MINISTRY OF FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA

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PM Formalization of
Micro Food Processing Enterprises (PMFME) Scheme

HANDBOOK
FOR
RED GRAM PROCESSING

AATMANIRBHAR BHARAT

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Chapter – 1

1.1 Introduction

Indian economy predominantly centres around agricultural produces with predominant share towards pulses and cereals. Among pulses red gram is a popular crop produced. In India this crop variant is also known as Arhar, Pigeonpea, and tur more common and often. In regards with net capita production worldwide India stands amongst the leaders of Red gram procurers, with about a fair share of 20% worldwide. Being part of the staple food in India, Red gram also serves major fraction of protein (22%) in dietary intake of Indian consumers which is about 3 times higher than compered cereal variants.

Therefore, red gram is among predominant sources of protein for vegetarian consumers.

The common combinations usually served in Indian households are of Pulses+cereals in forma of; Red gram+rice or Red gram+Chapati (wheat bread). Such combinations enhance biological value of the Red gram by using complementary combination for substituting essential amino acids lacking in Red gram. Red gram is also rich in riboflavin, lysin, thiamine, iron and niacin contents.

The importance of Red gram in context could be easily understood from the its usage wherein, even the industrial waste that is outer husk generated once Red gram is processed in form of dal, is also utilized as fodder for the cattle and animals. The nutritional content is consolidated in table number 1 as below:

Table 1: Red gram nutritional constituents of edible part /100gm

S.no	Constituents of red gram	Value
1.	Energy (cal)	335
2.	Protein (g)	22.3
3.	Fat (g)	1.7
4.	Mineral (mg)	13.1
5.	Vitamin	3.6
6.	Riboflavin (mg)	0.45
7.	Niacin (mg)	0.19
8.	Vitamin A. (mcg)	132

In India even developing pods of Redgrams are harvested and their green shelled seeds are often used for curries along with several African and south Asian countries. Whilst frozen and canned products of Red gram are popular for consumption in Caribbean and Latin American countries, presenting golden opportunities for Indian food processors to tap.

The seed coats of Red gram are fibrous envelops called as hull/husk/skin contains anti-nutritional components of polyphenol groups removed during processing by dehulling. This removal also improves organoleptic properties such as appearance, texture and reduces bitter taste along with therefore dehulling is a trivial component in processing of Redgrams. Zone-wise major commercial varieties are listed as below-

Table 2: Most recent varieties of Red gram commonly used in different zones in India.

I. North-Western Zone: (Punjab, Haryana, Rajasthan, Himachal Pradesh, J & K)	
Early varieties	➢ 'Parbhat', 'UPAS 120', 'T 21', 'Pusa Ageti', 'Pusa 74', 'Pusa 84', 'Pant A 1','Pant A 2', 'HPA 1', 'TT 5', 'AL 15', 'Manak', 'H 77-216', 'Sagar' ('H 77-208'), 'BS 1'
Medium varieties	➢ 'Sharda' ('S 8'), 'Mukta' ('R 60')
Late varieties	
II. North-Eastern Zone: (Eastern Uttar Pradesh, Bihar, West Bengal, Orissa, Assam)	
Early varieties	➢ 'Parbhat', 'UPAS 120', 'T 21', 'Pusa Ageti', 'Pusa 74', 'Pusa 84', 'Pant A 1', 'TT 5', 'BS 1'
Medium varieties	183', 'C 11', '20(105)' ('Rabi')
Late varieties	
III. Central Zone: (Madhya Pradesh, Gujarat, Maharashtra)	
Early varieties	➢ 'Parbhat', 'UPAS 120', 'T 21', 'Pusa Ageti', 'Pusa 74', 'J 9-19', 'TAT 10', 'Visakha 1'('TT 6')
Medium varieties	'Khargone 2', 'T 15-15', 'PT 301', 'JA 3', 'No.84', 'No.290-21', 'Hyderabad 185'
Late varieties	
IV. Peninsular Zone: (Andhra Pradesh, Tamil Nadu, Kerala, Karnataka)	
Early varieties	➢ 'Parbhat', 'T 21', 'Pusa Ageti', 'BDN 2', 'PT 221'
Medium varieties	5', 'GS 1', 'CPDM 1', 'F 52', 'C 28', 'SA 1', 'Palanadu'
Late varieties	➢ 'SA 1'

Source: Advances in Pulse Production technology, Jeswani and Baldev.

This process of dehulling is trivial in post-harvest processing of Redgram to make the product ready and safe for human consumption. This report will further discuss in detail mechanised and non-mechanised operations involved in processing of Redgram, packaging, sources of losses (pests' infestations etc.) their prevention, GMP and governing regulations.

Chapter – 2

2.1 Post-Harvest systems of Red gram

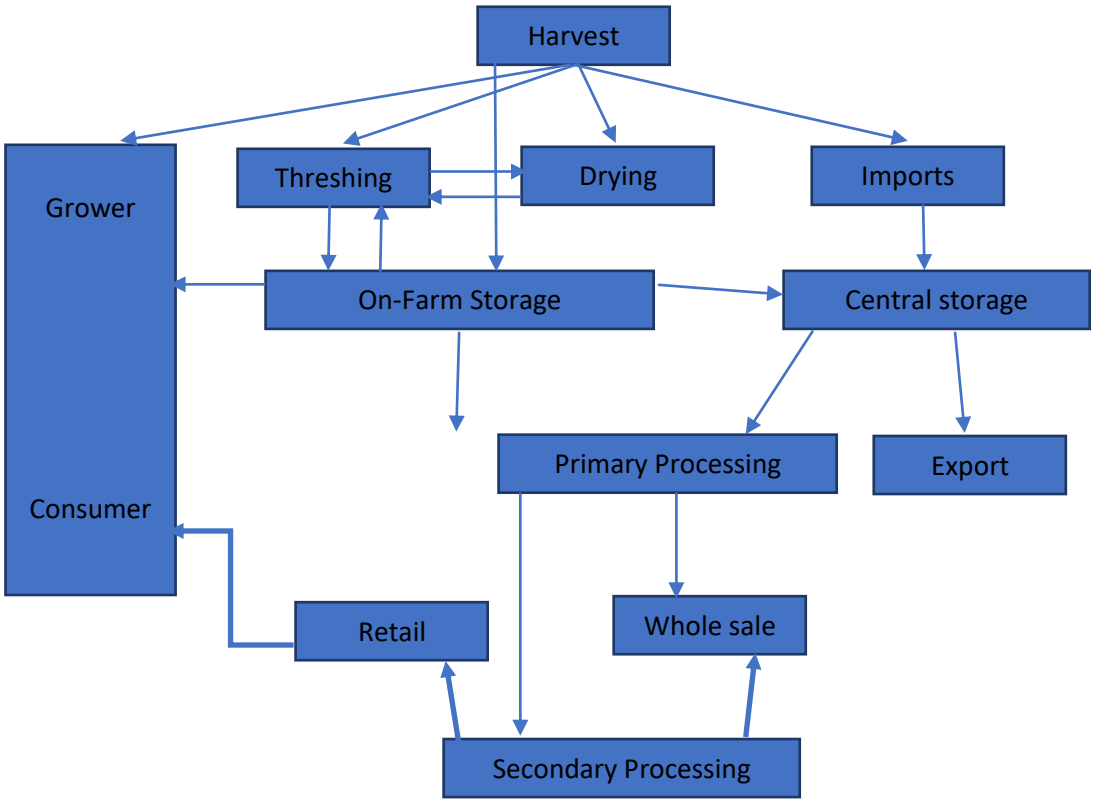


Figure 2.1: Post-Harvest Management of Red Gram (Source: ICAR bulletin 2019)

Processing of Red-grams initiate in the farms itself, where the operations can be either mechanised, manual or semi-mechanised. The red gram is first harvested followed by primary processing of threshing to separate out Redgram seeds, followed by winnowing. The winnowed seeds are transported to mandis or directly to secondary producers. On occasions farmers also require storage, which is referred as primary storage. At every stage some loss is expected owing to either the processing or infestations they are further tabulated under;

S.no	Stages	Expected Production loss (%)
1.	Threshing Yard	0.5
2.	Transport	0.5
3.	Processing (primary and secondary)	1.0
4.	Storage (Primary and secondary)	7.5
	Total losses	9.5

Source: agmarkenet.gov.in; 2021

2.2 Processing of Pulses (red gram)

Pulses are consumed in its dehusked and split form which is termed as dal. Pulse milling (dal milling) is accomplished in three major steps:

a) loosening of husk,
b) dehusking and
c) splitting of pulses.

Traditional methods for processing of pulses were labour intensive, time consuming and incurred losses. Modern technologies for processing of pulses have replaced old age methods and thus avoid losses and saves time.

Pulses undergo some basic unit operations during pulse milling such as cleaning and grading, drying, loosening of husk, dehusking, splitting and polishing.

2.2.1 Wet milling of pulses

Wet method of pulse processing involves cleaning to remove dust, dirt, chaff, stone pieces, immature grains and other seeds. The easy to dehusk pulses are then soaked into water for a period of 2 to 8 hours whereas difficult to dehusk type of pulses (pigeonpea, black gram, green gram) are often treated with red earth. The pulses are subsequently dried and then subjected to dehusking and splitting to obtain Dal.

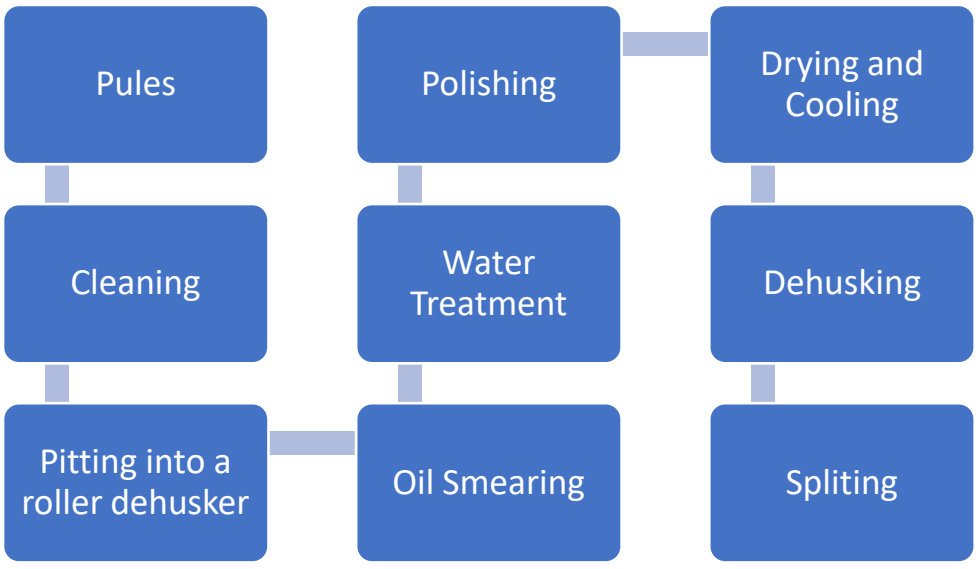


Fig. 2.1: Flow diagram for wet milling of pulse

2.2.2 Dry method of pulse milling

In case of dry method of pulse milling, the pulses after cleaning are fed into roller dehusker where a scratch, dent and crack are formed on the outer seed coat. Pitted pulses are then stored for 2 day to 3 days

after applying oil on the surface. Generally, 150 to 250 gm oil per 100 kg pulses is applied. The oil diffuses between husk and cotyledon and thus facilitates loosening of the husk. Water treatment (2.5 - 3.5 kg water/100 kg pulses for overnight period) helps in further loosening of the husk. Then the pulses are subjected to drying and cooling. Now, the dried pulses are dehusked and splited to obtain dal.

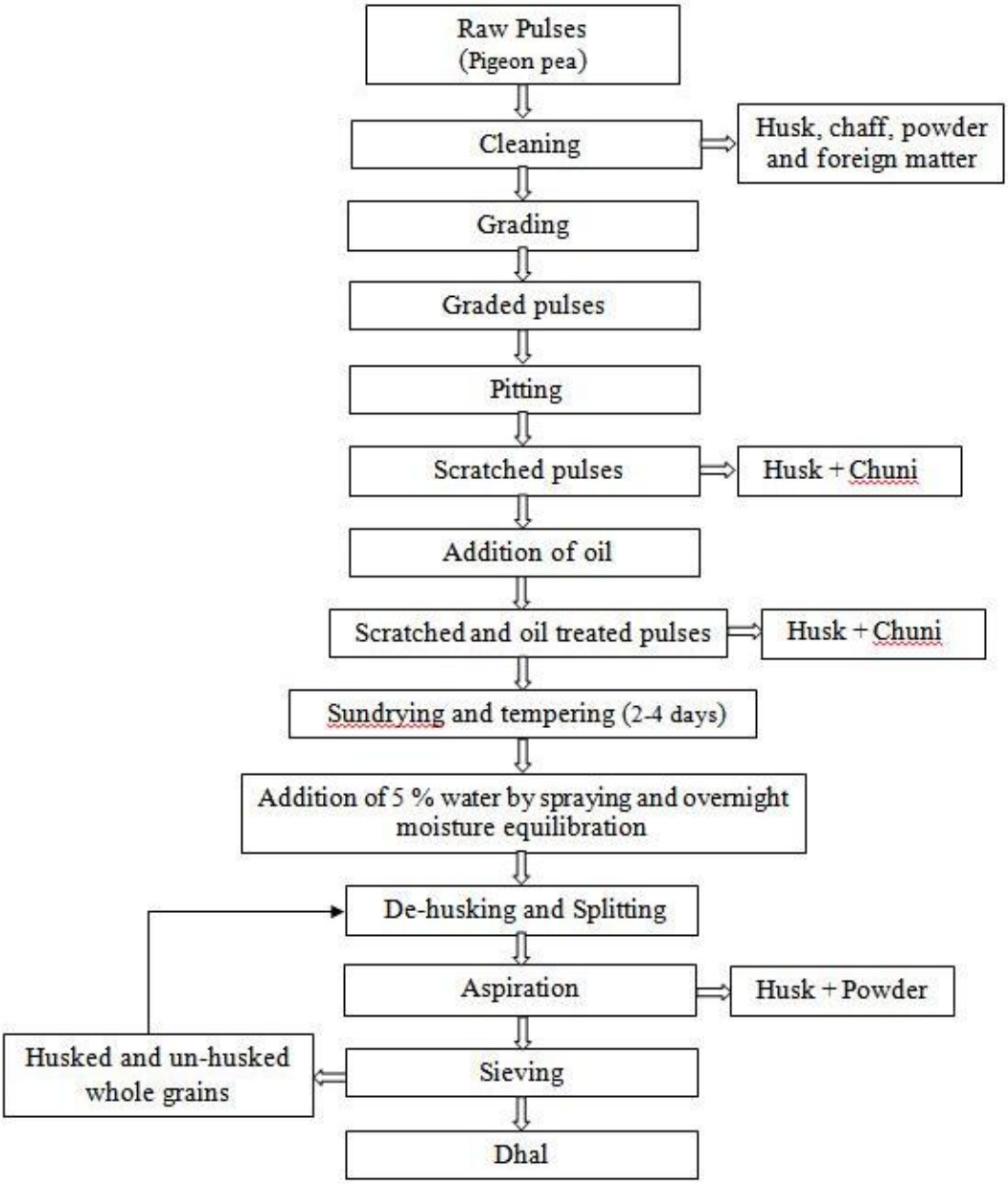


Fig. 2.2: Flow diagram for dry milling of pulse (pigeon pea)

2.3 Important unit operation in the processing of red gram (pigeon pea)

2.3.1 Cleaning: Red gram are first cleaned before milling. For cleaning purpose mostly reciprocating air-screen cleaners and reel screen cleaners are used. Reciprocating air cleaner has two screen having different

size of perforation which are used for separation of lighter materials like dust, leaves, husk etc. In reel screen cleaner there 2-4 cylindrical compartments, having different size of perforation screen which are fitted on a 5-7.5 mm diameter shaft. The cylindrical screen drum rotates at 5-35 rpm.

2.3.2 Drying: Drying of red gram is necessary reduce the moisture content. The process of drying can be performed either through Sun or mechanically. Sun drying process usually take 1-6 days where red gram by spread over the floor/roof in a 5 to 7.5 cm thick layer and followed by manual stirring. Mechanical drying is performed either batch type or continuous flow type at temperature ranges from 600 -1200ºC.

2.2.3 De-hulling: De-hulling operation is performed for the removal of seed coat which also helps in reducing the anti-nutritional factors like tannins and insoluble fiber thus enhancing the quality of nutrition, digestibility of protein, texture, taste etc.

2.2.4 Splitting: Splitting operation involves loosening the bond between the cotyledons and splitting. For cotyledons loosening, water at the rate of 1-5 kg/quintal is applied to dehusked pulse grain (gota) and is stored for 2-12 hours and later sun-dried for 4-8 hours. For splitting, machines like under-run-disc sheller (URD), impact machine (Phatphatia), roller mill, and hitting the gota against the metal sheet at discharge side of bucket elevator are used. In this operation the embryo attached to two cotyledons breaks away, thereby, causing a loss in dal recovery by 1.5 to 2%.

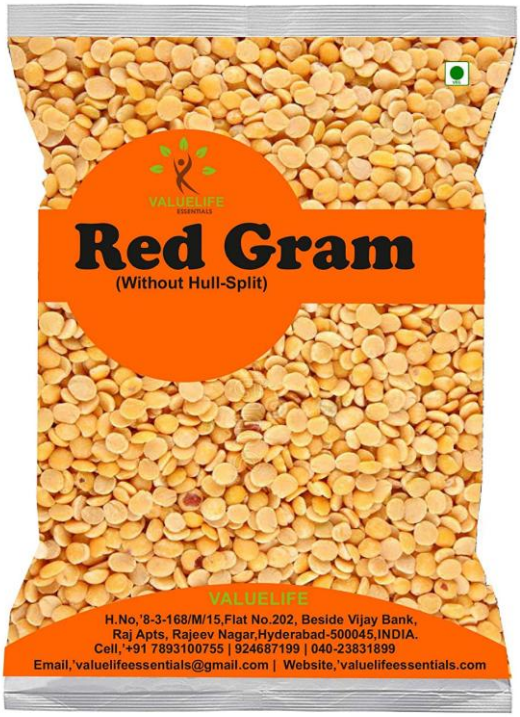
2.2.5 Polishing: In this operation dal is imparted with a glazing appearance to improve its consumer's acceptance and market value. Depending upon the need, different materials like water, oil, soapstone powder and 'selkhari' powder are applied to dal surface. Sometimes removal of sticking powder from dal surface is considered sufficient to improve its surface glaze.

Chapter – 3

3.0 PACKAGING:

Packaging is an important part of food manufacturing process. It protects the food products from physical, chemical, biological damages. Without packaging, food handling would be a messy, inefficient and costly exercise and modern consumer marketing would be virtually impossible. Thus, food packaging lies at the very heart of the modern food industry.

Packaging Institute International defined packaging as the enclosure of products, items or packages in a wrapped pouch, bag, box, cup, tray, can, tube, bottle or other container form to perform one or more of the following functions: containment, protection, preservation, communication, utility and performance. If the device or container performed one or more of these functions, it was considered a package.



3.1 NEED OF PACKAGING:

Packaging performs a series function:

3.1.1 CONTAINMENT: The containment function of packaging makes a huge contribution to protecting the environment from the myriad of products that are moved from one place to another on numerous

occasions each day in any modern society. Faulty packaging (or under-packaging) could result in major pollution of the environment.

3.1.2 PROTECTION: the primary function of the package: to protect its contents from outside environmental influences such as water, water vapor, gases, odors, microorganisms, dust, shocks, vibrations and compressive forces.

3.1.3 CONVENIENCE: Products designed to increase convenience include ready to cook or ready to eat foods which can be reheated in a very short time, preferably without removing the primary package. Thus, packaging helps in convenience of consumer. Convenient packages promote sales.

3.1.4 COMMUNICATION: Packaging contains a lot of information such name of its manufacturer, product name, terms and uses, date of manufacturing, best before. nutritional information thus helping the consumer to be more informed.

3.2 TYPES OF PACKAGING:

3.2.1 PRIMARY PACKAGING:

- Primary package is that package which directly came into contact with food products. It provides first or initial layer of protection to the food products.
- Examples - Metal cans, tea bag, paperboard cartons, glass bottles and plastic pouches.

3.2.2 SECONDARY PACKAGING:

- Secondary package is that package which surrounds or contains the primary package.
- It further used to group primary packages together.
- Act as carriers and many a times also used for the display of primary package.
- Examples are Corrugated case, Boxes.

3.2.3 TERTIARY PACKAGING:

- It contains number of secondary packages together.
- Mainly used for bulk handling of food products.
- Example: stretch-wrapped pallet.

3.2.4 QUATERNARY PACKAGING:

- Quaternary package is mainly used for handling the tertiary packages.
- It generally includes a metal container which can be transferred to or from ships, trains.

3.3 PACKAGING OF RED GRAM PRODUCTS:

Packaging of red gram and its products are mainly done to protect the food products from outside environment especially after the completion of process so that products can retain flavor, aroma, freshness for a longer period of time. Packaging is also done to increase their shelf life. Red gram products can be packed in wide range material which includes LDPE, PET, glass, aluminum etc.

3.3.1 LDPE:

Low-density polyethylene is heat sealable, inert, odour free and shrinks when heated. It acts as a barrier to moisture and has high gas permeability, sensitivity to oils and poor odour resistance. It is less expensive, therefore widely used. One of the great attributes of LDPE is its ability to be fusion welded to itself to give good, tough, liquid-tight seals.

3.3.2 PET:

PET can be made into film by blowing or casting. It can be blow moulded, injection moulded, foamed, extrusion coated on paperboard and extruded as sheet for thermoforming. Melting point of PET is higher than PP which is around 260°C and due to the manufacturing conditions does not shrink below 180°C. Thus, PET is ideal for high-temperature applications. PET is also flexible to low temperature (-100°C). It also acts as good barrier of oxygen and water vapour.

3.3.3 GLASS:

Now a day glass container has been also used for packaging. It has following advantages:

- act as strong barrier to moisture and gases.
- Prevent unwanted odors and microbial growth.
- do not react with food products.
- suitable for heat processing when hermetically sealed
- glass is re-useable and recyclable

- they are transparent to display the contents
- they are rigid, to allow stacking without container damage.

The disadvantages of glass include:

- glass have high weight which increases the transportation cost.
- very much fragile and low resistance to thermal shock as compare to other materials.
- potentially serious hazards from glass splinters or fragments.

3.3.4 ALUMINIUM:

Aluminium is used for packaging due its highly malleable properties: can be easily converted to thin sheets and folded, rolled or packed. Aluminium foil acts as a total barrier to light and oxygen odours and flavors, moistness, and germs, and so it is used broadly in food and pharmaceutical packaging, including long-life packs.

3.3.5 LAMINATE:

The laminates can be formed, filled, gas flushed and sealed on a single machine from reel stock. Gas flushing is achieved by saturating the powder with inert gas. The main advantages associated with laminates are lower material cost and lighter material weight. The disadvantages are that laminates do not have the mechanical strength and durability of rigid containers, and there can be difficulty in obtaining a satisfactory heat seal because of contamination of the heat seal area by powder during filling at high speed.

3.4 SOME RECENT DEVELOPMENT IN PACKAGING:

3.4.1 ASPECTIC PACKAGING

Aseptic packaging is the filling of sterile containers with a commercially sterile product under aseptic conditions, and then sealing the containers so that reinfection is prevented; that is, so that they are hermetically sealed. Application of aseptic packaging involves: packaging of pre-sterilized and sterile product and packaging of a non-sterile product to avoid infection by microorganisms.

The major reasons for the use of aseptic packaging are: to take advantage of high temperature- short time (HTST) sterilization processes, to enable containers to be used that are unsuitable for in-package sterilization and to extend the shelf life of products at normal temperatures.

3.4.2. ACTIVE AND INTELLIGENT PACKAGING

Active packaging is defined as packaging in which subsidiary constituents have been deliberately included in or on either the packaging material or the package headspace to enhance the performance of the package system.

Intelligent packaging is defined as packaging that contains an external or internal indicator to provide information about the history of the package and/or the quality of the food. Sachets and pads are the most widely used forms of active packaging and the various functions which they perform are discussed in the following:

- Oxygen absorber
- Carbon dioxide absorber or emitter
- Ethylene absorber
- Ethanol emitter
- Moisture absorber

3.4.3 MODIFIED ATMOSPHERE PACKAGING

MAP can be defined as packaging of food items where atmosphere inside the packet has been modified to increase the shelf life of food products. It involves active modification or passive modification. In active modification air is displaced with a controlled, desired mixture of gases, and the process is called as gas flushing. Passive modification occurs due to respiration and the metabolism of microorganisms associated with the food. The package structure normally incorporates a polymeric film, and so the permeation of gases through the film also influences the

3.5 Selection of packing material for dal packing

Various types of packaging materials are used for agricultural commodities, appropriate to the product characteristics and to the marketing system. The choice of the type of bag should take into account not only its inherent toughness and resistance to humidity, sunlight and pests but also the type of handling anticipated. The following types of bags may be used for the storage and transportation of grains

- Plant fibre bags
- Jute bags
- Cotton bags
- Sisal bags
- Paper bags
- PP woven bags
- Polyethylene bags

In general, jute, cloth and pp woven bags are used for packaging of pulse grains in bulk in sizes of 50 kg or 100 kg. Polyethylene bags are preferred for packing of pulse grains and value-added products for retail trade.

3.6 LABELING

Labeling performs the communication function of packaging, informing the consumer about nutritional content, net weight, product use and so on. Labeling acts as a silent salesman through distinctive branding, as well as facilitating identification at check-outs through the Universal Product Code (UPC).

There various types of labeling which are as follows:

3.6.1 GLUED-ON LABELS: These are the simplest type and consist of sheet material (typically paper), which has been printed and cut to size. They are attached to the package with adhesive, which is applied either at the time of application, or at the time of manufacture, in which case the adhesive is activated with moisture immediately prior to application.

3.6.2 SELF-ADHESIVE (PRESSURE-SENSITIVE) LABELS: These can be made from paper, plastic or aluminium foil laminated to paper or plastic, and can be produced to adhere to a wide range of materials.

3.6.3 IN-MOLD LABELS: It offers better resistance to heat, moisture and chemical than those labels made from paper. There are also recycling advantages with film labels. IML materials must be able to withstand the container manufacturing process. The heat generated during blow molding presents a challenge to most inks because pigments can change.

3.6.4 SLEEVE LABELS: A wide range of containers can be sleeve labeled including glass bottles, plastic bottles and metal cans. Sleeve labels shrink into or stretch around contours, penetrate variable geometries and conform to irregular features.

3.6.5 HOLOGRAPHIC LABELS: Holographic labels that incorporate a hologram have large application in food packaging for both marketing and security reasons, specifically in the areas of anticounterfeiting (authentication) and brand protection. Surface relief and volume are the most common type of hologram. Surface relief holograms exhibit a characteristic rainbow-colored pattern or image. Volume, or reflection, holograms have a very different appearance to surface relief holograms and are generally used for authentication.

Chapter – 4

4.0 STORAGE OF RED GRAM AND ITS PRODUCTS

The proper storage of red gram and its products with utmost care is very important otherwise it will become stale and rancid much faster which may further alter the aroma and flavor and can also harm the health of consumer. Food products are mainly vulnerable to light, air, heat, odour, and moisture. Thus, the proper storage requires following:

4.1 Dark Place: Processed food products should be always stored in a dark room to avoid it from sunlight or UV light, so that quality such as aroma and flavor should be maintained till final consumption.

4.2 Airtight: To avoid food products from absorbing moisture and unpleasant odour from air.

4.3 Hypothermia: Exposure of food products to heat will ruin its quality thus avoid keeping food products in sunlight or near heat.

4.4 Away from strong odour: Some food products have tendency to absorb any odour quickly thus processed food products must be stored separately.

4.5 Away from moisture.

Chapter – 5

5.1 SANITARY AND HYGIENIC REQUIREMENTS FOR FOOD MANUFACTURER/ PROCESSOR/HANDLER

The place where food is manufactured, processed or handled shall comply with the following requirements:

1. The premises shall be located in a sanitary place and free from filthy surroundings and shall maintain overall hygienic environment. All new units shall set up away from environmentally polluted areas.

2. The premises to conduct food business for manufacturing should have adequate space for manufacturing and storage to maintain overall hygienic environment.

3. The premises shall be clean, adequately lighted and ventilated and sufficient free space for movement.

4. Floors, Ceilings and walls must be maintained in a sound condition. They should be smooth and easy to clean with no flaking paint or plaster.

5. The floor and skirted walls shall be washed as per requirement with an effective disinfectant the premises shall be kept free from all insects. No spraying shall be done during the conduct of business, but instead fly swats/ flaps should be used to kill spray flies getting into the premises. Windows, doors and other openings shall be fitted with net or screen, as appropriate to make the premise insect free. The water used in the manufacturing shall be potable and if required chemical and bacteriological examination of the water shall be done at regular intervals at any recognized laboratory.

6. Continuous supply of potable water shall be ensured in the premises. In case of intermittent water supply, adequate storage arrangement for water used in food or washing shall be made.

7. Equipment and machinery when employed shall be of such design which will permit easy cleaning. Arrangements for cleaning of containers, tables, working parts of machinery, etc. shall be provided.

8. No vessel, container or other equipment, the use of which is likely to cause metallic contamination injurious to health shall be employed in the preparation, packing or storage of food. (Copper or brass vessels shall have proper lining).

9. All Equipment shall be kept clean, washed, dried and stacked at the close of business to ensure freedom from growth of mould/ fungi and infestation.

10. All Equipment shall be placed well away from the walls to allow proper inspection.

11. There should be efficient drainage system and there shall be adequate provisions for disposal of refuse.

12. The workers working in processing and preparation shall use clean aprons, hand gloves, and head wears.

13. Persons suffering from infectious diseases shall not be permitted to work. Any cuts or wounds shall remain covered at all time and the person should not be allowed to come in direct contact with food. 14. All food handlers shall keep their finger nails trimmed, clean and wash their hands with soap, or detergent and water before commencing work and every time after using toilet. Scratching of body parts, hair shall be avoided during food handling processes.

15. All food handlers should avoid wearing, false nails or other items or loose jewellery that might fall into food and also avoid touching their face or hair.

16. Eating, chewing, smoking, spitting and nose blowing shall be prohibited within the premises especially while handling food.

17. All articles that are stored or are intended for sale shall be fit for consumption and have proper cover to avoid contamination.

18. The vehicles used to transport foods must be maintained in good repair and kept clean.

19. Foods while in transport in packaged form or in containers shall maintain the required temperature.

20. Insecticides / disinfectants shall be kept and stored separately and `away from food manufacturing / storing/ handling areas.

5.2 Documentation and Record Keeping

Every organization has to maintain records of raw material procurement, production processes, and sales. This is to ensure that the business runs effectively and is profitable. Listed below are some reasons why there is a need for documentation:

1. It gives detailed knowledge about running the business.
2. It helps to control product quality.
3. It helps to keep track of the money invested in the business.
4. It helps to identify the separate costs of raw material or product ingredients.
5. It helps to identify the production cost of a particular process.
6. It helps to make sure that all the quality assurance practices were followed during the production.
7. It helps to make sure that the production equipment is running smoothly/effectively.
8. It works as an evidence for legal procedures.

9. It helps to set an appropriate product price.
10. It helps to take corrective measures at the right time.

5.3 How to Keep Records?

Every food processing organization follows a more or less similar way of keeping records. Production records keep a log of the following:

- The quantity and type of raw materials received
- The quantity and type of ingredients used during processing
- The processing conditions in which production took place (e.g. the temperature set or the air pressure applied)
- The product quality produced

Product quality can be maintained only when:

- The same quantity and quality of ingredients and raw materials are mixed in every batch
- A standard formulation is used for every batch
- Standard process parameters are applied for every batch

Every batch of food is given a batch number. This number is recorded in:

- Stock control books (where raw material procurement is noted)
- Processing logbooks (where production process is noted)
- Product sales records (where sales and distribution is noted)

The batch number must correlate with the product code number, which is printed on labels. This helps the processor to trace any fault found in a batch back to the raw material used or the production process.

5.4 Plant Performance and Monitoring:

➢ Carryout regular monitoring program involving maintenance of record and analysis of effluent sample.

➢ ETP assistants have to collect samples at different stages of treatment system in presence of ETP in-charge for analysis.

➢ ETP in-charge has to do the analysis and record the result also report the result to EHS-engineer and EHS-officer. EHS-engineer and EHS-officer both will assess the performance of the plant based on

laboratory analysis report and instruct the ETP in-charge and assistants about the action to be taken in case of any deviation from normal.

- The treated effluent has to be analyzed on daily basis and the results are recorded

5.5 Environmental Management System (EMS): Implementation and operation:

2. **Level-1:** EMS manual; describes the core elements of the EMS and their interactions. It outlines the structure of the document used in the EMS in line with-ISO 14001-2004 manual also describe the procedures elaborately how various requirements of ISO 14001-2004 are implemented.
3. **Level-2:** Documents; the filled formats which conveys the data that affects the environment. Ex – Operational control process, environmental management programs, emergency procedures, monitoring and management plans, training plan etc.
4. **Lavel-3:** Formats; used for recording and conveying data effecting the environment