Soy Product Processor

(Job Role)

Draft Study Material for Class XI

Qualification Pack: FICSI/QP8004

Sector: Food Processing

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Foreword

It is with great pride that I present the textbook *"Soy Product Processor"* for Grade XI. This comprehensive resource is the outcome of a collaborative effort by esteemed authors and the Ministry of Education, who have contributed their expertise and support to create this valuable educational tool.

In an age where knowledge and innovation are vital, the *"Soy Product Processor"* textbook stands out, offering students an in-depth understanding of soybean processing and its applications. The authors Dr. Rakesh Kumar Raman, Dr. Deepika Agrahar Murugkar, Dr. Preeti Dixit, Dr. Punit Chandra, Mr. Sumit Kumar Agrawal, and Dr. R. Ravichandran have combined their expertise and experiences to provide a holistic view of the subject, making this textbook both informative and engaging.

This textbook is more than just a collection of information; it takes students on a journey through the complexities of soy product processing, guided by the insights of accomplished experts. The content has been meticulously crafted to address the academic needs of Grade XI students while fostering a deep appreciation for the significance of soy in agriculture and food processing.

I extend my gratitude to the Ministry of Education for their vision and dedication to educational advancement, as well as to the National Council of Educational Research and Training (NCERT) and the Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE) for their steadfast support in bringing this initiative to life.

As students explore into the pages of *"Soy Product Processor,"* I am confident that they will discover a wealth of knowledge that not only enhances their academic learning but also sparks a lasting interest in the dynamic field of soybean processing.

May this textbook inspire curiosity, exploration, and a lifelong appreciation for the transformative role of soy products in our interconnected world.

Director
National Council of Educational
Research and Training

About the Textbook

A "Soy Product Processor" have diverse career paths and entrepreneurial opportunities. S/he can work in food processing, contributing to the production of soy-based products. Roles extend to nutrition, health, research, and development, with options to improve processing techniques. Entrepreneurs can establish businesses, from small-scale tofu production to unique soy-based items. Consultancy, supply chain management, and quality control roles are also available. Additionally, there are avenues in education, environmental sustainability, and international development. With a range of options, individuals in this field can make impactful contributions to the food industry and beyond."

This textbook for the job role of 'Soy Product Processor' has been developed to impart knowledge and skills through practical knowledge, which forms a part of experiential learning. Experiential learning focuses on learning by performing job activities along with regular classroom teaching–learning process. Therefore, the learning activities are student-centered rather than teacher-centered.

This textbook has been developed by subject and industry experts, and academicians, who have made it a useful and inspiring teaching– learning resource material for students. Care has been taken to align the content of the textbook with the National Occupational Standards (NOSs) for the job role so that the students acquire necessary knowledge and skills as per the performance criteria mentioned in the respective NOSs of the Qualification Pack (QP). The textbook has been reviewed by experts so as to ensure that the content is not only aligned with the NOSs but also offers quality learning. The NOSs for the job role of 'Soy Product Processor' covered through this textbook are as follows.

1. FIC/N9902: Work effectively in an organisation
2. SGJ/N1702:Optimize resource utilization at workplace
3. FIC/N9026: Prepare for production
4. FIC/N9901: Implement health and safety practices at the workplace
5. FIC/N8011: Produce soya beverages and paneer (tofu)

The textbook consists of five units. Unit 1 gives an introductory knowledge of the Soybean processing, the significance of soybean processing on country's economic development and nutritional security. It focuses on the soybean cultivation and soybean utilization, and gives knowledge of its application in different industries as a raw material. Unit 1 also talks about physicochemical characteristics of soybean in terms of quality, nutritional value, and suitability for various industrial applications.

Unit 2 focuses on the different processing steps involved in production of various soy based products using soybean grains. The unit also covers the basic soy products: soy flour, soy milk, tofu and by-products resulting from primary, secondary and tertiary processing of the soybeans.

Unit 3 aims to help the students learn to prepare and Maintain soybean processing unit for different unit operations. It gives an insight into the organisational structure of the soybean processing plant, Soy flour production plant, soy milk production plant and tofu production plant; different type of unit operations, tools, equipment and machinery used in a soybean processing.

Unit 4 explains the essential elements for soy processing industry such as identification of production requirement, methods of cleaning: CIP and COP etc. and different preparation required before starting the actual production of soybean products.

In Unit 5, the students will understand the significance of food safety and hygiene in food processing sector. Students will learn to exercise food safety and hygiene practices at workplace before, during and after the production cycle. It deals with the shelf-life of the food, various food safety hazards, importance of food safety regulations and standards in relation to soy products and the key responsibilities of the 'Soy Products Processor' that s/he needs to perform in a soy processing plant.

I hope this textbook will be useful for students, who will opt for this job role, as well as, teachers. Suggestions for improving this textbook are welcome.

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We also express our heartfelt appreciation to the Director, National Council of Educational Research and Training (NCERT), for his invaluable guidance and encouragement throughout the creation of this textbook.

Our acknowledgment goes to the Joint Director, Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), for his insightful direction, which has significantly influenced the content and structure of this resource.

We are deeply grateful to the esteemed authors who have contributed their expertise and knowledge to this textbook. Dr. Rakesh Kumar Raman, Dr. Deepika Agrahar Murugkar, Dr. Preeti Dixit, Dr. Punit Chandra, Mr. Sumit Kumar Agrawal, and Dr. R. Ravichandran have displayed exceptional dedication and commitment to the development of *"Soy Product Processor."* Their diverse expertise and experiences have enriched the textbook, ensuring its relevance and academic value.

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Module 1 Introduction to Soybean

Soybean (Glycine max) is a versatile and widely cultivated legume that belongs to the family *Fabaceae*. The soybean plant is an annual crop that grows upright and can reach a height of 1 to 2 meters. It has trifoliate leaves and produces clusters of pods containing two to four beans each. The beans are small and round, usually pale yellow, but they can also be green, brown, or black depending on the variety.

Fig. 1.1: Soybean Pod

Soybeans are known for their nutritional composition. They are a rich source of high-quality protein, essential fatty acids, vitamins and minerals. Due to their nutritional profile, soybeans and soy-based food products have gained popularity as a staple food in many parts of the world, particularly among vegetarians and vegans. They are used for the production of cooking oils, margarine, tofu, soy milk, soy flour, and a wide range of processed foods. In addition to their use as food, soybeans have numerous industrial applications.

In this unit, we will explore the historical background of soybeans, cultivation practices, and physicochemical characteristics that offer numerous applications as food and feed. Additionally, we will discover various traditional and innovative soybean-based products from around the world.

SESSION 1: SOYBEAN: A GOLDEN BEAN

Did you know that soybean has an ancient and intriguing history, spanning thousands of years and touching the lives of people across different continents and cultures? Soybeans have been an integral part of human civilization for thousands of years. In this session, we will explore the history of the soybean, starting from its origins in ancient China and tracing its journey as it spread across the globe.

Historical Background of Soybean

The journey of soybean began approximately 2000 BC in the northeast China. The first evidence of wild soybean was reported in China, between 9000 and 7800 years ago. As early as in 2853 BC, the Emperor Sheng-Nung of China named it as one of the five sacred grains. (Soybean History). During the Zhou dynasty in China (1046–256 BC), soybean gained importance as a crop.

As time passed, soybean cultivation spread across East Asia. By 1000 BC, soybean resembling modern varieties used as a food crop were found in Korea.

It is believed that with the development of sea and land trades, soybean moved out of China to Southeast Asian countries such as Japan, Burma (Myanmar), Indonesia, Malaysia, India, Nepal, Philippines, Thailand, and Vietnam between the first century AD and 1100 AD. However, it remained a minor crop everywhere except in China. (*source*)

What are legumes and pulses?

Legumes: *Legumes is a broad term, which includes all the lentils, pulses, beans and peas found in the family Fabaceae or Leguminosae. A legume consists of the leaves, stems or pods of the plants in the Fabaceae family. It is rich in dietary fibers and proteins.*

Pulses: *Pulses are the dried and split edible seeds of legume plants. Pulses include red gram dal, green gram dal etc.*

In Bharat, Soybean is believed to be introduced through the Himalayan routes, and via Burma (now Myanmar) by traders from Indonesia. However, some of the early soybean products such as soy sauce made its way from southern Japan to the Indian subcontinent through the East India Company in the 1600s. The soybean, originating from southern China, gradually spread to the northern parts of the Indian subcontinent during this period. (*source*)

The journey of soybean continued as it arrived in North America from China in 1765, where it was used as a dead weight in ships and disposed-off at the harbor on arrival (source). These seeds sprouted wildly and slowly over the next 155 years, they were primarily grown for forage. Due to systematic breeding in America between 1920s to 1950s, soybean was transformed from an inefficient fodder type crop to a highly nutritious human food source. USA surpassed China in soybean production and became one of the largest producers in the world. In the United States, soybean production expanded significantly during and after World War I, becoming one of the country's largest cash crops. The soy food movement gained momentum, and today soybean covers more than 70 million acres in the USA as a major crop.

Across the Caribbean, Mediterranean, Australia, Western Europe, Africa, Central Asia, Central America, and South America, soybeans found their way into new territories, enriching diverse cuisines and diets. Due to the higher global demand to feed the growing population genetically modified (GM) soybean crop was introduced in Brazil on a large scale resulting sharp increase in the soybean production making it top producer globally in 2020.

In addition to their role as a primary food source, soybean was recognized for their ability to fix nitrogen in the soil, which enhanced soil fertility and paved the way for sustainable farming practices. This trait made soybeans an essential rotational crop, especially in East Asia, where they were traditionally cultivated alongside rice.

Did You Know?

Each soybean pod produces three to four beans; occasionally they will produce five beans, but this is very rare.

The soybean was first introduced to America in 1765 by a sailor named Samuel Bowen.

Henry Ford once made a car with a body made almost entirely from soybean-based plastic in the 1940s? The "Soybean Car" was a sustainable and innovative concept ahead of its time.

Statue of Liberty monument's elevator runs on biodegradable hydraulic fluid made from soy oil.

It also plays a vital role in the production of various industrial products and animal feed. The soybean industry has grown exponentially, with countries like the United States, Brazil, and Argentina being major producers and exporters.

Production of Soybean

Let's explore the current production scenario and the major producers of soybeans around the world.

i. Major Soybean Producing Countries in the World

The world's total production of soybean is estimated to be around 405.31 million metric tons in the year 2022. Brazil is the leading producer of soybean and holds the top rank in global production, contributing nearly 31 percent of the world's total production. USA, Argentina, and China contribute 30 percent, 9 percent, and 3.5 percent, respectively, to the world's soybean production. India secures the fifth position with a significant share of 3.2 percent contribution to the global production. The following Figure 1.2 represents the contribution of major soybean producing countries.

Fig. 1.2: Major Soybean Producing Countries (Production in MMT, 2023)
(https://worldpopulationreview.com/country-rankings/soybean-production-by-country)

Brazil is the largest producer of soybeans and has significantly increased its output over the years. The country has vast areas of suitable agricultural land, and soybean cultivation has expanded into different regions of the country. The United States is second largest producer of the soybean production accounting for a significant portion of the global production. The main soybean-growing regions in the United States include the Midwest, particularly in states like Iowa, Illinois, and Minnesota.

Did you know?

Starting in 1935, Mahatma Gandhi became interested in soybean as a source of low-cost, high-quality protein in the vegetarian diet he advocated. He had learned of soybean from Shri Narhar Bhave (father of his famous nonviolent coworker Vinoba Bhawe) who was eating 168 grams of cooked soybean daily, and reported that they greatly improved his health. Starting in in October 1935 Gandhi began serving whole soybean (steamed for two hours) to all members of his community at maganwadi; they were in eaten with chapatti or bhakari for breakfast with rice for dinner, seasoned with a little salt and oil. In late 1935 Gandhi wrote seeral articles about soybean and soy foods and published information provided by the Baroda State Food Survey office in his popular magazine Harizan.

Source: https://www.mkgandhi.org/ebks/diet_and_diet_reform.pdf

ii. India

Soybean cultivation in India was negligible until 1970, but it grew rapidly thereafter, crossing over 6 million tons in 2003. India has emerged as one of the leading soybean producing nations, securing a place among the top 5 globally. This rise in soybean cultivation underscores its growing prominence in the agricultural sector. Soybean in India is primarily grown in central and western parts of the country, including states like Madhya Pradesh, Maharashtra, Rajasthan, and Gujarat. Madhya Pradesh is the leading soybean-producing state in India, contributing a significant share 39 % (5.32 million metric ton) of the national production (13.79 million metric ton). The region's favorable climate, suitable soil conditions, and increasing adoption of improved farming practices have contributed to the growth of soybean cultivation. Maharashtra is another important soybean-producing state with a share of 34 % (4.69 million metric ton) in total soybean production in India. Rajasthan contributes around 7 % of the total soybean production in the country. Other states like Karnataka, Gujarat and Telangana also have significant soybean production. These states have favorable climatic conditions and irrigation facilities, which allow for increased cultivation of soybeans.

Table 1.1: Soybean production in various states of India

S. No.	States	Estimated Production (MMT)
1.	Madhya Pradesh	5.32
2.	Maharashtra	4.69
3.	Rajasthan	0.99
4.	Karnataka	0.44
5.	Gujarat	0.24
6.	Telangana	0.18
7.	Chhattisgarh	0.04
8.	Others	0.13

Source: *Soybean Processors Association of India (SOPA), 2022*

The growth of soybean production in India is driven by rising demand for edible oils, protein-rich food and animal feed, and the availability of improved soybean varieties. The government has also implemented various policies and initiatives to support soybean cultivation and promote its processing industries. Soybean production in India has been steadily increasing, making the country an important player in the global soybean market.

Major soybean varieties grown in India

In India, several soybean varieties are grown, each adapted to different agro-climatic regions and varying farming practices. The choice of soybean varieties is crucial to achieve optimal yield and quality.

The popular soybean variety are high-yielding, have good resistance to diseases, tolerance to water logging, yield good oil content and have high nutritional value.

Major soybean varieties cultivated in India

NRC-2
NRC12
NRC 37
NRC 7
JS9305
JS 9560
JS 8021
DSb23
MACS 58
NRC142
NRC 150
NRC 132

Source: https://iisrindore.icar.gov.in/

The choice of variety for cultivation depends on factors such as climate, soil type, water availability and prevailing disease and pest pressures in a particular region. Farmers select the most suitable varieties based on these factors to achieve optimal soybean production, meet market demands and pricing.

Practical Exercise

Activity

1. Using soybean seeds, locate the world's major soybean producing countries on the world map.
2. Prepare a timeline chart of soybean cultivation across the world.

Check Your Progress

A. Multiple Choice Questions

1. Soybean legume belongs to the_____ family.
   (a) Fabaceae (b) Gramineae
   (c) Poaceae (d) Asteraceae

2. Legume includes beans, peas and _____.
   (a) Peanuts (b) Nuts
   (c) Sunflower (d) Seeds
   (e) Oilseeds

3. The journey of soybean began approximately 2000 BC from _____.
   (a) Korea (b) Japan
   (c) China (d) Africa

4. In the Indian subcontinent, _____ made its way from southern Japan through the Dutch East India Company in 1600s.
   (a) Tofu (b) Soy sauce
   (c) Tempeh (d) Soy milk

5. _____ holds the first rank in soybean production across the world in the year of 2022.
   (a) China (b) United States
   (c) Brazil (d) India

B. Fill in the Blanks

1. Botanical name of soybean is _____.
2. The soybean plant grows upright and can reach a height of_____.
3. The soybean from China to North America in 1765 was taken by _____.
4. Soybeans has the ability to fix _____ in the soil.

C. State True or False

1. Legumes are a subcategory of pulses. (True/False)
2. Soybean was first discovered in North America. (True/False)
3. USA is the second largest producer of soybean in the world in the year of 2022. (True/False)
4. In India, Gujrat is the largest soybean producing state. (True/False)
5. Soybean have good quality protein and high fat content. (True/False)

D. Subjective Questions

1. Describe the journey of soybean from China to other part of the world?
2. What are major varieties of the soybean used in India for the soybean cultivation?
3. How do you think soybean cultivation managed to spread and thrive across the world? Explore the factors that might have favored the expansion of soybean consumption to different regions!
4. What delicious products could you prepare with soybean in your kitchen?

What have you learned?

After completing this Session, you will be able to:

- Describe the historical background of soybean cultivation.
- Describe the soybean production scenario in the world.
- Identify major soybean producing countries across the world.
- Describe the current status of soybean production in India.
- Identify different types varieties used for soybean cultivation in India.

SESSION 2: SOYBEAN CULTIVATION AND SOYBEAN UTILIZATION

As we move forward to Session 2 of Unit-1, let us explore the general practices of soybean cultivation and usage of soybean as food and feed purposes. In this session you will also explore diverse range of traditional and innovative products consumed across the world.

SOYBEAN CULTIVATION

The soybean, botanically known as *Glycine max (L) Merrill*, belongs to the family *Fabaceae*. Soybean are primarily cultivated during the rainy seasons and are well-suited for upland crop rotation, especially when combined with maize, pigeon pea, sesame, and groundnuts. Being nitrogen (N) fixing legumes, when appropriately inoculated with rhizobia, they enrich the soil with nitrogen, which benefits the subsequent crops in the rotation by leaving behind a nitrogen supply for their growth.

The soybean seed is unique as it lacks endosperm but has a seed coat and a well-developed embryo. The embryo contains two cotyledons, which serve as food storage for the plant. A mark called a hilum or seed scar is present on the seed coat, protecting the embryo from harmful fungi and bacteria before and after planting. A cracked seed coat may hinder germination. The soybean embryo also comprises three crucial parts near the hilum: radicle, hypocotyl, and epicotyl as shown in Fig. 1.3. These are vital for germination, with the radicle becoming the primary root, the hypocotyl lifting the cotyledons above the soil, and the epicotyl becoming the main stem.

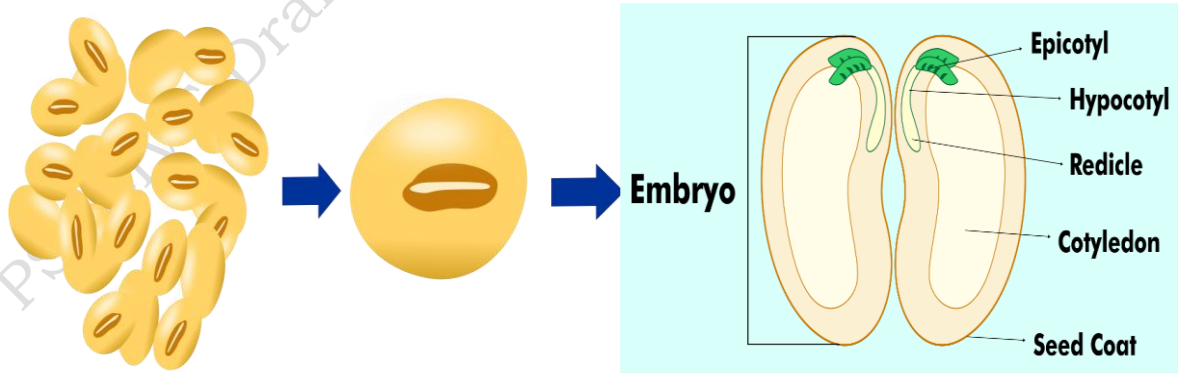

Fig. 1.3: Structure of Soybean Seed

Soybean cultivation exhibits several general characteristics which we'll discuss next are as follows:

i. Climate and Growing Conditions

Soybean cultivation thrives in moderate temperatures with an optimal growing range of 20-30°C. They require a frost-free growing season of around 90 to 120 days, depending on the variety. Soybeans prefer well-drained soils with a pH level of 6-7 but can tolerate a wide range of soil types. Soybean needs 400-500 mm of water for a good crop. High moisture during germination, flowering, and pod formation is critical, but dry weather is necessary for ripening.

ii. Crop Rotation

Soybeans are commonly used in crop rotation systems due to their ability to fix atmospheric nitrogen through a symbiotic relationship with nitrogen-fixing bacteria in root nodules. This nitrogen fixation process improves soil fertility and reduces the need for synthetic nitrogen fertilizers, making soybeans an effective rotational crop.

iii. Planting and Harvesting

Soybeans are usually planted directly in the field as seeds, either through broadcasting or using seed planters. The optimal planting time varies based on the local climate, but it generally occurs in the spring and pre monsoon seasons. Harvesting takes place when the soybean plants reach maturity, which is indicated by the yellowing and drying of the leaves. The beans are typically harvested mechanically using combine harvesters.

iv. Pest and Disease Management

Soybeans are susceptible to various pests and diseases, including aphids, caterpillars, beetles, fungal diseases (such as soybean rust and stem rot), and viral infections. Integrated pest management (IPM) practices, including the use of resistant varieties, crop rotation, cultural practices, and judicious pesticide use, are employed to manage these issues.

v. Yield and Productivity

Soybean yield can vary based on several factors, including genetics, cultivation practices, soil fertility, pest and disease management, and weather conditions. On an average, soybean yields range from 1 to 2 metric tons per hectare. However, with modern agricultural practices and improved varieties, higher yields can be achieved, especially in areas with favorable growing conditions.

vi. Drying and Storage of Soybean

Soybean should be harvested, when leaves start falling and pods look dry, but before getting dried completely. The moisture in the seeds at the time of

harvesting should not be more than 14 percent. Harvesting during wet weather conditions is generally avoided. The harvested grains should be protected from rain and excessive dew. The harvested crop is then dried for 8-10 days on the threshing floor having a moisture content around 8-10 percent.

Direct sun drying and excessive drying of grains is not recommended because it may damage the seed coat which will make them prone for disease and pest infestation. If produce is to be used as seed for next season, it should be stored in gunny bags of not more than 40 kg capacity in a cool and dry place as shown in Fig. 1.4.

Fig. 1.4: Storage of Soybean Grains

These are some of the general practices employed for soybean cultivation, however it is important to remember that specific practices and conditions may vary depending on the region, farming systems, and local agricultural practices.

SOYBEAN UTILIZATION

In India, soybean products are widely used for human consumption and animal feed. As a food source, soybean is consumed in various forms, including whole beans, sprouts, and processed into numerous traditional and innovative products. The high protein content of soybean makes it a crucial ingredient in vegetarian and vegan diets, providing a nutritious plant-based protein source.

Apart from human consumption, soybean meal, obtained after extracting soybean oil, is utilized as a valuable and protein-rich feed ingredient for livestock, poultry, and aquaculture industries. This nutritious feed supplement contributes to the health and growth of farm animals, supporting the overall livestock production sector. Let us now learn about the utilization of soybean in different industries.

i. Food Industry:

As discussed in previous session of the unit that soybean is grown widely and contains high-quality protein, essential fatty acids, vitamins and minerals. Soybean are used widely in variety of products under food processing industry due to their different application. Table 1.2 and Fig. 1.5 provides an overview of different soybean products under different forms of soybean.

Table 1.2: Soybean Utilization in Food Industry:

Whole Soybean Products	Soy-Based Products	Other Soybean Products	By-Products of Soybean Processing Industry
Soy flour	*Soy laddo*	Soy protein isolates	Hull
Soy milk	*Chakli*	Soy protein concentrates	De-oiled cake
Tofu	Soy cheese spread	Soy protein hydrolysates	Okara
Soy milk powder	Soy-based beverages	Texturized vegetable protein	Whey
Nuts	Bakery products	Soy lecithin	Dietary fiber
Tempeh	Dairy analogues		Edible biofilm
Miso	Soy chips		
Natto	Soy *sattu*		
Soy sauce	Soy chaap		
Soy flakes			
Soy puffs			
Soy sticks			
Soy butter			

Soybean products are now finding acceptability and a place as nutritional ingredients in the traditional foods.

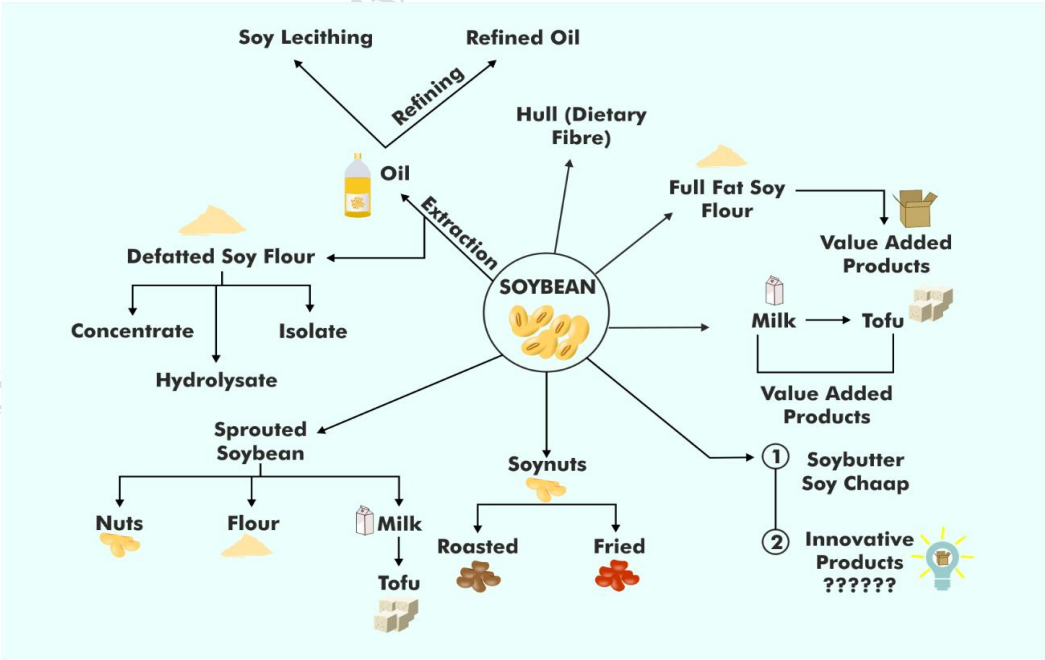

Fig. 1.5: Major Soybean Products in India

ii. Feed Industry

Hull, soybean meal and okara are used extensively as a high-protein component in animal feed for livestock, poultry, and aquaculture.

iii. Industrial Applications

Soybean oil is utilized in the manufacture of various industrial products, including inks, wax, paints, coatings, adhesives and lubricants.

iv. Pharmaceuticals, Health Products and Cosmetics

Soybean is a rich source of isoflavones, which have potential health benefits and are used in supplements and health products. Soy-based nutraceutical products are developed for their health-promoting properties. Soy-based sports nutritional products are widely consumed for their muscle recovery properties.

PRODUCTS OF SOYBEAN CONSUMED IN INDIA

In India, soybeans are used in the food industry from various sources like whole bean, full fat soy flour and defatted soy flour. The different products under each of these categories have their own special characteristics and are becoming popular in the country. Some of the soybean-based products from these sources are as follows:

These traditional soybean-based products showcase the versatility and adaptability of soybeans in Indian cuisine, providing nutritious and flavorful options for people of all dietary preferences.
Other than these products, some globally popular soy products are as follows:

i. Edamame

Edamame is fresh green soybeans still in their pods, which are cooked in boiling salted water. This appetizing dish is particularly consumed in Japan.

ii. Fermented Soy Products

The fermented products of soybean include followings:

Tempeh: Tempeh is a fermented soy product originating from Indonesia. It is made by fermenting cooked soybeans with a specific type of mold. The fermentation process gives tempeh a unique nutty flavor and a firm texture. Tempeh is often used in stir-fries, sandwiches, salads, and as a meat substitute.

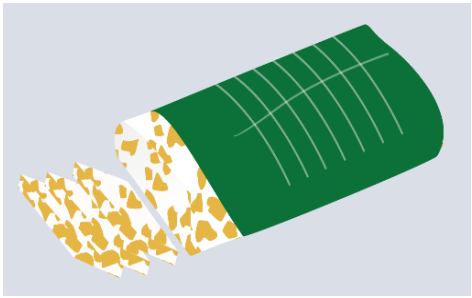

Fig. 1.6: Tempeh

Miso: Miso is a traditional Japanese seasoning produced by fermenting soybeans with salt and a fungus called *koji*. The resulting paste can vary in color and taste, depending on the fermentation period and additional ingredients. Miso is commonly used to make miso soup, a staple in Japanese cuisine, and it is also used as a flavorful ingredient in various sauces and dressings.

Fig. 1.7: Miso

Soy Sauce: Soy sauce is a liquid condiment made from fermented soybeans, wheat (or other grains), water, and salt. It is an essential ingredient in many Asian dishes, adding a savory umami flavor. There are various types of soy sauce, including light, dark, and tamari (gluten-free). It is used as a dipping sauce, marinade, and seasoning in numerous dishes worldwide.

Fig. 1.8: Soy Sauce

Natto: Natto is a traditional Japanese dish made from fermented small soybeans. The fermentation process creates a sticky and stringy texture, and it has a distinct, pungent aroma. Natto is often served with rice and other condiments, and it is considered a probiotic-rich food.

These soy products are not only flavorful but also offer a range of health benefits due to their high protein content, essential amino acids, and various nutrients. They have become part of the culinary heritage in their respective regions and have gained popularity worldwide as interest in plant-based diets and alternative proteins continues to grow.

iii. Innovative Products of Soybean

Soybeans is utilized to create a variety of innovative products catering to different dietary preferences and nutritional needs. Some of the popular innovative soybean-based products are as follows:

Soy Protein Isolates: Soy protein isolates are derivatives made by isolating protein from whole soybean meal. This process removes most of the carbohydrates, resulting in a high-protein product. It contains above 80 % soy protein. Soy protein isolates are often used in the food industry as an ingredient in various food products, including protein bars, shakes, meat alternatives, and more.

Soy Protein Concentrates: Soy protein concentrates also made from whole soybeans meal with protein content from 60-75%. The concentrate also contains carbohydrate. It is commonly used in baked goods, energy bars and vegetarian products.

Soy Milk Powder: Soy milk powder is a convenient and shelf-stable form of soy milk. It is made by dehydrating soy milk, resulting in a fine powder that can be reconstituted with water. It is commonly used in baked goods, energy bars and vegetarian products.

Soy-Based Meat Alternatives/Texturized Vegetable Proteins (TVP): TVP is protein rich product obtained from defatted soy flour that have been textured and flavoured, used especially for protein supplementation. TVP is available in nugget and granule forms, resembling the taste and texture of meat using extrusion technology.

Products like soy-based burgers, sausages, and ground meat have gained popularity as more people seek sustainable and plant-based protein sources. The high protein content and versatile nature of soy make it a common ingredient in these meat alternatives.

Practical Exercise

Activity

1. Prepare a table presenting the cultivation area, yield, total production of soybean in major soybean producing countries for the last five years.
2. Prepare a table presenting the cultivation area, yield, total production of soybean in major soybean producing states of India for the last five years
3. Market survey (online platforms and local market) of the soy based products and identify the components and composition.
4. Prepare an exhaustive list of products of soybean used around the world.

Check Your Progress

A. Multiple Choice Questions

1. Which among these is a nitrogen fixing _____ crop.
   (a) Soybean (b) Paddy
   (c) Rajma (d) Spinach

2. Soybean seed is unique as it lacks _____.
   (a) Seed coat (b) Embryo
   (c) Endosperm (d) Hilum

3. Optimal growing temperature for soybean cultivation ranges from _____.

(a) 20-30°C (b) 10-30°C
(c) 5 -39°C (d) 20-55°C

4. The moisture in the seeds at the time of harvesting should not be more than _____.

(a) 8 percent (b) 14 percent
(c) 25 percent (d) 19 percent

B. Fill in the Blanks

1. The embryo contains two_____ which serve as food storage for the plant.
2. Hilum present on the _____, protecting the embryo from harmful fungi and bacteria.
3. Radicle becomes the _____ during germination.
4. Soybean needs_____ of water for a good crop.

C. State True or False

1. A cracked seed coat will facilitate germination. (True/False)
2. Edamame is dried soybeans still in their pods. (True/False)
3. Tempeh is a fermented soy product originating from Indonesia. (True/False)
4. *Koji* fungus is used for fermenting soybeans with salt to prepare Miso. (True/False)
5. *Natto* is a traditional Chinese dish made from germination soybeans. (True/False)

D. Subjective Questions

1. Describe the soybean seed structure.
2. What are the different soy products consumed in India?

What have you learned?

After completing this Session, you will be able to:

- Describe the seed structure and functions of the various seed parts
- Describe the several general characteristics of soybean cultivation
- Describe the utilization of soybean for various purposes.

SESSION 3: PHYSICO-CHEMICAL CHARACTERISTICS OF SOYBEAN

The physicochemical characteristics of soybean play a crucial role in determining its quality, nutritional value, and suitability for various applications. This session aims to explore the key physicochemical properties of soybean including its nutritional composition. Understanding these characteristics is essential for optimizing the use of soybean in food and its potential health benefits.

i. Physical Characteristics of Soybean Seeds

Soybean seeds exhibit various physical characteristics that can vary depending on the variety. Here are some common physical characteristics of soybean seeds:

Seed Color: The color of soybean seeds can range from shades of yellow to light brown, brown, black, or even green. The most prevalent color is yellow, but other colors also exist in different soybean varieties.

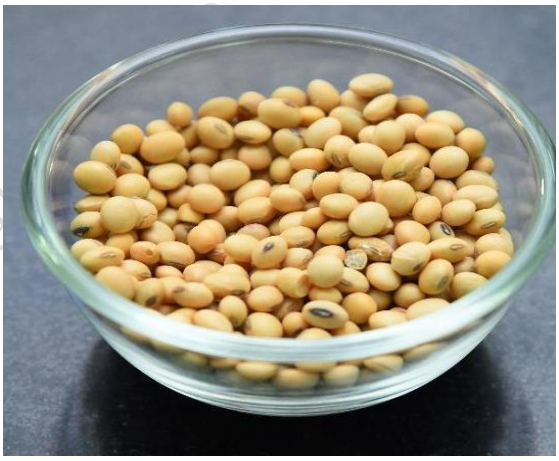

Fig. 1.9: Healthy Soybean Seeds

Seed Size: Soybean seeds are typically oval or rounded in shape. The size of soybean seeds can vary, but on average, they are approximately 5 to 8 millimeters in diameter and 8 to 12 millimeters in length.

Seed Weight: The weight of soybean seeds can vary widely depending on their moisture content and size. On average, soybean seeds weigh around 80 to 130 milligrams per seed.

These characteristics are essential for seed identification, selection, and processing purposes. Farmers and researchers consider these factors when choosing soybean varieties suitable for specific environmental conditions, agricultural practices, and end-use requirements.

ii. Nutritional Value of Soybeans

Soybeans, often referred to as "miracle beans," are a highly valuable agricultural commodity due to its unique nutritional characteristics. Soybeans have around 40% protein content which is the highest among all the vegetarian sources. Soybeans also contain approximately 20% oil, the second-highest among food

legumes, with peanuts having the highest oil content at about 48%. Additionally, soybeans contain beneficial components like vitamins, minerals, isoflavones and phospholipids.

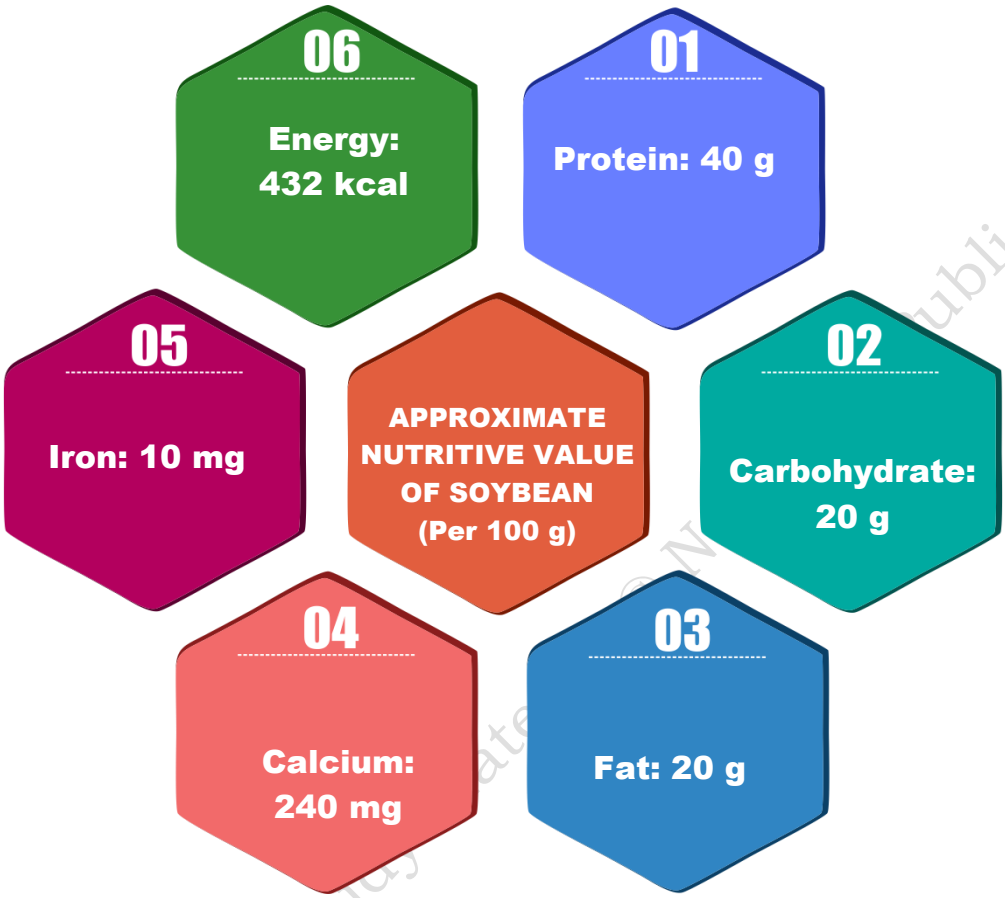

Fig.1.10: Nutritive Value of Soybean

Source: *Gopalan C., Rama Sastri B.V. and Balasubramanian S.C., reprinted 2012. Nutritive Value of Indian Foods, National Institute of Nutrition, ICMR, Hyderabad.*

Soybeans contain carbohydrates in the form of dietary fiber and oligosaccharides. Dietary fiber has two main types: soluble and insoluble. Including soybeans in our meals can significantly contribute to our daily fiber intake, supporting digestive health and overall well-being.

iii. Protein

Protein play a crucial role in the growth, repair, and maintenance of body tissues. Soybeans are exceptional in their protein content, having around 40%. Notably, soybeans are classified as a complete protein source, as they provide all essential amino acids required by the human body. This makes soybeans an excellent protein source as they are easily digestible and contribute to muscle development and various physiological functions.

iv. Fat

Soybeans contains 18 to 20 percent fat mainly polyunsaturated and monounsaturated fats, which are beneficial for heart health. Soybean oil, derived from soybeans, is widely used in cooking and food processing due to its nutritional advantages.

v. Minerals

Soybeans contain significant amounts of essential minerals: calcium, iron, magnesium, phosphorus, zinc, copper and vitamins: thiamin (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine (B6) and folate (B9). Including soybeans in our diet ensures a good supply of these essential minerals, promoting overall health and well-being.

vi. Anti-nutrients

While soybeans are nutritionally dense, they also contain certain compounds known as anti-nutrients which can interfere with nutrient absorption. The two main anti-nutrients found in soybeans are trypsin inhibitors and phytic acid. Trypsin inhibitors interfere with protein digestion. Phytic acid can bind to minerals like iron and zinc, reducing their bioavailability. However, various processing methods, such as soaking, blanching, sprouting, fermenting and cooking, can reduce and inactivates the levels of anti-nutrients, making the nutrients in soybeans more accessible to our bodies.

Practical Exercise

Activity

1. Compare the nutritional composition of soybean with other legumes.
2. Compare the nutritional composition of soybean with other protein rich food items (milk, egg, meat and fish).

Check Your Progress

A. Multiple Choice Questions

1. The size of soybean seeds on average is _____.

(a) 25 to 28 mm (b) 8 to 15 mm
(c) 1 to 2 mm (d) 5 to 8 mm

2. Soybean seeds weigh around_____ milligrams per seed.

(a) 80 to 130 (b) 120 to 160
(c) 30 to 50 (d) 10 to 30

3. Protein content of the soybean is around _____per 100g.
   (a) 10 % (b) 11 %
   (c) 25 % (d) 40 %

4. Oil content of the soybean is around _____per 100 g.
   (a) 20 % (b) 10 %
   (c) 5 % (d) 55 %

5. The most common anti-nutrient found in soybean is _____.
   (a) Amylase (b) Trypsin inhibitor
   (c) Tannin (d) Protease

B. Fill in the Blanks

1. _____ can bind minerals like iron and zinc and reduces their bioavailability.
2. Calcium content of soybean is around _____ per 100 gm of soybean.
3. Processing techniques such as soaking, sprouting, cooking etc. helps in reducing the levels of _____.
4. Soybean protein is considered complete protein due to the presence of all _____.

C. State True or False

1. Length of soybean seeds usually ranges from 8 to 12 millimeters. (True/False)
2. Miracle beans is another name given to soybean. (True/False)
3. Isoflavones and phospholipids are anti- nutrients and pose harmful effect on human body. (True/False)
4. Fat is needed for the growth, repair, and maintenance of body tissues. (True/False)

D. Subjective Questions

1. Describe the physical properties of soybean.
2. Why soybean is called a miracle bean?

What have you learned?

After completing this Session, you will be able to:

- describe the physical characteristics of soybean seeds.
- describe the nutritional value of soybeans.
- describe the anti-nutrients and methods of minimizing the effects of anti-nutrients.

Module 2 | Processing of Soybean

SESSION 1: SOYBEAN PROCESSING

Soybean processing is an important industrial activity that involves converting raw soybeans into a variety of valued soy-based products. The soybean is an essential legume due to its high protein content and versatility in creating various food and non-food items. This session will cover the quality of soybean grains along with primary, secondary, and tertiary processing of soybeans, demonstrating the wide range of products that may be derived from this miracle bean.

i. Quality of Soybean Grains

The soybeans designated for soy processing must adhere to stringent quality standards. They should be devoid of any extraneous matter, broken seeds, or seeds exhibiting signs of disease. Optimal moisture content within the range of 10 to 13 percent is imperative at the point of procurement. The seed index, denoting the weight of individual seeds in milligrams, serves as a crucial determinant of soybean quality. A seed index not falling below 100 milligrams is a baseline requirement; however, a more favorable scenario for soy milk and tofu production involves a seed index of 120 milligrams or higher. The consistent utilization of a uniform soybean variety throughout the production process is strongly recommended to ensure uniformity in product quality.

Soybean consignments acquired from farmers or traders necessitate meticulous storage practices. Such consignments should be systematically stacked in storage facilities, maintaining a distance from walls, pillars, and doors. Proper storage is of paramount importance to preserve the integrity of the procured soybeans.

ii. Primary Processing of Soybeans

Primary processing is the conversion of harvested soybean to start materials for soybean processing. Cleaning, grading sorting, de-hulling are examples of primary processing.

Cleaning and sorting and grading of Grains

The primary processing of soybeans begins with cleaning to remove impurities like stones, dust, and other foreign materials. Sorting and grading are essential to separate damaged or discolored beans from those of higher quality, ensuring the best possible raw materials for further processing.

Fig. 2.1: Damaged and Discarded Soybeans

Sorting and grading is generally done using hand operated manual or pedal-cum power operated double screen cleaner. At industrial scale, high speed mechanical sorting technology is being used for handling the larger quantities.

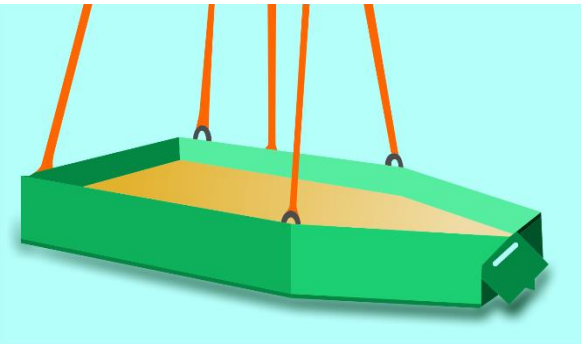

Fig. 2.2: Manual double screen cleaner

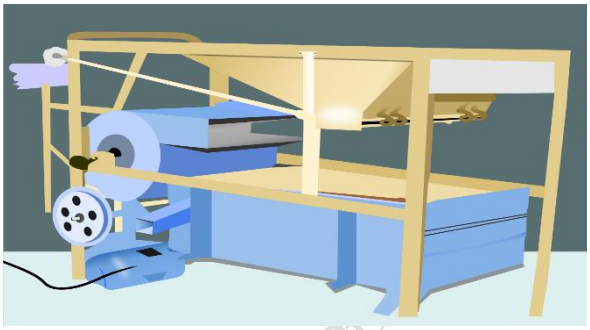

Fig.2.3: Pedal-cum power operated double screen cleaner

After cleaning and grading, store the soybeans in fresh HDPE bags or storage bins. Make sure the storage area is protected from direct sunlight, moisture, and pests. Only keep enough soybeans for 15-20 days of use stored this way.

De-hulling and Splitting

De-hulling, also known as decorticating, involves removing the outer hull or seed coat of the soybean. This process is vital to access the nutritious cotyledons within. Splitting the de-hulled beans into halves facilitates oil extraction and downstream processing. De-hulling is carried out by manual or power operated soybean de-huller to remove the soybean hull. This de-hulled soy splits are ready for making soy flour, milk and tofu.

iii. Secondary Processing

Secondary processing involves further refining initially processed soybean grains to create intermediate products, which can later be used to make various soy-based food items. These intermediate products can also be sold independently. Below, we briefly describe different soybean products that arise from these secondary processing steps.

Soy Grits

After de-hulling and splitting, the soybeans are further processed to produce soy grits by pulverizing the soy dal. Soy grits are coarsely ground soybeans and the size is usually defined by the end application. Soy grits are rich in protein and can be used as ingredients in various food products.

Fig. 2.4: Soybeans Grits

Soy Splits

The de-hulled soy splits are cleaned, packed and sold as soy splits.

Soy Flour

Soy flour is the result of finely grinding the blanched, dried, and milled soy dal. This fine powdered flour can be marketed on its own or serve as a key ingredient in various soy-based products. Notably, it finds application in a range of food items, including baked goods such as biscuits and cakes, as well as fried products, enhancing nutritional value of the products.

Fig. 2.5: Soybeans Flour

Soybean Oil

Soybean oil stands as one of the primary products derived from soybeans, obtained through either mechanical or chemical extraction methods. It has versatile applications in cooking, frying, and serves as a component in numerous food products. The oil extraction process from soybean grains primarily involves solvent extraction, resulting in soybean oil, while the remaining byproduct is known as soy cake.

Fig. 2.6: Soybean Oil

Soybean Meal (De-oiled Cake)

Following the extraction of soybean oil, the residual solids are referred to as soybean meal or de-oiled cake. The de-oiled cake has a high protein content and employed extensively in animal feed production. To ensure the removal of any solvent residue, this leftover solid from the soy oil industry undergoes a treatment process. Subsequently, it may either be ground into defatted soy flour or supplied in its existing form to other sectors within the food and feed industries for various applications.

Soy Milk

Soy milk is a popular plant-based milk alternative produced by soaking, grinding, and straining soybeans. It is a nutritious beverage rich in proteins, vitamins, and minerals, making it suitable for vegans and individuals with lactose intolerance.

Fig. 2.7: Soy Milk

iv. Tertiary Processing

Tertiary processing involves the transformation of soybeans into ready-to-eat (RTE) or ready-to-cook (RTC) soy-based products. This advanced stage of processing yields a variety of items, including but not limited to soy milk, tofu, isolates, concentrates, flavored soy beverages, soy ice creams, and various other soy-based food products.

Tofu

Tofu, also known as bean curd, is a traditional Asian food made by coagulating soy milk and pressing and shaping the resulting curds into blocks. It is a versatile ingredient that can be used in various savory and sweet dishes, making it a popular choice for vegetarians and vegans.

Fig. 2.8: Tofu Block

Isolates and Concentrates

Soy protein isolates and concentrates are highly refined forms of soy protein obtained by removing the carbohydrates and other components from soy flour. They are used as functional ingredients in the food industry to enhance texture, improve nutritional value, and stabilize products.

Flavored Soy Beverages

Soy milk based beverages flavoured with chocolate, vanilla, or fruits are commercially produced to cater to consumer preferences. These beverages offer a tasty and nutritious alternative to traditional dairy-based drinks.

Soy Ice Creams and Soy-Based Products

Soy-based ice creams and frozen desserts have gained popularity as dairy-free alternatives. Additionally, soy protein is used in the formulation of various meat analogs and plant-based products, contributing to the growing market for vegetarian and vegan foods.

Soybean processing is a sophisticated and diverse industry that harnesses the nutritional potential of soybeans to create a wide range of food and non-food products. From the primary processing of cleaning, sorting, and de-hulling to the secondary processing of oil extraction and soy milk production, and finally, the tertiary processing of tofu, isolates, and soy-based products, soybeans play a crucial role in meeting the demands of a growing population seeking nutritious and sustainable food options. With continuous research and innovation, soybean processing will continue to contribute significantly to the global food industry and the quest for a more sustainable future.

Practical Exercise

Activity

1. Take 100 grams of soybean grains from market and calculate the percent of healthy grain, broken grain, diseased grain and foreign material. Also calculate the average weight of healthy grain.
2. Make a table of soybean products and indicate level of processing (primary, secondary and tertiary).

Check Your Progress

A. Multiple Choice Questions

1. What is the primary purpose of de-hulling soybeans during processing?
   (a) To increase moisture content
   (b) To enhance flavor
   (c) To access the nutritious cotyledons
   (d) To remove foreign materials

2. What is the primary ingredient used to make tofu?
   (a) Soy oil (b) Soy cake
   (c) Soy milk (d) Soy flour

3. Soy protein isolates and concentrates are used in the food industry to:
   (a) Enhance flavor
   (b) Increase carbohydrate content
   (c) Improve texture and stabilize products
   (d) Increase fat content

4. What is the typical moisture content range of soybean grains during procurement?
   (a) 5-8% (b) 10-13%
   (c) 15-18% (d) 20-25%

5. What is the primary product obtained through solvent extraction from soybeans?
   (a) Soy grits (b) Soy cake
   (c) Soy flour (d) Soy oil

B. Fill in the Blanks

1. Primary processing of soybeans involves cleaning, sorting, and _____.
2. Soy milk is a popular _____based beverage rich in proteins, vitamins, and minerals.

3. Soybean _____ is widely used for cooking, frying and sauteing in various food products.
4. Tofu is made by _____coagulating soy milk and pressing the resulting curds into blocks.
5. Soy protein isolates and concentrates are refined forms of soy protein obtained by removing specially _____and other components.

C. State True or False

1. De-hulling is the process of removing the outer hull of soybeans to access the nutritious cotyledons. (True/False)
2. Soy flour is coarsely ground soybeans used as an ingredient in various food products. (True/False)
3. Flavored soy beverages, such as chocolate or fruit-flavored soy milk, are not produced commercially. (True/False)
4. Soybean oil cake, a residue of soy oil extraction, is a valuable protein source used in animal feed. (True/False)
5. Tofu is a dairy-based product made from cow's milk. (True/False)

D. Subjective Questions

1. What parameters would you check to ensure the quality of seeds and why?
2. Describe primary, secondary and territory processing of soybean.

What have you learned?

After completing this Session, you will be able to:

- Demonstrate primary, secondary and territory processing of soybean.
- Perform the quality check of soybean seeds.

SESSION 2: SOY FLOUR

Full fat soy flour contains approximately 40 percent protein and 20 percent oil and is a rich source of calcium, phosphorus and iron. It is important to note that soy flour cannot be cooked and consumed directly. Instead, it can be effectively utilized by blending it with other flours in a ratio of 9:1 (90% other flour + 10% of soy flour). This blend can then be employed in the preparation of various culinary staples like *chapatti (roti), poori, paratha* and more, enhancing both nutritional value and versatility.

i. Unit Operations for Soy Flour Preparation

The unit operation employed in preparation of soy flour for household level and micro level are outlined as follows:

Soaking

The initial step entails soaking soybean splits in four times their volume of water for a minimum duration of four hours. The inclusion of a small quantity of baking soda serves the purpose of preventing microbial growth during this soaking process.

Blanching

Following the soaking process, the soaked soybean splits undergo blanching to eliminate anti-nutrients, specifically trypsin inhibitors. In household settings, this involves boiling the soaked splits with water in a vessel for a duration of 30 minutes. On an industrial scale, a specialized blancher, as illustrated in Figure 2.9, is employed for this purpose. Industrial blanchers enhance efficiency and precision in the removal of anti-nutrients, contributing to the overall quality of the soy flour produced.

Fig. 2.9: Blancher for Small Scale and Industrial Scale Soybean Processing Unit

Drying:

Subsequent to the blanching process, the soybean grains undergo a drying process to diminish the moisture content to approximately 7-8 percent. At the household level, sun drying is commonly employed, while industrial dryers are used for commercial-scale drying operations. The drying duration typically spans 6-8 hours, with an optimal drying temperature set at 60°C. This thorough drying process is crucial for achieving the desired moisture level in the soybean grains, ensuring the quality and longevity of the final soy flour product.

Fig. 2.10: Dryer

Milling: The next step in the process involves the milling or grinding of the dried soy splits. At the domestic level, this is typically accomplished using a grinder, while at larger production scales, a grain mill is employed. This milling process is fundamental to reduce the soy splits into a fine powder, ultimately yielding the desired soy flour. The choice of equipment depends on the scale of production, with efficiency and consistency being key considerations in achieving the desired particle size for the final product.

Fig. 2.11: Mini Grain Mill

Packaging of Soy flour:

Upon obtaining the soy flour, the next phase involves careful packaging. The soy flour is weighed and placed into LDPE (Low-Density Polyethylene) packets with a thickness of 100 microns or more. These packets are sealed using a sealing machine, ensuring the preservation of the soy flour's quality. Alternatively, soy flour can be stored in airtight containers for households or smaller quantities.

For commercial products, additional details are incorporated onto the packets. A batch number and the date of manufacturing are typically indicated using a printer or coder, providing essential information for quality control and traceability. This systematic packaging and labeling process contribute to the overall safety and transparency of the soy flour for both producers and consumers.

Fig. 2.12: Package Sealing Machine

Shelf Life: The sealed packets of soy flour have a shelf life of one month. Once opened, it is advisable to consume the contents within a week to ensure freshness. Similarly, soy flour stored in an airtight container should be utilized within 10 days. Beyond these specified periods, there is an increased risk of the flour becoming rancid, potentially posing health hazards. Adhering to these recommended usage timelines is crucial for maintaining the quality and safety of the soy flour for consumers.

ii. Utilization of Soy Flour for Other Soy Based Products

Soy flour serves as an important ingredient in various products, including multigrain flour and a range of baked goods such as bread, cookies, and cakes. Additionally, it can be used as key component in traditional Indian snacks like *chakli* and *sev*. Its versatility is underscored by its ability to be incorporated into formulations at a maximum level of 10 percent, enhancing the overall protein content of the end products. This adaptability makes soy flour a valuable ingredient with widespread applications, contributing to the nutritional profile of a diverse array of food items.

Practical Exercise

Activity

1. Prepare soy flour at domestic level.
2. Make roti by incorporating 10 % soy flour in to wheat flour. Discuss its appearance and taste.

Check Your Progress

A. Multiple Choice Questions

1. What is the approximate protein content of full-fat soy flour?
   (a) 10% (b) 20%
   (c) 30% (d) 40%

2. Why is a pinch of baking soda added during the soaking process of soybean splits?
   (a) To enhance the flavor (b) To increase the shelf life
   (c) To avoid microbial growth (d) To improve color

3. What is the purpose of blanching soybean splits during soy flour preparation?
   (a) To enhance the protein content
   (b) To improve color and appearance
   (c) To remove anti-nutrients (Trypsin inhibitor)
   (D) To increase the shelf life

4. What is the recommended drying temperature for soybean splits during the drying process?
   (a) 40 Degrees (b) 50 Degrees
   (c) 60 Degrees (d) 70 Degrees

5. What is the shelf life of soy flour when stored in an air-tight container?
   (a) 1 week (b) 10 days
   (c) 1 month (d) 3 months

B. Fill in the Blanks

1. During soaking, soybean splits are soaked in _____ of the amount of water for a minimum of _____.
2. The process of blanching is done to remove _____ from the soaked grains.
3. Drying is done to reduce the moisture content of soy flour to _____.
4. Soy flour can be used as a constituent in baked products like bread, cookies, cakes, and traditional Indian snack products like _____ and _____.
5. Soy flour can be used in formulations at a maximum level of _____ to improve protein content.

C. State True or False

1. Full-fat soy flour contains approximately 20 percent oil.
2. Soy flour can be cooked and consumed directly without mixing with other flours.
3. Sun drying and industrial driers are used for the drying process of soy flour.
4. The shelf life of soy flour in an air-tight container is longer than when stored in sealed packets.
5. Soy flour can be used in baked products to improve protein content up to a maximum of 15 percent.

D. Subjective Questions

1. Explain the unit operations and their importance for the preparation of soy flour at both household and industrial levels separately.
2. Explain the factors affecting the shelf life of soy flour.
3. Enumerate the utilization of soy flour in various food products. Provide suitable examples and explain how the incorporation of soy flour affect the nutritional composition of these products?
4. Compare the nutritional content of soy flour with wheat flour, ragi flour, corn flour, sorghum flour and *besan* (Bengal gram flour).

SESSION 3: SOY MILK

Soy milk is plant-based milk derived from soybeans. It has become popular due to its nutritional value, cost effectiveness, suitability for individuals with lactose intolerance and or those opting for dairy-free alternatives. This session will explore into the process of soy milk preparation, encompassing both household and micro-industry levels. We will explore the essential unit operations, the necessary equipment and machinery, and discuss the achieved shelf life through pasteurization and sterilization. Additionally, the session will cover the wide array of consumer products that can be made using soy milk.

Fig. 2.13: Soy Milk

i. **Unit Operations for Soy Milk Preparation**

Household level: At the household level, soy milk preparation involves the following unit operations:

Soaking: Cleaned and de-hulled soybeans (dal/splits) undergo soaking in water at a ratio of 1:4 (beans to water) for up to 4 hours. This process rehydrates the soybeans, facilitating the grinding phase. A small amount of baking soda may be added to prevent microbial growth. The water used in soaking is discarded, and only the soaked beans are utilized for grinding.

Grinding: The soaked soy splits are ground into a smooth paste using a grinder. The ratio of soybeans to water is maintained at 1:7. Lukewarm water is added during grinding to achieve the desired consistency.

Cooking: The ground soybean paste is then boiled for approximately 20 minutes with constant stirring, ensuring thorough cooking.

Straining: Following cooking, the cooked material is strained through a fine mesh or cheesecloth to separate the soy milk from the solid residue. The solid residue, known as okara, is a by-product of soy milk processing and can be used in various other food preparations.

Sweetening and Flavoring (Optional): Additional steps involve optional sweetening with sugar or other sweeteners and flavoring with ingredients like vanilla, cocoa powder, or fruit extracts, depending on individual preferences. The prepared soy milk is then ready for consumption. It can be stored in bottles and refrigerated for up to 2 days.

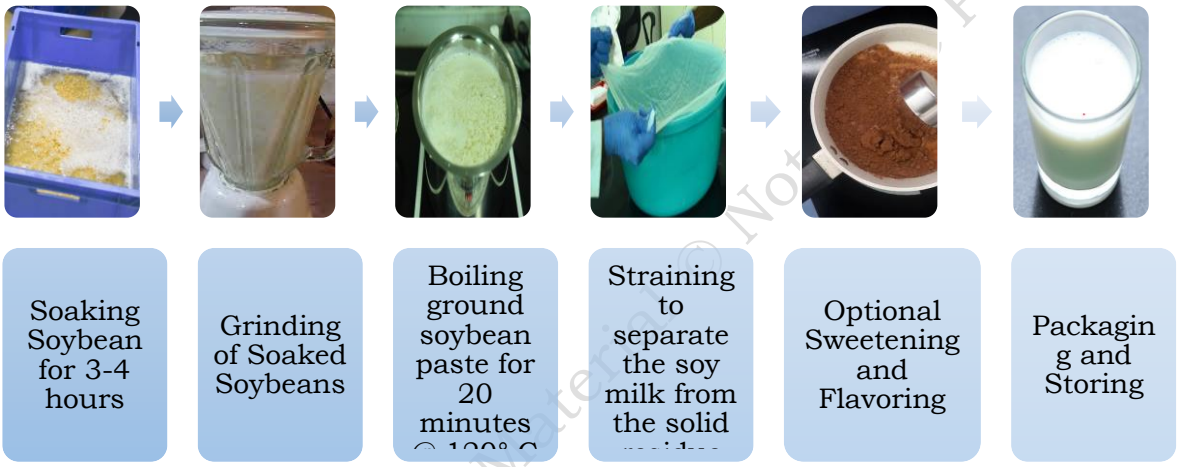

Fig. 2.14: Steps in Soy Milk Preparation

Unit Operations for Soy Milk Preparation at Micro Level

For micro-level production of soy milk, a more organized approach is adopted. The soybean milk production at micro level is done in continuous or batch process. Most of the unit operations are similar for household and micro level production of soy milk. Below is an outline of the unit operations for micro-level production of soy milk in a batch process:

Preparation required before starting production

1. Clean and de-hull the required quantity of soybeans. This should be done a day before the soaking process.
2. Ensure an adequate supply of potable water for every operation at all stages of the production process.
3. Clean and sanitize all tools, utensils, equipment, and machinery that will be used in the processing. This includes the grinder, cooking vessels, strainers, and any other equipment involved.

4. Thoroughly clean and sanitize the work area where soy milk production will take place. This includes countertops, surfaces, and any areas where equipment and tools will be used.
5. Ensure that all workers involved in the production adhere to strict personal hygiene practices.
6. Use Personal Protective Equipment (PPE) such as gloves and aprons to maintain cleanliness and prevent contamination.

Unit operations

Soaking: Cleaned de-hulled soybeans (*Dal*/splits) are soaked in water up to 4 hours, which rehydrates them and makes them easier to grind. A pinch of baking soda may be added to avoid the microbial growth. The water used in soaking must be discarded and only soaked beans are taken up for the grinding.

Trypsin Inhibitor:

Trypsin inhibitors are naturally occurring substances in soybeans that interferes with the digestion of proteins. They inhibit the activity of trypsin, an enzyme that helps to break down proteins for digestion. Heating soybeans during processing deactivates these inhibitors, making the proteins more digestible and available for the absorption by the body.

Grinding: Soaked soy splits are ground into a smooth paste using a grinder. Soybean and water ratio is kept 1:7. Lukewarm water is added during grinding to achieve the desired consistency.

Cooking: The ground soybean material is boiled for a duration of 20 minutes with constant stirring. Cooking or heating soybean in the soy processing serves as a critical step in enhancing the quality of the final product. This heat treatment helps to denature enzymes and deactivate trypsin inhibitors, addressing potential off-flavors and improving the overall taste and texture of the soy milk. Importantly, both urease and trypsin inhibitor enzymes are effectively inactivated during this heating process. The urease test is commonly utilized for quality evaluation in affirming whether the soybeans have undergone adequate heat treatment. This test

Detection of Trypsin Inhibitor by Urease Test:

Method:

Mix 0.2 g of soy product (soy flour, soy milk, tofu etc.) with 10 ml of water.
Add 3 g urea solution and few drops of phenolphthalein indicator.

Inference:

Pink colour of solution indicates that soy product is not properly processed.
No change in colour indicates that food product is processed properly.

confirms the neutralization of anti-nutritional components, particularly trypsin inhibitors. Beyond taste and texture improvement, the boiling process plays a pivotal role in optimizing the nutritional value of soy products, ensuring a more palatable and wholesome end product for consumers.

Straining: After cooking, the mixture is carefully strained through a fine mesh or cheesecloth to separate the soy milk from the solid residue, which we call okara. This leftover okara is not wasted; it is a by-product of soy milk processing and can be used in various other food preparations. Any surplus quantity of okara is sold as animal feed.

Sweetening and Flavoring: The soy milk can be sweetened with sugar or other sweeteners and flavored with permissible ingredients e.g. vanilla, cocoa powder, fruit extract etc. Remember, this step is optional. Make sure the soy milk meets the standards by regularly checking its consistency, taste, and ensuring it is safe from any harmful microbes.

Packaging and sealing: The finished soy milk, whether plain or flavored, is carefully packed into bottles or pouches ranging from 200 ml to 1 liter in size. Before selling, it is mandatory to pasteurize or sterilize the packed soy milk to keep it safe for consumption. Each packet is labeled with a batch number and date of manufacturing using a printer or coder. This helps in keeping the track of the soy milk's quality and ensures delivery of the fresh product to consumers.

ii. Equipment and Machinery for Soy Milk Preparation

The following equipment and machinery are commonly used in soy milk production:

Soaking utensils and Tanks: Suitable size containers are used to soak soybeans for household or micro-level production. While selecting the container size, one must consider that the volume of the soybean becomes double after soaking.

Grinders: High-powered industrial grinders are used for grinding of soaked soybeans. A variety of grinders are available in the market; the manufacturer may select suitable grinder as per the requirement of their unit.

Centrifugation:

Centrifugation is a process in which a mixture is spun rapidly in a machine called a centrifuge. This spinning creates a strong force that separates different components of the mixture based on their density. Heavier components move outward, while lighter ones move inward. This technique is commonly used in laboratories to separate substances like liquids from solids or different types of particles from each other.

Heating Equipment: Stoves or boilers are used to cook the ground material for soy milk preparation. In some commercially available equipment grinding and heating operations are combined in one unit.

Strainers or Filters: Straining/ filtration of soy milk is done either manually using muslin cloth and screw press or by centrifugation using appropriate equipment. This unit operation separates the solid residue from the liquid soy milk, ensuring a smooth, consistent product and complete extraction.

Fig. 2.15: Manual Filtration of Coagulated Soy Milk

Homogenizers: Homogenization is done in micro industry levels to ensure uniform texture and prevent sedimentation in soy milk over the extended storage of the products.

Fig. 2.16: Micro level Soy Milk Plant

iii. Shelf Life of Soy Milk

Soy milk is packed in pouches, bottles or cans. Soy milk pouches are packed using a Form Fill and Seal (FFS) whereas a Crown Capping machine is used for sealing the soy milk bottles. The shelf life of these packed soy milk is extended using pasteurization and sterilization techniques.

Pasteurization: Pasteurization is a common method, used to extend the shelf life of packed soy milk. The process involves heating the packed soy milk to a high temperature (usually above 80°C) for a short period (minimum 15 seconds) and then cooling it immediately using ice cold water which gives a thermal shock to microorganism.

This process destroys harmful microorganisms while preserving essential nutrients. Pasteurized soy milk typically has a refrigerated shelf life of around 4 days. Batch no. and date of manufacturing is mentioned on packet using Printer/ coder.

Fig. 2.17: FFS Machine

Fig. 2.18: Manual Crown Capping Machine

Fig. 2.19: Automatic Crown Capping Machine

Sterilization: Sterilization of the packaging bottles and cans is done for a longer shelf life up to 3-6 months. This process involves heating the soy milk to higher temperatures (above 121°C) and 103421 pascal pressure (15 psi) for at least 20 minutes to kill microorganisms including spores. This sterilization process of bottles is also referred as retorting**.**

v. Utilization of Soy Milk for Different Products

The plain soy milk is consumed as such by the consumers however several other products can also be made from it. Soy milk is a starting material for making tofu and flavoured soy milk.

Further utilization of soy milk in products like soy curd/yogurt, soy-based ice creams and other products (Fig. 2.11) expands its culinary potential, providing consumers with diverse, nutritious, and sustainable plant-based dairy alternatives.

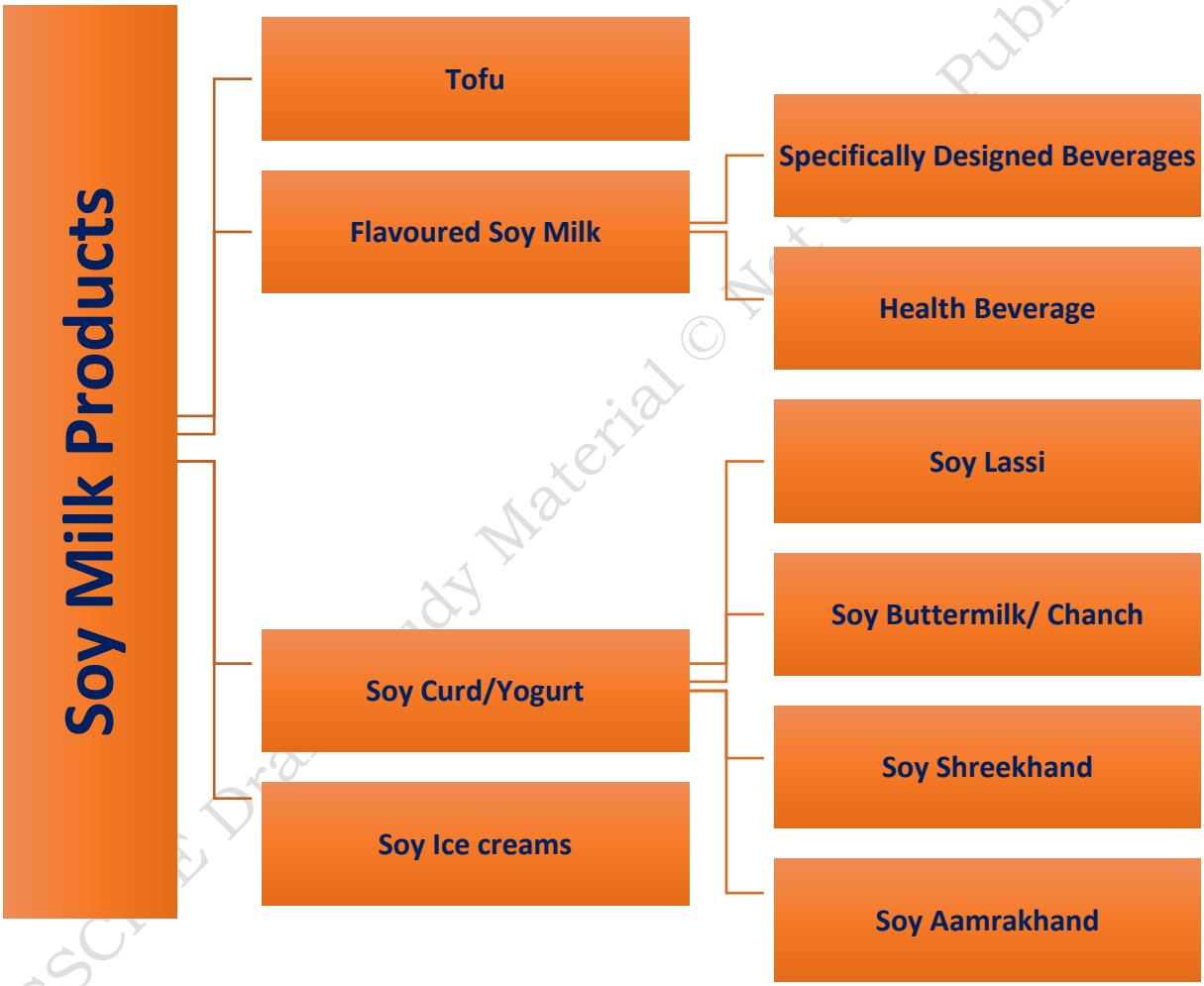

Fig. 2.20: Utilization of Soy Milk in Products

Soy Curd: Similar to regular milk, soy milk can also be used for making soy curd, a dairy-free alternative using simple fermentation process. For making soy curd-making, warm unsweetened soy milk in a pan, ensuring it reaches a temperature favorable to fermentation without boiling. Once warmed, introduce a spoonful of regular curd as a starter culture into the soy milk, stirring thoroughly to achieve an even mixture. Cover the container and set it aside in a

warm environment, allowing the curds to naturally form over a period of 5-7 hours. In colder seasons, placing the mixture in a closed space accelerates the setting process. Once the curds have successfully formed, keep the soy curd to the refrigerator to preserve its freshness and prevent any sour taste development. Soy curd is a nutritious dairy-free alternative which can be consumed plain or flavored with fruits, nuts, or sweeteners.

Soy Mattha: Soy *mattha* is made by churning the soy curd. The soy *mattha* has slightly tangy flavor and offers digestive benefits upon consumption, making it a popular choice in different regions of the world.

Flavored Soy Milk: Soy milk can be flavored with natural additives like vanilla, chocolate, or fruit flavors to enhance taste and appeal to a broader consumer base. Flavored soy milk can be consumed as a refreshing beverage or used as an ingredient in smoothies and other recipes.

The preparation of soy milk is adaptable to different production scales, ranging from household-level preparations to more extensive micro-level manufacturing. Employing suitable unit operations and equipment is crucial in ensuring both efficiency and hygiene throughout the production process, resulting in the delivery of high-quality soy milk. Techniques like pasteurization and sterilization play pivotal roles in extending the shelf life of soy milk, addressing varying consumer demands and preferences with a focus on product safety and longevity.

Practical Exercise

Activity

1. Make soy milk at household level.
2. Perform urease test in soy milk.
3. Make any products using soy milk.
4. Video demonstration on soy milk preparation and packaging.

Check Your Progress

A. Multiple Choice Questions

1. For sterlisation, soy milk is heated above 121°C and pascal pressure of
   (a) 103421 (b) 403241
   (c) 342110 (d) 234051

2. Which unit operation involves separating the soy milk from the solid residue?
   (a) Cooking (b) Grinding
   (c) Soaking (d) Straining

3. What is the purpose of adding a pinch of baking soda during soaking of soybeans?
   (a) Improve flavor (b) Enhance color
   (c) Avoid microbial growth (d) Increase protein content
4. Which method is used to extend the shelf life of packed soy milk by heating it for a short period and then cooling it?
   (a) Pasteurization (b) Sterilization
   (c) Fermentation (d) Homogenization
5. What is the by-product of soy milk processing known as?
   (a) Tofu (b) Okara
   (c) Curd (d) Cream

B. Fill in the Blanks

1. The ratio of soybean to water during grinding is kept as _____ for soy milk preparation.
2. _____ is used to separate the solid residue from the liquid soy milk.
3. Pasteurization involves heating the soy milk to a high temperature for a short period to destroy harmful _____.
4. _____ is a traditional Indian beverage made by fermenting soy milk with natural probiotics.
5. Soy yogurt is a nutritious dairy-free alternative made by fermenting soy milk through the process of _____.

C. State True or False

1. Soy milk can be directly consumed without any further processing. (True/False)
2. Blanching is a unit operation that involves grinding soaked soy splits. (True/False)
3. Sterilization involves heating packed soy milk to temperatures above 121°C to kill microorganisms. (True/False)
4. Flavored soy milk cannot be used as an ingredient in recipes. (True/False)
5. The shelf life of pasteurized soy milk is typically around 2 days. (True/False)

D. Subjective Questions

1. Describe the unit operations and their significance in preparation of soy milk.
2. Explain the process of pasteurization and its role in extending the shelf life of packed soy milk. Compare and contrast the shelf life of pasteurized soy milk with that of sterilized soy milk.

3. Provide examples of products that can be made using soy milk, and explain how its incorporation enhances their nutritional value and appeal to consumers.
4. Enlist the different products that can be made from soy milk?
5. Compare the nutritional content of soy milk with cow and buffalo milk.

What have you learned?

After completing this Session, you will be able to:

- Describe the unit operations involved in the preparation of soy milk
- Discuss the versatile utilization of soy milk as a starting material for various products.

SESSION 4: TOFU PREPARATION

Tofu, also known as bean curd, is a popular soy-based food with a long history in Asian cuisine. It is a versatile and nutritious product made by coagulating soy milk and pressing the resulting curds into blocks. This session provides a comprehensive guide to tofu preparation at both household and micro levels, discussing the required unit operations, equipment, and machinery. It also explores packaging and shelf-life considerations, as well as the preparation of various tofu-based products.

Now you have learnt about the preparation of soy milk and aware that the raw soy milk is used for preparation of tofu. Hence, here we will learn about the procedure of preparing tofu:

i. Tofu Preparation: Unit Operations for Household and Micro Levels

Household Level

At the household level, preparing tofu involves several unit operations following the steps discussed in Session 3. Initially, soybeans are de-hulled, soaked, ground, cooked, and strained to extract soy milk. Once we have the soy milk ready, the process of making tofu includes the following procedures:

Coagulation: In the coagulation process of tofu preparation, coagulants are introduced into soy milk. Coagulant salts such as Nigari, calcium/magnesium, Glucono-*δ*-Lactone (GDL), or acids like citric, acetic, and lactic are added at approximately 0.2 percent to the soy milk.

The mixture is gently stirred to ensure proper coagulation and is then left undisturbed for a minimum of 20 minutes.

This allows the coagulants to effectively work on the soy milk, leading to the formation of curds necessary for tofu production.

Fig. 2.21: Steps of Tofu Preparation at Household level

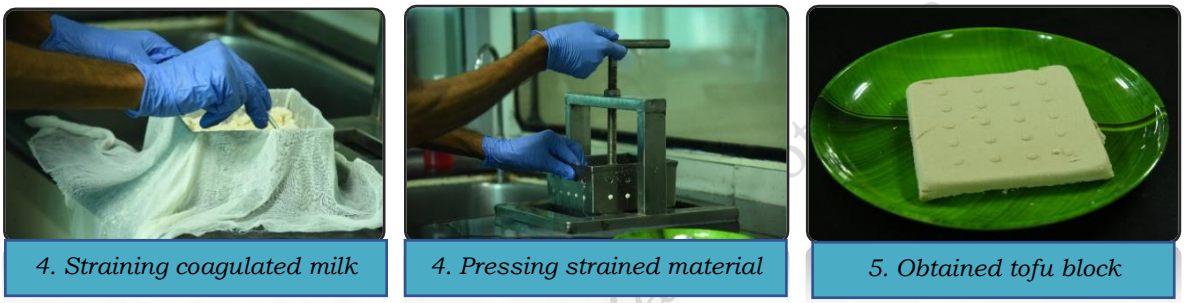

Fig. 2.22: Steps of Tofu Preparation at Household level

Straining and Pressing: After coagulation, the material is strained using muslin cloth to separate the whey. The resulting coagulated material, along with the cloth, is placed in a mold for setting. Any excess liquid, known as whey, is pressed out, and the curds are compressed to shape the tofu block. This process helps achieve the desired consistency and structure of the final tofu product.

Cutting and Packaging: The tofu block is cut into desired shape for consumption. Tofu blocks or pieces can also be submerged in potable water and kept in refrigerated conditions up to 4 days.

Fig. 2.23: Tofu submerged in water

Submerging tofu in water helps to prevent the dehydration and maintains its soft and delicate texture. It minimizes the chances of microbial deterioration of tofu. It also ensures that the tofu remains palatable and suitable for cooking or eating.

Unit Operations for Tofu Production at Micro Level

For micro-level production of soy tofu, a more organized approach is adopted. The soybean tofu production at micro level is done in batch process. The unit operations for tofu production at micro levels are as follows:

Preparation required before starting production:

1. Soybeans are de-hulled, soaked, grinded, cooked and strained to obtain soy milk as discussed above in the session 3. .....
2. Keep the bulk quantity of food grade coagulant ready in the right concentration. Usually, 20-30 gram of the coagulant is dissolved in 200 ml of water to coagulate 10 liter of soy milk.
3. Cleaned and sanitized tools, utensils, equipment and machinery for processing.
4. Properly cleaned and sanitized work area.
5. Ensure personal hygiene of workers including use of Personal Protection Equipment/ PPE.

Coagulation and Curds Formation: Coagulants are added to the soy milk (temperature 80-85-degree C) to induce coagulation. It is stirred gently for proper coagulation and allowed to rest for at least 20 minutes. Soy milk is taken in batches depending upon the machinery and equipment available. There should be no time lapse between the processes from production of soy milk to tofu preparation.

1. Heating soy milk

2. Bringing temperature of the soy milk to 80-85°C

3. Adding coagulant to the soy milk

4. Gentle stirring of the soy milk

Pressing and Shaping: The coagulated material is now strained using muslin cloth to remove the whey. The obtained coagulated material along with the cloth is put in a mold for setting. Excess liquid (whey) is further pressed out using manual or pneumatic press. The compressed tofu block is cut and weighed as per requirement.

Packaging, and Storage: The cut tofu blocks are weighed, packed and stored as desired in a temperature-controlled environment. For immediate consumption, the tofu blocks can be packed in normal packaging material, however vacuum packaging is done for longer shelf life up to 2-3 weeks under refrigerated conditions. Batch no. and date of manufacturing is mentioned on packet using Printer/ coder.

Fig. 2.22: Steps of Tofu Preparation at Commercial Scale

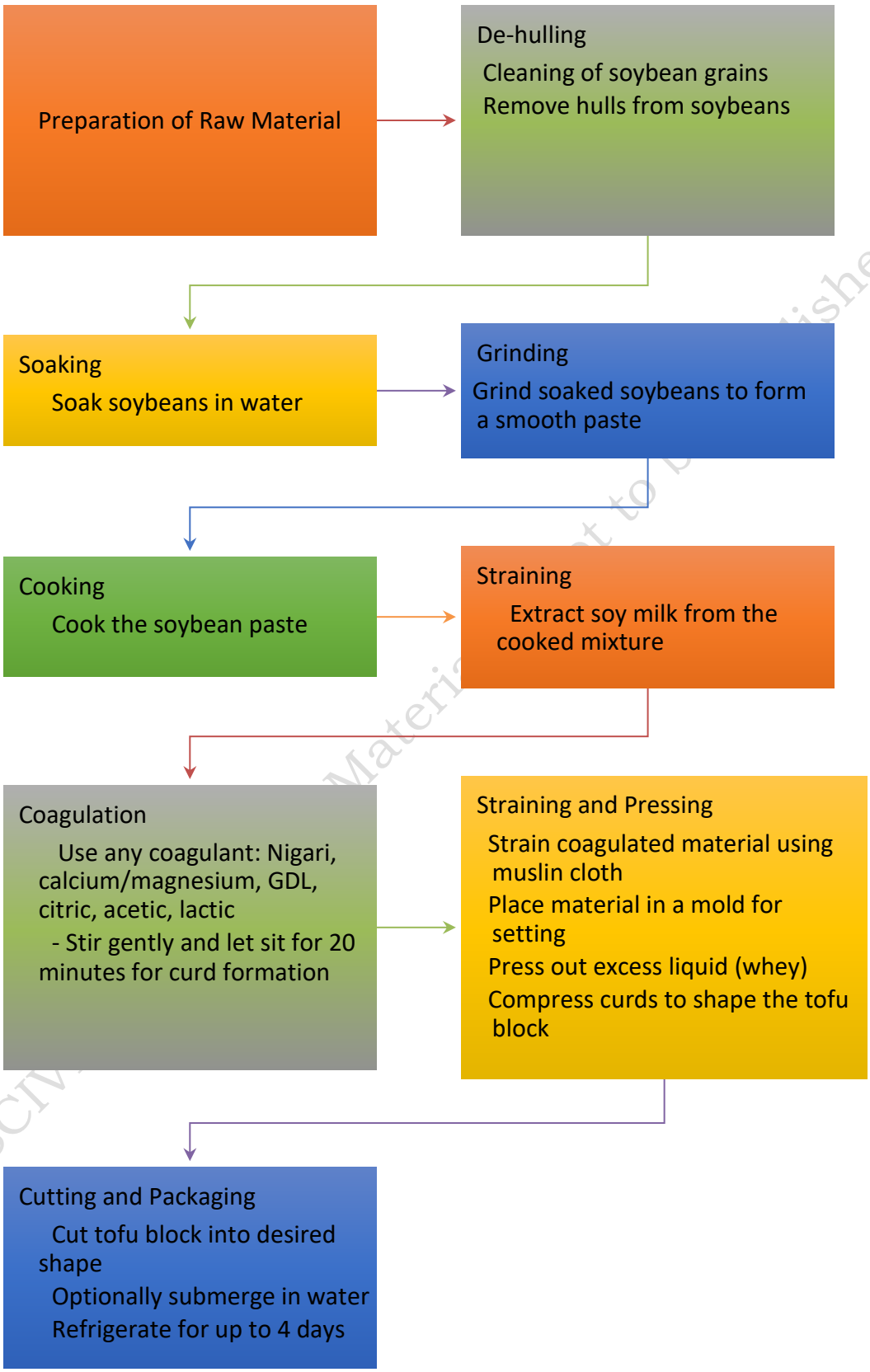

Fig. 2.23: Flow Chart of Tofu Preparation at Commercial Scale

ii. Equipment and Machinery for Tofu Preparation

The following equipment and machinery are commonly used in tofu production:

Coagulation Vessels: Containers where coagulants are added to the soy milk to form curds. A number of coagulation vessels will be required depending on the capacity of the unit/ plant and size of the batch.

Tofu Molds and Presses: Specialized molds and presses used to shape and press the tofu curds into blocks.

Fig. 2.24: Tofu Press

Cutting Equipment: Knives or cutting machines are used for shaping and portioning the tofu blocks.

iii. Packaging and Shelf Life of Tofu

Tofu is typically packaged in LDPE or two- or three-layer laminated bags and sealed or vacuum packed to prevent moisture loss and contamination. Proper packaging helps maintain tofu's freshness and texture.

The shelf life of tofu varies depending on its moisture content and packaging. Fresh tofu has a relatively short shelf life of about 7-10 days when refrigerated. Vacuum packaging increases the shelf life of the tofu up to 2-3 weeks. There are several other methods are available for further enhancing the shelf life of the tofu.

Fig. 2.25: Vacuum Packaging Machine

iv. Preparation of Tofu-Based Products

Tofu's mild flavor and versatile texture make it an ideal ingredient for a wide range of dishes and products. Some popular tofu-based products include:

- Cutlet
- Chilli tofu
- Tofu pakoda
- Tofu roll
- Bread roll
- Stuffing materials for snacks
- Tofu kebab
- All the Indian gravy dishes like matar-tofu, paalak-tofu, tofu bhurji etc.

Tofu can be prepared at both household and micro levels with simple unit operations and basic equipment. By understanding the coagulation process and employing the appropriate machinery, producers can create high-quality tofu blocks. Proper packaging and storage are essential for maintaining tofu's freshness and extending its shelf life. Beyond its basic form, tofu can be used to create a variety of delicious dishes and products, making it a valuable ingredient in both traditional and innovative cuisines worldwide. With its numerous health benefits and culinary applications, tofu continues to be a staple in various diets and a favorite among those seeking plant-based alternatives.

Check Your Progress

A. Multiple Choice Questions

1. Tofu is also known as:
   (a) Soy curd (b) Bean paste
   (c) Soy cheese (d) Soy cream
2. Which coagulant is commonly used to induce coagulation in soy milk for tofu production?
   (a) Vinegar (b) Lemon juice
   (c) Nigari (d) Baking soda
3. What is the primary purpose of pressing tofu curds?
   (a) To add flavor (b) To shape the tofu
   (c) To remove excess liquid (whey) (d) To enhance color
4. How does vacuum packaging affect the shelf life of tofu?
   (a) Reduces shelf life (b) Has no effect on shelf life
   (c) Increases shelf life (d) Changes the texture of tofu

5. Tofu is a versatile ingredient that can be used in various dishes, except:
   (a) Sandwiches (b) Salads
   (c) Soups (d) Coffee

B. Fill in the Blanks

1. The coagulation process in tofu preparation involves adding coagulants to the soy milk, such as _____, calcium/magnesium, or acids like citric acid.
2. The obtained coagulated material is strained using muslin cloth to remove the _____.
3. Tofu can be packed in LDPE or laminated bags and sealed or vacuum packed to prevent _____.
4. The shelf life of fresh tofu, when refrigerated, is approximately _____ days.
5. Tofu is a popular ingredient in various dishes, including cutlets, chili tofu, tofu pakoda, and _____.

C. State True or False

1. Tofu is made by coagulating soy milk and pressing the resulting curds into blocks. (True/False)
2. Vinegar and lemon juice are commonly used coagulants in tofu production. (True/False)
3. Pressing tofu curds helps remove excess liquid (whey) and shape the tofu block. (True/False)
4. Vacuum packaging has no effect on extending the shelf life of tofu. (True/False)
5. Tofu is not a versatile ingredient and is typically only used as a standalone dish. (True/False)

D. Subjective Questions

1. Describe the unit operations and their significance in preparation of tofu.
2. Describe the different types of coagulants used in tofu production.
3. Discuss the different methods to increase the shelf-life of tofu.
4. Provide examples of products that can be made from tofu and explain how its incorporation enhances their nutritional value and appeal to consumers.
5. Enlist the different products that can be made from tofu?

SESSION 5: BY-PRODUCTS OF SOYBEAN PROCESSING

In soybean processing, various by-products are generated as a result of extracting soybean oil and producing soy-based products like tofu and soy milk. These by-products are valuable and can be utilized in different ways, reducing waste and adding value to the overall soybean processing industry. This session will elaborate on by-products, their characteristics, and their various uses.

Understanding By-products

By-products are secondary products or residues generated during the main processing of a raw material. In the context of soybean processing, they refer to the leftover materials after extracting soybean oil or producing primary soy-based products. By-products of soybean can be utilized in the food, feed, and industrial sectors.

Different By-products and Their Uses

i. Hull: The hull is the outer shell or seed coat of the soybean and is removed during the de-hulling process. It is a fibrous material and constitutes about 8-10% of the soybean. The hull is not edible but finds applications in:

Dietary Fiber: it is being utilized as a source of dietary fiber in pharmaceutical industry.

Animal Feed: The hull can be used as a valuable ingredient in animal feed due to its fiber content and nutritional value.

Fertilizers: It can be utilized as an organic material in compost or as a soil conditioner.

Bioenergy Production: In some cases, soybean hulls are utilized in biomass energy production through combustion or gasification.

ii. De-oiled Cake: De-oiled cake, also known as soybean meal or soybean cake, is the solid residue left after extracting oil from soybeans. It contains a significant amount of protein (about 44-50%) and is used for various purposes, including:

Animal Feed: De-oiled cake is a major component of animal feed due to its high protein content and essential amino acids.

Food Applications: It can be used in some food formulations as a protein-rich ingredient and is a start material for important protein rich formulations like concentrates, isolates and hydrolysates.

iii. Okara: Okara is the pulp-like material left after soy milk extraction and is a by-product of soy milk production. It contains protein (6%), fiber and carbohydrates and has the following applications:

Animal Feed: Due to its protein content, okara is used in animal feed to supplement the diet of livestock and poultry.

Food Applications: Okara can be incorporated into bakery products, *halwa, gulab jamun* and other food items to enhance nutritional value and texture.

iv. Whey: Whey is the liquid by-product generated during coagulation of soy milk. It is water-based and contains proteins (0.6 % w/v), minerals, and some fats. Whey can be used in beverages and animal feeds.

Understanding by-products in soybean processing is crucial as it helps reduce waste and adds value to the overall production process. By-products like hull, de-oiled cake, okara and whey have various uses in animal feed, food applications, and even bioenergy production. Utilizing these by-products effectively ensures sustainability, efficiency, and maximum utilization of the soybean's nutritional potential, making soybean processing an environmentally friendly and economically viable industry.

Practical Exercise

Activity

1. Make tofu at household level.
2. Make any one product given in the list of tofu-based products.
3. Make a project report on different usage of soy by-products.
4. Develop/prepare some innovative product using okara.

Check Your Progress

A. Multiple Choice Questions

1. By-products in soybean processing refer to:
   (a) The main processed products from soybeans.
   (b) Residues generated during the extraction of soybean oil.
   (c) Raw soybeans before processing.
   (d) Processed soy-based products.

2. Which of the following is a common use of soybean hull?
   (a) Making soy milk (b) Food applications
   (c) Animal feed (d) Bioenergy production

3. De-oiled cake, a by-product of soybean processing, is rich in:
   (a) Fiber (b) Carbohydrates
   (c) Fats (d) Vitamins

4. Okara, a by-product of soy milk production, is used in:
   (a) Beverages (b) Animal feed
   (c) Bioenergy production (d) Industrial lubricants
5. Whey, generated during coagulation of soy milk, contains:
   (a) High levels of protein (b) Carbohydrates only
   (c) No nutritional value (d) Minerals and fats

B. Fill in the Blanks

1. By-products are secondary products or residues generated during the main processing of a _____ material.
2. The hull, removed during de-hulling, can be utilized in animal feed due to its fiber content and _____ value.
3. De-oiled cake, also known as soybean meal, is a valuable ingredient in animal _____.
4. Okara, a by-product of soy milk production, can be incorporated into bakery products to enhance nutritional value and _____.
5. Whey, the liquid by-product from coagulation, contains proteins, minerals, and some _____.

C. State True or False

1. By-products in soybean processing are the main processed products. (False)
2. Soybean hull can be used as a source of dietary fiber and in animal feed. (True)
3. De-oiled cake is low in protein content. (False)
4. Okara is a by-product of soybean oil extraction. (False)
5. Whey has no nutritional value. (False)

D. Subjective Questions

1. Enlist the different by-products of soybean and their possible utilization as food and feed.
2. Explain the potential of utilizing soybean hull for bioenergy production in India.

What have you learned?

After completing this Session, you will be able to:

- Describe the different by-products of soybean
- Enumerate the application of soybean processing by-products as food and feed.

Module 3 | Maintenance of Soy Processing Unit

In this unit, we will explore the preparation, cleaning and maintenance of the soy processing unit along with essential equipment and machinery used in the soybean processing. Soybeans are an important source of protein, making their processing crucial for various food and industrial applications. Understanding the equipment and maintenance procedures is vital for ensuring efficient soy processing operations.

SESSION 1: PREPARATION AND MAINTENANCE OF THE WORK AREA FOR SOY PRODUCTS PRODUCTION

Before starting any soy processing operations, it is essential to ensure that the work area is well-prepared, clean, and properly maintained to maintain product quality and safety standards. This session will cover the essential steps for the preparation, cleaning, and maintenance of the work area specifically tailored for soy flour, soy milk, and tofu production. Key aspects to be addressed include:

Contamination: *It refers to the presence of harmful substances or microorganisms in food that can make it unsafe to eat. These contaminants can come from various sources, such as chemicals, pathogens (like bacteria, viruses, or parasites), allergens, or foreign objects. Contamination can occur at any stage of food production, processing, handling, or storage.*

Cross-contamination occurs *when harmful substances or microorganisms from one food item are transferred to another, usually through direct or indirect contact. This can happen when tools, surfaces, hands, or utensils that have been in contact with one food item come into contact with another. Cross-contamination can lead to the spread of pathogens and allergens, posing a risk to food safety.*

Prepare the Work Area:

1. Organize the Space: The Soy Product Processor must arrange the work area systematically to ensure a smooth processing flow. S/he must allocate separate stations for each unit operation in soy processing, including cleaning and de-hulling, soaking, milling, drying, grinding, cooking, etc. Maintaining a schematic representation of the plant layout for easy reference and inspections should be ensured. This organization enhances efficiency and promotes a structured workflow throughout the soy product production process.

2. Equipment Inspection: The Soy Product Processor should conduct a thorough inspection of all equipment before initiating any processing activities to ensure they are in optimal working condition. S/he should address any

identified issues or malfunctions promptly to maintain the efficiency and safety of the soy processing operations. Checking equipment regularly contributes to the overall reliability of the production process and help prevent potential disruptions or product quality issues.

3. Assemble Necessary Equipment, Tools and Utensils: Before initiating the product process the Soy Product Processor should ensure that all required equipment and tools, including grinders, blenders, filters, dryer, mill, tofu molds, and utensils such as sieves, strainers, vessels, ladles, etc., are readily available. S/he should verify that the required items are in a clean, dry, and good condition. Given that soybeans are rich in protein and soy products have high moisture content, the work area and equipment are susceptible to microbial contamination and cross-contamination. Therefore, it is mandatory to conduct thorough cleaning of the equipment and working area both before and after production to uphold hygiene standards.

4. Raw Materials: Confirm the availability of all required raw materials, necessary chemicals, and any other ingredients in the desired quantities within the work area. Ensure a continuous and clean water supply throughout the processing period.

5. Personal Hygiene: Prioritize personal hygiene and safety practices among working personnel before commencing any tasks. This includes adherence to proper cleanliness standards and the use of necessary safety gear.

6. Safety Measures: Implement safety measures by placing fire extinguishers, first-aid kits, tool kits, and safety signs within the work area to foster a secure working environment. Conduct daily inspections of electrical points, wires, and switches to mitigate potential hazards. Display process flow charts, equipment handling instructions, and safety guidelines prominently. Keep a notebook and pen/pencil on hand for recording essential observations during the production process.

ii. Cleaning the Work Area (Pre and Post production)

1. Remove debris and dust: Regularly sweep, swab and clean the work area to remove debris, dust and potential contaminants.

2. Sanitization: Use appropriate food grade cleaning/ disinfecting agents to clean/sanitize the work surfaces, equipment and utensils regularly. This prevents microbial contamination and maintains product hygiene.

3. Clean spills immediately: In case of spills, clean them up promptly to prevent microbial growth and contamination, slips and falls.

4. Protective clothing: Wearing clean and appropriate protective clothing, such as hairnets, gloves, shoes and lab coats, helps prevent the transfer of contaminants from employees to the food products. Emphasize the importance of handwashing for all workers to maintain personal hygiene during soy processing.

iii. Maintaining the Work Area

- Routine maintenance: Schedule routine maintenance checks for all equipment to identify and fix any potential issues before they escalate.
- Equipment storage: Properly store all the tools and equipment after use to prolong their lifespan and prevent damage.
- Pest control: Implement measures to keep pests away from the processing area, as they can contaminate the products.

Fig. 3.1: Soy Processor Keeping Soy Flour Machine After Use

Maintenance of Tools, Machinery and Equipment

i. Preventive Maintenance: Preventive maintenance involves regular inspections, cleaning, and servicing of equipment to prevent breakdowns and reduce the risk of unexpected downtime during soy processing. It helps extend the lifespan of machinery and ensures smooth operations.

ii. Corrective Maintenance: Corrective maintenance is performed in response to identified issues or equipment malfunctions. When a problem arises, technicians troubleshoot and repair the faulty equipment promptly to minimize production disruptions.

iii. Predictive Maintenance: Predictive maintenance involves using data and analytics to predict potential equipment failures. By monitoring various parameters and analyzing trends, technicians can address potential issues before they escalate into critical problems.

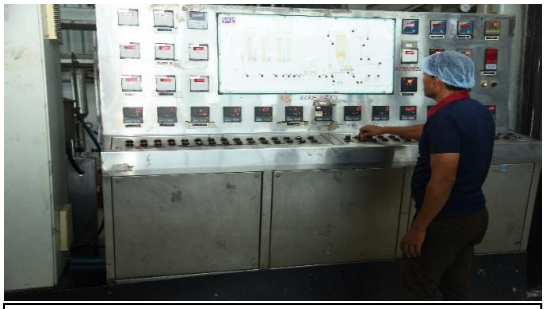

Fig. 3.2: Soy Processor Inspecting Machine

iv. Breakdown Maintenance: Breakdown maintenance is carried out when equipment experiences a complete failure. While not ideal, it is essential to have contingency plans in place for such situations to restore operations quickly.

Pre and Post-Production Cleaning and Maintenance of Equipment

Before starting the soy processing unit for a new production cycle and immediately after completing a production cycle, it is crucial to perform pre-production and post-production cleaning and maintenance of the equipment. Here's what you should do:

i. **Thorough Cleaning:** Clean all equipment, utensils, and processing surfaces to eliminate any residual traces of previous production. Use appropriate cleaning agents and sanitizers to ensure food safety.

ii. **Equipment Inspection:** Check all machinery and tools for signs of wear, damage, or malfunction. Address any issues found during the inspection to prevent potential problems during production.

iii. **Lubrication:** Lubricate moving parts of the machinery as per the manufacturer's guidelines to reduce friction and ensure smooth operation.

Fig. 3.3: Cleaning of Soy Processing Unit

iv. **Calibration:** Calibrate measuring instruments such as thermometers and pressure gauges to ensure accurate readings during processing.

v. **Disassemble (if necessary):** For equipment with removable parts, disassemble them carefully for a more comprehensive cleaning process.

vi. **Sanitization:** Sanitize all equipment and utensils using appropriate cleaning agents to eliminate any potential microbial contamination.

vii. **Storage:** Store all equipment in a clean and dry environment to prevent damage and prolong their lifespan.

viii. **Documentation:** Keep detailed records of process flow chart, SOP's for equipment operation and handling, maintenance activities, including cleaning schedules, inspections, and repairs performed. This documentation will help track equipment performance and plan future maintenance more effectively.

By following these steps and adhering to a proper maintenance routine, the soy processing unit can operate efficiently, produce high-quality soy products, and ensure the safety of the end consumers.

Practical Exercise

Activity

1. Visit FSSAI website and prepare a list of food grade chemicals and disinfectant used in food processing industry.
   - https://www.fssai.gov.in/upload/uploadfiles/files/Guidance_Document_Nutraceutical_18_05_2018.pdf
   - https://fssai.gov.in/upload/uploadfiles/files/Guidance_Note_Food_Hygiene_Safety_07_06_2020_Revised_10_06_2020.pdf
2. List out the tools which are required for mechanical maintenance in food processing plant.

Check Your Progress

A. Multiple Choice Questions

1. What is the purpose of arranging the work area systematically?
   (a) Reduce equipment costs (b) Create an artistic display
   (c) Facilitate smooth processing flow (d) Minimize worker breaks

2. What is the primary reason for cleaning the work area before and after production?
   (a) Enhance the aroma of soy products
   (b) Prevent contamination and maintain hygiene
   (c) Increase production speed
   (d) Provide exercise for workers

3. Which type of maintenance involves regular inspections and servicing to prevent breakdowns?
   (a) Corrective maintenance (b) Predictive maintenance
   (c) Preventive maintenance (d) Breakdown maintenance

4. What is the purpose of lubricating moving parts in equipment?
   (a) Improve product flavour
   (b) Reduce friction and ensure smooth operation
   (c) Add fragrance to the work area
   (d) Increase noise levels

5. What is the role of predictive maintenance in soy processing?
   (a) Troubleshoot faulty equipment
   (b) Address potential issues before they escalate
   (c) Perform immediate repairs
   (d) Clean spills promptly

B. Fill in the Blanks

1. Organizing the work area involves allocating separate stations for each _____ operations of soy processing.
2. Proper cleaning and sanitization prevent microbial contamination and maintain product _____.
3. Predictive maintenance uses data and analytics to predict potential _____ failures.
4. During pre-production cleaning, all equipment and processing surfaces are thoroughly cleaned to eliminate residual traces of _____ production.
5. Calibrating measuring instruments such as thermometers ensures accurate _____ during processing.

C. State True or False

1. The work area should be organized to create chaos and confusion. (True/False)
2. Lubricating moving parts helps reduce friction and ensure smooth operation of machinery. (True/False)
3. Corrective maintenance is performed to prevent equipment breakdowns. (True/False)
4. Pre-production cleaning involves eliminating residual traces of previous production. (True/False)
5. Documentation of maintenance activities is not necessary for efficient equipment operation. (True/False)

D. Subjective Questions

1. Explain the importance of preparing and cleaning the work area in soybean processing unit.
2. Explain the maintenance of tools, machinery and equipment used in soybean processing unit.
3. Discuss the importance of personal hygiene and safety practices for workers in a soy processing unit.
4. Describe the pre- and post-production cleaning and maintenance of equipment employed in soybean processing unit.

What have you learned?

After completing this Session, you will be able to:

- Explain the importance of preparing and cleaning the work area
- Explain the maintenance of tools, machinery and equipment
- Describe the importance of personal hygiene and safety practices for workers
- Describe the pre- and post-production cleaning and maintenance of equipment employed in soybean processing unit

SESSION 2: EQUIPMENT AND MACHINERY USED IN SOYBEAN PROCESSING

In the context of soybean processing, the effective utilization of equipment and machinery is paramount for ensuring the quality and safety of the end products. The following guidelines are imperative:

1. Equipment and containers must be hygienically designed, constructed and maintained in good order.
2. They must be made up of food grade materials (Stainless steel, plastic, iron, silicone etc.)
3. Chipped or enamelled containers are not to be used.
4. Food contact surfaces and edges must smoothly bonded to minimize accumulation of food particles, dirt, foreign matter etc.
5. Equipment must be located and installed in a manner which facilitates cleaning and maintenance. Ideal gap of minimum 1 feet from wall must be maintained.
6. Ensure appropriate power supply, inspect and maintain switches, motor and any other attachments.
7. Wear safety shoes while working with electrical equipment or appliances especially when water is used in processing.
8. Equipment must be self-draining in wet process areas and appropriately connected to drain lines.
9. Where possible, CIP (Cleaning in Place) method should be followed.

Soy Flour Equipment Maintenance

Cleaner and grader

- Regularly inspect and clean the machine's sieves and screens to prevent clogging.
- Lubricate moving parts to reduce friction and wear.
- Keep the machine's surroundings clean to avoid foreign particle accumulation.

Pedal operated: Proper lubrication of pedal chain, Comfortable and properly adjusted seat.

Power operated: Ensure appropriate power supply, inspect and maintain switches, motor and any other attachments such as fan belt etc.

Power operated de-huller:

- Check for the rusting in the de-huller sieve. Regularly inspect the de-hulling blades for signs of wear and tear, and replace them when necessary.
- Clean the de-hulling chamber to prevent the accumulation of hull debris.
- Check for any abnormal vibrations during operation and address them promptly.
- Continuous removal of hull during and after preparation.

Soaking Vessels: Soaking vessels must be clean and dry before and after the soaking operation.
Blanchers: Potable water is used for blanching process. Clean (CIP) and dry the blancher immediately after the process.

Dryer:

- The dryer shelves are cleaned before and after the drying operation.
- Clean the drying equipment regularly to prevent mold and bacterial growth.
- Inspect and clean the heating elements or burners to maintain proper heat distribution.
- Check and calibrate the temperature controller and moisture sensors for accurate readings.
- Lubricate any moving parts to minimize friction and enhance efficiency.

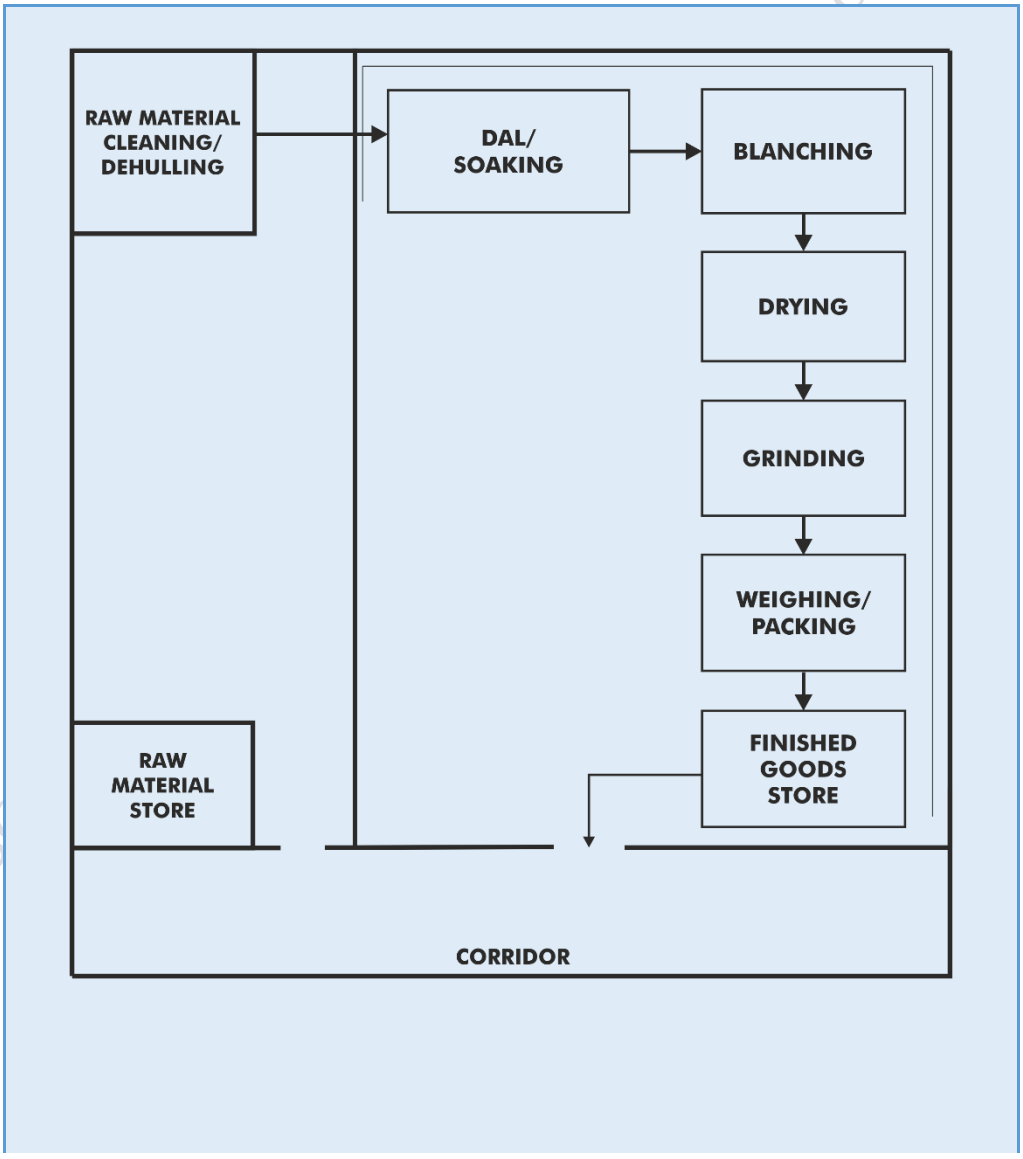

Fig. 3.1: Tentative Layout Plan of Soy Flour Production Facility

Milling machines:

- Machines are disassembled and cleaned thoroughly.
- Since soybean is high in fat, it is important to remove any residual material to prevent any clump formation.
- It is always recommended to dry clean the grinder with brush while the collecting vessels must be cleaned thoroughly.
- The cover is used to avoid dispersion of the milled flour particles in the air.

Sealing machines:

- Heating element should be checked regularly**.**
- Ensure the sealer is clean and free from any food residues.

Soy milk equipment: Cleaning, De-hulling, soaking equipment and operation are similar as mentioned in soy flour preparation section of the textbook.

Grinding and Cooking Unit

Grinding units:

- Regularly inspect and clean the grinding plates or blades to ensure smooth and efficient grinding.
- Monitor the machine's motor and belts for any signs of wear or malfunction.
- Check and adjust the clearance between grinding components for optimal performance.
- Lubricate the bearings as per the manufacturer's recommendations.
- Since soy milk preparation involves wet grinding process, proper cleaning before and after process is done to remove any residual food particles.

Cooking unit:

- If it is directly heated using LPG or diesel then the fuel source, heating burners, knobs etc. are checked thoroughly.
- Appropriate head space in the cooking container is maintained. The amount of material to be cooked should not be more than half of the volume of the container.
- The containers are checked for any leakages.
- In case heating and grinding is done together using a boiler, pressure and temperature gauges should be functioning properly and calibrated at regular intervals.
- The cooking containers need to be sealed adequately to avoid contact with air leading to beany flavour (off- flavour) in the soy products.
- Inlet and outlet point are cleaned thoroughly.

In many cases the cooking and the grinding unit is one in such a case the recommendations for both grinding and cooking units needs to be follow.

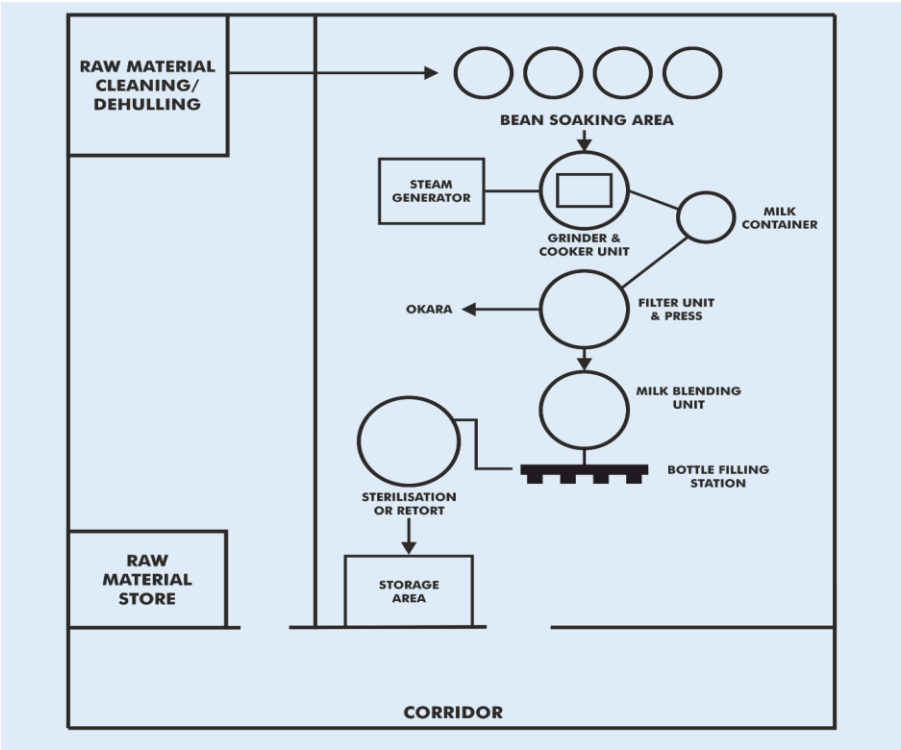

Fig. 3.2: Tentative Layout Plan of Soy Milk Production Facility

Strainers or Filters and screw press: Muslin cloth is generally used for straining. It should be clean and free from any holes; else it should be immediately replaced.
Vessels and screw press used for holding the extract should be clean.

Homogenizers:

- Clean and sanitize the homogenizer regularly to prevent contamination.
- Check and replace homogenizer valves or gaskets to maintain optimal performance and prevent leakages.

Sterilizing or retort unit:

- Pressure and temperature gauges should be functioning properly and calibrated at regular intervals.
- Clean and sanitize the sterilizer regularly to prevent contamination.
- Check and replace sterilizer valves or gaskets to maintain optimal performance and prevent leakages.
- Clean water is used to avoid scaling and mark on the bottles. Regular de-scaling must be done.
- Hold the sterilized retorted milk bottles for 48 hours before sending it to the market. This is done to ensure that no leaked bottles are sent to the market for sale.

Tofu Preparation Equipment:

Coagulation Vessels:

Vessel should be clean and free from any residue.

Tofu Molds and Presses:

- Clean the press thoroughly after each use to avoid contamination.
- Check and replace press filter cloth to maintain efficient whey removal.
- Inspect the pneumatic system of the press and seals for leaks or damage.

Cutting Equipment:

- Clean and hygienic knives are used for cutting the tofu.
- All food contact surfaces should be cleaned by food grade sanitizing solutions after every hour.

Vacuum packaging Machine:

- Ensure the vacuum sealer is clean and free from any residue.
- Regularly inspect the vacuum sealer's sealing bars and replace them when worn out.
- Check the vacuum pump's condition and replace it as needed. Calibrate the vacuum level to ensure consistent and reliable packaging.
- Hold the vacuum-packed tofu for 24 hours before sending it to the market. This is done to ensure that no vacuum leaked packets are sent to the market for sale.

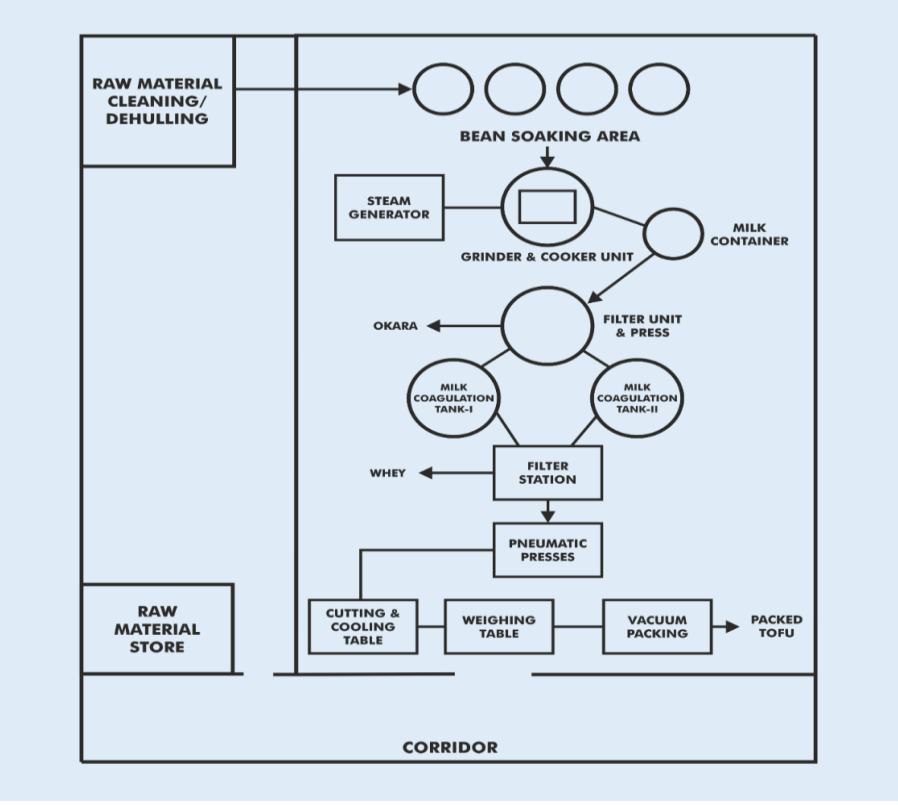

Fig. 3.3: Tentative Layout Plan of Tofu Production Facility

Maintenance of other components of a soybean processing unit

Ovens: Ensure that all the burners and elements are turned off before cleaning. After every shift or work cycle oven must be cleaned and sanitized.

Refrigerators and Freezers: The temperatures should be recorded and calibrated if required. Older manufactured soy products must be stacked in front and latest in the back so that easily used in a first-in, first-out (FIFO) and First expire first -out (FEFO) order.

Range Hoods/Ventilation System: The purpose of hoods or ventilation system is to remove the air of cooking, grease, dirt and dust. Hence to eliminate the risk of fire or contamination, it is a mandatory to keep the range hood, ventilation system and its filters clean.

Sinks: At the end of every shift, sinks are checked. Soiled sinks must be washed with disinfectant detergent, wiped thoroughly and sanitized.

Working tables and food preparation areas: Working tables and food preparation areas must be cleaned and sanitized after every work cycle.

Practical Exercise

Activity

1. Visit any food processing unit, list out the machinery used. Discuss with the Plant Managers about day-to-day challenges in food processing unit and do's and don'ts while working with heavy machinery.
2. Demonstrate a thorough cleaning and maintenance of equipment available in food laboratory of your school.

Check Your Progress

A. Multiple Choice Questions

1. What type of materials should equipment and containers used in soy processing be made of?
   (a) Wood and glass
   (b) Enameled containers
   (c) Food grade materials such as stainless steel, plastic, etc.
   (d) Aluminum and copper
2. Which of the following is not a recommended practice for maintaining equipment in the work area?
   (a) Regularly inspecting and cleaning sieves and screens
   (b) Lubricating moving parts to reduce friction
   (c) Using chipped or enameled containers
   (d) Keeping the surroundings clean to avoid foreign particle accumulation

3. What is the ideal gap to be maintained between equipment and the wall?
   (a) No gap is necessary (b) Half a foot
   (c) One meter (d) One foot

4. What is the purpose of using the CIP (Cleaning in Place) method?
   (a) To reduce energy consumption
   (b) To minimize water usage
   (c) To reduce cleaning time
   (d) To clean equipment without disassembly

5. Which of the following equipment should be self-draining in wet process areas?
   (a) Grinding units (b) Power operated de-huller
   (c) Homogenizers (d) Sealers

B. Fill in the Blanks

1. Equipment and containers must be _____ designed, constructed, and maintained in good order.
2. _____ or enameled containers should not be used in soy processing.
3. The equipment must be located and installed to facilitate cleaning and _____.
4. A gap of minimum _____ from the wall must be maintained for equipment.
5. Homogenizers should be cleaned and sanitized regularly to prevent _____.

C. State True or False

1. Equipment should be made of food-grade materials such as stainless steel, plastic, and silicone. (True/False)
2. Chipped or enameled containers can be used in soy processing. (True/False)
3. CIP (Cleaning in Place) method is used to clean equipment with disassembly. (True/False)
4. Homogenizers should be inspected and cleaned regularly to prevent contamination. (True/False)
5. Tofu molds and presses do not need regular cleaning. (True/False)

D. Subjective Questions

1. Explain the importance of maintaining equipment in soybean processing.
2. Draw and explain the layout plan for soy flour production unit.
3. Draw and explain the layout plan for tofu production unit.
4. Explain the CIP and COP in cleaning and maintenance of the equipment in soybean processing?

What have you learned?

After completing this Session, you will be able to:

- Explain the different methods of maintaining the tools and equipment used in soybean processing unit.
- Explain the layout plan for tofu production unit.
- Explain the CIP and COP in cleaning and maintenance of the equipment in soybean processing.

Module 4 Essential Elements for Soy Processing Industry

Industry scale production of soy-based products needs proper planning and layout for efficient flow of material and quality production. It is necessary to understand the value of each process and how it affects the final product outcome. In this unit we will explore the various aspects of industrial scale set-up and requirement.

SESSION 1: IDENTIFICATION OF PRODUCTION REQUIREMENT

The successful operation of a soy processing industry requires a comprehensive understanding of the production requirements. A "Soy Product Processor" must have awareness about the different production requirements. Following are the considerations that needs to be taken care of while planning for industrial scale production:

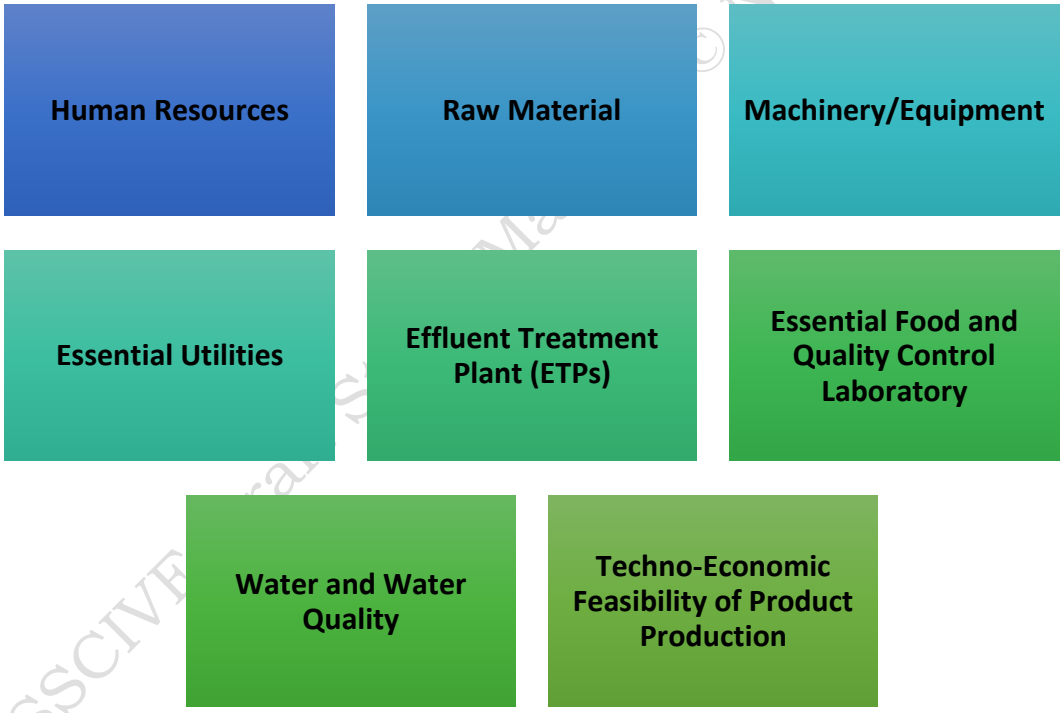

Fig. 4.1: Considerations for industrial scale production

Human Resources

Skilled and trained human resources are critical for the success of a soy processing industry. The workforce should be knowledgeable about the processing techniques, safety protocols, and equipment operation. Adequate staffing, proper training, and adherence to safety guidelines contribute to efficient production and a safe working environment.

In a typical set-up for processing of 500 liters milk /hour and 50 kg tofu/hour capacity, following human resources are considered essential:

1. Plant Manager

- Stores In-charge
- Raw material and finished goods handling Worker (3 No.)

2. Production Manager

- De-hulling and Soaking Equipment Operator
- Cooking and Grinding Operator
- Flavouring/ Tofu Making Operator
- Retort/Vacuum packaging Machine Operator
- Handling Workers

3. Quality Manager

- Food Technologist
- Lab Technician
- Lab Helper

4. Marketing/ Sales Manager

5. Administrative/Accounts Personnel

Raw Material

Soybeans are the primary raw material for the soy processing industry. The quality and availability of soybeans directly impact the production process and the final product quality. It is essential to establish reliable sources of high-quality soybeans and maintain proper storage facilities to ensure a continuous and uninterrupted supply.

Fig. 4.2: A Soy processing unit's storage facility

Food Consumables as ingredients for production: Coagulants, flavouring agents, sugar etc. must be ordered and maintained in stocks according to the need of the soy processing plant.

Industry Consumables: Muslin cloth, Fuel (coal, LPG, CNG), industrial oils, lubricants, hardware essential and spares, CIP (clean-in-place) cleaning and disinfecting agents etc.

Packaging Materials: Bottles, printed vacuum pouches, CC boxes, printed LDPE pouches, printed labels for bottles, printer ink etc.

Machinery/Equipment

Soy processing involves a variety of machinery, equipment and utilities for tasks such as cleaning, de-hulling, soaking, blanching, drying, grinding, cooking, pressing, packing and storing. Selection of appropriate machinery equipment and utilities based on the production capacity and process requirements are crucial.

Essential Utilities

Water softening device

Water softening device is used for removal of minerals and any dirt particles as an input in RO water plant.

RO water plant: RO water plant reduces total dissolved solids (TDS) and makes it potable for boiler feed, soybean soaking and other processing activities.

Boiler plant: This is used to produce the steam required for soybean processing.

Cooling tower: Cooling tower is used to cool down the circulating water used in rapid cooling of the soy milk.

Compressed air station: It is used in operating the pneumatic valves and machines used in soybean processing and packaging.
Refrigerators and Chillers: These are used for storing the packed tofu.

Cold room: Tofu and flavoured milk pouches in larger quantities are stored in cold rooms.

Fig. 4.3: A Soy processing unit's cold room facility

Effluent Treatment Plant (ETPs)

Effluent treatment plant is very crucial for any soy processing plant for treating the water used in processing activities (soaking water, tofu whey, CIP water etc.). No water should be released outside the factory without treating as per the guidelines of the Central Pollution Control Board.

Essential Food and Quality Control Laboratory

This is essential as per FSSAI guidelines to check the quality of food products. The laboratory is responsible for checking the quality of raw material, nutritional

analysis, and water quality periodically. Microbial analysis is done on every batch in this laboratory. Readiness of the plant for production needs to be certified by the Food and Quality Control Laboratory every day.

Fig. 4.4: Lab Technician working in quality control

Water and Water Quality

Water plays a vital role in various stages of soy processing, such as cleaning, steam generation, and cooling. It is crucial to ensure an adequate supply of water and maintain its quality to prevent contamination of the final products and the equipment. Implementing water conservation measures can also be beneficial from both environmental and economic perspectives. BIS standards for Potable water should be followed.

Techno-Economic Feasibility of Product Production

Before initiating soy processing, it is essential to assess the techno-economic feasibility of the products to be manufactured. This evaluation involves considering the site selection, market demand, production costs, potential revenues, profitability, break-even point, benefit cost ratio of the products and SWOT analysis. Understanding the economic viability helps in making informed decisions about product selection and overall business planning.

A detailed techno-economic feasibility will demonstrate deeper product knowledge and will also help in fund raising for your project. The typical techno-economic feasibility includes following components:

Investment in Technology

Fixed capital	
Investment on equipment	₹ 771500
Major equipment	Cost
Roaster	₹ 100000
Tray Drier	₹ 75000
Colloidal Mill	₹ 400000
Germinator	₹ 50000
Homogenizer	₹ 100000
Infrastructural Investment (@10%)	₹ 77150
Total Fixed Cost (TFC)	**₹ 848650**
Monthly working capital (Output 100kg/day)	
Raw material	368750
Labour wages	18688
Energy cost	12650
Misc services	3100
Total monthly capital	**403188**

Financial Analysis

TFC per month (depreciation@10% + interest on fixed capital + land & building rent + opportunity cost)	₹ 26464
TCP @ factory (TFC/month + monthly operational expenses)	₹ 429652
TCP @ market (TCP @ factory + marketing cost)	₹ 472617
Cost of production (/kg)	₹ 189
Expected price/kg	₹ 300
Expected profit/month	₹ 277383

Fig. 4.5: Example of techno-economic feasibility of soy product

1. Fixed capital: It includes the different equipment, their cost and infrastructure expenditure @ 10 percent of the total equipment cost.
2. Working capital: It includes raw material cost, labour wages, energy cost and miscellaneous expenditure.
3. Financial Analysis: It is done on the basis of fixed capital and working capital. Cost of production and expected price of the product is calculated using following formula: A typical example for techno-economic feasibility of soy biscuit is given in Fig.4.2.

Training on Soybean Processing

It is highly recommended to undergo Entrepreneurship Development Programme (EDP) on soy processing before initiating the set-up of any soy processing plant. Understanding the production requirements and essential elements for the soy processing industry is essential for achieving efficient and profitable operations. A well-structured process chart, product flow chart, and a thorough assessment of human resources, raw materials, machinery, water, and product feasibility are essential for the industry's success. By optimizing these elements, soy processing businesses can enhance their competitiveness and contribute to the global soy-based product market.

Practical Exercise

Activity

1. Prepare a detailed report on BIS standard for potable water.
2. Prepare a techno-economic feasibility for soy flour/soy milk/ tofu using the example given in the unit.

Check Your Progress

A. Multiple Choice Questions

1. Having skilled workforce in soy processing industry ensures which of the following
   (a) Safety protocols (b) Optimum equipment utilization
   (c) Success of the plant (d) All of the above
2. What is the primary raw material for the soybeans processing industry?
   (a) Tofu (b) Soy flour
   (c) Soybeans (d) Soy milk
3. CIP refers to
   (a) Copy-in-place (b) Clean-in-place
   (c) Clean-internal-parts (d) Customize-in-place

4. What is the primary purpose of water softening devices?
   (a) Removal of minerals and dust particles
   (b) Removal of off-flavor
   (c) Removal of bacteria
   (d) Removal of foreign materials

5. ETP stands for
   (a) Efficient Treatment Plant (b) Effective Treatment Plant
   (c) Emission Treatment Plant (d) Effluent Treatment Plant

B. Fill in the Blanks

1. _____ is employed to cool down circulating water used in rapid cooling of the soy milk.
2. RO water plant reduces _____ and makes it potable for boiler feed.
3. Guidelines to check the quality of food products are provided by _____.

C. State True or False

1. The quality of soybeans does not have any impact on the final product quality. (True/False)
2. Coagulants used for tofu preparation comes under food consumables category? (True/False)
3. LDPE pouches are a type of packaging materials. (True/False)
4. Compressed air station is used to produce the steam required for soy processing. (True/False)
5. ETP ensures proper treatment of water used in soy processing activities. (True/False)

D. Subjective Questions

1. What is the different production requirement for commercial scale production of soy-based food products?
2. What are the components of techno-economic feasibility and how the cost of production of soy-based product is calculated?
3. Prepare a techno-economic feasibility for the soy flour production.
4. Explain the importance of essential utilities, such as water softening devices, RO water plants, boilers, cooling towers, and compressed air stations, in soy processing.

What have you learned?

After completing this Session, you will be able to:

- Discuss the importance of skilled human resources, quality soybean sourcing, and essential utilities.
- Discuss the essential role of quality control laboratories in ensuring the quality and safety of soy-based products, including raw material analysis, nutritional assessment, and microbial testing.
- Evaluate the economic feasibility of product production, considering factors like market demand, costs, and revenue potential.

SESSION 2: METHODS OF CLEANING

In earlier sessions we have learnt that soybean is rich in nutrient especially protein and moisture is added during processing which provides favourable conditions to microorganism to grow and contaminate. Therefore, in the soy processing industry, maintaining a high level of hygiene is crucial to ensure the production of safe and quality soy-based products. This session discusses various methods of cleaning that play a significant role in maintaining the cleanliness and efficiency of processing equipment.

CLEANING-IN-PLACE (CIP)

Cleaning-in-place (CIP) is a method of cleaning the internal surfaces of fixed equipment, pipelines, and other processing components without the need for disassembly. It is a highly automated and efficient cleaning approach commonly used in the food and beverage industry, including the soy processing industry. CIP is designed to remove residual materials, product residues, microorganisms, and other contaminants from the internal surfaces of equipment, ensuring optimal hygiene and preventing cross-contamination. This method is considered cost-effective and time-saving, as it reduces downtime and labor associated with manual disassembly and cleaning.

The CIP process typically involves the following steps:

i. Pre-Rinsing

- Purpose: The first step is to pre-rinse the equipment and pipelines with water to remove loose debris and bulk residues.
- Water Flow: A high-velocity flow of water is used to dislodge and flush away larger particles.

ii. Chemical Cleaning

- Purpose: Chemical cleaning involves the use of specially formulated cleaning agents (detergents) to remove stubborn residues, organic materials, and microbial contaminants.

- Cyclic cleaning: the cycle of cleaning begins with alkaline detergent followed by acid detergent and then again alkaline detergent.
- Circulation: The cleaning solution is circulated in a closed loop throughout the equipment and pipelines for a specified duration to ensure thorough coverage and cleaning.
- Temperature: Elevated temperatures may be used to enhance the cleaning action and improve the effectiveness of the detergent.
- High flow rate: higher flow rates may be used to ensure cleaning action and reduce cleaning time.

iii. Rinsing

- Purpose: After the chemical cleaning phase, the equipment is thoroughly rinsed with water to remove any remaining cleaning solution and loosened contaminants.

iv. Post-Rinsing

- Purpose: The final step involves a post-rinse to ensure that no cleaning agents or residues are left on the internal surfaces.
- Purified Water: Post-rinsing may involve the use of purified water to prevent the introduction of new contaminants.

v. Frequency of CIP

- Depending upon a continuous production facility, CIP is recommended to be done once in every 24 hours.

vi. Neutrality check of CIP

- Due to the use of different chemical cleaning agents, it is essential to check the neutrality of the pH so that the cleaning operation is considered complete. This is done by drawing the water sample from the equipment and checking the pH to ensure that it is neutral.

Cleaning-in-place (CIP) is a well-established and widely used method in the soy processing industry for efficiently cleaning internal surfaces of equipment and pipelines. The process involves pre-rinsing, chemical cleaning, rinsing, and post-rinsing to achieve effective removal of contaminants and ensure hygienic and safe processing. By automating the cleaning process and eliminating the need for disassembly, CIP contributes to reduced downtime, increased productivity, and improved overall hygiene in soy processing facilities.

CLEANING-OUT-OF-PLACE (COP)

Cleaning-out-of-place (COP) is a method of cleaning and sanitizing equipment and components outside of their original location, typically in a dedicated wash area or cleaning station. COP offers distinct advantages and presents specific limitations that soy processing facilities should consider when choosing cleaning methods. This method of cleaning is generally adopted at household or small capacity processing units.

COP is suitable for cleaning a wide range of equipment, including complex machinery and large processing components. It provides a flexible approach that can be adapted to different equipment types and sizes.

COP allows for thorough cleaning of equipment, as parts can be disassembled and cleaned individually. This ensures that all surfaces and hard-to-reach areas are adequately cleaned, reducing the risk of contamination and microbial growth.

COP typically involves a dedicated wash area, which is designed and equipped specifically for efficient and effective cleaning. This enables the use of specialized cleaning equipment and ensures the proper disposal of wastewater and cleaning chemicals.

Though COP has many advantages, it can be more time-consuming and labor-intensive compared to other cleaning methods like CIP. Disassembling, cleaning, and reassembling equipment requires additional time and manpower. The steps involved in COP are shown in Fig. 4.6.

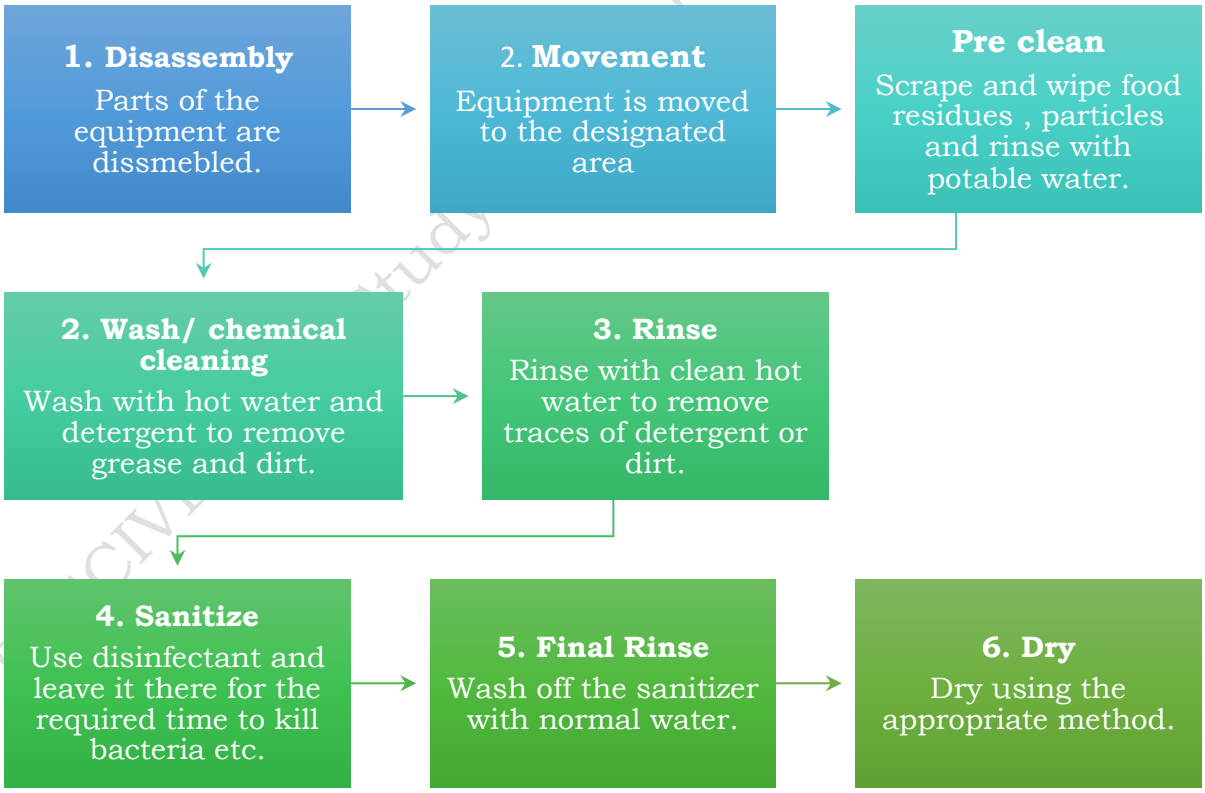

Fig. 4.6: Steps involved in COP

Cleaning-out-of-place (COP) offers effective cleaning for equipment with intricate designs and allows for thorough cleaning of individual components. While it has its advantages in achieving high levels of cleanliness, it also presents challenges related to time, labor, equipment complexity, and chemical handling. When choosing between COP and other cleaning methods, soy processing facilities should consider their specific equipment types, cleaning requirements, available resources, and workforce expertise to ensure effective and safe cleaning practices.

Cleaning of Soybean Processing Equipment

The cleaning of soybean processing equipment is essential to maintain product quality, prevent contamination, and ensure food safety. Proper cleaning procedures also extend the lifespan of the equipment and enhance its performance.

Effective cleaning procedures are essential in the soybean processing industry to maintain hygiene, prevent cross-contamination, and ensure the production of safe and high-quality soy-based products. This session provides comprehensive cleaning procedures for various types of equipment commonly used in dry processing of soybean.

Cleaning Procedures for De-hullers, flour grinders and packaging machines

i. Pre-Cleaning

- Removal of Residual Material: Before starting the cleaning process, remove any residual soybean material, dust, or debris from the crushers and grinders.
- Disassembly (if required): If possible, disassemble the equipment to access hard-to-reach areas.

ii. Brushing and Scrubbing

- Use brushes and scrubbers to remove stubborn residues and build-ups from the equipment.

Proper cleaning procedures for various soybean processing equipment are vital for maintaining hygiene and ensuring the production of safe and high-quality soy-based products. By following these cleaning methods for each equipment type, soy processing facilities can achieve optimal results, prevent cross-contamination, and adhere to industry standards and regulations.

Common Detergents and Sanitizers

To achieve effective cleaning and sanitization, the proper selection and use of detergents and sanitizers are crucial. Detergents play a vital role in the soy

processing industry by removing dirt, oil, grease, and other contaminants from surfaces and equipment. Generally, sodium hydroxide and potassium hydroxide as alkaline detergent and nitric acid as acidic detergent are used for cleaning of the equipment.

Disinfection of Tools and Equipment

Disinfection of all the food contact tools and surfaces using Isopropyl alcohol (IPA) is done every hour.

Precautionary Measures During Cleaning and Sanitization

Cleaning and sanitization involve potential risks, and certain precautions should be taken to ensure worker safety and product integrity. Let us discuss precautionary measures during cleaning and sanitization.

Personal Protective Equipment (PPE)

1. Aprons, gloves, masks, hairnet, gumboots etc.
2. Proper Use and Maintenance: Correct usage of PPE to ensure maximum protection.

Proper Handling and Storage of Chemicals

It is very important to understand the usage and application of various chemicals along with its handling hazards. Chemicals must be stored below eye level and at a secure and dry location. Every chemical is clearly marked with the name, hazard caution and procedures of handling it.

Precautionary measures during cleaning and sanitization, such as using appropriate PPE, handling chemicals safely, providing training and education to cleaning personnel, and complying with industry standards, are essential to create a safe and hygienic environment in the soy processing industry. By following these measures, processing facilities can ensure the well-being of their workers, produce high-quality products, and maintain a positive reputation within the industry.

Solid Waste Management

The soy processing industry generates waste materials that require proper disposal to minimize environmental impact. This chapter covers waste management practices.

Types of Waste in Soy Processing

Residual Soybean Material: This waste includes leftover soybean hulls or seed coats, and other by-products like okara and whey from the processing activities. The hulls and okara can be sold as such for animal feed products. The whey is treated as given earlier in session 5 of the Unit-2.

Processing waste comprises materials generated during the manufacturing of soy-based products, such as broken or damaged soybeans and substandard batches.

Packaging Material Recycling: All plastic and glass waste packaging material should be recycled and not be dumped along with other waste.

Effective waste management practices, including waste minimization, solid waste management techniques, and recycling initiatives, are essential for the soy processing industry to achieve sustainable and environmentally responsible operations. Implementing these strategies can not only reduce environmental impact but also lead to cost savings and improved overall efficiency in soy processing.

Understanding and implementing effective cleaning, sterilizing, and waste management practices are fundamental for the soy processing industry. Proper maintenance of hygiene ensures the production of safe and high-quality soy-based products, meeting consumer demands and industry standards.

Practical Exercise

Activity

1. Observe equipment in your food laboratory and make a list mentioning which equipment is suitable for CIP and which for COP.
2. Full day visit to a soybean processing unit/ plant for:
   - Demonstration of cleaning, maintaining and handling soybean processing equipment and tools.
   - Discussion on hygiene and sanitation standards in processing unit

Check Your Progress

A. Multiple Choice Questions

1. Presence of which component in soybean provides favourable conditions for microbial growth?
   (a) Fat (b) Anti-nutrients
   (c) Protein (d) Fiber

2. Cleaning-in-place (CIP) is used to clean the internal surfaces of
   (a) Movable equipment (b) Disassembled equipment
   (c) Fixed equipment (d) Light equipment

3. CIP involves pre-rinsing, chemical cleaning, rinsing, and _____
   (a) Drying (b) Post-rinsing
   (c) Labelling (d) Assembling

4. COP stands for
   (a) Cleaning-out-of-place
   (b) Cleaning Operational Process
   (c) Current Operating Procedure
   (d) Continuous Output Production

5. What advantages does the Cleaning-out-of-place (COP) method offer for cleaning equipment and components in soy processing facilities?
   (a) Rapid cleaning process
   (b) Suitable for large capacity processing units
   (c) Limited adaptability to equipment types
   (d) Thorough cleaning of hard-to-reach areas

B. Fill in the Blanks

1. Cleaning-in-place (CIP) is a method used to clean internal surfaces of equipment and pipelines without the need for_____.
2. Chemical cleaning in the CIP process involves the use of specially formulated cleaning agents, such as _____, to remove stubborn residues.
3. Cleaning-out-of-place (COP) involves cleaning equipment _____of its original location in a dedicated wash area, often adopted at household or small capacity processing units.
4. COP allows for thorough cleaning as parts can be disassembled and cleaned individually, reducing the risk of _____.
5. Proper handling and _____of chemicals used in cleaning are essential to ensure worker safety, and each chemical should be marked with its name, hazard caution, and procedures of handling it.

C. State True or False

1. Cleaning-in-place (CIP) involves disassembling equipment to clean internal surfaces.
2. COP is a method suitable for cleaning only small household appliances.
3. In CIP, chemical cleaning involves the use of specialized cleaning agents to remove residues and contaminants.
4. COP requires a dedicated wash area designed for effective cleaning.
5. Effective waste management practices in the soy processing industry can lead to improved efficiency and cost savings.

D. Subjective Questions

1. Describe Cleaning-in-place (CIP) and Cleaning-out-of-place (COP) methods of cleaning.
2. Elaborate on the significance of proper chemical handling and storage in cleaning procedures.
3. Explain the importance of efficient waste management practices in the soy processing industry.

What have you learned?

After completing this Session, you will be able to:

- Discuss different cleaning methods, including Cleaning-in-place (CIP) and Cleaning-out-of-place (COP).
- Discuss importance of proper chemical handling and storage during cleaning procedures.
- Discuss the significance of cleaning soy processing equipment to ensure food safety, maintain product quality, and prolong equipment lifespan.
- Demonstrate proper use of Personal Protective Equipment (PPE).

Module 5 Food Safety and Hygiene

Soy processing demands a nuanced understanding of food safety and hygiene measures throughout soybean processing operations. In this unit we will understand food safety, various food safety hazard, food safety regulation relating to soy foods and the role of "Soy Product Processor" in maintaining hygiene standards, preventing potential hazards, and adhering to regulatory norms specific to soy processing.

SESSION 1. FOOD SAFETY

Food safety refers to the practice of handling, manufacturing and storing food in a way that prevents contamination and reduces the risk of food borne illnesses. It is a critical aspect of public health as consuming contaminated or unsafe food can lead to various health problems, ranging from mild gastrointestinal issues to severe and even life-threatening conditions. Ensuring food safety involves implementing proper food handling, manufacturing and storage methods as well as adhering to regulations and standards set by food safety authorities.

Shelf Life of Food

The shelf life of food refers to the period during which a food product remains safe to consume and maintains its desired quality when stored under appropriate conditions. It is the timeframe within which the food product is expected to retain its nutritional value, taste, texture, and appearance without becoming hazardous to health or losing its appeal to consumers.

The shelf life of food is influenced by various factors, including the composition of food, packaging, storage conditions and the presence of preservatives or additives. This principle extends seamlessly to soy-based products. Therefore, understanding and effectively managing the shelf life of soy-based products becomes imperative. This ensures not only the reduction of food wastage but also guarantees that consumers consistently receive soy-based products of optimal quality and safety standards. Table 5.1 provides an overview of the shelf life for various commercially available soy products, along with the different packaging and storage conditions for optimal preservation.

Table 5.1: Shelf life of some commercially available soy product

Name of the Soy Product	Shelf Life of the Product	Packing and Storage Conditions
Full Fat Soy Flour	3 months	Stored under ambient condition
Defatted Soy Flour	3 months	Stored under ambient condition
Soy Milk	6 months	In sterilized bottles and stored under ambient condition
Tofu	2-3 weeks	Vacuum packed and stored under refrigerated condition

These specific shelf life durations and storage recommendations play a crucial role in maintaining the quality, safety, and freshness of the respective soy products. It is essential for consumers, producers, and distributors to adhere to these guidelines to ensure the optimal satisfaction of soy-based foods while minimizing the risk of spoilage or degradation.

Factors Affecting Food Safety and Shelf Life of Food

Several factors influence the safety and shelf life of food products:

Temperature: Proper temperature control is essential to prevent the growth of harmful bacteria. Refrigeration or freezing can extend the shelf life of perishable foods.

Moisture: Excessive moisture can promote mold and bacterial growth, leading to spoilage and reduced shelf life.

Oxygen: Oxygen can cause oxidative reactions that degrade the quality of certain foods, leading to rancidity and loss of nutrients.

pH Levels: Acidic foods generally have a longer shelf life as they inhibit the growth of many bacteria. Alkaline foods may be prone to spoilage.

Packaging: Proper packaging can protect food from physical damage, contamination, and deterioration, thereby extending shelf life.

Preservatives: Some food products contain natural or artificial preservatives to inhibit the growth of microorganisms and increase shelf life.

Storage Conditions: Following recommended storage conditions, such as cool, dry, and dark environments, can help maintain the quality and safety of food.

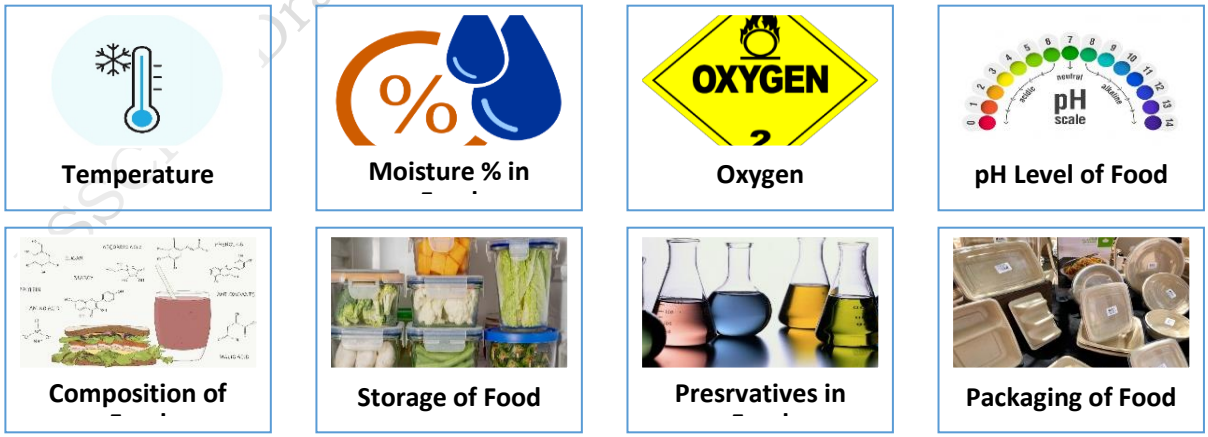

Fig. 5.1: Factors Affecting Food Safety and Shelf Life of Food

In addition to the mentioned factors, several other elements can contribute to spoilage in soy products:

Light Exposure: Extended exposure to light, especially sunlight, can accelerate the deterioration of certain nutrients and contribute to flavor changes in soy products. Proper storage in opaque containers or packaging helps mitigate this risk.

Microbial Contamination: Despite the inhibitory effects of acidic conditions in some soy products, microbial contamination, such as the presence of harmful bacteria, molds, or yeasts, can still occur. Contaminated raw materials, equipment, or processing environments can introduce and foster the growth of unwanted microorganisms.

Inadequate Processing: Improper processing techniques, including insufficient heat treatment or incomplete cooking, may leave soy products susceptible to spoilage. Adequate processing is essential to eliminate or minimize harmful microorganisms.

Enzymatic Reactions: Enzymatic activities naturally present in soy can lead to quality deterioration over time. While enzymes play a crucial role in various processes, uncontrolled enzymatic reactions can negatively impact the sensory attributes and nutritional quality of soy products.

Air Exposure: Even in the absence of excessive oxygen, prolonged exposure to air during processing, packaging, or storage can contribute to the degradation of soy products. Hermetic sealing and airtight packaging are essential to minimize air exposure.

Variability in Raw Materials: Differences in the quality and composition of raw soybeans can affect the shelf life of soy products. Variability in factors such as moisture content, protein levels, and processing conditions can contribute to inconsistencies in the final product's stability.

Temperature Fluctuations: Fluctuations in storage temperatures, especially in environments where soy products are transported or stored, can impact their shelf life. Consistent temperature control is essential to prevent temperature-related spoilage.

The shelf life of various soy products mentioned in Table no 5.1 is defined by considering all the factors relating to food safety mentioned above. By addressing these factors and implementing appropriate measures in processing, packaging, and storage, producers can enhance the shelf life and overall quality of soy products, ensuring they reach consumers in optimal condition.

Food Safety Hazards

Food safety hazards are biological, chemical, or physical agents that can contaminate food, making it unsafe for consumption. These hazards can lead to food-borne illnesses or other adverse health effects. Food safety hazards as shown in Fig. 5.2 are categorized as follows:

Biological Hazards: These include microorganisms such as bacteria, viruses, parasites, and fungi. When food is contaminated with pathogenic microorganisms, it can cause foodborne infections or intoxications.

Chemical Hazards: Chemical hazards arise from the presence of harmful substances in food, such as pesticides, heavy metals, allergens, food additives, or naturally occurring toxins.

Physical Hazards: Physical hazards refer to foreign objects or materials accidentally introduced into food, like glass, metal fragments, plastic, or stones.

Allergens: Allergens are substances that trigger allergic reactions in susceptible individuals. Common allergens include milk, eggs, peanuts, tree nuts, wheat, soy, fish, and shellfish. All soy products packaging label have to compulsorily mark with the allergen warning "Allergen: Contains Soy".

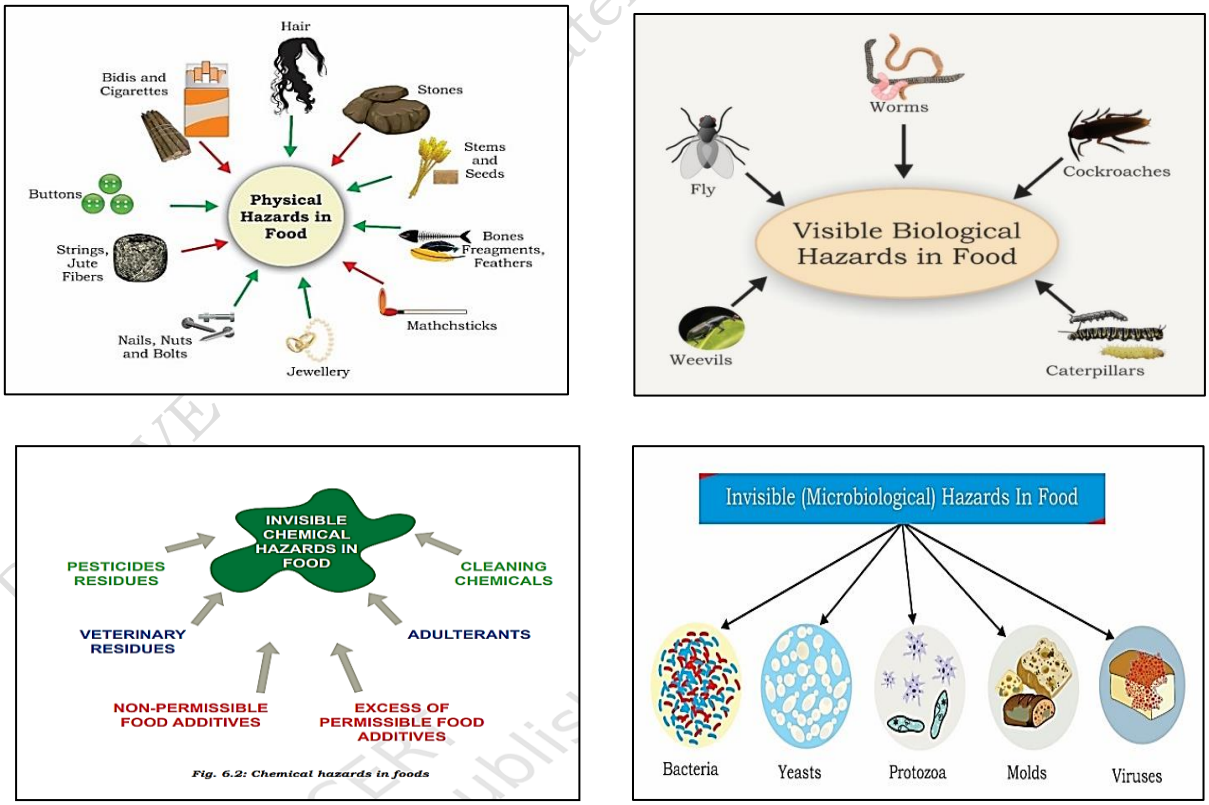

Fig. 5.2: Food safety hazards

Proper food safety practices, adherence to regulations, and knowledge of potential hazards and contaminants are essential to safeguard public health and ensure the quality and safety of food products from production to consumption.

Practical Exercise

Activity

1. Identify and categorize food safety hazards in your food laboratory considering the hazards mentioned in this session. Suggest the measures for removal of these hazards.
2. Study the shelf life of tofu for 3 days and tabulate your observations.

Check Your Progress

A. Multiple Choice Questions

1. Food safety refers to the practice of handling, manufacturing, and storing food to prevent contamination and reduce the risk of _____.
   (a) Food wastage (b) Flavor deterioration
   (c) Foodborne illnesses (d) Overcooking

2. What is the purpose of the shelf life of food?
   (a) To enhance food flavor (b) To prevent spoilage
   (c) To increase food weight (d) To improve food texture

3. Which factor does not influence the shelf life of food products?
   (a) Temperature (b) Oxygen
   (c) Taste (d) Packaging

4. Biological hazards in food safety involve:
   (a) Physical contaminants (b) Harmful chemicals
   (c) Pathogenic microorganisms (d) Food additives

5. Allergens are substances that:
   (a) Enhance food flavor (b) Trigger allergic reactions
   (c) Extend shelf life (d) Act as preservatives

B. Fill in the Blanks

1. Proper _____ control is essential to prevent the growth of harmful bacteria.
2. Excessive _____ can promote mold and bacterial growth in food.

3. Acidic foods generally have a longer shelf life due to their lower _____ levels.
4. _____ can cause oxidative reactions that degrade food quality and flavor.
5. Food safety hazards are categorized as biological, chemical, and _____.

C. State True or False

1. Food safety refers to the practice of handling, manufacturing, and storing food to prevent contamination and reduce the risk of foodborne illnesses. (True/False)
2. The shelf life of food products is not affected by factors such as temperature, packaging, and moisture. (True/False)
3. Chemical hazards in food can arise from the presence of harmful substances like allergens, pesticides, and heavy metals. (True/False)
4. Physical hazards include microorganisms like bacteria and viruses that can contaminate food. (True/False)
5. Allergen labeling on food products is not necessary, as allergic reactions are rare. (True/False)

D. Subjective Questions

1. What do you understand by the term "shelf life" of food products? What are the key factors that influence the shelf life of soy-based products?
2. What are the different types of food safety hazards?
3. Why is it crucial for soy products to be clearly labeled with allergen warnings?

What have you learned?

After completing this Session, you will be able to:

- Explain the importance of food safety in preventing contamination and reducing the risk of foodborne illnesses
- Describe the concept of shelf life, various hazards in food safety, including biological, chemical, and physical agents.
- Discuss the significance of adhering to regulations and proper handling practices to ensure public health and maintain the quality of food products from production to consumption.

SESSION 2: FOOD SAFETY REGULATIONS AND STANDARDS IN RELATION TO SOY PRODUCTS

Food safety regulation relating to soy foods in India are crucial for protecting public health and ensuring that the food consumed by citizens is safe and free from contamination or adulteration. Over the years, India has witnessed a

significant evolution in its food safety regulations, from early unstructured practices to a well-defined modern framework.

Food certification is the way to ensure good manufacturing practices, best hygiene practices and food quality and safety. The major food quality and certification in India are as follows:

Food Safety and Standards Authority of India (FSSAI)

Food standards and regulation are required to integrate quality into every aspect of food handling, production and services. It provides a control system to ensure the hygienic supply of food and facilitate trade within and between nations.

Fig. 5.3: Logo of FSSAI

Food standards regulations in India were enacted and amended from time to time as per the need of the hour ensure that food producers and sellers comply with the requirements of food safety. Major prevailing food standard regulations before 2006 included Prevention of Food Adulteration Act 1954 (PFA, 1954), Fruit and Vegetable Product Order (1955), Meat Food Products Order (1973), Vegetable Oil Products Order (1998), Milk and Milk Products Order (1992), Meat Food Products Order (1973), Agricultural grading and Marketing (AGMARK) (1937). Since the government had several regulations and laws, food industry found it cumbersome. A need was therefore felt to integrate all such laws for regulating the quality of food. With this in view, the Food Safety and Standards Act was passed by the Indian Parliament on August 4, 2006 to oversee the standards of food safety to bring the different pieces of legislation pertaining to food safety under one umbrella. After 2 years of passing this act, the Food standardization and regulatory agency Food Safety and Standards Authority of India (FSSAI) was formed. The FSSAI comes under Ministry of Health & Family Welfare, Government of India. Fig. 5.3 shows the various prevailing laws being covered under FSSAI.

The FSSAI is the regulatory body responsible for ensuring food safety and standards in India. It sets standards for food products and regulates their manufacturing, storage, distribution, sale, and import.

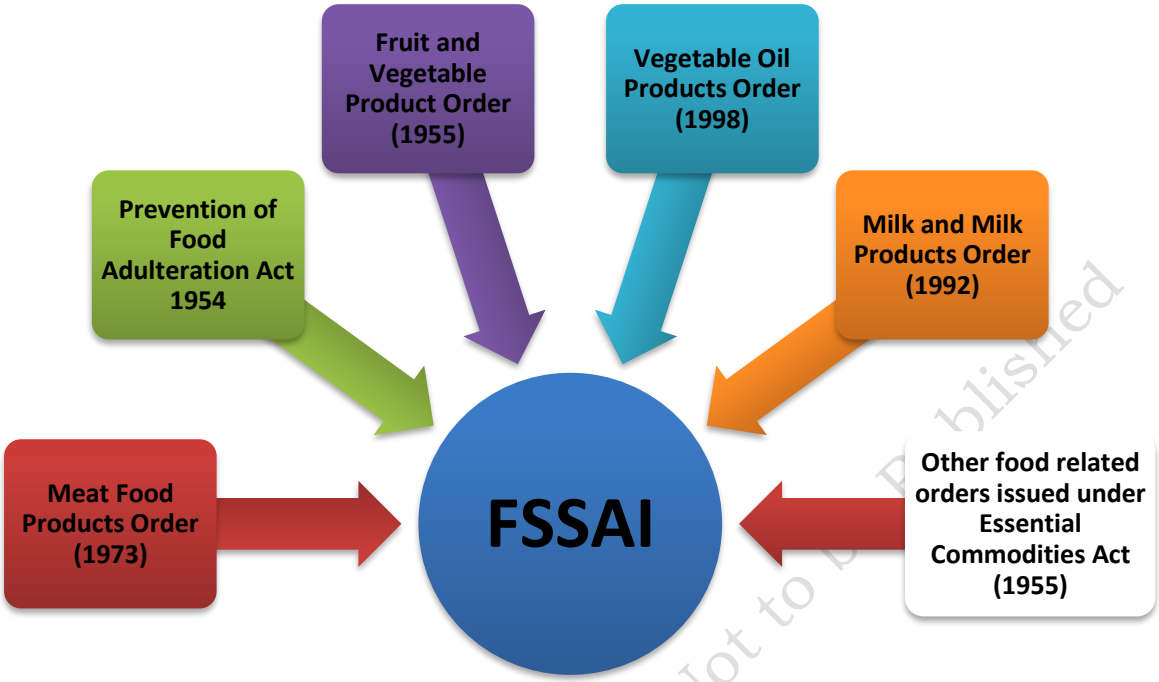

Fig. 5.4: Laws covered under Food Safety and Standards Authority of India (FSSAI)

Role and function of FSSAI

The main role of FSSAI is to bring together the scientific community and the various regulatory agencies in the country to initiate an integrated food safety regulatory framework. FSSAI performs the following functions:

Setting Food Standards: One of the primary responsibilities of the FSSAI is to lay down science-based standards for various food products to ensure their safety, quality, and nutritional value. These standards apply to all food businesses operating in India.

Licensing and Registration: The FSSAI mandates the licensing and registration of food businesses to ensure their compliance with food safety regulations. The licensing process varies based on the size and nature of the food business.

Food Safety Enforcement: The FSSAI, in collaboration with state food safety departments, conducts inspections and surveillance to enforce food safety standards. It takes necessary actions against non-compliant businesses and addresses potential food safety hazards.

Scientific Panels and Research: The FSSAI has established various scientific panels comprising experts to advise on specific food-related matters, risk assessment, and formulation of food standards based on the latest scientific evidence.

Consumer Awareness: The FSSAI conducts campaigns and educational programs to raise awareness among consumers about food safety, nutrition, and their rights as consumers.

Food Recall and Traceability: The FSSAI has laid down procedures for food recall in case of food safety emergencies. It also promotes the use of technology for ensuring traceability in the food supply chain.

Capacity Building: The FSSAI provides training and capacity building programs to stakeholders in the food industry to enhance their understanding of food safety requirements and compliance.

The Food Safety and Standards Authority of India (FSSAI) have emerged as a pivotal organization in India's quest for safer and healthier food. Its proactive approach towards setting standards, enforcing regulations, and educating consumers has contributed to improving the overall food safety scenario in the country.

Food Quality Certifications

There are several food quality certifications available in India, such as ISO 22000, FSSC 22000, BRC, and HACCP. These certifications ensure that food products meet certain quality and safety standards, and are recognized globally.

Organic Certification: Organic certification ensures that food products are produced without the use of harmful pesticides and chemicals. There are several organic certification bodies in India, such as the National Programme for Organic Production (NPOP), which is recognized globally.

Halal/ Kosher Certification: These certifications are required only for exporting in specific regions of the world.

Bureau of Indian Standards (BIS): Bureau of Indian Standards (BIS) is the National Standard Body of India. BIS is responsible for the harmonious development of the activities of standardization, marking and quality certification of goods and for matters connected therewith or incidental thereto.

BIS through its core activities of standardization and conformity assessment, has been benefiting the national economy by providing safe, reliable and quality goods; minimizing health hazards to consumers; protecting the environment, promoting exports and imports substitute; controlling over proliferation of varieties etc. The standards and certification scheme of BIS apart from benefitting the consumers and industry also support various public policies especially in areas of product safety, consumer protection, food safety,

environment protection, building and construction, etc. Formulation of BIS standards of many soy products are in progress and will reflect on BIS website in future. The important BIS standards for various soy products are given below in Table 5.2

BIS Standard	Name of the Soy Product
IS 7835 : 2013	Edible medium - Fat soya flour
IS 7836 : 2013	Edible low - Fat soya flour
IS 7837 : 2013	Edible full - Fat soya flour
IS 16489 : 2018	Soymilk (Non - Dairy Product)
IS 17651 : 2021	Soy nuts
IS 17652 : 2021	Soy Butter
IS 17673 : 2021	Soy Amrakhand
IS 18226 : 2023	Soy Dahi (Non-Dairy Product)
IS 18228 : 2023	Soy Nuggets and Soy Granules
Source: https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/knowyourstandards/Indian_standards/isdetails/	

Minimum requirement for labeling and marking on the packaging of soy products: The ink used for marking shall be of such quality which may not contaminate the product. Each package shall be suitably marked legibly and indelibly to give the following information:

- Name and type of the product
- Nutritional information
- List of ingredients
- Method of use
- Name and address of the manufacturer
- Date of manufacture or packaging
- Lot/batch number
- Net quantity
- Expiry/use by date
- Storage instructions
- Vegetarian green dot logo
- FSSAI logo
- MRP
- Customer helpline number/email address and
- Any other requirements under the Food Safety and Standards (Labelling and Display) Regulations, 2020 and the Legal Metrology Act, 2009 and rules framed there under.

Good Manufacturing Practices (GMP)

Good Manufacturing Practices (GMP) are a set of guidelines and standards that ensure the safe and consistent manufacturing, processing, and packaging of food products. GMP focuses on maintaining hygiene, sanitation, and quality throughout the production process. The key elements of GMP includes:

- Facility and equipment monitoring and care,
- Maintenance of personnel hygiene,
- Raw material and process controls
- Documentation and record keeping.

Good Handling Practices (GHP)

Good Handling Practices (GHP) focus on maintaining food safety and quality during the transportation, storage, and handling of food products. These practices aim to minimize the risk of contamination and ensure that food products are safe for consumption. Key elements of GHP include:

- Storage Conditions
- Cross-Contamination Prevention
- Cleaning and Sanitization
- Pest Control

Hazard Analysis Critical Control Points (HACCP)

Hazard Analysis Critical Control Points (HACCP) is a systematic approach to food safety that identifies, evaluates, and controls potential hazards throughout the food production process. HACCP is based on seven principles:

1. Conducting a Hazard Analysis: Identifying potential hazards associated with each step in the production process.
2. Identifying Critical Control Points (CCPs): Determining the points in the process where control measures can be applied to prevent, eliminate, or reduce hazards.
3. Establishing Critical Limits: Setting criteria to ensure that CCPs are under control.
4. Monitoring CCPs: Regularly monitoring CCPs to ensure they are within critical limits.
5. Implementing Corrective Actions: Developing procedures to take corrective actions when CCPs exceed critical limits.
6. Verifying the System: Validating and verifying the effectiveness of the HACCP plan.
7. Documenting and Record Keeping: Maintaining detailed documentation of the HACCP plan and related activities.

HACCP is widely used in the soy food industry to ensure the production of safe and high-quality soy food products.

Practical Exercise

Activity

1. Write a concise summary highlighting the importance of food safety regulations, certifications, and practices in the soy food industry in India. Include key takeaways such as the role of FSSAI, BIS standards, certifications, and principles like HACCP. Discuss in your class on how these practices can be applied in real-world scenarios to ensure food safety**.**

Check Your Progress

A. Multiple Choice Questions

1. Food safety regulations aim to protect public health by ensuring that food is safe and free from _____.
   (a) Flavors (b) Contamination
   (c) Additives (d) Labels
2. Which regulatory body is responsible for ensuring food safety and standards in India?
   (a) ISO (b) BIS
   (c) FDA (d) FSSAI
3. The main role of the Food Safety and Standards Authority of India (FSSAI) is to:
   (a) Promote food additives
   (b) Monitor agricultural practices
   (c) Enforce labeling laws
   (d) Ensure food safety and standards
4. Organic certification ensures that food products are produced without the use of _____.
   (a) Packaging materials (b) Allergens
   (c) Harmful pesticides and chemicals (d) Food additives
5. Good Manufacturing Practices (GMP) focus on maintaining hygiene, sanitation, and quality throughout the _____ process.
   (a) Distribution (b) Packaging
   (c) Advertising (d) Production

B. Fill in the Blanks

1. The Food Safety and Standards Act was passed by the Indian Parliament on _____.
2. Food certification ensures good manufacturing practices, hygiene, and food quality and _____.

3. Bureau of Indian Standards (BIS) is responsible for standardization, marking, and quality _____ of goods.
4. The main elements of Good Manufacturing Practices (GMP) include facility and equipment monitoring, personnel hygiene, raw material and process _____, and documentation.
5. Hazard Analysis Critical Control Points (HACCP) is a systematic approach to food safety that identifies, evaluates, and controls potential _____ throughout the food production process.

C. State True or False

1. FSSAI is responsible for regulating food safety standards and practices in India. (True/False)
2. Organic certification ensures that food products are produced using harmful pesticides and chemicals. (True/False)
3. Good Manufacturing Practices (GMP) focus on maintaining hygiene, sanitation, and quality throughout the production process. (True/False)
4. Hazard Analysis Critical Control Points (HACCP) is a set of guidelines for food packaging. (True/False)
5. Food safety regulations and certifications play a significant role in ensuring the quality and safety of soy products in India. (True/False)

D. Subjective Questions

1. Explain the role and functions of the Food Safety and Standards Authority of India (FSSAI). How does FSSAI contribute to ensuring food safety and quality in India's food industry?
2. Explain the role of Bureau of Indian Standard in food quality control and enlist the various soy-based products for which the BIS standards are available.
3. Describe the key principles of Hazard Analysis Critical Control Points (HACCP) and its importance in ensuring the safety of soy food products.
4. Discuss the significance of Good Manufacturing Practices (GMP) and Good Handling Practices (GHP) in the context of food safety for soy products.

What have you learned?

After completing this Session, you will be able to:

- Explain the role and functions of the Food Safety and Standards Authority of India (FSSAI)
- Describe the BIS standards for soy-based products
- Describe the key principles of Hazard Analysis Critical Control Points (HACCP).
- Explain various food safety regulations.

SESSION 3: SOY PRODUCT PROCESSOR

A "**Soy Product Processor**" has a diverse range of career opportunities and self-employment prospects. Primarily, individuals in this role can find employment in the food processing industry, contributing to the production of various soy-based products like soy flour, soy milk, tofu, soy sauce etc. Additionally, there are avenues in nutrition and health, where processors focus on creating fortified soy products or collaborating with companies in the dietary supplement sector. Some may choose to work closely with farmers and agricultural businesses, ensuring a steady supply of quality soybeans. Research and development offer a path for those interested in improving soy processing techniques and creating innovative soy-based products. Entrepreneurs can establish their own soy product processing businesses, ranging from small-scale soy milk and tofu production to creating unique soy-based items for niche markets. Consultancy services, supply chain management, quality control, and educational roles are also viable options, as is contributing to environmental sustainability efforts within the soy processing industry. Whether working in local or international contexts, individuals in this field have the opportunity to make meaningful contributions to the food industry and beyond. Let us now understand the responsibilities of a “Soy Product Processor”.

A **Soy Product Processor** is responsible for handling and processing soybeans into various soy-based food products. Their job involves ensuring the quality, safety, and efficiency of the production process. Some of the key job responsibilities of a soy product processor include:

Receiving and Inspecting Raw Materials: Inspecting incoming soybeans for quality and ensuring they meet the required standards for processing.

Cleaning and Sorting: Cleaning and sorting soybeans to remove impurities and foreign materials.

Preparing Soybeans: Preparing soybeans for processing, which may involve soaking, grinding, or dehulling, depending on the specific product being produced.

Processing and Formulation: Operating the machinery and equipment to process soybeans into different products, such as soy flour, soy milk, tofu, or any other soy products.

Quality Control: Conducting regular quality checks during processing to ensure that the products meet the desired standards for taste, texture, and nutritional value.

Food Safety Compliance: Adhering to Good Manufacturing Practices (GMP), Good Handling Practices (GHP), and Hazard Analysis Critical Control Points (HACCP) to maintain food safety and prevent contamination.

Packaging and Labeling: Ensuring that the finished products are properly packaged and labeled according to regulations and company standards.

Equipment Maintenance: Maintaining and cleaning processing equipment regularly to prevent cross-contamination and ensure efficient production.

Inventory Management: Keeping track of raw materials and finished product inventory levels to ensure an uninterrupted production process.

Compliance with Regulations: Complying with all relevant food safety and regulatory requirements set by the Food Safety and Standards Authority of India (FSSAI) or other relevant authorities.

Documentation: Maintaining records of production processes, quality checks, and other relevant information for traceability and audits.

Personal Hygiene and Sanitation

Personal hygiene and sanitation in the soy processing unit conceptually refer to its adoption by the personnel and its implementation in the work area. Hygiene means clean and contamination-free environment for the staff and the working area. Soy plant worker can eliminate the possibilities of infection which they may carry on their body, hair or clothes by following hygiene and sanitation standards.

Aspect of maintaining personal hygiene and sanitation include hands, hair, cloths and personal habits as discussed below:

Hands Hygiene

Hands are the most likely source and carrier of contamination in food industry. Therefore, they must be washed with soap solution and water at least for 20 seconds followed by rinsing in running water.

1. Wash hands before and after handling of food material.
2. Use protective hand gloves while working. Gloves must be cleaned and sanitized after every work cycle.
3. Personnel working in soy processing unit should not wear hand jewelry, wristwatch or bangles.
4. Person suffering from any kind of skin diseases or open wound are not allowed to work in soy processing unit.
5. Wash basins are provided near the working area.

Hair hygiene

1. Hair to be kept short and clean.
2. Combing of hair is avoided in working area.
3. Hair is covered using hairnet.

Cloth hygiene

1. Apron should be used by every personnel working in processing area.
2. The apron needs to be regularly washed.
3. Adequate changing rooms, rest rooms and cabinets for clothes and personal belongings are provided while developing the layout of the soy processing unit.

Prohibited activities

1. Touching nose, eye, ear, mouth and hair while working is strictly prohibited as it carries a lot of bacteria which immediately contaminates the soy products.
2. Coughing or sneezing without covering the mouth and nose with cloth.
3. Eating, drinking, consumption of tobacco products or chewing gum is strictly prohibited in plant premises.

Aspects of Maintaining a Hygienic Workplace - Waste Disposal and Pest Control

Waste Disposal: Proper waste disposal is essential to prevent the accumulation of waste materials that could attract pests or become a breeding ground for harmful bacteria. Waste should be segregated, stored in appropriate containers, and disposed of regularly following local regulations.

Pest Control: Implementing effective pest control measures is crucial to prevent pest infestations in the food processing facility. Regular inspections, sealing entry points, and using approved pest control methods help minimize the risk of contamination.

Cleaning and Sanitization: Regular and thorough cleaning of all surfaces, equipment, and utensils used in food processing is vital to maintain a hygienic workplace. Sanitization procedures should be followed to kill harmful bacteria and prevent their growth.

Drains and Floor Cleaning: Cleaning and maintaining drains and floors prevent the buildup of food debris and standing water, which can attract pests and create a breeding ground for bacteria.

Good Storage Practices: Properly storing raw materials, intermediate products, and finished goods in designated areas helps maintain a clean and organized workplace, reducing the risk of cross-contamination and pest infestation.

By strictly following personal hygiene guidelines and maintaining a hygienic workplace with proper waste disposal and pest control measures, soy product processors can ensure the production of safe, high-quality soy-based food products. These practices are essential for complying with food safety regulations and protecting the health of consumers.

Practical Exercise

Activity

1. Prepare a HACCP for soy flour.
2. Demonstrate effects of not wearing an apron, gloves, hairnet on personal and product level.
3. Demonstrate how will you maintain hygiene and safety in Soy Processing unit using the following guidelines:

   3.1 Practice Personal Hygiene:
   - Wear an apron and hairnet.
   - Ensure you are not wearing any hand jewelry.
   - Wash your hands thoroughly with soap and water for at least 20 seconds before starting the activity.

   3.2 Receiving and Inspecting Raw Materials:
   - Use actual or simulated soybeans and inspect them for quality.
   - Separate any impurities or foreign materials.
   - Clean the soybeans using a sieve or other appropriate tools to remove impurities.

   3.3 Preparing Soybeans:
   - Simulate the preparation process based on the specific soy product (e.g., grinding, soaking, dehulling).

   3.4 Processing and Formulation:
   - Use props to represent machinery and equipment to process soybeans into different products.

   3.5 Quality Control:
   - Conduct a quality check by examining the final product for taste, texture, and appearance.
   - Adhere to Food Safety Practices:
   - Follow GMP, GHP, and HACCP principles.
   - Emphasize hygiene, sanitation, and contamination prevention.

   3.6 Packaging and Labeling:
   - Use mock packaging materials to properly package the finished product.
   - Create labels with essential information as mentioned in the text.

3.7 Maintain a Hygienic Workplace:

- Keep your simulated work area clean and organized.
- Practice waste segregation and disposal following local regulations.

3.8 Reflection and Discussion:

- Reflect on your experience simulating the soy processing activities.
- Discuss with a partner or group how each step contributes to food safety and quality.
- Share challenges you faced and insights gained from the exercise.
- Write a short report summarizing your practical exercise.

Check Your Progress

A. Multiple Choice Questions

1. What is the main responsibility of a Soy Product Processor?
   (a) Designing packaging for soy products
   (b) Managing sales and distribution
   (c) Ensuring quality, safety, and efficiency of soy processing
   (d) Conducting market research for new soy products

2. Which organization in India is responsible for setting food standards, regulating food manufacturing, and ensuring food safety?
   (a) Indian Health and Safety Authority (IHSA)
   (b) Food and Drug Administration (FDA) India
   (c) Food Standards and Safety Authority of India (FSSAI)
   (d) Indian Food Regulatory Commission (IFRC)

3. What is the purpose of the Hazard Analysis Critical Control Points (HACCP) approach?
   (a) To promote vegetarian diets
   (b) To regulate food exports
   (c) To ensure consistent manufacturing of food products
   (d) To prevent hazards in the food production process

4. Which certification ensures that food products are produced without the use of harmful pesticides and chemicals?
   (a) ISO 22000 (b) FSSC 22000
   (c) Organic Certification (d) BRC Certification

5. Which element of Good Manufacturing Practices (GMP) focuses on maintaining hygiene, sanitation, and quality during production?
   (a) Equipment Maintenance (b) Raw Material Controls
   (c) Facility Monitoring (d) Inventory Management

B. Fill in the Blanks

1. The Food Safety and Standards Authority of India (FSSAI) is responsible for ensuring _____ and standards in India.
2. _____ is a set of guidelines that ensure the safe and consistent manufacturing, processing, and packaging of food products.
3. _____ certifications ensure that food products meet certain quality and safety standards, and are recognized globally.
4. Hands should be washed with soap solution and water for at least _____ seconds to maintain proper hygiene.
5. Proper waste disposal and effective _____ measures are crucial to prevent contamination and maintain a hygienic workplace.

C. State True or False

1. The shelf life of a food product refers to the period during which it remains safe to consume and maintains its desired quality.
2. Biological hazards in food safety refer to foreign objects or materials accidentally introduced into food.
3. The FSSAI is responsible for regulating food safety and standards in India, including setting standards for food products and enforcing their manufacturing and distribution.
4. HACCP is a systematic approach to food safety that focuses on maintaining hygiene and quality during the transportation, storage, and handling of food products.
5. Personal hygiene and sanitation practices, such as handwashing and proper clothing, play a crucial role in preventing contamination in a soy processing unit.

D. Subjective Questions

1. Explain the key responsibilities of a “Soy Product Processor” in the production of soy-based food products.
2. Describe the different factors affecting the personal hygiene and sanitation?
3. Describe the importance of waste disposal and pest control in maintaining a hygienic workplace in a soy processing unit.

What have you learned?

After completing this Session, you will be able to:

- Perform key responsibilities of a “Soy Product Processor”.
- Demonstrate essential hygiene and safety practices required in soy processing, encompassing personal hygiene, waste disposal, pest control, and maintaining a clean workplace.
- Apply concepts like GMP, GHP, and HACCP in a practical context, ensuring the production of safe and high-quality soy-based food products while complying with relevant regulations.

GLOSSARY

***Additives**: Substance that is added to something in small amounts for a special purpose.*

***Adulteration**: Adding inferior or harmful substances to food, which can lead to health risks and reduced quality.*

Allergens: Edible products causing allergic reactions.

***Ambient Condition:** Typically means "room temperature," ranging from 15°C to 30°C (59°F to 86°F), depending on the climate.*

***Bioavailability**: Refers to the extent and speed at which a substance, such as a drug or nutrient, is absorbed and becomes available for use in the body.*

***Bureau of Indian Standards (BIS):** The National Standard Body of India responsible for quality certification and standardization of goods.*

***CC boxes**: Refer to Corrugated Cardboard boxes, which are commonly used for packaging and transporting various food products. Corrugated cardboard is a durable and versatile material known for its strength and protective properties, making it suitable for a wide range of food items, including fresh produce, packaged goods, and more.*

***Compliance**: Adherence to regulations, guidelines, and standards.*

***Consumer Helpline**: A contact number or email address where consumers can seek assistance or report issues.*

***Contamination**: The presence of harmful substances or microorganisms in food that can compromise its safety and quality.*

***Cotyledon**: an embryonic leaf in seed-bearing plants, one or more of which are the first leaves to appear from a germinating seed.*

***Cross-Contamination Prevention:** Measures to prevent the transfer of harmful substances from one food product to another during handling or storage.*

***Dairy Analogues** :plant-based dairy alternatives crafted from sources like soy, nuts, or oats to replicate the characteristics of traditional dairy products.*

***Dehulling:** The process of removing the outer husk or shell from seeds or grains.*

***Dietary fiber:** include soluble fibers, found in fruits, vegetables, and oats, and insoluble fibers, present in whole grains and bran, collectively contributing to digestive health and overall well-being.*

Essential amino acids: *Nine specific amino acids that the human body cannot produce on its own and must be obtained through diet, playing crucial roles in protein synthesis and various physiological functions.*

Expiry/Use by Date: *The date indicating when a product should no longer be consumed for optimal safety and quality.*

Food additives: *Substances intentionally added to food during processing or production to enhance flavor, color, texture, extend shelf life, or improve nutritional content, ensuring food safety and quality.*

Food Certification: *A process to verify that food products adhere to specific quality, safety, and hygiene standards through inspections and audits.*

Food Quality: *The characteristics of food products related to taste, appearance, texture, nutritional value, and safety.*

Food Safety and Standards Act: *Legislation enacted by the Indian Parliament to oversee food safety standards in the country.*

Food Safety and Standards Authority of India (FSSAI): *The regulatory body responsible for setting food safety standards and ensuring compliance with regulations in India.*

Food Safety Regulation*: Laws and guidelines established by authorities to ensure that food products are safe, free from contamination, and adhere to specified quality standards.*

Foodborne Illnesses: *Diseases caused by consuming contaminated or unsafe food.*

Freezing*: Process of lowering the temperature of a substance below its freezing point, causing it to solidify and undergo a phase transition from liquid to solid, commonly used in food preservation to extend shelf life and maintain product quality.*

GHP *(Good Handling Practices): Practices aimed at maintaining food safety and quality during transportation, storage, and handling.*

GMP *(Good Manufacturing Practices): A set of guidelines ensuring safe and consistent food production, processing, and packaging.*

HACCP *(Hazard Analysis Critical Control Points): A systematic approach identifying, evaluating, and controlling potential hazards in the food production process.*

Halal Certification: *Certification required for exporting food products to specific regions following Islamic dietary laws.*

Hygiene Practices*: Practices focused on maintaining cleanliness and sanitation during food handling, preparation, and processing.*

Impurities*: Unwanted substances or foreign materials present in raw materials.*

Isoflavones*: Type of phytoestrogen, plant-derived compounds with a chemical structure similar to human estrogen, found in soybeans and other legumes, known for their potential health benefits and hormonal balancing properties.*

Kosher Certification: *Certification required for exporting food products to specific regions following Jewish dietary laws.*

Labeling: Providing essential information about a product on its packaging, including ingredients, nutritional information, and expiration date.

Labeling*: Providing essential information about a product on its packaging.*

LDPE pouches*: Flexible and transparent packaging materials made from low-density polyethylene, commonly used for a variety of products due to their moisture resistance and lightweight properties.*

Licensing and Registration: *The process through which food businesses obtain official permission to operate and adhere to food safety regulations.*

Monounsaturated fats: *Type of dietary fat characterized by a single double bond in their fatty acid chain, commonly found in plant-based oils such as olive oil and avocados, exhibiting cardiovascular benefits and positive effects on lipid profiles when consumed in appropriate proportions.*

Naturally occurring toxins: *Chemical compounds produced by living organisms in nature that can be harmful to humans when consumed or exposed to, commonly found in certain plants, fungi, and seafood, posing potential health risks if not properly managed or processed.*

Net Quantity: *The actual amount of product contained in its packaging.*

Organic Certification*: Verification that food products are produced without harmful pesticides and chemicals.*

Oxidative reactions: Oxidative reactions in food involve the interaction of oxygen with components like fats and proteins, leading to changes in flavor, color, and nutritional quality over time.

Pathogenic microorganisms*: Pathogenic microorganisms in food,comprising bacteria, viruses, and fungi, can cause foodborne illnesses, posing health risks when consumed, emphasizing the importance of proper food handling, storage, and hygiene practices.*

Perishable foods*: Products' storability is very low and decay rapidly.*

pH Levels: *pH levels represent the acidity or alkalinity of a substance on a scale from 0 to 14, with 7 being neutral, below 7 acidic, and above 7 alkaline; in the context of food and beverages, pH plays a critical role in flavor, texture, and preservation.*

Physicochemical*: Examination of physical and chemical characteristics such as texture, color, flavor, and composition, influencing the quality, safety, and sensory attributes of food products.*

Polyunsaturated fats: *Healthy dietary fats with more than one double bond in their fatty acid chain, found in plant-based oils, fatty fish, and certain nuts and seeds, known for their cardiovascular benefits and role in supporting overall health.*

Preservatives: substances added to inhibit the growth of microorganisms, prevent spoilage, and extend shelf life, ensuring product safety and maintaining quality over time.

Pungent*: Refers to a strong, sharp, or spicy taste or smell that is often associated with certain foods, spices, or substances, creating a noticeable and intense sensory experience.*

Quality Control: *The process of checking and maintaining the quality of products to meet desired standards in terms of taste, texture, and nutritional value.*

Rancidity*: Rancidity refers to the development of off-flavors and odors in fats and oils, typically caused by the breakdown of unsaturated fatty acids through oxidation processes, leading to a stale or unpleasant taste in food products.*

Raw Materials*: Unprocessed ingredients used in food production, such as soybeans.*

Refrigeration *: Refrigeration temperature typically ranges from 32°F to 40°F (0°C to 4°C), providing a cool environment that slows down microbial growth and enzymatic activity, preserving the freshness and safety of perishable food items.*

RO*: Reverse Osmosis (RO)is a water purification process that removes contaminants by passing water through a semipermeable membrane.*

***Sanitization**: The process of cleaning and treating surfaces, equipment, and utensils to eliminate harmful bacteria.*

***Seed coat**: the protective outer covering of a seed.*

***Shelf Life**: Shelf life refers to the duration during which a product remains safe to use and meets its intended quality standards when stored under specified conditions.*

***Simulation**: Creating a replicated or modeled environment for practicing specific tasks or scenarios.*

***Soy Product Processor:** An individual responsible for handling and processing soybeans into various soy-based food products, ensuring quality, safety, and efficiency.*

***Standardization**: The process of developing and implementing uniform standards for products and processes.*

***SWOT**: SWOT analysis is a strategic tool used to assess Strengths, Weaknesses, Opportunities and Threats, guiding decision-making and strategy development.*

***TDS**: TDS measures the total concentration of dissolved substances, including minerals, salts, and organic matter.*

***Techno-economic feasibility**: Techno-economic feasibility assesses the practicality and financial viability of a project or technology.*

***Gluten**: This is a type of protein found in grains specially wheat*

***Perishable**: Products storability is very low and decay rapidly.*

***Sanitation**: The process of handling food cleanly, healthily and safely*

***Spoilage**: Deterioration of food and other perishable goods*

***Toxins**: Poisonous substance produced within living cells or organisms*

ANSWER KEY

Unit 1: Introduction to Soybean
Session 1: Soybean: A Golden Bean

A. Multiple Choice Questions

1. (a)
2. (a)
3. (c)
4. (b)
5. (c)

B. Fill in the Blanks

1. *Glycine max*
2. 1-2 meter
3. Samuel Bowen
4. Nitrogen

C. State True or False

1. False
2. False
3. True
4. False
5. True

Session 2: Soybean Cultivation and Soybean Utilization

A. Multiple Choice Questions

1. (a) 2. (a)
3. (c) 4. (a)

B. Fill in the Blanks

1. Cotyledons
2. Seed Coat
3. Primary Root
4. 400-500 Mm

C. State True or False

1. False
2. False
3. True
4. True
5. False

Session 3: Physico-Chemical Characteristics of Soybean

A. Multiple Choice Questions

1. (d) 2. (a) 3. (d)
4. (a) 5. (b)

B. Fill in the Blanks

1. Phytic acid
2. 240 mg
3. anti-nutrients
4. essential amino acids

C. State True or False

1. True
2. True
3. False
4. False

Unit 2: Introduction to Soybean
Session 1: Soybean Processing

A. Multiple Choice Questions

1. (c) 2. (c) 3. (c)
4. (b) 5. (d)

B. Fill in the Blanks

1. de-hulling
2. plant
3. oil
4. coagulating
5. carbohydrates

C. State True or False

1. True
2. False
3. False
4. True
5. False

Session 2: Soy Flour

A. Multiple Choice Questions

1. (d) 2. (c) 3. (c)
4. (c) 5. (b)

B. Fill in the Blanks

1. in 4 times, 4 hours
2. anti-nutrients (Trypsin inhibitors)
3. 7-8 percent
4. bread, cookies, cakes and traditional Indian snack products like chakli and sev
4. 10 percent

C. State True or False

1. False
2. False
3. True
4. False
5. False

Session 3: Soy Milk

A. Multiple Choice Questions

1. (b) 2. (d) 3. (c)
4. (a) 5. (b)

B. Fill in the Blanks

1. 1:7
2. Straining/Filtration
3. Microorganisms
4. Mattha
5. Fermentation

C. State True or False

1. False
2. False
3. True
4. False
5. False

Session 4: Tofu Preparation

A. Multiple Choice Questions

1. (a) 2. (c) 3. (c)
4. (c) 5. (d)

B. Fill in the Blanks

1. Nigari
2. Whey
3. Moisture loss and contamination
4. 7-10
5. Tofu kebab

C. State True or False

1. True
2. False
3. True
4. False
5. False

Session 5: By-Products of Soybean Processing

A. Multiple Choice Questions

1. (b) 2. (c) 3. (a)
4. (b) 5. (d)

B. Fill in the Blanks

1. Raw
2. Nutritional
3. Feed
4. Texture
5. Fats

C. State True or False

1. False
2. True
3. False
4. False
5. False

Unit 3: Maintenance of Soy Processing Unit

Session 1: Prepare, Clean, And Maintain the Work Area For Soy Flour, Soy Milk, And Tofu Preparation

A. Multiple Choice Questions

1. (c) 2. (b) 3. (c)
4. (b) 5. (b)

B. Fill in the Blanks

1. unit
2. hygiene
3. equipment
4. previous
5. readings

C. State True or False

1. False
2. True
3. False
4. True
5. False

Session 2: Equipment and Machinery Used in Soybean Processing

A. Multiple Choice Questions

1. (c) 2. (c) 3. (d)
4. (d) 5. (b)

B. Fill in the Blanks

1. hygienically
2. chipped
3. maintenance
4. 1 feet
5. contamination

C. State True or False

1. True
2. False
3. False
4. True
5. False

Unit 4: Essential Elements for Soy Processing Industry

Session 1: Identification Of Production Requirement

A. Multiple Choice Questions

1. (d) 2. (c) 3. (b)
4. (a) 5. (d)

B. Fill in the Blanks

1. Cooling tower
2. total dissolved solids (TDS)
3. FSSAI

C. State True or False

1. False
2. True
3. True
4. False
5. True

Session 2: Methods of Cleaning

A. Multiple Choice Questions

1. (c) 2. (c) 3. (b)
4. (a) 5. (d)

B. Fill in the Blanks

1. disassembly
2. detergents
3. outside
4. Contamination
5. storage

C. State True or False

1. False
2. False
3. True
4. True
5. True

Unit 5: Food Safety and Hygiene

Session 1: Food Safety

A. Multiple Choice Questions

1. (c) 2. (b) 3. (c)
4. (c) 5. (b)

B. Fill in the Blanks

1. temperature
2. moisture
3. pH
4. Oxygen
5. physical

C. State True or False

1. True
2. False
3. True
4. False
5. False

Session 2: Food Safety Regulations and Standards In Relation To Soy Products

A. Multiple Choice Questions

1. (b) 2. (d) 3. (d)
4. (c) 5. (d)

B. Fill in the Blanks

1. August 4, 2006
2. safety
3. certification
4. controls
5. hazards

C. State True or False

1. True
2. False
3. True
4. False
5. True

Session 3: Soy Product Processor

A. Multiple Choice Questions

1. (c) 2. (c) 3. (d)
4. (c) 5. (c)

B. Fill in the Blanks

1. food safety
2. Good Manufacturing Practices (GMP)
3. Food Quality
4. 20
5. pest control

C. State True or False

1. True
2. False
3. True112
4. False
5. True