



2nd WORKSHOP “FEED-TO-FOOD”

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HEAT TREATMENTS IN FEED AND FOOD PROCESSING
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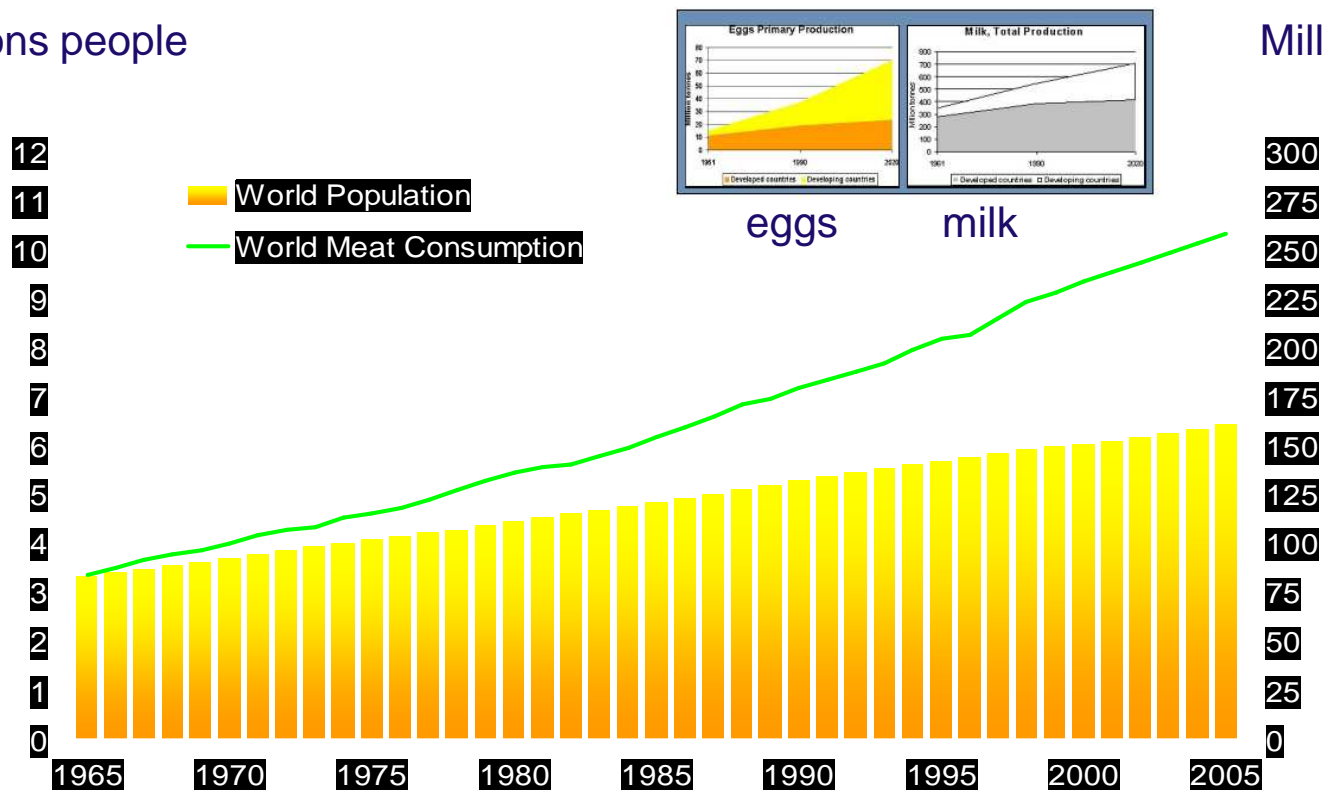
Institute for food technology

The increase in world population and per capita income, affect the increase in meat consumption.

More meat means more grains, more soybean....additives ie. more feed

World population growth — meat consumption

Billions people



In 2050, it will be necessary to feed 9.2 billion people

Source: IFIF, United Nations, FAO

Agricultural-food sector of the EU has to produce

- more
- better
- everywhere
- at affordable prices

When it is known that the production must come from agricultural surface that are reduced and degraded in many areas, a drastic increase in efficiency of resource use will become the necessity.

Increasingly stringent requirements for:

- People health



- Feed safety

- Sustainability in environment protection



are directly connected with requirements for:

- Feed safety
- Better feed quality
- Better use of raw materials and compound feed

Feed industry is:

- increasingly important link in the food chain
- important factor in solving
 - ✓ efficiency of resources use
 - ✓ the current global food crisis
- of great economic importance in EU



The technological processes in which the mixtures and/or raw materials for their production can be translated **into usable**, namely **more usable forms** of feed, are investigated.

Heat treatments (HT) have found a significant practical application among the most studied technological processes to improve the usable value of feed

The effects of HT are not always positive.

Depending on the nature of raw materials, choice of HT and the conditions applied in the technological process, both positive and negative effects on product quality are possible.

Positive effects of HT

Increasing digestibility of components

Starch, proteine, fibre

Destruction of anti-nutritive components

Tripsin inhibitors, lectins

Inactivation of undesirable enzymes

Urease, peroksidase, lipoksigenase, mirosinase

Destruction of toxic components

Glukozinolates, gossipol, aflatoksin

Destruction of microorganisms

Yeasts, bacteria, salmonella

Structuring and shaping of components and mixtures

Texturing of high protein components (soybean, blood meal), fish feed

Taste improvement

Increased metabolic energy

Negative effects of HT

Destruction of thermo-sensitive vitamins and other ingredients

Vitamin A vitamin C, vitamin B1, pigments

Inactivation of enzymes

Amylase, phytase

Destruction of amino acids

Lyzine, methionine, cystine

Undesirable chemical reactions

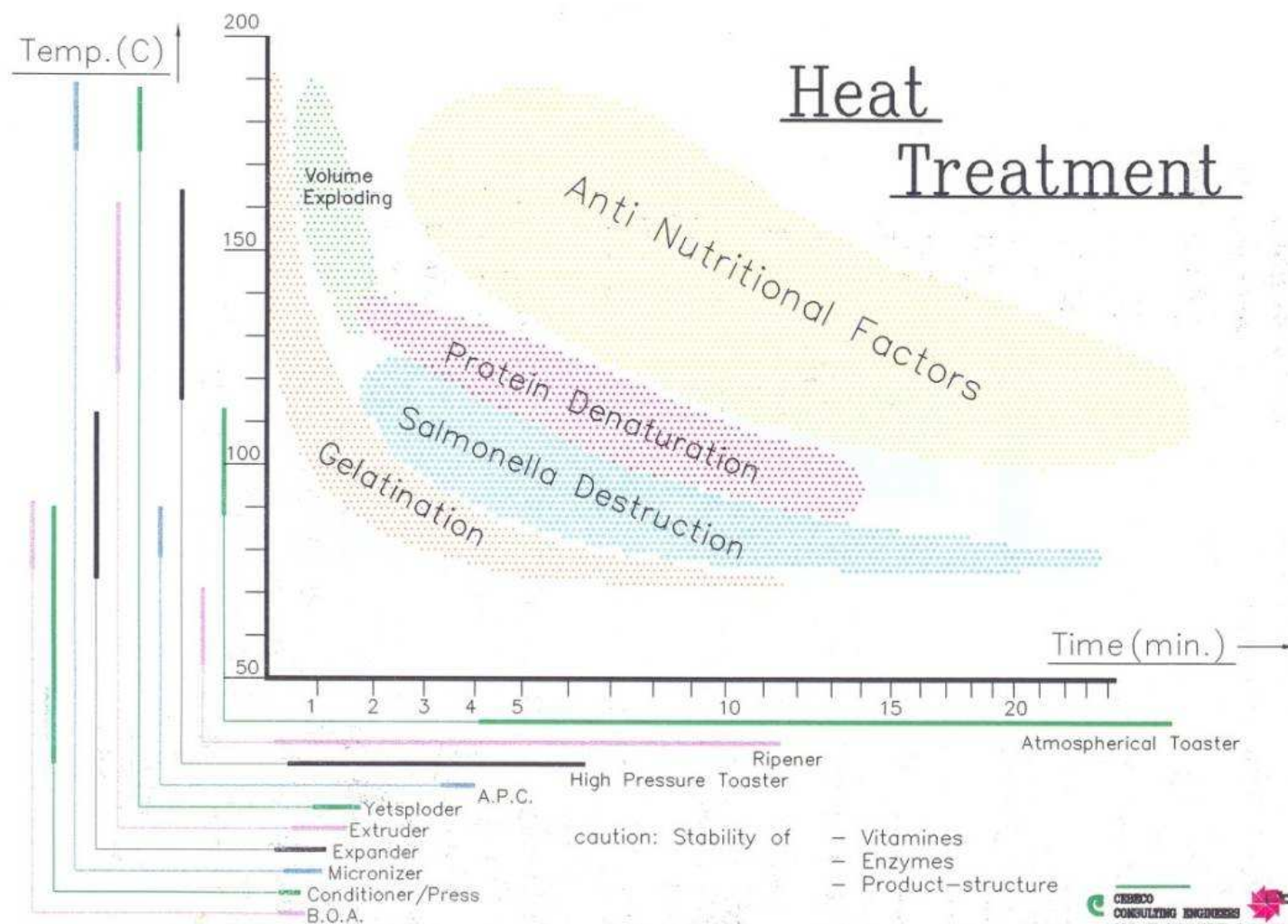
Mallard's, starch-fat

Da bi toplotni tretman imao željene efekte potrebno je održavati tačno definisanu temperaturu i vreme trajanja procesa, i ovi parametri se moraju precizno kontrolisati odgovarajućim mernim instrumentima tokom procesa.

Areas in which, depending on the temperature achieved and length of its action, one can expect certain positive and/or negative effects of HT on:

- starch gelatination
- destruction of *Salmonella*
- destruction of protein
- antinutritional substances, and
- volume expansion

Are shown on diagram



HT have found a significant practical application among the most studied technological processes to improve the usable value of feed

There are many HT, each different in the:

- heat source,
- construction of the device or
- process parameters applied,



There are no conditions that are optimal for all products, but the temperature and length of the process, as well as humidity and turbulence of the material must be controlled variables.

One must make a compromise between:

- biochemical characteristics of raw materials
- type of HT
- applied processing parameters and
- requirements of an animal

When selecting the HT and equipment for their application, basic questions are:

- **What will be processed?**
- **What quality of the final product is needed?**

The products may be required to be:

- with reduced trypsin inhibitor content,
- with gelatinised starch component,
- with increased or decreased protein digestibility,
- with preserved activity of ingredients and additives,
- powdery,
- hard pelleted,
- crumbled,
- specially shaped,
- expanded,
- flaked,
- with defined density,
- guaranteed *Salmonella* free,
- *Salmonella* free,
- manufactured in the cheapest way,
- manufactured from cheap raw materials, etc.

The efficiency of HT depends on a range of factors.

Two unavoidable factors of all HT are temperature and time of their application, although the impacts such as humidity, pressure, shear force and others causing additional effects cannot be neglected either.

Combining of these parameters is the starting point for development of all kinds of heat treatments and devices that are used in feed industry.

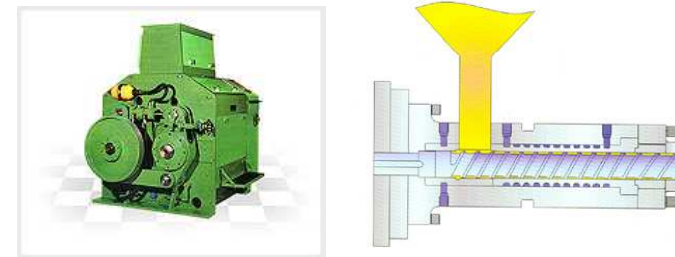
Basically, all the different process techniques increase the temperature of the product.

If the moisture is adding in the process, we are talking about **hydrothermal treatment**.



Most of the HT are hydrothermal because moisture released from the material to be treated participates in the process.

Mechanical effects can be located in or out of the HT device



The mechanical treatment causes an additional effect to heat treatments so that they become **thermo-mechanical processes**

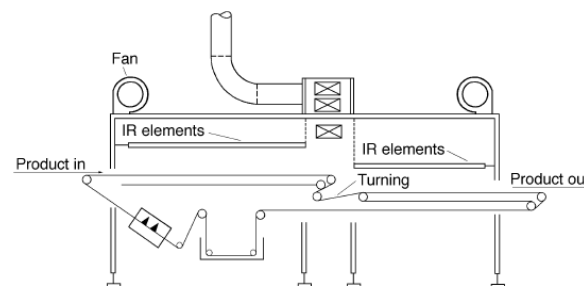
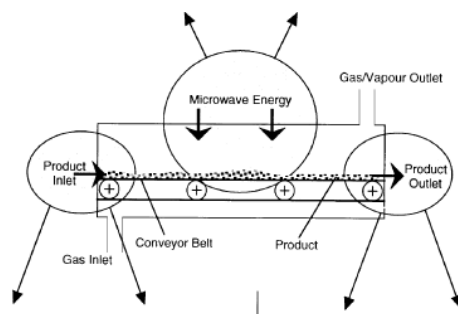
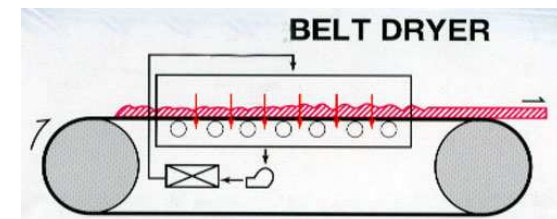
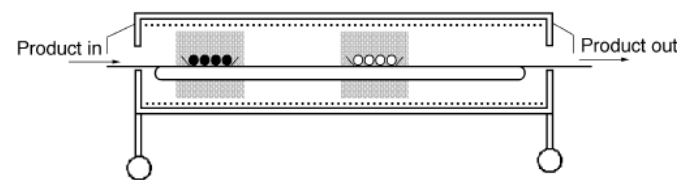
There are many possible combinations, and types of HT in feed processing



Most frequently used are:

- **Cooking**
 - ✓ at atmospheric pressure
 - ✓ in closed vessels under the pressure of steam
 - ✓ explosive cooking (2.3 do 3.0 Mpa)

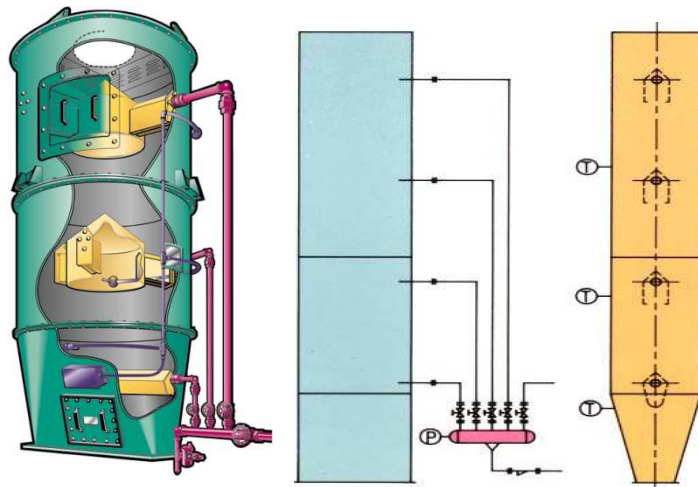
- **Roasting**
- **Popping**
- **Micronisation**



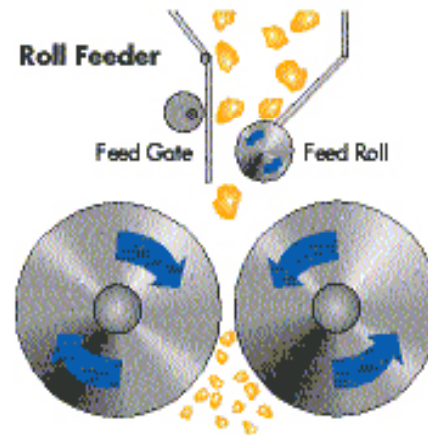
DRUM DRYER

Stages of the process

**Tosting/
Conditioning**



Steam flaking

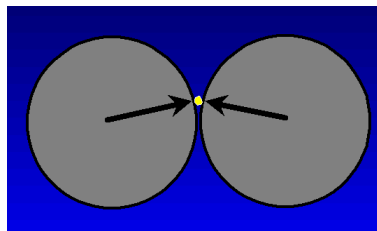


**Drying/
cooling**

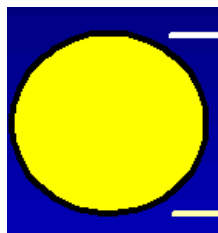


Hot fluid is steam

Flaking is mechanical process after HT which induce the additional influence of temperature.

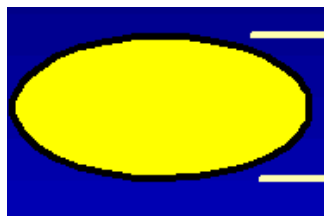


The efficiency of the processes depend on: moisture, temperature, retention time and thickness of the flakes.



$$P : V = 50 : 1$$

- Cross section
- Surface area
- Ratio of area (P) to volume (V)



$$P : V = 75 : 1$$



$$P : V = 200 : 1$$

Source CPM

Conditioning is preparing for the next technological operation (pelleting, extruding....)



Conditioning results with:

- improved physical quality of the product
- higher capacity of the device that follows in the process
- lower energy consumption
- less wear of working parts of the devices
- the possibility to treat more raw materials
- increased hygienic correctness of products
- increased usable value of products

Conditioning methods are:

- by water
- by steam (dry saturated 8-10 bara 150-180 C)
 - ✓ short-term(10 to 30 sec.)
 - ✓ prolonged (up to 3 min.)
 - ✓ long-terme (30 min.....)

Heating by direct steam infusion is limited.

For each 12-15 C moisture increased by 1%

- mechanically (for materials that are difficult to pelleted)
Pellet press, exspander, compactor.....

Material is compressed and excess air is extracted, which allows dosing of large quantities of bulk material on the pellet press

Higher energy consumption.

Pelleting does not lose significance due to the development of new technologies



**Jače predgrevanje
se obezbeđuje
produženim
kondicioniranjem**



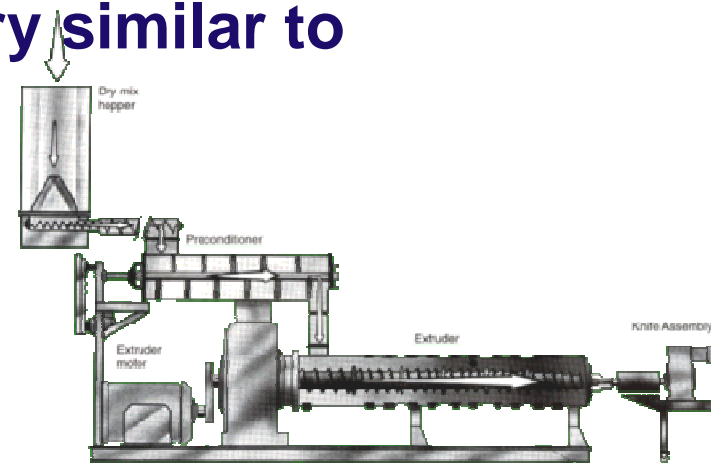
Ekspanding and extruding

Extrusion is the process in which the material (feedstuff or compound feed) is pushed through the barrel by means of screws of different configurations and pressed through the die at the end of barrel.

The extrusion and expansion processes are based on the same principles.

Basically, the expanders are very similar to extruders, and they differ in:

- the method of shaping of the final product and
- intensity of treatment



The basic concept of extrusion process is high temperature, short time, whereby the high temperature is a direct result of friction (dry extrusion), or pre-conditioning and steam injection (wet extrusion), or a combination of both.

The material for extrusion is exposed to relatively high pressure, which can range up to 25 MPa.

The pressure difference between the inside of the extruder and the external environment causes partial evaporation of water at the exit point, and hence the expansion of the product.

Thanks to extrusion, it is possible to achieve a range of effects on the treated material, such as:

- grinding
- hydration
- cutting
- homogenisation
- mixing
- dispersion
- compression
- heat treatment
- inactivation of antinutritional substances
- expansion
- binding of particles
- formation of porous structure
- partial dehydration
- sterilisation.

The type and intensity of induced changes depend on:

- the added energy in relation to time and quantity of product
- design of screws (spiral shape, segments for slowing down, type and length of individual segments, the ratio between the length and diameter)
- type and structure of the material to be treated, humidity and fat content,
- capacity,
- additional heating and cooling of each barrel section
- die geometry

Extrusion is a complex and complicated technological process, but it is very flexible and provides the possibility for processing of a range of different raw materials:

- **Oilseeds** (soybean, sunflower, rapeseed, cotton seed, peanuts, etc.)
- **Cereals** (wheat, corn, barley, rice, oats, etc.)
- **Legumes** (beans, peas and field pea)
- **Raw materials with high moisture content** (fresh fruits and vegetables, animal, fish and milk proteins)
- **Combinations of raw materials** (different portions of some of the above raw materials which are mutually complementary in nutrient content)
- **By-products and wastes from the food industry** (e.g. rendering plant products, meat and meat and bone meal, waste from fish processing industry, by-products of dairy industry, breweries, sugar refineries, etc.)
- **Complete animal feed mixtures** (balanced meals for piglets, calves, poultry, dairy cows and horses, fish feed, pet food, etc.).



Exstruding will be the topic in lectures of some of the most prominent world-class researchers and equipment manufacturers which are with us today.

Thanks for your attention