Chapter 10

Breadings—What They Are and How They Are Used

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Breadings (or *breaders)* refers generally to a group of cereal-flour-based blends or thermally processed wheat-flour dough-based dry bread crumbs. Breadings typically contain seasonings and chemical leavening agents and are applied as coatings to fried or baked foods to achieve certain textures, colors, and flavors. Suderman and Cunningham (1983) defined a breading as 1) a flour-based bread-crumb or cracker meal that is applied to a food in a dry form primarily to create a desired coating texture (the coating can be fine to coarse in particle size) or 2) a dry food coating made from flour, starch, seasonings, etc., that is fine in nature and is applied over moistened or battered food products. Breadings typically fall into one of the following categories, based on their processing, applications, functions, and end-product-attribute requirements: flour breadings, cracker meals or cracker crumbs (traditional breadings), American bread crumbs (ABC, home-style bread crumbs), Japanese bread crumbs (JBC or J-crumb, Oriental-style bread crumbs, or *panko),* and extruded crumbs.

Breading formulations, ingredients, and processing technologies have developed over time, and several different terminologies for breadings have come into use. However, there is a lack of standard concepts, definitions, and classifications of breadings among the breading industry and the processors for seafood, poultry, and snack foods. The situation could result in misunderstanding, miscommunication, and improper applications between the suppliers and their customers.

The batter and breading industry and end-users have created a set of terms that relate to a particular manufacturing process and finished product. Historically, breadings for fried chicken have been nothing more than seasoned, unprocessed wheat flours. These same preparations, when mixed with water, become simple batters, defined as suspensions of cereal solids (with or without seasonings) in water. In this example, a mix marketed as a batter, but used dry, can be termed a *breading*, a *breader*, a *coater*, or a *duster*.

Duster, or *predust*, refers to a fine, dry material that is dusted onto a food item or a substrate before the application of other coating materials. Predusts may contain unprocessed flours or blends of starch, egg whites, and other minor ingredients such as salt and spices. These types of materials may be used in a dry form as predusts or in water suspensions as batters.

In this chapter, *breading* is used only for a dry application for coated food. A mix that is marketed as a batter but used as a breading can cause unnecessary misunderstandings and confusions.

Breading is an appealing coating component for a variety of purposes. It mainly improves end-product qualities, such as flavor, texture, and appearance. This can add more value to substrates such as meat, fish, poultry products, and vegetables, to increase profits.

The use of breadings for food coating is hundreds of years old. Although breadings have been used by numerous sectors of the food-preparation industry for as long as foods have been fried, their use to commercially manufacture prefried convenience foods began only in the middle 1950s. The still burgeoning convenience-food and franchise-supply industries had their origins at that time, primarily in the frozen-fish area with the introduction of the fish stick or fish finger. It can be fairly claimed that the fish stick was one of the earliest frozen convenience foods.

This chapter attempts to refine the multiple definitions and concepts to allow a more concise discussion of breading characteristics, functional attributes, effects of ingredients on the functional properties, breading applications, finished-product characteristics, and methods of manufacture. For reference, breadings are defined here as thermally processed bread crumbs or dry flour blends used for food coating. They can be made from a blend of bread crumbs (such as cracker meals, American bread crumbs, Japanese bread crumbs, and extruded crumbs) or from wheat flour, in combination with other ingredients, such as corn flour, starches, gums, coloring agents, leavening agents, and seasonings.

Three themes form the basis of this chapter. The first is the functional attributes of breadings—the relationships among physical characteristics of a breading to create breaded or "coated" foods and how these factors can be optimized to provide products that meet definable market criteria. The second is an overview of breading classes and their means of manufacture. The final theme is breading applications and finished-product characteristics.

Functional Attributes of Breadings

Functional attributes are built into a breading such that it interacts with the coating application or fry-line conditions and with the food substrate to provide the parameters within which appropriately defined products can be manufactured. The parameters, which include visual, textural, and sensorial characteristics, are critical to a variety of coated foods.

Breading attributes are partially, and in some cases totally, dependent upon each other for effective coating quality. However, for purposes of clarity and ease of understanding, each is described separately below, with the dependencies made apparent in each section. The attributes are discussed first as being process-related rather than product-related, because coating processes influence the coated-product quality.

GRANULATION

Granulation is one of the fundamental physical attributes of breadings that influence breading behavior during storage and food processing. In the breading industry, breads are granulated into three broad ranges: coarse, medium, and fine. Typical ranges in terms of mesh and granulation size are presented in Table 10.1. Exact sizes depend on manufacturers and their customers, but general classifications are fine, finer than 16 mesh (U.S. sieve); medium, 8–16 mesh; and coarse, 4–8 mesh.

General size classification is a convenient way to represent breadings, but the granulation ranges can also be subdivided into more-detailed categories, such as extra coarse, coarse, and medium coarse in the coarse category. These subdivisions are based on customers' breading requirements and end-product needs for attributes such as appearance, texture, pickup level, and coverage. Some manufacturers use the percentage distribution of breading on given sieves to determine coarse, medium, and fine (for instance, defining medium-size breadings as 25% on a 20-mesh sieve, 45% on a 40-mesh sieve, 20% on a 60-mesh sieve, and less than 10% through a 60-mesh sieve). The reason for this is that each range of granulation has a particular role to play in the formation of a functional, attractive, and economical coating system.

Coarse granules, while they provide distinct highlights, visual interest, and crunchy texture, have small surface areas for any given weight and, as a result, have a slow rate of water absorption. They absorb moisture very slowly compared with fine particles, but breadings with an open structure absorb moisture faster than dense breadings. After tempered loaves are cut into convenient sizes using cubing, band, or reciprocating slicers, slow line speeds are required to provide sufficient time for drying the crumbs in conventional ovens or by dielectric or infrared means to a final moisture of 3–6%. The drying time may be much longer if the breads are to be processed to a compact density. Therefore, production line speeds and drying times are determined on the basis of crumb size and crumb texture. The efficiency or throughput of a production line is a primary cost consideration; as a result, the drying time of a breading is a major factor that affects productivity in any specific application.

A typical coating system is comprised of an adhesion batter and a breading (breader). Predust is optional as a first pass for improving adhesion, flavor, texture, and pickup. The drying rate, or setting time, of each coating component places a constraint upon line speed or throughput.

Medium-sized bread crumbs absorb moisture more quickly than do coarse ones because of a higher area-to-weight or -volume ratio. The absorption rate is dependent, in any individual breading, upon granulation, texture, and density. Medium-sized crumbs also contribute adequate weight, and they improve the continuity of coverage, which coarse crumbs cannot do.

TABLE 10.1
Typical Granulation Ranges for Processed Breadings

	Breading Category		
Granulation Measurement	Coarse	Medium	Fine
U.S. sieve, mesh	4–8	8–16	>16
Diameter, μm	2,400–4,700	1,200–2,400	<1,200

Fine crumbs absorb moisture even faster and lose their physical identity sooner than do coarse and medium-sized ones because of their very high area-to-volume ratios. Fine particles provide a rapidly drying matrix into which coarser granules can be embedded. Finer breadings are usually used on relatively small pieces of food substrates. A blend of coarse and fine breadings can provide combined functionalities and textural characteristics.

Due to influences of breading size on coating set time, product qualities, and line efficiency, many food processors use a combination of crumb particle sizes for coated products. This enables the production line to run at efficient speeds and provides economically appropriate yields, as well as the desired product attributes. Other factors, such as substrate shape, substrate size, and batter viscosity, also influence the performance of breading applications.

POROSITY AND DENSITY

Porosity is a measure of the void spaces in a crumb breading and is expressed as a fraction showing the volume of voids over the total volume. High porosity is typically exhibited by a coarse, open cellular structure. The porosity of a crumb breading is one of the most important attributes that impacts the quality of the coated product. Crumb porosity directly relates to the level of oil and moisture exchange during frying; the more porous the crumb, the more oil it absorbs. The amount of oil absorbed during frying affects the product's flavor, texture, and appearance. Breading density decreases with increasing porosity, and the strength, toughness, and ductility generally decrease with increasing porosity.

Degrees of breading porosity or density are affected by many factors, such as ingredients, flour quality, formula, process conditions, and so on. Density is a straight mass-to-volume relationship: density = mass/volume. The density of breading is measured in grams per cubic centimeter or pounds per cubic foot. The normal density range is from 0.6 to 0.2 g/cm^3 (37 to 12 lb/ft^3). The term *density* is often used interchangeably with the phrase *specific gravity*. However, specific gravity is defined as the ratio between the weight of a given volume of a material and the weight of the same volume of water.

Density or porosity and granulation of breadings are among the major determinants of texture, and both characteristics are also closely linked in determining water and oil absorption rates. Appropriate porosity is developed by the type and intensity of heat treatment applied to a breading during its manufacture. A breading with a more porous or open structure not only absorbs moisture more rapidly than a denser particle but also exchanges that moisture for frying oil more freely. Finally, oil drains more rapidly from particles that have high porosity, exhibited by a coarse, open cellular structure.

When porosity is combined with granulation, many possible variations from coarse and dense to fine and porous can result. The coarse and dense particles exhibit reduced moisture and oil absorption and resist fry-darkening, whereas fine and porous coatings absorb moisture and oil quickly and fry-darken quite rapidly.

The density of a breading is related not only to porosity or specific gravity but also to particle size or mesh. Density measurements in specifications refer to a particular breading of a described mesh. It can be misleading to compare densities of various breadings without eliminating mesh as a variable.

STRUCTURE AND TEXTURE

Bread crumb structure is developed through the processing steps, such as mixing, fermentation, punching, proofing, baking (thermal), and grinding to obtain a particular cell structure, cell wall thickness, and shape. Breading crumb texture is related to the perception of crispness, crunchiness, hardness, tenderness, toughness, and persistence. Due to the relationship between structure and texture, a breading process can be varied to develop a particular breading structure in order to achieve particular texture characteristics.

Some examples of breading structure include flaky and dense for cracker, granular flake and more porous for ABC, splinter flake and airy-open for J-crumb, and very fine-grained and dense for flour. The structural differences make oil and moisture exchange rates different during frying, which affects coated-product qualities, including texture, flavor, and color. From a strict process standpoint, porosity and shape are among the major determinants of texture.

ABSORPTION RATE

The rate at which a crumb absorbs moisture is a result of the interaction of crumb granulation, porosity, and the type of heat treatment a breading undergoes during its manufacture. Breading must fit with a specific batter to absorb moisture at a desired rate with controlled setup characteristics. For instance, high-speed processing lines require crumbs that absorb moisture fast so that breaded coatings set quickly. Therefore, the rate of moisture absorption by a crumb is a very important factor to ensure correct breading application on a substrate.

How soon a breading absorbs moisture from a batter to make the coating set is directly related to production efficiency and retention of acceptable product appearance. These rates are determined empirically by on-line tests under pilot or full-scale trials. Rapid rates permit a line to run at maximum throughput within the parameters imposed by the market. Absorption rates are measured in a variety of ways, some of which use instruments blending known amounts, such as 25 g of crumb and 50 mL of water, followed by observing the time, in seconds, to achieve "dryness." Dryness is defined subjectively as the visual absence of water on the breading surface. The sample must be of known, specified mesh. With practice and experience, one can make reliable comparisons that simulate on-line conditions.

The difference in moisture level between the crumb used for breading and the substrate or battered substrate is another factor that determines the absorption rate. Water always migrates from high-moisture materials to low-moisture materials to achieve moisture equilibrium, the condition reached by a sample when the net difference between the amount of moisture absorbed and the amount desorbed, as shown by a change in weight, becomes insignificant. After the crumb is applied to the battered food, the coating system creates a giant moisture gradient, especially between the crumb and the battered food, that results in water migration.

COLOR AND BROWNING

Bread crust color develops during baking. Carbohydrates caramelize or proteins and reducing sugars undergo the Maillard reaction. These reactions darken the bread crust and create characteristic flavors as well.

Golden brown has always been the most popular color for fried foods. To enhance brown notes in baked coating applications, caramel colors can be added to breadings to impart a rich, deep, golden color. Higher levels of reducing sugars such as lactose or dextrose add brown notes through increased Maillard browning.

A new trend in the coating industry is to blend colored particulates with breadings for visual attraction. The colored bits are usually made from specially stabilized spices or starch-based blends that don't blacken or brown at frying temperatures.

Breadings are available over a wide range of browning rates and mesh sizes, which enables processors to produce large food portions such as chicken parts in the following manner. The raw portions are fully cooked in water or steam, cooled, then coated and fried briefly to a color similar to the one obtained when fully fried. The rapid color development can be achieved by appropriate levels of reducing sugars found in milk solids or corn syrups, as well as agents such as paprika, turmeric, annatto, and caramel that give certain combinations of colors.

Rapid browning rates for coatings on fully cooked substrates not only permit high processing speeds but also allow reduced frying times and temperatures. Such productivity improvements have many commercial advantages. The savings apply not only to labor costs but also to improved returns on capital equipment, decreased product shrinkage, and the ability to use batters of higher solids-to-water ratios. The decrease in product shrinkage is caused by reduced moisture loss and less oil absorption. In practice, weight does not change significantly when a food is briefly fried (called parfried) because oil is exchanged for moisture on an approximately equal-weight basis. However, for parcooked substrates that will be frozen after parfrying and then fully cooked by frying or baking, the browning rate of the coating needs to be optimized based on the size of the substrate and the process conditions.

A coating of uniform coloration can be obtained by the blending of coarse and fine particles having specified rates of browning, while coating highlights after full cooking can be achieved by blending two different crumbs. This blending option is but one of many industry practices that provide color and mesh choices in so many combinations that variety can be thought of as normal in breading manufacture.

FRY TOLERANCE

Fry tolerance is defined as the ability of a breading to maintain its color, texture, and appearance through the frying process. Breadings vary substantially in the color, texture, and appearance they can provide during frying. Fry tolerance also directly affects these attributes, and excellent fry tolerance of crumbs should allow the food portions to be coated, fried, and completely cooked without causing defects in the attributes. Many factors (such as coating ingredients, oil, crumb ingredients, crumb processing, substrates, and fry processing) affect fry tolerance.

Breadings with rapid browning rates during frying have, by definition, a low fry tolerance. These permit coating production lines to run at high throughputs. A color that simulates a fully fried appearance can be obtained on commercial lines within 30–60 s by the careful selection of a breading with this characteristic.

A very coarse and low-tolerance crumb may give unacceptably dark highlights or coloring, whereas a finer-mesh, more-tolerant crumb will run safely with even more color at frying temperature settings well beyond 200°C (400°F).

Fry conditions can be adjusted for maximum output and rapid oil turnover, allowing the free fatty acid level of the oil to be maintained below 0.7% oleic, a level widely considered acceptable.

Effects of Key Ingredients on the Qualities of Breadings

The qualities of breadings depend on the functionalities of the ingredients in the formulation and the breading processes. Several major ingredients, such as flours, leavening agents, modifying agents, coloring and browning agents, and flavoring agents, are used to deliver the desired qualities in a breading. The effects of ingredients on breadings are briefly described below.

FLOURS

Grain flours, especially wheat flour, are the main ingredients of most breadings, and the function of the flours is primarily to affect bread-crumb structure and texture. Flours can be used directly as coaters or can be baked and ground into crumb. Nongrain flours, such as soy, potato, water chestnut, manioc, and almond flours, are often used to directly coat substrates or foods for specially "crusted" products. Nongrain flours are not usually used directly in the formulation of bread crumbs because of their higher costs and their impacts on dough properties during processing.

Consistency of flour quality is extremely important for manufacturing breaders because the flour's water absorption and the dough's physical properties affect the processing and functional properties of breadings. Flour-quality consistency can be related to protein quantity and quality; enzyme activity; and starch, damaged starch, and pentosan contents. Most of these parameters directly or indirectly influence flour water absorption, dough mix time, mix tolerance, dough mix stability, loaf volume, and crumb grain and texture. Therefore, flour specifications should be established as strictly as possible so that consistency of bread-crumb quality is achieved. Formulation and processing should be adjusted if the flour quality is not adequate.

LEAVENING AGENTS

Two kinds of leavening agents—chemical leaveners and yeast—are used in the production of breaders. Leavening agents are used to achieve a light and crunchy texture and to increase the volume and porosity of bread crumbs. Leavenings also play an important role in creating different textures of bread crumbs for different fried-coating products.

Yeast is the most commonly used leavening agent in bread-crumb formulas, while chemical leavening agents are mostly used in flour coaters and adhesion batters. A combination of chemical leavening and yeast has also been used in the manufacturing of breadings to create unique qualities of bread crumbs, especially extruded varieties.

Commercial yeast products include compressed yeast, bulk yeast, active dry yeast, and instant active dry yeast. Compressed yeast is better than the others for making bread crumb, based on gassing power and percentage of glutathione leached. However, compressed yeast must be stored at a consistent, low temperature in the bakery to prevent loss of gassing power.

Chemical leavening systems consist of sodium bicarbonate and acids that vary in their reaction rates under different temperatures. A blend of acids has been used in flour coaters for many products.

MODIFYING AGENTS

Modifying agents (fats, emulsifiers, dough conditioners, etc.) are used in the formulation of bread crumbs for their effects on porosity, loaf volume, and texture. Modifying agents have similar impacts on end-product quality as do leavening agents, but approaches to achieving results of similar quality are different.

Emulsifiers or dough conditioners added into a formulation for bread crumbs can improve the interaction of gluten subunits for gas retention and can reduce gas coalescence, resulting in good loaf volume and fine crumb grain. However, the mechanism for this effect is not completely understood. Emusifiers such as sodium stearoyl lactylate, calcium stearoyl lactylate, ethoxylated mono- and diglycerides, polysorbates, and diacetyl tartaric acid esters of monoglycerides are mostly used in yeast-raised bakery products, including breadings.

Breading manufacturers usually use emulsifiers in breading production to improve the quality of flours that may be not as good as those used for loaf breads. Emulsifiers can strengthen the gluten protein network for better gas retention, improved texture, and increased volume.

Selection of the type and level of the emulsifiers in breading productions should be based on the type of bread crumbs, ingredient quality, and processing conditions. In addition, cost, regulations, and benefits should be taken into account.

COLORING AGENTS

In the breadings industries, coloring agents such as paprika, spice extracts, and artificial colors are used for background hues and intense tones of bread crumbs. Using colored tortilla chips as part of a breading system also adds visual appeal.

The color of most fried foods is golden brown, as that is the one most accepted by consumers. However, many other color variations are possible, and they can also be acceptable. Some brown and toasted colors result from Maillard reactions, so formulations of breadings often contain reducing sugars and dextrins to increase browning through this process. Nonfat milk powder and whey powder are also frequently used. Breading manufacturers can also add caramel colors to enhance brown notes in baked applications. For a redder note, paprika or oleoresin paprika can be used, and annatto can add yellow or orange notes.

Breading Categories

Breadings are typically based on cereal flour, mostly wheat flour, or a product derived from a cereal flour, such as a bread crumb. Breadings typically fall into one of five categories based on their required function, cereal-grain base, and specialty application. Four of the breading categories meet the definition of "thermally processed cereal particles"; these crumb categories are cracker crumbs or cracker meal (CM), American bread crumb (ABC), Japanese bread crumb (JBC), and extruded crumbs. The fifth category consists of nonthermally processed flours. Characteristics of these groups are shown in Table 10.2, and comparative manufacturing processes of the thermally processed breadings are outlined in Figure 10.1 and detailed by Darley et al (1982, 1983).

CRACKER CRUMB (OR CRACKER MEAL)

Cracker crumb or CM breadings are produced from cracker-type formulations. True CMs depend upon extended fermentation times followed by intensively hot baking. Some CMs are produced without the fermentation step. CM normally has a hard and dense texture, Besides wheat flours, other ingredients are used to achieve the preferred texture, level of browning, and specific color required, such as yellow or orange.

A typical CM process is as follows. Flour, reducing sugars, salt, chemical leavening (optional), and any coloring agents are intensively blended and mixed with water in a mixer to form a dough, which is then forced through a series of paired rollers with decreasing clearance between them. This rolling action forms the dough into a sheet approximately 1 in. thick. Alternatively, the dough can be extruded in a sheet. The dough sheet is then conveyed onto a moving band or steel belt for rapid baking. The amount of effective cooking is adjusted not only by the baking time and the temperature, but also by the dough thickness and the water-solids ratio in the dough itself. The degree of cooking, or extent of cook, is determined by various cereal chemistry methods, e.g., amylography or differential scanning colorimetry. Discussion of this methodology is outside the scope of this presentation.

TABLE 10.2
Characteristics of Processed Breadings

Breading Characteristic	CM[a]	ABC[a]	JBC[a]	Extruded	Flour Coater
Granule shape	Flat/spherical	Spherical/ crumb	Splintered	Shredded/ dense	Grainy
Presence of crust	Minimal	High	Minimal	Minimal	None
Granulation					
Range	Wide	Wide	Wide	Medium/fine	Very fine
Mesh	4–100	4–80	4–80	20–110	>120
Color	Variable	Variable	Variable	Variable	White
Browning rate	Slow/rapid	Moderate/ rapid	Slow	Slow	Slow/ moderate
Density	High	Medium	Low	Low	High
Texture	Firm	Crisp	Tender to crisp	Firm to hard	Firm to hard
Water absorption rate	Variable	Rapid	Rapid	Rapid	Variable
Oil absorption	Low	Medium	Variable	Low	Low
Process suitability	Prefry, full-fry, raw-breaded	Prefry, raw-breaded	Full-fry, raw-breaded	Prefry, full-fry, raw-breaded	Prefry, full-fry

[a] CM = cracker meal, ABC = American bread crumb, JBC = Japanese bread crumb.

The baked dough sheet, which still retains approximately 35% moisture, is crumbled through a granulating mill or a slow-speed grinder. It is then dried to a final moisture content of approximately 8%. This moisture level ensures the long-term stability of the breading and contributes to its absorptive capacity. The dried large pieces are then roller milled, sifted, and blended as required to arrive at the appropriate mesh specification. Exact size designations for granulation depend on the manufacturer, but general classifications are fine (60–140 mesh, U.S. sieve), medium (20–60 mesh), and coarse (4–20 mesh).

Traditionally, CM is a finely granulated crumb that is simple and inexpensive. It is often used as a predust to improve total coating pickup. It often carries flavors and spices because they can be protected from the frying oil by the batter and outer coating. The breading, especially if it has coarser granulation, can be used as an outer coating, although it does not have some of the textural appeal that other types of crumb exhibit. Cracker-crumb or CM breading is very sturdy and can take the abuse of a commercial processing line.

AMERICAN BREAD CRUMB

These types of crumbs are typically used on raw-breaded or partially fried products destined for oven-heating. They are prepared from baked loaves of yeast-raised bread. After baking, the loaves are dried to the required moisture content and then ground and sieved into fine, medium, and coarse sizes. The crust of the bread provides darkened highlights. This crumb has a crispy and crumchy texture that is less tough than a CM crumb.

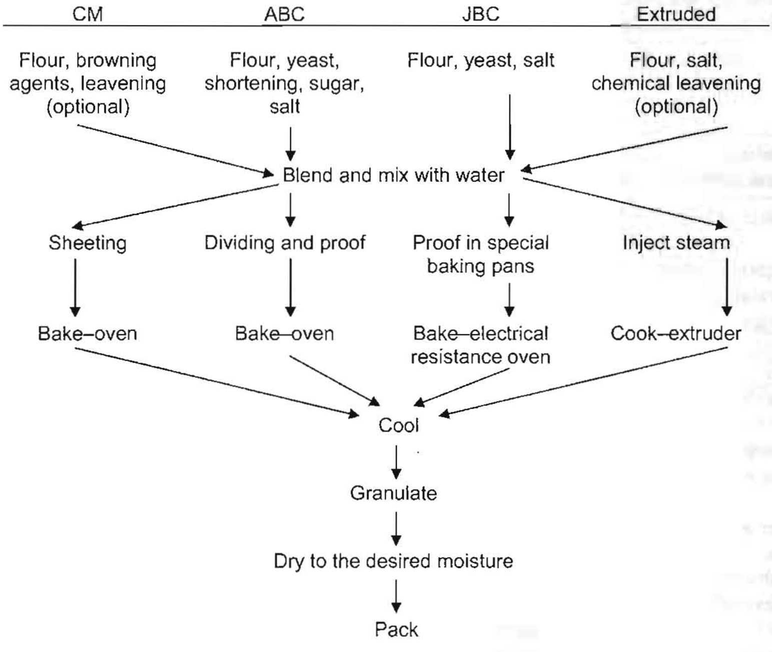

Fig. 10.1. Processing steps for breading manufacture. CM = cracker meal, ABC = American bread crumb, JBC = Japanese bread crumb.

These breadings are produced in a wide variety of ways that are centered about a traditional baking system. The flour is formed into a dough by combination with water, yeast, shortening, and appropriate levels of sugar and salt as required to meet the criteria of the final processor. Both batch and continuous mixing systems are used, but the procedures follow the mature technology of breadmaking. The dough is divided, proofed, and baked into loaves, which are allowed to cool and are then shredded, dried, and sifted to meet mesh specifications.

A movement toward ABCs exists, because of the crumbs' crispy and crunchy texture. However, the crumb industries are also looking for a crumb that is less fragile, and this is the opposite of where the market is going—lighter, crisper coating systems are inherently fragile.

The crumb has a round shape, is very porous, and, when fried, provides a nice crunch. This crumb also provides excellent visual highlights because of the varying crumb piece sizes and the occurrence of crust pieces. At times, it may be necessary to combine the coarse and fine crumbs, sometimes even flour, to improve the coverage of the product.

JAPANESE BREAD CRUMB

This type of crumb, also called *panko* type, is made using standard dough-mixing methods; however, the dough is proofed in special baking pans that permit a unique heat treatment during baking. This method of baking results in bread that is essentially free of brown crust particles.

Instead of oven-baking, manufacturers use alternative methods, either cooking via microwaves or using electrical resistance. These methods cook the bread rapidly and leave little or no visible crust. JBC has a more-elongated shape than ABC. It also exhibits a porous structure that results in a tender and crispy texture. By modifying the process and by adjusting the bread formulations and ingredients used, the characteristics of the crumb structure and the textural characteristics can be altered.

Use of the microwave baking process provides for a more resilient crumb for breading applicators. This patented process gives more resiliency while still having the same finished-product attributes.

An alternate method of baking utilizes electrical resistance, which allows the proofed dough to be cooked rapidly in 10 min or less. The pans are unloaded, and the loaves are cooled, shredded, granulated, dried. As previously noted, these crumbs are crust-free and have a very porous character and splintered appearance. Such crumbs are available with natural colors such as paprika or annatto or with FD&C certified colors.

The JBC is tender, delicate, and crisp in texture but is more fragile than its Western counterpart. As a result, care must be taken on the production line so that the crumb does not break down. Special breading applicators have been developed to minimize the crumb breakdown.

EXTRUDED CRUMBS

Breadings can be made on a wide variety of continuous mixers or cooker-extruders. These machines have also been used to manufacture pregelled starches, low-density snacks, and crispy crackers. In this system, flour is continuously mixed under highly turbulent and intensive conditions; steam is injected; and the resulting slurry of cooked flour is pumped through an orifice. The processing conditions generally involve a temperature of 150°C at a pressure of 120 bar for a period of 15 s. Under these conditions, the starches within the dough are gelatinized, and the continuous "rope" of cooked dough produced is then shredded, dried, and sifted.

The extrusion process offers ample advantages over traditional processes for breading preparation. Extrusion is able to make use of a wide variety of raw materials, provide for short and economical processing times, occupy minor processing space, and offer a great deal of flexibility for the processes. The crumbs can be engineered to enhance performance, such as increasing the fryer tolerance of a cracker meal analogue or mimicking the ability to toast like ABC and JBC analogues. Extruded crumbs are of medium size, strawlike, hard, and open-textured. The can be produced in different colors and are used as an outer coating or as a predust.

A variety of crispy corn flakes also have been used in the coatings industry. The flakes are not only high in fiber but also add a new, unique texture to coated products that may be fried, baked, or cooked in the microwave. Cereal manufacturers have designed corn flakes specifically for use in breading formulations for coating chicken, meat, fish, and vegetables. Flakes with distinctive flavor profiles make ideal choices for breading appetizers, entrees, and frozen foods. Crushed flakes, which feature small granules, can add a special texture and flavor appeal. A broad range of flakes are available, including mini-flakes that are dense, as well as larger, thin flakes. To improve sensory appeal, the coating industries have developed a variety of lightly sugar-coated flakes for breading application.

GRAIN-FLOUR BREADINGS AND NONGRAIN-FLOUR BREADINGS

Flour breadings, i.e., coatings that are not thermally processed, create an uneven, home-style appearance. The majority of them contain flour from grains. Most of these breadings consist of wheat flour; however, rice flour, corn flour, and malted barley flour may also be used. In addition, grain-flour breadings might contain other ingredients, including starches, gums, food fibers, chemical leaveners, coloring agents, and seasonings. Nongrain-flour breadings, such as soy, potato, water chestnut, manioc, and almond, are usually used for value-added applications or to allow certain claims, such as low-carbohydrate, special texture, gluten-free, or other health considerations.

Grain-flour breadings can be divided into three subcategories—plain flour breading, classic breading, and original breading—based on inclusion or exclusion of additives or spices. As its name implies, plain flour breading is just plain flour without additives or spices. Classic breading contains a limited number of additives or spices. It is exemplified by the common blend of flour, salt, sugar, and pepper that many people use at home. Original breading, which is the most common and popular, is a special combination of various flours in addition to many different spices, herbs, and seasonings.

For people who have certain food allergies (e.g., gluten or casein) or may be on a low-carbohydrate diet, alternatives to grain-based flours can serve as breading substitutes with excellent results. For example, almond flour, made of finely ground almonds, can be used in place of regular breading with the exception that the temperature of the fryer should be slightly lower than usual.

Other flours, such as pecan or hazelnut flours, have functions similar to those of almond flour when used as a breading substitute.

An alternative gluten- and casein-free breading involves the use of manioc flour. Manioc is not a grain; rather, it comes from the tropical cassava root. Roasted manioc flour has a texture and, when seasoned with spices, a flavor similar to those of a corn-flake crumb breading. Roasted manioc flour breading can be used for chicken nuggets that are made in batches and frozen to be used later as convenient, "fast food" meals. It can also be used for other meats, such as pork chops, and as a cracker-crumb substitute in omelets.

Water-chestnut flour has been used as a Chinese cooking ingredient for a long time. Chinese people usually mix it with rice flour to make *dim sum* items like steamed puddings. When used as a breading, water chestnut flour makes a fried product very crunchy.

WHOLE-GRAIN BREADING AND GLUTEN-FREE BREADING

Consumer demands for healthy choices have led batter and breading companies to develop whole-grain and multigrain breadings. Multigrain breading contains more than one type of grain besides wheat and is made of whole-grain flour, which contains all parts of the grain kernel, including the bran, germ, and endosperm. Whole grain is a healthy choice because it contains nutrients, fiber, and other healthy plant compounds found naturally in the grain.

Demands for gluten-free breadings have been increasing during the last decade. These breadings are developed for people with celiac disease caused by eating gluten—a condition that damages the lining of the small intestine and prevents it from absorbing parts of food that are important for staying healthy. Gluten is found in wheat, barley, rye, and possibly oats. All gluten-free breadings need to meet the 20-ppm maximum defined by the U.S. Food and Drug Administration. The processing equipment must be cleaned before manufacture of gluten-free breadings to avoid cross contamination.

Characteristics of Finished Products

Breadings make all types of foods look and taste good, but they also provide and protect flavor, texture, and appearance. In addition, these products may offer some nutritional value related to health and fitness. Those who develop products coated with breadings, however, face several technical challenges. Different flours, different bread crumbs, different crumb processes, and different crumb formulations can be used to accomplish different goals and achieve the best results in terms of finished-product characteristics.

APPEARANCE AND COLOR

The appearance and color of coated foods have dramatic influences on how the products are perceived. Applying coating to meat, fish, or vegetables with breadings is one of the ways to make these foods more attractive. It is so true that people eat with their eyes.

In addition to a rich, golden color resulting from frying, breadings can also have some highlights that increase eye appeal. Other ingredients, such as bacon bits, spices, herbs, or parsley flakes, added to a breading can increase visual excitement. These breadings, called inclusion breadings, provide the product with another layer of texture and flavor.

While coarser fractions do provide initial, visual interest, there are constraints upon the proportion of coarse granules that is appropriate. The criteria to be considered include product shape, the yield requirement from both regulation and textural standpoints, and the reheating method to be used.

Some foods such as onion rings have high area-to-volume ratios; here, the proportion of coating is usually half or more of the total weight. In such cases, a high proportion of coarse particles is practical and can be desirable to give a specific textural impact. Other foods, either because of low area-to-volume ratios or regulatory constraints, may have quite low yields; in such cases, the proportion of large particles must be held at low levels to ensure an even coating and to avoid the excessive loss of poorly held coarse crumbs at the point of serving.

A crumb breading system gives a product with a uniform surface, while a flour coater provides a home-style appearance. Most items for the foodservice industry are fried once, at the point of serving. The selection of browning rate and particle size must take into account the frying time required to ensure that the food is fully cooked from a frozen state. Large substrates or long-frying foods require a slow browning rate since the crumb is in contact with hot oil for a long time. Parfried foods that are fully cooked in an oven just before being served require a fast rate of browning to achieve an appetizing appearance because breadings brown less or more slowly in an oven.

Golden brown always has been the benchmark color for fried foods. Product developers have tried other color combinations, such as reddish brown, orange-yellow, etc., by using natural or artificial colorants in a breading or adhesion batter. Also, processed cereals, such as ground colored tortilla chips, starch-based color bits, etc., have been used to add special visual appeal.

TEXTURE

Crumb type, particle size, porosity, shape, and absorption are the major crumb factors that contribute to texture. Coarse and dense crumbs may be acceptable when the food is oven-heated and a nongreasy appearance is desired. Dense crumbs tend to absorb less oil when prefried. However, this type of crumb, when deep fried, may have an unacceptably hard texture. Coarse and porous crumbs for both deep-fry and oven-bake applications generally give crispy textures. In some cases, however, where the coating is present at low levels, the fine material may be insufficient to retain the oil, and the surface may appear excessively "wet."

In general, each category of crumb breading gives a distinct texture, with ABC or extruded crumbs providing crispy crunchiness, JBC contributing tender crispiness, and cracker meal yielding crunchy hardness. Cracker meal, ABC, and JBC have a splintered shape, while extruded crumbs have a shredded shape. The major factors that contribute to texture are the base's mesh, porosity, and absorption. Selection of the type of crumb texture is usually based on the substrate. Hard substrates require hard, crunchy crumb texture while soft substrates require crispy crumb texture.

Breading companies incorporate several different crumb types for more textural interest. A variety of other ingredients can create a three-dimensional look. These include cereal crumbs, tortilla crumbs, potato shreds, and bean thread noodles. Each adds unique flavor as well as textural and visual appeal.

Flour coaters can provide different types of texture through variation of the formulations. Flour coaters, which are manufactured from flours ranging from fine flour to coarse meal or a mixture of both, create a flakey, home-style appearance. The addition of starch, spices, leavening, or coloring helps to customize the texture, flavor, and color. Breading manufacturers use leavening agents to achieve a light and crunchy texture.

Through oil penetration into a coating, the frying of a coated product can obviously improve the product's mouthfeel. Additional texture from a layer of coating makes a fried food very desirable. Examples include a light bread crumb adding a nice crispy texture to soft, gooey mozzarella sticks or tiny shell-off shrimp or a heavier crumb adding crunch to a perfectly cooked chicken breast.

FLAVOR

Flavor retention in a breading might be one of the most challenging areas for the coating industry. Most flavoring components are oil-based volatiles with very low tolerance to frying temperature, and they either flash off or scorch during frying. The key to solving this problem is to identify flavoring ingredients that can survive the high temperatures yet be economical or to introduce flavors to those parts of the finished products where the flavors can be preserved.

Much of the appeal of breaded foods comes from the process by which they absorb fat in the fryer. In addition to fatty mouthfeel, adding fried-food flavor might be the key attribute that makes the product taste good. The type of crumb used affects flavor. Some crumbs are more flavorful than others. The crumb's texture and porosity can also affect flavor as they can impact the amount of oil absorbed during frying which, in effect, changes how the flavor is perceived. Too much fat absorption is associated with an oily taste but with a prolonged flavor impact. Too little fat usually makes the product taste dry with a harsh flavor.

Coating systems can also serve as a flavor carrier, and almost any spice can be added to a system to enhance the product's flavor profile. However, when breading food, it is important to keep the favor components as far away as possible from heat, as some of the flavor can be lost in the cooking process. Therefore, using a flour or fine crumb predust with a high level of flavorings leads to more-successful flavor retention as compared to adding the spices and flavors to the outer crumb.

Breadings frequently contain peppers and spices not just for flavor but also for visual appearance. Salt levels may be fairly high, often in the range of 3–12%. Many practices use very high levels of spices in order to preserve a perceivable level after frying if a predust or batter is not an option. Natural or artificial flavors can also be used, with flash-off as a major concern.

Use of encapsulated flavors, which help to deliver bold flavor notes that carry through the frying to the finished product, is a new trend in the coating industry. It is a very economical way to deliver sufficient flavor without the need for high levels of flavor in the formula. For frying applications, any encapsulated flavor is acceptable if it prevents the flavor from being flashed off and does not add undesirable color to the product after frying. The encapsulation matrix can be based on starch, protein, gums, or inactive yeast cells.

DRYNESS

Consumers like fried foods but don't accept a greasy appearance. A visually dry surface of a coating is usually associated with a perception of low oil content, but this may not be appealing if it results in a dull color. The coating thickness, which has a major effect on dryness, is a function of the surface-to-volume ratio and the desired pickup level for a specific food. A very oily appearance can be offset by the selection of a nonporous, medium-particle-size crumb with an adhesion batter that sets early to form a film, thereby reducing oil uptake. Dryness of a product when tasted can be minimized by increasing the level of fat absorbed.

Summary

In this chapter, breadings have been defined and their characteristics outlined. Various commercial breadings, effects of major ingredients on the breading functionalities, and finished-product characteristics of breadings have been described.

This overview is presented as an indication of the scope of this industry and in the hope that it may be of assistance to those concerned with the production and marketing of breaded foods.

Cited References

Darley, K., Dyson, D., and Grimshaw, D. 1982. Production of Oriental-style breading crumbs. U.S. patent 4,423,078.

Darley, K., Fenn, M., and Dyson, D. 1983. Manufacture of bread crumb-like product. U.S. patent 4,354,961.

Suderman, D. R., and Cunningham, F. E., Eds. 1983. Batter and Breading Technology. AVI Publishing Co., Westport, CT.

Additional Resources

Gerdes, S. 2001. Batters and breadings liven tastes. Food Prod. Design 11(9):81-95.

Kuntz, L. 1997. The great cover-up: Batters, breadings and coatings. Food Prod. Design 7(1):38–57.

Schwarzbach, Z. 2002. Uncovering breadings and coatings. Food Prod. Design (http://mamakaong.tripod.com/breadings_coatings.htm)