Indira Gandhi
National Open University
School of Agriculture

BPVI-036
Processing of Pulses and Oilseeds

Block

1

PROCESSING OF PULSES

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BPVI 036 PROCESSING OF PULSES AND OILSEEDS

The course is designed for a over view of processing of pulses and oilseeds. Among food grains, pulses and oilseeds are important for their protein supplementation and energy inputs in a balanced diet for vegetarians especially in the Indian sub continent. Age old methods for processing these grains were tedious, wasteful and time consuming. Modern methodologies for processing these grains were developed in last three decades and they have replaced most of the old practices thus avoiding losses. The aim of processing pulses and oilseeds is to get a quality product in higher quantity, reduce the losses during processing, get value added products – both primary and secondary and utilize the by-products in a economical manner. The basic principles of processing pulses include removal of seed coat or husk which is done in two steps, first - loosening of seed coat by a pre-treatment and second - subsequent removal of husk in a proper abrasive machine; conversion into splits, and grinding into a flour of suitable particle size range wherever necessary. The course details are given in four blocks which covers most of the aspects of processing.

Block 1 deals with pulses. The production, agronomy, physical properties and composition of pulses is covered in unit 1, while unit 2 deals with primary processing of pulses like cleaning, grading and de-hulling, different milling methods and machinery and preparation of secondary products from pulses like besan and papad.

Block 2 deals with soybean wherein production, composition and constraints are discussed and processing of soybean to soy flour, soy milk, and several bakery products from soybean are explained.

Block 3 explains processing of oilseeds especially newer methods of oil extraction with merits, refining of oils and utilization of oilcake which is an important by-product from oil industry.

Block 4 deals with practicals in the field of processing of pulses and oilseeds wherein identification of various pulses and oilseeds, their physical & mechanical properties, use of different machines for processing, determination of quality of products and several related aspects are covered.

BLOCK 1 PROCESSING OF PULSES

India is one of the major pulse growing countries in the world. The production of pulses in India in 2001-02 was 13.19 million tonnes, which was about 27-28% of the world production. Among the different pulses grown in the country, the respective share of production has been: chickpea (bengal gram / chana) 40.50% ; pigeon pea (tur /arhar) 17.90%; green gram (moong) 9.20%; black gram (urad) 9.10% ; lentils (masur) 6.10% and other minor pulses 17.20%. Among the important states engaged in growing pulses have been : Madhya Pradesh 22.90% ; Uttar Pradesh 18.12% ; Maharashtra 14.25% ; Rajasthan 10.84%; Andhra Pradesh 8.64% ; Karnataka 5.76% and others 19.49% . Thus about 80.51% of the pulses supply is contributed by five major states. Off late the production and area under pulses cultivation in the country has been stagnated. This is because of unfavorable climatic and ecological factors, non-availability of high yielding varieties, improper research support, socio economic factors and constraints in post harvest technology. As a result of stagnating production and surging population, the per capita availability of pulses has come down from 70 grams/ day in 1960's to 27 grams/day in 2001. The same was only about 34% of the World Health Organization's recommendation of 80 grams/capita/ day.

Basic processes in dal milling are cleaning, grading, conditioning, dehusking, splitting, separation, polishing and bagging. Major variation is involved with dehusking process only. Dals like Arahar, Urad, Moong and Lentil are difficult to dehusk as a result repeated operations by dehusking rollers are required. Repeated soaking, drying, tempering is done to loosen portions of husk sticking after rolling operations. Sometimes Linseed oil is also used during dry milling operation to impart shine or better appeal to the milled dal.

Unit 1 deals with production, statistics, acreage, agronomical practices, gross and proximate composition of pulses. It also explains the physical and mechanical properties of various pulses alongwith amino acid composition of proteins contained in the pulses.

Unit 2 explains the various stages involved in processing of pulses and by-product utilization. It explains the process of cleaning, grading, drying and milling of pulses alongwith its principles. The unit also discusses the home scale and commercial methods of pulses milling alongwith production of besan, papad and use of by-product like chuni-bhusi as animal feed.

UNIT 1 PULSES, PRODUCTION, TECHNOLOGY AND COMPOSITION

Structure

1.0 OBJECTIVES

After reading this unit you should be able to:

- know about the importance of pulses in the human diet;
- learn regarding the production statistics and acreage of various pulses in India;
- understand the agronomical practices for pulses; and
- explain the composition of India pulses.

1.1 INTRODUCTION

Pulses may be defined as the dried edible seeds of cultivated legumes. They belong to the family of peas, beans and lentils. The English word pulse is derived from the Latin pulse, meaning pottage or thick pap. The pulses are a large family and various species are capable of surviving in different climates and soils.

Traces of pulse crops have been found from ancient times in archaeological sites of both the Old and New Worlds and they appear to have been among the earliest domesticated plants. These findings indicate an almost simultaneous arrival of cereals and pulses around 10,000 BC.

Pulses are cultivated in all parts of the world, and they occupy an important place in human diet. They however, make a much more important contribution to the diet of all classes of society in the East than in the West. In India especially, people who are mostly vegetarian depend largely on cereals and arid pulses as their staple food, which serve as the main source of dietary protein and energy. The commonly grown pulse crop in India are Chickpea, Pigeon pea Blackgram, Green gram, Cowpea, Lentil, Pea etc. Among the pulses, Chickpea and Pigeonpea is the important crop

compiling of 50% of pulses area and 60% of total production. Madhya Pradesh, Karnatka, Bihar, Chattisgarh, Gujrat and Tamil Nadu, Orrisa account for about 90% production. Pulses are grown in 'kharif' (rainy season) and 'Rabi' (winter season).

Food Value

Pulses contain more protein than any other plant. They serve as a low-cost protein to meet the needs of the large section of the people. They have, therefore, been justifiably described as "the poor man's meat". Their low moisture content and hard testa or seed-coat permit storage over long periods. In addition to providing dry pulses, many of the-crops are grown for their green edible pods and unripe seeds. Nutritionally, immature fruits have distinctly different properties to those of the mature seed, the protein content is lower but they are relatively richer in vitamins and soluble carbohydrates. The leaves arid shoots of some of the crops are used as pot-herbs.

In general, pulses contain 20 to 28 per cent protein per 100 gm. Their carbohydrate content is about 60 per cent per 100 gm. Pulses are also fairly good sources of thiamin and niacin and provide calcium, phosphorus and iron. On an average 100 gram of pulses contain energy 345 kcal, protein 24.5 gm., calcium 140 mg., phosphorus 300 mg., iron 8 mg thiamin 0.5 mg. riboflavin 0.3 mg. and niacin 2 mg.

Natural Benefits and Curative Properties

The nutritive properties of pulses resemble in many respects those of the whole cereal grains; but there are important differences. First, the pulse protein is low in sulfur containing amino acids, but rich in lysine in which many cereals are deficient. A combination of pulses and cereal proteins may, therefore, have a nutritive value as good as animal proteins. Secondly, pulses as a class are good sources of the B group of vitamins except riboflavin. More important, the greater part of these vitamins present in the harvested seeds is actually consumed. There are no losses comparable with those that may arise in the milling and cooking of cereals. Pulses are therefore, an excellent preventive against beriberi. Thirdly, although pulses, like cereal grains, are devoid of Vitamin C, large amount of ascorbic acid is formed on germination. Sprouted pulses are, therefore, an important food which will protect against scurvy. Dietitians in Asian and African hospitals make beneficial use of sprouted pulses for their menus, especially when fresh vegetables and fruits are scarce or too expensive.

In health, the digestion of pulses and the absorption of their principal nutrients is practically complete and nearly as effective as is the assimilation of cereals. Their digestion, may, however, be incomplete in gastro-intestinal disorders. Only small quantities of well-cooked pulses should, therefore, be included in the diets of patients with stomach disorders.

Uses

Pulses are used as a common foodstuff in various forms. Pulses, dehusked, decorticated and whole seed, are used as dhal and taken with chappatis and cooked rice, Whole seeds take longer time to cook than the dehusked and decorticated ones which are relatively better digestible.

Pulses are also commonly used in the form of flour such as that of Bengal gram, green gram, black gram, known as 'besan'. It is used for mixing with cereal flour in various proportions for chappatis and other preparations.

The practice of utilizing germinated seed or sprouting or young seedlings of pulses as a fresh vegetable is widespread in the Orient. The storage of dried seed and their sprouting as required enables a continuous supply of fresh vegetable material to be

produced. There is an amazing increase in nutrients in sprouted pulses when compared to their dried embryo. In the process of sprouting, the vitamins, minerals and protein increase substantially with corresponding decrease in calories and carbohydrate content.

Sprouting of the pulses not only improves nutritive value but also digestibility. During sprouting, starch is broken down to dextrin and maltose, and proteins are broken down to polypeptides, peptides and amino acids. Some of the bound iron is converted to a more readily assimilable form. Phosphorus is liberated from phytate. The ascorbic acid or vitamin C content rises from negligible levels in the seed to 12 mgs. Per 100 gram after 4.8 hours of germination. Riboflavin and niacin contents increase significantly. These changes are brought about by enzymes which become active during germination.

1.2 Production Statistics and Acreage

The area coverage of pulses in India is 21.66 million hectare a production of 13.19 million tones with average yield of 609 kg/ha achieved in 2001-2003. Yield levels in India are lower than world average (790 kg/ha). (Agriculture Statistics at a glance-2003)

Table 1: Area, Production and Yield of Total Pulses during 2001-02 of Major Pulses Producing States

State	Area (m.ha)	%of Total Area	Production (m.t)	% of Total Production	Yield (Kg/ha)
1	2	3	4	5	6
Madhya pradesh	3.83	17.68	3.02	22.90	789
Uttar pradesh	2.70	12.47	2.39	18.12	884
Maharashtra	3.39	15.65	1.88	14.25	555
Rajasthan	3.36	15.15	1.43	10.84	425
Andhra Pradesh	1.91	8.82	1.14	8.64	595
Karnataka	1.89	8.73	0.76	5.76	399
Bihar	0.70	3.23	0.56	4.25	802
Chhattisgarh	0.82	3.79	0.42	3.18	514
Gujrat	0.73	3.37	0.38	2.88	525
Tamil Nadu	0.68	3.14	0.29	2.20	426
Orissa	0.73	3.37	0.28	2.12	379
Best Bengal	0.25	1.15	0.18	1.36	703
Haryana	0.19	0.88	0.15	1.14	796
Jharkhand	0.12	0.55	0.09	0.68	807
Others	0.36	1.66	0.22	1.67	-
All India	21.66	100.0	13.19	100.00	609

Source: Agricultural Statistics at a glance- 2003

1.3 Agronomical Practices

Black gram or, Urad (Vigna mungo)

Selection of Soil: light to medium soil is suitable**.**

Field Prepration: 2-3 plouging finally field should be weed free.

Sowing time: Kharif- Onset of monsoon to 15 of July**.**

Spacing Row to row- 30cm, plant to plant- 10 cm, depth- 5-7 cm.

Seed treatment: By fungicides like thirum or mencozab 2.5 gm per kg of seed.

Seed rate: 15-20 kg/ha.

Recommended Varieties: Type 9, Jawahar Urd 2, Jawahar Urd 3, Khargone 3, PUD-1, PU 19, PU 30 & LBG 20.

Fertilizer requirement and time of application: 20N, 50P & 20 K kg/ha. Full N, P & K are applied as basal at the time of sowing.

Weeding & Interculture: First hand weeding 20-30 days after sowing (DAS). Weedicide Basalin @ 2-2.5 litre/ha applied as PPI.

Insect & Disease: Major insect are Aphids, jassids & thrives, Tobacco catter pillers.

Disease – Downy mildew, yellow mosaic.

Greengram or Moong (Vigna radiata)

Selection of Soil: light to medium soil are suitable**.**

Field Prepration: 2-3 plouging finally field should be weed free.

Sowing time: Kharif- Onset of monsoon 15 June to 15 of July**.**

Spacing Row to row- 30cm, plant to plant- 10 cm, depth- 5-7 cm.

Seed treatment: By fungicides like thirum or mencozab 2.5 gm per kg of seed.

Seed rate: 15-20 kg/ha.

Recommended Varieties: SPDM 11, PDM 54, Pusa 105, K 851, Khagone 1, Pusa 16, ML 131, PDM 11, ML 337, BM- 4, Jawahar 721, Pusa Vishals

Fertilizer requirement and time of application: 20N, 50P & K 20 kg/ha. Full N, P & K are applied as basal at the time of sowing.

Weeding & Interculture: First hand weeding 20-30 days after sowing (DAS). Weedicide Basalin @ 2-2.5 litre/ha applied as PPI.

Insect & Disease: Major insect are Aphids, jassids & thrives, Tobacco catter pillers

Disease – Downy mildew, yellow mosaic.

Pigeonpea or Tur (*Cajanus cajan*)

Selection of Soil: Well drained black to medium black are suitable**.**

Field Prepration: Once deep ploughing followed by 2-3 plouging by desi plough and finally leveling of field, it should free from weeds.

Sowing time: Onset of monsoon to 2nd week of July.

Spacing: Row to row & Plant to Plant- Early Vareities- Row to row- 30 cm & P xP- 15 cm, Medium- 60 cm PxP- 20 cm, Late- 75 cm. PxP- 20 cm.

Seed Treatment: Seed treatments with Fugicide Thirum 3 gm for 1.0 kg of seed. Then with Rhizobium culture 5 gm / kg of seed.

Seed rate: 15-18 kg/ha.

Recommended Varieties: Early Maturing: Prabhat, ICPL - 87, Pusa 33 Khargone

Medium Maturing: **Mukta**, Sharda, JA - 4, JKM 7, BAMR 736

Late Maturing- JA 3,Sweata, NP (WR) 15

Fertilizer requirement and time of application: 20.60.20 kg NPK/ha. All are applied as basal.

Weeding & Interculture: First weeding 25-30 DAS. Or, application of weedicide Alachlor 1.5 Lt /ha applied as pre-emergence.

Insect & Disease: Leaf roller, Gallfly**,** Bihar hairy catter pillar, Pod borer . Disease wilt.

Chickpea (*Cicer aeritinum*)

Selection of Soil: medium to deep black well drained soils are suitable**.**

Field Prepration: During kharif 2-3 plouging, rough seed bed.

Sowing time: Up to 30th November.

Spacing Row to row-30 cm, Plant – P- 10, depth-10-12

Seed treatment: With Thirum + Cabandiziam 3 gm in equal proportion per kg of seed. Then seed treatment with Rhizobium culture 5 gm per kg of seed.

Seed rate (kg/ha): 75- 100

Recommended Varieties: JG 74, Gwalior 2, JG 315, PG 5, Vishal, JG 130, JG 11, JG 218, JG 412, JG 16&18 , JAKI 9218, JG 322, Vijay, Radhey, Ujjan 21.

Fertilizer requirement and time of application: 15 -20-, 40-50, 15 kg NPK/ ha. All N, P & K given at the time of sowing.

Weeding & Interculture: First weeding 30-35 DAS. Application of Basalin 1.2 kg a. i as PPI. Before sowing., I

Insect & Disease: Gram catter pillar. Disease - Wilt, root rot.

1.4 COMPOSITION

The composition of protein, fat, minerals, fibre, carbohydrates, minerals and vitamins etc of different pulses is given in Table 2. The protein content of green gram is maximum while that of Bengal gram is minimum.

1.5 PHYSICAL AND MECHANICAL PROPERTIES OF PULSES

The physical and mechanical properties of some of the important pulses like gram, Urad, Arhar and Pea etc. are given in Table 3.

1.6 AMINO ACID COMPOSITION OF PROTEINS

The amino acid composition of proteins in different pulses like black gram, lentil, and dry pea etc. is given in Table 4 &5. While most pulses contain high level of leucine the content of tryptophan is low except in case of black gram. All the pulses are rich in lysine which is essential amino acid for human diet.

Table 2: Composition of Indian Pulses (Per 100 g Edible Portion)

Grain	Protein g	Fat g	Mineral g	Fibre g	Carbohydrates g	Energy k.cal.	Calcium mg	Phosphorus mg	Iron mg	Carotene mg	Thianine mg	Riboflavin mg	Niacin mg	Vitamin mg
Bengal gram (Whole)	17.1	5.3	3.0	3.9	60.9	360	202	312	10.2	189	0.30	0.15	2.9	3
Bengal gram dhal	20.8	5.6	2.7	1.2	59.8	372	56	331	9.1	129	0.48	0.18	2.4	1
Black gram dhal	24.0	1.4	3.2	0.9	59.6	347	154	385	9.1	38	0.42	0.37	2.0	0
Green gram (whole)	24.0	1.3	3.5	4.1	56.7	334	124	326	7.3	94	0.47	0.39	2.1	0
Green gram dhal	24.5	1.2	3.5	0.8	59.9	348	75	405	8.5	49	0.72	0.15	2.4	0
Lentil	25.1	0.7	2.1	0.7	59.0	343	69	293	4.8	270	0.45	0.20	2.6	0
Dry Pea	19.7	1.1	2.2	4.5	56.5	315	75	298	5.1	39	0.47	0.19	3.4	0
Rajmah	22.9	1.3	3.2	-	60.6	346	260	410	5.8	-	-	-	-	-
Pigeon-pea (dhal)	22.3	1.7	3.5	1.5	57.6	335	73	304	5.8	132	0.45	0.19	2.9	0

Table 3: Dimensional Properties, Husk and Cotyledon Content for Different Pulses

S. N.	Pulses	Dimensions (mm)			Sphericity	Cotyledon content (%)	Husk content (%)
		Length	Breadth	Thickness			
1.	Gram	7.0725 to 8.3900	5.2750 to 5.7625	3.4850 to 5.5875	0.7678 to 0.8122	87.21 to 88.71	11.29 to 12.79
2.	Moong	4.375 to 5.2200	3.3125 to 3.8625	3.205 to 3.7075	0.7678 to 0.8595	88.11 to 88.71	11.00 to 8.41
3.	Urad	4.6875 to 5.4825	3.5703 to 4.302	3.1400 to 3.7335	0.7859 to 0.8366	87.33 to 88.11	11.89 to 12.88
4.	Arhar	5.1950 to 5.9625	4.6425 to 5.8575	3.7850 to 4.5475	0.8383 to 0.8917	83.60 to 90.81	9.19 to 16.40
5.	Massor	3.9225	3.7676	2.3775	0.8349	86.53	13.47
6.	Pea	7.0725 to 7.1625	6.5175 to 6.600	5.9275 to 5.8975	0.9174 to 0.9120	85.65 to 87.51	12.49 to 14.35

Table 4: The Amino Acids Content (g/100g Protein) of Common Indian Pulses

Grain	Lysine	Thrionin	Methionine	Cystine	Leucine	Isoleucine	Valine	Phenylalanine	Tryptophan
Bengal gram (chickpea)	7.04	3.52	1.28	1.28	9.28	5.12	4.96	5.76	0.80
Black gram	6.40	3.52	1.44	1.28	8.00	5.44	4.96	4.96	4.96
Green gram	7.36	3.20	1.28	0.96	8.16	5.60	4.12	5.60	0.96
Lentil	7.04	3.52	0.80	1.12	7.52	4.32	4.91	4.32	0.96
Dry pea	7.04	3.84	0.96	0.96	7.20	4.00	4.16	7.36	0.64
Pigeon pea	7.68	3.20	3.36	2.24	8.32	6.56	7.20	5.76	1.44

Table 5: Amino Acids Composition (Mg/100 g) of Pulses

Amino acid	Pulses
Isoleucine	45.3
Leucine	78.9
Lysine	67.1
Methionine & Cystine	25.3
Tryptophan	12.3

Check Your Progress Exercise

Note: a) Use the spaces given below for your answers.

b) Check your answers with those given at the end of the unit.

1) Write the importance of pulses in agriculture.

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2) Give the area, production and average yield of pulses in India.

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3) Write the fertilizers requirement and seed rate of black gram.

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4) Give the four varieties and time of sowing of green gram.

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5) Write the suitable soil types and time of sowing for getting good seed yield of pigeon pea.

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6) Mention four popular varieties of chickpea also name the most damaging insect of this crop.

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7) Write the composition of chickpea.

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8) Mention the physical and mechanical properties of pea.

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9) Give the amino acid composition of pulses.

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1.7 LET US SUM UP

Pulses are very important source of protein. They form an essential adjunct to a predominantly cereal-based diet with enriched biological value in Indian dietary. Besides rich source of protein (20-30 % almost 3 times than that of cereals) they enrich the soil through direct biological nitrogen fixation (an important factor for sustainable agriculture) by Rhizobium. From time memorial pulse crops have been valued as food, fodder and feed.

The common pulses grown in India are black gram, green gram, chickpea, pigeonpea, lentil and pea.

1.8 KEY WORDS

Food Value : Calorific value of food such as pulses, cereals etc.

Pulses : Dried edible portion of cultivated legumes

Pulse Flour : Flour of edible portion of pulses such as Bengal gram, green gram, black gram (known as besan)

Seed Treatment	:	Treatment of seeds by fungicides like thirum etc.
Weeding Practice	:	Removal of weeds during cultivation of pulses
Seed Rate	:	Quantity of seeds to be planted per unit area of the field
Composition of Pulses	:	Content of protein, fat, fibre, vitamins etc. per 100gms of pulses (edible portion after processing)
Physical Properties	:	Refers to length, breadth and thickness of pulses

1.9 SOME USEFUL REFERENCES

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1.10 ANSWERS TO CHECK YOUR PROGRESS

1. Pulses are very important in agriculture because they enrich the soil through biological nitrogen fixation (Rhizobium).
2. In India, total area under pulses production is 21.66 million ha

   production : 13.19 million tonnes

   and average yield of pulses is : 609 kg/ha respectively.
3. NPK requirements of black gram are NPK 20, 50 and 20 kg/ha

   Seed rate – 15.20 kg/ha
4. Varieties are: Pusa vaisakhi, Khargone – 1, Pusa 16 and Jawahar – 22

   Time of sowing: 15th June to 15th of July
5. Black to Medium soil with good drainage capacity is suitable for pigeon pea.
6. Popular varieties of chickpea are JG – 315, JG-315, Ujjain- 21, & Vishal
7. Composition of Chickpea (in 100 g) is:-

   Protein – 17g, Fat (g) - 5.3, Mineral – 3.0, Fibre – 3.9

   Carbohydrate- 60.9, Energy (K.Cal)- 360

   Calcium- 202, Phosphorous- 312, Iron- 10.2

   Carotene- 189, Thianine- 0.30, Riboflavin- 0.15

   Niacin- 2.9, Vitamin- 3.0

8. Physical & mechanical properties of pea are:

Length (mm)	-	7.072 to 7.1625
Breadth (mm)	-	6.517 to 6.600
Thickness (mm)	-	5.927 to 5.897
Spherecity (mm)	-	0.9174 to 0.9120
Cotyledon Content (%)	-	85.65 to 87.51
Husk Content (%)	-	12.44 to 14.35

9. Composition of amino acid of pulses is (mg/100 g)

Isoleucine 4.53, Leucine – 78.9, Lysine – 67.1,
Methionine & Cystine- 25.3, Tryptophan- 12.3