Extrusion technology for the development of snack products enriched with fish

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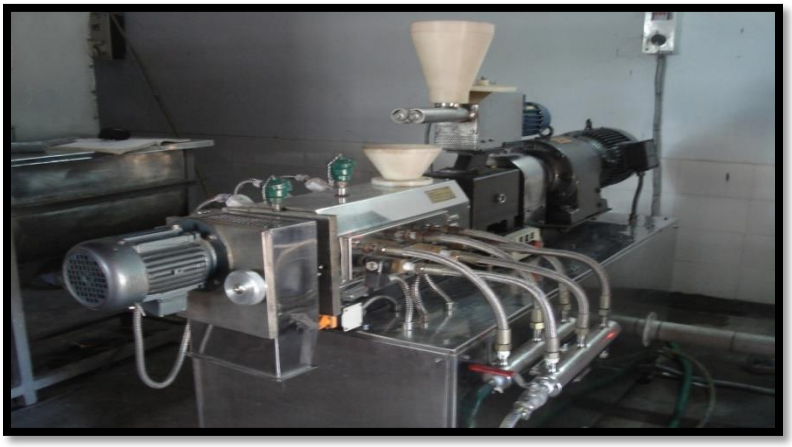
Food extrusion is a size enlargement process where small granular or powdered particles are reinforced into larger sized particles with different shapes, texture, colour etc. It is used for the manufacture of food products such as ready-to-eatbreakfast cereals, snack foods, soft moist pet foods and textured vegetable protein. In extrusion cooking, food material is heated either by an external heat source or through heat produced by friction and forced through dies to expand and extrude in desired shapes. Food extrusion provides a great versatility for the development of low-cost, high-nutritive and convenient food products such as cereal-based snack food products. Extruded snacks are gaining importance now-a-days due to their peculiar taste, texture and convenience.Food extrusionis a size enlargement process where in small granular food or powdered particles are reinforced into larger pieces with different shapes, texture, colour etc. Extruded products are rich in calories and contain low levels of protein, which makes it necessary to fortify them with protein-rich diets. One of the possible ways for alleviating this problem is to utilize fish and fish proteins to enrich cereal-based extruded products. Demand for fish meat and fish meat-based products is increasing and utilization of by-catch, low-cost and underutilized fish and shellfish is given greater emphasis. Utilizing fish meat and fish portions and its derivatives like fish protein hydrolysate powder, dry fish powder etc.to develop extruded products will add value to the low-cost and underutilized fish and shellfish, thus promoting their utilization.

Extruders

Extruders are the tools used to introduce mechanical shear and thermal energy to food ingredients.Extruders are classified into two according to operation: Hot and cold extruders. Based on type of construction extruders are classified into: Single screw and twin screw extruder. Twin-screw extruders are used for high-moisture extrusion, products that include higher quantities of components such as fibres, fats, etc. and for the production of more sophisticated products. Twin screw extruders are again classified as co-rotating and counter-rotating types based on the direction of rotation of the screws. In the counter-rotating position the extruder screw rotates in the opposite direction, whereas in the co-rotating position the screw rotates in the same direction.



Twin screw extruders consist of five main parts:

(i) Pre-conditioning system

(ii) Feeding system

(iii) Screw

(iv) Barrel

(v) Die and cutting mechanism

Pre-conditioning is not applied to all extrusion processes. It is applied when moisture contents around 20 to 30% and long residence times are required for of the material. Pre-conditioning favours uniform particle hydration, reduces retention times within the extruder and increases throughput and increasing the life of the equipment, due to a reduction in the wearing of barrel and screw components. It also reduces the cost of energy involved in the process.

The feeding system is normally composed of a holding bin where the material is loaded and the discharge of the material can occur through a vertical or horizontal feeding screw. It ensures a constant and non-interrupted feeding of the raw materials into the extruder for an efficient and uniform functioning of the extrusion process.

The screw of the extruder is its most important component. It determines the cooking degree, gelatinization and dextrinization of starch and protein denaturation and also ensures final product quality. Screws can be mono-piece or multi-piece. Screw elements can vary in number and shapes, each segment is designed for a specific purpose. Some elements only convey raw or pre-conditioned material into the extruder barrel, while other segments compress and degas the feed. Others promote kneading, backflow and shear.

Barrels or sleeve surrounds the screw and are often jacketed to permit circulation of steam or superheated oil for heating or water or air for cooling, thus enabling the precise adjustment of the temperature in the various zones of the extruder. Generally barrels are equipped with pressure and temperature sensing and temperature control mechanisms. The barrel is divided into feeding, kneading and high pressure zones.

The die has two main functions: to give shape to the final product and to promote resistance to the material flow within the extruder permitting an increase in internal pressure. The die can be in various designs and number of orifices. Dies are usually designed to be highly restrictive, giving increased barrel fill, residence time and energy input.

The cutting mechanism is necessary for obtaining final products with uniform size. Product size is determined by the rotation speed of the cutting blades. This mechanism can be horizontal or vertical.

Principle of extrusion cooking

Raw materials (cereal flours and fish meat/fish protein hydrolysatepowders) are fed into the extruder barrel through a feeder and the screws convey along it. Towards the barrel end, smaller flights restrict the volume and resistance to movement of the food is increased. As a result, it fills the barrel and the spaces between the screw flights and becomes more compressed. As it moves further along the barrel, the screw kneads the material into a semi-solid, plasticized mass. The food is heated above 100˚C and the process is known as extrusion cooking (or hot extrusion). Here, frictional heat and the additional heating that is used cause the temperature to rise rapidly. The food is then passed to the section of the barrel having the smallest flights, where pressure and shearing is further increased. Finally, it is forced through dies (restricted openings) at the end of the barrel. As the food emerges under pressure from the die to normal atmospheric pressure and temperature, it expands to the final shape, gets characteristic texture and cools rapidly as moisture is flashed off as steam.

Coating of extruded products

The flavouring of extruded products follows a similar pattern to colouring. A product with fish incorporated has characteristic fishy flavour and it may develop further flavours by thermal reactions between flavour precursors in the mix or be flavoured by adding synthetic or natural flavorings. The addition of flavouring is usually carried out on the dry extrudate by spraying or dusting, because of the changes caused by the losses of volatiles during extrusion.This can be performed with simple rotating drums with electric heaters installed or with a gas operated hot air installation.

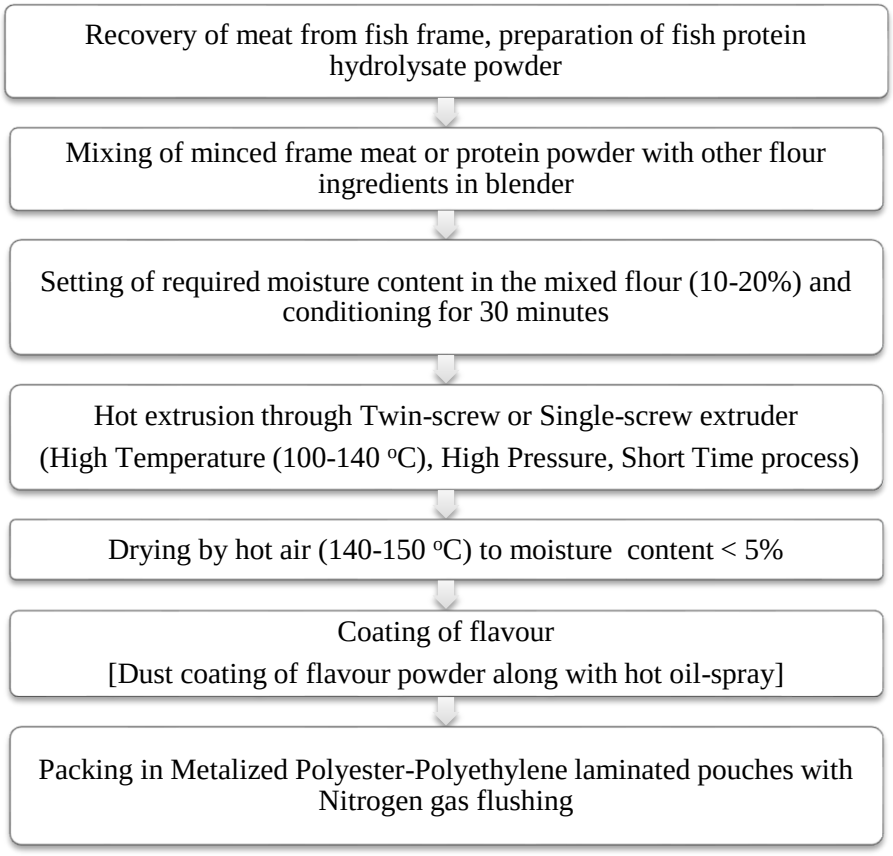
Packagingof extruded products

One of the major properties of snacks is the crispness, which is achieved during the manufacture of the product. Retention of desirable texture (crispness) is directly related to the moisture level in the product.The moisture content of snack is very low, and any increase due to the hygroscopic nature of the product may lead to loss of crispness of the product.Moisture also accelerates other biochemical changes such as oxidative rancidity. Oxygen inside the package may be replaced by an inert gas like Nitrogen. Low water vapour and gas permeability of the package is, therefore, a very critical requirement. Also the packaging material must be physically strong enough to withstand the processes of vacuumising/gas flushing. Metalized Polyester-Polyethylene laminated pouches with Nitrogen flushing are used for the packaging of extruded products.

Storageof extruded products

Extruded product can be stored at ambient temperature. Nitrogen flushed pouches can be bulk packed in carton box and stacked inside the store.Generally the shelflife of properly packed extruded products is four months.

Procedure for the preparation of extruded snacks enriched with protein from fish



Advantages of extrusion cooking

- Versatility - wide variety of products are possible by changing the ingredients, varying the operating conditions & and shape of the dies
- Low operational costs
- High production yields - operate continuously and have high throughputs
- Good quality nutrient enriched products - involves high temperatures applied for a short time and the limited heat treatment therefore retains many heat sensitive components
- No effluents - is a low moisture process, eliminates water treatment costs and does not create problems of environmental pollution

Extruded products and technologies developed and commercialized by ICAR-CIFT

ICAR-CIFT has developed technologies for the preparation of extruded products fortified with fishery products and by-products such as fish meat, cooked red meat from tuna canning industries, fish protein hydrolysate powders, dried seaweed powders. Apart from these, technologies for various agri-based products such as dried jack fruit seed powder, coconut milk residue, coconut haustorium etc.were also developed in collaboration with institutes like ICAR-CPCRI, Kasargode, CARD-KVK, Pathanamthitta etc. Various products were developed in ICAR-CIFT and commercialized through the Business Incubation Unit to several entrepreneurs.

References

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Advances in Food Extrusion Technology (2016).Edited by MedeniMaskan, AylinAltan. CRC Press