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HUMAN NUTRITION AND DIETETICS

200 LEVEL

NTD 210

FOOD PRESERVATION AND PROCESSING

SOLUTION

 **FRYING AND EXTRUSION**

1. EXTRUSION OF CEREALS

Cereal grains are grown all over the world and provide more food energy than any other type of crop, they are therefore staple crops. They can also be consumed in their natural form as whole grain and they are a rich source of vitamins, minerals, carbohydrates, fats, oils and protein. 

 ***IMAGE SHOWING THE DIFFERENT TYPES OF CEREALS***

A commonly used processing methods for cereal is extrusion. This technology is used to develop breakfast cereal, extruded snacks, cereal based ingredients and several other cereals based on extruded food products.

Cereals contain a large amount of starch and the starch usually insoluble, tasteless and unsuited for human consumption. Therefore, in other to make it digestible and acceptable, it must be cooked.  The machine which forces the mix through the die is an **extruder**, and the mix is known as the **extrudate**. The extruder consists of a large, rotating screw tightly fitting within a stationary barrel, at the end of which is the die. In the extrusion cooking process, shear is a fourth dimension that impacts product quality. Almost any cereal can be cooked using an extruder, but if expansion is a major objective, the numbers of functional cereals are limited to de-gemmed corns and rice. Cereals that have high amounts of lipids are more difficult to expand due to dough slippage within the extruder barrel. This type of cereal usually requires high moisture and high temperature before significant puffing will occur. The most common cereals used on a daily basis for making breakfast cereal and snack foods are wheat, corn, barley, rice, oats, sorghum

 The application of extrusion is able to bring gelatinisation, solubilisation and complex formation of starches, polymerisation of protein, partial or complete deactivation of enzymes, and reduction of microbial load and production of particular forms of texture. The process can be used to make many food products from cereal besides breakfast cereal and snacks, such as flat bread, soup bases, modified starches, brewing adjunct, drink bases, high dextrose equivalent syrups, biscuits, croutons, breading and confectionery. Besides these end products, extrusion cooking is also used for making intermediate products for further processing for both food and non-food uses.

 Merits of using extrusion

Some of these advantages include the following:

1. Adaptability: The extrusion process is remarkably adaptable in being able to accommodate the demand by consumers for new product
2. Product characteristics: The extrusion process allows a variety of shapes, texture, colour and appearances which is not easily formed using other production methods to be produced.
3. Energy efficient: the extruders operate at relatively low moisture while cooking food products, so less re-drying is required, this makes it enery efficient.
4. Low cost: the extrusion process has lower processing costs than other cooking and forming processes
5. Less space: the extrusion processing needs less space per unit of operation than other cooking system.
6. It reduces microorganisms in the final product
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 De merits of using extrusion

1. it creates insulin-desensitizing starches which is a potential risk-factor for developing diabetes
2. it leads to loss of lysine which is an essential amino acid necessary for developmental growth and nitrogen management
3. Destruction of Vitamin A (beta-carotene)

The Extruders used in processing snack foods can have four functions: mixing, cooking, shaping, and puffing. Various combinations of these functions can be performed simultaneously by a single piece of equipment.

 Types of extruders

The extruders are divided into two major categories: single-screw and twin-screw.

Single-screw extruders

These have compressive screws with decreasing channel depth turning at high speeds to increase shear and mechanical energy input for heating. The resulting friction induces heating of a product. In some cases, the barrel is jacketed for steam to allow additional contact heating in the metering section. To increase capacity and efficiency, it is common to preheat ingredients in a pre-conditioner by adding steam before they enter the extruder. The Categories of single-screw extruders include

1. The Cold Forming (Pasta-Type) Extruder: deep flight, smooth barrel, low shear speed. Little or no cooking. Used for pasta, pastry dough, cookies, egg-rolls, ravioli, processed meat and certain candy
2. The High-Pressure Forming Extruder: grooved barrels to prevent a slip at the wall and greater compression in the screw design. It is Commonly used for pre-gelatinised cereal and fried snack foods
3. The Low-Shear Cooking Extruders: moderates shear machines with high compression machines and grooved barrels to enhance mixing. Soft-moist foods and meat like snacks such as simulated jerky
4. The Collet Extruders: high shear machines with grooved-barrels and screw with multiple shallow flights. Used for puffed snacks and expanded curls or collets
5. The High Shear Cooking Extruders: high shear machines, with screws of changing flight depth are used to make pet food, ready-to-eat cereal candy, crisp breads, precooked food ingredients, pre-gelatinised corn flour, crackers and wafers.

Twin-screw extruders

This consists of two parallel screws in a barrel with a figure-eight cross section, the degree of quality control and processing flexibility they offer can make them attractive to food industries. Twin screws produce a more uniform flow of the product through the barrel due to the positive pumping action of the screw flights. They can also handle viscous, oily, sticky or very wet material and some other products, which will slip in single screw extruders, lead to less wear in smaller part of the machine than in single screw extruder and clean-up is very easy.

There are four types of twin-screw extruders which are:

1. Non-intermeshed, co-rotating
2. Non-intermeshed, counter rotating
3. Intermeshed, co-rotating
4. Intermeshed, counter rotating

 FRYING

 Frying is an old and widely used method of cooking and processing food. It is a process in which a food is immersed in heated oil for a short duration in a process known as immersion-oil frying. Numerous types of edible oils of plant and animal origin are used in frying, depending on regional availability. It is a cheap and fast process of simultaneous heat and mass transfer that changes the sensory and nutritional characteristics as result of complex interactions between food and oil

 Frying is efficient because it is a result of high temperature and fast heat transfer. The oil into which the food is immersed acts like a heat transferring compound. The process has a preserving action which is caused by thermal destruction of microorganisms, enzymes, and reduction of water activity on the surface of the food. Changes in food and oil depend on the characteristics of the food, oil type, surface volume ratio of the oil, and rate of air incorporation into the oil, temperature, heating process, length of immersion, and the kind of material the frying container is made of.

Frying process

The frying process is such a popular process due to the characteristics of the foods that are produced. It is a highly complex process. More specifically, there is simultaneous heat, moisture, and oil transfer taking place between the product and the heating medium (frying oil). There is also the formation of a crust layer and the composition of the oil is steadily changing throughout the process.

Frying mechanism

Deep fat frying or immersion frying

This is one of the oldest methods of cooking. Foods are fried primarily to cook and to make them more desirable, palatable, and digestible. Usually, foods to be fried are immersed in hot oil at a temperature range between 120 and 180°C, depending on the raw material and the final product desired, there are also physicochemical changes that take place during frying such as starch gelatinization which characterized by swelling of starch granules; protein denaturation; browning; crust formation, which develops as a result of drying out of the surface of the fried product; flavour component formation that characterizes fried foods; shrinkage; and swelling. These physical and chemical changes lead to structural transformations at both the macro and micro level.

Fried foods are high in calories.

Pan-frying

 This is the use of a shallow, slope-sided frying pan or skillet to cook in oil. It depends on conduction and convection. In pan-frying, a layer of oil has four functions: it lubricates the surface; increases contact between the food and the pan; reduces cooking time; and increases flavour and colour.

 There are several changes that are observed in oils when used in frying and they include:

* 1. The Development of unique sensory characteristics of oil and food being fried (see Sensory Evaluation).
	2. A Change in density and viscosity
	3. A Change in colour, such as darkening due to formation of polar compounds
	4. Formation of foam due to polymer formation
	5. Change in fatty acid composition, with increase in saturated acids
	6. Increase in acid value due mostly to hydrolytic reactions.

Frying Applications

Normal cooking vegetable oils such as canola, sunflower, corn, or soybean oil are good, but canola oil (low in saturated fatty acids) provides a better nutritional profile. Specialty oils such as virgin olive oil, roasted sesame oil, rice bran oil, groundnut oil, and butter/butter oil are applied for preparing special dishes with particular exotic flavour and taste.

**MERITS**

1. It adds an outside layer of flavour and crunch to soft foods.
2. Frying cooks and browns beautifully.
3. It adds texture and yields the smooth and taste-imparting feel that comes only from various oils and fats.

**DE MERITS**

1. The process of deep-fat frying is dangerous and requires special equipment and controlled environments

 **Equipment used**

 Pan-frying is practiced in stainless steel, aluminium, and heavy cast-iron skillets, all with sloping sides. Deep-frying occurs in the deep fryer with either a fry basket insert, the long-handled slotted skimmer. Deep-frying thermometers are used to help the cook maintain a constant temperature. Deep-fat fryers are available in many sizes, from large multi gallon commercial vats to small personal fryers that hold two or three cups of oil.

Other frying pans, too, are associated with specific foods.

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