bringing the micropyle close to the hilum with the chalaza at the opposite end of the ovule. Here the raphe extends along the whole length of the ovule, most common e.g. linseed and most seeds.
  3. **Amphitropous:** The stalk grows adherent to the ovule and the rotation of the ovule is only 90°. The hilum, chalaza and micropyle are widely separated, with hilum between chalaza and micropyle. The raphe runs only from hilum to the chalaza e.g. colchicum.
  4. **Campylotropous:** The nucellus and coats of one side develop very rapidly while the development of other side is almost arrested resulting in a curved nucellus. The hilum, chalaza and micropyle are together at one end and there is no raphe e.g. solanaceous seeds.
overview ovules → seed

- atropous (orthotropous)
- Hemitropous
- Anatropous
- campylotropous
- Amphitropous
A typical seed consists of:

1- Testa formed of one or two seed coats originated from the integuments of the ovule.

2- Perisperm formed from the nucellus

3- Endosperm surrounding the embryo and developed from the primary endosperm nucellus of the embryo sac

4- An embryo developed from the fertilized ovum

- Cotyledons: one or two which store food for growth
- Plumule: It is the stem growing point
- Radicle: It forms the root system
A TYPICAL SEED CONSISTS OF

**Corn**
- Stored food
- Seed coat
- Cotyledon
- Embryo

**Bean**
- Seed coat
- Embryo
- Cotyledon (stores food)
The Kernel: the structure of the seed enclosed within the testa.

KINDS OF SEEDS

Albuminuous seed:
- The **embryo** is surrounded by the **endosperm** e.g. Linseed.
- The **embryo** is surrounded by the **endosperm** and **perisperm** e.g. Cardamom

Exalalbuminous seed:
- the **embryo** alone exists within the testa e.g. Mustard
Seeds with a testa of two coats
Linseed, Colchicum, Cardamom, Mustard

Seeds with a testa of one coat
Foenugreek, Nux-vomica, Strophanthus

THE TESTA (SEED COAT)
Outgrowth of the Testa

1- Arillus
arises from the funicle or the tissue of hilum e.g. Cardamom

2- Arillode
arises from the tissue of micropyle e.g. Nutmeg

3- Strophiole
local enlargement along the line of the raphe e.g. Colchicum seed
Extension of the testa which may be:

I- Plume of hairs e.g. Salix
II- Awn e.g. Strophanthus

4- Wing
MICROSCOPICAL CHARACTERS

A - Testa
- Epidermis
- Hypodermis,
- Pigment layer,
- Sclerenchyma,
- Nutritive layer

B - Kernel
- Perisperm
- Endosperm
- Embryo

C - Reserve Food Materials
( Cell Content)
**MICROSCOPICAL CHARACTERS**

(A) **TESTA:**

Epidermis, Hypodermis, Pigment layer, Sclerenchyma, Nutritive layer

<table>
<thead>
<tr>
<th>1- Epidermis</th>
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<tbody>
<tr>
<td><strong>1- Palisade like</strong></td>
</tr>
<tr>
<td>i ) With conical lumen, where the lumen is enlarged at the base and narrows to a pore at the apex (Leguminous seeds: Foenugreek)</td>
</tr>
</tbody>
</table>

<p>| 2- Parenchyma filled with mucilage |
| i ) (Linseed) |</p>
<table>
<thead>
<tr>
<th>3- Lignified sclerides</th>
<th>i) <strong>Nux vomica</strong> [ stone cells ]: They are equally thickened with narrow lumen.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>ii) Solanaceous seeds</strong>: Anticlinal &amp; inner tangential walls are lignified &amp; the outer tangential walls are thin, cellulosic (<strong>Capsicum</strong>)</td>
</tr>
<tr>
<td>4- Prosenchyma</td>
<td>Elongated fiber like cells (<strong>Cardamom</strong>)</td>
</tr>
</tbody>
</table>
### 2-Hypodermis

<table>
<thead>
<tr>
<th>1- Basket like cells (bearer cells)</th>
<th>Foenugreek</th>
</tr>
</thead>
<tbody>
<tr>
<td>2- Collenchyma</td>
<td>Linseed</td>
</tr>
<tr>
<td>3- Giant parenchymatous cells</td>
<td>Black mustard</td>
</tr>
</tbody>
</table>

**Diagram:**
- [Image 1](#): Basket-like cells in Foenugreek tissue.
- [Image 2](#): Collenchyma cells in Linseed tissue.
- [Image 3](#): Giant parenchymatous cells in Black mustard tissue.
3) The pigment layer responsible for the dark colour of the seed e.g. Linseed

4) Sclerenchymatous layer e.g. Linseed & Cardamom

5) Nutritive layer (Hyaline layer): cells filled with starch. e.g. Foenugreek, Nux vomica
B- The Kernel

The perisperm may be large or membranous coat or hardly distinct.
- Large containing starch e.g. Cardamom
- Infolding penetrating the endosperm e.g. Nutmeg

The endosperm may be starchy e.g. Graminae, oily e.g. Umbelliferae or having hemicellulosic walls e.g. Colchicum and Nux vomica

The Embryo, consists of
a) One cotyledon (monocotyledon) or two cotyledons (dicotyledons) or more
b) Plumule: It is the stem growing point
c) Radicle: It forms the root system
Types of Embryo

1- Straight e.g. Linseed

2- Coiled e.g. Stramonium

3- Curved e.g. Poppy

4- Bent on itself
   a) Incumbent
   b) Accumbent Fenugreek
   c) Orthoplocus Black mustard
Curved embryo (Papaver)

Coiled embryo (Stramonium)

Straight embryo (Linseed)

Incipient embryo (Cannabis)

Orthoplocally embryo (Mustard)

Accumbent embryo (Foenugreek)
C- Reserve Food Materials

**Starch:** It gives blue colour with iodine e.g. Maize & Cardamom

**Protein**
- Amorphous mass e.g. Cardamom
- Aleurone grains in ripe seeds e.g. Leguminoseae
  It gives red colour with Millon’s reagent and yellow ppt with picric acid

**Fixed oil and fat**
It gives red colour with sudan III

**Ca Ox Crystals**
Seeds of Medicinal Importance

According to the constituents

**Fixed oil**
- Linseed
- Fenugreek
- Black Mustard
- White mustard
- Nutmeg

**Glycosides**
- Linseed
- Fenugreek
- Mustard Seeds
- Strophanthus

**Volatile oil**
- Nutmeg
- Cardamom

**Mucilage**
- Linseed
- Fenugreek
- Mustard seeds
- Psyllium

**Alkaloids**
- Nux vomica
- Colchicium
Official seeds
• LINSEED
• Flax Seed-Semen Lini
• بذر الكتان

• The dried ripe seeds of

Linum usitatissimum Linne family Linaceae.

Description

A. Morphology

Shape: Elongated ovate, compressed to nearly flat rounded at one end and obliquely pointed at the other.
• Raphe: Distinct yellow ridge along one edge running from the hilum to the rounded end.

• Hilum and micropyle appear as a slight depression near the pointed end.
T. S. of Linseed

Epidermis
Pigment layer
Endosperm
Cotyledon
Powder

Colour: Yellowish-brown with readily visible dark reddish-brown fragments of the testa.

Odour: It has a characteristic

Taste: mucilaginous oily.

Powder linseed
Microscopically, it is characterized by:

1. Dark brown fragments showing pigment cells (Polygonal flattened cells with pitted walls and reddish-brown contents)

2. Fragments of the endosperm and cotyledons

Endosperm
3. Fragments with yellowish-brown sclerenchymatous cells (appearing crossed by thin walled elongated cells on one side and by rounded somewhat thickened parenchyma on the other and accompanied by pigment layer.) known as Mat-like structure.

4. Mucilaginous epidermis.
Small amount of a cyanogenic glycoside (linamarin).

-25% of protein.
-3-6% of mucilage

30 to 40% of fixed oil containing high contents of the unsaturated fatty acids: oleic acid (39%), linoleic acid (15%) and α-linolenic acid (that can not be manufactured by mammals and must be consumed as part of diet).
Uses & Actions

Internally

Linseed is used in patients with **rheumatoid arthritis** and **psoriasis**.

Rheumatoid arthritis

Psoriasis
Uses & Actions (cont.)

- Demulcent in acute or chronic gastritis (mucilage)
- Bulk laxative in habitual constipation,
  due to its mucilage & fixed oil
  which have a lubricant effect.

  The laxative action arises from an increase in the volume of the intestinal bowel contents and consequent reflex stimulation of peristalsis.
Uses & Actions (cont.)

- Anti-inflammatory (Omega-3 fatty acids have demonstrated effect due to reduced production of inflammatory mediators).

- Heart protecting against angina pectoris, since Omega-3 fatty acids reduce the whole blood viscosity & lower cholesterol level.
Side effects:

• When taken *internally*, Linseed must be accompanied by *plenty of fluids*, otherwise *flatulence* may occur.

Contraindications

• The drug is contraindicated in case of *intestinal obstruction*.
Why linseed is not toxic

• Toxic effects arising from the liberation of HCN from the cyanogenic glycoside (linamarin) by the enzyme linamarase.

1-When crushed seeds are taken internally, **linamarase is partly inactivated** under the influence of the acidity of the stomach and less than 1% of the cyanogenic glycoside is hydrolysed.

2- Hydrolysis time of four hours is required **in vivo** system.

3- The majority of HCN, liberated is converted rapidly into the relatively non toxic thiocynate through a detoxification mechanism in the body.

4- The minor part of HCN remained is eliminated via the urine and the faeces.
Chemical tests:
1- General test for cyanogenic glycoside (Guignard's paper test):

Crushed
Moist with water

Yellow
Na picrate paper

Brick Red
Na picramate

Linamarin glycosides

Linamarase enzyme

37 °C

HCN
Chemical tests (cont.)

2-For Mucilage:
   **Red** colour with **Ruthenium Red**

3-For Fixed oil:
   **Red** colour with **sudan III**

4-For Proteins:
   **Millon's reagent**: **red**
FOENUGREEK بذر الحلبة

- Semen Fœnugreek

- The dried ripe seeds of *Trigonella foenum-graecum* Linne, family Leguminosae (Fabaceae).
• **Description**

  **A. Morphology**

• **Shape:** Rhomboidal.

---

Accumbent embryo

Albuminous seed
B. Histology

Testa (One seed coat)

1- Epidermis: Palisade-like cells,

2- Subepidermal layer: basket-like cells, with bar-like thickening on the radial walls

3- The parenchymatous nutritive layer.

4- Endosperm: Several layers of polyhedral cells with stratified contents of mucilage.

5- Cotyledons: Parenchymatous cells containing fixed oil, and aleurone grains

T. S. of Foenugreek seed
• Powder

Yellowish in colour, with strong characteristic odour and a mucilaginous slightly bitter taste.

It is characterized by:

1. Fragments of testa showing the *palisade like epidermal cells*, the *basket-like cells* of the sub-epidermal layer.
Palisade like epidermal cells

Side view                                Top view

Basket-like cells of hypodermis (basal view)
Active Constituents

28% of mucilage

- hydrolysis
- mannose & galactose

Alkaloids: Gentianine, trigonelline & choline

23-25% proteins & amino acids.

Flavonoids: Apigenin, luteolin, vitexin & quercetin.

0.6-1.7% saponins glycosides

- hydrolysis
- Steroidal sapogenin, gitogenin,
Active Constituents (cont.)

- **coumarin**, (5-8 %)
- **vitamins** (nicotinic acid) & minerals (a rich source of selenium).
- **volatile constituents** responsible for the flavor of Fœnugreek.
• Uses and actions
  1- Hypoglycemic in diabetic patients.
  2- Lactagogue.
  3- Treatment of dyspepsia & gastritis.
  4- Hypocholesterolemic actions in normal and diabetic humans.
  5- It has demulcent, laxative and nutritive properties.
  6- Used as tonic, in hepatomegaly and splenomegaly.
• 7-Topically for wounds, leg ulcers & to reduce inflammation.

• 8-Foenugreek seeds are a potential source of diosogenin, a basic compound in the semi-synthesis of steroid drugs such as cortisone and sex hormones.
Side effects and/or toxicity

1- Repeated external applications can result in undesirable skin reactions.

2- Minor gastrointestinal symptoms, such as diarrhea and flatulence.
Contraindications

1- The hypoglycemic activity of fœnugreek may interfere with an existing hypoglycemic therapy.

2- Oxytocic and uterine stimulant activity, the use of fœnugreek during pregnancy and lactation in doses greatly exceeding those normally encountered in foods is not advisable.
Chemical tests

It gives positive histochemical tests with sudan III and methylene blue

- Positive test for saponin.
Cardamom seed is the dried ripe or nearly ripe seeds of *Elettaria cardamomum* var. *miniscula* family Zingiberaceae, recently separated from the fruit. (WHY?)
Cardamom (Elettaria cardamomum)
WHY seeds should be recently separated from the fruit?

1- To avoid loss of volatile oils. The loss of oil from seeds kept in the pericarp is small but a loss of 30% in 8 months takes place when the seeds are separated from the fruits.

2- To protect against insect attack.
Description
A. Morphology
L. Cut of Cardamom seed

T. Cut of Cardamom seed
• Externally, transversely wrinkled, hilum, depressed; raphe, indicated by a channel extending on one side from base to apex.

• Internally: A thin dark testa, a whitish starchy perisperm grooved on one side, and in the center a small yellowish translucent endosperm, surrounding a paler minute embryo.
B. Histology

-Arillus: Elongated, collapsed, flattened, thin walled cells, containing small droplets of oil.

-Testa: Two seed coats

A) Outer seed coat

1- Epidermis is fiber-like (prosenchyma) with long narrow cells, having slightly thickened walls

2- A layer of collapsed parenchymatous cells, with brownish contents

3- Inner epidermis of thin-walled flattened cells.
T. S. of Cardamom seed
B) Inner seed coat

1- Yellowish to reddish-brown, rectangular, strongly lignified sclereids.

2- Inner epidermis of flattened cells.
   - Perisperm: Thin-walled cells, packed with minute starch granules and containing small prisms of calcium oxalate.
   - Endosperm: Small thin-walled parenchymatous cells, each filled with granular mass of protein, but no starch.
   - Embryo: Small thin-walled cells containing aleurone grains but no starch.
• **Powder**

• It is reddish to greyish-brown with a strong aromatic odour and an agreeable aromatic and pungent taste

• 1. Numerous fragments of perisperm cells having starch granules and one or more prisms of calcium oxalate

• 2. Polyhedral masses of adherent starch granules from perisperm. Individual granules up to 4 microns in diameter.
3. Occasional particles of epidermal cells, often crossed at right angles by the cells of the collapsed layer.

4. Fragments of arillus
5. Numerous fragment of yellowish to reddish-brown to dark brown sclereids.

6. Absence of sclerenchymatous fibres (Pericarp of fruit) and of starch granules more than 10 microns (c.f. Graminaceous fruits and Ginger).
Powdered Cardamom Seed

ar., arillus; ca. pr., prism of calcium oxalate; ep., epidermis; hy., hypodermis; ol., oil globules; ol. l., oily layer; per., perisperm; scl. (b.v.), sclerenchymatous layer basal view; scl. (s.v.), sclerenchymatous layer side view; scl. (t.v.), sclerenchymatous layer (top-view); st., starch; xy., xylem vessel.

[Diagram showing various structures labeled with abbreviations like ar., ep., hy., ol., ol. l., scl. b.v., scl. s.v., scl. t.v., st., ca. pr., xy., etc.]
**Active Constituents**

- **Volatile oil.** 2.8-6.2%. The oil contains a high percent of terpinyl acetate and cineole and smaller quantities of other monoterpenes, including alcohols and esters.

- **Starch** (up to 50%)

- **Fixed oil** (1-10%) & calcium oxalate
Uses and actions

Domestic
- Flavoring in curries & cakes (called queen of spices).

Digestive
- Improves appetite
- Relieve constipation.
- Used for anorexia, colic, cramp, dyspepsia, heartburn, vomiting and nausea.

Emotions/mind and nervous system
- For mental fatigue and nervous strain.
Chemical tests

It gives positive histochemical tests with sudan III and iodine
1. Loose seeds

- They are usually quite ripe and are difficult to authenticate. They yield less volatile oil than those which are stored in the pericarp until required for use.

2. Cardamom husk

- The pericarps of the Cardamoms are imported in compressed masses.

3. Immature fruits

- Mouldy or insect infested fruits and Cardamom "Splits" (partially opened fruits).
Black mustard
Sinapis Nigrae
بذر الخردل الاسود

Black mustard is the dried ripe seeds of *Brassica nigra* family
Brassicaceae (Cruciferae).
Surface:

Externally: mucilaginous when placed in water.

Internally: light yellow and oily

Two folded cotyledons embracing a small radicle (orthoplocus arrangement).
Epidermis with Mucilage
Hypodermis (Giant cells)
Sclereids of unequal height and thickening
Pigment layer
Aleuron layer
Embryo

T. S. of Black mustard seed
Powder

Microscopically it is characterised by:

- **1**- The reddish-brown fragments of testa, showing polygonal sclerenchyma cells in surface view.

- **2**- Mucilaginous epidermis.
- **3**- Numerous fragments of cotyledons.
- **4**- Absence of starch.
Allyl isothiocyanate is responsible for the powerful pungent taste and odour obtained by moistening the powdered seeds.
Uses and actions

- **Spice**

- **Externally:** Rubefacient and counter irritant

- **Oil** appears to be associated with a reduction in risk of cancers of alimentary tract.

Contraindication

- Hypersensitive skin and peptic ulcer.

- Severe circulatory damage and varicose veins.
Black mustard

White mustard
# Black mustard and White mustard seeds

<table>
<thead>
<tr>
<th></th>
<th>Sinapis Nigrae</th>
<th>Sinapis Alba</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
<td>The dried ripe seeds of <em>Brassica nigra</em>, F. Cruciferae</td>
<td>The dried ripe seeds of <em>Brassica alba</em>, F. Cruciferae.</td>
</tr>
<tr>
<td><strong>Active constituents</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1- Mucilage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2- Protein</td>
<td></td>
<td></td>
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<tr>
<td>3- F.O.</td>
<td></td>
<td></td>
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<tr>
<td>4- Sinigrin glycoside</td>
<td></td>
<td></td>
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<tr>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myrosinase</td>
<td></td>
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<tr>
<td>Sinigrin → allyl isothiocyanate</td>
<td></td>
<td></td>
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<tr>
<td>(responsible for the pungent odour of B.M)</td>
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<tr>
<td><strong>Uses</strong></td>
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<td></td>
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<tr>
<td>1- Externally in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Rheumatic pain</td>
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<tr>
<td>b) Counter irritant</td>
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<tr>
<td>2- Internally</td>
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<tr>
<td>promotes appetite (Spice)</td>
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<tr>
<td>3- Oil</td>
<td></td>
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<tr>
<td>reduces risk of cancer in alimentary tract</td>
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</table>
Black mustard

White mustard

Orthoplocal embryo

A

B

cots.

rad.

t.

C

D

E

ep.
m.
g.
scl.
p.
al.
em.
ol.

col.

hy.
PSYLLIUM SEED

The dried ripe seeds of Plantago psyllium and Plantago albicans, F. Plantaginaceae.

Active constituents:

1- Mucilage (10 – 12 %)

2- Small amount of iridoid glycoside.

3- Fixed oil - protein.
• Uses:
  1- Bulk laxative (alone or associated with other purgatives as: Senna & Cascara).

2- Promising in lowering **cholesterol** and controlling **diabetes**.
• Psyllium husk:

• Psyllium seed husk are indigestible and are a source of soluble **dietary fiber**.

• The seeds are placed in water, the seed coat swells (the epidermal cells) forming layers of mucilage around the seed which are peeled & left to dry.

• It is then purified and used as laxative (in chronic constipation).
• Contraindication

• The indigestible fiber in psyllium seed can cause **flatulence** and **abdominal discomfort**.

• If psyllium seed is not taken with adequate water, it can **clump** together in a mass and **block the digestive tract**.

  Sufficient fluid is essential to the **safe** and **successful** use of psyllium seed.