



PM Formalization of Micro Food Processing Enterprises (PMFME) Scheme

HANDBOOK OF LENTILS



AATMANIRBHAR BHARAT

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ABBREVIATIONS

1	PET	Polyethylene terephthalate
2	LDPE	Low-density polyethylene
3	FSSAI	Food Safety and Standards Authority of India

Introduction

Lentil or masoor (*Lens culnaris Mediu.*) is one of the oldest food crops. Its cultivation dates back to beginning of agriculture itself. Lentil is a valuable human food. Mostly it is consumed as a dry seed (whole decorticated and split). It is also ground into flour to make variety of preparation. In India, it is commonly consumed as dal (seed boiled and meshed in to soup). It is also used in preparation of several snakes and sweets. The straw and pod walls have high feed value. De-hulled lentil seed contain 24-26% protein, 1.3 % fat, 2.2 % ash, 3.2 and fiber and 57% carbohydrate. It is a rich source of calcium (68 mg/100g seed). It is also rich in vitamins C and riboflavin.

Taxonomy:

As per Joshi et al., (2017) its taxonomic description is as follows:

Kingdom- Plantae

Subkingdom- Angiosperm

Division- Eudicots

Subclass- Rosids

Order- Fabales

Family- Fabaceae

Sub-family- Faboideae

Tribe- Vicieae

Genus- *Lens*

Species- *culinaris*

Production:

According to data from FAO in 2016 (FAOSTAT statistics, 2014), the average annual global lentil production was estimated to be 4.457 million metric tons between 2009 and 2013. India ranked first in terms of land and second in terms of production, with 39.79 per cent and 22.79 per cent of world area and production respectively. Canada ranked first in lentil production (41.16%) due to a very high level of productivity (1633 kg/ha) compared to India (611 kg/ha).

According to the Economics and Statistics Directorate, during the Twelfth Plan (2012-15) the Lentil region of the country was 14,79 lakh hectares with a production of 10,38 lakh tonnes. Madhya Pradesh ranks 1st in acreage i.e. 39.56 per cent (5.85 lakh ha) followed by UP (34.36 per cent) and Bihar (12.40 percent). UP ranks first with 36.65 percent (3.80 lakh tonnes) in terms of production, followed by Madhya Pradesh (28.82 percent) and Bihar (18.49 percent). The highest yield was recorded by the state of Bihar (1124 kg/ha), followed by West Bengal (961 kg/ha) and Jharkhand (956 kg/ha). The national average yield was 753 kg/ha. The lowest yield was observed in Maharashtra (379 kg/ha) and Chhattisgarh (410 kg/ha).

Selection of raw material/variety/cultivar

Lentil is one of the main grain legumes commonly cultivated in India. In Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar, Orissa, West Bengal, and Assam, Lentil is ideal for rice-fallows. The main growing areas for lentils are Bihar and Uttar Pradesh.

Varieties most suitable for these areas are as follows:

1) Pant L 406:

A selection from genoplasm line P 495, released in 1979, widely adapted, matures in 135-140 days, semi-spreading plant type, green foliage, seeds grey mottled and small (1.8 g/ 100 seeds), resistant to rust, tolerant to wilt/root rot diseases, suitable for North-West and North-East plains, and average yield 14-15 q/ha.

2) Pant L 639:

Developed from cross L 9-12 x T 8, notified in 1982, widely adapted, matures in 135-140 days, semi-spreading, light green foliage, seeds grey mottled and small (1.9 g/ 100 seeds), resistant to rust, and tolerant to wilt/root diseases, suitable for North- West and North-East plains, and average yield 14-15 q/ha.

3) Pant L 4:

Developed from cross UPL 175 x (PL 184 x P 288), released in 1993 for North- West plain zone, semi-spreading, foliage green, seeds grey mottled and small (1.9 g/100 seeds), resistant to rust, and wilt/root rot diseases, matures in 135-140 days and average yield 15-16 q/ha.

4) VL Masoor 1:

A selection from hill land race, notified in 1983 for hills of Uttar Pradesh (Now Uttaranchal), matures in 165 days, light green foliage, seed coat black, seeds small (1.9 g/100 seeds), tolerant to rust and wilt diseases and average yield 11 q/ha.

5) Arun:

Mutant of BR 25, notified in 1986 for Bihar, matures in 115-120 days, medium bold seeded, tolerant to rust and wilt diseases, average yield 12-13 q/ha.

6) Ranjan:

Mutant of B 77 (Asha), notified in 1984 for West Bengal, spreading plant type, flowers white, seeds mottled and small (1.8 g/ 100 seeds), average yield 12 q/ha.

7) Lens 4076:

Developed from cross Pant L 234 x Pant L 639, released in 1993 for North-West plain and Central zones, semi-spreading plant type, deep green foliage, seeds bold (3.1 g/ 100 seeds), grey mottled, resistant to rust, average yield 12-14 q/ha in NWPZ and 10-12 q/ha in CZ.

8) K 75 (Malika):

A selection from Bundelkhand local, released in 1986 for NEPZ and CZ, semi - spreading, deep green foliage, seeds bold (3.0 g/100 seeds), average yield 12-14 q/ha in NEPZ and 10-12 q/ha in CZ.

9) LH 84-8 (Sapna):

Developed from cross L 9-12 x JL 2, released in 1991 for NWPZ, semi-spreading, green foliage, matures in 135-140 days, seeds bold (2.7 g/ 100 seeds), tolerant to rust disease, average yield 14-15 q/ha.

10) DPL 15 (Priya):

Developed from cross PL 406 x L 4076, released in 1995 for NWPZ, semi-spreading, green foliage, matures in 135-140 days, seeds bold (2.7 g/ 100 seeds), resistant to rust, tolerant to wilt/root rot diseases, average yield 14-15 q/ha.

11) DPL 62 (Sheri):

Developed from cross JLS 1 x LG 171, released in 1997 for NWPZ, semi -erect, foliage green, less hairy, resistant to rust and wilt diseases, matures in 130-135 days, seed grey mottled and bold (3.4 g/100 seeds), average yield 17 q/ha.

12) WBL 58 (Subrata):

Developed from cross JLS 2 x T 36, released in 1998 for West Bengal, semi-spreading, green foliage, tolerant to rust, matures in 120-125 days, average yield 12-13 q/ha.

13) JL3 (Jawahar Masoor 3):

A selection from local germplasm of M.P., released in 1999 for CZ, erect plant type, dull green foliage, tolerant to wilt disease, matures in 115-120 days, seeds grey mottled and bold (3.0 g/100 seeds), average yield 12-14 q/ha.

14) IPL 81 (Noori):

Developed from cross K 75 x PL 639, released in 2000 for Central Zone, semi-spreading, green foliage, tolerant to rust and wilt, matures in 115-120 days, seeds grey mottled and bold (2.7 g/100 seeds), average yield 12.5 q/ha.

15) Pusa Vaibhav (L 4147):

Duration – 120 days, Yield – 17 q/ha

Remarks – IARI, New Delhi, 1996, Resistant to rust, small seeded, NWPZ.

16) KLS 218:

Duration – 120-125 days, Yield – 13 q/ha

Remarks – CSAU, Kanpur, 2005, Resistant to rust, small seeded, NEPZ.

17) HUL 57:

Duration – 121 days, Yield – 14 q/ha

Remarks – BHU, Varanasi, 2005, Resistant to rust, small seeded, NEPZ

18) VL-126:

Duration – 160-170 days, Yield – 13 q/ha

Remarks – VPKAS, Almora, 2006, small seeded, Resistant to rust, NHZ

Table 1: Disease resistant/ tolerant varieties

Sr. No.	Disease	Varieties
1.	Rust	Pant L 406, Pant L 639, Pant L 4, L 4076, Sapna, Priya, Sheri, IPL 81, Vaibhav, LL 56, LL 147
2.	Wilt	Pant L 406, Pant L 639, Pant L 4, L 4076, Priya, Sheri, Jawahar Masoor 3, Vaibhav, IPL 81

Table 2: Recommended Varieties of Lentil (State-wise)

Sr. No.	State	Small seeded	Bold seeded
3.	Jammu and Kashmir	Pant L 406, Pant L 639	-
4.	Himachal Pradesh	Pant L 406, Pant L 639	Vipasha
5.	NEH	Pant L 406, Pant L 639	
6.	Punjab	LL 56, LL 147, Pant L 4, Vaibhav	L 4076, Sapna, Priya, Sheri
7.	Haryana	Pant L 4, Vaibhav	L 4076, Sapna, Garima, Priya, Sheri
8.	Delhi	Pant L 4, Vaibhav	L 4076, Sapna, Priya, Sheli
9.	Uttaranchal	VL Masoor 1, VL Masoor 4	
10.	Uttar Pradesh (West)	Pant L 4, Vaibhav	L 4076, Sapna, Priya, Sheri
11.	Uttar Pradesh (East)	Pant L 406, Pant L 639	Malika
12.	Uttar Pradesh (Bundelkhand)	-	Malika, L 4076, JL 3, Noori
13.	Bihar and Jharkhand	Pant L 406, Pant L639, Arun	Malika
14.	West Bengal	Pant L 406, Pant L 639, Ranjan	Malika, Subrata
15.	Madhya Pradesh and Chhattisgarh	-	JL 1, Malika, L 4076, Jawahar Masoor 3, Noori
16.	Maharashtra	-	Malika, L 4076, Noori, Jawahar Masoor 3
17.	Rajasthan	-	Malika, L 4076, Jawahar

Post-harvest management

Crop is ready for harvest when leaves begin to fall, stem and pod turn brown or straw in color and the seeds are hard and scrape with 15% moisture inside. Over-ripening can lead to a drop in pods as well as shattering and cracking of seeds if the moisture content of the seed falls below 10% due to delays in harvesting. The crop should be allowed to dry on the threshing floor for 4-7 days and threshed manually or by a bullock/power-drawn thresher. Clean seeds should be sun-dried for 3-4 days, taking their moisture content to 9-10 per cent. The seed should be stored safely in suitable bins and fumigated to protect it from bruchids (Anonymous, 2017)

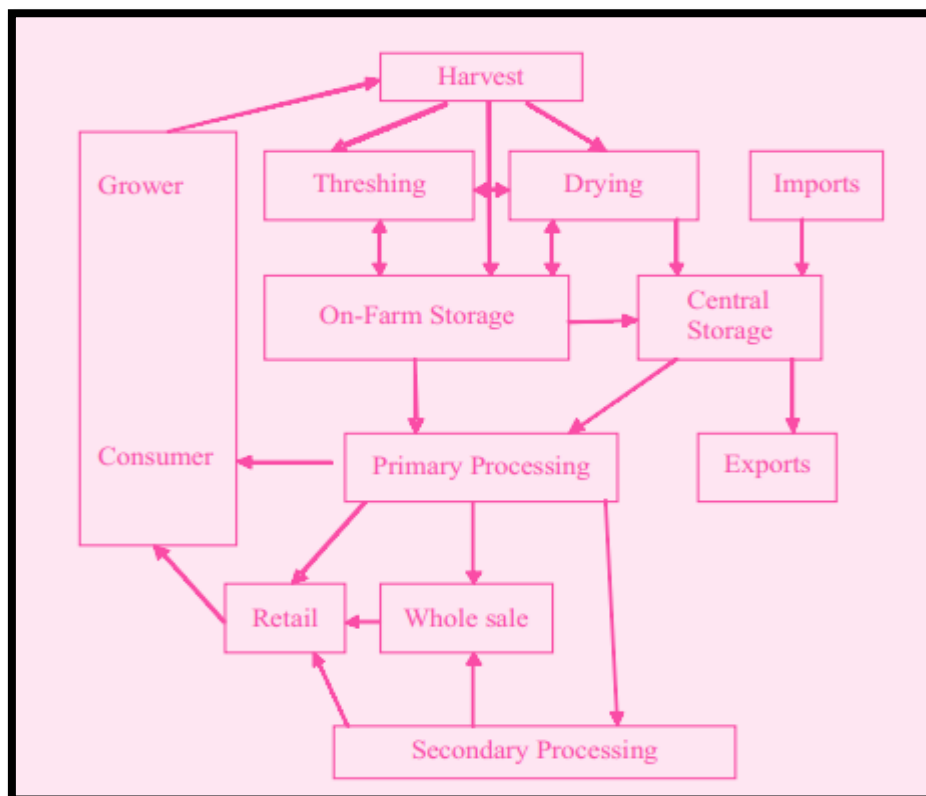


Figure 1: Post-harvest system of Lentils

Source: Lal and Verma, 2007

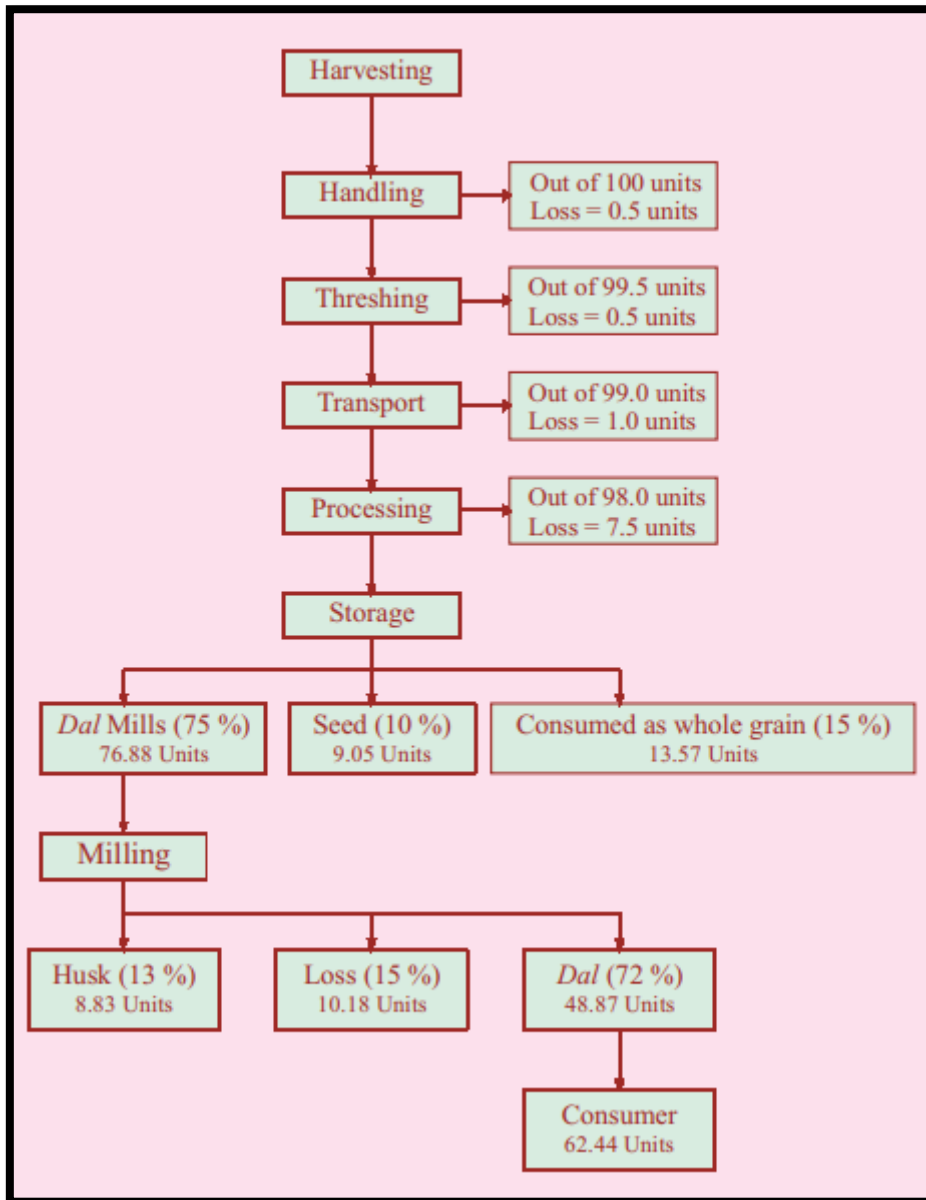


Figure 2: Post harvest profile of Pulses

Source: Lal and Verma, 2007

Post harvest operations:

Various technologies for post-harvesting lentil operations are available, in other words. Traditional or modified methods used in different phases of the post-harvest scheme, depending on the resourcefulness of the farmer growing the crop.

Table 3: Traditional and improved technologies for post-harvest operations

Sr. No.	Post-harvest operations	Traditional technologies	Improved technologies
1.	Harvest	Manual	Manual and mechanized

2.	Pre-drying	Standing or in shocks	Standing or in shocks
3.	Storage of harvested crops	In fields or on threshing floor	In fields or on threshing floor
4.	Threshing	Manual	Mechanized
5.	Pre-cleaning	Hand winnowing	Mechanized
6.	Drying	Natural	Artificial
7.	Cleaning and sorting	Winnowing in the wind	Mechanized
8.	Storage of grains	In traditional granaries	In bags or in bulk
9.	Processing/Milling	Manual	Mechanized

Post harvest losses:

Post-harvest losses mean a quantitative and qualitative loss that occurred in a given commodity during the different phases of the post-harvest method. Seeds of poor quality, improper farming practices and insect infestation in the field can cause loss of output even before harvesting. From harvest onwards, the grain undergoes a series of operations during which quantitative and qualitative losses may occur.

Table 4: Post harvest losses at different stages

Sr. No.	Stage of operation	Type of loss
1.	Late harvest	Shattering losses, losses due to attack of birds and other pests
2.	Insufficient drying of grain	Losses due to development of moulds and insects
3.	Improper threshing	Broken grains and threat of insect development at a later

		stage
4.	Poor storage	Losses caused by combined action of insects, moulds, rodents and other pests
5.	Improper milling	Broken and powdering los
6.	Transport	Quantitative loss
7.	Defective packaging	Quantitative and qualitative los

Harvesting:

Harvest is the method by which the usable portion or sections of the plant are gathered and carried out at the time of development of all the nutrients and the sufficient maturity of the edible parts. In general, harvesting takes place 10 to 15 days after the grain has attained physiological maturity. Lentil harvesting should take place at a time when the grain has moisture content in the range of 15-20 percent and the upper leaves of the plant are dry, while the pods turn pale yellow.

The plants are pulled up and allowed to pre-dry in the sun in order to harvest the pulse crops by hand. This procedure should be conducted early in the morning, whilst the night's dampness minimizes the chance of losses. In the case of pulse crops, mechanized harvesting is minimal due to the shortage of automatic harvesters at a reasonable price

Pre-drying:

This is the stage of the post-harvest phase during which the processed commodity is dried in order to undergo the next threshing process. The cut parts of the plant may contain too much green plant matter at the time of harvesting, and all the grains may not have attained a consistent degree of maturity and may be too high in moisture content. This makes pre-drying essential.

Pre-drying can be done in two ways:

1. Once maturity has been reached, allow the crops to stand in the field before harvesting for pre drying.

- Place the stacks of freshly harvested crops in the field or on the dry ground. Prolonged air exposure (in the sun or in the shade) decreases the grain's moisture content to the optimal amount.

Threshing:

Threshing" is the method of separating the grains from the plants. These activities can be carried out by hand, or with the aid of animals or machines, in the field or on the threshing floor.

Table 5: Threshers suitable for lentils

Sr. No.	Threshers	Technical details	Capacity (kg/h)
1.	Sonalika	25 hp tractor, Peg type, Single blower	300-350
2.	CIAE	7 hp motor, Peg type, Double blower	300-450

Drying:

Usually, after threshing, the moisture content of grains remains higher than the desired for safe grain storage (13-14 percent). Drying is a process of the post-harvest method during which the product is dried quickly until it meets the safe-moisture level. The purpose of the drying process is to reduce the moisture content of the grain for safe storage and further processing. Essentially two methods are used for drying grain, i.e. natural drying and artificial drying.

- Natural drying:** In order to achieve the desired moisture level, the grain is spread over the drying floor in thin layers where it is exposed to air. Period can vary based on the moisture content required for safe storage. In order to ensure uniform drying, the grain must be stirred constantly, particularly if it is in direct sunlight.
- Artificial drying:** Here, heated air (dryers) or unheated air (dehumidifiers) is blown through a grain mass. This is the most commonly used practice in semi-humid and humid environments where natural drying cannot be used. Artificially heated air is required to flow through a grain mass in bulk or in bags to absorb moisture from the grain mass.

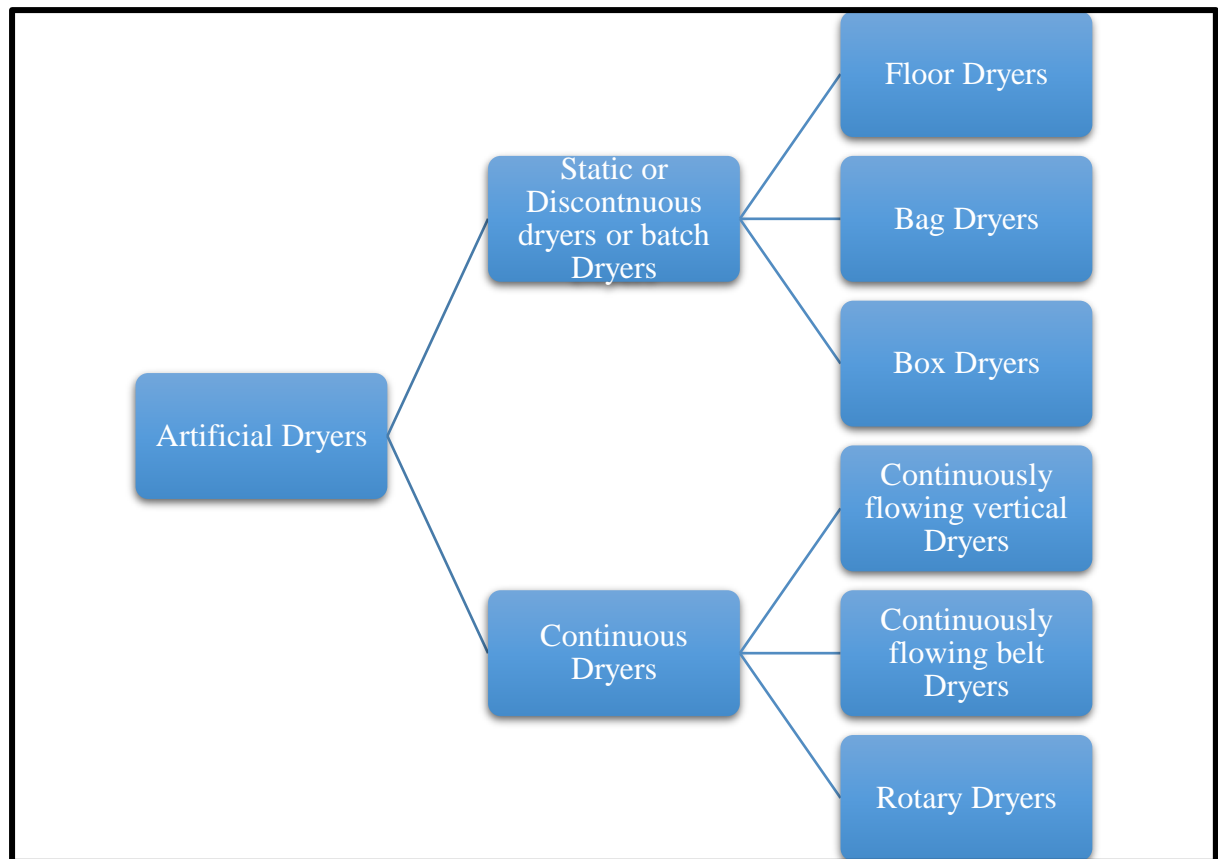


Figure 3: Types of Dryers

Storage:

Means the process of the post-harvest method during which the goods are kept in such a way as to guarantee food security other than during the time of agricultural production.

Important points to be considered while storage:

1. The best way to maximize the shelf life of stored grain is to lower the temperature of the storage room. The stored life of most foods is reduced by half per 10⁰C rise in temperature.
2. If necessary, the temperature of the storage area should be lower than 25⁰C but above freezing temperature. Likewise, the storage chamber's relative humidity should be 15% or below particularly if grains are stored for the purpose of seed storage.
3. For a 1% decrease in moisture content, grain storage life is doubled when grain moisture content is between 5 and 14 per cent.
4. For every 5⁰C reduction in storage temperature, the storage life of the grain is doubled when the temperature is between 0 and 50⁰C.

Nutritional composition

Table 6: Nutritional value of lentil per 100 g dry weight

Sr. No.	Nutrient	Whole Lentils	Split Lentils
1.	Energy	1,477 kJ	1443.5 kJ
2.	Carbohydrates	60 g	59.2 g
3.	Sugars, total	2 g	-
4.	Dietary fiber	30.5 g	10.8 g
5.	Fat	1.1 g	2.2 g
6.	Protein	25.8 g	25 g
Vitamins			
7.	Vitamin A	39 IU	58 IU
8.	Thiamine (B1)	0.9 mg	0.5 mg
9.	Riboflavin (B2)	0.2 mg	0.1 mg
10.	Niacin (B3)	2.6 mg	1.5 mg
11.	Pantothenic acid (B5)	2.1 mg	0.3 mg
12.	Vitamin B6	0.5 mg	0.4 mg
13.	Folate (B9)	479 µg	204 µg
14.	Vitamin C	4.4 mg	1.7 mg
Minerals			
15.	Calcium	56 mg	41 mg
16.	Iron	7.54 mg	7.6 mg
17.	Magnesium	122 mg	72 mg
18.	Phosphorus	451 mg	294 mg
19.	Potassium	955 mg	578 mg
20.	Sodium	6 mg	7 mg
21.	Zinc	4.78 mg	3.9 mg
Other constituents			

22.	Water	10.4 g	11.8 g
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Units μg = micrograms, mg= milligrams, IU, International Units

Source: USDA National Nutrient Database for Standard Reference, Release 23 (2011)

Lentils are known to be among the good sources of prebiotics (Dwivedi et al., 2014) and produce nutritionally significant amounts of prebiotic carbohydrates, including oligosaccharides (RFO), sugar alcohols, fructo-oligosaccharides (FOS) and resistant starch (RS) carbohydrates. Total prebiotic carbohydrate concentrations of lentils suggest that a 100 g portion of lentils may provide more than 13 g (12.3 g-14.1 g) of prebiotics, stressing the role of lentils as the leading source of these prebiotic carbohydrates (Johnson et al., 2013).

Products of Lentil:

I. *Whole lentil:*

Introduction

Whole lentil can be primarily processed, packaged and marketed.



Figure 4: Whole lentil

Processing

To achieve packaged whole lentil the under given steps are to be followed-

a) Cleaning

The cleaning process requires fixed and mobile cleaning machines, depending on various concepts, in order to obtain the export of a commodity containing more than 3% of foreign matter in pulses, to ensure compliance with food legislation, to avoid excessive transport of foreign matter to consumption points or export ports and to use the full storage capacity (MEB, 2011).

Dry cleaning process; coarse separation, fine separation, magnetic separation, peeling and stone separation are added to pulses. Usually, dry cleaning equipment makes the distinction according to individual weight. Lighter powder, husk and other foreign material are removed by airflow (MEB, 2011).

In the case of coarse separation, usually rough sieves, vacuum cleaners (aspirator sieve, duo vacuum cleaners, and classification vacuum cleaners), cylindrical sieves, scalpels (drum, vibro, circular) and selectors are used. The coarse cleaning materials are then re-cleaned in fine separators. Silo aspirator purifiers, mill aspirator purifiers and triières are used in fine separation. Magnetic separation happens as the metal parts within the pulses are taken up by the magnets. When peeling, scraping and friction motions are used to remove the outer layer of the finished product, stone separators of various forms but with the same functions are used for the separation of stones. (MEB, 2011).

b) Calibration:

The cleaned product is subject to a calibration process. The calibration process is conducted by screening machines. The aim of the calibration is to obtain uniform groups by lowering foreign materials to the required level and by improving and classifying the quality for commercial purposes. Calibration is often carried out in order to achieve a homogeneous structure and to standardize the product in terms of cooking time for the final consumer.

c) Sorting:

The pulses passing through the calibration process are exposed to color sorting and hand sorting. In a color-based sorting process, the main aim of sorting is to distinguish the colored grains in the unit. In this way, a computer-based color sorting system is used and is especially used in the production diagrams. In our country, the color sorting method for the production of pulses is used up to 90%. By sorting machine, the elimination of foreign seeds and tiny stone particles that escape from the stone separator, homogeneous colour, clean and high quality pulses is obtained.

Items from the sorting machine are subject to hand sorting. Manual sorting is carried out by selectors on both sides of a selection band of lengths ranging from 5 to 7 meters in order to select foreign matter and damaged particles under hygienic conditions. Defective product separation channels occur in the selection bands. The bands typically have a stainless steel body. In the selection band, there is a lighting and speed control system. Hand sorting is specifically influenced by variables such as light setting, band setting, speed setting, and

number of employees. Finally, the pulses passed by the hand sorting process are passed through the metal detector, which extracts the metal bits and then packaging

d) Packaging:

Cellophane, polyethylene (PE) carton packets, polyethylene bags are used as packaging for the protection of pulses from moisture and insects. In addition to this, it has recently become widespread as a paper/PE/foil/PE spectacle packaging material. In general, volumetric full automatic filling system and vertical form packing machines are used for the packaging of pulses. The packets are passed through metal detectors for any possible metallic impurities. The shelf life of the pulses, which were cleaned, calibrated, sorted, packed and served, is as long as two years.

Equipments



Figure 5: Soaking and washing machines



Figure 6: Magnetic separator



Figure 7: De-stoner



Figure 8: Automatic pulse cleaning machine



Figure 9: Sorting Machine



Figure 10: Packaging machine



Figure 11: Metal detector

HACCP plan for whole lentil

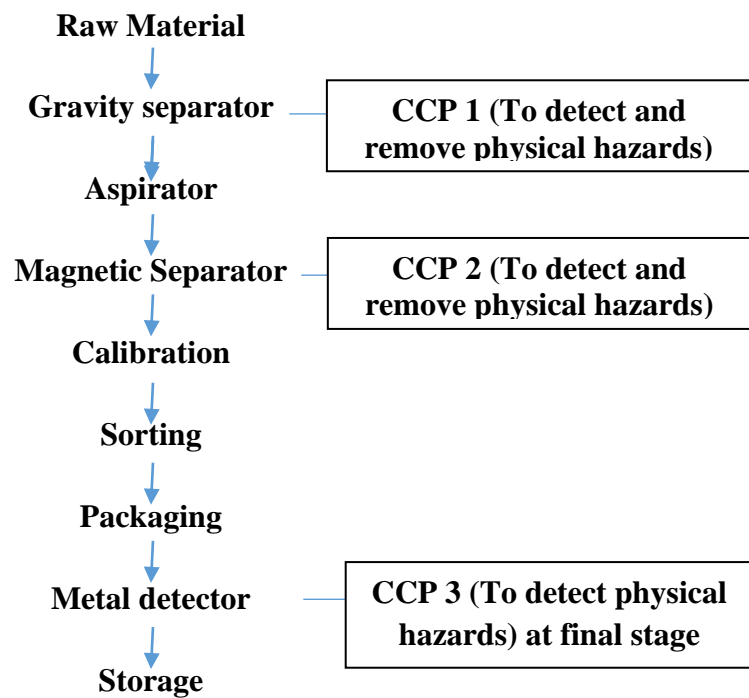


Figure 12: HACCP plan for whole lentil**II. *Split lentil pulse:*****Introduction**

Whole lentil can be de-husked, decorticated, split and polished to achieve split lentil pulse which can be packaged and marketed.

**Figure 13: Split lentil pulse****Processing**

- (a) After cleaning, calibration and sorting operations as mentioned above, some operations are carried out, such as de-husking, drying, splitting and polishing.
- (b) De-husking

Usually, carborundum/emeric coated rollers are used for de-husking of different pulses. Cylindrical or taper rollers are used for this purpose. Rollers are available in various sizes based on power requirements, capacity, roller size and speed. Oil/Water applications are conducted on pitted pulses. Screw conveyors with full or cut screw are used as the screw slowly moves the grain along with the oil/water application at the conveyor entry.
- e) Drying

Sun drying has traditionally used, but because it is a based operation, many dryers are used for this purpose.
- f) Splitting

Roller mills, under runner disk sheller, attrition mill (chakki), elevator and hard surface and impact sheller are used to split the de-husked pulses.
- g) Polishing

It denotes the removal of powder from de-husked splits and the use of oil and water to make the split lentil shine and luster. Cylindrical hard rubber roll, leather belts or emery cone polishers are used for this purpose. Rollers fitted with brushes can also be used to give the lentil shine.

h) Powder and husk separation:

Husk and powder is separated from the de-husked and polished split pulses by using suction fan or blower.

i) Packaging:

Similar as given for whole lentils

Equipments



Figure 14: Soaking and washing machines



Figure 15: Magnetic separator



Figure 16: De-stoner



Figure 17: Automatic pulse cleaning machine



Figure 18: Sorting machine



Figure 19: Tray Dryer



Figure 20: Rotatory drum drier



Figure 20: Milling machine



Figure 21: Polishing machine



Figure 22: Packaging machine



Figure 23: Metal detector

HACCP plan for Split lentil pulse

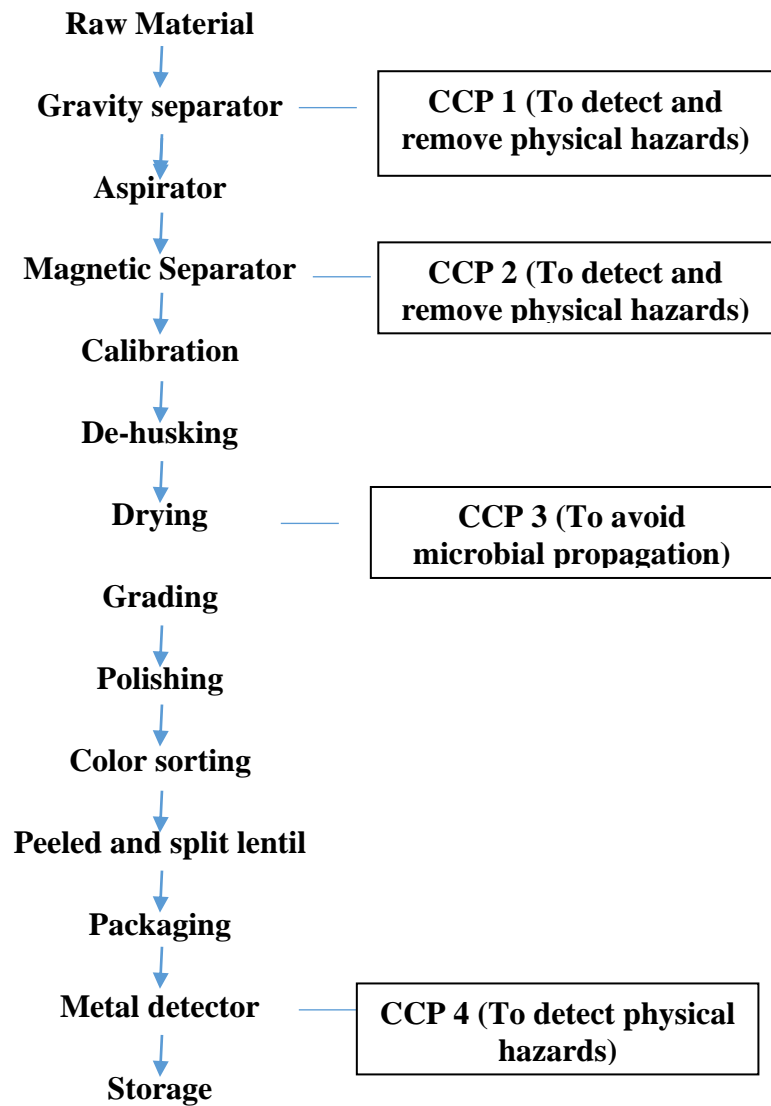


Figure 24: HACCP plan for Split lentil pulse

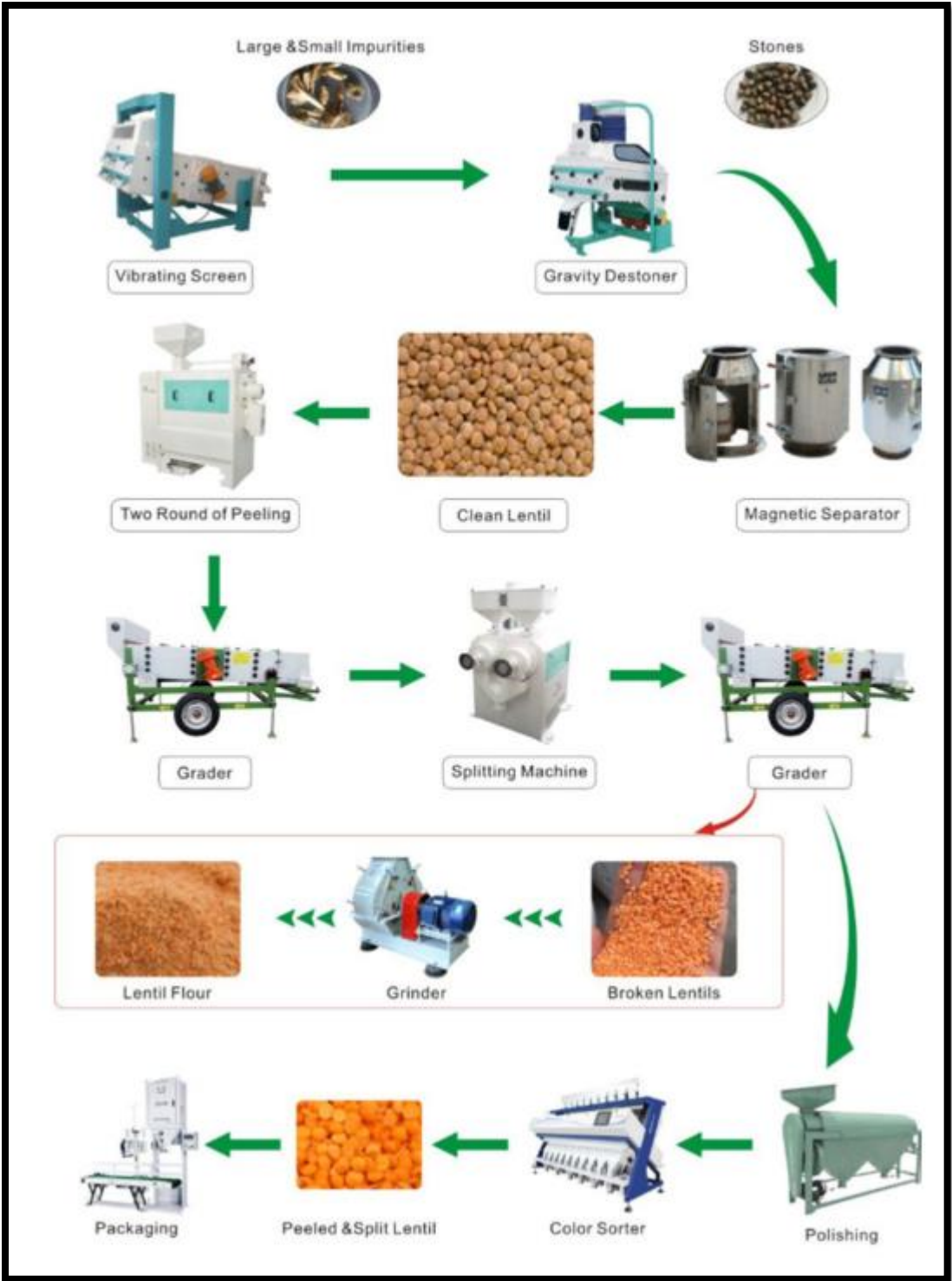


Figure 25: Processing flowchart for split lentils
Source: www.grain-processing.org/PRODUCTS/Bean-Processing-Equipment/lentil-processing-project-processing-project.html

Small scale equipments for lentil processing

Mini Dhal Mill is becoming popular in the country because it produces excellent yield results and is therefore considered an ideal replacement for village chakkies. Some mini dal mills developed for this purpose are shown in the figure below.

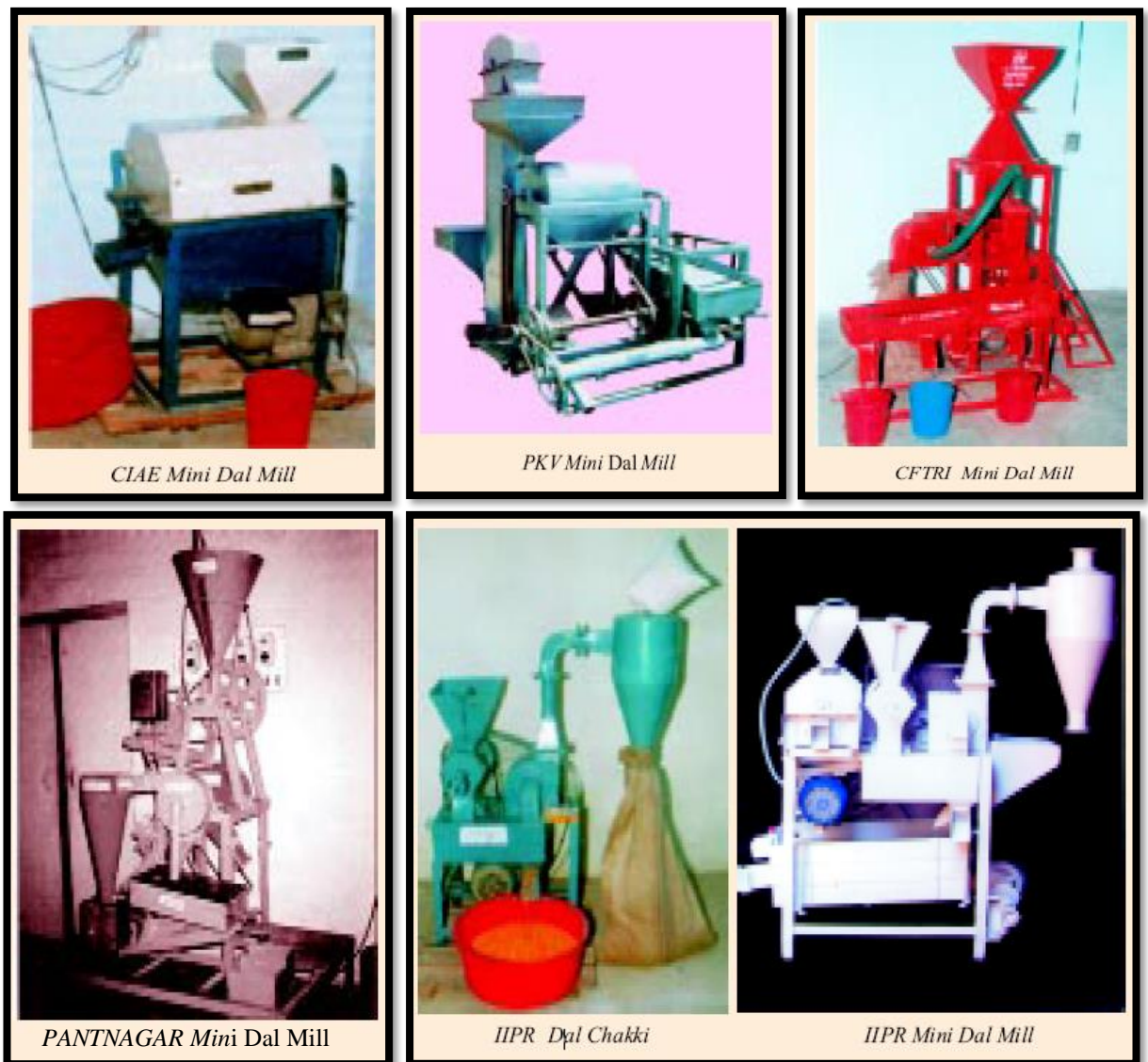


Figure 26: Different types of Dal mills Source: Lal and Verma, 2007



Figure 27: Stages of lentil processing

Source: www.grain-processing.org/PRODUCTS/Bean-Processing-Equipment/lentil-processing-project-processing-project.html

Food Safety Standards by FSSAI for products I and II

As per FSSAI draft notification dated 14 December, 2017 on Food Safety and Standards (Food Product Standard and Food Additives) Amendment Regulation the guidelines to be followed for lentils are as follows-

Table 7: Food safety standards by FSSAI

Sr. No.	Parameter	Limit
1.	Moisture Content (percent by mass)	<p>Maximum 14 percent by weight (obtained by heating the pulverized grains at 130⁰C-133⁰C for 2 hours</p> <p>Maximum 12 percent for pulses without seed coat</p>
2.	Extraneous Matter	<p>Not more than 1.0 percent by mass of which not more than 0.25 percent. by mass shall be mineral matter and not more than 0.10 percent by mass shall be impurities of animal origin</p>
3.	<p>Defects</p> <p>(I) Seeds with serious defects. (Seeds in which the cotyledons have been affected or attacked by pests; seeds with very slight traces of mould or decay; or slight cotyledon staining.) (% not more than)</p>	1.0

	(II) Seeds with slight defects. (Seeds which have not reached normal development; seeds with extensive seed-coat staining, without the cotyledon being affected; seeds in which the seed coat is wrinkled, with pronounced folding or broken pulses *)	Not more than 7.0% of which broken pulses must not exceed 3.0%
4.	Other edible pulses (not more than), % by mass	2.0
5.	Discolored seeds (not more than), % by mass	3.0
6.	Uric acid (not more than)	100 mg per kg

Note– * The broken pulses. Broken in the whole pulse in which the cotyledon is separated or one cotyledon is broken. Broken in split pulses are pulses in which the cotyledon is broken.

Sub-regulation 2.13 permits irradiation of Pulses as per the following doses:

Table 8: Limits of Irradiation by FSSAI

Sr. No.	Food	Purpose	Dose Limit (Kilo Gray)	
			Min	Max
1.	Lentils	Insect disinfestations	0.25	1.0
		Reduction of microbial load	1.5	5.0

Labeling Regulations by FSSAI for products I and II

As per FSS (Packaging and Labeling) Regulations, 2011 the label of the above discussed lentil products should contain the following information:

- i. The Name of food
- ii. Declaration regarding Veg.
- iii. Name and address of the manufacturer
- iv. Net Quantity
- v. Lot/Code/Batch Identification
- vi. Date of manufacturing or packing
- vii. Best Before and Use by Date
- viii. FSSAI Logo and License No.
- ix. Country of origin
- x. Instructions for use
- xi. Warning and advisory statements
- xii. Written statement indicating that treated with ionizing radiation and Radura logo in green color (if irradiated)

Note: Nutritional Information is not necessary for the above discussed lentil products

III. *Fried crispy whole lentil:*

Introduction

Fried crispy whole lentil or masoor dal namkeen recipe is a crisp and delicious tea-time snack. Masoor dal namkeen is a popular snack in North India and can be prepared with minimal ingredients.



Figure 28: Fried crispy whole lentil**Processing**

Raw material:

- i. Whole lentil (wash and soak for 9-10 hour) – 250 gm
- ii. Salt– 10 gm
- iii. Black Pepper Powder – 5 gm
- iv. Red Chili Powder – 5 gm
- v. Dry Mango Powder – 5 gm
- vi. Oil for frying – Sunflower oil

Processing:

- i. Clean and sort whole lentils for any physical impurities
- ii. Soak lentils for 4 to 5 hours in 3 times of water
- iii. Remove all water from the whole lentil and keep it on a cotton cloth for 15 to 20 minutes
- iv. Heat the oil in pan on high flame, put lentil in hot oil
- v. Fry it until lentil becomes crispy
- vi. Take out the lentil and keep in a strainer
- vii. Add the salt, black pepper powder, red chili powder and dry mango powder, mix well
- viii. Allow to cool and pack

Equipments

Figure 29: Fryer



Figure 30: Soaking machine



Figure 31: Packaging machine

HACCP plan for Fried crispy whole lentil

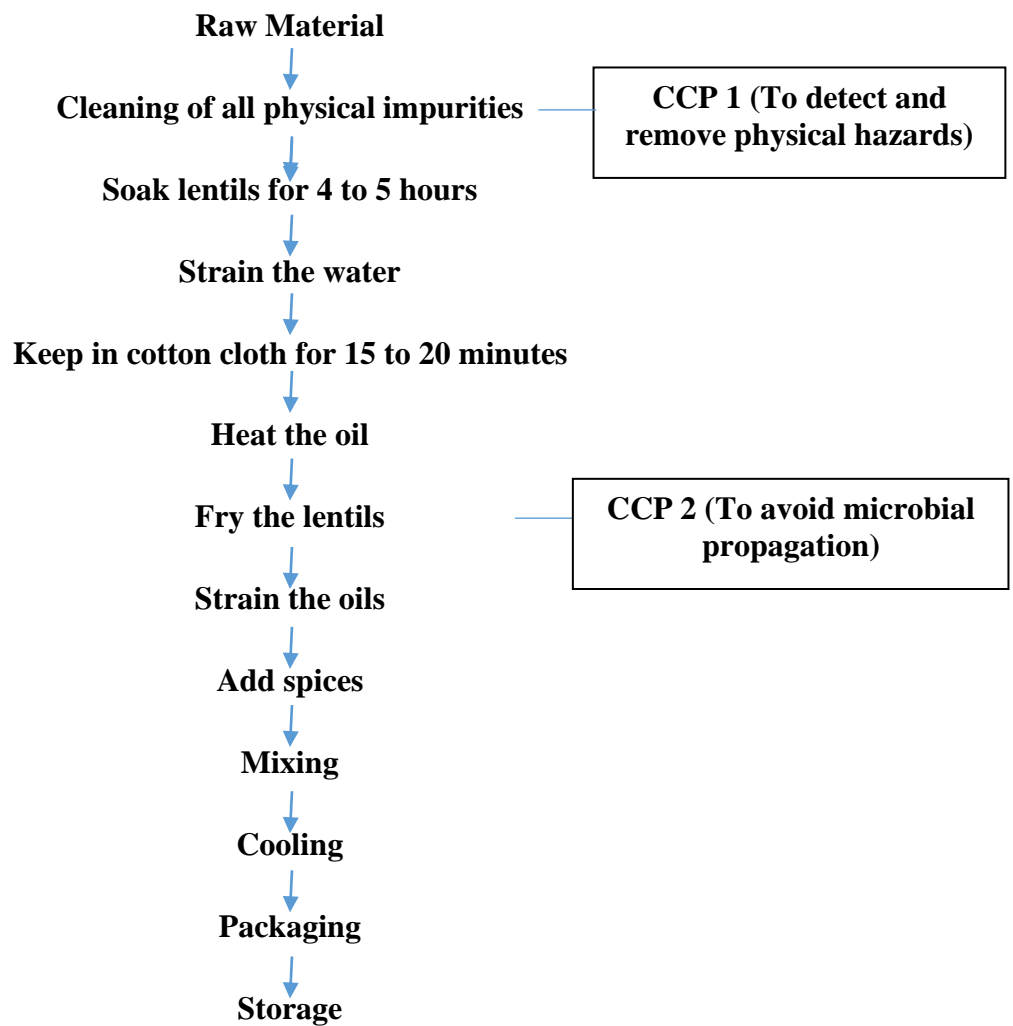


Figure 32: HACCP plan for Fried crispy whole lentil

IV. *Roasted crispy whole lentil:*

Introduction

Roasted whole lentil or Bhuni Masoor dal namkeen is a crispy, nutritious and delicious tea-time snack. This is one of the most nutritious namkeen recipes with minimum ingredients.



Figure 33: Roasted crispy whole lentil

Processing

Raw material

- i. Dried whole lentils- 100 gm
- ii. Sunflower oil-5 gm
- iii. Garlic powder-5 gm
- iv. Red chili pepper flakes- 2 gm
- v. Oregano flakes/ Cumin powder- 2gm
- vi. Salt- 4 gm
- vii. Pepper- 2 gm

Processing

- i. Rinse the lentils, and then put them in a pan. Add 3 times water. Bring to a boil. Reduce heat to low heat and cook for 18-20 minutes, stirring occasionally.
- ii. Meanwhile, preheat oven to 400 F.
- iii. Drain lentils, and then place back in the pot. Toss with remaining ingredients.

- iv. Line with a large baking sheet of parchment paper or aluminum foil. Spread the lentils over the surface in a single sheet. Bake for about 12 minutes. Stir, then bake for another 12-15 minutes, until the mixture is absolutely crunchy. (Keep an eye on them for the last few minutes so as not to burn.) Sprinkle with salt and pepper.
- v. Let them cool down and pack.

Equipments



Figure 34: Boiler



Figure 35: Oven

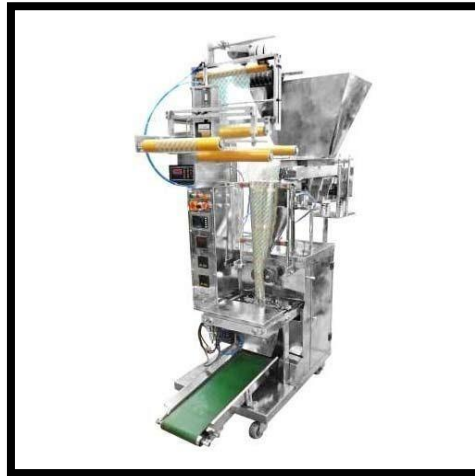


Figure 36: Packaging machine

HACCP plan for Roasted crispy whole lentil

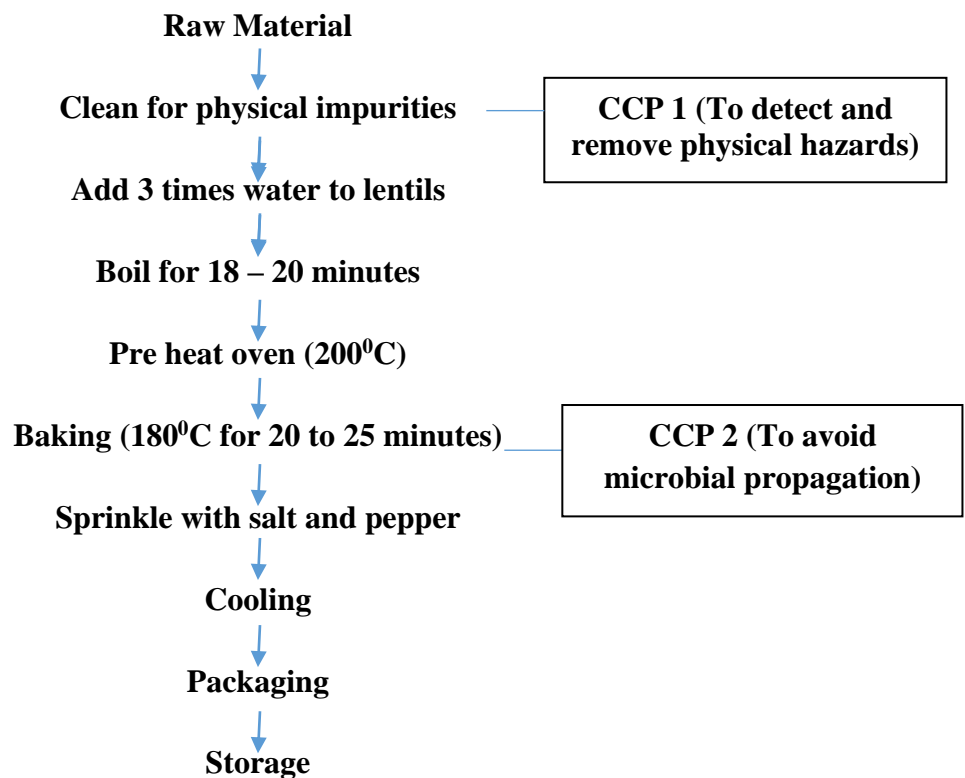


Figure 37: HACCP plan for Roasted crispy whole lentil

V. *Lentil fried crackers:*

Introduction

The split red lentils in the traditional crackers give them a bit more substance and nutrition than refined wheat flour crackers available in market and add an almost nutty quality to the texture. A spice mix of coriander, cumin, turmeric and mustard powder gives an Indian curry flavor.



Figure 38: Lentil fried crackers

Processing

Raw material

- i. Red lentils - 250 gm
- ii. Water – to prepare dough
- iii. Coconut oil – 10 gm
- iv. Salt - Pinch
- v. Soybean oil- for frying

Processing

- i. Making the Dough
 - a) Mill red lentils in food processor or blender to create a fine flour; set 1/2 cup of red lentil flour aside
 - b) Place 1 cup of the flour, 1/2 cup water and a pinch of salt in mixing bowl; combine until dough is formed
- ii. Rolling the Dough and Cutting the Crackers
 - a) Generously flour work surface with red lentil flour set aside previously; place mound of dough on top floured work surface
 - b) Roll dough to 1/8 inch with rolling pin covered in a sleeve or over parchment paper covering dough (to avoid sticking)
 - c) Cut out with 3 inch round biscuit cutter; place cut out discs on floured surface until all are ready to fry
 - d) Continue to cut out discs, re-rolling dough and flouring board, until complete
- iii. Frying the Crackers
 - a) Place paper towel covered plate nearby

- b) Heat skillet to medium high; take oil in pan, pouring out excess and reserve
- c) Fry; turn or flip as soon as bubbles appear (in about 30 seconds)
- d) Fry 15 more seconds or so; remove to paper towel covered plate to cool
- e) Repeat process until all crackers are fried, re-oiling the pan each time
- f) Let them cool and pack

Equipments



Figure 39: Dough making Machine



Figure 40: Dough sheater



Figure 41: Dough cutting machine



Figure 42: Fryer

HACCP plan for Lentil fried crackers

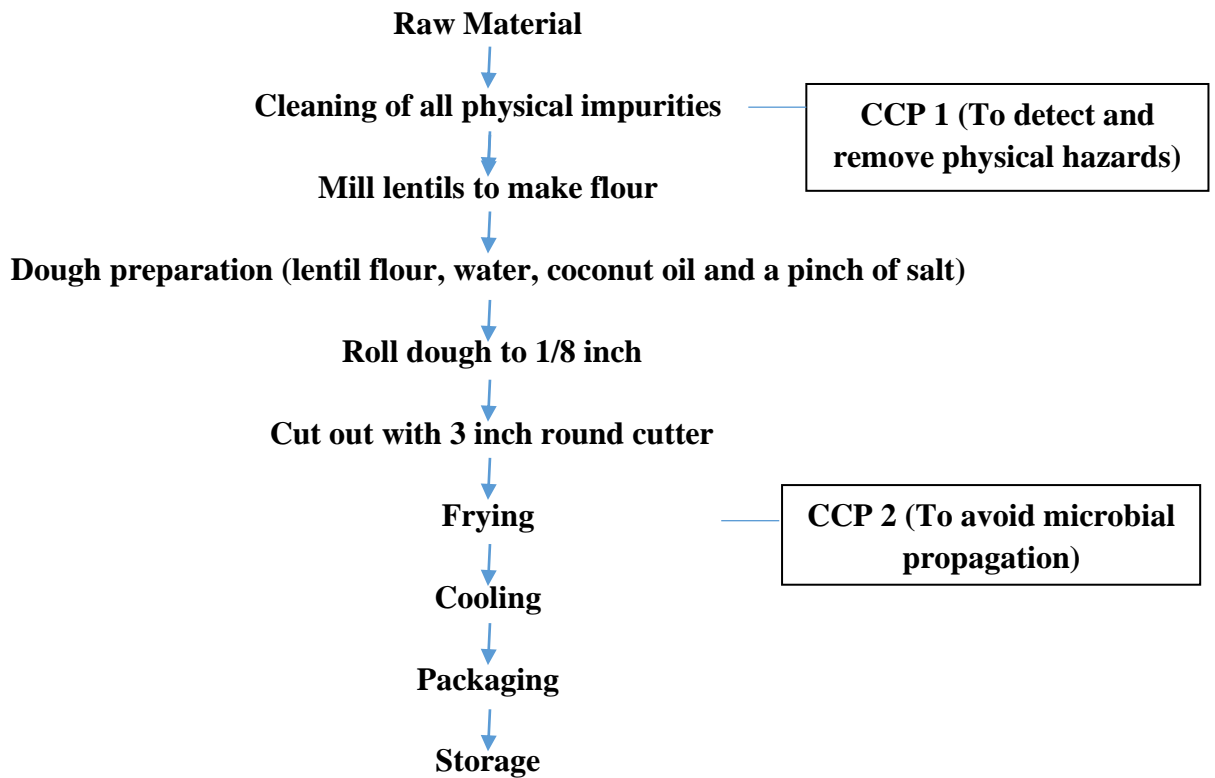


Figure 43: HACCP plan for Lentil fried crackers

VI. *Lentil baked crackers:*

Introduction

These crackers are high in protein and free of gluten. No frying or oil is needed as these healthy chips are oven baked. Suitable for vegan, gluten-free, grain-free, nut-free and oil-free diets.



Figure 44: Lentil baked crackers

Processing

Raw material

- i. Red lentils - 250 gm
- ii. Water – to prepare dough
- iii. Coconut oil – 10 gm
- iv. Salt - Pinch

Processing

i) Making the Dough

- a) Mill red lentils in food processor or blender to create a fine flour; set 1/2 cup of red lentil flour aside
- b) Place 1 cup of the flour, 1/2 cup water and a pinch of salt in mixing bowl; combine until dough is formed

ii) Rolling the Dough and Cutting the Crackers

- a) Generously flour work surface with red lentil flour set aside previously; place mound of dough on top floured work surface
- b) Roll dough to 1/8 inch with rolling pin covered in a sleeve or over parchment paper covering dough (to avoid sticking)
- c) Cut out with cutter; place cut out shapes on floured surface until all are ready to bake
- d) Continue to cut out shapes, re-rolling dough and flouring board, until complete

iii) Baking the Crackers

- a) Transfer shapes, by lifting them with a large knife or thin spatula, on a baking tray lined with parchment paper.
- b) Bake for 14 minutes, and then flip the crackers on the other side. Bake for another 12 minutes.

- c) Place on cooling rack
- d) Let them cool and pack.

Equipments



Figure 45: Dough making Machine



Figure 46: Dough sheater



Figure 47: Dough cutting machine



Figure 48: Oven



Figure 49: Packaging machine

HACCP plan for Lentil baked crackers

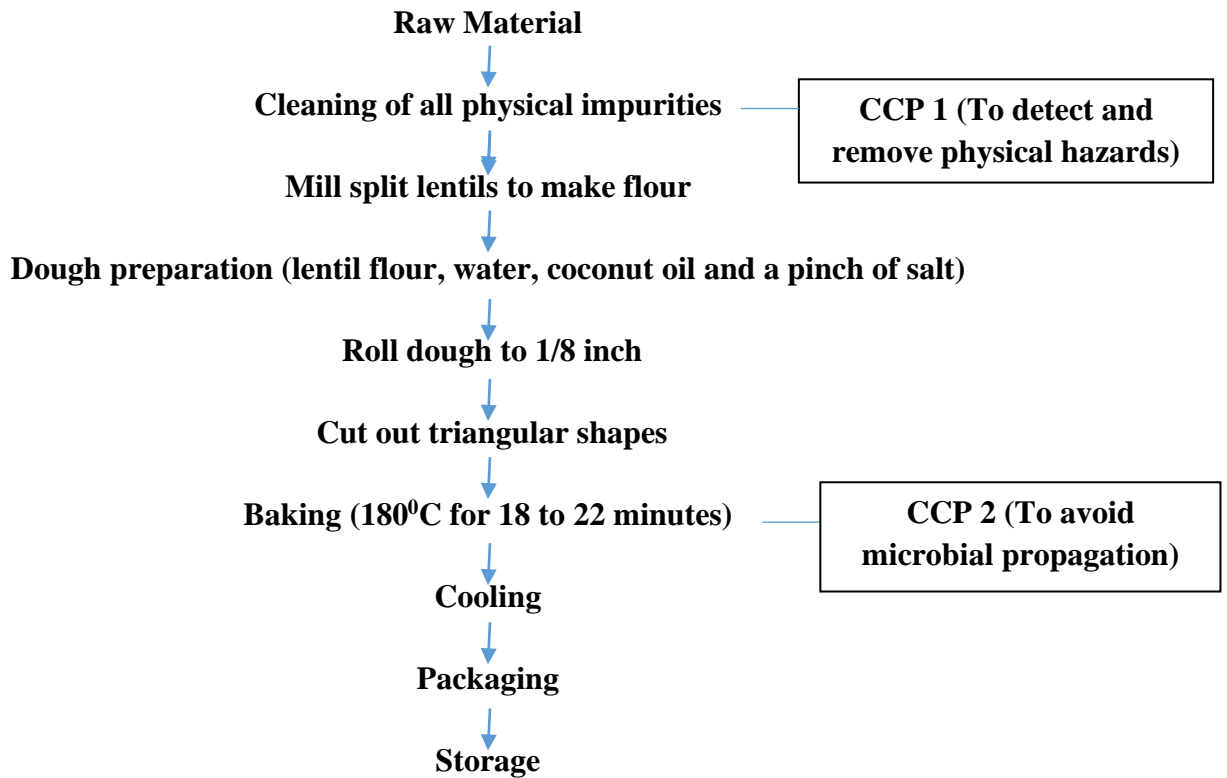


Figure 50: HACCP plan for Lentil baked crackers

VII. Lentil finger fries:

Introduction

These fingers are just perfect, nutritious, nicely crisp and well spiced, good enough to tease the taste buds. It is a perfect snack for people on high protein diet. It can make a

great starter as well as a finger food. Apt for growing children as it's loaded with proteins.



Figure 51: Lentil finger fries

Processing

Raw material

- i. Red lentils – 200 gm
- ii. Salt – 5 gm
- iii. Onion powder (granulated dried onion) – 10 gm
- iv. Garlic powder- 5 gm
- v. Ground cumin – 2 gm
- vi. Paprika - 2 gm
- vii. Ground black pepper – 2 gm
- viii. Water – approx 480ml
- ix. Lemon juice – 10 ml
- x. Oil (soybean oil) – for frying

Processing

- i. Combine the lentils, salt, onion powder, garlic powder, cumin, paprika and pepper in a blender. Process until finely ground, essentially a flour with a few larger granules in it.
- ii. Pour it into a measuring cup or small bowl. You need to be able to dump the ground lentil mixture into the boiling water without stopping to scrape the last bits from the blender.
- iii. Bring the water and lemon juice to a boil in a medium-sized saucepan. Turn the heat to medium-low and remove the saucepan from the heat (when the lentils are applied, it will splatter if you do not). Pour the lentil flour into the water in a slow stream until it is all mixed in and smooth, whisking vigorously with one hand.

- iv. Remove the whisk and trade it for a wooden spoon. Return the saucepan to the heat and cook it, stirring constantly, for 5 minutes. The mixture will be quite stiff.
- v. Scrape it into the prepared pan using a rubber spatula. Have a glass of cold water nearby and keep dipping the spatula into the water as you smooth the surface of the cooked lentil mass.
- vi. Leave it until it is cool. At this point it can be covered with plastic wrap and refrigerated overnight.
- vii. When the mixture is cool, cut it into French fry sized sticks. You can lift the whole slab out with the paper and transfer it to a cutting board.
- viii. Heat the oil over medium-high heat in a small, deep, heavy-bottomed saucepan until it starts to slightly ripple. Drop in 1 lentil fry and wait until you see that it's followed by a lot of bubbling. Then the oil is going to be hot enough. Carefully lower the lentil sticks with a slotted spoon in the batch. At first, the oil bubbles furiously, then subsides to a slow, steady bubbling. Separate the fries in the oil gently with the spoon as they fry.
- ix. Let them fry for 5 to 8 minutes, depending on the heat of the oil and size of the fries, until they are a rich golden brown, stirring them occasionally with a slotted spoon to distribute them. Letting them get deep golden will make them more crisp than if they're just a lighter shade.

Equipments



Figure 52: Refrigerator



Figure 53: Fryer



Figure 54: Cutting machine

HACCP plan for Lentil finger fries

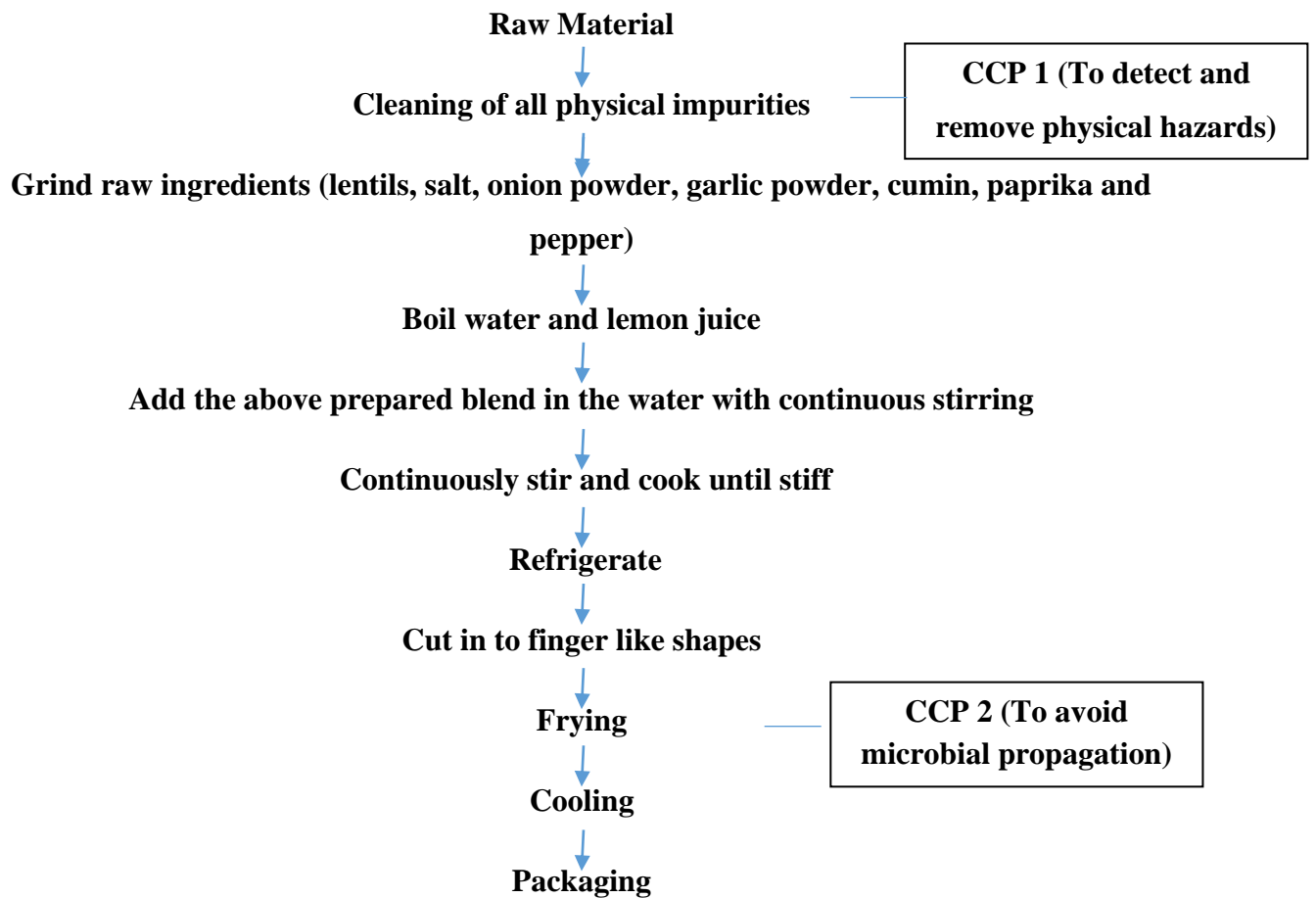


Figure 55: HACCP plan for lentil finger fries

VIII. *Crispy lentil energy bites:*

Introduction

These Crispy Lentil Energy Bites is unique vegan and gluten free treat recipe. Lentils are crisped up in the oven giving these bites a one-of-a-kind flavor.



Figure 56: Crispy lentil energy bites

Raw materials

- i. Green lentils – 100 gm
- ii. Coconut oil, melted – 10 gm
- iii. Coconut sugar – 10 gm
- iv. Cinnamon – 2 gm
- v. Sea salt – 1 gm
- vi. Oats – 200 gm
- vii. Coconut, unsweetened, shredded – 25 gm
- viii. Pumpkin seeds – 15 gm
- ix. Dark chocolate chips – 20 gm
- x. Peanut butter – 20 gm
- xi. Honey or maple syrup (or a combination) – 40 gm

Processing

- i. Preheat oven to 400°F. Line a baking sheet with parchment paper.
- ii. Rinse lentils and transfer them to a small saucepan
- iii. Cover with 2 cups of water and bring to a boil.
- iv. Lower heat to medium and simmer for 15 minutes
- v. Drain and transfer to a small mixing bowl

- vi. Stir in the coconut oil, and coat lentils well
- vii. Sprinkle with the coconut sugar, cinnamon, sea salt, and stir well.
- viii. Spread lentil mixture evenly onto lined baking sheet and bake for 15 minutes, stirring halfway through, keeping an eye on them so they do not burn. Set aside to cool
- ix. Meanwhile, in a large mixing bowl, stir together the oats, seeds, coconut, and chocolate chips. Add in crispy lentils, then the peanut butter and honey/maple syrup and stir well again
- x. Roll into heaping tablespoon sized balls and refrigerate for 30 minutes to set. Pack and store in the fridge or freezer

Equipments

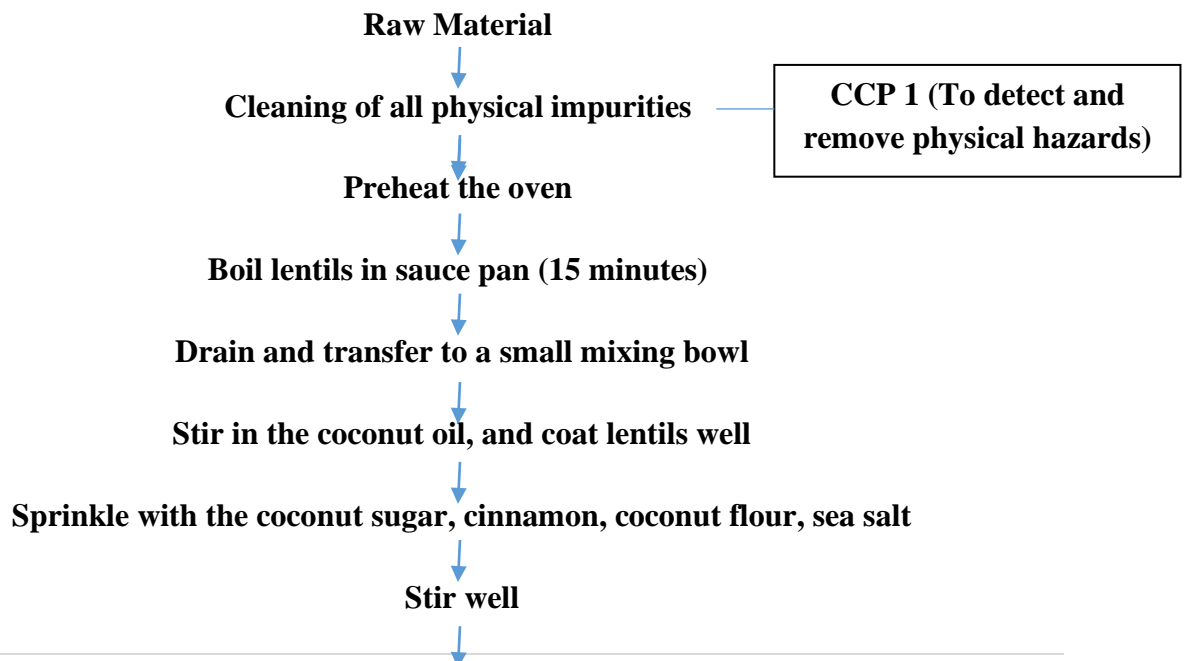


Figure 57: Oven



Figure 58: Refrigerator

HACCP plan for crispy lentil energy bites



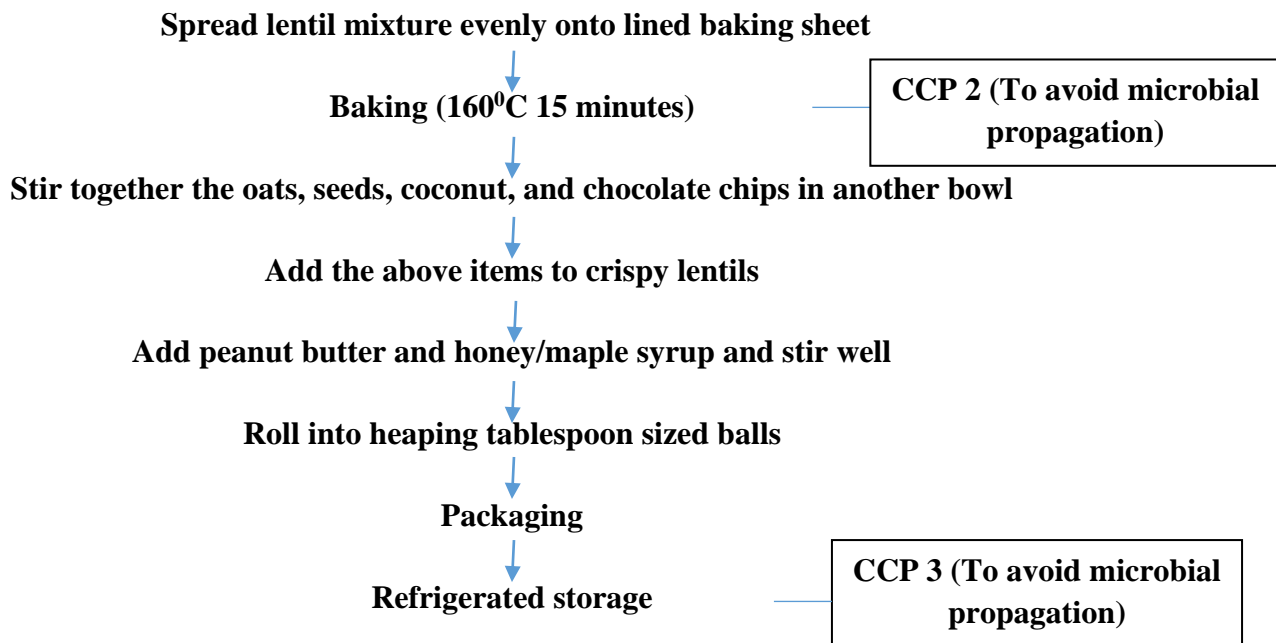


Figure 59: HACCP plan for crispy lentil energy bites

Packaging Requirements for Product number I, II, III, IV, V, VI, VII and VIII

Packaging materials allowed for packaging as per FSSAI are as follows:

- (i) IS : 10146 (Specification for Polyethylene in contact with foodstuffs);
- (ii) IS : 10142 (Specification for Styrene Polymers in contact with foodstuffs);
- (iii) IS : 10151 (Specification for Polyvinyl Chloride (PVC), in contact with foodstuffs);
- (iv) IS : 10910 (Specification for Polypropylene in contact with foodstuffs);
- (v) IS : 11434 (Specification for Ionomer Resins in contact with foodstuffs);
- (vi) IS: 11704 Specification for Ethylene Acrylic Acid (EAA) copolymer. (vii)
- IS: 12252 - Specification for Poly alkylene terephthalates (PET).
- (viii) IS: 12247 - Specification for Nylon 6 Polymer; (ix)
- IS: 13601 - Ethylene Vinyl Acetate (EVA);
- (x) IS: 13576 - Ethylene Metha Acrylic Acid (EMAA)

Labeling Requirements for Product number III, IV, V, VI, VII and VIII

As per FSS (Packaging and Labeling) Regulations, 2011 the label of the above discussed lentil products should contain the following information:

- i. The Name of food
- ii. Declaration regarding Veg.
- iii. Name and address of the manufacturer
- iv. Net Quantity
- v. Lot/Code/Batch Identification
- vi. Date of manufacturing or packing
- vii. Best Before and Use by Date
- viii. FSSAI Logo and License No.
- ix. Country of origin
- x. Instructions for use
- xi. Warning and advisory statements
- xii. Nutritional Information
- xiii. Name of Oil used for frying in case of fried lentil snack
- xiv. State “Gluten free”
- xv. State “Contains Trehalose” if Trehalose is added.

Food Safety Standards by FSSAI for bakery products (product number 6)

As per FSSAI draft notification dated 14 December, 2017 on Food Safety and Standards (Food Product Standard and Food Additives) Amendment Regulation the baked products may contain food additives specified under FSSAI regulations.

These products shall conform to following standards, namely:-

- a) Ash insoluble in dilute hydrochloric acid (on dry basis): shall not be more than 0.1 per cent.
- b) Acidity of extracted fat (as oleic acid):- not exceeding 1.5 per cent.
- c) It may contain Oligofructose (dietary fibres) upto 15% maximum subject to label declaration under Regulation 6.1.3

FOOD SAFETY MEASURES

PERSONAL HYGIENE

- Mask:- To avoid microbial contamination through mouth
- Cap:- To avoid hair fall in to the food material
- Coat:- To avoid dust particle and other unwanted material entering in to the food material
- Shoes:- To avoid contamination from the legs

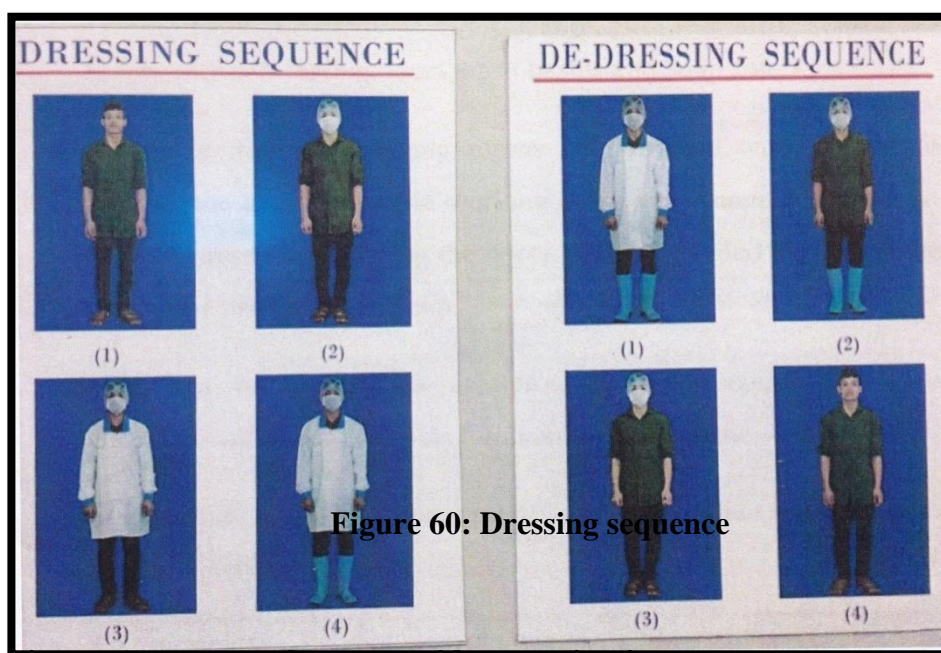


Figure 60: Dressing sequence

Protective measurements done to avoid contamination

- **Foot dip:** At the entrance of the processing hall and production hall are provided with foot dip. It is filled with chlorinated water. 100ppm chlorine is used
- **Hand dip:** after foot dip the entrance is provided with hand dip with chlorinated water. 20 ppm chlorine is used.
- **Fly proofing vermin and arrival control:** Special type of tube lights are provided for attraction of fly.
- **Lighting and ventilation:** Special types of tube lights are provided proper ventilation to avoid order and condensation.
- **Toilet facility:** All sections are provided with adequate number of toilets with self-closing doors, wash basins and soap solutions.

- **Changing room:** Changing rooms are provided with shelves for keeping the street cloth and working dress in different places. Stands are also present for keeping the boots. It also provided a waste basket for put the used mask and cap.
- **Sanitation room:** Rooms are provided for keeping detergents, chemicals and other materials for maintaining hygiene.
- **Cold storage:** The cold storage room having a constant temperature of -18°C to store the product.
- **Transportation facilities:** Adequate number of vehicles for transportation of raw materials and finished products
- **Machinery:** Adequate machine for the working of whole company is provided. The machine room is kept clean.
- **Laboratory:** The lab is situated in the first floor of the building. The lab is placed with a documentation room, inspection room, media preparation room, discarding room and incubation room.
- **Water treatment system:** In the seafood industry the water quality and availability are important things. Always water is brought in tanker and pumped to overhead tank.
- **Metal detector:** The packaging section should contain a metal detector to find out the unwanted metal and matter.
- **Door arrangement:** Each doors are arranged has a self closing door which useful to avoid contamination

Steps of effective hand washing

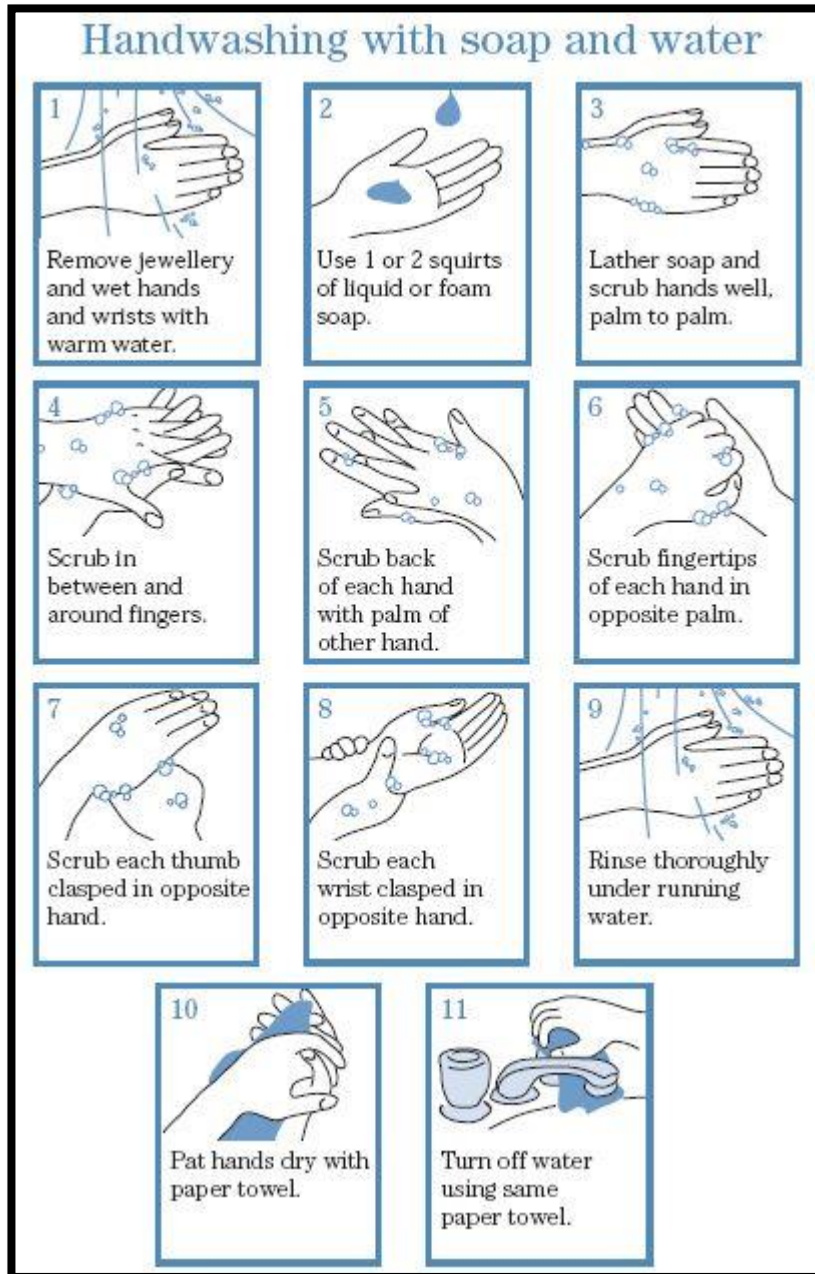


Figure 61: Hand Washing Technique

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