

PROCESSING OF PUFFCORN



AATMANIRBHAR BHARAT

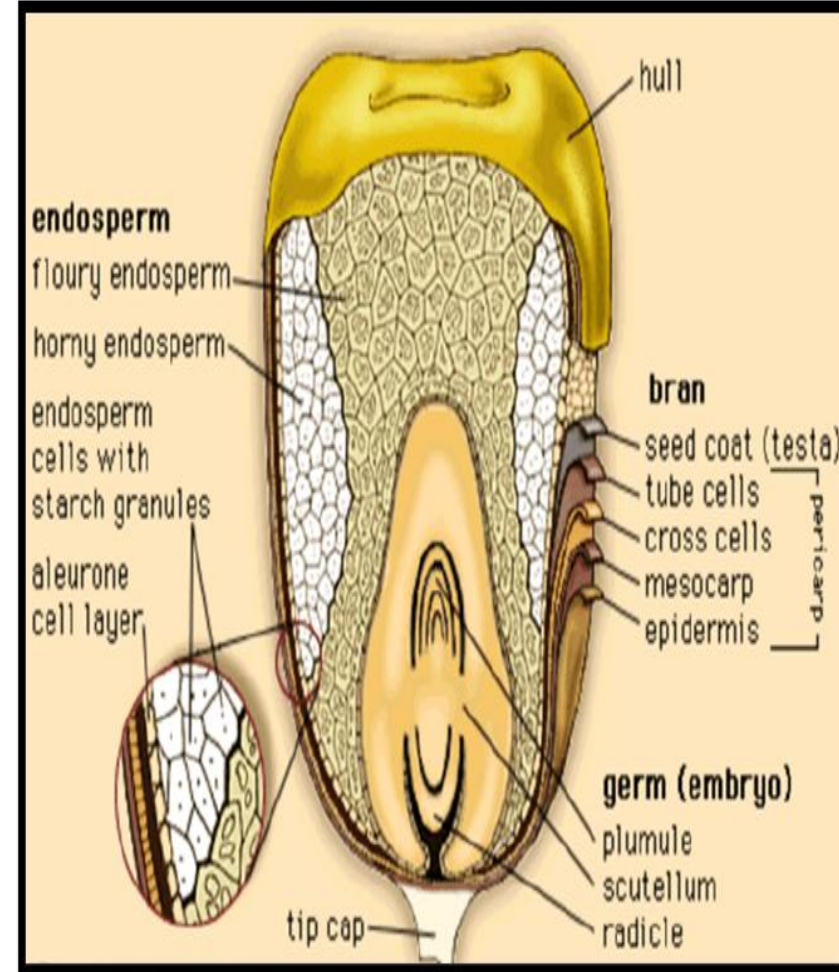
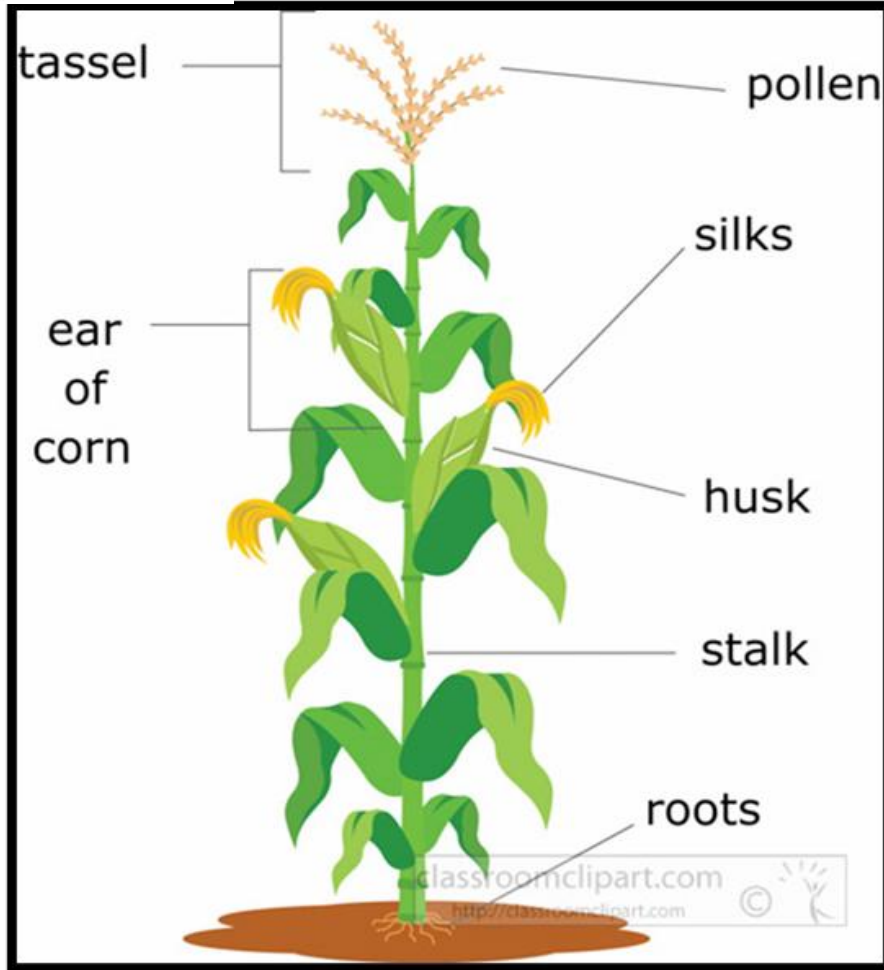
**PM Formalisation of Micro Food Processing
Enterprises Scheme (PM FME Scheme)**

INTRODUCTION

- ❖ Maize, also known as corn, is a coarse grain and it is now being recognized as staple diet and its demand is increasing year by year.
- ❖ In India, maize is the third important cereal crop after rice and wheat in terms of area. Andhra Pradesh, Karnataka and Maharashtra are the major maize producing states.
- ❖ The products from maize are value added products which include maize starch, liquid glucose, dextrose monohydrate, anhydrous dextrose, sorbitol, puffed corn, corn gluten to name a few.

STRUCTURE AND PHYSIOLOGY

- ❖ The maize plant generally grows up to 2.5 m in height, some natural strains can grow up to 12m height.
- ❖ A leaf grows from each node, which is generally 9cm in width and 120cm in length.
- ❖ Ears, grain bearing tip part of the stem of a cereal plant, develop above a few of leaves in mid-section of the plant, between the stem and leaf sheath. They are female inflorescences tightly enveloped by several layers of ear leaves commonly called husks.
- ❖ Certain varieties of maize have been bred to produce many additional developed ears. These are the source of baby corn used as vegetable mainly in Asian cuisine.



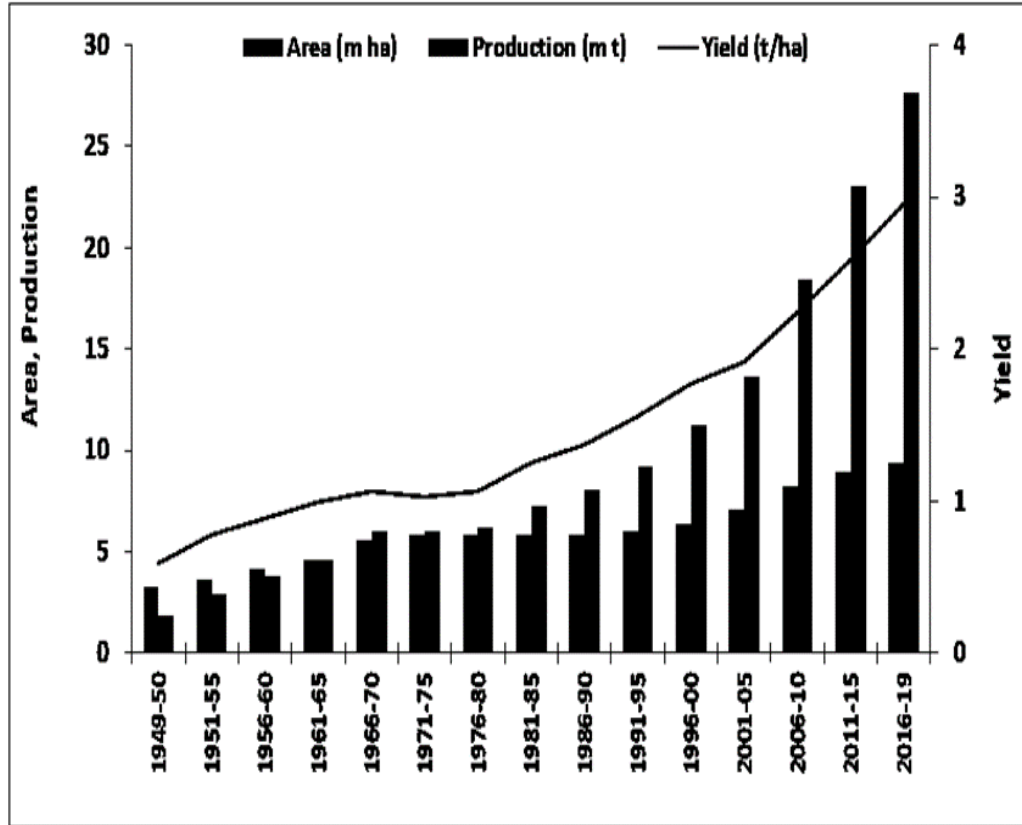
VARIETIES

Many forms of maize are used for food. Some are classified based on amount of starch each variety.

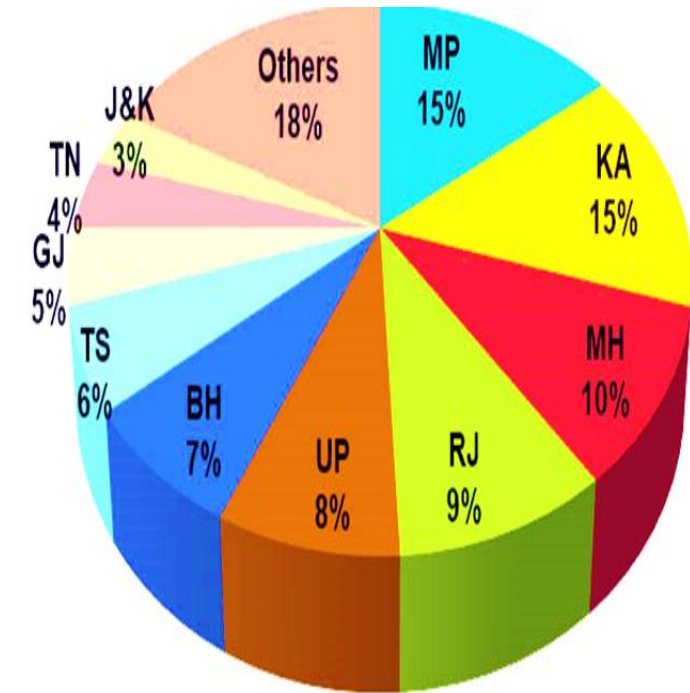
1. Flour corn
2. Pop corn
3. Dent corn
4. Flint corn
5. Sweet corn
6. Waxy corn
7. Amylomaize
8. Pod corn

MAIZE PRODUCTION

- ❖ Among the maize growing countries India rank 4th in area and 7th in production, demonstrating around 4% of world maize area and 2% of total production.
- ❖ In India the maize production area has reached to 9.2 million ha during 2018-19, (DACNET, 2020)
- ❖ Among all cereals, maize has highest growth rate in terms of area and productivity. In India, maize is predominantly grown in two seasons, rainy (kharif) and winter (rabi) season
- ❖ Kharif maize represents around 83% of maize area in India, while rabi maize correspond to 17% maize area.



Maize production



Bulk production of maize in India

PRODUCTION

- ❖ Among Indian states Madhya Pradesh and Karnataka has highest area under maize (15% each) followed by Maharashtra (10%), Rajasthan (9%), Uttar Pradesh (8%) and others.
- ❖ After Karnataka and Madhya Pradesh Bihar is the highest maize producer.
- ❖ Andhra Pradesh is having highest state productivity. Some districts like Krishna, West Godavari etc. records as high as 12 t/ha productivity.
- ❖ Approximately 47% bulk production of maize in India, is used as poultry feed, 13% is used as livestock feed and 13 % for food purpose, remaining for industrial purposes like in starch industry, processed food and export.

GROWING OF POPCORN VARIETY OF MAIZE

- ❖ **Site selection/Soil type:** Popcorn variety is very sensitive to water-logging and considerable yield losses occurs, if the crop faces water-stagnation for more than two days. Hence, it is better to plant the crop on well-drained sandy-loam to silty-loam soil types.
- ❖ **Time of planting:** As the plant type of the popcorn is weak and affected more by diseases and pest and thus should be preferably to be grown in mild climate i.e. winter season/hilly areas for better yield and quality.
- ❖ **Land preparation:** Popcorn needs well pulverized, fine and smooth field for seed emergence and root growth. Hence, deep tillage operation using mould board plough followed by two harrowing and one planking is needed for good field preparation and early season weed management.
- ❖ **Seed rate:** About 4-5kg of seed per acre should be used for plantation.
- ❖ **Seed treatment:** Untreated seeds should be treated with fungicides and insecticides before sowing to protect it from seed and soil borne diseases and some insect-pests

SOWING /SPACING

- ❖ **Method of sowing/Spacing:** Southern side planting is advised on East-West oriented ridges. Optimum plant density (33,724/acre) should be maintained to tap full potentials of hybrids. For proper germination and early vigour, seed should be sown at 3.5-5 cm depth.
- ❖ **Weed management:** Weeds damage significantly to Popcorn variety production and the critical period for crop-weed completion is 15-45 days after sowing.
- ❖ **Cultural control:** Inter-cropping of one or two rows of higher canopy producing legume crops in between maize rows reduces weed problem considerably.
- ❖ **Mechanical control:** Mechanical weed control in Popcorn variety is possible through tractor drawn cultivator and rotary weeder; Self-propelled power weeder; and animal drawn blade harrow.

- ❖ **Chemical control:** Recommended dose of atrazine at pre-emergence followed by either of the post-emergence herbicide for effective weed control (mentioned below) is also equally effective.
- ❖ **Integrated weed management:** Pre-emergence Atrazine application followed by one hand weeding at 35-40 days gives good weed control.
- ❖ **Nutrient management:** It can be grown both organically or by integrated nutrient management involving organic and inorganic nutrient supplementation.
- ❖ **Organic nutrient management:** Following options for nutrient management in organic pop corn production to be used based on availability in suitable combination.
- ❖ Maize is sensitive to Zinc deficiency. Zinc deficient crop shows stunted growth and develop short inter-nodes. A white (or pale-yellowish) tissue with reddish veins appears on leaf blade.
- ❖ **Water management:** Four to six irrigations are needed during the rabi crop season

HARVESTING AND POST-HARVEST HANDLING:

- ❖ Maize can be harvested when the husk has dried and turned brown. Apart from hand-picking, combined harvester may also be used for quick harvesting.
- ❖ After manual harvesting, depending upon the cultivated area, manual shellers or maize dehusker-cum-sheller or maize thresher may be used for separating grains from cobs.
- ❖ The optimum moisture in grain for long-term storage should be below 14%.
- ❖ Portable Maize Dryer can also be used for reducing the moisture content of the cobs.
- ❖ Sun drying of the cobs and seeds is required in absence of other drying options prior to marketing as moisture above optimum level reduces market prices and increases chance of aflatoxin contamination



Manual harvesting



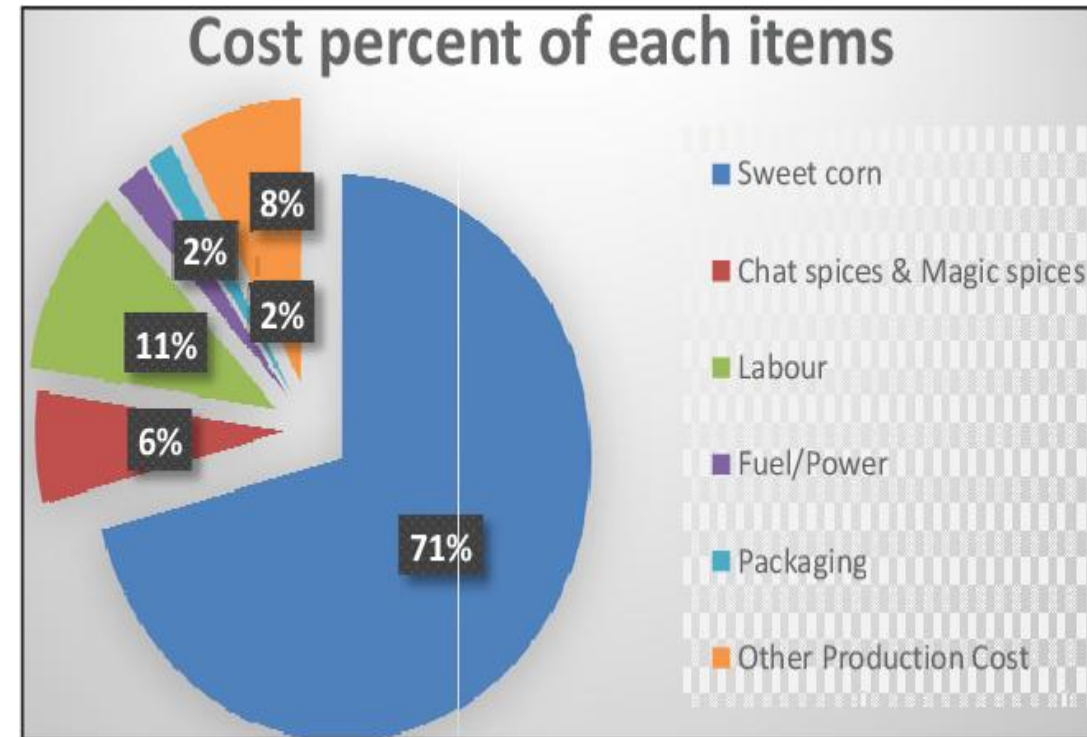
Mechanical harvesting

SNACK PRODUCTS

- ❖ Most snack manufacturers use some form of existing technology as the basis for creating snack products and incorporate variations that increase the resulting snacks' health image.
- ❖ Therefore, puffing and popping using advance technologies are processes, which can accomplish all these targets.
- ❖ As a simplest, inexpensive and quickest traditional method of dry heat application for preparation of weaning food formulations and ready-to-eat snacks products, popping and puffing have been practiced since hundreds of years.
- ❖ Explosion puffing by sudden release and expansion of water vapour is a relatively well known and widely used process.
- ❖ Convenient snack foods like popcorn, popped and puffed rice, popped sorghum, popped wheat roasted and puffed soybean and other legumes are very popular not only in Indian subcontinent, but also worldwide.

VALUE ADDED PRODUCTS FROM MAIZE

There are various value added products from Maize are available in market. Some of them are noted in the Figure.



INTRODUCTION AND PROCESSING OF PUFF CORN



PRODUCT DESCRIPTION : PUFF CORN

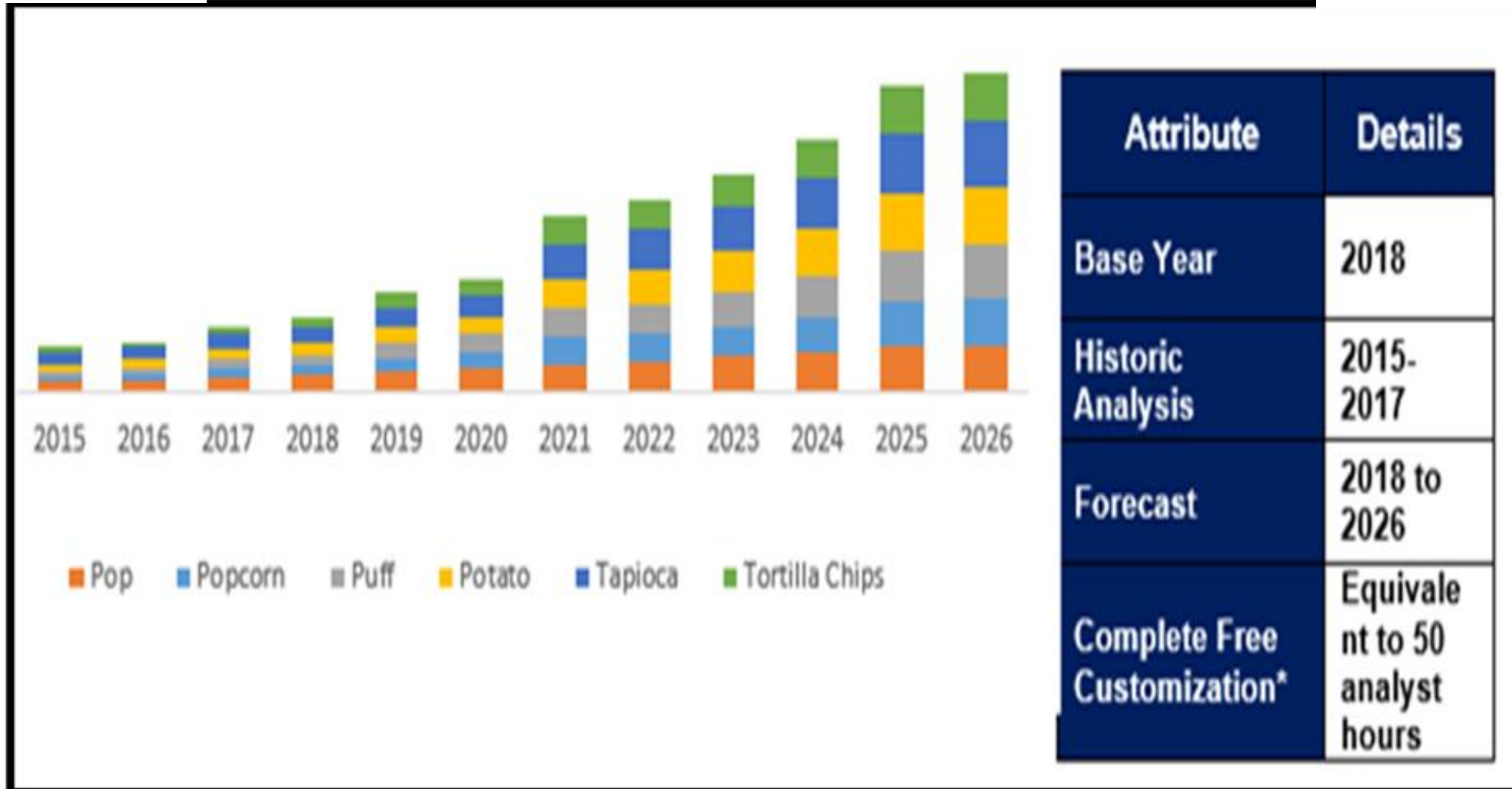
- ❖ Puff corn or corn puffs are puffed or extruded corn snacks made with corn meal and baked.
- ❖ Puffcorn is an extruded puffed corn snack which belongs in the snack group products made with corn grits, rice, wheat, or other cereals. Puff corn is often flavoured with cheese, oil, chili, onion, or garlic powder, and many other spices.
- ❖ Types of puffcorn can vary between a lower specific length, higher bulk density, lower lightness, higher redness, lower yellowness, higher hardness, and lower springiness, gumminess, and chewiness when using different percentages of oat flour.
- ❖ Puffcorn is commonly known as a ready-to-eat functional breakfast cereal or an extruded functional snack
- ❖ Extrusion is one of the most important process new process this user in the morning for technology it is application has increased in the past 2 decades.

MATERIALS AND FORMULATION

- ❖ Corn grit and white were cleaned by hand picking and windowing to remove powder in matter before they were Milled do a fine powder using moullinex mill grinder.
- ❖ Corn flour 63.5% vegetable oil 26% sunset yellow colored cheese powder 6.85 % milk powder 2.15 % and salt 1.5 % at the level of 0% 5% 10% and 15% of total content of ingredients and word processor using and extrusion process.
- ❖ **Fatty Acid Composition:**Fatty acid methyl ester were prepared using the AOAC methods of analyzed by gas chromatography. Sesame seed powder is used because it remains in cake form and there are some bio active nutritional components are rich in fatty acids.
- ❖ **Phenolic Compounds:**Phenolic compounds were determined using the method described by AOAC methods.
- ❖ **Peroxide and Acid Values:** Peroxide and acid values of puffed corn snack oils were measured using the AOAC methods. Acidity value is the important parameter which is related to the hydrolysis of tryglycerols and free fatty acids in oil.

MARKET POTENTIAL

- ❖ However the rapid industrialization in the snacks food sector has led to significant consumption of puffed corn. The consumption of puffed, which earlier was limited mostly to the the west has now started to soar in East Asian and Indian societies as well.
- ❖ The increasing consumption of puffed cereals among school going children as snacks owing to their high protein content has augmented the demand of puffed corn flakes in India and other developing countries in recent times.
- ❖ Moreover, the rising consumer demand for snack options with low calorie count has fuelled the consumption of corn puffs and other puffed cereals among weight watcher

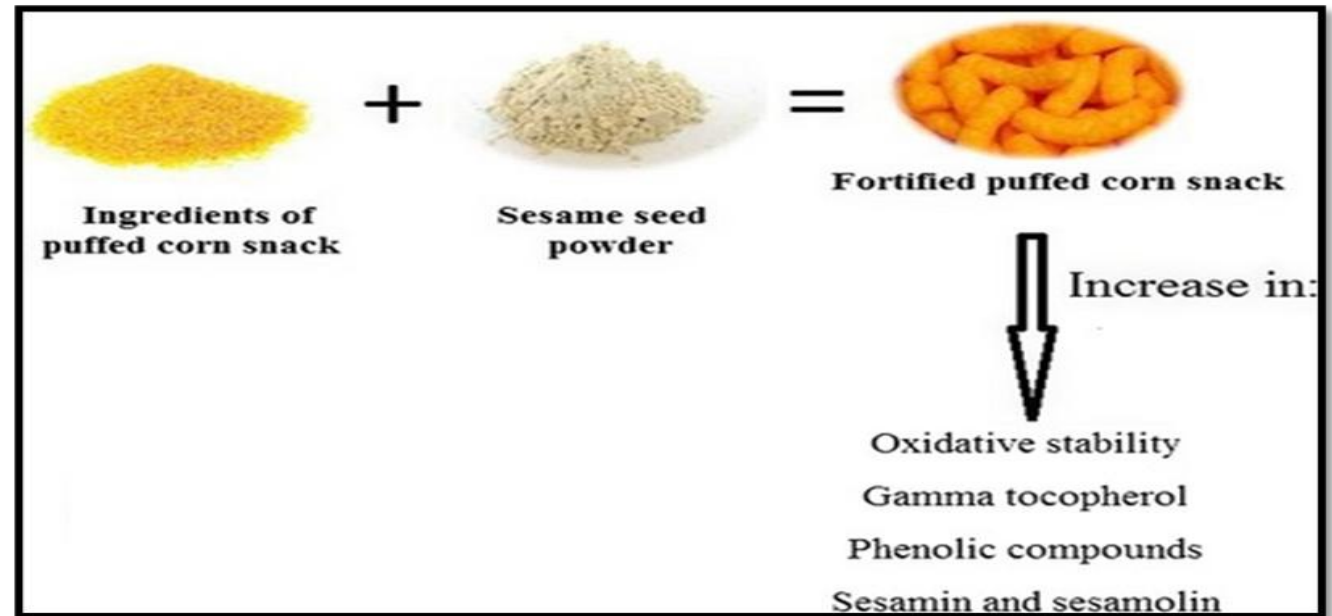


RAW MATERIAL SELECTION

❖ **Selection of raw material** :Corn kernels of variety VL Amber popcorn can select for processing. The typical composition of corn includes endosperm 82.3%, germ 11.5%, bran 5.3% and tip cap 0.8%. The typical analysis of corn contains moisture 9-15, starch 61%, protein content 8.5%, fiber 9.5%, oil 4 % and ash 1.6% dry basis.

❖ Other raw materials are:

- Sugar- 6.25%
- Salt – 1.25%
- Vegetable oil- 0.63%
- Monoglycerides- 0.38%
- Malt- 0.20%



EFFECT OF MOISTURE CONTENT

- ❖ The effect of moisture content during extrusion cooking is important as it greatly affects the extrudate texture.
- ❖ The extrudates significantly presents more structural ruptures and less mechanical resistance when the moisture content in extrusion cooking decreases.
- ❖ It is well known that the decrease of moisture content in extrusion cooking tends to increase the specific mechanical energy, and consequently to favor the macromolecular degradation of the starch through dextrinization.
- ❖ The resulting melt then gives more fragile structures leading to low resistant cell walls and more structural fractures

❖ **Puffing percentage** :Puffing percentage is taken as percentage of puffed product (N_p) out of total product in feed sample (N_t).

$$\text{Puffing percent} = \frac{N_p}{N_t} \times 100 \quad (5)$$

N_p = Number of puffed grains observed in sample,

N_t =Total number of grains in the sample

❖ **Expansion ratio**: Expansion ratio is the ratio of volume of final product after puffing to the volume of raw product before puffing

❖ **Hardness** :Hardness is defined as the maximum peak force during the first compression cycle (first bite). The hardness value depicts the texture perception of the consumer at first bite. It was measured using a Texture Analyzer.

❖ **Crispness**: Crispness is related to the mechanical properties of the crust. Factors that determine these properties like the solid matrix i.e. starch properties, water content, crust structure, oil content.

PUFFING PROCESS

MECHANISM OF PUFFING ACTION

Grain kernels contains water



When heated gets converted to steam



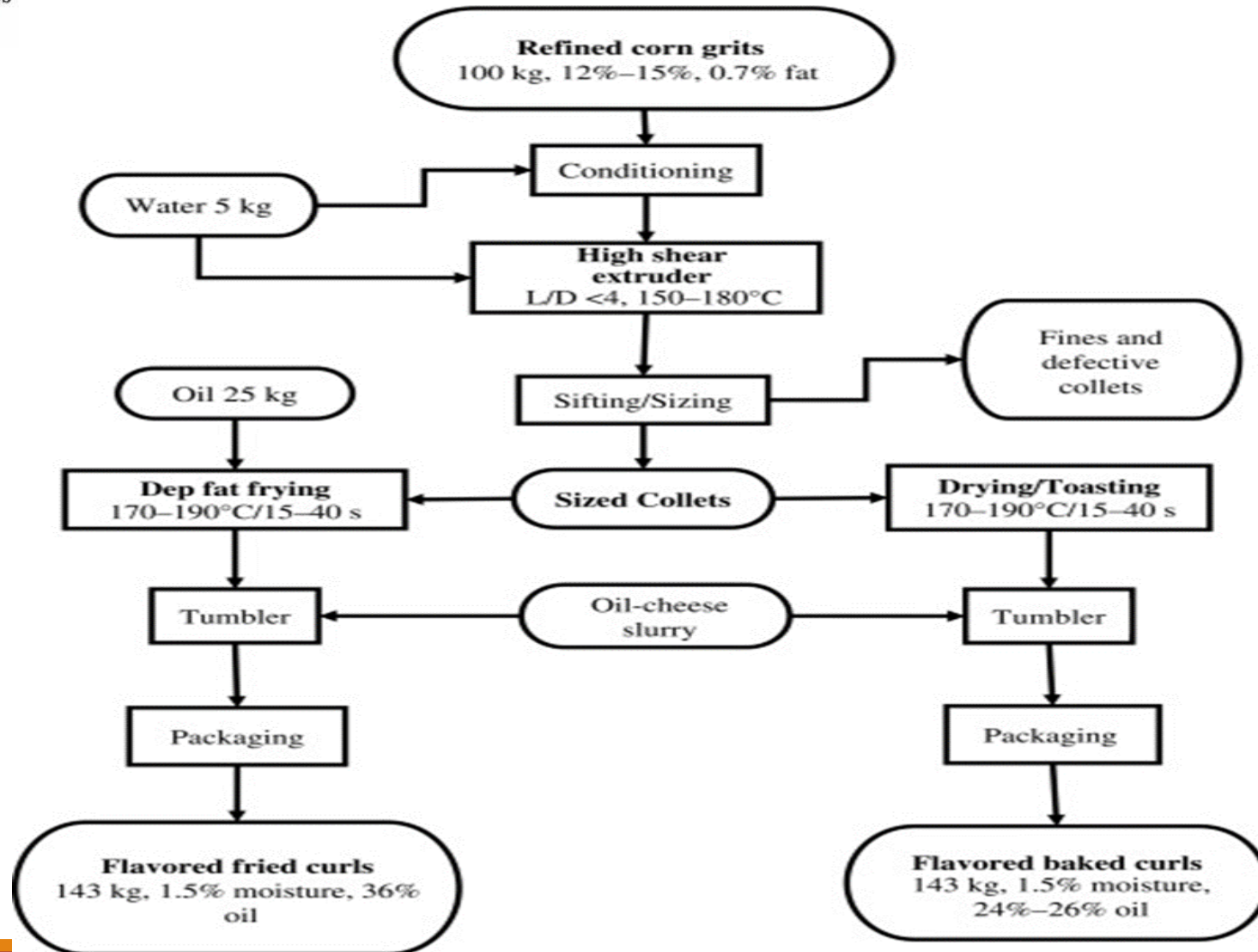
Pressure developes(930 KPa)




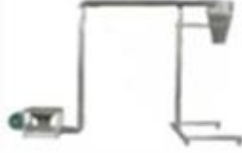






Pericarp bursts & starch and proteins expands



Puffed grain



| | | | |
|---|---|--|---|
| Mixer | Screw conveyor | Twin-screw extruder | Air conveyor |
|  |  |  |  |
| Dryer | Hoister | Flavoring machine | Cooling conveyor |
|  |  |  |  |

EQUIPMENT'S IN PUFFING HOT AIR PUFFING SYSTEM

- ❖ The hot air puffing system for corn works on centrifugal air blower and electric heaters arranged typically in chamber. The air blower supplies air at atmospheric temperature (30°C), at the rate of 0.0912 to 0.136 m³/s.
- ❖ This air passes over series of electric heaters for heating from atmospheric temperature (30°C) to puffing temperature (180 to 260°C). It takes about 20 minutes for initial heating of air, to reach temperature of 180-200°C.
- ❖ This hot air can be used for puffing in the puffing chamber. Once air is used, then recycles through re-circulating pipe for further heating.

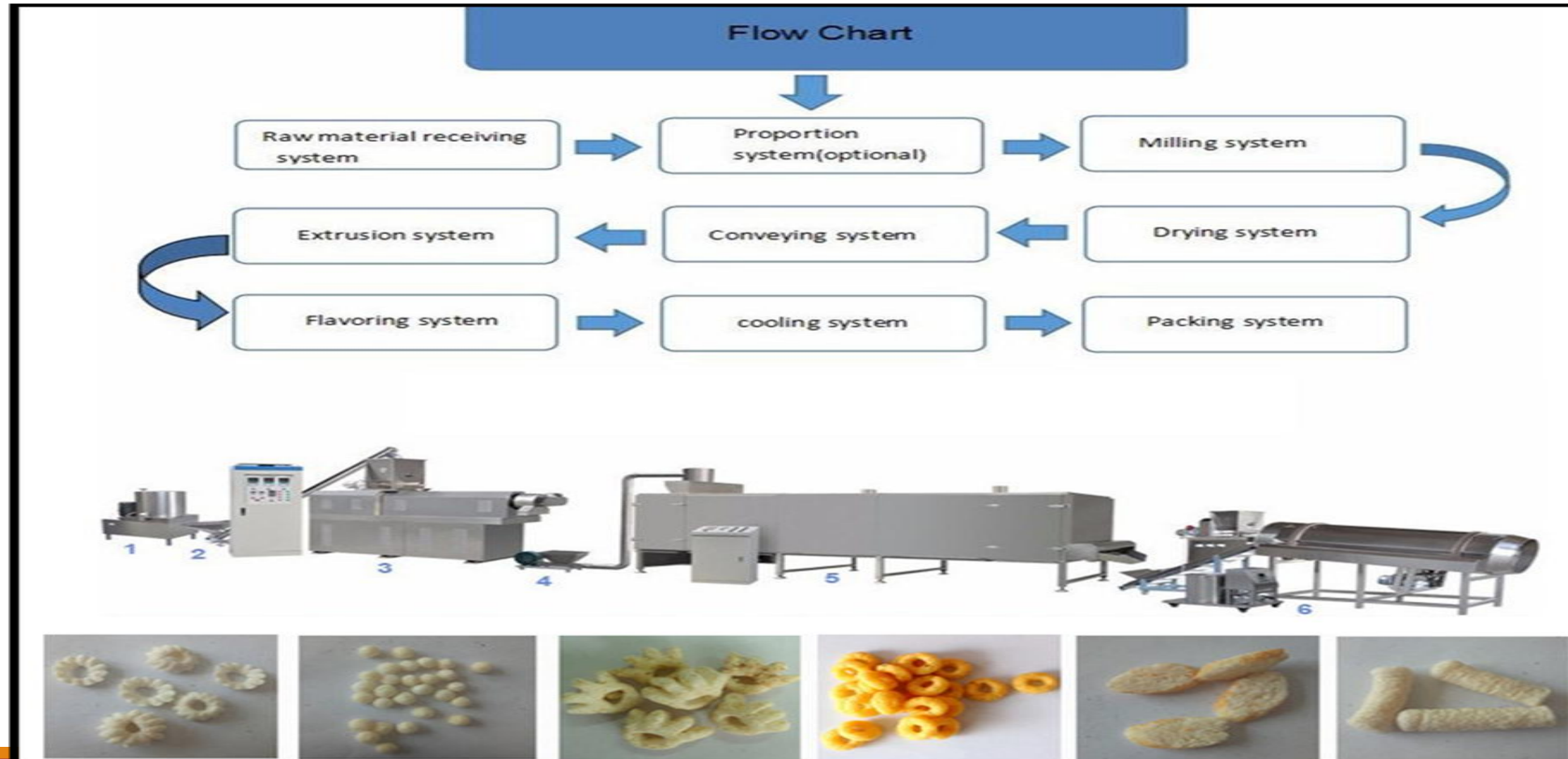
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- ❖ The puffing chamber is vertical cylinder of diameter 76.2 mm, from the bottom of which hot air comes in typical manner.
 - ❖ The product to be puffed was fed through the feed gate that works on positive feeding mechanism.
 - ❖ The typical arrangement made to take, the puffed final product, out of the puffing chamber, carried the puffed material towards cyclone separator. T
 - ❖ The final product is taken out of the process from this cyclone separator and waste air again re-circulated for its reuse. Experimentation for selection of appropriate process parameters.

PUNCTURE TESTING

- ❖ Puncture testing simulates closely the tooth action in food masticating and for cellular food products such as extrudates, it provides local, cell wall-based mechanical properties which are pertinent to correlate with sensory criteria.
- ❖ Extrude Samples Two kinds of extrudates
 - (1) Commercial, corn-based snacks samples purchased at a local supermarket.
 - (2) Laboratory-made snacks samples: Extrusion-cooking experiments generally carried out in twin-screw co-rotating extruder equipped with a 500 mm length barrel and an automatic startup system.




EXTRUSION PROCESS AND EQUIPMENT



NUTRITIONAL PROPERTIES

| | % Daily Value* |
|---------------------------------|-------------------|
| Total Fat 1.3g | 2% |
| Saturated Fat 0.3g | 1% |
| Trans Fat 0g | |
| Cholesterol 0mg | 0% |
| Sodium 211.5mg | 9% |
| Potassium 62.1mg | 2% |
| Total Carbohydrate 26.7g | 9% |
| Dietary Fiber 1.3g | 5% |
| Sugars 12.5g | |
| Protein 2.7g | 5% |
| <hr/> | |
| Vitamin A 15% | • Vitamin C 0% |
| Calcium 1% | • Iron 15% |
| Thiamin 25% | • Riboflavin 25% |
| Vitamin B6 25% | • Vitamin B12 25% |
| Folic Acid 23% | • Niacin 25% |
| Magnesium 6% | • Phosphorus 7% |
| Zinc 10% | • Copper 5% |
| Pantothenic Acid 2% | • Vitamin D 10% |



Corn Puffs Calories

| Nutrition Facts | | | |
|--|-------|--------------------|-----|
| <i>Trader's Joe sweetened Corn Puffs(1cup)</i> | | | |
| Calories | 115 | | |
| Carbohydrate | 9% | | |
| Sodium | 6% | | |
| Sugar | 10.9g | | |
| <i>Corn Puffs Poppers Kroger(2 ½ cups) Martin's Ditto Corn Puffs(1 oz)</i> | | | |
| Calories | 160 | Calories | 130 |
| From Total Fat | 17% | Total Fat | 7% |
| From Saturated Fat | 7% | From Sodium | 8% |
| Sodium | 11% | From Carbohydrates | 7% |
| Carbohydrates | 5% | Dietary Fiber | 4% |
| Dietary Fiber | 8% | | |

GENERAL FAILURES

- ❖ Poor quality raw materials.
- ❖ Irregular shape of the extrudates due the lack or excess water for mixing.
- ❖ High temperature of the conventional oven or longer residence time of puffed corn in oven.
- ❖ Failure of extrusion equipment due to over loading, lack of water, poor current supply, etc.
- ❖ Poor quality of packaging material.

EXPORT POTENTIAL OF PUFFED CORN:

- ❖ The increasing consumption of puffed cereals among school-going children as snacks owing to their high protein content has augmented the demand for puffed corn in recent times.
- ❖ The "Global Puffed Food Market Analysis to 2027" is a specialized and in-depth study of the food and beverage industry with a special focus on the global market trend analysis.
- ❖ Overview of the puffed food market with detailed market segmentation by type, application, and geography.
- ❖ The global puffed food market is expected to witness high growth during the forecast period. The key statistics on the market status of the leading puffed food market players and offers key trends and opportunities in the market.
- ❖ India is exporting puffed corn product to many countries. Among them some countries are – USA, Bangladesh, Australia, etc.



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