



Meat
Foundation

A Guide to Meat Processing

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1 | Introduction

Robust scientific evidence demonstrates that meat is a rich source of high-quality protein, essential vitamins, and highly bioavailable minerals that support human health throughout the lifespan. Studies consistently show its role in maintaining muscle mass, preventing iron-deficiency anemia, and supporting cognitive development, while also contributing to overall nutrient adequacy in diverse populations. Despite this strong scientific support, public discourse around meat consumption is often clouded by confusion over processing definitions, labeling practices, and ingredient functions. This white paper provides clarification and presents the scientific case for meat—particularly processed meat—as a safe, nutritious, and essential component of modern diets.

This white paper serves as a guide to nutrition experts, public health authorities, and the scientific community. By reviewing existing published scientific information, this article assesses how meat is processed, common categories of processed meats and their characteristics, the meaning of different labeling claims, and an overview of the nutritional benefits and public health implications of meat consumption.

1.a. What is Meat?

According to the American Meat Science Association, meat is skeletal muscle and its associated tissues from mammalian, avian, reptilian, amphibian and aquatic species harvested for human consumption. Edible offal such as organs and non-skeletal muscle tissues are also meat.¹ Products within the meat category are often subdivided into numerous other categories recognizable by consumers. Some meat subcategories include red, white, game, fresh, poultry, processed, and more. These subcategories do not adequately describe the unique properties associated with the various products and species, such as visual and cooked color, myoglobin content, lipid content, and nutrient profile, and are inappropriate to classify meats for health and nutritional purposes broadly.² Among the numerous meat³ subcategories, there is an overlap of products which contributes to confusion among health professionals and consumers.

All meat undergoes some degree of processing—from basic cutting and packaging to sophisticated preservation techniques. Recognizing these gradations is crucial for evaluating both nutritional impacts and potential public health implications. Meat is either classified as minimally processed or further processed at the point of sale to consumers.⁴ Ultimately, at the point of consumption, all meat is fully processed.

Minimally Processed Meat (MPM): Raw, uncooked meat products that have not been significantly transformed compositionally and contain no added ingredients. Products may be reduced in size by fabrication, mincing, grinding, and/or a meat recovery system.

Further Processed Meats (FPM): Products that undergo an alteration, beyond minimal processing. Products may contain approved ingredients and/or be subjected to preservation through salting, curing, drying, or fermentation; thermal processing; batter/breading; or other processes to enhance sensory, quality, and safety attributes. Products may include ready-to-cook or not ready-to-eat and ready-to-eat⁵ products.

¹ Seman, D. L., Boler, D. D., Carr, C. C., Dikeman, M. E., Owens, C. M., Keeton, J. T., ... & Powell, T. H. (2018). Meat science lexicon. *Meat and Muscle Biology*, 2(3), 1-15.

² *Id.*

³ The term meat as used throughout the paper includes poultry.

⁴ Seman, D. L., Boler, D. D., Carr, C. C., Dikeman, M. E., Owens, C. M., Keeton, J. T., ... & Powell, T. H. (2018). Meat science lexicon. *Meat and Muscle Biology*, 2(3), 1-15.

⁵ Ready-to-eat- Meat products that require no further preparation on the part of the consumer before they are consumed. These products are often reheated to enhance palatability.
Ready-to-cook - Poultry that is eviscerated, with or without removal of the head, feet, and skin, and is ready to cook without the need for further processing other than washing."

2 | Meat Processes

There are numerous ways meat can be prepared into minimally and further processed products for consumers. Meat is processed for many reasons, but often it is for sensory enhancement, storage extension, and, most importantly, food safety. Table 1: “Processes applied to meat to create minimally or further processed meat items,” outlines a few of the common meat processes, defines them, describes the function or purpose of that process, and gives examples of products that undergo that process and whether the result is a minimally or further processed product.

2.a. Sensory Enhancement

A consistently satisfying eating experience is vital—not only to encourage repeat purchases but also to support nutrient intake from the dense protein and micronutrient profile of meat. People will not consume products they do not enjoy, and meat is a nutrient-dense food that provides essential nutrients as part of a healthy, balanced dietary pattern. Meat is an excellent source of many vitamins and minerals. People can obtain many essential nutrients by including meat in their diet, consuming relatively low calories compared to getting those same nutrients from other foods.

Characteristics that enhance sensory and contribute to a positive eating experience include visual attributes, aroma, and palatability. Meat color has the most significant influence on consumer perception and visual acceptance of products.⁶ Consumers desire both raw and cooked products to have an acceptable color. The ideal color for raw beef is a bright cherry-red color, raw pork should be reddish-pink, lamb should be pinkish-red, and cured meat should have a bright pink color. When addressing the aroma characteristics of meat, the largest concern is off-odors. Over time, off-odors can develop and alter consumers’ acceptance of meat items. The biggest off-odors of concern include rancid, oxidized, sour, and putrid. The palatability of meat is determined by the tenderness, juiciness, and flavor of products. In many cases, meat items are processed to improve one of these sensory characteristics, with the largest influence on improving tenderness and flavor.

Processing meat for sensory reasons includes everything from adding spices and seasonings to enhance and add flavor, to curing products to get an attractive, bright pink color. Many meat products are processed to add or enhance flavor beyond the natural flavor inherent to meat products. For example, pork loin may be marinated with teriyaki seasoning and spices to create a more desirable flavor preferred by consumers. Ham is often cured to create the traditional pink color desired by consumers.

⁶ Resurreccion, A. V. A. (2004). Sensory aspects of consumer choices for meat and meat products. *Meat Science*, 66(1), 11-20.

2.b. Storage Extension

Extending shelf life serves a dual purpose: it suppresses spoilage and pathogenic microorganisms to protect public health, and it reduces food waste, an often-overlooked aspect of sustainability. When meat is processed for storage extension, the goal is to provide consumers with a safe, attractive, and palatable product for as long as possible. The most common way of extending the storage time of meat is to reduce bacterial growth and product oxidation.⁷ Products are processed multiple ways to slow or prevent the growth of spoilage microorganisms such as *Brochothrix thermosphacta*, *Carnobacterium* spp., *Enterobacteriaceae*, *Lactobacillus* spp., *Leuconostoc* spp., *Pseudomonas* spp., and *Shewanella putrefaciens*. Processing reduces spoilage bacteria and can also reduce pathogen growth. Products are also processed to reduce lipid oxidation. Excessive spoilage bacterial growth, and oxidation can lead to sensory quality decline, resulting in discoloration, off-odors, and off-flavors.

Meat products are also regularly processed for storage extension purposes alone. For instance, drying (dried sausages or jerky) removes much of the water from meat, reducing the water activity and preventing the growth of numerous spoilage microorganisms. Reducing the growth of spoilage microorganisms and chemical reactions slows decomposition to extend storage length.

2.c. Food Safety

Foremost, processing safeguards public health. Validated interventions—thermal treatments, curing, fermentation, and more—have driven down foodborne illness risk for decades. Numerous pathogens are inherent to meat products, including *Salmonella* spp., Shiga toxin-producing *Escherichia coli*, *Listeria monocytogenes*, *Clostridium perfringens*, and *Clostridium botulinum*. Processing meat can control, reduce, and/or eliminate some of these pathogens. Heat-treated meat items are a great example and reach temperatures high enough to kill or reduce pathogenic bacteria, which improves the safety, as well as the storage life of the product. Other products have added ingredients that help control the growth of pathogenic microorganisms. For example, adding salt and nitrite to meat products inhibits the growth of numerous pathogens, such as *Listeria monocytogenes*, *Clostridium perfringens*, and *Clostridium botulinum*. Hot dogs have several added ingredients, such as nitrates and nitrites, and are also heat-treated to reduce bacterial growth. All ingredients are generally recognized as safe (GRAS) by the Food and Drug Administration and used within the USDA Food Safety and Inspection Service's (FSIS) regulatory parameters.

⁷ Borch, E., Kant-Muermans, M. L., & Blixt, Y. (1996). Bacterial spoilage of meat and cured meat products. *International journal of food microbiology*, 33(1), 103-120.

3 | Common Minimally and Further Processed Meats

Meat packers and processors are constantly developing new products to meet consumer nutritional needs and changing preferences. As people grow, their nutritional needs evolve. Over time, a person may develop hypertension and require a low sodium dietary pattern. Some consumers have a soy allergy and need processed meat products without ingredients like hydrolyzed soy protein. Alongside changing nutritional needs, consumers often desire a variety of different flavors and products that can fulfill their adventurous eating habits. In response to consumer needs and preferences, the meat industry has developed thousands of items that meet a variety of nutritional needs while still providing palatable products. The broad array of minimally and further processed meat products available to consumers continues to grow to provide options to a diverse population.

3.a. Types of Minimally Processed Meat

Minimally processed meat (MPM) items are those that do not undergo any major transformation or have added ingredients. Steaks, chops, roasts, ground items (with no added ingredients, including spices and seasonings), and diced meat are all MPMs. These items vary in size, shape, and nutritional profile. There are thousands of different MPM products across the species (beef, pork, lamb, veal, chicken, and turkey) of products typically available to consumers today. Some common MPM products include beef strip steak, 90% lean ground beef, beef pot roast, chicken breast, chicken thigh, turkey drumstick, whole turkey, pork loin chop, pork tenderloin roast, lamb riblets, lamb stew meat, and many more.⁸ There are also a few sub categories of minimally processed meat items that are occasionally used in products, including advanced meat recovery items and lean finely textured meat.

3.a.1. Advanced Meat Recovery

Advanced meat recovery (AMR) is a lean meat product made by applying mechanical pressure to remove meat from bones.⁹ This process does not alter the composition of the meat. Products as a result of the AMR process cannot contain tissues from the central nervous system or bone. AMR products are produced with equipment that does not crush, grind, or pulverize bones. Following AMR processes, bones appear comparable to those that have been hand-deboned. To verify that bone is not introduced into the product, meat from advanced meat recovery systems must be tested regularly and cannot contain more than 0.15% (150 mg/100 g) of calcium.¹⁰

⁸ North American Meat Institute (US). (2014). The Meat Buyer's Guide 8th Edition.

⁹ Seman, D. L., Boler, D. D., Carr, C. C., Dikeman, M. E., Owens, C. M., Keeton, J. T., ... & Powell, T. H. (2018). Meat science lexicon. Meat and Muscle Biology, 2(3), 1-15.

¹⁰ USDA. 2016. Definitions. 9CFR 301.2. (r) Meat (2). <https://www.gpo.gov/fdsys/pkg/CFR-1998-title9-vol2/pdf/CFR-1998-title9-vol2-sec301-2.pdf>. (accessed 18 April 18).

USDA. 2016. Definitions 9CFR 318.24 Product prepared using advanced meat/bone separation machinery; process control. <https://www.gpo.gov/fdsys/pkg/CFR-2012-title9-vol2/pdf/CFR-2012-title9-vol2-part318.pdf>. (accessed 18 April 2018).

3.a.2. Lean Finely Textured Meat

Lean finely textured meat (LFTM) is lean meat derived from edible high fat trimmings that have been desinewed and subjected to a mild heat treatment to melt and separate the fat and allow recovery of the lean meat portion.¹¹ LFTM gets its fine texture from the process to remove the lean from the high-fat trimmings. The lean meat is finely ground during the process of removing it from fat using a centrifuge, like how milk is separated from cream. The resulting LFTM product is 94-97 percent lean meat.

3.b. Types of Further Processed Meat

Building on the range of MPM, many items can be further processed for specific food safety, sensory enhancement, and storage extension purposes. The further processing of meat products enhances sustainability. Further processing products can lengthen the storage life of products and reduce food waste. Less palatable meat items can be further processed into products consumers enjoy. Without further processing, there would be an enormous amount of food waste. Examples of further processed meat (FPM) products, including their description, processing methods, and common ingredients, can be found in Table 2. In addition to Table 2, there are other generalized categories further processed meat items fit into, including delicatessen meats (deli meat) and ready-to-eat (RTE) meats.

3.b.1. Delicatessen Meats

Delicatessen meats have numerous synonyms, including deli, luncheon, and lunch meat. Many deli meat items overlap with FPM items in Table 2. Deli meat refers to RTE items that are typically sliced and assembled in a sandwich for consumption.¹² Deli meats can be in the FPM ham category, sausage category, or others. There is a wide array of deli meat products that can meet almost every dietary requirement. Deli meat can be formulated to meet the food labeling regulations for low fat, reduced fat, low sodium, and reduced sodium, as well as the American Heart Association (AHA) certification, meeting [AHA's Heart-Check program requirements](#). Additionally, deli meats come in a variety of different flavors like oven roasted, smoked, mesquite, cajun-style, or honey-flavored. Deli meat includes items like oven roasted turkey, black forest ham, mesquite chicken, roast beef, corned beef, pastrami, bologna, olive loaf, and many more.

¹¹ *Id.*

¹² 9 CFR 430.1

3.b.2. Ready-To-Eat Meats

Ready-to-eat meats are items that are safe to eat without additional preparations, although some RTE meats may receive additional preparation for palatability or aesthetic, epicurean, gastronomic, or culinary purposes.¹³ Most RTE meat items are thermally processed to achieve the lethality of pathogenic microorganisms. Many of the FPM items in Table 2 can be RTE or non-RTE including bacon, bologna, Canadian bacon, corned beef, smoked ham, dry-cured ham¹⁴, hot dogs, jerky, pastrami, cooked and smoked sausage, dry and semi-dry sausage, and some specialty meats.

¹³ *Id.*

¹⁴ Dry cured hams do not undergo thermal processing but meet pathogen control through added ingredients, aging and water activity

4 | Common Meat Processing Ingredients

Further processed meat items can have a variety of ingredients. Ingredients may provide key functions during and after processing and affect product safety, storage life, and sensory characteristics. Some products require specific ingredients and processes. For example, bacon must be cured using salt, nitrate or nitrite, added water, and a cure accelerator (ascorbate or erythorbate). Cure accelerators (along with other ingredients) are often used in many cured meat products other than bacon but are only required in bacon. Bacon is often cooked at extremely high temperatures in a frying pan, and cure accelerators inhibit the formation of nitrosamines during high-temperature cooking.¹⁵

There are strict labeling requirements for all meat products. Any meat product with two or more ingredients must comply with FSIS' ingredient labeling regulations.¹⁶ All ingredients must be included on the product label in descending order of predominance. A list of ingredients commonly used to further process meat is found in Table 3. Table 3 includes the ingredient name, description, function/use, regulatory level, and examples of when the ingredient is used.

4.a. Spices and seasonings

In addition to the ingredients found in Table 3, spices and seasoning are commonly used in further processed meat products. Spices are aromatic substances of plant origin and seasonings are any ingredient added to improve or modify flavor.¹⁷ There are limitless combinations that give further-processed meat items distinct sensory profiles, formulated to meet consumer preferences. Some spices have natural antimicrobial and antioxidant properties that need to be considered during formulation and further processing.

Specific ingredients are required or prohibited in the formulation of certain products. These products must also follow specific processes to bear that specific product name, *e.g.*, meet a standard of identity. For example, pepperoni must be a dry sausage comprised of pork or pork and beef. Pepperoni can also have antioxidants present and may be dipped in a potassium sorbate solution to control mold growth. Additionally, extenders and binders, hearts, tongues, and other byproducts are not permitted ingredients in pepperoni.¹⁸ Common spices used in further processed meat products include allspice, anise, bay leaves, cardamom, cassia, celery seed, cinnamon, clove, coriander, cumin, garlic, ginger, mace, marjoram, mustard, onion, paprika, pepper, sage, and thyme.¹⁹

¹⁵ "A potentially carcinogenic compound formed from the reaction of nitrous acid and secondary amines in foods exposed to high heat treatment. Nitrosamine formation in cured meats is minimized through proper processing techniques and adherence to current production regulations including the use of antioxidants especially sodium ascorbate/erythorbate." (Seman et al. 2018).

¹⁶ 9 CFR 317.2(f) and 381.118

¹⁷ Aberle, E. D., & Forrest, J. C. (2001). *Principles of meat science*. Kendall Hunt.

¹⁸ United States Department of Agriculture. Food Safety and Inspection Service. (August 2005). Food Standards and Labeling Policy Book.

¹⁹ Aberle, E. D., & Forrest, J. C. (2001). *Principles of meat science*. Kendall Hunt.

4.b. Binders, Extenders and Fillers

Some of the non-meat ingredients in further processed meats are classified as binders, extenders, and fillers (BEFs). Binders, extenders, and fillers are non-meat ingredients that can be incorporated into comminuted and cured items. These ingredients have numerous functions, including improving batter stability, water binding capacity, texture and flavor, yield, slicing characteristics, and reducing formulation costs.²⁰ Binders, extenders, and fillers are characterized by high-protein content, as well as their ability to bind water and fat. Many BEFs have a meat-like texture, hydrate rapidly, and have an affinity for juice retention.

Common BEFs include hydrolyzed vegetable proteins (see Table 3) from soy, wheat, or peas. Dairy can also be used to make BEFs. For example, nonfat dried milk solids, calcium-reduced nonfat dried milk, dried whey, and reduced whey are BEFs derived from milk. Other BEFs include sodium caseinate, carrageenan, modified food starch, and textured vegetable proteins.

4.c. Efforts to reduce sodium

Adding sodium to muscle tissues can improve the quality of the meat and poultry products. Sodium chloride, sodium phosphates, sodium nitrite, and sodium lactate are all commonly used compounds. Compounds such as sodium chloride have important quality, shelf-life, myofibrillar functionality, and food safety properties. However, there are numerous concerns with high levels of sodium in the diet. Consumer health is a driving force in producing meat. The meat industry offers nutrient dense protein food products while continuously improving and maintaining safety. In response to public requests, the industry has been and remains actively involved in efforts to reduce sodium in meat products. The meat industry is constantly undergoing product reformulation to reduce the level of sodium and offer numerous products that meet the low and lower sodium labeling claims.

4.d. Supporting Busy Families and Young Children

Processed meats provide busy households with convenient, ready-to-eat or quick-cook high-quality protein sources. This convenience is crucial for working parents who must balance nutrition, time constraints, and children's selective eating habits. Consistent flavor, softer texture, and familiar formats—such as turkey deli slices, ham, meatballs, or beef sticks—can encourage adequate protein intake during key growth phases. These products also supply essential nutrients like iron, zinc, and vitamin B12 with minimal preparation, ensuring that young children receive safe, nutrient-rich meals even on the busiest weekdays

²⁰*Id.*

5 | Nutritional Benefits of Minimally and Further Processed Meats

Minimally and further processed meats offer nutrient-dense, time-efficient options that help individuals meet their protein and micronutrient recommendations. These products provide consumers with a convenient and balanced dietary source of all essential amino acids and are also important sources of micronutrients, such as iron, selenium, vitamins B₁₂, B₆, thiamin, riboflavin, niacin, and potassium. Per serving, meat provides more protein than dairy, eggs, legumes, cereals, vegetables, or nuts. The iron and zinc in MPM and FPM are also more bioavailable than from other sources, meaning these minerals are more easily absorbed and utilized by the body. Both MPM and FPM are excellent sources of protein and micronutrients, especially for vulnerable populations.

5.a. Protein

Protein underpins nearly every physiological system—from metabolic regulation and immune competence to cognitive development and satiety. Protein is an important macronutrient that supports various metabolic and physiologic functions, including the regulation of appetite, food intake, body weight, and body composition.²¹ Protein is critical for developing, maintaining, and repairing muscles. In children, protein is key for growth and brain development. In aged populations, protein is essential in preventing muscle loss.²² Research has also highlighted meat's high protein and low carbohydrate content provides both weight control benefits and diabetes management.²³ Scientific literature demonstrates the importance of protein in the diet and that not all proteins are created equal. Dietary protein supplies the body with nitrogen and amino acids. There are nine amino acids that are essential and classified as indispensable in the diet including histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. Protein is found in all living things, but is present in different proportions and varies in total amino acid composition, including the number and levels of indispensable amino acids. Of the indispensable amino acids, some are limiting including leucine, lysine, methionine, and tryptophan. These limited indispensable amino acids play important roles in different metabolic functions. For example, leucine activates the mammalian target of the rapamycin (mTOR) pathway which signals protein synthesis in human skeletal muscle.²⁴

²¹ Górska-Warszewicz H, Laskowski W, Kulykovets O, Kudlińska-Chylak A, Czeczotko M, Rejman K. Food Products as Sources of Protein and Amino Acids-The Case of Poland. *Nutrients*. 2018;10(12):1977. Published 2018 Dec 13. doi:10.3390/nu10121977

²² Campbell, W. W., et al. (1999). "Effects of an omnivorous diet compared with a lactoovovegetarian diet on resistance-training-induced changes in body composition and skeletal muscle in older men." *Am J Clin Nutr* 70(6): 1032-1039.

²³ Leidy, Mattes. Higher protein intake preserves lean mass and satiety with weight loss in pre-obese and obese women. *Obesity, Obes Res*. 2007; 15: 421-429.

Layman, D. K., et al. (2009). A moderate-protein diet produces sustained weight loss and long-term changes in body composition and blood lipids in obese adults. *J Nutr* 139(3): 514-521.

Paddon-Jones, D., et al. (2008). Protein, weight management, and satiety. *Am J Clin Nutr* 87(5): 1558S-1561S.

Leidy, H. J., et al. (2010). The influence of higher protein intake and greater eating frequency on appetite control in overweight and obese men. *Obesity*. 18(9): 1725-1732.

Leidy, H. J., et al. (2011). The effects of consuming frequent, higher protein meals on appetite and satiety during weight loss in overweight/obese men. *Obesity*. 19(4): 818-824.

²⁴ Drummond MJ, Rasmussen BB. Leucine-enriched nutrients and the regulation of mammalian target of rapamycin signaling and human skeletal muscle protein synthesis. *Curr Opin Clin Nutr Metab Care*. 2008;11(3):222-226. doi:10.1097/MCO.0b013e3282fa17fb

Leucine also stimulates insulin secretion from pancreatic β cells.²⁵ Lysine can synthesize carnitine, and carnitine deficiencies are associated with fatty acid oxidation and metabolic disorders.²⁶ Tryptophan plays a key role in the production of the neurotransmitter, serotonin. Deficiencies in tryptophan can result in lower serotonin levels, which can lead to mood disorders like anxiety and depression.²⁷ Because meat has greater amounts of limited indispensable amino acids than other foods, it is the best source of high-quality protein. Minimally and further processed meats also have a higher protein to energy ratio and are more digestible than other foods. Processed meats in particular deliver complete, highly bioavailable protein in a convenient format to families across the world.

5.b. Micronutrients

Minimally and further processed meat products contribute more zinc, vitamin B₁₂, phosphorus, and iron than plant foods.²⁸ For example, a three-ounce serving of a lean beef item like a top sirloin steak typically has less than 120 calories and is an excellent source of six nutrients, including protein, zinc, vitamin B₁₂, vitamin B₆, niacin, and selenium; and is a good source of four nutrients—phosphorous, choline, iron, and riboflavin.²⁹ In addition, more than 65 percent of beef cuts sold at retail meet government standards for “lean,” including 17 of the 25 most popular cuts, while seven pork cuts meet USDA “lean” guidelines.³⁰ Pork is also lean and nutrient-rich. A three-ounce serving of pork tenderloin is a source of nine key essential nutrients—an excellent source of thiamin, selenium, protein, niacin, vitamin B₆, and phosphorus; and a good source of riboflavin, zinc, and potassium in less than 125 calories.³¹ Among pork consumers, fresh lean pork accounts for 23 percent of total protein intake, 25 percent or more of total intakes of selenium and thiamin, and 10 percent or more of total intakes of phosphorus, potassium, zinc, and B vitamins.³² Lamb is also nutrient dense and, on average, a 3-ounce cooked portion provides greater than 20 percent of the daily value of zinc, vitamin B₁₂, niacin, and protein in about 175 calories.³³

5.c. Consumption Importance in Vulnerable Populations.

Meat consumption is beneficial to numerous at-risk populations. Up to 16 percent of adults in the U.S. and over 20 percent of individuals over age 60 are marginally depleted in vitamin B₁₂. B₁₂ deficiencies increase with age, resulting in six percent of adults age 70 and older being vitamin B₁₂-deficient.³⁴ Several studies demonstrate meat intake decreases

²⁵ Yang J, Chi Y, Burkhardt BR, Guan Y, Wolf BA. Leucine metabolism in regulation of insulin secretion from pancreatic beta cells. *Nutr Rev*. 2010;68(5):270–279. doi:10.1111/j.1753-4887.2010.00282.x

²⁶ Hoppel, C. (2003). The role of carnitine in normal and altered fatty acid metabolism. *American Journal of Kidney Diseases*, 41, S4-S12.

²⁷ Jenkins TA, Nguyen JC, Polglaze KE, Bertrand PP. Influence of Tryptophan and Serotonin on Mood and Cognition with a Possible Role of the Gut-Brain Axis. *Nutrients*. 2016;8(1):56. Published 2016 Jan 20. doi:10.3390/nu8010056

²⁸ Górska-Warszewicz H, Laskowski W, Kulykovets O, Kudlińska-Chylak A, Czeczotko M, Rejman K. Food Products as Sources of Protein and Amino Acids-The Case of Poland. *Nutrients*. 2018;10(12):1977. Published 2018 Dec 13. doi:10.3390/nu10121977

²⁹ U.S. Department of Agriculture, Agricultural Research Service, 2019. USDA FoodData Central. Beef Top Sirloin Steak. Accessed January 2020.

³⁰ Russell Cross. Comment #571. Submitted to DGAC July 14, 2014.

³¹ U.S. Department of Agriculture, Agricultural Research Service, 2019. USDA FoodData Central. Pork, fresh, loin, tenderloin, separable lean only, cooked, roasted. Accessed January 2020.

³² Murphy MM, Spungen JH, Bi X, Barraj LM. Fresh and fresh lean pork are substantial sources of key nutrients when these products are consumed by adults in the United States. *Nutrition Research*. 2011; 31: 776-783.

³³ Carson, Jo Ann S., Hilton, G.G. and VanOverbeke. (2007) Lamb: It's place in the U.S. diet. http://leanonlamb.com/media/activity/lamb_in_US_Diet.pdf. Accessed May 7, 2015.

³⁴ Allen, L. H. (2009). "How common is vitamin B-12 deficiency?" *Am J Clin Nutr* 89(2): 693S-696S.

bone fracture risk, which is crucial to the aging population because bone fractures can be a critical life event.³⁵ Meat plays an integral role in ensuring adequate vitamin and mineral intake.³⁶ The preponderance of scientific evidence affirms the healthful role lean meat products, including minimally and further processed meats, play in dietary patterns. Moreover, numerous randomized, controlled trials illustrate that meat is a valuable component of a healthy dietary pattern. Other studies demonstrate that meat, when consumed in combination with vegetables, helps the body absorb more nutrients from those vegetables.³⁷

The high iron content in meat is particularly important to certain vulnerable populations, including the 1.2 million children in the U.S. with anemia. Meat's importance also holds true for teenage girls and pregnant women who are at a higher risk of anemia.³⁸ Although iron supplementation is an option, it is not as bioavailable as iron in meat. The heme iron present in meat is the most absorbable form of iron, and a prolonged deficiency could lead to negative long-term health outcomes, including decreased mood, shortness of breath, dizziness, headaches, and more.³⁹ The natural presence of heme iron also aids the absorption of non-heme iron.⁴⁰

Throughout the life span, various subpopulations, such as children and pregnant women, have increased protein needs during growth and development, and meat is a logical choice. Per serving, meat provides more protein than most other foods. Protein is critical for developing, maintaining, and repairing strong muscles and vital for reducing the muscle loss that occurs with aging.⁴¹ Finally, research shows that meat's high protein and low carbohydrate content translates into a low glycemic index, which offers benefits for both weight and diabetes control.⁴² The high protein quality in MPM and FPM is vital in maintaining autonomy and musculoskeletal health in older adults by helping prevent frailty, disability, falls, and sarcopenia. A review in the journal *Applied Physiology, Nutrition, and Metabolism* stated that the growing body of evidence indicates that protein intake well above the current Recommended Dietary Allowance helps promote healthy aging.⁴³

³⁵ Monma Y, Niu K, Iwasaki K, Tomita N, Nakaya N, Hozawa A, Kuriyama S, Takayama S, Seki T, Takeda T, Yaegashi N, Ebihara S, Arai H, Nagatomi R, Tsuji I. Dietary patterns associated with fall-related fracture in elderly Japanese: a population based prospective study. *BMC Geriatr*. 2010;10:31. PMID:20513246.

³⁶ Institute of Medicine, National Academy of Sciences. *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. National Academy Press., Washington, DC. 2001. <http://www.nap.edu/openbook.php?isbn=0309072794>

³⁷ Kris-Etherton PM, Yu S. Individual fatty acid effects on plasma lipids and lipoproteins: Human studies. *Am J Clin Nutr* 1997;65:1628S-44S.

³⁸ Kris-Etherton PM, Pearson TA, Wan Y, Hargrove RL, Moriarty K, Fishell V, et al. High-monounsaturated fatty acid diets lower both plasma cholesterol and triacylglycerol concentrations. *Am J Clin Nutr* 1999;70:1009-15.

³⁹ Gilmore LA, Walzem RL, Crouse SF, Smith DR, Adams TH, Vaidyanathan V, Cao X, Smith SB. Consumption of high-oleic acid ground beef increases HDL-cholesterol concentration but both high- and low-oleic acid ground beef decrease HDL particle diameter in normocholesterolemic men. *J Nutr* 2011;141:1188-1194.

⁴⁰ Gilmore LA, Crouse SF, Carbuhrn A, Klooster J, Calles JAE, Meade T, Smith SB. Exercise attenuates the increase in plasma monounsaturated fatty acids and high-density lipoprotein cholesterol, but not high-density lipoprotein 2b cholesterol caused by high-oleic ground beef in women. *Nutr Res* 2013;33:1003-1011.

⁴¹ Accessed July 2, 2010: <http://www.anemia.org/patients/feature-articles/content.php?contentid=000338>.

⁴² Iron and Iron Deficiency. <http://www.cdc.gov/nutrition/everyone/basics/vitamins/iron.html>.

⁴³ National Academy of Sciences. *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. National Academy Press. Washington, DC. 2001.

⁴⁴ Paddon-Jones, D., Campbell, W.W., Jacques, P.F., Kritchevsky, S.B., Moore, L.L., Rodriguez, N.R., and van Loon, L.J.C. Protein and healthy aging. *American Journal of Clinical Nutrition* (2015); 101(Suppl):1339S-1345S.

⁴⁵ Leidy, Mattes. Higher protein intake preserves lean mass and satiety with weight loss in pre-obese and obese women. *Obesity*. *Obes Res*. 2007; 15: 421-429.

⁴⁶ Donald K. Layman, Ellen M. Evans, Donna Erickson, Jennifer Seyler, Judy Weber, Deborah Bagshaw, Amy Griel, Tricia Psota, and Penny Kris-Etherton. A Moderate-Protein Diet Produces Sustained Weight Loss and Long-Term Changes in Body Composition and Blood Lipids in Obese Adults. *The Journal of Nutrition*, March 2009

⁴⁷ Phillips SM, Chevalier S, Leidy HJ. Protein "requirements" beyond the RDA: implications for optimizing health. *Appl Physiol Nutr Metab*. 2016 May;41(5):565-72. doi: 10.1139/apnm-2015-0550. Epub 2016 Feb 9.

6 | Perceived Public Health Concerns

Over the past decade, the consumption of MPM and FPM has been the subject of many scientific studies and news stories. Evaluating and addressing potential public health concerns associated with meat consumption is necessary and must continue. Processing meat is one of the oldest forms of food preservation, dating back to as early as 3,000 B.C.⁴⁴ The use of ingredients and different processes to preserve meat is thoroughly studied both for its effectiveness and, more importantly, for its impact on public health. These ingredients and processes are utilized to mitigate public health hazards. Regardless, some concerns associated with MPM and FPM consumption remain at the center of scientific evaluation, including nitrosamine formation, heterocyclic amines, and health outcomes.

6.a. Nitrosamine Formation

When exposed to specific conditions, a class of carcinogens known as nitrosamines can be formed in foods. Nitrosamines are formed by a reaction between nitric oxide and secondary or tertiary amines. Secondary and tertiary amines are present in all foods. These compounds are a part of all proteins as side chains of proline, hydroxyproline, histidine, arginine, and tryptophan. Nitrosamine formation occurs when nitric oxide and secondary or tertiary amines in foods are exposed to very high temperatures. Forms of nitric oxide are present in many foods. All cured FPMs, contain nitrates and nitrites which are precursors to nitric oxide and, therefore, have the potential to form nitrosamines. However, the levels of nitrates and nitrites are closely regulated by USDA and nitrosamines are rarely formed in many FPM.⁴⁵ Bacon is an item that has a higher risk of nitrosamine formation, because it is cured and cooked at very high temperatures, often in a frying pan. As a result of this increased risk, there is a lower level of nitrites allowed by USDA and cure accelerators must be used to mitigate risk. With the addition of cure accelerators such as ascorbate (a form of vitamin C) and erythorbate (a similar compound to vitamin C), nitrosamine formation is prevented.

⁴⁴Romans, J. R., W. J. Costello, C. W. Carlson, M. L. Greaser, and K. W. Jones. 2001. *The Meat We Eat*. 14th ed. Interstate Publ., Danville, IL. pp. 779–887

⁴⁵Table 3. Common ingredients used in meat processing.

Aberle, E. D., & Forrest, J. C. (2001). *Principles of meat science*. Kendall Hunt.

6.b. Heterocyclic Amines

Heterocyclic amines (HCA) are compounds that can form during high temperature cooking like grilling. Together, when amino acids and creatine are put under high heat, the Maillard reaction⁴⁶ occurs and can form HCAs. The formation of HCAs can be reduced or prevented by trimming away excess fat before grilling to reduce high heat flare-ups. Additionally, using lower temperatures when grilling, indirect heat, and turning meat frequently can reduce HCA formation. Additionally, using different marinades, spices, and seasonings can almost eliminate HCA formation. Research shows marinating or seasoning meat with rosemary, onion, garlic, lemon juice, and others can greatly reduce HCA formation.⁴⁷

6.c. The Effect of Meat Consumption on Cancer Outcomes

The potential role that MPM and FPM may have on cancer outcomes is a widely debated topic. Scientific evaluations continue to explore high consumption of processed meat and any relation with colorectal cancer in both the general population and specific sub-groups. In 2018, the International Agency for Research on Cancer (IARC) released a Monograph addressing the consumption of red and processed meat and its association with cancer. IARC concluded processed meat is a Group 1 carcinogen, meaning there was sufficient evidence in humans that intake causes colorectal cancer. IARC also concluded that red meat is a Group 2A carcinogen, meaning it is probably carcinogenic based on limited evidence that intake of red meat causes colorectal cancer in humans.⁴⁸ Many of the observed associations are weak in magnitude and may be due to methodological challenges and limitations. It has been shown repetitively across varying worldwide study populations that, on average, those who consume high levels of processed meat have demographic, lifestyle, other dietary, and clinical factors that are associated with an increased risk of chronic disease and cancer.⁴⁹ These other factors have demonstrated an increased cancer risk independently of processed meat consumption. In the Monograph, IARC noted that “Chance, bias, and confounding could not be ruled out with the same degree of confidence for the data on red meat consumption since no clear association was seen in several of the high-quality studies and residual confounding from other diet and lifestyle risk is difficult to exclude.”⁵⁰ Cancer is complex. There are numerous known

⁴⁶Maillard reaction – a form of non-enzymatic browning similar to caramelization; a chemical reaction between an amino acid and a reducing sugar, usually requiring heat

⁴⁷Smith, J. S., Ameri, F., & Gadgil, P. (2008). Effect of marinades on the formation of heterocyclic amines in grilled beef steaks. *Journal of food science*, 73(6), T100-T105.

Gibis, M. (2007). Effect of oil marinades with garlic, onion, and lemon juice on the formation of heterocyclic aromatic amines in fried beef patties. *Journal of agricultural and food chemistry*, 55(25), 10240-10247.

Tsen, S. Y., Ameri, F., & Smith, J. S. (2006). Effects of rosemary extracts on the reduction of heterocyclic amines in beef patties. *Journal of food science*, 71(8), C469-C473.

⁴⁸IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. (2018). Red meat and processed meat. International Agency for Research on Cancer, World Health Organization.

⁴⁹Bylsma, L. C., & Alexander, D. D. (2015). A review and meta-analysis of prospective studies of red and processed meat, meat cooking methods, heme iron, heterocyclic amines and prostate cancer. *Nutrition journal*, 14(1), 125.

Alexander, D. D., Weed, D. L., Miller, P. E., & Mohamed, M. A. (2015). Red meat and colorectal cancer: a quantitative update on the state of the epidemiologic science. *Journal of the American College of Nutrition*, 34(6), 521-543.

Alexander, D. D., Mink, P. J., Cushing, C. A., & Scurman, B. (2010). A review and meta-analysis of prospective studies of red and processed meat intake and prostate cancer. *Nutrition journal*, 9(1), 50.

Alexander, D. D., Weed, D. L., Cushing, C. A., & Lowe, K. A. (2011). Meta-analysis of prospective studies of red meat consumption and colorectal cancer. *European Journal of Cancer Prevention*, 20(4), 293-307.

Klurfeld, D. M. (2018). What is the role of meat in a healthy diet?. *Animal Frontiers*, 8(3), 5-10.

⁵⁰IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. (2018). Red meat and processed meat. International Agency for Research on Cancer, World Health Organization.

and suspected factors that contribute to cancer incidence but separating one factor from another can be challenging. Research needs to continue to evaluate the effect of MPM and FPM on cancer outcomes, including mechanistic evaluations of exactly how meat may be linked to cancer.

6.d. The Effect of Meat Consumption on Heart Health

For adults over 65, heart disease is the leading cause of death.⁵¹ Some studies determined a link between decreased heart health and meat consumption, but the evidence was inconsistent. Overall, the evidence implicating meat consumption in adverse cardiometabolic outcomes is of low quality. Therefore, the relationship between meat consumption and heart health is uncertain. Furthermore, evidence demonstrates that the magnitude of association is very small if a causal relationship exists between meat consumption and heart health.⁵² Research needs to continue to evaluate the effect of MPM and FPM on heart health outcomes.

6.e. The Role of Processed Meat and Protein: Satiety, Weight Control, and Glucose Spiking

Protein-rich foods, including processed meats, are often considered for their potential to enhance satiety and support weight management. High-protein diets, which include high meat and processed meat consumption, can improve body composition and glucose control in adults with type 2 diabetes. This suggests that protein can affect weight control and glucose regulation.

Regarding weight control, systematic reviews and meta-analyses indicate that increased processed meat intake is only very weakly associated with increases in body weight and waist circumference. Due to methodological limitations, the certainty of these findings is low, and as the work is observational, it is impossible to attribute the results to processed meat consumption rather than other dietary and lifestyle factors.⁵³

⁵¹Heron, M. (2019). Deaths: Leading Causes for 2017. U.S. Department Of Health And Human Services. Centers for Disease Control and Prevention. National Center for Health Statistics. National Vital Statistics System. Volume 68, Number 6.

⁵²Zeraatkar, D., Han, M. A., Guyatt, G. H., Vernooij, R. W., El Dib, R., Cheung, K., ... & Rabassa, M. (2019). Red and Processed Meat Consumption and Risk for All-Cause Mortality and Cardiometabolic Outcomes. *Ann Intern Med*, 171, 703-710.

Zeraatkar, D., Johnston, B. C., Bartoszko, J., Cheung, K., Bala, M. M., Agarwal, A., ... & Alonso-Coello, P. (2019). Effect of Lower Versus Higher Red Meat Intake on Cardiometabolic and Cancer Outcomes. *Ann Intern Med*, 171, 721-731.

⁵³Rohde, J., Heitmann, B., Händel, M., Sørensen, T., & Larsen, S. (2025). Processed Meat Intake and Changes in Weight, Waist, Body Mass Index, and Fat Mass: Systematic Literature Review, Meta-Analysis, and GRADE Assessment of Cohort Studies of Adults. *Nutrition reviews*. <https://doi.org/10.1093/nutrit/nuaf030>

6.f. Excessive Consumption: Ultra-Processing Versus Food Texture

The NOVA classification system often defines ultra-processed foods (UPFs) as industrial formulations made mostly or entirely from substances derived from foods, with little to no whole food content. Scientific concerns around UPFs typically center on their associations with increased risk of obesity, metabolic disorders, cardiovascular disease, and certain cancers. These risks are thought to be driven less by processing itself and more by factors like excessive energy density, poor nutrient profile, hyper-palatability, and reduced satiety. Additionally, UPFs often displace nutrient-dense whole foods in the diet. However, the category is heterogeneous, and not all processed foods carry equal health risk—underscoring the need for a more nuanced understanding of food processing and its role in public health.

Emerging research challenges the traditional view that the main problem with overconsumption is food processing, highlighting the critical role of food texture instead. Studies show that the texture of industrially processed foods—specifically, their softness or liquidity—can significantly increase the rate at which they are consumed, leading to higher daily energy intake and promoting overeating, independent of the level of processing itself.⁵⁴ Foods that are liquid or soft are eaten much faster than harder foods, resulting in a higher energy intake rate and less oro-sensory exposure per calorie, which diminishes the body's ability to sense and regulate intake.⁵⁵ Meta-analyses further confirm that harder, chunkier, more viscous, and solid foods increase satiation and reduce the amount consumed, without affecting acceptability, suggesting that modifying texture could be a practical strategy to curb overconsumption.⁵⁶ Additionally, neural studies reveal that the brain's reward systems are highly sensitive to the oral texture of high-fat foods, with smoother, fattier textures driving preference and intake through specific neural pathways.⁵⁷ These findings indicate that the sensory experience of texture, rather than processing alone, is a key driver of overeating, and that reformulating foods to enhance texture could help address the global challenge of overconsumption and obesity.⁵⁸

⁵⁴Camps, G., Mars, M., Siebelink, E., Lasschuijt, M., De Graaf, K., & Bolhuis, D. (2023). Speed limits: the effects of industrial food processing and food texture on daily energy intake and eating behaviour in healthy adults. *European Journal of Nutrition*, 62, 2949 - 2962. <https://doi.org/10.1007/s00394-023-03202-z>
⁵⁵Graaf, K. (2020). Sensory Responses in Nutrition and Energy Balance: Role of Texture, Taste, and Smell in Eating Behavior. *Handbook of Eating and Drinking*. https://doi.org/10.1007/978-3-030-14504-0_117

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⁵⁷Brunstrom, J., Newbury, A., Vinoy, S., De Graaf, K., Kildegaard, H., Almiron-Roig, E., Appleton, K., Yeomans, M., & Geurts, L. (2021). Sensory and physical characteristics of foods that impact food intake without affecting acceptability: Systematic review and meta-analyses. *Obesity Reviews*, 22. <https://doi.org/10.1111/obr.13234>

⁵⁸Grabenhorst, F., Farooqi, I., Fletcher, P., Sutcliffe, M., Khorisanton, P., & 黃飛揚, F. (2023). A Neural Mechanism in the Human Orbitofrontal Cortex for Preferring High-Fat Foods Based on Oral Texture. *The Journal of Neuroscience*, 43, 8000 - 8017. <https://doi.org/10.1523/JNEUROSCI.1473-23.2023>

⁵⁹Brunstrom, J., Newbury, A., Vinoy, S., De Graaf, K., Kildegaard, H., Almiron-Roig, E., Appleton, K., Yeomans, M., & Geurts, L. (2021). Sensory and physical characteristics of foods that impact food intake without affecting acceptability: Systematic review and meta-analyses. *Obesity Reviews*, 22. <https://doi.org/10.1111/obr.13234>
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7 | Conclusion

Minimally and further processed meat products play a significant role in a healthy, well-balanced diet. Animal-derived proteins are the only sources of all essential amino acids. All consumers, including children, aging adults, and other vulnerable populations, can more easily meet their macronutrient requirements by incorporating meat into their diet. Meat packers and processors are committed to providing consumers with a wide array of products, allowing them to choose the foods that best fit their personal lifestyle and family dietary needs. The industry is committed to offering safe, wholesome, and nutritionally diverse products that cater to diverse consumer needs.

TABLE 1: PROCESSES APPLIED TO MEAT TO CREATE MINIMALLY OR FURTHER PROCESSED MEAT ITEMS

Process	Definition	Function	Product Examples	Minimal or Further Processed
Batter/Breading	Items are often coated with pre-dust, a seasoned batter consisting of a blend of flour, starches, and water, and/or a breading. Products may be uncooked but partially fried to set the batter or fully-cooked.	Sensory Enhancement – creates a specific flavor, texture, and/or mouthfeel	Chicken nuggets, chicken fingers, corn dogs, and more	Further Processed
Blending	Additional mixing of meat products to solubilize and swell meat proteins.	Sensory Enhancement – uniformly distributes ingredients throughout product	Sausage, hot dogs, and more	Further Processed
Co-Extruding	Extrusion of multiple layers of raw materials simultaneously. For example, the process of forming sausage into a cylindrical shape while simultaneously coating the sausage with a layer of solubilized collagen or alginate.	Sensory Enhancement – adds value and increases functionality to create more palatable products	Hot dogs, mayonnaise, homogenized milk, and more	Further Processed
Curing	The inclusion of nitrate or nitrite salts. There are numerous curing methods: Brine or Pickle: a slow curing method where product is immersed in a solution of curing agents (nitrates, nitrites, and more) dissolved in water. Dry Curing: an older method in which curing ingredients are rubbed in dry form over the meat surface. Traditional Curing: the addition of traditional manmade salt and nitrate/ nitrite to products. Natural Curing: the addition of natural sources of nitrates and nitrites from celery juice/ salt, sea salt, turbinado sugar, and others.	Sensory enhancement, storage extension, and food safety – creates a unique appearance, flavor, and texture, while enhancing product safety by hindering bacterial growth and lengthens storage time	Ham, bacon, hot dogs, some sausages, and more	Further Processed
Dicing	Reducing size of product into smaller blocks or particles.	Sensory enhancement – increases ease and uniformity of cooking and handling	Stew meat	Minimally processed
Drying	Removing water from a meat product by evaporation or sublimation following lethality.	Sensory enhancement and storage extension – transforms meat into a shelf-stable form while increasing palatability	Jerky, dry sausages and more	Further Processed

TABLE 1: PROCESSES APPLIED TO MEAT TO CREATE MINIMALLY OR FURTHER PROCESSED MEAT ITEMS

Process	Definition	Function	Product Examples	Minimal or Further Processed
Emulsifying	A mixture of immiscible substances, one of which is dispersed in the form of droplets or globules within the other. When muscle, fat, water, and salt are subjected to high-speed cutting and shearing forming a meat batter.	Sensory enhancement – transforms meat items into more palatable forms	Hot dogs, some snack sticks, some sausages, and more	Further Processed
Fabricating	Disassembly of a carcass by separating it into smaller primal, subprimal, and/or retail cuts.	Sensory enhancement and storage extension – reducing the size of the carcass into smaller pieces so multiple carcasses can be differentiated into homogeneous groups, and then cooked and stored more efficiently than an intact carcass	Round, loin, rib, t-bone, flank, picnic shoulder, blade chop, brisket, rack, and more	Minimally Processed
Fermenting	Bacterial metabolism of carbohydrates to an organic acid, typically lactic acid, under low heat conditions.	Sensory enhancement, storage extension, and food safety – as the conversion of sugars to organic acids takes place, food is preserved and unique flavors formed	Summer sausage, pepperoni, salami, snack sticks, and more	Further Processed
Grinding/Comminuting	A process of reducing meat particle size by cutting and pressing through specifically sized orifices in a grinder plate.	Sensory enhancement – changes the product size into a palatable form that is easily handled by consumers and in a state that allows for ease of mixing and forming	Ground meat, meatballs, patties, and more	Minimally Processed
Injecting	The process of inserting solutions into meat products using needles.	Food safety, sensory enhancement, and storage extension – injected solutions carry spices and seasonings equally throughout products. Solutions may also contain antimicrobials, which control pathogen and spoilage bacteria growth.	Bacon, ham, some roasts, chops, and many more.	Further Processed
Marinating	Delivering ingredients to products by saturating them in a water-based solution for a length of time.	Sensory enhancement – adds flavor to product	Fajita meat, enhanced pork loin, and more	Further Processed
Tenderizing	Subjecting products to a physical, chemical, or enzymatic processes to improve texture.	Sensory enhancement – makes whole muscle items more tender	Steak, chops, and more	Minimally Processed

TABLE 1: PROCESSES APPLIED TO MEAT TO CREATE MINIMALLY OR FURTHER PROCESSED MEAT ITEMS

Process	Definition	Function	Product Examples	Minimal or Further Processed
Pasteurizing	Applying heat to a product as a means of destroying some spoilage and all pathogenic bacteria, excluding spores.	Food safety and storage extension – eliminates pathogen and spoilage bacteria	Some hams, hot dogs, corned beef, and more	Further Processed
Restructuring/ Forming	The forming of some steaks, roasts, nuggets, patties or other shapes following particle reduction via fabrication, chopping, chunking, slicing, flaking, comminuting or others.	Sensory enhancement – can alter tenderness, and mouthfeel of products while making them into a product shape with more consumer appeal	Patties, nuggets, meat fingers, and more	Minimally or Further Processed
Retorting	Using temperature (116 and 121°C) and pressure to cook meat in a sealed package.	Food safety, sensory enhancement, and storage extension – reduces bacterial growth, results in shelf stable products, and creates a convenient, palatable item for consumers	Canned stew, chili, corned beef, chicken, and more	Further Processed
Smoking	Applying the smoke during thermal heat treatment. Smoking can be achieved through the burning of logs, woodchips, and sawdust, or by drenching the product in a liquid smoke concentrate, or exposure to an atomized cloud of distilled liquid smoke.	Sensory Enhancement – creates a unique smoke flavor, aroma, and surface color	Bacon, ham, jerky, pastrami, some ham, some sausages, and more	Further Processed
Sterilizing	Killing all microorganisms, spores, and pathogens by heating meat products in hermetically sealed containers (exceeding 121°C) and high-pressure (at least 0.082 MPa).	Food safety and storage extension –eliminates all microorganisms and spores	Some RTE lunch meat, ham, sausage, and more.	Further Processed
Thermal Processing	Subjecting product to heat processing to achieve a specified level of safety, prolong shelf-life, and enhance sensory characteristics.	Sensory enhancement, storage extension, and food safety – reduces or kills microorganisms (spoilage and pathogenic) while transforming the product into a palatable state	Hot dogs, ham, salami, bacon, lunch meat, and more	Further Processed

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TABLE 2: COMMON FURTHER PROCESSED MEAT PRODUCTS¹

Meat Item(s)	Description	Process	Common Ingredients²	Example Products
Bacon	Cured pork belly. If meat from other portions of the carcass or other species is used, the product name must be qualified to identify the portions. For example, Pork Shoulder Bacon, Turkey Bacon-Cured Turkey Breast Meat-Chopped and Formed, or Beef Bacon-Cured and Smoked Beef Plate.	Smoking, curing, thermal processing, and injecting.	Salt, sugar, sodium erythorbate, or ascorbate, sodium nitrite, and water. Can have other spices and seasonings.	Maple Bacon, Hickory Smoked Bacon, Peppered Bacon, Thick Cut Bacon, Lower Sodium Bacon, Turkey Bacon Made with Turkey Leg Meat, and many more.
Bologna	Comminuted semisolid sausages in large diameter casings that not have more than 30% fat or 40% fat and added water. A popular type of sausage.	Comminuted, emulsified, blended, cured, thermally processed, and can be smoked or unsmoked.	Salt, nitrite, added water and can have phosphates, sugar and other spices and seasonings.	Bologna, Beef Bologna, Turkey Bologna, German Bologna, and more.
Canadian Bacon	Cured pork from a trimmed boneless pork loin.	Can be cured, smoked or unsmoked, and thermally processed.	Can have salt, sugar, nitrate/nitrite, and water, as well as other spices and seasonings.	Cherrywood Smoked Canadian Bacon, back bacon, and more.
Corned Beef	Cured beef from the brisket, navel, clod, middle ribs, round, rump, or similar cut.	Fabricated, cured, can be injected, and heat treated.	Salt, nitrite, peppercorns, bay leaves, mustard, dill seeds, and more.	Corned beef brisket, Corned Beef Top Round, Delicatessen Corned Beef, and more.
Ham (General Category)	A large category of further processed meat items from the leg of a pork carcass. Hams may be fresh, cured, or cured-and-smoked. Generally, ham is the cured leg of pork. Fresh ham is an uncured leg of pork. Products can be bone-in or boneless	Can be blended, thermally processed, cured, uncured, diced, fabricated, restructured, comminuted, injected, or smoked or unsmoked.	Ingredients vary widely based on the type of ham.	Deli Ham, Honey Cured Ham, Spiral Sliced Ham, Fresh Ham, Lean Ham, Low Sodium Ham, Ham Center-Cut Slice, and many more.
Fresh Ham	The only type of ham that is not cured. The term “fresh” must be on the label.	Fabricated and can be diced or thermally processed.	Typically, none or just spices and seasonings.	Fresh Ham Uncooked, Fresh Ham Cooked, and more.
Smoked Ham	Hams that are cured and smoked. Products can be bone-in or boneless and cooked or uncooked prior to sale.	Cured, injected, smoked, and can be thermally processed.	Salt, nitrite, added water and can have phosphates, sugar, and other spices and seasonings.	Hickory Smoked Ham, Cured and Smoked Spiral Sliced Ham, Smokehouse Ham, Black Forest Ham, Honey Ham, Honey-Cured Ham, and more.

TABLE 2: COMMON FURTHER PROCESSED MEAT PRODUCTS¹

Meat Item(s)	Description	Process	Common Ingredients²	Example Products
Dry Cured Ham	Fresh hams rubbed with a dry-cure mixture and aged. Six months is the traditional aging process but may be shortened according to aging temperature or lengthened to over a year for flavor development. Dry curing produces a salty product that is shelf stable with very low water activity.	Cured, dried, and can be smoked.	Salt, nitrate, or nitrite and can have other spices and seasonings added.	Country Cured Ham, Westphalian Ham, Prosciutto, Serrano Ham, and more.
Hot Dogs (Frankfurters)	Comminuted semisolid sausages in small diameter synthetic casings that do not have more than 30% fat or 40% fat and added water. Can be made from beef, pork, turkey, chicken, or a combination. A popular type of sausage.	Comminuted, emulsified, blended, cured, thermally processed, and can be smoked or unsmoked.	Salt, sodium nitrite, added water (ice) and can have phosphates, hydrolyzed vegetable protein, and more.	All Beef Franks, Reduced Sodium Frankfurters, Skinless Bun Length Beef Franks, Turkey Hot Dogs and more.
Jerky	A nutrient dense meat product that has been made shelf stable through drying.	Thermally processed, dried, and can be marinated, and smoked.	Salt, sugar, seasonings, and spices.	Beef jerky, teriyaki beef jerky, peppered beef jerky, turkey jerky, bacon jerky, and many more.
Pastrami	Beef plate or thin meats that are prepared and often served as deli meat. Other meat items and species can be used but must be identified on the label.	Smoked, cured, and heat treated.	Salt, sodium nitrite, added water, and can have other spices and seasonings.	Delicatessen Pastrami, Pastrami, Smoked Pastrami, Top Round Pastrami, Turkey Pastrami, and more.
Roast Beef	Large ready-to-eat beef items.	Thermally processed and injected.	Added water and often contains phosphates, salt, sugar, and other seasonings and spices.	Roast Beef Premium Deli Ultra Thin, Roast Beef Deli Style, Medium Cooked Roast Beef, Lower Sodium Roast Beef, and more.
Sausage (General Category)	Coarse or finely comminuted meat from various species containing various ingredients, moisture levels, and undergone various processes. Numerous classes of sausage are recognized by the United States Department of Agriculture (see below).	Blending, thermal processing, curing, emulsifying, fermenting, grinding, and smoking.	Salt, nitrite, added water, and can have phosphates, sugar, and other spices and seasonings.	Sopressata, Pepperoni, Salami, Breakfast Sausage, Italian Sausage, and more.
Fresh Sausage	Coarse or finely comminuted sausages that must be refrigerated and cooked.	Grinding.	Salt, added water, and numerous spices and seasonings.	Bratwurst, Italian Sausage, Whole Hog Sausage, Breakfast Sausage, and more.

TABLE 2: COMMON FURTHER PROCESSED MEAT PRODUCTS¹

Meat Item(s)	Description	Process	Common Ingredients ²	Example Products
Uncooked Smoked Sausage	Uncommon sausage type. Similar to fresh sausage but have a different color and flavor profile.	Grinding and smoking.	Salt, added water, and numerous spices and seasonings.	Fresh Smoked Pork Sausage, Kielbasa, and Linguica.
Cooked and/or Smoked Sausage	Comminuted semisolid sausages.	Grinding, blending, smoking, thermally processed, and can be emulsified and cured.	Salt, sodium nitrite, added water (ice) and can have phosphates, other spices and seasoning.	Frankfurters, bologna, knockwurst, braunschweiger, Smoked Hot Beef Sausage, and more.
Dry and Semidry Sausages	Comminuted sausage that is fermented by bacterial growth. They are often cultured with lactic acid, similar to cheese, pickles, and yogurt.	Grinding, blending, curing, fermenting, and drying.	Salt, sodium nitrite, and numerous spices and seasonings.	Sopressata, Pepperoni, Salami, Summer Sausage, Lebanon Bologna, and more.
Specialty Meat, Loaves and Jellied	Typically, ready-to-eat sausage like products made from comminuted meats that are seasoned and usually thermally processed rather than smoked. They are usually sliced and served cold.	Can be ground, blended, thermally processed, and emulsified.	Salt, added water, and numerous spices and seasonings.	Head Cheese, Jellied Corned Beef, Ham and Cheese Loaf, Olive Loaf, Scrapple, and more.

¹ This is not an all-encompassing list. There are thousands of different further processed meat products.

² Not all ingredients are listed. There are unlimited combinations of ingredients for each product.

Source: United States Department of Agriculture Food Safety and Inspection Service.

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Classification: Antimicrobials				
Buffered Vinegar	Vinegar is acetic acid made from the initial fermentation of natural sugars to alcohol, followed by the secondary fermentation to vinegar. After this, the vinegar is combined with things like soda ash or baking soda to increase the pH to a more neutral level so it does not denature protein.	Used to control pathogen and spoilage bacteria growth, including <i>Listeria monocytogenes</i> and others.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label. Typically 0.5–2%.	Made by combining vinegar with buffering agents like soda ash or baking soda to raise the pH to a more neutral level so it does not denature protein.
Calcium Propionate/ Sodium Propionate	The calcium and sodium salts of propionic acid (a naturally occurring short-chain fatty acid).	Used as an antifungal to inhibit mold and other spoilage microorganisms.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label. Typically 0.1–0.3%.	Made by reacting propionic acid with calcium hydroxide or sodium hydroxide. Propionic acid is made by bacterial fermentation of carbohydrates.
Lactic Acid (Sodium and Potassium Lactate)	The sodium salt of lactic acid and the potassium salt of lactic acid.	Used as humectants, pH control agents, flavor enhancers, and to increase water-holding capacity and cook yield. Most importantly, it decreases bacterial growth.	Allowable limits are under FSIS Directive 7120.1, which states up to 4.8% (alone or in combination) in the finished product.	Fermented dairy products
Lemon Juice	The liquid that is extracted from a lemon and it primarily made up of citric acid.	It is a multifunctional ingredient used to enhance flavor, adjust pH, influence bacterial growth, can be used as a leavening agent, as well as can be used to reduce oxidation.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Lemons

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Nisin	Nisin is a mixture of antimicrobial polypeptides (amino acids bonded together) produced by strains of <i>Lactococcus lactis</i> and is particularly effective against gram positive bacteria.	Used to control gram-positive pathogen growth, including <i>Listeria monocytogenes</i> and extend shelf life.	The expectation is that nisin should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label. The safe regulatory limit is less than 250 ppm in finished product (21 CFR 184.1538).	"Nisin is derived from non-fat milk solids or from a non-milk-based fermentation source, such as yeast extract and carbohydrate solids."
Potassium Carbonate	A white, water-soluble salt that forms a strongly alkaline (having a pH greater than 7) solution when dissolved is used as a buffering agent.	pH control, buffering agent, and binds moisture.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Naturally found in soils and is made with potassium hydroxide and carbon dioxide.
Potassium Sorbate	The potassium salt of sorbic acid, a naturally occurring compound found in certain fruits (like rowanberries).	Used to inhibit the growth of molds, yeasts, and some bacteria. It also helps maintain color, texture, and overall quality of processed meats by preventing microbial breakdown.	USDA does not specify a fixed regulatory limit for potassium sorbate, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label and is often used at levels up to 0.1% in products.	Made from sorbic acid derived from acetylene or crotonaldehyde. It can also be found in small amounts in natural sources like rowanberries and other berries.
Sodium and Potassium Acetate	The sodium and potassium salt of acetic acid, used for preservation.	Inhibits the growth of spoilage and pathogenic microorganisms, extends shelf life, and buffers pH.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Produced by reacting acetic acid (vinegar component) with potassium hydroxide.

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Sodium Benzoate	The sodium salt of benzoic acid used to extend shelf life. It is water-soluble, tasteless, and odorless.	Used to inhibit the growth of yeast, bacteria, and mold, and is a common ingredient in various products to prevent spoilage.	"The expectation is that sodium benzoate should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label. The safe regulatory limit is $\leq 0.1\%$ in food or up to 1,000 ppm (21 CFR § 582.3733)."	Made by combining benzoic acid (a naturally occurring compound found in some plants and is a byproduct of some fermenting processes) with a sodium source like sodium hydroxide, baking soda, or soda ash.
Sodium Diacetate	Is a salt formed by combining sodium acetate (the sodium salt of acetic acid) with acetic acid.	Inhibits pathogen growth, acts as a pH regulator and quality improver, helping to maintain the desired taste and texture of meat products while preventing spoilage.	USDA does not specify a fixed regulatory limit for sodium diacetate, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label and is often used at levels up to 0.3% in products.	Acetic acid (derived from natural sources like fermentation of ethanol or synthetic sources) and sodium carbonate or sodium hydroxide are readily available. It is not usually sourced from a specific natural "raw material," as it is a chemical compound created in controlled industrial processes.
Classification: Antioxidants				
Butylated Hydroxyanisole (BHA)	An antioxidant commonly used to prevent rancidity in food products, cosmetics, and other items.	Prevent oxidative spoilage by stabilizing the oils and fats in products, which increases shelf-life.	0.01% of fat content	Made by combining anisole (which is a compound found in some plants, like aniseed) with isobutene (a type of chemical made from petroleum).
Butylated Hydroxytoluene (BHT)	An antioxidant commonly used to prevent rancidity in food products, cosmetics, and other items.	Prevent oxidative spoilage by stabilizing the oils and fats in products, which increases shelf-life.	0.01% of fat content	Made with p-cresol, which is a type of phenol (similar to what you might find in things like pine tar), and then it's mixed with isobutene.

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Citric Acid/Sodium Citrate	Citric acid is a natural acid, sodium citrate is its salt.	pH control, reduces oxidation, flavor enhancer and enhances the effectiveness of other antioxidants.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Citric acid is made using microbial fermentation of sugar sources like corn syrup or molasses. It is also found naturally in citrus fruits, berries, and tomatoes. Sodium citrate is made by neutralizing citric acid with sodium salts.
Propyl Gallate	An antioxidant commonly used to prevent rancidity in food products, cosmetics, and other items.	Prevent oxidative spoilage by stabilizing the oils and fats in products, which increases shelf-life.	0.02% of fat content	Propyl Gallate is made by reacting gallic acid (found in oak bark, grape seeds, green tea, berries, pineapple and witch hazel) with propyl alcohol.
Tertiary-Butylhydroquinone (TBHQ)	An antioxidant commonly used to prevent rancidity in food products, cosmetics, and other items.	Prevent oxidative spoilage by stabilizing the oils and fats in products, which increases shelf-life.	0.02% of fat content	Made by reacting hydroquinone (a type of chemical found in plants) with isobutene. Found in tea and coffee and is also used in cosmetics.
Tocopherols	A class of organic compounds that make up Vitamin E, a fat-soluble antioxidant.	Prevents oxidation, extends shelf life, and helps stabilize color.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Vegetable oils including soybean, sunflower, corn and wheat germ.

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Classification: Basic Cure Ingredient				
Salt (Sodium Chloride)	NaCl. Generally, a white crystalline solid. Sodium chloride is made up of roughly 40% sodium and 60% chloride. Salt is one of the oldest ingredients used in meat processing and is a critical ingredient to all cured meat products.	Salt preserves through dehydration and alteration of the osmotic pressure of microorganisms, which inhibits growth. Salt is often used in combination with other ingredients for the desired antimicrobial effect and flavor development.	Products will become unpalatable with high concentrations of salt, so it is self-limiting.	Sea salt, rock salt
Water	Water is the most abundant component of muscle/meat. However, added water is a necessary functional component in many further processed meat products. Added water is the amount of water added to meat products, not the water that is already a component of muscle. Added water is also often referred to as the amount of water added in excess of the moisture to protein ratio.	Added water is a solvent used to dissolve, carry, and disperse substances, including ingredients. Without added water to dissolve and disperse small quantities, it would be very difficult to achieve uniform distribution of ingredients during mixing.	Any added water must be included in the ingredient statement. USDA FSIS1 limits the amount of added solution (added water with dissolved ingredients). Numerous products can have added solution, and that must align with the standard of identity2 found in 9 CFR 319. For products with added solutions that do not have a standard of identity, the calculation for the percentage of added solution is found in 9 CFR 317.2(e)(2)(i). The percentage of added solution must be on the label.	Natural Water Sources

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Classification: Basic Cure Ingredient – Cure Accelerator				
Sodium acid pyrophosphate	Sodium acid pyrophosphate or SAPP is the sodium salt of acid pyrophosphate	Accelerates cure by speeding the “fixing” of cured color, improving shelf appearance and consistency. Improves moisture retention by retaining water during cooking.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Produced via controlled dehydration and partial neutralization of phosphoric acid.
Tartaric acid	A strong natural organic acid that is the most water-soluble of the solid acidulants. It is a white, crystalline powder, odorless, and with an acidic taste.	A multi-functional ingredient that helps enhance flavor by providing a distinctive sour or tart flavor to processed meats, complementing other flavor profiles. Tartaric acid also helps lower pH to balance the overall acidity of the meat product and inhibit the growth of pathogens and spoilage microorganisms, extending the shelf life of the meat.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Occurs naturally in grapes, apples, cherries, papaya, peach, pear, pineapple, strawberries, mangos, and citrus fruits.

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Classification: Basic Cure Ingredient – Cure Accelerator (Acidulant)				
Glucono-delta-lactone (GDL)	A neutral (less acidic than the open-chain form) cyclic ester (an alcohol and acid combine, releasing a water molecule which creates a ring structure bond) of gluconic acid, produced with the acid by fermentation of glucose.	Multifunctional ingredient that lowers pH, accelerating nitrite-to-nitric oxide conversion, enhances color development, and controls pathogen growth. As an acidulant, it allows for gradual acidification, resulting in better control of texture and moisture retention. GDL also improved protein coagulation, improving firmness and sliceability of products.	USDA does not specify a fixed regulatory limit for GDL, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Made from glucose via microbial oxidation.
Classification: Basic Cure Ingredient – Cure Accelerator (Reductant)				
Sodium Ascorbate Or Ascorbic Acid	The sodium salt of ascorbic acid, a refined food-grade chemical similar to Vitamin C. Ascorbic acid is Vitamin C	Stabilizes the color of cured meats. Inhibits the formation of nitrosamines. Accelerates curing, which aids in controlling bacterial growth. Similar to sodium erythorbate or erythorbic acid.	Bacon must have 120 ppm of nitrite and 550 ppm of ascorbate or erythorbate.	Fermentation of glucose often from corn. Also comes from sugar beets, cherries, cassava, or other starchy crops.
Sodium Erythorbate or Erythorbic Acid	The sodium salt of erythorbic acid, a refined food-grade chemical similar to vitamin C and made from sugar.	Stabilizes the color of cured meats. Inhibits the formation of nitrosamines. Accelerates curing, which aids in controlling bacterial growth. Similar to sodium ascorbate or ascorbic acid.	Bacon must have 120 ppm of nitrite and 550 ppm of ascorbate or erythorbate.	A stereoisomer of ascorbic acid (Vitamin C) and made from fermentation of glucose or sucrose (often from corn).

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Classification: Basic Cure Ingredient – Curing Agent				
Plant-derived curing agents (celery, beet, etc.)	Nitrate and nitrite extracted from plants that are used to cure meat.	Responsible for the distinctive properties that characterize cured meat products. It stabilizes the color of lean tissue, provides flavor, inhibits the growth of a number of pathogens and spoilage bacteria, and slows down rancidity.	“USDA FSIS1 closely regulates the allowable levels of ingoing sodium nitrite found in 9 CFR 424.22. Bacon: 120 ppm + 550 ppm of sodium ascorbate or sodium erythorbate Dry-cured bacon: 200 ppm Frankfurters or cured sausages: 156 ppm Brine cured of injected products like ham or pastrami: 200 ppm Dry-cured meat items: 625 ppm”	Derived from celery powder or juice, beet juice or powder, swiss chard, spinach powder, sea salt blends and more.
Sodium and Potassium Nitrate	NO ₃ . A curing agent that is often incorporated into the meat as a form salt (sodium nitrate). Sodium nitrate is transformed into nitrite through non-enzymatic processes and nitric oxide (NO) by bacteria during the curing process.	Nitrate is used for long cured items that continually need nitrate to produce nitrite throughout the curing process.	The allowable level of sodium nitrate can be calculated based on the regulatory limit for allowable level of nitrite. ³ Nitrate is not permitted in bacon.	Made neutralizing nitric acid with sodium carbonate. Also comes from natural sources such as leafy greens, beets, celery, chard, and parsley.
Sodium and Potassium Nitrite	NO ₂ . The main curing agent that is often incorporated into meat in the form of salt (sodium nitrite).	Responsible for the distinctive properties that characterize cured meat products. It stabilizes the color of lean tissue, provides flavor, inhibits the growth of a number of pathogens and spoilage bacteria, and slows down rancidity.	“USDA FSIS1 closely regulates the allowable levels of ingoing sodium nitrite found in 9 CFR 424.22. Bacon: 120 ppm + 550 ppm of sodium ascorbate or sodium erythorbate Dry-cured bacon: 200 ppm Frankfurters or cured sausages: 156 ppm Brine cured of injected products like ham or pastrami: 200 ppm Dry-cured meat items: 625 ppm”	Made by neutralizing nitrous acid with sodium carbonate or bicarbonate. Also comes from natural sources such as leafy greens, beets, celery, chard, and parsley.

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Classification: Basic Cure Ingredient - Phosphates				
Disodium Phosphate (DSP) and Monosodium Phosphate (MSP)	Acid-base buffering agents, that are water-soluble salts of phosphoric acid.	These functional phosphates help maintain optimal pH for protein functionality, microbial stability, and color retention. DSP and MSP also enhance protein solubility and swelling, to increase moisture retention and reduce cooking loss.	9 CFR §424.21(c) Allows phosphates (calculated as P ₂ O ₅) permitted up to 0.5 percent of the finished product weight.	Produced via the neutralization of phosphoric acid with sodium carbonate or sodium hydroxide
Sodium Hexametaphosphate (SHMP)	A polyphosphate compound made of a mixture of sodium metaphosphate polymers. It is a white, odorless, water-soluble powder or granule	Used to increase protein-water binding capacity, reducing purge and cooking loss. It also helps reduce lipid oxidation, improve texture, and stabilize pH.	9 CFR §424.21(c) Allows phosphates (calculated as P ₂ O ₅) permitted up to 0.5 percent of the finished product weight.	Made by heating sodium dihydrogen phosphate (NaH ₂ PO ₄) to induce polymerization
Sodium Tripolyphosphate (STPP)	A white, crystalline or granular powder made up of a chain of three phosphate units that are highly soluble in water.	A multifunctional ingredient that greatly increases waterholding capacity by protein swelling, helps stabilize pH, helps bind fat and moisture, and reduces oxidation.	9 CFR §424.21(c) Allows phosphates (calculated as P ₂ O ₅) permitted up to 0.5 percent of the finished product weight.	Produced by thermal condensation of disodium phosphate and monosodium phosphate.
Tetrasodium Pyrophosphate (TSPP)	A white, granular or powdered polyphosphate salt composed of two phosphate units.	A multifunctional ingredient that improves yield, helps stabilize high pH, helps bind fat and moisture, and reduces oxidation by binding iron and calcium, preventing off-flavors and oxidative rancidity.	9 CFR §424.21(c) Allows phosphates (calculated as P ₂ O ₅) permitted up to 0.5 percent of the finished product weight.	Made by heating sodium phosphate salts to induce polymerization and dehydration.

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Classification: Casing Agent				
Calcium Chloride	An inorganic salt, that consists of calcium and chloride ions. It's a white powder and highly soluble in water.	Firming agent, tenderizer, and color stabilizer.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Produced as a byproduct of the Solvay process, or by neutralizing hydrochloric acid with calcium carbonate. Found naturally in seawater and mineral springs.
Sodium Alginate	The sodium salt of alginic acid that is a natural, water-soluble polysaccharide derived from brown seaweed, primarily kelp.	Moisture retention, film forming, gelling, and binding agent	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Extracted from the cell walls of brown seaweed, mainly kelp.
Classification: Emulsifier				
DATM (diacetyl tartaric acid esters of monoglycerides)	An ester that is usually a waxy, off-white powder or solid that can be added to foods during processing to emulsify and stabilize product.	Acts as an emulsifier and stabilizer. It helps bind fat and water together, improving texture, sliceability, and uniformity.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Made by reacting monoglycerides (from plant or animal fats) with tartaric acid (natural acid found in grapes) and acetic acid (vinegar).
Classification: Flavoring Agent				
Diacetyl	A water-soluble and volatile, alpha-diketone (meaning has two carbonyl groups) compound with a buttery odor. Often in liquid form but can be converted to a powdered form by encapsulating them within a solid material to prevent volatility.	Aids in flavoring (both dairy flavors, particularly butter flavorings but also cheese, milk, and yogurt, as well as brown flavors such as caramel, butterscotch, and coffee flavors) and has some antimicrobial properties as well.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Occurs naturally in plants, fruits, coffee, honey, cocoa, and dairy products. Made as natural by-product of fermentation.

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Disodium Inosinate and Guanylate	IMP is derived from inosinic acid (a nucleotide). GMP is derived from guanylic acid (another nucleotide).	Amplifies MSG's effect by 20–30× when used in combination. Often used in low-sodium, plant-based, or lean meat products where natural umami is deficient. This allows products to use less MSG.	Use levels are low: typically 10–100 ppm, depending on the product.	Originally derived from animal tissues (e.g., fish, meat extract), but now produced microbially by fermentation for consistency.
Monosodium Glutamate	The sodium salt of glutamic acid, a naturally occurring amino acid.	Used as a flavor enhancer, particularly for umami (savory taste).	Use levels typically range from 0.1% to 0.5% in finished products.	Produced by fermenting carbohydrate sources (e.g., sugar beets, sugar cane, molasses) using <i>Corynebacterium</i> spp.
Classification: Leavening Agents				
Potassium or Sodium Carbonate/ bicarbonate	Are alkaline salts used as leavening agents and pH control. Sodium carbonate, also known as soda ash or washing soda, is a strongly alkaline, water-soluble salt of carbonic acid. Sodium bicarbonate, commonly known as baking soda, is a milder, amphoteric compound with buffering and leavening properties.	Buffers or raises pH, which leads to increased moisture retention, juiciness, and tenderness.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Sodium carbonate is found in mineral form in trona, soda lakes and desert soils. Sodium bicarbonate occurs in mineral springs and as natron (a naturally occurring blend of carbonates and bicarbonates).
Classification: Miscellaneous				
Bleached Flour	Flour that has been treated to have a softer, finer texture and milder flavor. The treatment also changed the color of the flour to whiter.	Used to help bind and retain water to improve texture. Bleached flour is also used in batter and breadings found in some processed meat items.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label and clearly state "bleached" flour.	Milled wheat flour subjected to chemical bleaching.

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Caramel or Caramel Coloring	Water-soluble food coloring made by heating sugars with acids/alkalis.	Used to visually enhance products by adding brown pigments to make them more attractive and appetizing to consumers.	USDA does not specify a fixed regulatory limit for plant-derived starches, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Caramel coloring is made by breaking down carbohydrates like sugar
FD&C Red No. 40	A azo dye that provides a bright red or reddish-orange color.	Colorant	As per 21 CFR 74.340; certified batch required	Made from petroleum-derived compounds, such as aromatic hydrocarbons like benzene derivatives, through a multi-step chemical synthesis process.
Palm Oil	Vegetable oil from palm fruit (<i>Elaeis guineensis</i>).	Serves as fat, lubricating agent, moisture binder, texturizer, improving mouthfeel and cooking performance.	USDA does not specify a fixed regulatory limit for plant-derived starches, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Refined from palm fruit mesocarp oil.
Soybean Oil	Widely used vegetable oil (e.g., solvent-extracted, refined).	Serves as fat, lubricating agent, moisture binder, texturizer, improving mouthfeel and cooking performance.	USDA does not specify a fixed regulatory limit for plant-derived starches, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Refined extract from soybean seeds.

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Yellow 5	Certified synthetic yellow dye.	adds bright yellow color to blends, counters color deterioration, enhances visual appearance.	USDA does not specify a fixed regulatory limit for plant-derived starches, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Must be declared as FD&C Yellow No. 5 in the ingredient list.	Synthetic organic azo dye from petroleum-derived precursors.
Classification: Non-Meat Proteins				
Hydrolyzed Vegetable Protein	A type of flavoring to give meat-like flavor to food products. The hydrolysis of the protein in vegetables results in high levels of free glutamic acid. There are two possible types, acid or enzyme hydrolyzed.	Flavor enhancement. Used to increase protein content, cooking yield, or alter sensory and slicing characteristics.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Soybeans, wheat, corn
Milk Proteins	Dehydrated dairy ingredients derived from skim milk are often incorporated as nonfat dry milk	Improve binding, stabilize emulsions, enhance protein content, and improve overall texture and yield.	USDA does not specify a fixed regulatory limit for plant-derived starches, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Milk
Soy/Soy Protein	A functional, plant-based protein additive derived from soybeans.	Added to improve texture, enhance moisture retention, stabilize emulsions, and reduce formulation costs.	"Isolated Soy Protein: Permitted at up to 2% of the finished product weight. Soy Protein Concentrate: Allowed at levels up to 3.5% of the finished product weight. According to 9 CFR § 424.21(c)."	Soybeans

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Classification: Non-Starch Hydrocolloids				
Carrageenan (kappa-carrageenan)	A hydrocolloid (water-binding agent) polysaccharide (carbohydrate).	Increases water holding capacity, improves firmness, improves yield, and helps reduce fat in formulations.	Under 9 CFR §319.140, this item is used at 0.75% or less in the finished product.	Derived from red seaweeds.
Classification: Smoke				
Smoke/Liquid Smoke	Smoke – a mixture of gases, vapors, and fine particles produced by the combustion of wood, typically hardwoods. Liquid Smoke - a water-soluble condensate derived from capturing and condensing real wood smoke	Enhance flavor, improve color, extend shelf life, and provide antioxidant and antimicrobial benefits. Also, it contributes to moisture retention and allows for consistent, controlled processing.	USDA does not specify a fixed regulatory limit for smoke or liquid smoke; the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Wood smoke, and condensed smoke (makes liquid smoke), is made from burning mesquite, applewood, hickory, and other woods.
Classification: Starches				
Starches (corn, rice, potato, and others)	Functional carbohydrate additives obtained from botanical sources.	Added to enhance moisture retention, improve texture, stabilize emulsions, and control viscosity.	USDA does not specify a fixed regulatory limit for plant-derived starches, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Corn, potato, tapioca, wheat, and others.
Classification: Sweetener				
Maltodextrin	A polysaccharide derived from starch hydrolysis (breakdown).	Used to add volume, stabilize and carry flavors, bind components together, and retain water especially in low moisture products.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Made from starches like corn, rice, potato, or wheat through partial hydrolysis, breaking down the starch into shorter glucose chains

TABLE 3: INGREDIENTS COMMONLY USED IN FURTHER PROCESSING

Ingredient	Description	Function/Use	Regulatory Level	Source
Sorbitol	A sugar alcohol (a type of carbohydrate sweetener that allows for less sugar in foods) used as a humectant (a substance that attracts and binds water) and sweetener.	Works to bind and retain water/ moisture retention and adds sweetness, which can reduce the amount of sugar needed in the product.	USDA does not specify a fixed regulatory limit, the expectation is that it should be used at the minimum level necessary to achieve its intended technical effect. Required to be included on the product label.	Can be made through the chemical hydrogenation of glucose or fructose or made by specific yeasts. It is also found naturally in many fruits, such as berries, cherries, plums, pears, and apples.
Sugar (Dextrose/ Corn Syrup) and Cultured Sugar/ Dextrose	A sweetener used in meat products. A variety of sugars, including molasses and other sweeteners, are commonly used. Type of sugars used range from sucrose (cane or beet sugar) to dextrose (corn sugar). The dextrose group includes corn syrup, corn syrup solids, and sorbitol.	Added for flavor. Counteracts harshness of salt by preventing moisture loss and directly diminishing the saltiness in products. Sugars also can interact with amino acids create browning during cooking.	No specific level regulated in meat as long as the items is compliant with any appropriate standard of identity.	Sugar cane, sugar beets, as well as corn starch. Made by enzymatic hydrolysis to glucose.