

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



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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 FRUITS PROCESSING

RISA PROJECT



COURSE OBJECTIVES

- ❖ To give beneficiaries fundamental knowledge on food processing innovations and safety.
- ❖ To equip beneficiaries with innovations in fruit processing
- ❖ To guide beneficiaries through the basics of product development



COURSE CONTENT

INTRODUCTION TO FUNDAMENTALS OF FOOD
PROCESSING AND SAFETY

THEORY ON FRUITS AND FRUIT
COMPOSITION

INTRODUCTION TO FRUITS PROCESSING

INNOVATIONS IN FRUIT PROCESSING

PACKAGING & BRANDING

INTRODUCTION TO PRODUCT DEVELOPMENT
AND SCALE UP

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Learning outcomes

- Understand the concept of food processing
- Identify the unit operations in fruit processing
- Process high quality fruit product; fresh juice, dehydrated fruit
- Determine appropriate packaging for fruit products
- Apply the principles of product development and scale up in fruit innovation



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
 - Testing
3. Hygiene & Safety

Day 2

1. Fruits as a raw material for processing
 - Types of fruits
 - Composition of fruits
 - Unique Flavour Profiles of fruits
2. Fruit quality and testing
 - Quality specifications for processed fruits
 - Quality testing
3. Introduction to fruits processing

TEACHING PLAN

DAY 3

1. Innovations in fruit processing
 - Dried fruit & fruit powders
 - Purees
 - Jams
 - Alcoholic beverages
 - Fruit juices
 - Activity on Pasteurization
2. Labelling and packaging
 - What is packaging
 - Labelling
 - Packaging materials

DAY 4

1. Introduction to product development & Scale up
 - What is product development
 - Importance of product development
 - Product development processes
 - Activity on idea generation
 - How to scale up

Introduction to food processing and safety

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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.

MINIMALLY PROCESSED	PROCESSED	ULTRA PROCESSED
 CORN	 CANNED SWEET CORN	 CORN CHIP
 POTATO	 BAKED POTATO	 FRENCH FRIES
 CARROT	 CARROT JUICE	 CARROT CAKE
 WHOLE WHEAT	 FLOUR	 COOKIES
 APPLE	 APPLE SAUCE	 APPLE JELLY BABY
 MILK	 CREAM	 ICE CREAM

Benefits of processing



Shelf life extension



Quality improvement



Convenience and availability



Value addition & Nutrition



Food security

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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. Testing
4. Records & Price Keeping

1. Food Composition

Component of food

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

Major

- Carbohydrates
- Proteins
- Fats
- 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 double 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



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Water

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



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Vitamins and Minerals

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

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

- Antioxidants
- Colorants
- Flavorants



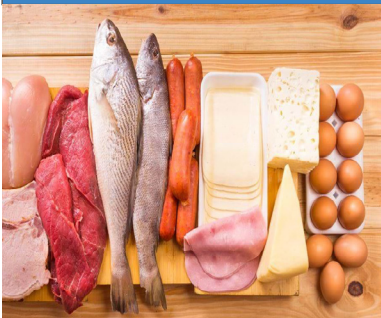
Sobolo

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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



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2. Weight & Measures



Digital weighing scales



Food thermometer



Measuring cup



Measuring spoons

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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
- Booking keeping



Testing

Food product testing is the scientific analysis of food and its contents. It is done to provide information about various characteristics of food, including its structure, composition, and physicochemical properties.

- Food testing includes:

Food contaminant testing



Food microbiology testing



Nutrition and composition testing



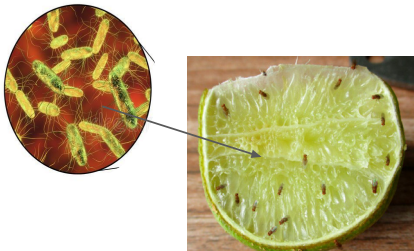
Food Safety And Hygiene

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.

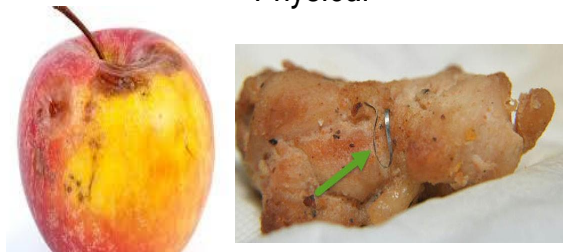
Food hygiene: Every circumstance and action required to ensure that the food is safe and acceptable at every stage of the food chain.

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

Biological



Physical



Chemical



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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.

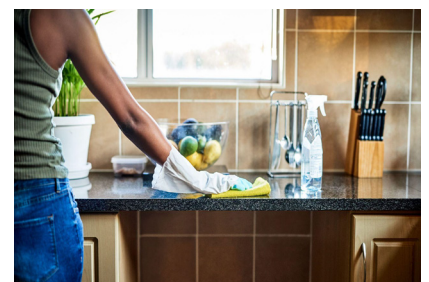
• Personal hygiene



• Storage environment



• Production area



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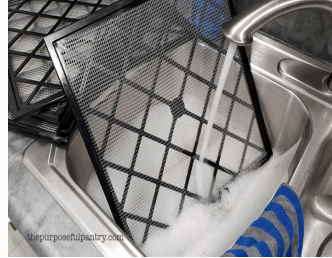
Materials & Equipment



- use of right equipment



- use of clean and quality raw materials



- ensure the sanitation of each equipment before and after production



- use of right cleaning tools and chemicals

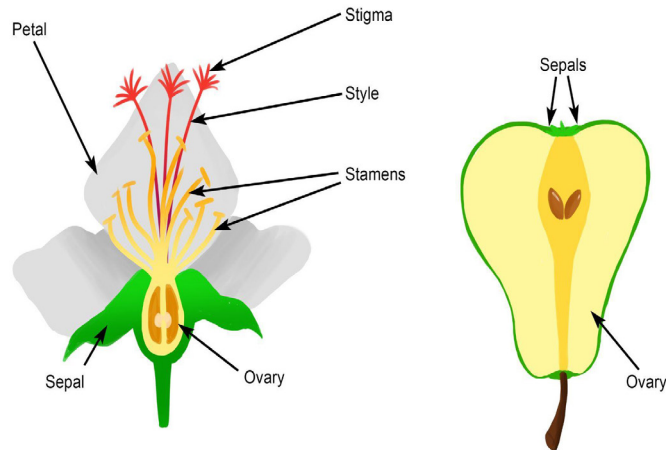
INTRODUCTION TO FRUITS



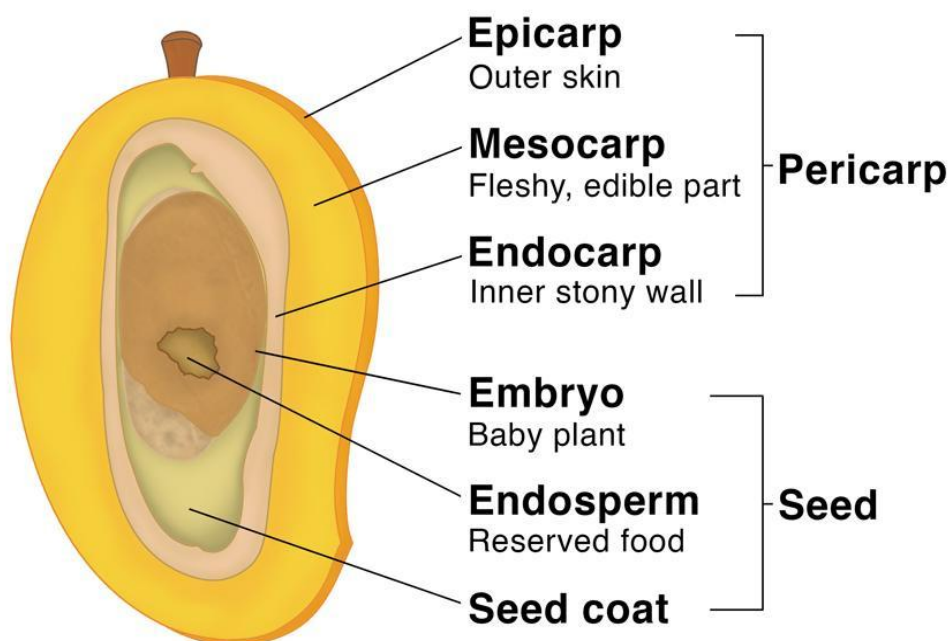
Fruits

Fruits are produced from flowers and they are the ripened ovary or ovaries of a plant together with adjacent tissues.

Fruits are fleshy or pulpy in character often edible, juicy and usually sweet with fragrant, aromatic flavours .



Parts of a Fruit



The pericarp of the fruits might be fleshy as in guava, mango, etc. or might be dry as in coconut etc.

Types of Fruits

Based on the number of ovaries and the number of flowers involved in the fruit formation, fruits are classified into three major groups namely

- Simple Fruit
- Aggregate Fruits
- Composite/Multiple Fruits

	
simple	multiple
	Types of Fruit Anatomy simple =  multiple =  aggregate = 
aggregate	

Simple Fruits

These fruits develop from a single matured ovary in a single flower. They are classified as;

- Drupe**s: These are also known as stone fruits since it contains a very hard seed on the inside. Eg., mango



- Berries**: These type have a single seed in the center and are very juicy.

Eg., grapes



- Pomes**: Such fruits bloom from trees. Eg., app



- Hesperidium and Pepos**: These are covered with a leathery or hard rind and are fibrous and very juicy. Eg., citrus, watermelon



Aggregate Fruits

These fruits develop from a number of matured ovaries formed in a single flower. Individual ovaries are called “fruitlets.” Examples include soursop and strawberry



Composite Fruits

These fruits develop from a complete inflorescence. They are also known as multiple fruits. Composite fruits are of two types;

- **Sorosis:** developed from the ovaries of several flowers.

An example is pineapple



- **Syconus:** develops from flowers that develop in a hollow fleshy stalk of inflorescence.

An example is fig



Composition Of Fruits

Fruit edible portion composition ranges* (Fresh weight basis)

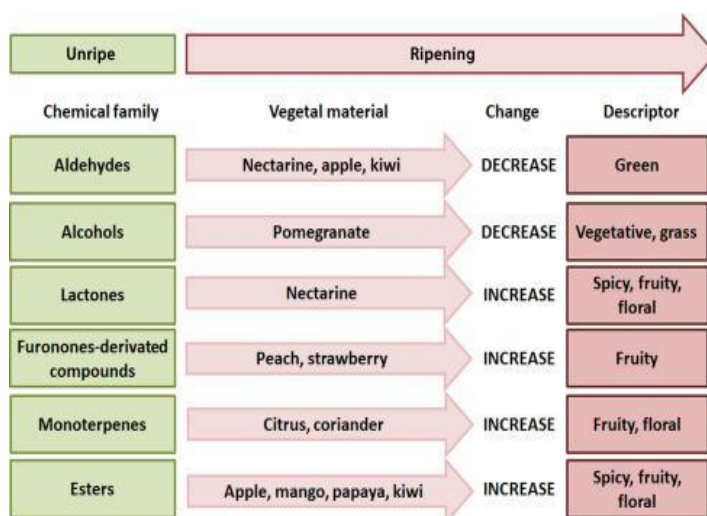
Component	Range (%)
Water	97 - 70
Carbohydrates	25 - 3
Protein	5 - trace
Lipids	25 - trace
Acids	3 - trace
Phenolics	0.5 - trace
Vitamins	0.2 - trace
Minerals	0.2 - trace
Dietary fibre	<1 to >15
Pigments	0.1 - trace



Flavour Constituents Of Fruits

The volatiles that are well-known to affect fruit flavor include;

- Esters (fruity aroma)
- Alcohols (fruity or earthy aroma)
- Aldehydes (slightly grassy and bitter aroma)
- Lactones (peach-like aroma)
- Terpenoids (scented oils aroma)



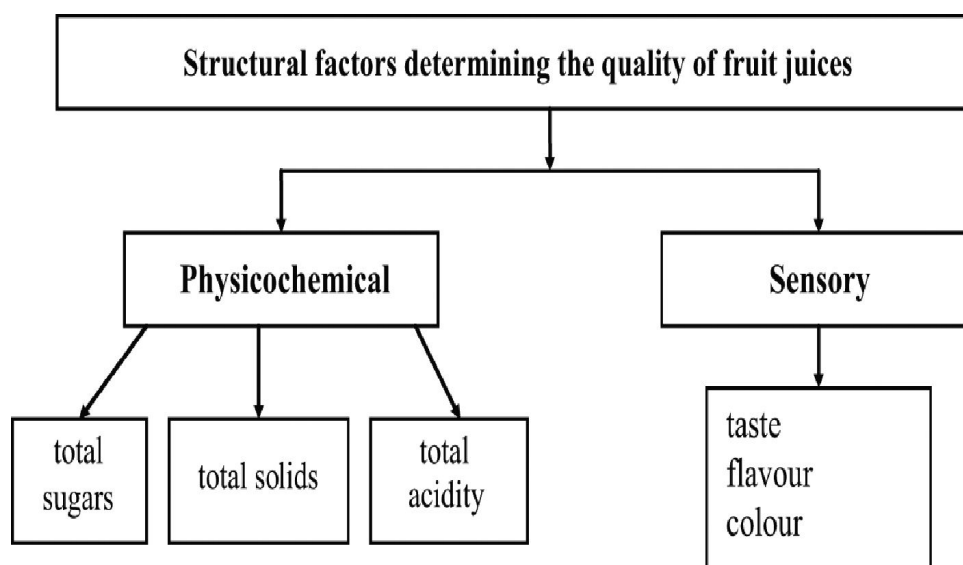
Fruit Pigments (Colour)

Fruits also contain different pigments that gives it its unique color. The main pigments in fruits include;

- Carotenoids contributing red, yellow, and orange (for example, apricot and tomato)
- Flavonoids contributing yellow (for example, citrus)
- Anthocyanidins contributing red, purple, and blue (for example, grape and blueberry).



Quality Attributes of Fruit



Retaining quality attributes of fruits during processing

The quality of processed fruits is determined by:

- the quality of the raw materials utilized (e.g. cultivar, maturity, cultural practices)
- the efficiency and care taken during handling, processing, storage, and distribution
- Internal quality parameters:
(dry matter, soluble solids (SSC), firmness, internal and external color, acidity, and nutraceutical content.)



Testing Fruits

Who should test ?

- Farmers
- Processors
- Produce distributors



What should be tested

- Nutritional value
- Adulteration
- Presence of contaminants
- Acidity
- Brix



Instruments for testing fruits



pH Meter
Testing acidity



Refractometer
Measure total solids /
sugar content in fruits.



Penetrometer
Determine the stage
of ripeness of fruit

FDA Test Requirement for Fruit and Fruit Products

Microbiological Parameters

- Aerobic Plate Count
- Enterobacteriaceae
- E. coli
- Staphylococcus aureus
- Yeast and Moulds

Physicochemical Parameters

- Soluble solids
- Total Sulphur dioxide content
- Heavy metals (Pb, As)
- Pesticide Residues

INTRODUCTION TO FRUIT PROCESSING



Competition In The Fruit Processing Industry

- New product development
- Innovation in new flavors
- New packaging
- Distribution
- Producing healthier juices.



Challenges Faced By The Ghana Fruit Processing Industry

- High presence of imported fruit juice brands, hence high patronage compared to the local brands.
- High cost of packaging materials e.g. glass bottles, crown corks, tetra packs, stand-up pouches, cartons.
- Pilfering and theft of finished products by staff.
- High cost of capital loans for long-term investment.



Fruit Processing

Fruit can go through numerous types of processing:



Canning



Drying



Juicing



fruit preserves

Common operations in Fruit Processing

- Sorting and grading
- Cleaning
- Peeling
- Cutting
- Blending
- Extraction
- Pasteurization



Sorting And Grading

- **Sorting:** This process separates your produce on the basis of shape, weight, size, appearance, and color. Sorting ensures that only your good quality produce passes forward for further processing.
- **Grading:** This requires trained experts and top-line equipment to ensure that the product is uniform and of high quality before you send your product for processing. it is critical

					
0	1	2	3	4	5
0% colour Completely green	35% colour Some eyes partially filled with colour	50% colour Most eyes partially filled with colour	75% colour All eyes contain colour; some green edges	90% colour All eyes filled with yellow; trace of green on edges	100% colour Completely yellow

Benefits Of Fruit Processing

The objective of processing fruits is to:

- Preserve the color
- Preserve flavor
- Improve the texture
- Preserve the nutritional content
- Prolong the shelf life



Equipment Required For Fruit Processing

GRINDER



JUICE EXTRACTOR



JUICE FILLER



DEHYDRATOR



PASTEURIZER



STOVE

Common products from Fruits



Dehydrated Fruits



Fruit Powders.



Fruits in alcoholic beverages



Fruit Puree



Fruit Jam



Fruit Juices

Dehydrated/ Dried Fruits

Dried fruit is fruit from which the majority of the original water content has been removed either naturally, through sun drying, or through the use of specialized dryers or dehydrators

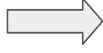
Examples of fruits that can be dehydrated are bananas, mangoes, pineapples, peaches, apples, oranges, pawpaws etc.



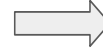
Making Dried Pineapple Fruit



1. Choose fresh fruits that are ripe and wash thoroughly



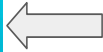
2. Peel and slice fruit into uniform size and thickness



3. Spread the diced fruit in a single layer on the mesh dehydrator trays. Dehydrate for 8-10 hours at 60°C



4. Dried fruit is done when darker in color, pliable and chewy .



5. Store dried fruit in an airtight container at room temperature

Fruit Powder

- Dry fruits



- Mill it into powder



Fruit Puree

- A form of processed fruit made by grinding, squeezing or mixing different types of fruit into a smooth, puree or paste.
- Fruit purees are often used as baby foods and can also be used for smoothies and alternative sweeteners in porridges and baking



Fruit Jam

- Made from chopped or crushed fruit.
 - cooked with sugar until the pectin releases and the mixture is thickened to a spreadable consistency.
- Jam can last up to a month in the refrigerator or up to a year in the freezer
- Canning prolongs the shelf life considerably.
 - If you process by canning in a boiling water bath, you can expect up to two years of shelf life when stored in a cool, dry place.



Fruits In Alcoholic Beverages

- Fruits and fruit juices and can be used in making alcoholic beverages such as spirits, wines, vodkas, cocktails.

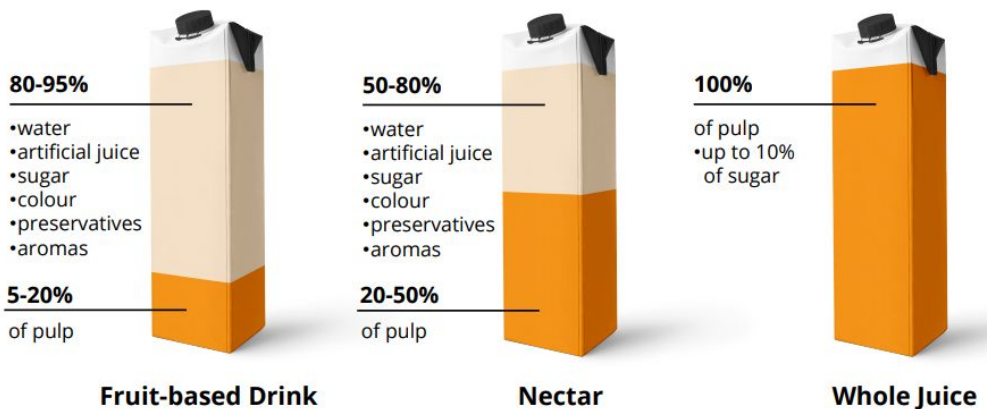


Fruit Juices

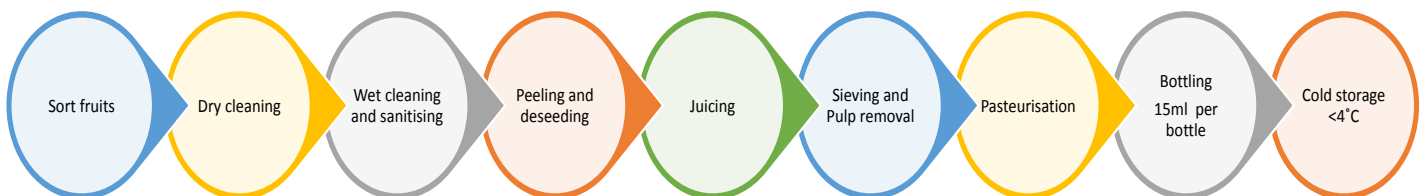
Fruit Juice is a drink made from the extraction or pressing of the natural liquid contained in fruit .



Types Of Fruit Based Beverages



Flow diagram of fresh juice processing

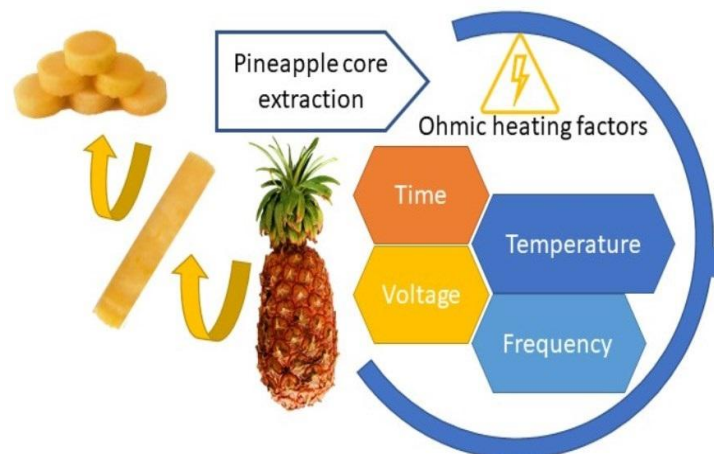


Innovations in fruit products

- The goal of recent innovations is to consume the fruit in its natural state.

This is achieved by reducing the amount of heat and preserving flavour and colour

- Minimal processing
 - Ohmic heating
 - Proper pasteurization technique



Preservatives Used Fruit Juice/ Beverages

Ingredient	Use
Sulphur Dioxide	Retards microbial and enzymatic activity
Benzoates	Antimicrobial @ pH <4.5
Sorbates	Antimicrobial @ pH <6.5
Carbon Dioxide	pH reduction, anaerobic atmosphere
Ascorbic Acid	Retards enzymatic browning

How to pasteurize fruit juice with or without preservatives

- Activity session

PACKAGING OPTIONS IN FRUIT PROCESSING



Packaging options for fruit beverages



Plastic bottles



Paper carton
packages.



Aluminum cans



Plastic pouch



Glass bottles

Packaging Materials For Dried Fruits & Fruit Powder



Plastic pouches



Glass jars

Packaging options to attract kids



FDA Label Requirements

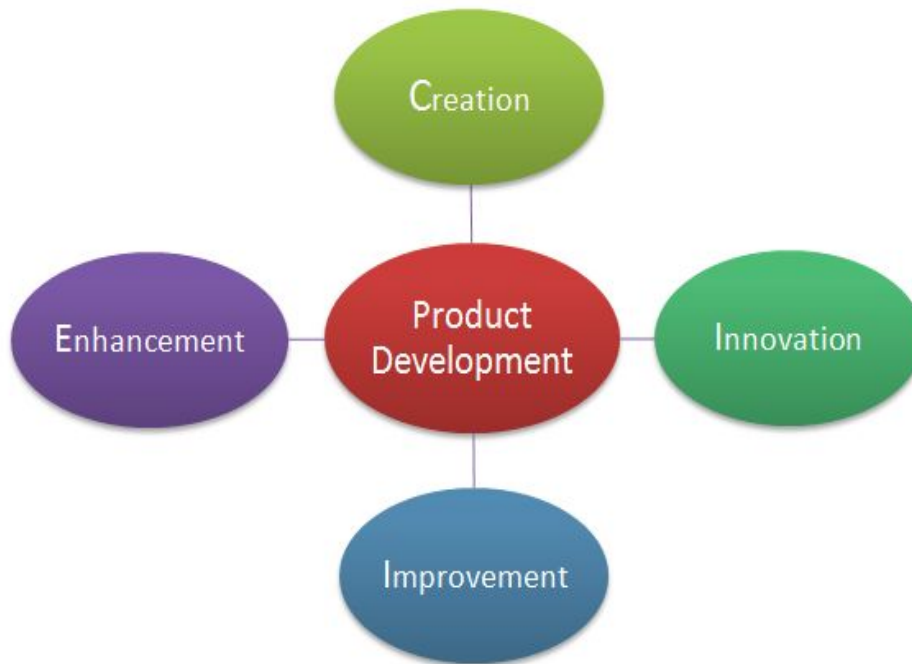
- ◆ The name of the food
- ◆ List of ingredients & additives
- ◆ Net Contents and Drained Weight
- ◆ Name and Address of manufacturer
- ◆ Country of Origin
- ◆ Lot/Batch Identification
- ◆ Date Marking and Storage Instructions
- ◆ Instructions for Use
- ◆ % of juice declaration
- ◆ Food Allergen.



INTRODUCTION TO PRODUCT DEVELOPMENT AND SCALE UP



What is product development

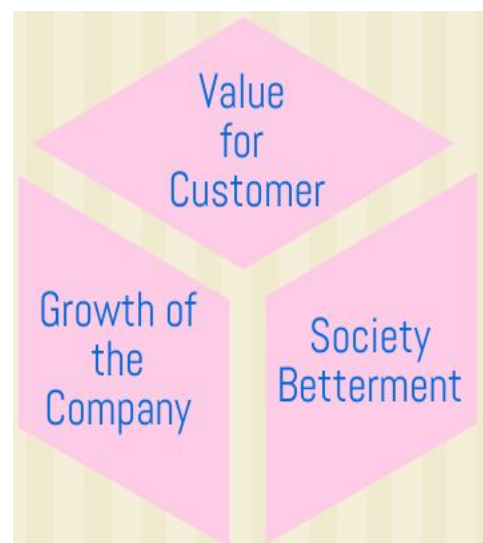


- It all about:
- Science
 - Business
 - Creativity

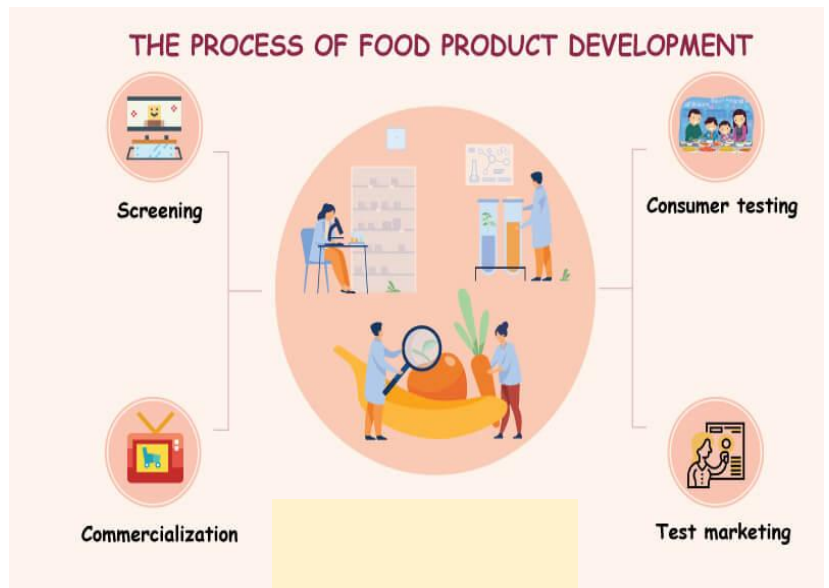
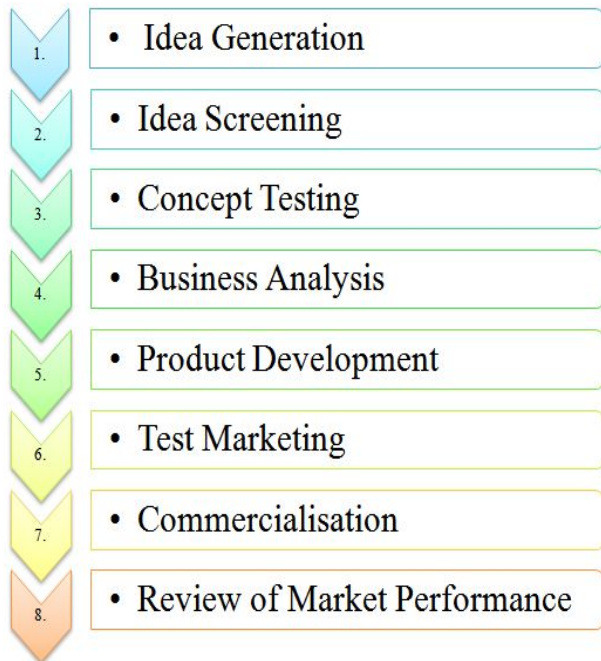
Importance Of Product Development

This is important because

- Meet needs of target market
- Fills gaps in product portfolio
- Competitive and relevant in the market.



Stages in Product Development



Idea Generation

Ideation

Ideas are for a brand-new product and some are for a line extension of an existing product. Once ideas have been generated, it is important to identify the target customer.

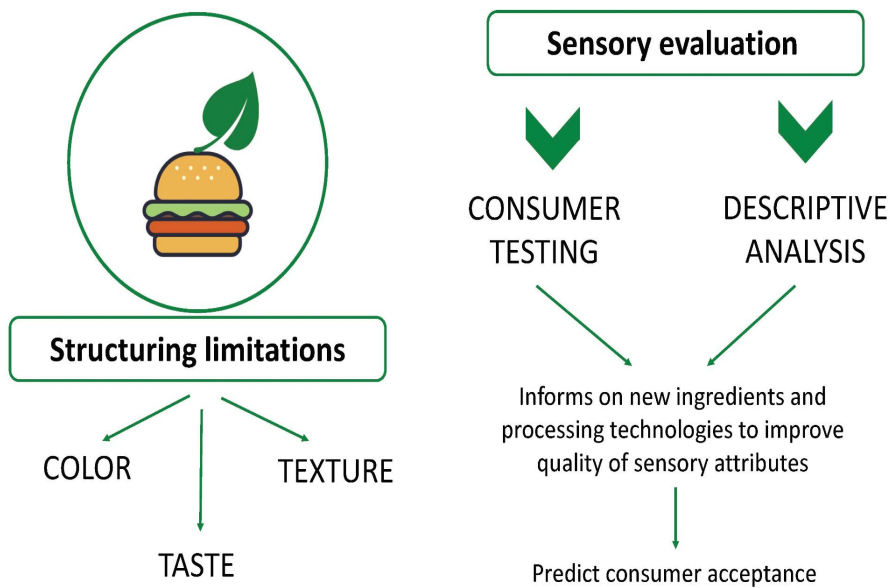
Idea Screening

Screen the idea to determine its feasibility i.e., cost, available equipment and technology, target group etc.

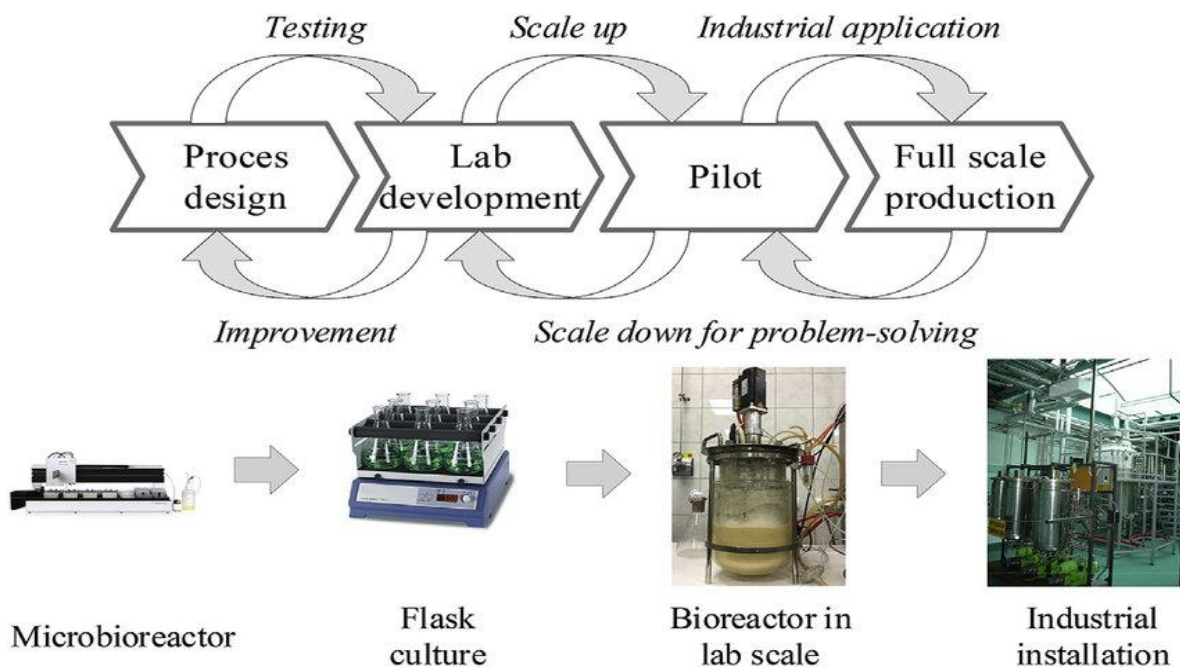
The best 3 ideas can move to the next stage.



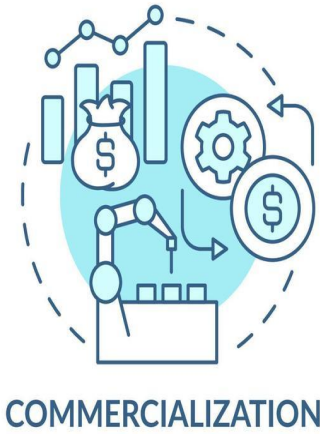
Prototype development and testing



Manufacturing – Pilot scale up



Commercialization



At this stage we go into full scale manufacturing and sale

Factors to consider during scale Up

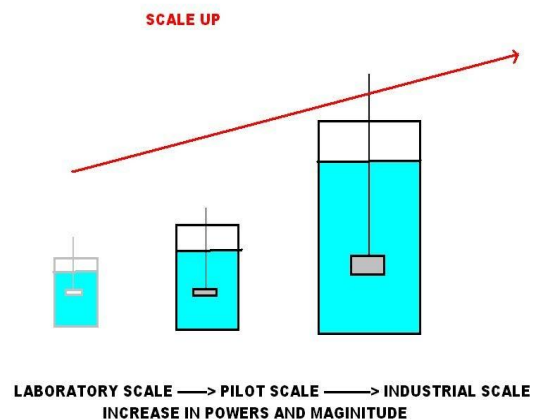
- Profitability of current line
- Staff strength
- Quality systems
- Space to scale up
- Equipment availability



Production Scale-Up

To scale up follow these few guidelines:

- Know the product well
- Document recipe
- Convert recipe to weights
- Construct a flow diagram
- Decide how much to produce
- Decide the product pack and label
- Run trials



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 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.***