

Coated Fish Products for Export and Domestic Markets

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Man's quest for newer taste in foods knows no bounds. This has led to the development of a wide variety of coated food products, which have now become a part of culinary tradition. These foods include meat, poultry, vegetable, fruit and fish products that are covered with batter and breadings before cooking. The first commercially successful coated product was 'fish finger'. Later several other fish and fishery products became popular particularly with the advent of fast food trade. Battered and breaded fish products offer a convenience food valued widely by the consumer. Batters and breadings serve many functions as food coatings. But as far as fish-processing industry is concerned the most important function or advantage of coating is 'value addition' by increasing the bulk of the substrate and thus reducing the cost element of the finished product.

Key words : Coated fish products, value addition

The technology of coating has undergone several refinements and improvements. Today different varieties of sophisticated batters and breadings in different colours and mesh size are readily available and are used depending upon the requirements of the end products. Similarly the entire operation of processing of coated fish products starting from portioning/forming to the packing of finished products in appropriate packaging materials are being carried out using highly sophisticated and automatic machines of varying capacities. A large number of coated fish and fishery products both for export and domestic market based on shrimp, lobster, crab, squid, cuttlefish, bivalves, farmed fish and minced meat from low priced fish have been identified. In this paper an attempt is made to briefly review the technological improvements and advancements made in the field of coated fish and fishery products.

Food technologists all over the world are focusing much attention on the development of products that are convenient to the consumer while maintaining high standards of quality. Battered and breaded products are

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included in this developmental effort because of their diversity and appeal. Battered and breaded products offer a convenient food valued widely by the consumer (Suderman & Cunningham, 1983). Meats, fish, vegetables, fruits and cheese are coatable materials, which are commercially prepared in various forms. Many products are coated and immediately frozen, or they may be pre-fried, and then frozen for distribution and sales to consumers and food service establishments. They can be quickly reconstituted by conventional heating methods. Some products are designed for reheating in microwave ovens.

There is great demand for seafood/seafood based products in heat and eat convenience form. One factor responsible for such a situation is the increase in the number of women getting educated and taking up employment. Reasonably good income in the family, education, awareness and consciousness towards hygiene and health and increased emphasis on leisure pursuits are some of the other reasons.

Battering and breading enhance food product's appearance and organoleptic characteristics in addition to improving its nutritional value. Coating acts as a moisture barrier, minimizing moisture losses during frozen storage and microwave re-heating. The most important function of coating is value addition by increasing the bulk of the substrate thereby reducing the cost element of the finished product.

There are several ingredients used in the formulation of coatings. Each ingredient performs its functions to contribute to the unique characteristics and functionality of coatings. The commonly used ingredients fall under five categories. They are polysaccharides, proteins, fats, seasonings and water. Besides small quantities of leavening agents, gums, spices, colour, etc., may be added to provide specific functional effects.

There have been a number of interesting developments in coating technology during the past decade, many of which have originated from the USA although the Japanese industry is said to be more innovative than its US or UK counterparts. Probably one of the best-known coatings to come from Japan is the 'tempura' or puff type speciality batter. These batters provide coatings of exceptionally high volume, which are also light in texture.

Another innovative coating to originate in Japan, but which was subsequently developed in the USA is the aptly named 'Japanese crumb'.

Japanese-style bread crumbs are manufactured in a variety of different flavours and colours.

Most coated products are now available with a three-way cook option. They can be baked in a conventional oven, prepared under the grill or fried. The hunt is now on for coatings, which are suitable for use in a microwave oven. Fig.1 gives representative samples of coated fish products in different forms.

What is a coated product?

A coated food product is one, which is coated with another foodstuff (Tony, 1998). Two types of coatings are in common use. They are batter and bread crumbs.

Batters: Batter is a fluid mixture of water, flour, starch and seasonings. Batters are of two types, conventional-adhesive and leavened-tempura. Adhesive batter acts as a bond or interface between the substrate and subsequent coating. The primary purpose of batter is to increase crumb adhesion to the product. The formulation and viscosity of adhesive batters determine the amount of coating pick up. The thicker the batter (higher viscosity) the more crumbs will be picked up by the products. Consistent batter viscosity is required to produce uniform coated products. These batters are pumpable, and are suitable for continuous mixing. The batter should be kept cool to avoid the growth of microorganisms. Pre-chilled water should be used for mixing the batter where automatic temperature control is not available. When the batter temperature increases the viscosity falls and the batter will not stick to the substrate. However, if the batter temperature is very low and the fish to be coated is at a very low temperature, then the batter freezes on the conveyor belt. Tempering the frozen fish prior to battering will help to overcome this problem.

Leavened batters are referred to as puff or tempura batters. Wheat and corn flours play an important role in this system (Karel & Robert, 1990). Chemically leavened batter itself can serve as the outside coating of the food and thus requires visual and structural qualities more complex than those of the interface/adhesive batter. Because of the leavening action of these batters they cannot be pumped without substantial loss of the leavening gas (carbon dioxide). The wider use of tempura batter in conjunction with coarse crumbs represents a new coating process evolving into a major product line arrangement.

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Breadings: The term 'breeding' is a general or descriptive term that covers a wide range of cereal based food coating. A breeding is defined as a dry mixture of flours, starch and seasonings, coarse in nature and applied to a moistened or battered food product prior to cooking. The main ingredients used for batter mix and bread crumbs are more or less same but the manufacturing techniques employed are different. Most breadings are developed using certain variations of established baking techniques.

Breadings may be identified by their functional characteristics when applied to a substrate. The major functional characteristics of breeding are mesh size, area to volume relationship, browning rate, moisture absorption, oil absorption, colour and texture.

Mesh size, generally denoted coarse, medium and fine, is important in the formation of an attractive, economical coating system. Coarse particles are desirable to achieve visual and textural targets, however, its excess use on a small surface area may cause its falling off on transportation. Hence a balance among different sizes is desirable.

Area to volume relationship - A high area to volume, e.g. as obtainable in the case of fish fingers, permits good coverage with breeding. However, it will be difficult to apply coatings on cube shaped foods.

Browning rate depends on the proportion of reducing sugars in the breadings. Fast browning rates permit the use of high processing speeds, reduced frying time and lower temperature of frying.

Moisture absorption of breeding is a function of its particle size, porosity and gelation. It is porosity and mesh size that determine the rate of absorption of moisture and the texture of the product.

Oil absorption and rate of heat transfer are higher in porous than in dense granules. Oil absorption and exchange of oil for moisture during frying are important factors in the development of the proper texture.

Colour in the final product can be due to reducing sugars and also the colour, if any, added to the breeding.

Texture - Mesh size, porosity and absorption are the major factors contributing to the texture of the breeding. Coarse, dense crumbs may be

acceptable when the food is oven heated and non-oily appearance is desired. Dense crumbs absorb less oil when pre-fried; however, may yield an unacceptable hard texture when fully fried. It is appropriate to select a coating with medium particle size.

Breading types: A wide variety of breading materials is available in different size grades and colours. They can be used alone or in combination with other types of crumbs. Important crumbs are:

Cracker meal/Traditional breading is widely used in fish products. Unless other ingredients are added, cracker meal does not develop colour as quickly as other breadings.

Home-style bread crumbs are more porous than cracker meal and tend to absorb more oil and moisture. They cannot tolerate long frying times and tend to darken more quickly.

Japanese style crumb also called 'Oriental style or Panko crumb' has a characteristic flake-like elongated structure and excellent visual appeal and, provides a unique surface texture when fried. Because of its lightness, it is possible to produce the crumb in large sizes without the sensation of hard particles. As it is fragile, special care is required in applying the crumb. Conventional breading machines damage the structure quickly and the selection of an appropriate machine is essential.

Extruded crumbs are light and tend to float in oil, may turn black in the fryer and deteriorate the oil quality. Because of these the fryers are usually provided with a system to remove the floating particles.

Frying medium: Fat is the frying medium. Some fats may have specific flavour, which may be carried over to the product. Fat, besides being the heat transfer medium, is also a food ingredient and will influence the eating quality. Usually bleached and refined vegetable oils are used for frying.

The fat, because of the high temperature it is exposed to, may become degraded due to oxidation, polymerisation and contamination by food particles. Therefore, the fat used should be tested for evaluation of quality by determination of its free fatty acids, smoke point, peroxide value as well as colour for the prescribed standard limits.

Steps in the production of coated products

The production of coated fish products involves several process stages and steps and uses a subtle combination of art and technology. In most cases it involves the following steps.

Portioning/forming: The material to be coated, in the block frozen form, is converted into the required size and shape. This may be done manually using a band saw or in automatic cutting machine, where loss often of the order of 5-10% will occur. Skinless and boneless fillets of fish are, nowadays, converted into predetermined size and shape using specially designed forming machine. There are forming/moulding machines available for other applications.

Pre-dusting: This is for uniform batter adhesion in frozen or even greasy food surfaces. Pre-dust is often very fine raw flour, or may contain spices and seasonings.

Application of batter: Low viscosity batter can be applied in an overflow configuration; however, batter with medium viscosity requires a total submersion system depending upon the product requirements. After pre-dusting the product is drawn through the batter applicator where it will be submersed in the batter. The batter may be applied using a pour-on application system in addition to the submersion method. The line speed of the applicator shall be adjusted to ensure proper batter pickup. Excess batter, if any, is blown off in an air current using an air blower kept as close to the product as possible to prevent excess batter forming lumps and causing blockade in the breading machine.

Application of breading: Breadings are applied to the battered food products using breading applicators. Specially designed breading machines are used to ensure uniform particle size distribution or granulation on both top and bottom of the product with minimum crumb breakdown. For soft products the crumb depth is maintained as thin as possible to avoid product damage in the machine. A deep bed of crumbs is necessary for frozen or hard products. Pressure rollers are used to apply sufficient force to press the crumbs over the product. Any excess crumb is blown off as such particles carried to the dryer will appear as unsightly black specks on the product.

Pre-frying or flash frying: The coated products are often flash-fried in refined vegetable oil at 180-200°C for 20-30 seconds in order to set the

coating on the fish portion. The coated product is passed through the frying medium over a conveyor for the required time.

Freezing: The flash fried product will have the surface partially thawed whereas the centre will still be in frozen stage. Therefore, it is quickly frozen to maintain the quality. The flash-fried product is cooled in a current of air using fans. Cooling allows the coating to recover from the frying shock and also to stabilize itself. The product is then fed to the freezer through conveyor belts and is frozen till the core temperature is around -10°C .

Packing and storage: The coated product may undergo desiccation, discolouration and become rancid during storage. Use of proper packaging can prevent/retard these changes and enhance shelf life. Thermoformed containers are most commonly used for packing coated products. The packaged products are usually stored at -20°C .

Coating systems

The varied and complex systems, which are termed batters and breadings, are merely components of the finished product. Using these components products are custom designed in terms of texture, flavour and visual attributes.

The four basic coating systems are single line, Tandem line, Tempura or batter fry line and Tempura Japanese.

The single batter breading system, even one with a pre-dust rarely involves a pickup greater than 30%. Tandem lines consist of two batter breading machines and occasionally a pre-duster. Pickup with in this system is greater than 30%. The single and Tandem lines are commonly used for shrimp and fish sticks.

Tempura lines are used for products that are coated with a leavened batter and immediately fried. These batters must be applied and processed evenly because they are the outermost coatings in the finished product. In this method the coated products should not touch each other before the batter is set in frying. Pickup in this system is normally between 30-50%. In Tempura Japanese system a leavened batter in conjunction with Japanese style or porous breadcrumbs are used. Pickup in this case also varies from 30-55%.

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Equipment in battering and breading process

Prior to the introduction of machines breading lines in food processing plants consisted of a conveyor surrounded by a personnel who battered and breaded by hand. The process was slow, tedious, low production rates and difficult to maintain the hygienic standards. Today a large number of automatic and highly sophisticated processing equipment of varying capacities are available. Commonly used equipment in the production of coated products are grading equipment, peeling and deveining equipment, cooking equipment, meat bone separator, fish meat strainer, automatic band saw, forming machine, kneading machine, pre-duster, battering and breading machine, fryer, freezing equipment such as blast freezer, cryogenic thermal freezer, modular spiral belt freezer, fill and seal machine, vacuum packing machine with gas fleshing capability etc.

Determination of fish flesh content in frozen coated product

Fish flesh content in frozen coated fish product is determined by Anon (1997). The method uses (1) combination of heat and water to breakdown adhesive properties of coating (batter and / or breading) and (2) hands to assist in determining when coating's ability to adhere to flesh's frozen surfaces is diminished and can be easily removed. Fish flesh content is calculated using the formula $\% \text{ flesh} = (W_d / W_b) \times 100$. Where W_d is the weight of debattered and/or debreaded test sample; W_b is the weight of battered and/or breaded test sample.

Processing of some coated fish and fishery products for International market

Fish finger or fish portion

Fish fingers or portions or sticks (Fig.1) are regular sized portions cut from rectangular frozen blocks of fish flesh. They are normally coated with batter, and then crumbed before being flash fried and frozen. They may be packed in retail or catering size packs.

The typical British fish finger normally weighs about 1 oz (28 g) of which up to about 50% of the total weight may be batter and crumbs. Food Advisory Committee of the UK government has recommended a minimum fish content of 55% for battered and 60% for the fingers coated with breadcrumbs.

Fish blocks are the most common starting material for battered or breaded fish portions and sticks. The use of fish blocks has risen dramatically over the last 10-20 years. Fish blocks are boneless fillets placed together into a frame, compressed slightly and frozen to form a solid block of fixed dimensions. The blocks are convenient to store, ship and handle. A very common 16¹/₂ lbs fish block is 18⁷/₈ inches long, 10 inches wide and 2³/₈ inches thick. On the production line, the blocks are subdivided by a series of band saws and a subsequent chopper. The band saws determine the portion thickness, while the chopper cuts the portions into the desired width and shape. The most common shapes are square, rectangular, wedge and French cut. As the industry expanded, mince or fish flesh recovered by means of a bone separator, was added back in to the block. Some blocks, particularly those used for catering products are made with high proportion of mince, even up to 100%. Studies have indicated that fingers can be made from different white-fleshed varieties of low cost fish.

Antony *et al.* (1994) studied the effect of packaging materials on the shelf life of frozen fish fingers. According to them the fingers packed in LD/HDPE/NY/PC pouches remained in satisfactory condition up to 32 weeks at -20°C. Reddy *et al.* (1992) studied the frozen storage (-20°C) behavior of breaded and battered "fish fingers" prepared from croaker (*Sciaenidae*) and perches (*Nemipterus japonicus*). Fingers prepared from perch was found better than those prepared from croaker. The products were acceptable even at the end of the storage period of 22 weeks.

Shrimp products

Battered and breaded shrimp (Fig.2) can be prepared both from wild as well as from farmed shrimp in different styles and forms. The most important among them are butterfly, round tail-on, peeled and deveined (PD), nobashi (stretched shrimp), etc.

The products from farmed shrimp have indicated longer shelf life, 16-18 months compared to those from wild variety 12-14 months at -20 °C (unpublished data).

Squid products

Squid rings (Fig.2) and stuffed squid are the popular coated products processed out of squid. Cleaned squid tubes are cut in the form of rings of uniform size, cooked in boiling brine (3%) for 1-2 minutes followed by

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cooling, breading and battering. The coated rings are flash-fried, cooled, frozen and packed. Stuffed squid is generally processed out of small size animals. The cleaned tubes are filled with a stuffing mixture prepared using cooked squid tentacles, potato, fried onion, spices etc. It is then battered, breaded and flash-fried.

Clam and other related products

Meat shucked out from depurated live clams after boiling is blanched in boiling brine, cooled, battered, breaded, flash-fried and packed. Other bivalves such as oyster, mussels etc. can also be converted into coated products by the same method.

Fish fillets: The brined fillets are battered and breaded. Fillets from freshwater fish are also used for the production of coated products. The only problem noticed in this case is the presence of fin bones; its complete removal is still a major hurdle.

Mince based products

Fish mince from marine as well as freshwater fish can be used for processing a variety of coated products such as fish cutlets, burgers, balls, etc.

Fish cutlet: Cooked fish mince is mixed with cooked potato, fried onion, spices and other optional ingredients. This mass is then formed into the desired shape, each weighing approximately 30g. The formed cutlets are battered and breaded (Fig.1). José *et al.*, (1984) have studied the storage characteristics of cutlet prepared from low priced fish. According to them the raw cutlet had a shelf life of 6 days, 11 weeks and 19 weeks at 4 °C, -8°C and -20°C.

Fish burgers: More or less similar to fish cutlets, burgers (Fig.1) are made using mince of lean white fish and are only mildly flavored. Cooked mince is mixed with cooked potato and mild spices and formed into burgers using forming machine. Burgers are battered, breaded and flash-fried before packing and freezing.

Fish balls: Fish balls (Fig.1) are generally prepared from mince of low cost fish. Balls can be prepared by different ways. The simplest method is by mixing the fish mince with starch, salt and spices. This mix is then made



Fig. 1. Coated fish products: fish finger, fish burger, fish balls, fish cutlet and fish fillet

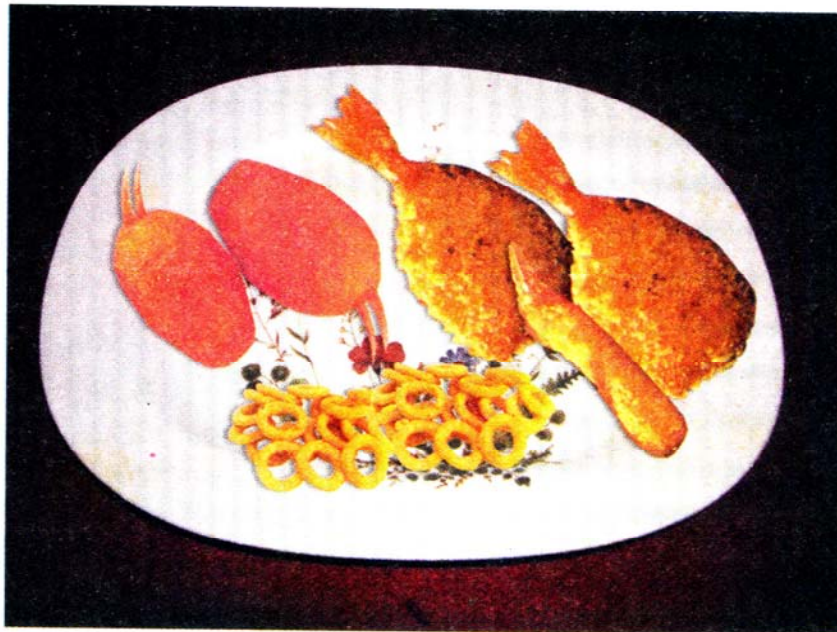


Fig. 2. Coated shellfish products: Crab claw balls, breaded shrimp and coated squid rings

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into balls and cooked in boiling 1% brine. The cooked balls are then battered and breaded.

Crab Claw Balls: Swimming legs of crab may be used for this purpose. Crab claws are severed from the body, washed in chilled portable water and the shell removed using a cracker. The leg meat is then removed and then mixed with 2% starch based binder and this is stuffed on the exposed end of the claw. Alternatively the body meat mixed with the binder also can be used for stuffing. The stuffed claw is then frozen, battered and breaded and flash fried (Fig.2). The coated products are packed in thermoformed containers with built in cavities.

Marketing

Marketing of coated fish products is completely different from the traditional seafood products. Appearance, packaging and display are all important factors leading to successful marketing of any coated product. Packaging requirements change with product form, target group, market area, species used and so on. The latest packaging must also keep abreast with the latest technology.

It is a recognized principle that the development of export market should have the backing of an equally strong domestic market. The rapid industrialisation and the consequent urbanization of rural India provide ample scope for development of such market. Increasing number of workingwomen, shrinking family size and general consciousness about hygiene and health etc. are other favorable factors.

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