

**RESEARCH AND INNOVATION SYSTEMS
IN AFRICA (RISA) PROJECT: BRIDGING THE RESEARCH
INNOVATION-INDUSTRY ASSIMILATION GAP THROUGH
TECHNOLOGY CAPACITY BUILDING IN RURAL GHANA PROJECT**



For training and enquires

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OVERVIEW OF THE TRAINING PROGRAM

This is the Research and Innovation Systems in Africa (RISA) funded project titled “**Bridging the Research Innovation-Industry Assimilation Gap through Technology Capacity Building in Rural Ghana Project**”. This training is being done by the University of Ghana Business School Innovation and Incubation Hub (UGBS Nest) in partnership with the Dairy Research Improvement and Innovation Consortium (DRIInC). The project seeks to build the capacities of rural small enterprises by training them on process enhancement innovations from the existing research and innovation knowledge available at DRIInC at the University of Ghana.

In building the capacities of local entrepreneurs, we seek to prioritize learnings towards empowering disability-owned businesses and under-represented groups of society. By delivering the project through our existing research and technology transfer infrastructure, the project widens the scope of the number of small enterprises that are likely to assimilate knowledge and innovations emanating from research communities in Africa.

The overall objective of the project is to improve the technology assimilation capacity of rural enterprises through capacity-building training across six (6) regions in Ghana. The project also aims at documenting learnings from these capacity-building approaches through building an ecosystem of hub partners and rural enterprises which continually creates the synergistic research-industry innovation assimilation loop that makes an impact beyond this project.

BACKGROUND

The innovations in food processing manuals are training manuals developed by the Research Innovation Systems in Africa (RISA) in simple terms for the average person to understand and practice. This manual was developed by faculty members from the Dairy Research, Improvement, and Innovation Consortium (DRIInC) in collaboration with the University of Ghana Business School Nest (UGBS Nest).

The training program is designed to bridge the knowledge and skills gap between traders, farmers, and small-scale food processors. Innovative processing training has been developed for dairy, egg, tomatoes, fruits, fish, and palm fruit. This training manual is designed to give step-by-step innovative ways to process these foods and scale up.

TARGET BENEFICIARIES

This training targets local entrepreneurs, disability-owned businesses, and under-represented groups of society. This will help educate them on proper food handling methods to prevent food contamination as well as processing equipment to increase productivity and save time.

COLLABORATING DEPARTMENTS

The University of Ghana Business School Innovation and Incubation Hub (UGBS-Nest)

The UGBS Innovation and Incubation Hub (UGBS-Nest) is an initiative of the University of Ghana Business School (UGBS). The goal of UGBS Nest is to promote student innovations and technology-based entrepreneurship, thereby facilitating the practical application of knowledge for public use. The main aim of the Innovation and Incubation Hub is to provide support and training for students and innovators who are interested in converting their social and innovative ideas into startups. The UGBS Nest provides necessary infrastructural support, prototype development support, research assistance, help in getting funding, business consulting assistance, mentoring, and guidance to grow student start-ups into successful ventures. The UGBS Nest, in its quest to project the entrepreneurship and innovation development capacity of the University of Ghana and the Business School, has adopted an operational direction that fits the agenda of the University and its strategic direction.

The Dairy Research Improvement and Innovation Consortium (DRIInC)

The Dairy Research Improvement and Innovation Consortium is made up of researchers and experts from various departments and centers within the College of Basic and Applied Sciences (CBAS) of the University of Ghana. DRIInC primarily conducts research into holistic dairy production and processing in Ghana. Due to demand in the food industry, DRIInC has extended its training and research activities to cover other food and agro-processing sectors. With an increasing demand for quality food products in the country, DRIInC aims to improve the nutritional value, quality, and safety of foods through research and training of farmers and handlers of food products.

INNOVATIONS IN TOMATO PROCESSING



COURSE OBJECTIVES

- To give beneficiaries fundamental knowledge on food processing innovation and safety.
- Walk beneficiaries through the basics of product development
- Provide knowledge on the basic principles underlying tomato puree and tomato paste processing.
- To equip beneficiaries with the skill of processing and packaging tomato puree and tomato paste.



LEARNING OUTCOMES

- Explain the importance of food processing.
- Apply the principles of product development to tomato innovation.
- Identify the unit operations involved in tomato puree and paste processing.
- Determine appropriate packaging for a developed tomato product.



COURSE CONTENT

INTRODUCTION TO FUNDAMENTALS OF
FOOD PROCESSING AND SAFETY

OVERVIEW OF TOMATO PRODUCTION

INTRODUCTION TO TOMATO PROCESSING

FUNDAMENTALS OF TOMATO PASTE AND
PUREE PROCESSING (WITH PRACTICALS)

QUALITY EVALUATION OF TOMATOES

PACKAGING CONSIDERATIONS FOR
TOMATO PUREE AND PASTE

INTRODUCTION TO FUNDAMENTALS OF
PRODUCT DEVELOPMENT

TEACHING PLAN

DAY 1

1. Introduction to food processing and safety
 - Food processing & Benefits.
2. Factors to remember when processing
 - Food Composition
 - Weights & Measures
 - Records & Price keeping
 - Hygiene & Safety
3. Quality and Testing in Food Processing
 - What is quality, why is it important?
 - Testing

DAY 2

1. Overview of Tomato Production
 - Production Volumes
 - Post-Harvest Losses of Tomatoes
2. Introduction to Tomato Processing
 - Variations and Standardization of tomatoes
 - Varieties of tomatoes
 - Economic importance of tomatoes
 - Physical Properties and Composition of tomato
3. Tomato Paste and Tomato Puree processing
 - Unit operations used in tomato paste and puree processing
 - Materials and Equipment
4. Hands-on tomato paste and puree processing

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TEACHING PLAN

DAY 3

1. Quality Evaluation of Tomatoes
 - Sensory test
 - Quality specification of tomato paste and puree
2. Packaging considerations for processed tomato products
 - Defining packaging
 - Requirements for Labelling
 - Packaging materials for tomato puree and paste

DAY 4

1. Introduction to Fundamentals of Product Development
 - What is product development
 - Importance of product development
 - Approaches to product development
 - Product development process

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Introduction To Food Processing And Safety

What is food processing?

- Food processing refers to a group of procedures or processes used to change food from its original form into one that may be consumed by either people or animals.
- Food processing often entails transforming raw food ingredients into consumable, enticing, marketable, and long-lasting products.



Benefits of processing



Shelf life



Variety



Food safety



Value addition



Quality improvement



Convenience

Factors to remember when Processing

There are four major considerations that must be made for effective processing and profitability:

1. Food composition
2. Weights and Measures
3. Records Keeping & Price
4. Hygiene and Safety



1. Food Composition

Component of food

The component of food may be grouped into major and minor.

Major

- Carbohydrates
- Proteins
- Fats/Oils
- Water

Minor

- Vitamins (A,B,C,D,K)
- Minerals (Calcium, iodine, iron)



Properties of Carbohydrates

Sugars

- Sweet
- Caramelize under heat
- Easily ferment
- Good preservative



Starch

- Not soluble in cold water
- Pasty



Cellulose

- Resistant to breakdown
- Insoluble in cold water



Pectin

- Gummy
- Imparts viscosity in tomatoes
- Can form gels with acids



Properties of Proteins

- Foaming



- Coagulation



- Flavor



- Gelling



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Properties of Fats



- Browning



- Emulsification



- Shortening



- Lubrication

Water

- Water is important for maintaining the proper function of the body.
- In processing, water affects
 - i. Processing method
 - ii. Shelf life



Vitamins and Minerals

Nutritionally, these components are required in small quantities by the body

In food processing they have important functional properties and are used additives to serve as:

- Antioxidants
- Colorants
- Flavorants



Sobolo

Food Types

Animal food and products

- Meat
- Poultry
- Pork
- Fish
- Milk
- Cheese (wagashie)



Starchy roots, tubers & plantains

- Yam
- Coco yam
- cassava
- plantain



Cereals & Grains

- Maize
- Rice
- Wheat
- Millet
- Sorghum



2. Weight & Measures



Digital weighing scales



Food thermometer



Measuring cup



Measuring spoons

3. Records & Price keeping

Records promote traceability and provide documentation that the food business has followed appropriate practices. Another legal requirement is that food firms maintain records relating to the manufacture, processing, packing, distribution, receipt, holding, or importation of food products. Records kept include:

- Receival records
- Raw material issue records
- Product formulation record
- In-process record
- Cleaning records
- Packing report



Food safety and hygiene

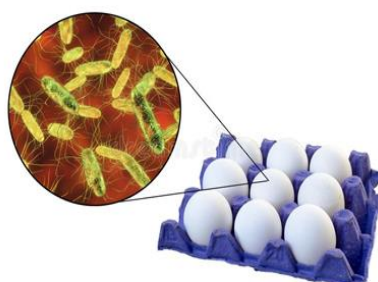
Food Safety: The guarantee that when food is prepared and/or consumed according to its intended usage, it won't have a negative impact on the consumer's health.

Food hygiene: Every circumstance and action required to ensure that the food is safe and acceptable at every stage of the food chain.

Food Hazard: A biological, chemical or physical agent in food with the potential to cause an adverse health effect.



Physical



Biological



Chemical

Good Hygiene Practices (GHPs)

GHPs are basic measures and conditions applied at any step within the food chain to provide safe and suitable food. They are requisites to producing standard quality food product.

Person



- Personal hygiene

Place



- Storage environment



- Production area

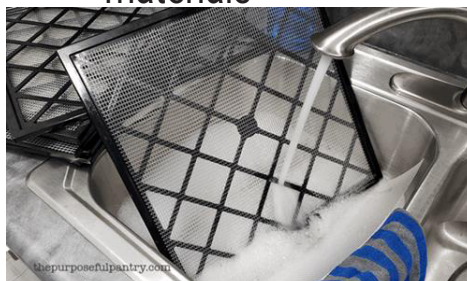
Materials & Equipment



- use of right equipment
- ensure the sanitation of each equipment before and after production



- Use of clean and quality raw materials



- use of right cleaning tools and chemicals

Overview of Tomato Production

Overview of Tomato Production

- On a global scale, tomatoes are the most important vegetable crop with about 182.2 million tons of production.
- According to data from FAO Stat, the world produced 186.821 million metric tonnes of tomatoes on 5,051,983 hectares in 2020, achieving an average yield of 37.1 metric tonnes/hectare (mT/ha).
- Tomatoes are a critical part of the Ghanaian diet and could play a key role in diversifying the economy and agricultural sector.
- More than 90,000 farmers grow the crop and 300,000-plus people are involved in its wholesale and retail trade.



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Tomato Production in Ghana

Tomato-producing regions in Ghana

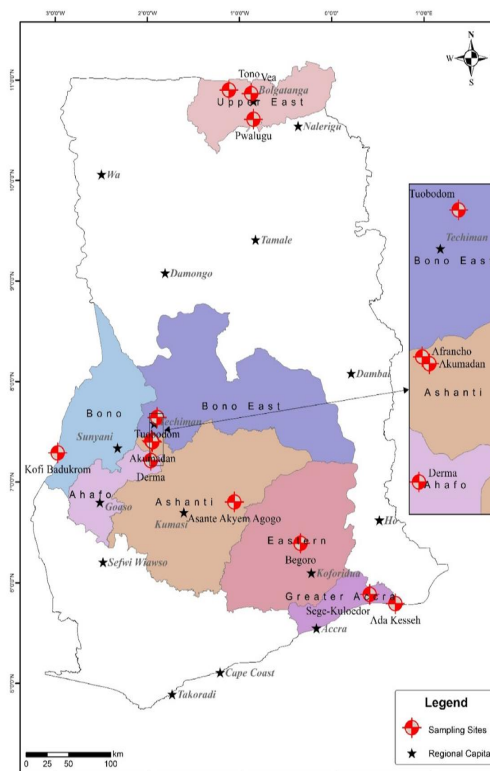
- Bono
- Bono east
- Ahafo
- Ashanti
- Eastern
- Greater Accra
- Upper east

Bumper harvest

- August and October
- January to March

Lean season

- December to February
- April to May.



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Economic Importance of Tomatoes

- Improves livelihood and income of all actors along the tomatoes value chain.
- Reduces post-harvest losses, particularly during gluts season.
- Enhance the value chain through a value-added process.
- Reduces the country's dependence on imported tomato paste and so improving foreign exchange reserves.
- Provide employment opportunities and development opportunities in rural areas of the country.



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How Tomatoes are Used in Different Industries

• Food Application



• Animal feed



• Fertilizer



• Medical & Pharmaceutica



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Post-Harvest Losses of Tomatoes



What are post-harvest losses?

- Out of the 510,000 metric tons of fresh tomato fruits produced annually in Ghana, the country loses about 153,000 metric tons (30%).

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Factors that contribute to postharvest losses in tomatoes

- Inappropriate and insufficient storage facilities
- Rough handling during harvesting result in bruising
- Long distances from farms to markets
- Improper harvest and postharvest practices result in losses due to spoilage of the product before reaching the market.



Introduction to tomato processing

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Importance of tomato processing

- Reduce post-harvest losses
- Value addition to tomatoes
- Makes it available all year round
- Introduces varieties of tomato products
- Improves the eating quality of tomatoes.



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Variation and standardization of fresh tomatoes

- Different varieties have different characteristics and will thereby affect the outcome of the product.
- Factors include climate, soil requirement, maturation stage
- Standardization is therefore key to ensuring consistent processes and processing outcomes.



Varieties of tomatoes produced in Ghana

The varieties of tomatoes in Ghana include;



Grape tomato



Red beefsteak tomato



Cherry tomato



Cocktail tomato



Roma tomato



Sauce tomato

Examples of Processed Tomatoes

Tomatoes can be processed into;



Freshly packaged tomatoes



Tomato puree



Tomato sauce



Tomato powder



Tomato paste

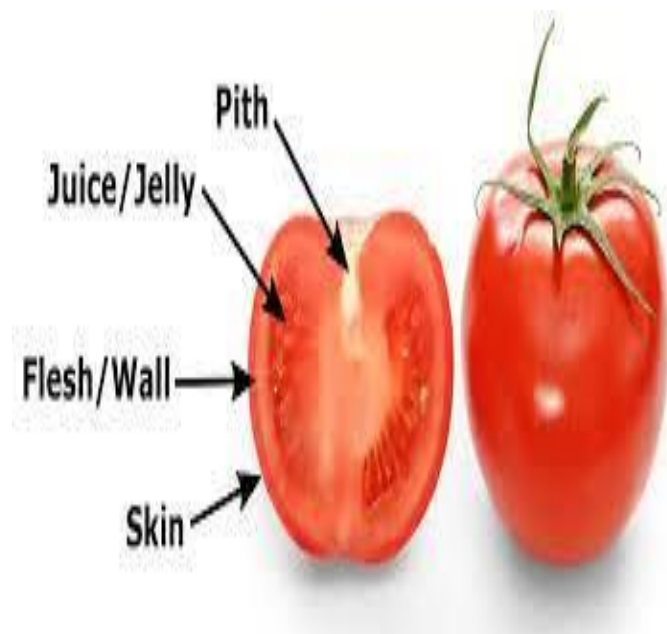


Tomato juice 35

Physical properties of tomatoes

Tomato is the fruit of the plant and is made of four basic parts:

- skin,
- outer fruit wall or flesh,
- central pith,
- juicy jelly inside with the seeds.



Composition of Tomato

Composition:

- Proteins 17.71 (g/100 g)
- Carbohydrates 5.96 (g/100 g)
- Fats 4.96 (g/100 g)
- Water 94.17 (g/100 g)

Other components include; vitamins A, C and K, and potassium.

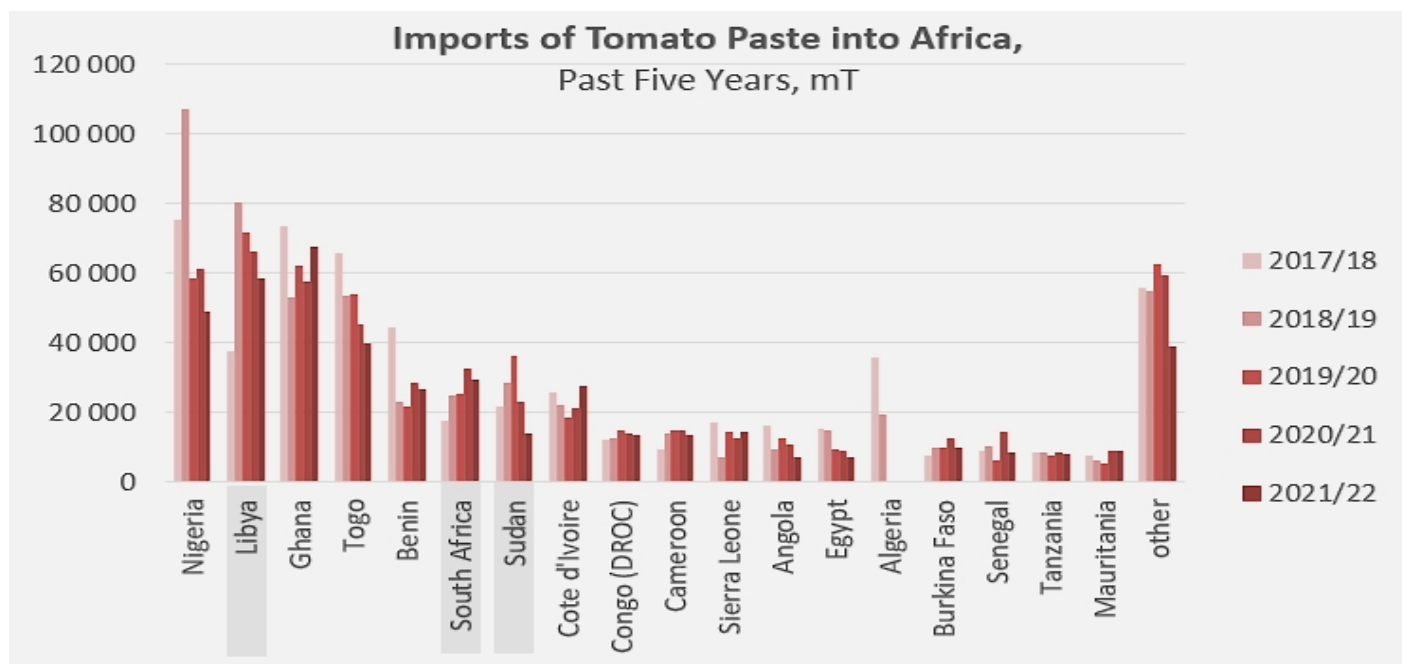


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Tomato Paste and Puree Processing



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- Ghana is a net importer of fresh tomatoes and tomato products from Burkina Faso and Europe.
- Ghana is considered the second largest importer of tomato paste.

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Physical Qualities of Tomatoes to Consider Before Processing

- Whole, mature and ripe
- Fresh in appearance
- Should have no visible mould or disease
- Clean and free of any visible foreign matter
- Free of any foreign smell and/or taste



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Product Standard Specification for Tomato Paste and Tomato Puree

- **Tomato puree:** Tomato concentrate that contains no less than 7% but less than 24% of natural total soluble solids
- **Tomato paste:** Tomato concentrate that contains at least 24% of natural total soluble solids
- Tomatoes that do not meet these specifications may be considered **tomato mix**
- Processed tomato puree and paste must have good flavour and odour, fairly good red color, and must possess a homogeneous texture



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Additional Product Standard Specification for Tomato Paste and Tomato Puree

- **Contaminant:** any substance not intentionally added to food, which is present in such food as a result of the product packaging, transport, or holding of such food or as a result of environmental contamination.
- **Product must be free from:**
 - Tomato peel
 - Seeds or particles of seeds
 - Extraneous plant materials
 - Dark specs or scale like particles



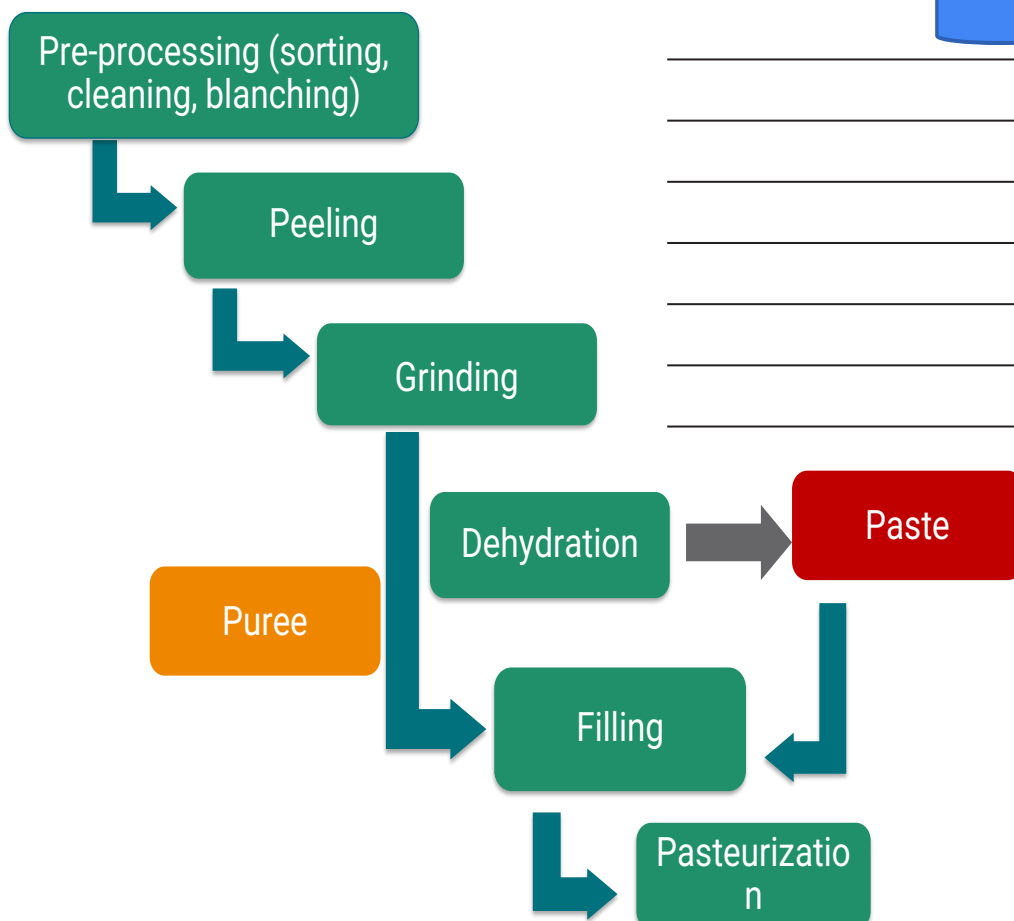
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Understanding the Unit operations Used in Tomato Puree and Paste Processing

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Processing Steps for Tomato Paste and Puree

NOTES

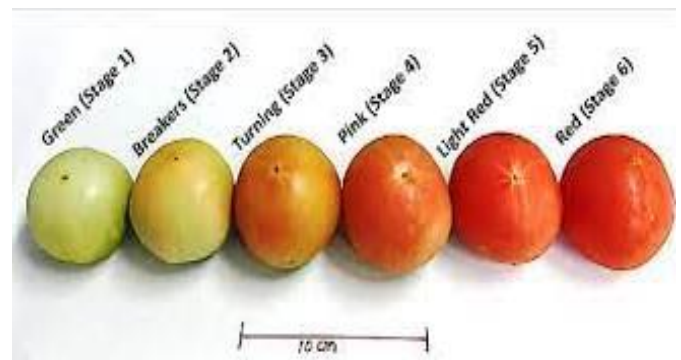


Sorting and Cleaning

It is a pre-unit operation done to select good tomatoes and clean them for processing.

Here tomatoes are selected based on

- Size,
- Color
- Maturity



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Blanching

- Blanching is scalding tomatoes in boiling water or steam for a short time.
- This is mainly done to stop chemical activities.
- By blanching tomatoes, lycopene, a chemical compound responsible for the red color is preserved.
- It also facilitates peeling.



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Separation- Peeling and Deseeding

Peeling

- Involves the removal of tomato skin.
- It is a quality requirement.
- Peeling improves paste and puree consistency as well as texture.



Deseeding

- It is the removal of the seed of the tomatoes after blanching.
- Tomato products, especially paste, must be free from seeds and peel.

Size reduction-Milling

- This is done to break down tomatoes into pulp by grinding using a blender, mortar and pestle, or a mill to turn the tomatoes into pulp.
- It results in a uniform liquid mixture for further processing



Concentration

- Concentration is increasing the solid contents through the removal of water.
- The moisture can be removed by careful heating or by pressing the pulp through a filter or drip bag.
- Machines like evaporators, jacketed pans, or condensers can be used.
- Similar results can be achieved by cooking in a saucepan on an open fire, baking in an oven, or using a dehydrator.
- Paste or puree is obtained depending on the final percentage of solids.



Pasteurization

- Pasteurization is the application of heat to rid microorganisms that lead to spoilage.
- Microorganisms of concern in tomato paste and puree processing are bacteria (*E. coli*, *Salmonella sp*, and *Staphylococcus aureus*) and mould (*Aspergillus sp* and *Penicillium griseofulvum*)
- Pasteurization extends the storage life of food products.
- It is not the same as total sterilization.



Hands-On Practical

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Equipment and materials for making tomato puree and paste



Stainless steel pan



Seive



Stainless steel tray



Dehydrator



Knife



Spoon



Tomatoes



ladle

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Equipment and materials for making tomato puree and paste.



Glass jars



Blender



Cooking gloves



Weighing scale

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Tomato puree and paste processing

Stage 1: Pre-processing

Preparation of jars and lids:

- Clean jars and caps and place them in a pan containing water.
- Heat jars and caps until the water boils, covering the jars and caps with the water for approximately five minutes.
- remove jars and caps and turn them upside down to allow water to drain completely.



Preparation of raw materials

- Choose mature, firm tomatoes. Reject any that are rotten, injured, or overripe.

Cleaning of raw materials

- Wash tomatoes in potable water to get rid of foreign particles that are present in them.
- Sanitize tomatoes in a 1% solution of sodium metabisulphite to reduce the microbial load that are present on them.



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Tomato puree and paste processing

Stage 1: Pre-processing

Weighing

- Measure the weight of tomatoes using a scale.
- This will aid the processor to determine the material input and output after processing



Blanching

- Place tomatoes in boiling water for 5 minutes to halt chemical activities and loosen the skin



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Tomato puree and paste processing

Stage 2: Processing

Separation

- Remove skin and seeds from pulp for further processing.



Size reduction/ Grinding

- Mill tomatoes using a blender or attrition mill to reduce particle size as well as ensure uniformity of the mixture



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Tomato puree and paste processing

Stage 2: Processing

Concentration (for Paste)

- Thinly spread the mixture on a stainless-steel tray.
- Gently place the tray inside the dehydrator at 45 °C for 8 hours
- This stage is critical to the final product.
- Overspreading/under spreading will affect even heating and may result in the burning of product, loss of bright red color, or watery paste.



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Tomato puree and paste processing

Stage 2: Processing

Filling and packaging

- For tomatoes **puree**, fill jars with pulp mixture and seal for pasteurization
- Fill dehydrated **paste** in jars and seal for pasteurization



Tomato puree and paste processing

Stage 2: Processing

Pasteurization

- Submerge jars containing paste and puree in a water bath and pasteurize. Ensure that water bath has the same temperature as jars



Cooling

- Gradually add cold water to slowly cool the water bath. Alternatively, wait until the following day to let the vessels cool in the water bath.



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Tomato puree and paste processing

Stage 3: Post-Processing

Storage

- To keep the color from fading, tomato paste, and puree should be kept out of direct sunshine.
- Pasteurized puree stored in glass jars will have an extended shelf life up to 12 months whereas plastic pouches that cannot be pasteurized after packing have a shelf life of only three months.



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Quality Evaluation of Tomatoes

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Quality Assessment of Raw and Processed Tomato Products

Parameter	Raw Tomatoes	Processed
Color (a*/b*)	0.60 -0.95 Bright red	0.60 -0.95 Dull red
Brix	4-8°	> 8°
pH	< 4.5	< 4.5
Acidity	0.2-0.6%	> 0.4%



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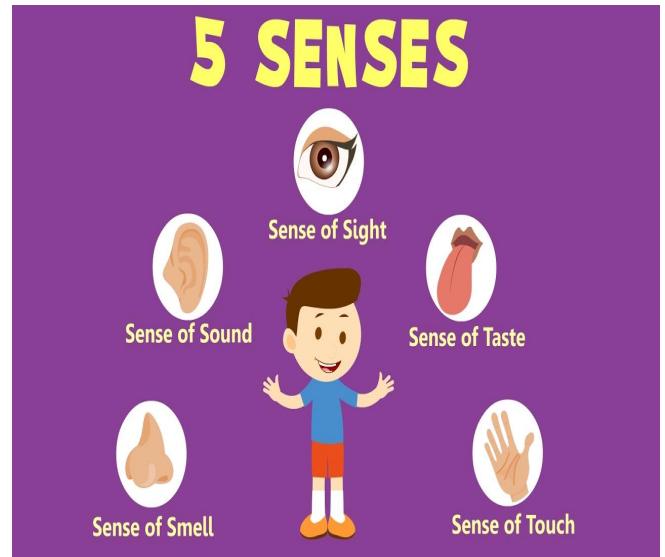
Sensory Evaluation

Definition

It is used to evoke, measure, analyze and interpret reactions to those characteristics of food material as they are perceived by sense of sight, smell, taste, touch and hearing

Importance

- Ensure consumer expectations are met or exceeded
- provides support to research and development, marketing, and quality control
- It helps to determine the shelf life of a product



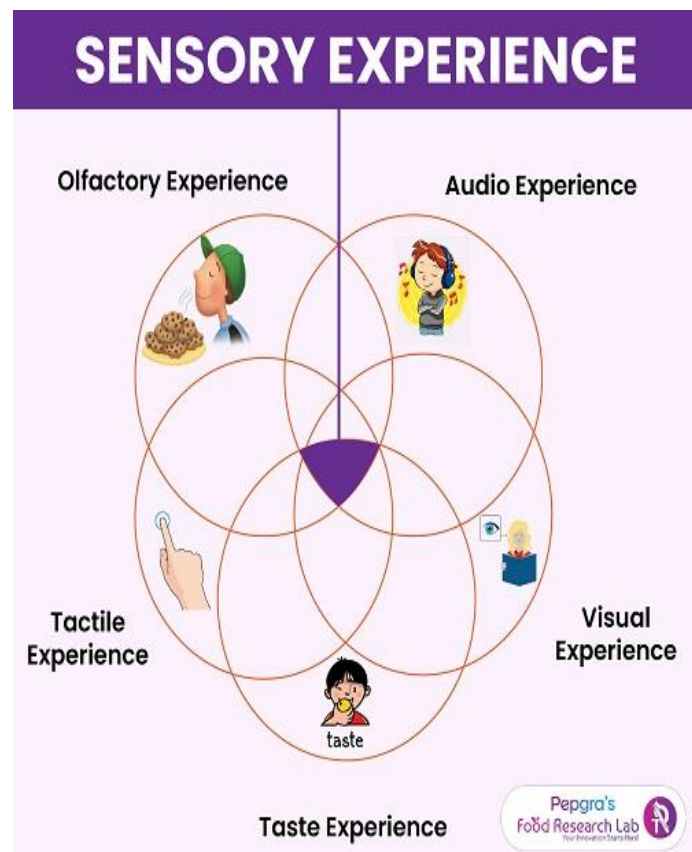
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When to use sensory

- Inspection of Raw Materials
- New product development or improvement of existing product
- Cost reduction
- Quality control
- Selection of packaging material
- Shelf-life studies

Main category

- Product oriented test
- Consumer oriented test



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Packaging Considerations for Processed Tomatoes



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Functions of food packaging

Marketing and information

- package conveys important information about the product such as cooking instructions, brand identification, and pricing

Traceability

- its the ability to follow the movement of a food through specified stage(s) of production, processing and distribution.

Convenience

- Packaging plays a vital role in minimizing the effort necessary to prepare and serve foods.



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Types of packaging materials for processed tomatoes

Plastic Packaging Materials

Plastic packaging can be used for tomato paste, tomato puree, tomato powder, and fresh tomatoes

The plastic packaging creates a modified atmosphere for the packed tomatoes thus;

- slows down the physiological processes and delays ripening,
- causes minimum weight loss,
- delays a change in color,
- lower total soluble solids content of the tomato fruit.



Types of packaging materials for processed tomatoes

Glass Packaging material

- It can be used for tomato products such as T tomato puree, tomato paste, tomato sauce, tomato juice, tomato powder

Advantages

- High moisture and air barrier properties
- Withstand high temperature
- Transparent
- Reuse

Disadvantages

- Break
- Expensive
- Bulky



Pickled tomato



Tomato puree



Tomato powder



Tomato ketchup

Types of packaging materials for processed tomatoes

Metal packaging materials

- It can be used for the packaging of tomato puree, tomato paste, tomato sauce, tomato juice

Advantages

- It provides a perfect physical
- Reduce the risk of spillage
- Resistant to extreme heat and cold

Disadvantages

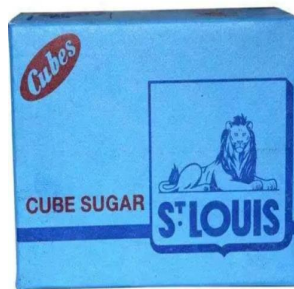
- Bulkiness
- Cost
- Equipment required



Fundamentals of Product Development

Introduction

What can you say about these products?



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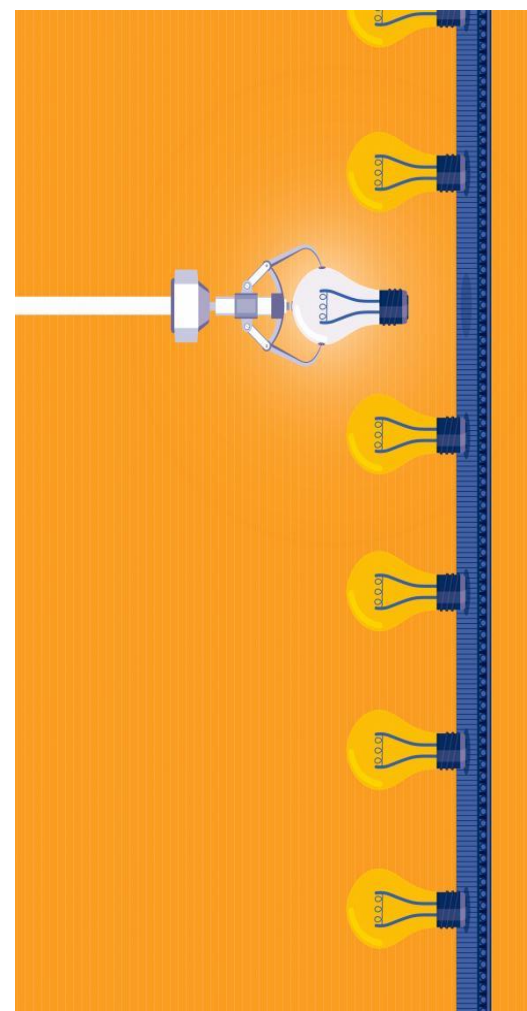
Product Development

Product Development is an integrated, systematic qualitative and quantitative procedures used to create new products or improve existing ones from concept to successful as well as environmentally friendly goods. It entails **creation, enhancement, innovation** and **improvement**.



Why product development?

- Meet consumer needs with new products
- Generate consumer interest
- Explore market opportunities
- Create a competitive market
- Capitalize on consumer trends
- Improve production efficiencies



Approaches to Product Development

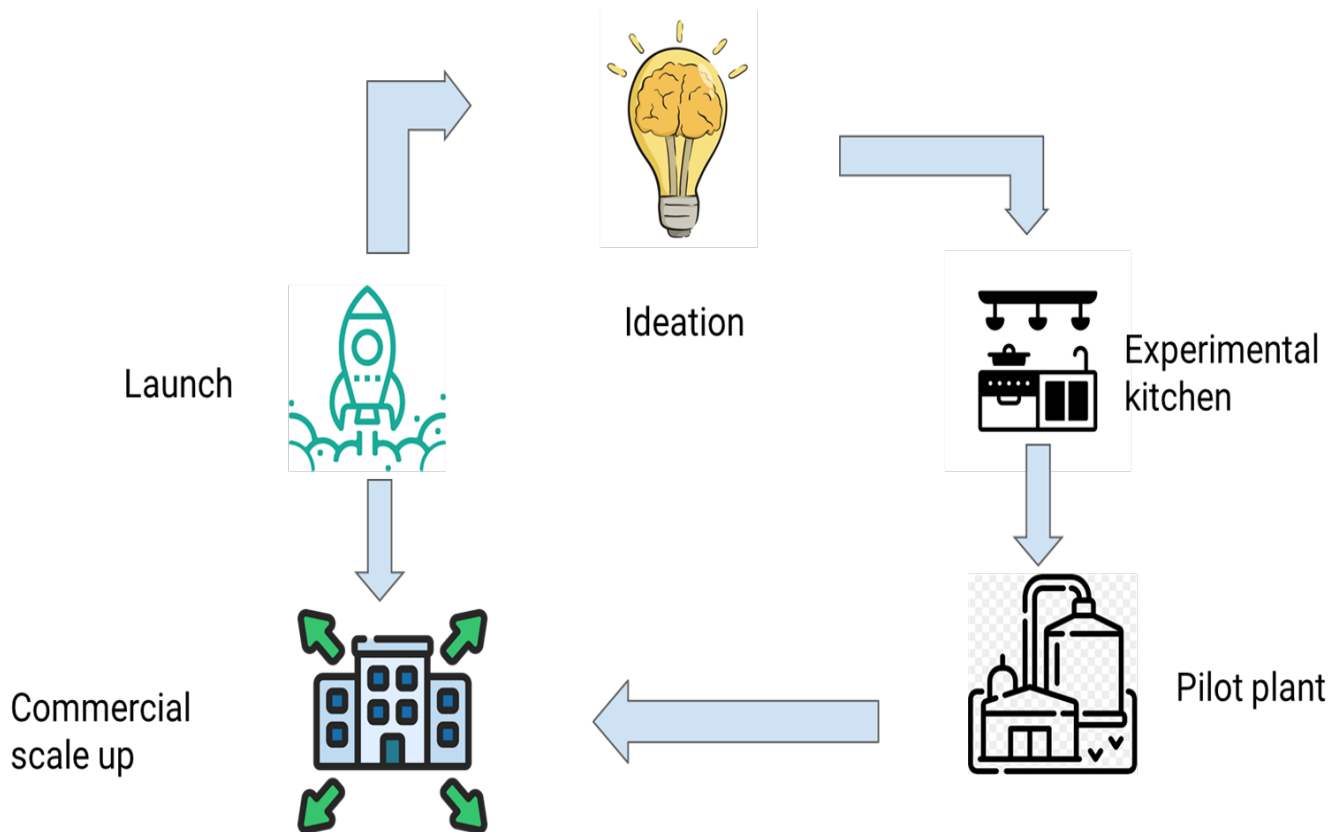
Consumer focused

- It is consumer centered
- Involves consumer throughout the process
- Results in product repurchase

Product focused

- Development is based on product expertise and/or technology
- The consumer is made to accept the product
- Not recommended for fast moving consumer goods.

Product Development Process



Ideation: Ideas are generated from many sources(trends,research, consumers, policies etc.). At this stage, concept is unclear and must go through further probes to determine feasibility.

Experimental kitchen: This stage is where ingredient sourcing is considered as well as formulations.

Pilot plant: Similar to prototyping but emphasis on process flow and more product testing.

Commercial scale up: Development of product in larger quantities and additional testing.

Launch: Introduction to market accompanied by advertisement, sales, marketing, monitoring and evaluation.

It all about:

- Science
- Business
- Creativity



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- <https://slideplayer.com/slide/13970148/>

Attachments

FDA labelling requirement

 FOOD AND DRUGS AUTHORITY GHANA Your Well-being, Our Priority	FOOD AND DRUGS AUTHORITY	DOC. TYPE: FORM	
		DOC NO.: FDA/FER/RQT- 04	
		Page 1 of 1	Ver. No.: 01
		Effective Date: 02/01/20	
GENERAL LABELLING REQUIREMENTS FOR PRE-PACKAGED FOOD			

- Name of Product (Brand and Generic names)
- Net weight, Net volume or Drained Weight for solid in liquid medium e.g. Tuna in Brine
- List of ingredients (specific names of ingredients and/or E-numbers)
- Date of manufacture
- Best Before Date or Use by Date (*Where applicable*)
- Batch or lot number
- Country of Origin
- Name and complete address of manufacturer/agent
 - *Labels of locally manufactured food shall have in addition, the specific premises location address of the manufacturer (ie. House Number/Plot Number/ Ghana Post Digital Address)*
- Directions for use, if any.
- Any instructions for storage/handling
- Labelling shall be in English
- Labelling shall be legible and shall be of indelible ink.

These are stipulated in the FDA Guidelines for the Labelling of Pre-packaged Foods (FDA/FERD/GL-LAB/2013/02).

NB:

- ***Where a product has both Primary and Secondary Packaging, the labelling of both the Primary and Secondary packages shall conform to the FDA's requirement on labelling of food products***
- ***Documentary evidence must be provided to substantiate nutrition information and claims on labels (if any).***
- ***All vegetable oils, both imported and locally produced, are to bear the plant source of the oil and labelled as such e.g., corn oil, groundnut oil, rapeseed oil, sunflower oil, etc.***