



FOOD PROCESSING

BACKGROUND READING

A recent search for “processed food” on the internet brought up results that suggest, by and large, that they are harmful to health and should be avoided.¹ Why have processed foods garnered such media criticism? This module sheds some light why and how foods are processed, as well as the actual harms and benefits associated with the industry.

In this curriculum, **food processing** is defined as the practices used by food and beverage industries to transform raw plant and animal materials, such as grains, produce, meat and dairy, into products for consumers.²⁻⁴ Nearly all our food is processed in some way.⁵ Examples include freezing vegetables, milling wheat into flour and frying potato chips. Slaughtering animals for meat is also sometimes considered a form of food processing.

Although some forms of food processing use the latest technology, others have been practiced for centuries. Early Egyptians brewed beer and discovered how to bake leavened bread, and the ancient Greeks made salted pork, a precursor to ham and bacon.³

Modern food processing is sometimes defined as taking place at a plant or factory.³ This is distinct from food preparation, which usually takes place in kitchens.³ Many activities—washing and cooking, for example—are common to both processing and preparation. The companies that process foods are sometimes called food manufacturers.⁶

While food processing can offer many benefits to businesses and consumers, certain aspects of the industry raise concerns over nutrition, food safety, worker justice, local economies and the environment.

Degrees of food processing

Not all foods undergo the same degree of processing. In this curriculum, processed foods are classified in three categories: minimally processed food, processed food ingredients and highly processed food.⁴ Even though there is no universally accepted method of categorizing processed foods, it is helpful to make the distinction between foods like toaster pastries, which are highly processed; flour, which is a processed food ingredient; and milk, which is generally considered minimally processed. These distinctions allow for a more nuanced discussion of processed food.

Minimally processed food

Fruit, vegetables, legumes, nuts, meat and milk are often sold in minimally processed forms. Foods sold as such are not substantially changed from their raw, unprocessed form and retain most of their nutritional properties.^{5,7,8} Minimal forms of processing include washing, peeling, slicing,

juicing and removing inedible parts.^{4,7,9} Some nutritionists also characterize freezing, drying and fermenting as minimal forms of processing.⁴ To prolong **shelf life** and inhibit the growth of **pathogens**, perishable foods may have preservatives added to them, or they may be sealed in sterile packaging.^{7,9,10} Some minimally processed foods and beverages may be exposed to controlled amounts of heat, or in some cases radiation, to inactivate pathogens.^{7,10} Milk, for example, is commonly heat pasteurized.^{7,10} After purchase, consumers may cook these foods and mix them with other ingredients as part of their preparation.

Processed food ingredients

This group includes flours, oils, fats, sugars, sweeteners, starches and other ingredients. High fructose corn syrup, margarine and vegetable oil are common examples.⁴ Processed food ingredients are rarely eaten alone; they are typically used in cooking or in the manufacture of highly processed foods.⁴ To create these ingredients, starting materials such as grains and oil seeds may be milled, refined, crushed or exposed to chemicals.⁴ Unlike minimal forms of processing, these techniques radically change the nature of the original raw materials.⁴ Processed food ingredients tend to be **nutrient-poor**,⁴ meaning they are high in **calories** relative to the amount of vitamins, minerals and other key **dietary nutrients**.

Highly processed foods

Highly processed foods are made from combinations of unprocessed food, minimally processed food and processed food ingredients.⁴ Many are designed with consumer convenience in mind.⁴ They are often portable, can be eaten anywhere (while driving, working at the office and watching TV, for example) and require little or no preparation.^{4,11} Discussions of “processed foods” in the popular media often refer to products in this category. Highly processed foods include snacks and desserts, such as cereal bars, biscuits, chips, cakes and pastries, ice cream and soft drinks;⁴ as well as breads, pasta, breakfast cereals and infant formula.^{4,5,11} Highly processed animal products include smoked, canned, salted and cured meats¹¹ and products made from extruded remnants of meat, such as nuggets, hot dogs and some sausages and burgers.⁵ Many vegetarian alternatives to meat are also highly processed.¹¹ Highly processed foods are made using techniques like mixing, baking, frying, curing, smoking and the addition of vitamins and minerals.⁴

Given the wide variety of foods that could qualify as highly processed and the lack of any clear, widely accepted criteria for defining them as such, it is difficult to make any generalizations about the nutritional value of highly processed foods. Some health professionals, however, have expressed concern over the growing popularity of certain highly processed foods in diets.^{5,12-14} These concerns are discussed further below.

Why are foods processed?

Food manufacturers process foods and raw ingredients to add value to their products,² in the form of longer shelf lives, added dietary nutrients, appealing textures and other features.

Preservation

Historically, the most important reason to process or prepare foods has been to make them last longer before **spoiling**.¹⁵ Early civilizations used techniques like salting meats, fermenting dairy (into cheese or yogurt, for example) and pickling vegetables.¹⁵ More recently, in the 1790s, Napoleon Bonaparte offered a prize to the scientist who could best develop ways to preserve foods for the armies of France; the competition prompted the discovery of safe canning practices by Nicolas Appert.² Louis Pasteur, working with beer and wine, would later discover **pasteurization**,² a process that uses controlled amounts of heat to extend the shelf life of milk, juice and other products. Some argue that preservation is still the most important reason to process food because illness, even death, can result from eating spoiled food.² When perishable products have longer shelf lives consumers can enjoy them for a greater part of the year,^{2,3} distributors can ship them over greater distances, and retailers can stock them on shelves for extended periods.¹⁶ Refer to *Food Distribution and Transport* for more information.

Food Safety

Processing and preparing foods can make them safer to eat by destroying toxins and eliminating or inhibiting pathogens.³ Preservation techniques such as refrigerating, freezing, fermenting, drying and adding salt or sugar can slow or stop the growth of pathogens.³ Heat processes, such as pasteurization and cooking, can eliminate pathogens.³ Because these techniques help protect consumers, most cases of **foodborne illness** involve raw animal products, fruits and vegetables that have been contaminated by pathogens.¹⁷ For more information, refer to the module on *Food Safety*.

Variety

By modifying the flavors, textures, aromas, colors and form of foods and raw ingredients, food processing can create greater variety in our food supply.^{6,18} Grains, for example, can be milled into flour, which is then used to make a wide variety of products.^{6,18} Grains are also the core ingredients in most ready-to-eat breakfast cereals. In 1860, Dr. J. H. Kellogg invented a form of granola-like cereal designed to fit the austere diets of Seventh Day Adventists; he and his brother later founded the company that bears his name.¹⁹ Today, a trip down the breakfast aisle of a supermarket reveals a tremendous variety of products that are derived, in part, from wheat, rice, corn and several other grains. Breakfast cereal manufacturers achieve this variety by adding flavors, cooking, drying, toasting and spraying on vitamins.²⁰ The shapes of cereal grains are altered by processes like shredding, flaking (flattening them in a roller), puffing (expanding them with pressure) and extruding (using high temperatures and pressures to force a slurry of grains through a hole).²⁰ Changing the qualities of foods in these and other ways can make products more appealing to some consumers.³ Every year, roughly 20,000 unique processed foods are introduced on retail shelves;²¹ of these, only the most highly successful remain.²² New products are further discussed in *Marketing and Labeling*.

Convenience

Food processing can create products that require little or no preparation on the part of consumers.^{3,19,23} Among the early examples of processed **convenience food** was pemmican, strips of dried buffalo meat mixed with fat and berries that could be eaten “on the go” by First Nations peoples of the Great Plains.¹⁹ Modern examples include baby food, canned foods, frozen pizzas, instant noodles, bottled juices and ready-to-serve cakes, cookies and pies.^{19,23} Fast food offers another form of processed, ready-to-eat calories for busy eaters.¹⁹ From 1966 to 1999, the amount of time U.S. adults ages 25 to 54 spent cooking meals decreased by 25 percent (43 percent among women).²⁴ Americans, in general, are consuming fewer calories at home and more at full-service and fast-food restaurants.²⁵ These trends may reflect a growing demand among busy consumers for convenient food.⁶

Nutrition

Enrichment and fortification are two of the ways that processing can restore or raise nutrient levels in food. **Enrichment** means the restoration of some of the nutrients that are lost during certain forms of processing (refer to the section below on dietary concerns).¹⁹ **Fortification** goes a step further; it means adding certain nutrients *above* the levels that naturally occur in a food.¹⁹ The term fortification is also used more generally to refer to any addition of nutrients to a food.²²

Fortification was designed to prevent nutrient deficiencies in the general population.²² In the 1830s, French chemist Jean Boussingault advocated adding iodine to table salt to prevent goiter (enlarged thyroid glands),²² a condition frequently caused by iodine deficiency. Today, many foods are typically fortified in the United States, including salt (with iodine), milk (with vitamin D) and grain products (with thiamin, niacin, riboflavin, iron and folic acid).²² These additions have helped prevent nutrient deficiencies in the U.S. diet, but food manufacturers sometimes use fortification as a selling point for foods of questionable nutritional quality, such as candy, snacks and sweetened breakfast cereals.²² Some research also suggests that synthetic vitamins may not offer the same nutritional benefits as vitamins that occur naturally in food.²⁶

Some forms of preservation can also maintain nutrient levels in certain foods. After fruits and vegetables are harvested, they begin to lose their nutritional quality.²⁷ Freezing or canning can preserve levels of certain nutrients.²⁷ Despite a common belief, canned foods are not necessarily less nutritious than their fresh or frozen counterparts.²⁷ Factors such as when the produce was harvested, how long it had been stored and how it will be prepared determine whether the fresh, frozen or canned version of a food is the most nutritious choice.²⁷

Dietary concerns

Although highly processed foods are not inherently unhealthy, many foods in this category are high in added sugar, sodium, saturated fats or trans fats and contain little dietary fiber.⁴ Some of these foods, such as cakes, cookies and soft drinks, are among the major sources of calories among U.S.

adults²⁸ and children.²⁹ Breads and snack foods are often made with **refined grains**—grains that have been processed to remove the bran and germ, which contain important nutrients like B-vitamins, iron and fiber.³⁰ Since fortification replaces only a small fraction of nutrients in the diet, 100 percent **whole grains** and other whole foods are recommended over refined alternatives.²² The convenience that many highly processed foods offer may also encourage unhealthy eating patterns, such as skipping meals and overconsuming calories.⁵ “Premium” versions of highly processed products exist, such as those with less sugar, fat or salt, no trans fats and various fortifications.^{5,22} Some of these may be an improvement, while others simply replace reduced levels of fat with higher amounts of sweeteners.⁵ Premium products also tend to be more expensive, making them available only to those who can afford them.⁵ Given these concerns, some nutritionists recommend diets based primarily on unprocessed and minimally processed foods.⁵

Food safety concerns

Although many forms of food processing are designed to minimize food safety risks, rapid growth in the food processing industry can contribute to foodborne illness outbreaks.³¹ As processing plants have become larger (refer to the section on concentration and consolidation, below), they handle larger volumes of products—sometimes from many different sources—and distribute them over a broader geographic area.³¹ This can increase the risk of widespread exposure to contaminated products,³¹ as evidenced by the 2009 nationwide recall of contaminated products made with peanut paste.³² For more information, refer to the module on *Food Safety*.

The *Food and Drug Administration* (FDA), an organization responsible for ensuring the safety of our food supply, has been criticized for inadequately inspecting food processing facilities.^{33,34} To help address this gap, the FDA has been advised to hire more food safety inspectors and provide them with additional training.³³

Worker justice impacts

In addition to affecting our food supply, the practices common to certain food processing industries affect the people who work for them. In particular, workers in U.S. meat and poultry processing plants often suffer health risks, poor working conditions and labor violations.³⁵⁻³⁷ They may be expected to perform dangerous tasks, such as working with sharp knives and hooks, under hazardous and exhausting conditions, sometimes without adequate training.³⁷ Injuries, some life-threatening or fatal, are not uncommon;³⁵⁻³⁷ 36 percent of employees in the meat industry are injured each year.³¹ Compared to all other job categories, the food processing industry as a whole ranks among the highest for job-related injuries.³¹ Injured employees of meat and poultry processing plants are not sufficiently protected under U.S. labor laws; they are often unable to receive compensation and an injury may cause them to lose their jobs.³⁷ Processing plants frequently hire migrant workers who are willing to accept low wages and poor working conditions.³¹ In some cases, illegal immigrants are smuggled into the country by the companies that

hire them^{31,36} and face fears of deportation.^{36,37} These and other threats of retribution can squelch efforts on the part of employees to organize unions.³⁷

Social and economic impacts: Industry concentration and consolidation

The U.S. **food system** has been compared to an hourglass:³⁸ at the top are many producers, at the bottom millions of consumers. The narrow part of the hourglass represents the small number of companies that largely control how food is passed between producers and consumers. The industries at this bottleneck, including food processors and retailers, can have considerable influence over who produces food, how it is produced and what is eaten.^{38,39}

Flour milling, soybean processing, dairy processing and livestock slaughter are among the processing industries that have grown more **concentrated** under the control of a small number of companies.^{40,41} For example, only four companies control over 80 percent of the beef packing industry.⁴² Under this arrangement, farmers have fewer choices of where to bring their crops and animals for processing.³⁹ As a result, they may be pressured into adopting the production practices dictated by the dominant companies—particularly when they are locked into contracts—and may lose the autonomy to set their own prices.³⁹ Contracts are further discussed in the module *Food Animal Production*.

Some processing industries have also become more **consolidated**,⁴³ meaning there are fewer and larger processing plants.⁴⁰ As smaller processing plants shut down, producers may be left without any nearby facilities to process their crops and animals. For more on industry concentration and consolidation, refer to *History of Food*.

In some areas, the addition of more **local** and **regional** food processors may help “loosen” the bottleneck between producers and consumers by offering farmers more options on where to process their goods.^{44,45} Partnering with nearby processing and slaughtering facilities can also help farmers sell their products directly to consumers, as opposed to shipping their products to a far-off facility.⁴⁶ By dealing with fewer middlemen, farmers can retain a larger share of profits, keep money within their own region and strengthen its economy.⁴⁶ For more information, refer to *Food Distribution and Transport*.

Environmental and health concerns over packaging

Food packaging can offer numerous benefits, such as making products easier to store and transport, preserving them and making them easier to prepare.^{6,47} It also allows for the display of marketing, labels, recipes and other information.⁴⁷ Solid waste from food packaging, however, poses an environmental concern. Food packaging accounts for roughly two-thirds (by volume) of total packaging waste in the United States.⁴⁷ Discarding packaging materials in landfills has the potential

to pollute air and water, while combusting them for energy can emit **greenhouse gases**, dioxins and other pollutants (depending on the materials used) that are harmful to health and the environment.⁴⁷ Recycling, **composting** and reusing containers offer more environmentally sound alternatives. Manufacturers can also reduce the amount of materials used in food packaging, ideally without compromising benefits to consumers.^{6,47}

Some forms of food packaging also pose health concerns. Bisphenol A (BPA) is a chemical commonly used in the linings of metal cans and in the manufacture of hard plastics, such as some bottles and food storage containers.⁴⁸ Studies have found links between BPA exposure and cardiovascular disease, diabetes, male sexual dysfunction, certain cancers and changes to immune function.⁴⁸ A recent study of products packaged in metal cans and plastic wrap, including soups, vegetables and infant formula, detected low levels of BPA in those foods.⁴⁸ As a precautionary measure, some manufacturers have stopped using BPA in bottles and packages.

Conclusion

Most of our food has been processed to some degree, sometimes using techniques that have been practiced for centuries. Processing food offers many benefits: It can enhance preservation, reduce food safety risks and create greater variety in the food supply. However, the practices and ingredients used in some highly processed foods raise dietary concerns. Furthermore, the nature of the current food processing industry can have a negative impact on food safety, worker justice, the economy and the environment. Addressing these problems will require concerted efforts on the part of consumers, workers, businesses, policymakers and other stakeholders in the food system.

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