Reading Manual for
Roasted Peanut Processing

National Institute of Food Technology Entrepreneurship and Management

Ministry of Food Processing Industries

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CONTENTS

CHAPTER 1 – INTRODUCTION

Ground nut (*Arachis hypogaea*) is one of the major oilseeds cultivated in India with an annual production of nearly 80 to 85 lakh MT. The groundnuts are mainly produced in Gujarat (20.84 lakh tones), Andhra Pradesh (5.82 lakh tones), Rajasthan (11.26 lakh tones), Karnataka (2.87 lakh tones) and Maharashtra (2.66 lakh tones) (APEDA, 2018). Groundnuts are the fourth most source of edible oil and is also a rich source of protein. It is consumed as such, as snacks, also included in traditional cuisines and confectioneries. Though the crop is native to South America and initially discovered in Brazil and Peru. Currently groundnuts have been grown in one hundred countries with China (17,519,600 T) being the leading producer followed by India (6,727,180 T). While the major export is from Argentina (5, 38,575 MT), followed by USA (4, 47,572 MT) and India (3, 63,496 MT) (FAOSTAT, 2019). Worldwide ground nuts are cultivated in 22 million hectares, in India the area under groundnut cultivation is about 38, 90,000 hectares (ICRISAT). Even though the highest production is noticed in Gujarat (1190 kg/ha), more productivity is recorded in Tamil Nadu (1604 kg/ha).

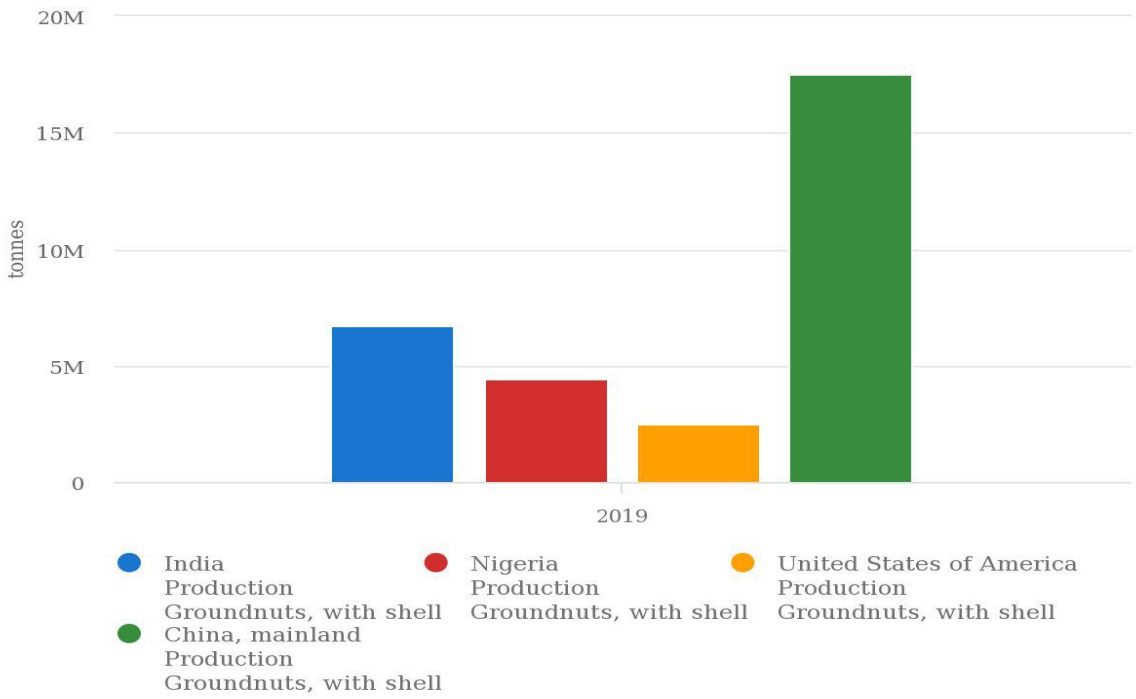


Figure 1: Ground nut production in major countries in 2019 (Source: FAOSTAT, 10 Feb 2021)

1.1. MAJOR NUTRIENTS IN GROUNDNUTS

Peanuts are energy dense (2176 KJ) nuts consisting good amount of protein, carbohydrate, vitamins and minerals. Consumption of peanuts will help to alleviate malnutrition, which is a serious health concern in many developing countries. Salted as well unsalted peanuts have lower sodium levels, hence occasional consumption of salted peanuts are not detrimental to health.

Table 1: Nutritional composition of groundnuts

Nutrients	Per 100 gram of groundnut
Protein	23.65
Carbohydrate	17.27
Total fat	39.63
Total fiber	10.38
Total folates	90.89 (µg)
Calcium	54 mg
Iron	3.44 mg
Sodium	12.21 mg
Potassium	679 mg
Zinc	3.18 mg

1.2. HEALTH BENEFITS OF GROUNDNUTS

1.2.1. Antioxidant activity

Groundnuts was found to have the ability to reduce oxidative stress and have similar antioxidant profiles like certain fruits like berries. The major antioxidant metabolite in groundnut is p-coumaric acid. Roasting groundnuts found to increase the coumaric acid levels upto 22%. Hence roasted groundnuts are good for health (Blomhoff *et al*., 2006).

1.2.2. Anti-cancer activity

The bioactive compounds found in groundnuts viz., phytosterols, insotiol hexaphosphate and resveratrol have free radical scavenging potency thereby hindering cancer occurrence. An inverse negative correlation was observed among peanut consumption and risk of colon cancer (Awad *et al*., 2000; Yeh *et al*., 2006).

1.2.3. Lipid profile of peanuts

The lipid profile of peanuts reflects its cardiac friendly property. Peanuts have more mono unsaturated fatty acids (50%) and only 14% saturated fatty acids. Hence it is equally beneficial as other healthy oils like olive oil. Certain studies reported that consumption of peanuts reduced total cholesterol (11%) and LDL cholesterol (14%) levels while maintaining the HDL levels (Pelkman 2004).

1.2.4. Effect of peanut on diabetes

Consumption of peanuts aids in reducing the risks of diabetes. Magnesium and dietary fiber are contributory factors to function peanuts as anti-diabetic (Jiang *et al*., 2002).

1.2.5. Effect of peanuts on Alzheimer's disease

Consumption of peanuts five times a week, can reduce gall stones by 25% (Tsai *et al*., 2004).

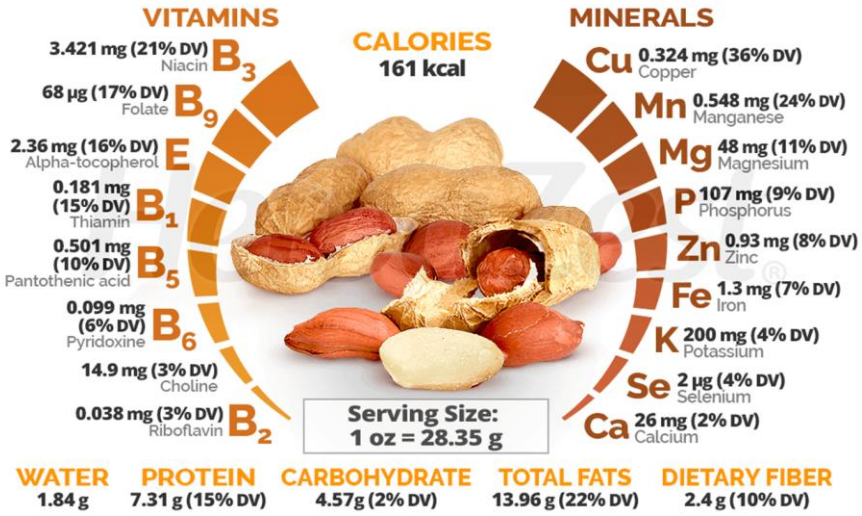


Figure 2: Nutrients in one serving of peanuts (www.herbazest.com)

CHAPTER 2 – GROUNDNUT PRODUCTION ASPECTS

2.1. CULTIVATION

Ground nut (*Arachis hypogaea*) is herbaceous plant, belongs to the legume family which grows up to 30 – 50 cm tall. It is widely cultivated in tropical, sub-tropical and warm temperate zones, while the productivity is reduced due to cultivation in marginal lands under rain fed conditions apart from abiotic and biotic factors that influence the growth and yield of the plant. Generally the plant grows well at 24 to 27 degree Celsius in well drained sandy, sandy loam soils where it facilitates the penetration of peg and further its harvest. Hence hard soils and clay are not suitable for ground nut cultivation. In India ground nut is cultivated in all the four seasons while 85% of it is done in kharif season, where 50 – 125 cm well distributed rains are received. Good quality bold seeds should be utilized for efficient germination, seeds should be sorted to avoid infected and shriveled seeds. Several seed treatments viz., carbendazim (2 g/kg of seeds), Thiram (3 g/kg of seeds) are also recommended to correct the seed related diseases. The ground nut seeds are sown following a spacing of 60 cm x 10 cm in spreading varieties and 45 cm x 10 cm in bunch varieties at a seed rate of 120 – 175 kg/ha. Commonly cultivated varieties of ground nut are TMV 7, CO 3, Kaushal, COGn 4, Kadiri-2, Kadiri-3, BG-1, BG-2, Kuber, VRI 2, Chandra, GAUG-1, GAUG-10, PG-1, T-28, T-64, Chitra, Parkash, Amber etc. The expected yield from spreading type groundnuts are 1500 to 2000 kg/ha and bunch type from 1000 to 1500 kg/ha respectively and the kernel to pod ratio will be 70:30.

Figure 2: Groundnut field
(Source: https://agritech.tnau.ac.in/agriculture/oilseeds_groundnut.html)

2.2. HARVESTING

Understanding the crop maturity and then harvesting ground nut pods require experience and vigilance from farmers as the pods will be in soil. The pods harvested before attaining maturity will results in low yield and shrunken seeds, while delayed harvest leads to seed germination. Hence the indication for proper harvest is yellowing of the foliage and fall of old leaves. In bunch varieties of ground nuts the pods are harvest by pulling and in spread type it is done by ploughing. Harvesting is usually a labor intensive process in India especially during peak harvest period where labor shortages are also experienced by farmers. Agricultural research institutions like Central Institute of Agricultural Engineering, Bhopal had developed several strippers and threshers for easing the harvesting of ground nuts.

2.2.1. STEPS INVOLVED IN HARVESTING OF GROUND NUT:

2.2.1.1. Stripping: can be done either manually or using drum or comb type strippers.

Figure 3: A farmer is manually stripping ground nut pods from his field

2.2.1.2. Threshing: is done with the help of mechanical threshers to remove the pods from the plant. Mechanical threshing results in grounds nut without much breakage in pods and damage to seeds.

2.2.1.3. Winnowing: is done to remove the chaff from the pods. In mechanical threshers, the chaff is removed and then the pods are collected.

Figure 4: Groundnut pod thresher (1000-1500 kg / hr)

2.2.1.4. Curing: curing is generally referred to the drying process that is done to the pods to reduce its water content to 10 – 15 %. The pods, skin and kernels are found to have different levels of equilibrium moisture with same humidity. The efficient drying process avoids contamination and spoilage of pods during storage. Curing is done in various ways either through sun drying, windrowing, forming heaps (proposed by Directorate of Oilseeds Research, Hyderabad), tripod structures (proposed by National Research Centre for Groundnut). In all these methods drying is depending on available sunlight. However exposure of pods to direct sunlight is not advisable as these process mostly depends on individual farmers' accuracy in judging the required dryness for the pods without considering the actual moisture the pod attains during this drying process. Likewise the pods left on ground for drying can lead to mould infestation and pods left for too long on ground for drying can result in splitting of kernels during shelling.

Thus several other methods like heaping the pods so as to ensure a shade drying by avoiding direct sunlight is suggested by DOR and NRCG. Use of artificial dryers are found to be effective when pods are exposed to 27 - 32 degree Celsius with an airflow of 10 - 12 c.f.m. artificial can be done using batch dryers, bulk dryers and continuous flow dryers.

2.2.1.4.1. Batch dryers: in batch dryers the pods are dried at 54 ˚C with air flow of 110 cu. ft. per minute. This enhanced the drying of pods in 16 hours with a moisture reduction from 48 % to 8%. However temperature of heating should be limited to 54 ˚C, as excess temperature (say for example 60 ˚C) produced off-flavor that detrimentally affected the quality of the kernels.

Figure 5: Groundnut pod batch dryer

2.2.1.4.2. Bulk dryer: in this process pods were dried in bulk layers of 1.8 m height with air temperature of < 40 ˚C and air velocity of 0.5 meters per second. This drying process produced pods with satisfactory quality.

2.2.1.4.3. Continuous flow dryers: in this process the produce is moved from one end to the other meanwhile heated air is blown through the produce for efficient moisture reduction. The recommended air temperature is ambient temperature (38 ˚C) with an air flow rate of 5 – 100 f.p.m. (feet per minute).

2.2.1.5. Shelling: shelling or decortication of pods are done as shelled kernels fetch more value to farmers. Shelling is done using mechanical decorticators, the machine will have an oscillating sector and concave sieve near to it. The pods will be fed to the machine through a hopper, there it will be fall into cast iron peg assemblies. The pods will be broken in between the oscillating

sector and the sieve. The blower connected to decorticator will remove the broken shells and other light materials and clean kernels will be collected.

Figure 5: Mechanical groundnut decorticator

Figure 6: Manually operated groundnut decorticator

2.2.1.6. Cleaning: generally the threshers and decorticators are attached with blowers to wade off the foreign materials dirt and dust attached to the pods. Even loose shelled kernels are means of mould infestation and possible biological damage, thus to be avoided in the finally produce. The presence of foreign materials should be less than 5% is the thumb rule for ensuring good quality pods.

Figure 7: Peanut Cleaning Machine Combined With Elevator Capacity at 800-1500 kg/h

(Source: http://www.biodiesel-machine.com/peanut-cleaner.html)

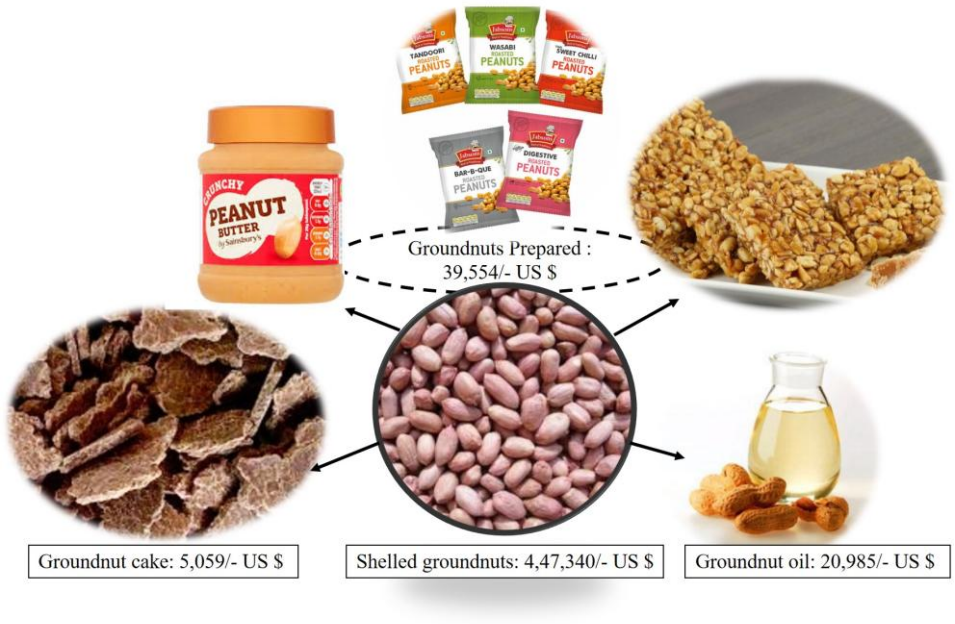


Figure 8: Export value of ground nut products in 2018 (data source: FAOSTAT, 10 Feb 2021)

CHAPTER 3 – ROASTED PEANUTS

The peanuts is a popular edible nut widely used for its butter, confections and snacks. The main process it undergoes before being converted to any of these products is roasting. While roasting the kernel produce around 300 flavour compounds. Roasting involves heating at high temperature without any enzymatic reaction leading to the production of several pyrazine compounds namely hexanal, hexanol methylpyrrole and benzene acetaldehyde. Roasting is done via many ways like dark roasting, deep frying and blister frying.

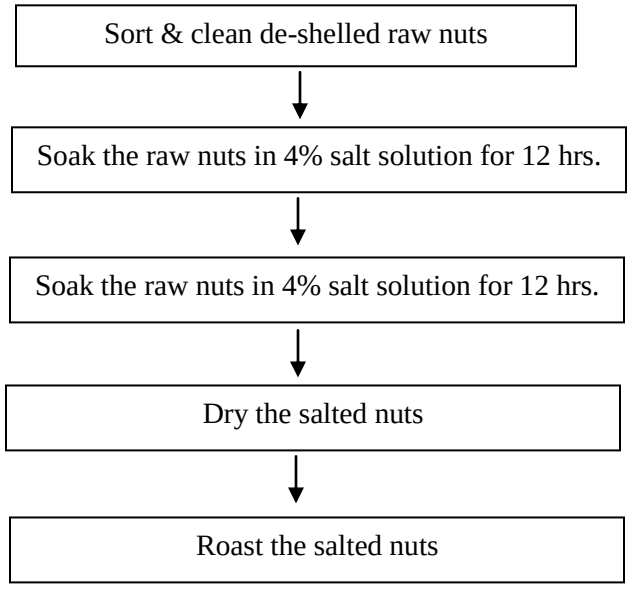
3.1. DARK ROASTING

Dark roasting or conventional roasting is done at 350° F for fifteen to twenty minutes in a shallow frying pan. The peanuts roasted this way had highest breakdown. The dark roasted peanuts had low peroxide value when compared to oil roasted or blister fried peanuts.

3.1.1. Salted peanuts

Salted peanuts are prepared by soaking the raw nuts in 4% salt solution for 12 hours and further drying these salted nuts and roasting them.

3.1.1.1. FLOWCHART FOR SALTED PEANUTS



Pan roaster

Automatic seasoning system

Figure 10: Equipments for salted/ masala peanuts

3.2. BLISTER FRYING

In blister frying the blanched skinned peanuts are boiled in water for 10 minutes and drained. The drained nuts are fried using oil still it is wet, resulting in blisters on its surface. This process also provides better flavor profile and crispy texture to the product with low break-down. This process also leads to increase surface damage in peanuts leading to leaching of nutrients mainly sugars.

3.3. DEEP FRYING

Oil roasting is faster process yielding peculiar nutty flavor to peanuts and high crispiness and hardness compared to dry roasted nuts. Oil roasting is done using an electric skillet or deep fryer, where in oil is taken enough to cover the peanuts to be roasted. If 2 cups of raw or blanched peanuts are taken, 1 ½ cup of oil is taken to roast the same.

Electric skillet

Deep fat fryer

Figure 3: frying equipment

3.4. MICROWAVE ROASTING

Microwave roasting of peanuts are done using 700 watt microwave, in which the peanuts are dampened and sprinkled with salt, further it was kept in microwave for 1 – 2 ½ minutes with intermittent stirring in 30 seconds interval.

3.5. HACCP PLAN FOR GROUND PROCESSING

Critical control point (CCP)	Potential hazard	Corrective measures
Raw material reception	Contaminated, immature pods, high pest infestation, dead insect remnants	The firm should not accept raw groundnuts of inferior quality. Quality check in terms of sorting, microbial analysis and eradication of insect remnants should be done.
Pre-processing storage	Mould growth and rodents attack, moisture absorption	Immediately process the received raw materials. While storing stack the gunny bags on wooden planks. Continuously monitor the moisture in the storage facility
Processing line	Cross contamination	Workers in primary processing

		section handling semi-processed foods are capable of contaminating the final produce if proper cleanliness is not maintained. Workers should wash hands before handling production line at different stages and all the equipments used in processing should be cleaned well ahead of processing.
Packaging	Moisture influx to final product, cross contamination	The packaging material used should be food grade quality and it should be oxygen barrier to avoid moisture absorption by final products. The storage containers should be cleaned before packing. The package should be tamer resistance to withstand conveyance. Avoid condensation of cold stored groundnuts while unloading as part of transit.
Storage of final product	High water activity in produce, improper storing conditions	The aw activity of final product should be low (< 0.7) to prevent mould growth. Vacuum packaging or nitrogen flushing could be used. The relative humidity of the storage environment should be 55-65%.

CHAPTER 4 – GRADING OF PEANUTS

Amount of moisture, percentage of loos kernels and foreign materials determine the quality of peanuts. In this regard, certain quality criteria and limits have been set up by the national and international agencies for grading the peanuts produced and exported. According to varying size, peel colour and pod shape ground nuts are classified as coromondal, bold, java or Spanish and red natals.

Bold

Java

Red skin Java

Figure 9: Groundnut kernel varieties

The kernels are graded according to kernel counts per ounce:

Type		Counts per Ounce
Bold	:	35/40, 38/42, 40/45, 45/50, 45/55, 60/70, 70/80
Java	:	40/50, 45/55, 60/70, 70/80, 80/90, 100/120
Red skin java	:	70/80, 80/90

The grading criteria of kernels used for oil milling and edible nuts are different. The edible nuts to be exported are categorized as handpicked and selected (HPS). The ISI standards for HPS kernels are as follows:

Table 1: ISI standards for HPS Kernels

Characteristics	**HPS Bold 1**	**HPS Bold 2**	**HPS Bold 3**	**HPS Khandesh**
Number of kernels per 25 g of the material	Max 40	45 to 53	54 to 58	71 to 75

Broken, damaged and slightly damaged kernels, % by weight (max)	Nil	1	1	1

Adopted from: FAO, Groundnut Post Harvest Operations compendium

Microbial contamination, insect infestation and off odours are other characteristics analyzed during grading and sorting. Sorting is mostly manually done in developing countries however colour graders are now being used to identify and separate aflatoxin infected kernels.

Table 2: CODEX standards for peanuts

Quality factors	**Permissible levels**
Moisture content	Peanuts in-pod – 10% Peanut kernels – 9.0%
Mouldy or decayed kernels	0.2% m/m max
Rancid kernels	Oxidation of lipids: not more than 5 meq active oxygen/kg) Production of free fatty acids: not more than 1.0%
Extraneous matter	Peanuts in-pod – 0.5% m/m max Peanut kernels – 0.5% m/m max
Filth (impurities of animal origin like dead insects)	0.1% m/m max

Source: www.codexalimentarius.org

Microbial contamination and production of toxins like aflatoxin is a major concern in groundnuts used for human consumption and feed. The aflatoxin B_1 limit for groundnuts intended for human consumption has been set as 2 µg per kg. However, the exporting countries should meet the importers requirements and meet the specific limits set by them for aflatoxin

levels. The details regarding country specific aflatoxins limits could be obtained from FAO's Groundnut Post Harvest Operations compendium.

Table 3: Tolerance limits for aflatoxin as set by European Union

Intended use	Tolerance limit (µg per kg)	
	B_1	$B_1 + G_1 + B_2 + G_2$
Groundnut for direct consumption	2	4
Groundnut for further processing	5	10
Groundnut milk and its related products	0.05	---

Adopted from: FAO, Groundnut Post Harvest Operations compendium

The following quality measures need to be adopted to avoid aflatoxin contamination in groundnuts:

- Harvest kernels after attaining proper maturity.
- Sort and separate immature pods from matured pods.
- Avoid handling / mechanical damage while harvesting the pods.
- Immediately process the pods after harvest.
- Reduce the moisture of the pods to 6-8% before storing.
- While storing the pods in gunny bags, keep the stacked bags on wooden planks to avoid moisture absorption.
- Educate farmers about scientific and hygienic harvesting and post-harvesting practices.

Table 4: Microbial parameters for peanuts as prescribed by American Peanut Council

Parameters	Specified limits
Total Plate Count	<10,000/g (roasted product)
Yeast and Mold	<100/g (roasted product)

Enterobacteria	<10/g (roasted product)
Coliforms	<10/g MPN (roasted product)
E. coli	<3.6/g MPN (roasted product)
Salmonella	Negative

Adopted from: www.nutfruit.org

PACKAGING MATERIALS FOR ROASTED PEANUTS

LDPE covers

Pillow pouches

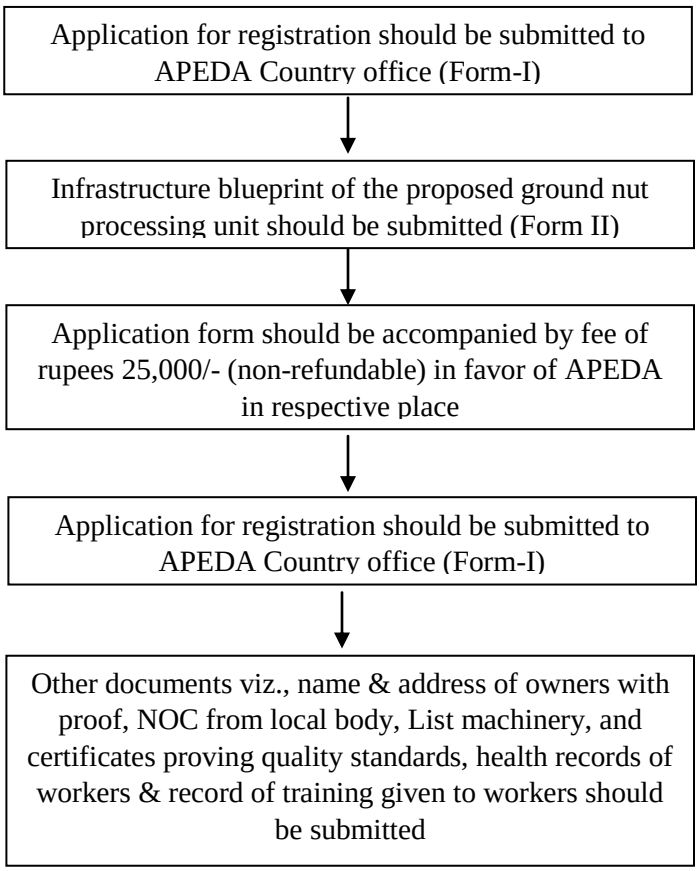
Vacuum packaging machine

CHAPTER 5 – REGULATORY REQUIREMENTS FOR DOMESTIC & INTERNATIONAL GROUNDNUT TRADE

5.1. CRITERIA FOR GRANT OF REGISTRATION CERTIFICATE FOR PEANUT PROCESSING UNITS THROUGH APEDA

To upgrade Indian groundnuts in international market abiding to the quality standards and phytosanitary requirements proposed by the importing country, APEDA has laid down several guidelines for grant of registration certificate for establishing groundnuts processing units and export.

5.1.1. FLOWCHART OF REGISTRATION PROCESS UNDER APEDA



5.2. STEPS IN GRANTING REGISTRATION

Once the application is submitted the proposed processing facility will be inspected by a committee constituted by APEDA officials, state officials and officials from Directorate of

Ground Research. The date of inspection will be informed to the applicant one week ahead, so that the applicant can keep the necessary document ready. The committee will provide the inspection report in form III format. After inspection the officials should submit report with recommendations or suggestion if any, within two weeks to the APEDA office. The peanut processors should ensure compliance to Good Agricultural Practices (GAP) and further Good Manufacturing Practices (GMP) throughout the groundnut value chain in accordance with code of practice to prevent/reduce aflatoxin level in groundnuts (CAC/RCP – 55-2004).

Once the officials are satisfied by the application details and verified by the physical inspection, the committee could recommend APEDA to grant the registration certificate and it will be issued by AEDA in format form IV. If the unit doesn't conform to the standards/complaints from financial agencies/absence of NOC from local bodies, the registration can be revoked or suspended. The unit owners/manufacturers can submit an appeal within 30 days to APEDA Chairman against cancellation of the registration. In case of mutilation or loss of original certificate, duplicate will be issued on paying 1000 rupees to APEDA.

5.3. FSSAI: QUALITY STANDARDS FOR ESTABLISHING A FBO

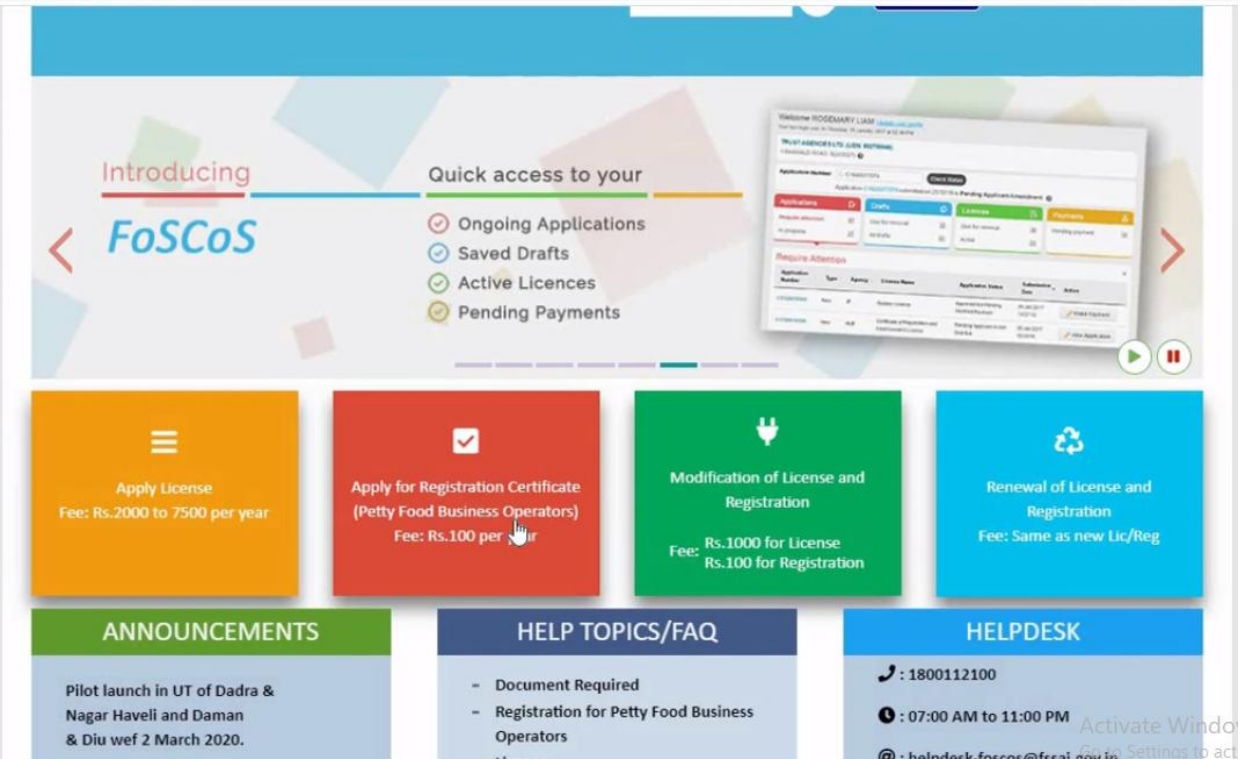
Any food business operations (FBOs) require registration or license from Food Safety Standards Authority of India (FSSAI). A food business operation with an annual turnover of 12 lakh or less should take **FSSAI registration** and if the annual turnover is >12 lakhs – 20 crores the FBOs need to take **FSSAI State Licensing** and **above 20 crores** should go for **central licensing**. The **registration fees is 100**/- for a year and **3000/- per year for licensing**. The **validity of the registration / license can be from 1 year to 5 years** as chosen by the food business operator. **Renewal of registration / licensing should be done 30 days prior** the expiry of the current registration or license. Any application filed after this period for renewal will have to bear fine of rupees 100/-.

5.3.1. The documents required to apply for registration:

- Proof of premise
- Identity proof of the manufacturer
- No objection certificate from Municipality / Panchayat

- Health fitness certificate by physician declaring the fitness of workers in the FBO
- Document declaring the safety of the water (with respect to both microbial and mineral contamination) utilized in the Plant.

These documents should be uploaded in the FoSCoS – FSSAI website (https://foscos.fssai.gov.in/) for obtaining registration or licensing.



5.3.2. Documents required for licensing:

- Blueprint of the plant with marked dimensions of each processing area.
- List of manufacturer(s) with full address
- Details of the equipment utilized with specifications , capacity and power consumption
- Data of water analysis (bacteriological and chemical) from govt. authorized water testing laboratories.
- Photograph of unit

- Government authorized identity proof along with photo of the manufacturer/ proprietor / partner / director of the FBO.
- Proof of possession of food plant premises (sale deed/ rent agreement/ electricity bill)
- In case of partnership business the partnership deed/ memorandum & articles of association towards the constitution of the firm/ self-declaration of proprietorship.
- Form IX: nomination of persons by a company along with the board resolution.

5.3.3. General hygienic requirements

- Stored peanuts should be fumigated to avoid insects' infestation and pyramid stacking is recommended.
- The transportation facility should be well ventilated to avoid moisture retention in the product from respiration of groundnuts.
- During bulk storage of groundnuts, the warehouse should be fumigated before storing groundnuts and it should not contain any opening that allows the entry of rodents/birds/rain water.
- De-shelling, grading and sorting equipments can accumulate debris and dirt, hence the conveyor belts and pulleys need to be cleaned before sorting groundnuts.
- The location of the processing unit should be away from pollution and other such industrial areas where there are chances for fumes, excessive soot etc. to avoid cross-contamination.
- There should be compartmentalization for raw material storage, pre-processing section, primary and secondary processing sections. The final product should be stored away raw materials.
- Floors and ceilings should be cleaned, paintings of walls should be water proof, easy to clean, and also flaking of plaster should be avoided.
- Rodent and insect control measures need to be taken.

- Proper waste disposal measures, segregation of biodegradable and non-degradable waste should be done.
- The drainage flow should be opposite to the manufacturing line.
- The windows and ventilations should be screened.
- The processing facility should be well-lit, however the light should not mask the colour of the product.

Table 5: Recommended light intensity for peanut processing facility

Room	Intensity
Inspection area	540 lux
Work rooms	220 lux
Other processing area	110 lux

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