

Modules from the BIP FOOD INNOVATION AND THE CONSUMER

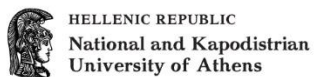
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FOOD INNOVATION AND THE CONSUMER

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BLENDED INTENSIVE PROGRAM | ONLINE: 10 - 31 March 2025 | FACE-TO-FACE: 4 - 11 April 2025

PARTNERS:



4.1 New food technologies for food formulation

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FOOD INNOVATION AND THE CONSUMER

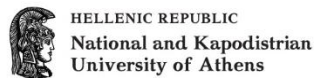
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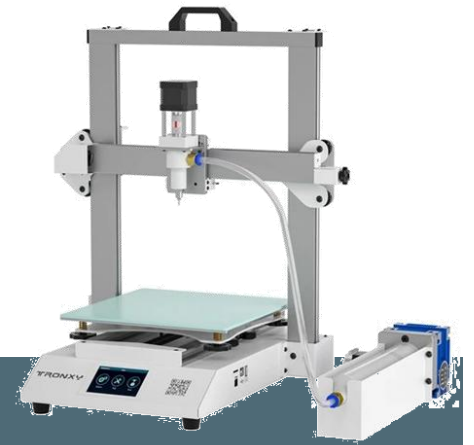
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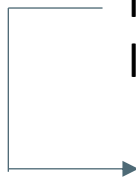
- Food formulation has evolved significantly with the integration of cutting-edge technologies that enhance the nutritional value, sensory properties, and sustainability of food products.
- Among the techniques shaping the present and the future of food production in this module are presented: **3D food printing, extrusion, and cook-vidé cooking.**

3D FOOD PRINTING



3D Food Printing

Fabricate physical parts or structures in 3D by depositing materials layer by layer.



Food Industry

It allows the creation of personalized foods with dimensional, sensory and nutritional characteristics adapted to the individual needs of each consumer.



1985

Chuck Hull,
stereolithography (SLA)

1988

3D systems created by
Chuck Hull launches its
first printing machines.

1990

Development of new
methodologies for 3D
printing (Laser and FDM)

2005

Dr. Bowler creates self-
replicating 3D (RepRap) in
open-source initiative

2010

The first 3D printer launched by Marketbot goes on the market

Organovo, develops Bioprinting technology capable of manufacturing organic tissues

2012

Essential Dynamics shows its "Imagine" 3D printer for Chocolate

2013

In Spain Foodini presents its prototype of a 3D printer for food.

NASA Grants t to Systems & Materials Research Corporation (SMRC) to Develop Food 3D Printer

2019

It is increasingly used in industrial manufacturing, mass production and construction.

SELECTIVE SINTERING PRINTING

It can be by laser or by hot air. The energy allows the fusion of specific areas of the particle bed by sweeping cross-sections.

JET PRINTING

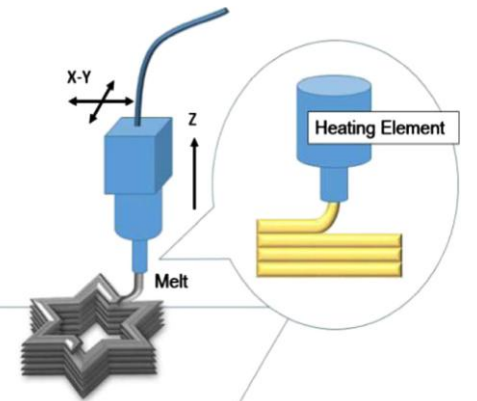
A jet of ink droplets is dispensed from a thermal or piezoelectric head to make surface fillings or decorations of products such as cookies, cakes and pizza.

BINDER JET PRINTING

The powdered materials are deposited layer by layer and small binder droplets are ejected and deposited on the surface of the powder bed to join the layers. Surface heated by irradiation.

EXTRUSION PRINTING

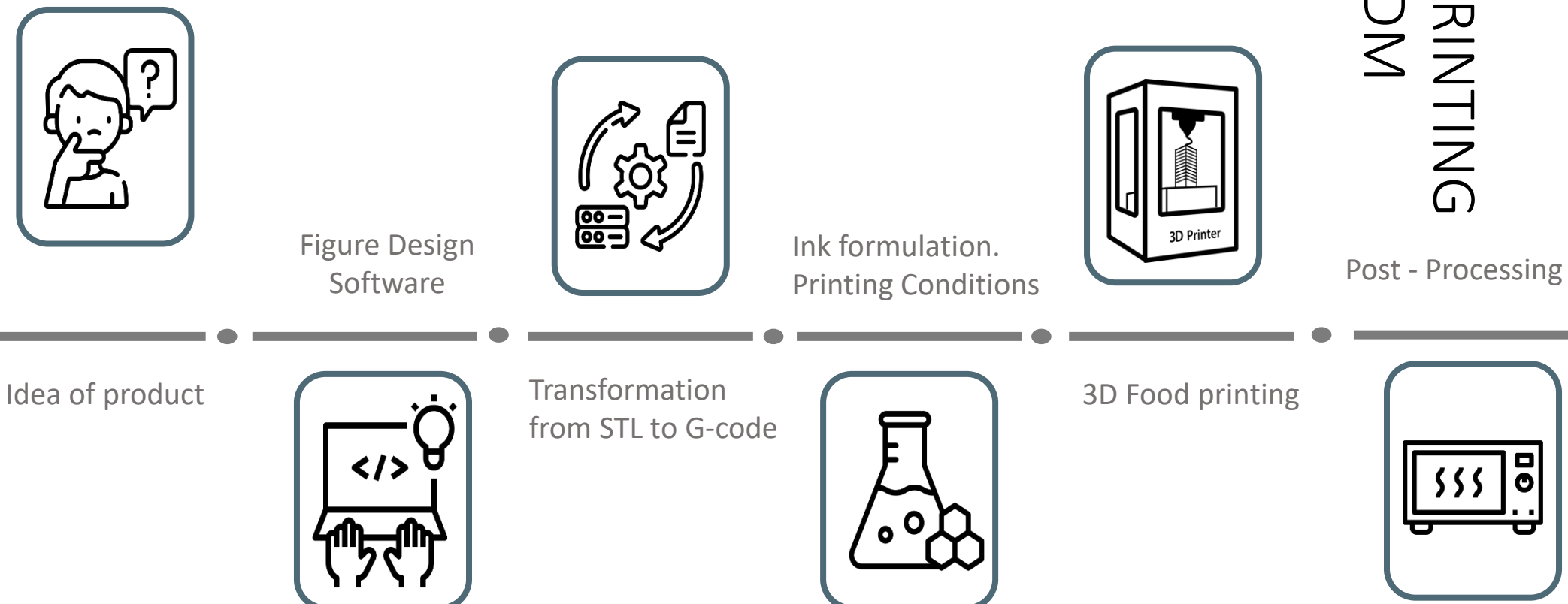
Known as fused deposition modeling (FDM). It will allow us to develop complex shapes by deposition layer by layer of extruded material through a nozzle.



TYPES OF 3D PRINTING IN FOOD

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ADVANTAGES

- Personalized nutrition and healthier food development
- Freedom to design more complex and novel shapes
- Possibility of using alternative sources of materials
- Reduction of food waste
- Possibility to simplify and accelerate the manufacturing process
- It can solve problems related to allergies and cross-contaminations

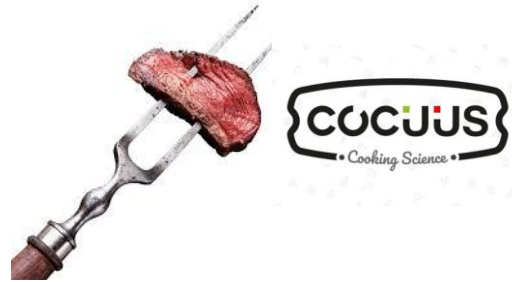
DISADVANTAGES

- High cost
- Low material compatibility
- Slow print time
- Food safety and hygiene of printers
- Consumer perception
- Printing precision

ADVANTAGES AND DISADVANTAGES

Upprinting Food

It is a startup based in The Netherlands, whose main objective is the 3D printing of sustainable food printed from food waste from different industries.



COCUUS

Spanish technology company. It develops industrial solutions for the production of animal, vegetable or cellular protein analogues using 2D/3D laser printing, bioprinting and mechatronics.

Revo FOODS

Startup, based in Vienna, which through 3D printing technology has managed to introduce to the market its alternative salmon, based on pea protein, algae oil and citrus fiber printed in 3D.





FOOD INK Restaurant

London-based Food Ink is the world's first restaurant with 3D printing. It is a one-of-a-kind gourmet experience in which all food, utensils and furniture are produced entirely by 3D printing in a futuristic immersive space.

MULTIDISCIPLINARY TEAM: architects, artists, chefs, designers, engineers, futurists, industrialists, inventors and technologists.

It produces its dishes using the by Flow multi-material 3D printer, which heats pasta-filled cartridges and overlays them in multiple layers.

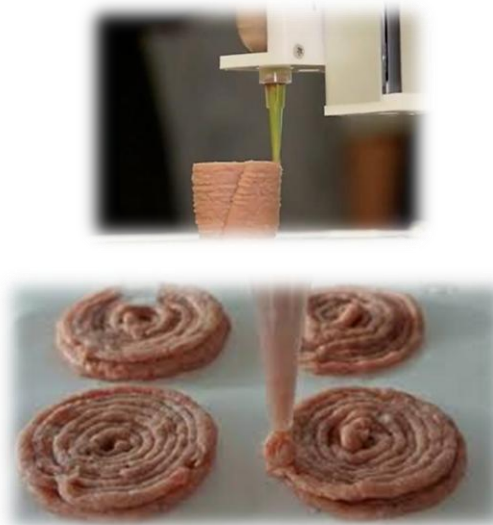


Materials for 3D printing

Printable materials: hydrogel, creams, bread doughs, hummus, chocolate, mashed potatoes, etc.

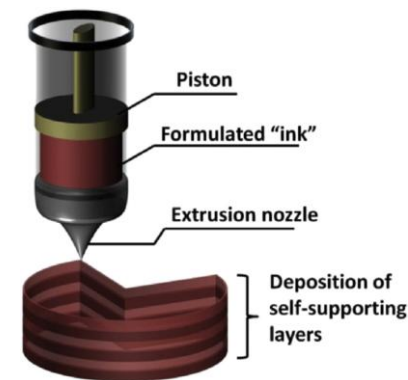
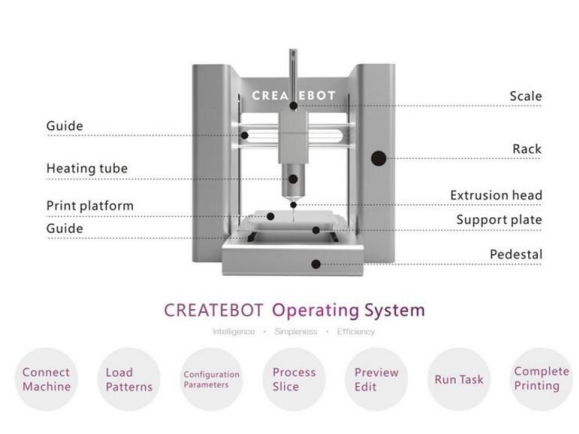
Non-printable materials: With the help of hydrocolloids (xanthan gum, gelatin), in fruits, meat, vegetables... A

Alternative ingredients: algae, fungi, insect or lupine meal, cell cultures, etc.



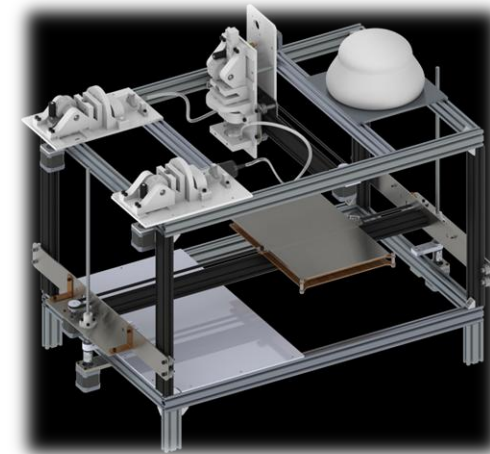
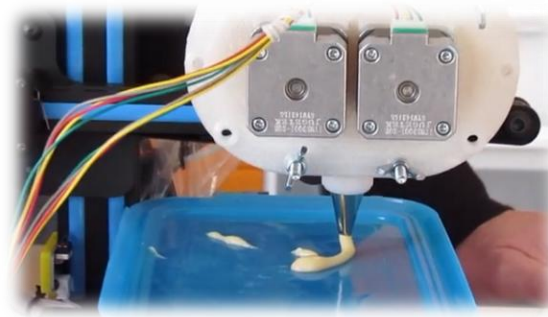
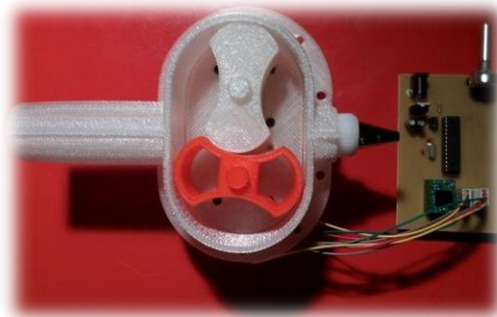
Parameters to take into account in the 3D printing process

- Design: Type of geometry, reinforcements, base, height, etc.
- Product: Composition, percentage of different ingredients, temperature, thermal and mechanical properties of food, chemical reactions, food safety, etc.
- Printer: Nozzle size, horizontal travel speed, step height, extrusion speed, deposition zone temperature, print cartridge temperature.
- Other: Print chamber temperature

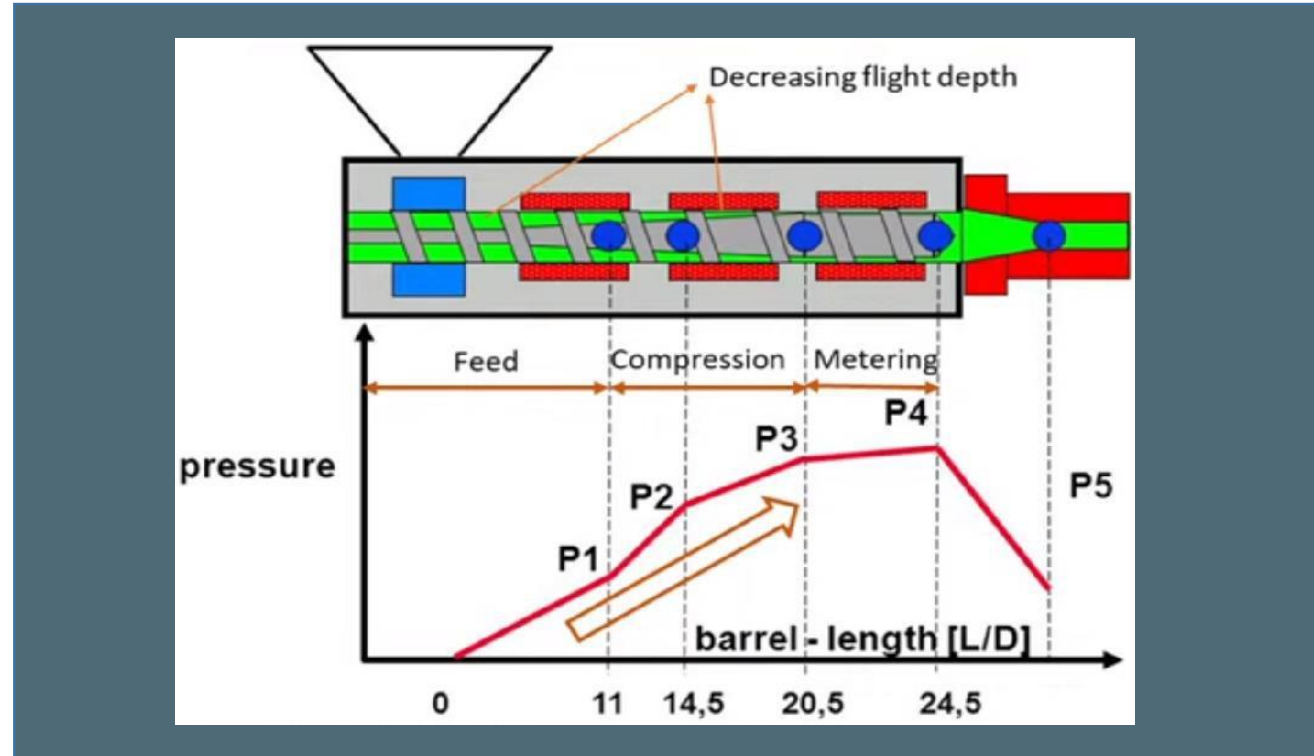


Needs and lines of work in 3D printing

- Control of printing conditions
- Integration of food parameters in design programs
- Possibility of cooking the product in the same printer (MW, IR, hot air, etc.)
- Possibility of multiingredients, pumping and dosing systems, ZIP systems, etc.



Food extrusion processing



Overview (process temperature)

- Extrusion can be done:



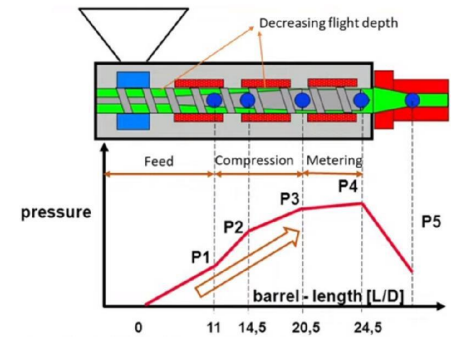
Cold



products with high density and high humidity are obtained, such as cookies, muffins, candies or sausages.



applying heat



Overview (mechanic system)

- There are a wide variety of extruders:



Piston



Roller



Screw

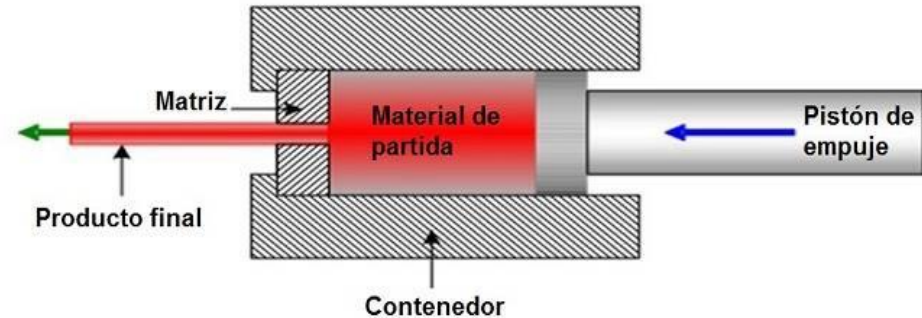
- **Single-screw**
- **Double-screw**
- **Multiple-screws**

Overview

- There are a wide variety of extruders:



Piston



- The simple one of the extruders.
- Consists of a single piston that forces the material through a hole
- Designed for precise delivery and uses in confectionery and meat industry.

Overview

- There are a wide variety of extruders:

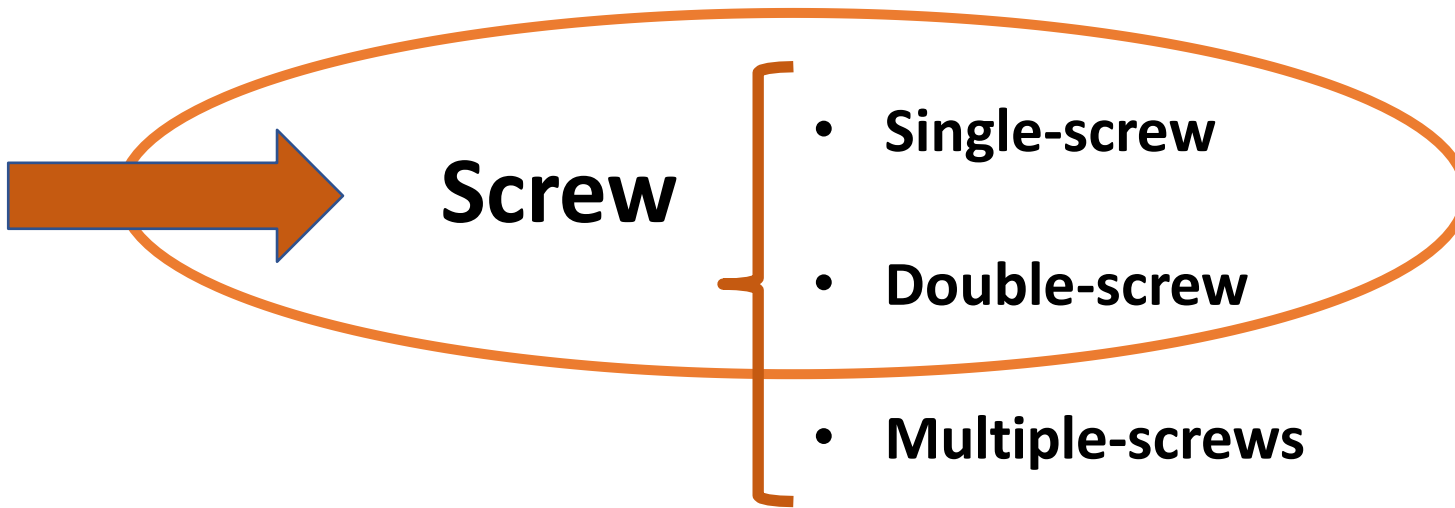


Roller

- Consists of two counter-rotating.
- The gap between the Rolls is controlled.
- A variety of products can be obtained by altering the gap, rotation speed, and the roller surface.
- For crackers, hard cookies, etc. Also, for the production of flakes (after baking).

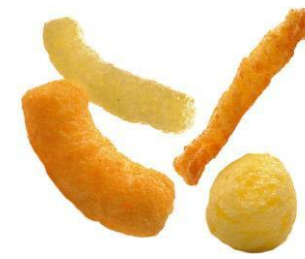


Overview



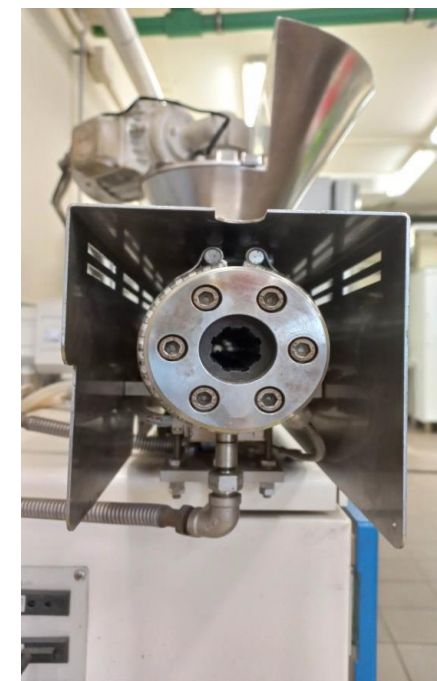
Single-screw and twin-screw systems are the most used extruders in the food industry.

Overview (screw extruders)



- Extrusion processing is a **commonly used** processing technology in the **food industry** (wide number of applications).
- Food is forced through the extruder and is cooked by the high-pressure, high-shear, and high-temperature environment created by the screws encased in the barrel. to force food materials through a small hole.
- **Materials often puff** due to the release of pressure and conversion of water into steam.
- This technique allows obtaining a wide variety of **textures**, **shapes** and **colors** from an initial ingredient.

Single-screw extruder



Single-screw

- It means that there is only one screw inside the barrel.
- The length to diameter ratio (L/D) varies between 2:1 until 25:1 (it is the ratio of the screw diameter to the length of the barrel).
- We have three sections inside the barrel, feed section, transition section and metering section.



Feed section

Feed section has deep flighted screws which aid conveying the material forward



Transition section

The material is partially cooked and subjected to high pressure



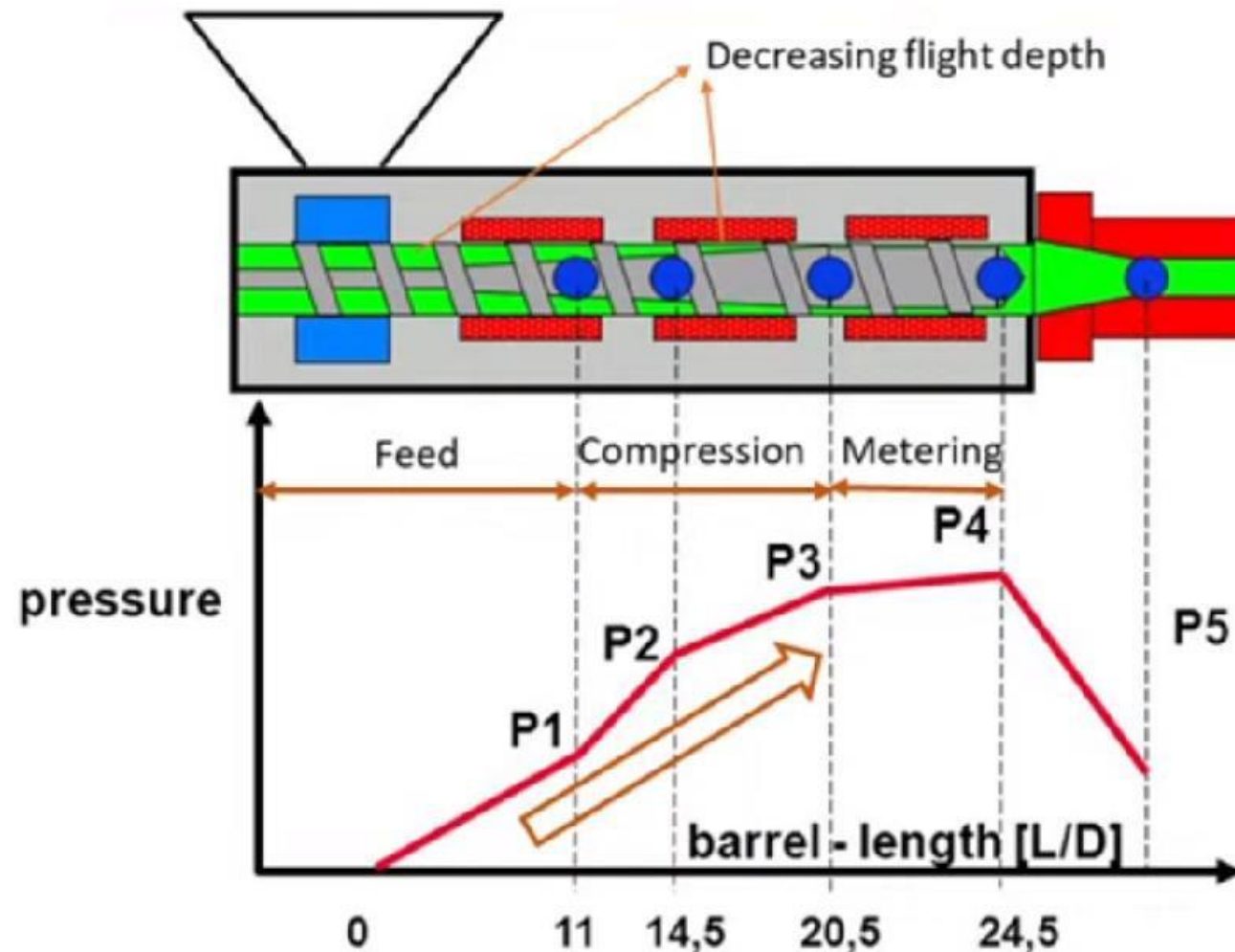
Metering section

Receive the compressed material, homogenize it, and force it through the die at a constant pressure

Single-screw

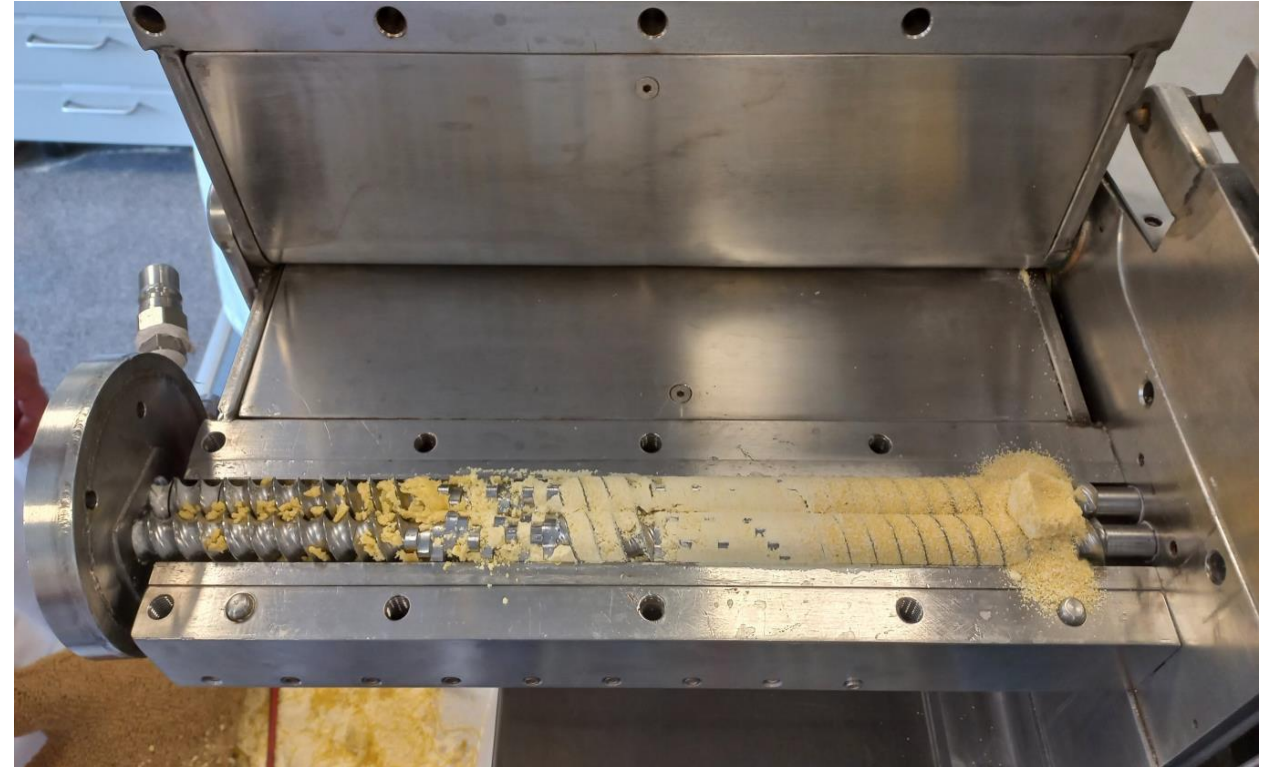
- The **screws** have **different compression ratios**. (1:1 / 2:1 / 3:1 / etc.).
- The ratio of the screw channel depth in the feed zone to that of the metering zone developing the pressure to process raw materials.
- In general, food extruders are **segmented into 4 heating zones** and these segments are **jacketed** to allow temperature control.
- **Cooling systems** are achieved with water or air.
- At the end, the extruder has a die (with one or more openings), and it **plays an important role**. Restrictive die increases barrel fill, retention time, and energy input.

Extruder



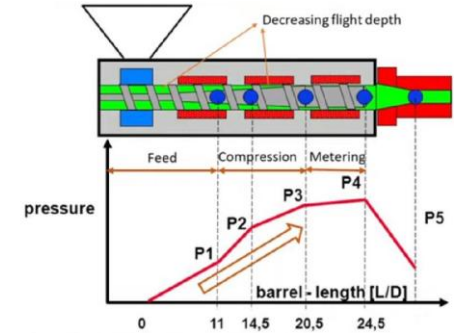
Double-screw extruder

In the food industry twin-screw systems are more used because of their flexibility.



Multiple operations - one machine

- Extrusion applying heat is a thermo-mechanical processing operation that combines several unit operations:
 - Mixing
 - Kneading
 - Shearing
 - Heating
 - Forming
 - Partial drying
 - Etc.



Ingredients

**More used
Extrusion
ingredients**



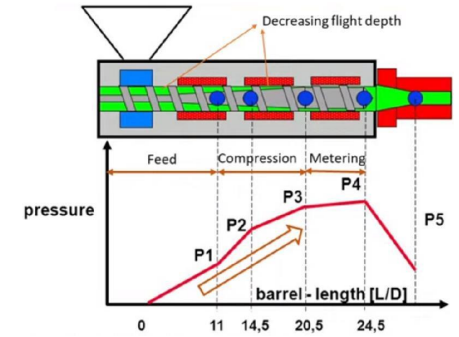
**Starchy
foods**

Cereal flours such
wheat, corn, rice,
etc.



**Protein-
rich foods**

Soybean, sunflower,
vegetable, and cereal
protein isolates

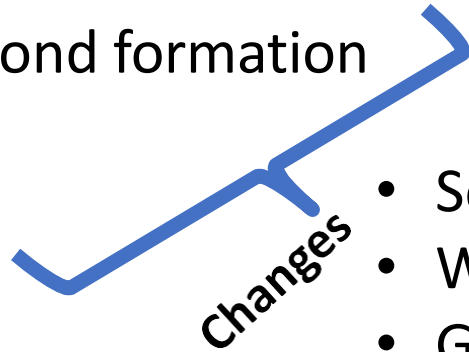


Complementary ingredients:

- plant extracts
- functional products
- Salts
- Legumes
- Insects (ants, crickets, etc.)
- Etc.

It improves the functional properties of foods

- Extrusion affects the structure and composition of proteins.
 - Denaturation.
 - Bond formation



- Solubility
- Water retention capability
- Gelation
- Texturing
- emulsification



Meat substitute



It improves the functional properties of foods

- Denaturation and inactivation of antinutritional factors.
- Some vegetables have high nutritional value, but high concentrations of antinutritional factors.

- The conditions used in extrusion improve the suitability of these plant foods for human consumption.

- Aflatoxins.
- Gelation of vegetable proteins.
- Saponines
- Lectins
- Enzymes inactivation
- Etc.

better digestibility

Snack production (expanded products)



Texturized proteins

