Easiness of preparation is a welcome bonus

Marinated and coated microwavable chicken foods offer numerous varieties

Batter and breaded foods originated in northern England during the Industrial Revolution in the early 1820's. Cotton mill workers and other industrial labourers often had their main meal of the day in the factory canteens. These meals often consisted of battered, oil-fried fish in combination with potatoes fries. These "fish and chips" meals, wrapped in old newspapers, were a staple for generations and are the basic of today's modern convenience foods.

By Henk W. Hoogenkamp

There are nearly endless varieties in deep-fried chicken products.

It is widely believed that those "batter-breaded foods" evolved over time into today's convenient coated food products. Although contemporary convenience foods are mainly driven by American origin fast food, coated foods are relatively new to the United States. Japanese and Chinese cultures have used flour-dipped, oil-fried fish, meats, and vegetables for centuries.

Of all plant protein sources, soy isolate is used most often. However, there is an ongoing trend in the poultry food development to remove allergens and, as such, soy protein is increasingly being replaced by pea protein and micronized rice fibre. The latter is especially true for countries like the UK, Canada, and Scandinavia .

Besides eliminating soy plant protein ingredients because of allergenicity, the soy protein is also sometimes removed because of consumer responses that view and perceive the ingredient as unfavourable. Despite major gains in the last 20 years, soy protein is still associated with adulteration and this is an issue of concern for the soy industry. Even though massive marketing campaigns try to induce the love of consumers, soy protein is still not universally embraced.

There is an endless variety of coating systems. Most of the coated foods are wheat flour based and add extra value to formulated muscle foods. Of more recent development is the use of potato starch and rice bran and rice flour in coating systems for gluten-free products. Potato starches are high in amylose and are associated with improved textural properties. High molecular weight amylose starches deliver increased crispiness with greater oil resistance. The latter means less oil pick-up during frying, which results in crispier texture and less greasy appearance. Like plant protein, the use of potato starch and micronized rice bran as a pre-dust or batter component also improves adhesion, not to mention a significant reduction of oil pick-up.

Some pre-dusts contain adhesion-promoting ingredients, such as soy protein concentrate or egg albumen. Like vital wheat gluten, a 5% to 10% addition to the pre-dust formula of micronized rice bran has proven to be effective in improving the film barrier on retaining yield and crispiness. Pre-dusting is a good vehicle to carry spices and seasonings. Without pre-dust, a somewhat less strong adhesion will develop between the coating and the (formed) meat, which can cause the infamous "blow-away" from the product. Coating cracking is usually caused by insufficient and irregular uptake of the marinade ingredients combined with creation of steam inside the substrate during oven cooking. Overmixing can further complicate these variables, especially when traces of CO_2-snow are still present in the formed meat.

The use of functional plant protein ingredients in formed or marinated meat substrates is of importance in controlling moisture, enhancing flavour, as well as reducing costs. During thermalisation, moisture that has not been fully penetrated the meat membranes have the tendency to escape from the substrate and travel through the coating in the form of steam. Apart from negatively impacting yield, this phenomenon also causes the product to dry out and cause problems with coating blow-off and coating cracking. These properties are possibly the main values that functional non-meat protein, offers in moisture management during thermalisation as well as the final reconstitution prior to consumption.

Batter characteristics

Batters are a blend of starches, flours, seasonings, and possibly leavening agents that need to be mixed with water to form a viscous liquid. The batter liquid that adheres to the pre-dust provides adhesion, texture, crispiness, and flavour. Batter needs to be evenly applied to the meat substrate to allow uniform breading distribution. Apart from starch and carbohydrates, usually small amounts of gums, such as guar, xanthan, and methylcellulose are added to manipulate or fine-tune batter viscosity for better adhesion or faster throughput. Typically, batter is ap-

Coatings influence the surface of a product

Tab. 1: Coatings can be divided into the following categories

Flour based breading	Cracker meal breading
Japanese or Oriental bread crumbs	American bread crumbs
Batters, including tempura batters	Glazes
Rubs and rotisserie coatings	

Source: Hoogenkamp

Coating is an essential process step

Tab. 2: Examples for chicken coating sequences

	Step							
	1	2	3	4	5	6	7	8
Nuggets	Form	Predust	Cook	Batter	Flouring	Tempura	Fry	Cooling
Nuggets	Form	Predust	Batter	Breading	Par Fry	Cook	Cool	Freeze
Chicken Fingers	Form	Batter	Breading	Fry	Cook	Cool	Freeze	
Chicken Burgers	Form	Batter	Breading	Fry	Cool	Freeze		
Chicken Filets	Predust	Batter	Breading	Par-fry	Steam	Cool		
Escalope	Batter	Breading	Cook	Chill	Freeze			
Whole Broilers	Marinate	Roast	Chill	Freeze				
Parts	Cook	Predust	Batter	Breading	Fry	Cool		
Chicken Thighs	Predust	Batter	Predust	Coat	Cook			
Chicken substrate	Enzymes	Batter	Breading	Par Fry	N_2 freeze			

Source: Hoogenkamp

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plied with a batter machine that runs the product through a multi-layer batter curtain and bath, after which excess batter is removed with an air knife.

A spin-off version of adhesion batter is tempura batter. Tempura batters play a dual role, since it serves as the adhesion medium and outer layer at the same time. The main difference is the leavening agent that is added to the batter. Tempura batter is applied as the conveyor belt carries the product through the batter bath. A second belt on top guides the product down into the bath and ensures complete immersion for complete coverage. Since tempura batters cannot be circulated, a different type of applicator is used, sometimes called a "tempura dipper". In this system, a top and bottom conveyor transports the product through a batter bath, thereby preserving the batter's puffing effect. As the product leaves the bath, excess tempura batter is blown off. The product continues to a separate outfeed belt, which transfers it directly to the fryer with no excess tempura batter where it will puff up light and crisp around the product.

Leavening agents typically regulate texture and crispiness. Sodium bicarbonate, sodium acid pyrophosphate and/or sodium aluminium phosphate are usually used to obtain the right degree of the characteristic open and light structure. Tempura batters puff when fried due to the significant amount of leaving agents that provide the desired appearance and crunchy texture.

Coating for crunch

Breading crumbs are oven-baked cereals applied immediately following the pass through the curtain batter applicator. A conveyor belt transfers the product onto a bottom layer of breading. From a hopper above, a top layer is applied – the thickness of which is manually adjustable. A pressure roller or vibration plate system aids the breading in adhering to the substrate. Excess breading is then blown off and the product is transferred to an outfeed belt. Excess breading is returned to the circulation system, while the coated product transfers to the next stage of processing.

Even surprising snacks like „Chicken-Popcorn" can be produced using an adequate coating.

The choice of breading greatly influences final product characteristics, including texture, crispiness, crunchiness and eye-appeal. The most popular breadcrumbs are:

- American bread crumbs have a typical crunchy texture
- Extruded crumbs made with a continuous cooking extruder that allows textural properties to be regulated from dense to crunchy
- Cracker crumbs that have sort of a biscuit-like texture (called rusk in the UK)

A further coating system is the Japanese or Oriental crumb, which is produced from a highly yeast-leavened dough, providing an extremely porous product with a light and crispy texture that is suitable for many types of reformulated poultry foods. Oriental crumbs generally have a longer fry tolerance.

Batter and breaded foods usually contain about 8% to 15% oil absorption, and this is the only hindrance for its all-time popularity to soar even further. A major drawback of fried foods is the widely used hydrogenated oils that can dramatically increase unhealthy transfats. Despite the perceived high fat absorption of fried breaded chicken and the typical presence of skin, the products continue to enjoy worldwide popularity.

A possible solution to reduce oil absorption is to force a reaction between a calcium-ion source that is present in specially made breading and calcium-reactive pectin. This technology creates a barrier that shields the coated product from the usual oil uptake. Following the coating of the substrate, the product travels through a pectin solution prior to par frying. New technology is being developed using enzyme dips to improve microwave ability. Another innovative method to reduce oil absorption is to use modified pre-dust flour containing micronized rice bran.

A multi-step cover system is usually necessary to obtain high levels of pick-up. In affluent countries, there is a trend to decrease the total amount of pick-up from about 30% to about 22%. This reflects the desire of modern consumers, who do not want a thick batter interface but prefer a healthier, light-calorie coating system. However, there is a trade-off that taste might be sacrificed for lower fat pick-up. The consumer still longs for traditional golden-coloured batter and breaded foods that are deep-fried in oil with a crispy, crunchy texture, albeit at reduced total fat calories. Yet, it is also true that batter and breaded foods have lost some of their premium status and have begun to be relegated to price-sensitive shoppers. Especially in the UK, coated chicken foods have reached the point of lowest costs and have become very price-sensitive. The result of this is that innovation is no longer economically affordable.

Cook yield

To calculate for the cook yield (or pick-up), multiply the finished product weight by 100 and then divide by the starting green weight. For example: 600 kg of product were obtained from batter-breading and cooking 568 kg of chicken. What is the final yield percentage?

Answer:
600 kg x 100% / 568 kg =
105% cook yield or
5% pick-up

Cook yield is the percentage weight after the par or fully cook process.

Overall yield

To determine the percentage of overall yield, multiply the finished product weight by 100 and then divide by the product weight after the cooling or freezing cycle is complete. For example: 559 kg of product is obtained after batter-breading, cooking freezing from 568 kilos of green weight chicken. What is the overall yield?

Answer:
559 kg x 100% / 568 kg =
98.4% overall yield

Overall yield is the percentage weight at the end of the processing cycle after cooling or freezing.

Calculating pick-up and yield

Throughout the world of further poultry processing, there always seems to be some confusion on how to calculate the yield and pick-up. Under USDA requirements, marinating pick-up is based on green weight, while total breading or coating pick-up is calculated using finished (final product) weight. Therefore, a 25% marinating pick-up represents 80% meat portion and 20% added marinating (100 ÷ 100 + 25 = 80). However, a 25% breading pick-up reflects 75% meat portion and 25% added coating or breading ingredients.

Products that have more than 30% breading need to be labelled "fritters" under USDA regulations. In other parts of the world, these standards are often different and can be further complicated by the calculation methods used to determine the yield of breaded products that have been par-fried or fully-cooked.

Fully cooked convenience

Early versions of further processed poultry products, in-factory fully-cooked or fully-thermalised in oil frequently turned dry when reconstituted. These poultry products had excessive moisture loss, a problem that worsened when kept in a holding oven to maintain serving temperature. That's because prolonged frying tends to rapidly dehydrate the outer surface of the product. Today, most coated foods are flash-fried or par-fried after the pre-dusted substrate has been fully cooked.

The main purpose of frying coated foods is to seal the product and to create a golden-brown colour. However, in terms of product quality and convenience, much has changed in recent years. Both food-service operations and consumers want more convenience, albeit for different reasons. Low-skill food handlers are expected to operate by the imperative to control food-borne microbial risks, as well as by the pressing need for improved food handling during rapid re-thermalization. Consumers, of course, simply prefer to have "goof-proof" foods they can quickly heat and eat, hence, the desire for microwavable products.

Fish snack foods preferably need a light-calorie coating.

It is obvious that marinade distribution and moisture retention are key requirements. Poultry meat retains a fibrous appearance and texture when the marinade is fully absorbed. For reformulated boneless products, it often helps to increase the surface area of the meat by maceration to allow higher absorption. Macerating is actually a trade-off: the larger the surface area of the meat, the higher the absorption. Or to put it differently: the smaller the meat pieces, the less the simulation of whole-muscle appearance. However, protein-marinated meat has the tendency to realign itself. Apart from the selection and fine-tuning of marinade ingredients such as salt, phosphates, flavourings, and plant protein support ingredients, the processing equipment such as formers, coating systems, and thermalization conditions are main criteria to optimise quality.

Microwaveable coated chicken

Ever since the invention of microwave technology for home use, manufacturers of batter-and-breaded foods have tried to develop a system that allows direct heating of these products from the deep-frozen state. Most, if not all, of those attempts failed due to the lack of juiciness and crispiness.

Process in steps

Tab. 3: Example for processing of crumbed microwavable foods

Formed substrates
↓
The substrates travel through an enzyme-modified, temperature specific dipping solution
↓
Coat the dipped foodstuffs in a pre-dust, and fully cook
↓
Cover the pre-dust-coated substrates with a batter
↓
Apply breadcrumbs to the battered substrates
↓
Flash-fry the crumbed foodstuffs for 30 to 60 seconds, at 180 ° to 200 °C
↓
Blast freeze the flash-fried products for 20 to 45 minutes, at –21 ° to –28 °C
↓
Nitrogen-freezing and package and seal the frozen products
↓
Store the frozen products at or below –18 °C

Source: Hoogenkamp FleischWirtschaft International 2/2014

For some time, technology has been available to reconstitute formulated coated food and meat products directly from frozen state by means of microwave cooking. In general terms the close interaction between the type of oil, frying temperature and coating system determines the quality of crispiness and crunchiness. For years, the direct reconstitution from frozen state by microwave thermalization was a bridge too far for equipment engineers and food formulators. However, the challenge to heat and serve directly from the frozen state has been solved by implementing a series of specific in-line processing steps. Besides the need to reformulate most substrates in order to lock-in moisture migration, an extra enzyme dip is needed when the formed substrate travels through the processing line. At a specific enzyme solution and temperature, the substrate is "sealed" prior to the following sequence of pre-dust, batter, and breading coating. Upon inactivation of the enzymes, the substrate remains flexible and "plastify" which prevents moisture migration and coating cracking. This technology is especially of interest for low-fat further processed coated food and meat products.

However, with the advances of enzymatic technology, a groundbreaking solution is now available. As a departure from traditional coating systems, enzymatic treatment by means of an extra wash of the substrate will eliminate or greatly reduce the uncontrolled movement of free water in the substrate. The result is a coated product that retains its organoleptic qualities, along with texture, crispiness and crunchiness. However, additional equipment such as an applicator for the extra enzyme dip will be necessary, as well as nitrogen freezing to achieve the needed rapid and steep temperature decline. An additional downside to this new technology is the need to reduce fat (and skin) considerably, which may affect price economics and taste. This drawback might hinder successful penetration in the very price-sensitive market for batter and breaded foods.

Besides the additional processing step of enzymatic wash-treatment of the substrate, it is necessary to use a specially-formulated low-moisture extruded breading and change the substrate formula. An example of a schematic of processing line set up is as follows:

- Forming of the substrate
- Enzymatic treatment
- Predust (with fine crumb)
- Batter
- Coarse crumb breading (specially formulated)
- Fine crumb breading
- Flash fry
- Fully cook
- Nitrogen freezing
- Packing
- Reconstitution by Microwave

This system allows microwave cooking while safeguarding quality: crispy and crunchy on the outside and juicy on the inside. The easiness of fast food preparation by means of microwave is a welcome bonus. It can greatly reduce the complexity of a typical food service kitchen and speed up customer waiting time. For specific food service operations such as in-flight galley's preparation, coated foods and meat products can now finally be part of the airline menu offerings while maintaining much preferred organoleptic quality.

The enthusiasm of above needs to be put into perspective however. There are specific downsides associated by implementing the active enzyme substrate encapsulation technology. Besides the need to invest in additional specific processing equipment and special formulated breading, the necessity to immediately freeze the finished product to extremely low temperatures by means of nitrogen might complicate the cost efficiency in a market that is typically very price sensitive.

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