



Meat Science Lexicon*

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Abstract: The American Meat Science Association (AMSA) became aware of the need to develop a Meat Science Lexicon for the standardization of various terms used in meat sciences that have been adopted by researchers in allied fields, culinary arts, journalists, health professionals, nutritionists, regulatory authorities, and consumers. Two primary categories of terms were considered. The first regarding definitions of meat including related terms, e.g., “red” and “white” meat. The second regarding terms describing the processing of meat. In general, meat is defined as skeletal muscle and associated tissues derived from mammals as well as avian and aquatic species. The associated terms, especially “red” and “white” meat have been a continual source of confusion to classify meats for dietary recommendations, communicate nutrition policy, and provide medical advice, but were originally not intended for those purposes. In this paper, processed meat is defined in terms of the actions of processing, i.e., “minimal processing” and “further processing”; the main distinction being whether additional ingredients were included or excluded. Meat processing has become more complex as technologies have improved, and the official words to describe them have not remained current.

Keywords: further processing, meat, meat lexicon, minimal processing, offal, red meat, white meat, terminology

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Introduction

Many terms used to describe meat and meat processing have been accepted into the scientific jargon for a number of years, but as technology has improved and

the variety of meat products has become more abundant so has the necessity of providing clear and concise definitions for the terms used to define meat and meat processing. Many of the meat terms commonly used by consumers, journalists, public health officials, nutritionists, and medical researchers may or may not, in fact, be used to convey their original meanings. In some instances their original meanings have evolved over time to mean something different. Such confusion can result in misinformation regarding meat consumption patterns, meat product manufacturing, and food safety. This lack of consistent messaging led the AMSA to develop a meat science lexicon to address the confusion.

Disclaimer: The definitions supplied in this document were developed to provide consistency in application and research concerning food proteins derived from animals. These terms are not necessarily intended to replace terms as commonly used for international meat and poultry products' trade and regulations, e.g., as provided in the North American Meat Institute's 'Meat Buyer's Guide', Title 9 CFR, and/or other internationally recognized references.

In this paper, we will present 3 definitions that address 3 of the most prominent issues regarding the proper use of meat-related terms. These include first a definition of ‘meat’, second definitions for ‘red’ and ‘white’ meat, and finally a discussion and classification for various levels of meat processing. Consequently, the objective of the lexicon is to define meat and meat products and provide a standardized lexicon of terms for use by scientists, food technologists, meat industry personnel, health and allied professionals, journalists, regulatory authorities, nutritionists, and consumers to accurately describe and classify meat and meat products when conveying meat related information.

Background and Development of the Lexicon

Evolution of terms

Historically, terms used in the meat industry were never created using a single systematic method nor were their definitions designed to include all possibilities of their usage. They were, instead, created in a more empirical, practical fashion over decades, and even centuries, to describe an industry and its related practices encompassing a variety of species, processes, technologies, and products all evolving over time. A host of terms, some considered jargon, were created for scientific, regulatory, and day-to-day industry needs. As in other industries, much jargon is commonly used in the meat industry because it is an “ancient craft” and these terms are still considered the most appropriate. The same is true for many terms that describe the traditional processes the industry uses to derive food from animals. Generally, 3 distinct processes are used in the meat industry: 1) slaughter/chilling (or harvest), 2) fabrication (minimal processing), and 3) further processing. The slaughter process refers to the steps followed from the time the live animal is stunned or immobilized through the dressing process to the point that the carcass is placed in refrigeration for cooling. In a practical sense, the meat industry often refers to this period as the conversion of muscle to meat. The fabrication (deboning, cutting) process takes the chilled carcass (considered meat at this point) and cuts it into smaller, more useful components (e.g., wholesale, primal, subprimal, retail cuts, and trimmings). It is called fabrication because the carcass itself (which is in a form of limited value for consumers) is converted (fabricated) into more useful end-products for consumers or raw materials for subsequent processes and products. Finally, certain cuts like hams and the trimmings generated from

fabrication are converted into a variety of value-added, newly created, and uniquely different meat products by a host of technologies including grinding, chopping, mixing, curing, smoking, cooking, drying, and fermenting. These additional procedures are classified as processing.

However, in the context of slaughter, fabrication, and processing, this general framework does not include nor fully encompass the complexities of modern meat fabrication and processing techniques and can readily contribute to term-related confusion. The poultry industry, for example, does not use the term “fabricate” to describe the deboning of the carcass, but prefers to call it “further processing”. Other examples include wholesale cuts that can be mechanically tenderized, meat cuts with “enhanced” flavor and tenderness by the addition of added ingredients (e.g., salt, water, flavorings), and meat from various meat recovery systems that separate lean meat from fatty trimmings or bones (e.g., finely textured beef, advanced meat recovery, and mechanically separated meats).

The terms used by industry personnel, meat scientists, or regulatory officials may seem different than those used (or understood) by consumers unless they have some historical perspectives of the terms. For example, ground beef is not considered to be a “processed product” because it comes from the raw product fabrication stage, but according to regulatory labeling ground turkey is a “processed” product. Yet, consumers may consider both to be processed. These complexities and nuances, among many others, were thoroughly considered. Other terms currently found in scientific and popular press literature can be equally ambiguous. The term “fresh” for example, can be used in some contexts to mean that meat has never been frozen (Department of Agriculture, 2017b) while in other contexts, fresh may classify a meat product as one prepared for consumption without added curing ingredients (Department of Agriculture, 2017a). Consumers may, however, consider meat to be “fresh” when it still shows good color and has been displayed for only a short time. Fresh meat, therefore refers to meat that contains no added ingredients and is not frozen. This product is quite perishable and has a very short shelf life even under refrigeration.

Red and white meat

Meat is a single term that encompasses a range of species and describes the consumable tissues that make up a host of safe, wholesome, nutritious, and desirable products for the consuming public. These products range in form from raw fresh cuts created via the fabrication process to those made utilizing more advanced

processing methods. Much confusion has arisen from the terms red meat and white meat when used as categorical terms. The Federal Meat Inspection Act of 1906 was established to ensure the wholesomeness of what was considered red meat species (beef, swine, sheep, goat, and horse). As time passed, and as meat from other species, primarily poultry, became more popular, these were added to the inspection regulations (Poultry Products Inspection Act of 1957). The distinction between “meat” and “poultry” still exists in the USDA regulations, but with time, meat from lighter colored avian species has been referred to as white meat to distinguish it from the red meat species. Consumers generally recognize that poultry has both red (dark) and white meat, but they consider poultry to be ‘white’. However, these terms do not provide an adequate description of the variation that can exist between and within species. Though differences among muscle fiber types, mitochondrial densities, myoglobin concentration, instrumental color variations, and other variables could imply that certain products should be grouped as red or white, it is more informative to precisely describe the actual parameter of interest when communicating scientific information. For example, in terms of nutritional studies of meat consumption, the red and white meat terms are often used as surrogate descriptors when unsaturated or saturated fat content of meat is actually of interest.

Processing

All foods require preparation and processing to varying degrees and meat may simply be the primary ingredient in a product just as flour is the base ingredient in a host of cereal, bakery, and pasta products. Meat preparation for consumption generally includes particle size reduction of the meat base; addition of non-meat ingredients (for various functions ranging from flavor, to protection against pathogens, to preservation of shelf-life); and/or thermal processing. Other preparation techniques that are used to enhance meat products include fermentation, smoking and drying. Meat products were divided into 2 categories based on the degree of preparation applied; this resulted in 2 major process classifications: 1) minimal processing, and 2) further processing. These 2 major classifications and their subclasses refer to the level of processing applied to meat when merchandized to the end-user.

In recent years, the term “processed meat” has developed a negative connotation, implying a product manipulated in a manner making it less wholesome, nutritious or safe for long-term health than a meat prod-

uct that has not been “processed”. Processed meats are often associated with products that are prepared using added ingredients such as curing agents like sodium nitrite. Sodium nitrite is used to improve food safety, extend product shelf-life, and to slow development of rancidity (Sindelar and Milkowski, 2012). More accurate definitions and terminology for meat and processed meat will allow for standardized communication among scientists, nutritionists, health care professionals, journalists, consumers, and others.

The definitions were organized using a lexicon/taxonomy system that has resulted in the Meat Science Lexicon described in this document. There are many different uses of meat terms and descriptions of a variety of meat products. The use of meat terms occur in different contexts and some terms have specific meanings in one context but not others. The meat industry has become more complex over the years as use of new technologies have been adopted and accepted, and as the regulatory environment has changed. Thus, new terms appear describing the output of these new technologies; however, these do not always have a systematic or scientific definition. Furthermore, there is increased public awareness and participation in discussions about meat due to increased use of social media.

Meat Science Lexicon

During the slaughter process an animal is converted into a carcass component and a non-carcass component. The non-carcass component can be further divided into edible and inedible portions referred to as offal. Offal includes items such as organs, skin, hides, blood, horns, head, intestinal contents, feet, and other portions of the animal not associated with the carcass component. Edible offal is also referred to as variety meats. Variety meats include organs and tissues such as the liver, hearts, kidneys, uteri, cheek meat, and other organs or tissues that are deemed wholesome, and sold as food for human consumption. The acceptability/palatability of offal varies by geographic region based on consumer cultural practices, regulatory requirements, hygiene legislation, and religion.

Inedible offal is also referred to as by-products. By-products include hides, feathers, poultry blood, and organs such as the lungs that in the U.S. are not inspected and, therefore, are not sold as food for human consumption. Products derived from the carcass component and edible offal are referred to as meat.

Meat. Skeletal muscle and its associated tissues derived from mammalian, avian, reptilian, amphibian,

and aquatic species harvested for human consumption. Edible offal consisting of organs and non-skeletal muscle tissues also are considered meat.

Red/white meat. These terms provide a traditional, broad classification of meats based on specie, color and/or lipid composition that have been used for regulatory/historic/nutritional/health classification purposes. Red meat has been most commonly associated with beef, pork, and lamb, whereas white meat has been most commonly associated with breast muscle from chicken and turkey. These designations do not adequately describe the unique properties associated with the various species such as visual and cooked color, myoglobin content, lipid content, and nutrient profile, and are inappropriate to broadly classify meats for health and nutritional purposes.

Cell cultured/in vitro tissue. As of 2017, research is ongoing to produce animal-sourced food without harvesting animals by culturing muscle tissue from stem cells in a liquid medium (Hocquette, 2016). To be considered meat, these products must be comparable in composition and sensory characteristics to meat derived naturally from animals. In particular, the essential amino and fatty acid composition, macro and micro nutrient content, and processing functionality should meet or exceed those of conventional meat.

Meat processing. All meat is processed to varying degrees. This can include any meat product produced via various levels of physical or biochemical transformation of meat from a chilled carcass into a final or finished product that is deemed desirable by consumers.

Classifications

Listed below are descriptions of the major meat classifications and subcategories presented by classification, species and specific category in Tables 1–6 for ease of use and identification of a specific meat item or product. Examples of common names are given in the descriptions below as well as in Tables 1–6.

Minimal processing

Any process where raw, uncooked meat products have not been significantly altered compositionally and contain no added ingredients, but may have been reduced in size by fabrication, mincing, grinding, and/or a meat recovery system.

a. Raw, intact (Table 1): Mechanical processes such as cutting, slicing, shaping, and portioning that do not fundamentally or only minimally alter

Table 1. Description for Minimal Processing—raw, intact, no ingredients added category

Process category	Species	Product categories
Raw Intact	Beef	Carcass
	Veal	Primal (Wholesale) cuts
	Pork	Subprimal cuts
	Lamb	Retail cuts
	Goat	Steaks, roasts, chops (bone-in, boneless, portioned)
	Other	Trimmings Edible offal
	Chicken	Carcass
	Turkey	Parts
	Duck	Breast, thigh (bone-in, boneless, portioned)
	Goose	Trimmings
	Other	Edible offal
	Fish	Whole
	Other	Fillet Steak cuts Trimmings

the physical composition of the raw meat.

Product Examples: Primal and subprimal cuts (wholesale/whole muscle cuts), retail cuts, and trimmings.

b. Raw, non-intact, (Table 2): Mechanical processes such as grinding, flaking, cubing, forming, and blade tenderizing that disrupt the structure of meat to enhance tenderness or provide a specific shape to meet product specifications.

i. Mechanically tenderizing: Physical alteration of meat to enhance texture, e.g., cubing, blade tenderization, maceration, and pounding.

ii. Grinding/comminuting/dicing/flaking: Reducing the particle size of meat. This is sometimes an initial step before other processes.

iii. Forming: Pressing meat into uniform shape, primarily for portion control. e.g. patties, pressed, and/or shaped products.

c. Offal/variety meat processing (Table 1): Basic processing of the raw, skeletal and/or non-skeletal portion of the non-carcass component of an animal that is deemed wholesome, and sold as food for human consumption either as a single item or incorporated into products that require additional preparation steps.

Product Examples: Tongue, heart, liver, tripe, sweetbreads, hog maw, oxtail, intestines, kidney, feet, paws and other edible bones, knuck-

Table 2. Description for Minimal processing—raw, non-intact, no added ingredients, physically altered category

Process category	Product type	Species	Product categories
Raw Non-Intact, no added ingredients	Mechanically tenderized	Beef	Tenderized steaks and chops, cube steak, etc.
	Ground	Beef, Turkey, Pork, Goat, Lamb, Chicken	Ground
	Formed/shaped	Beef, Turkey, Pork, Goat, Lamb, Chicken	Patties (various species)

les, ears, snouts, gizzard, oxlips, cheek meat, head meat, honeycomb tripe, omasum, abomasum, bungs, uteri, ovaries, ears, pork skin, testicles, marrow, and blood.

d. Raw, lean recovery (Table 3): A mechanical process, beyond fabrication, that removes or separates lean meat with minimal nutritional change; the remaining lean meat from knife trimmed bones or high fat raw meat. This raw meat product is labeled as species specific meats (Table 3).

Product Examples:

i. Finely textured meat: A lean meat derived from edible high fat trimmings that has been desinewed and subjected to a mild heat treatment to melt/separate the fat fraction and allow recovery of the lean meat portion.

ii. Partially defatted tissues: Meat that is mechanically recovered from edible trimmings after desinewing following the application of mild heat to melt/remove the lipid component. The raw meat product derived from pork or beef trimmings must have at least 12% visible lean meat and generally have a protein content between 17 and 20% (USDA, 2018a).

iii. Mechanically separated/deboned meat: A paste-like product derived by mechanically removing edible lean tissue from bones of pork, poultry and fish by the application of high pressure and extrusion through a fine sieve. The most common ways of accomplishing this is use of a screw and screen, a belt and drum system, and the use of back-pressure. Mechanically separated meat must be identified on a food label. Mechanically deboned beef is not allowed in human food in the USA (USDA, 2018b). Mechanically deboned pork, chicken, and turkey are al-

lowed in human food in the USA but must be included on the finished product label (USDA, 2018b). According to 9 CFR chapter III subchapter A part 381, mechanically separated chicken may or may not contain skin with attached fat and shall not contain more than 1% bone solids. Further, at least 98% of bone particles shall not exceed 1.5 mm at the greatest dimension and there shall not be any pieces greater than 2.0 mm at the greatest dimension. Mechanically separated chicken shall not have a calcium concentration greater than 0.235% when made from mature chickens or turkeys. Calcium cannot exceed 0.175% when made from other poultry (USDA, 2016b). This differs from the Canadian Food Inspection Agency definition where mechanically separated chicken contains no more than 0.027% of calcium for every 1% protein, with no bone particles larger than 2 mm in size, and has a minimum protein content of 10% protein (14% if destined for retail sale; CFIA, 2016).

iv. Meat from Advanced Recovery Systems (AMR): A lean meat product derived by mechanical pressure to remove tissue from bones that does not alter the composition of the meat. The USDA Food Safety and Inspection Service does not require meat obtained from AMR systems to be specifically identified on a food label. These products cannot contain tissues from the central nervous system. According to 9 CFR 301.2. (rr) Meat (2), (USDA, 2016a) obtained from the AMR process is produced with equipment that does not crush, grind, or pulverize bones. Bones emerging from this process appear comparable to hand-deboned meat. Meat from advanced meat recovery systems cannot contain more than 0.15% (150 mg/100 g) of calcium (USDA, 2016a).

Table 3. Description for Minimal processing—the raw, lean recovered category

Process category	Process	Species	Product categories
Raw, Lean Recovered	Finely Textured Meat ¹	Beef	Raw material to be used in ground meats
	Partially Defatted Tissues	Beef, Pork	Raw material to be used in further non-intact products
	Advanced Meat Recovery	Beef, Pork	Use in ground beef or other non-intact products
	Mechanically Separated/Deboned	Chicken, Turkey, Fish	Use in various processed meat and seafood products

¹Some processes also include an antimicrobial agent such as ammonium hydroxide or citric acid.

An example of the differences in definitions, regulations, and specifications that exist between the United States regulatory agencies (USDA-FSIS) and the Canadian Food Inspection Agency for raw lean recovered products is given in Table 4. Other discrepancies exist between U.S. regulations and other regulatory agencies throughout the world.

II. Further processing

Further processing describes any process where meat products undergo a transformation, beyond minimal processing, containing approved ingredients, and may be subjected to a preservation or processing step(s) through the application of salting, curing, fermentation, thermal processing (smoking and/or cooking), batter/breading, or other processes to enhance sensory, quality, and safety attributes. These products may include ready-to-cook and ready-to-eat products.

a. Raw, intact with added ingredients. Topical addition of non-meat ingredients (spices, exogenous enzymes, etc.) to intact muscles typically for the purpose of seasoning or tenderization. No curing ingredients are used in this classification.

b. Raw, non-intact with added ingredients (Table 5): Processes that use ingredients to alter the composition, functional, and/or sensory characteristics of the raw meat. No processes in this

subdivision use ingredients for the purpose of curing nor do they include thermal treatment.

i. Deep basting, vacuum-marinating, tumbling, or injecting whole muscles with approved non-meat ingredients (salt, water, spices, phosphates, antimicrobials, plant extracts, etc.) for the purposes of enhancing flavor, quality, and safety. Product examples include enhanced, basted, or marinated whole muscle cuts.

ii. Adding approved non-meat ingredients to comminuted meat, sometimes followed by portioning, forming or shaping using casings or cold bonding agents. Product examples include fresh sausages (Italian sausage, bratwurst, bockwurst, chorizo, kielbasa, whole-hog sausage, breakfast sausage, chicken sausage, turkey sausage, etc.) and restructured meat products.

c. Further processed, unheated or mildly heated, not fully cooked (Table 6): Processes beyond adding ingredients, some of which include thermal treatments for fermentation, flavor enhancement, color formation, or partial frying. Some products are ready to eat without further cooking. In some cases, multiple processes may be used. Preservation or processing step(s) may include:

Table 4. Differences between the Canadian Food Inspection Agency and USDA-FSIS regarding definitions used to describe recovered meat

Process category	USDA Food Safety and Inspection Service regulations	Canadian Food Inspection Agency
Meat Recovered from bones	Advanced Meat Recovery or Mechanically Separated	Mechanically Separated
Meat recovered from fat through heating to remove lipid fraction	Finely Textured (species), Partially Defatted Chopped (species), or Partially Defatted Chopped (species) Fatty Tissue	Partially Defatted Chopped (species)

Table 5. Description for Minimal processing—raw, non-intact with added ingredients

Process category	Product type	Species	Product categories
Raw Non-Intact, added ingredients	Marinated, basted whole-muscles	Beef, Turkey, Pork, Goat, Lamb, Chicken	Marinated roasts, steaks, cuts, and pieces
	Fresh sausage and formed/shaped meat products, e.g. patties, pressed, and/or re-shaped products, using casings or cold bonding agents.	Beef, Turkey, Pork, Goat, Lamb, Chicken	Fresh pork, beef, poultry sausages (Italian sausage, bratwurst, bockwurst, chorizo, kielbasa, whole-hog sausage, breakfast sausage, chicken sausage, turkey sausage); food service steaks, cutlets, roasts, etc
	Tenderized meat products with exogenous enzymes added, e.g. papain, bromelain, or ficin,	Beef	Enzyme tenderized steaks

Table 6. Description for Further processed–unheated or mildly heated, not fully cooked products

Product category	Process	Species	Meat product examples
Not thermally treated	Non-shelf stable	Beef, Pork, Chicken, Turkey	Bacon Pancetta ¹ Genoa Salami ¹ Italian Dry salami ¹ Sopressata ¹
	Shelf stable	Beef, Pork, Chicken, Turkey	Genoa Salami ¹ Italian Dry salami ¹ Sopressata ¹ Prosciutto Dry Cured Ham Bresaola
Thermally treated	Non-shelf stable	Pork, beef, chicken, turkey	Ham Danish canned ham Frankfurters Smoked Sausage Luncheon Meats Ring Bologna Liver Sausages
	Shelf stable		Pepperoni ¹ Hard Salami ¹ Beef Jerky Summer Sausage ¹ Snack Sticks ¹
Commercially sterile	Shelf stable	Beef, pork, chicken, turkey, seafood	Canned beef and pork, canned bacon, canned ham Pickled Sausages Pickled Pigs Feet Pickled Pork Hocks Tuna Sardines (in can) Clams (in can)

¹Some products in the list do not require refrigeration and others do require refrigeration. This can be the result of different packaging techniques and products with different water activities.

i. Cold Smoking: Application of smoke to meat at a low temperature ($\leq 30^{\circ}\text{C}$) so as to produce unique flavors (Rørå et al., 2005, Indrasena et al. (2008), and Sikorski and Sinkiewicz, 2014). Since cold smoking occurs at optimum temperatures for microbial growth, additional processing steps should be employed to ensure safety.

ii. Drying: The removal of moisture from meat through evaporation or sublimation.

iii. Fermentation: The use of bacteria to produce organic acids (primarily lactic acid) which preserves and imparts unique flavors to meat products.

iv. Direct acidification: Lowering the pH of a meat product through the direct addition of an organic acid(s) like lactic acid, vinegar, and/or glycono- δ -lactone.

v. Curing: Meat curing means the incorporation of salt, sodium or potassium nitrite and/or sodium or potassium nitrate [saltpeter], the latter of which is usually restricted to long-term cured or specialty meats. Additional ingredients (phosphates, ascorbic acid, etc.) are typically used in concert with curing agents to enhance functional properties, sensory characteristics, and food safety. The fundamental utility of nitrite and/or nitrate (which must be converted to nitrite in situ) as a curing agent is to provide a cured color to meat products, inhibit the growth of a number of aerobic and anaerobic microorganisms, and particularly to suppress the outgrowth of *Clostridium botulinum* spores and prevent botulism. Nitrite and/or nitrate levels in cured meats are regulated by government agencies in many countries and their use is permitted only at levels sufficient to accomplish their intended purpose. Nitrite use in bacon in the US is restricted to minimize possible nitrosamine formation during cooking. Nitrite also functions as an antioxidant to inhibit warmed-over flavor, and contributes to the characteristic flavor of cured meats (Keeton, 2011).

Use of many ingredients (sodium nitrite, phosphates etc.) are restricted to specified levels by regulatory agencies and/or are self-limiting (i.e., salt, sugar).

vi. Battered/breaded: Raw products that are typically coated with pre-dust or with a seasoned batter consisting of a blend of flour(s), starches and water, and/or a breading to produce a specific flavor, texture and/or mouth-feel. Coatings adhere to the product by briefly cooking/frying in oil, known as partial frying (par-frying), to set the coating.

Product Examples: Pork ribs/sandwich; dry-cured products (country-style ham, bacon, jowl, prosciutto di parma, pancetta, coppa, bresaola, lox, and capicola); air dried sausages (Italian style salami, genoa, milano, and sopressata); par-fried batter/breaded meats (nuggets, tenders, breasts, and patties), fritters, fish sticks, and fish portions. Some of these may be classified as further processed, fully cooked, if heated to the appropriate time/temperature pasteurization endpoint.

d. Further processed, fully cooked (Table 6): Processes that heat products to an appropriate time/temperature pasteurization endpoint. Processes may include:

i. Thermal processing (including smoking and/or cooking).

ii. Drying: Products as described in section II. b, ii (above), but fully cooked to a pasteurization endpoint temperature.

iii. Fermentation: Products as described in section II. b, iii (above), but fully cooked to a pasteurization endpoint temperature.

iv. Direct acidification: Products as described in section II. b, iv (above), but fully cooked to a pasteurization endpoint temperature.

v. Curing: Products as described in section II. b, v (above), but fully cooked to a pasteurization endpoint temperature.

vi. Pickling: Immersion in a vinegar based solution followed by cooking, smoking or retorting.

vii. Battering/breading: Products as described in section II. b, vi (above), but fully cooked to a pasteurization endpoint temperature.

Product Examples: Deli/luncheon meats (olive loaf, minced ham, pickle and pimento loaf, honey loaf, head cheese, souse, scrapple, corned beef, corned beef brisket, beef tongue, and pastrami); cured products (ham, bacon, pork shoulder, and pork butt); pasteurized packaged/canned products (not commercially sterile); jerky; cooked sausages (frankfurters, wieners, bologna, cotto salami, Vienna sausage, bratwurst, braunschweiger, liverwurst, bockwurst, Polish sausage, knackwurst, Lebanon bologna, mettwurst, and mortadella); dry and semi-dry sausages (pepperoni, hard salami, summer sausage, cervelat, and thuringer); surimi; *sous vide* meats; fully cooked/ready-to-eat, battered/breaded meats (nuggets, tenders, breasts, and patties), fritters, fish sticks, fish portions, and pickled herring.

e. Offal/variety meat further processing: Further processing of the raw, skeletal and/or non-skeletal portion of the non-carcass component of an animal that is deemed wholesome, and sold as food for human consumption either as a single item or incorporated into products that require additional preparation steps.

Product Examples: Tallow, gelatin, lard, pork rinds, chicharrons, blood and tongue sausage.

f. Commercially sterile processing (Table 6): Processes for products treated in a sealed container in a manner to achieve inactivation of spoilage and pathogenic microorganisms and/or their spores. These products are considered shelf-stable and do not require refrigeration to maintain their shelf-life. Process examples include retorting and irradiation (see glossary for detailed definitions).

Product Examples: Retorted canned products (hams, Vienna-style wieners, corned beef hash, roast beef, corned beef, beef stew, meat pot pies, chili con carne, tamales, spaghetti with meat balls, Spam, pickled pig's feet, tuna, and salmon); retorted pouch products (meats in meals ready-to-eat); cooked, irradiated, ready-to-eat meat products for applications like space travel and hospital diets.

Glossary*

*This list is not intended to be all inclusive.

Additive– Any food ingredient added to a meat product other than meat or edible offal. Additives must be approved by regulatory agencies (i.e., USDA-FSIS) and included on the product label. They are generally added to improve product qualities such as appearance, flavor, shelf-life, and safety (antimicrobials).

Acidification– Lowering the pH of a product via fermentation of simple sugars to an organic acid (i.e., lactic acid) or direct addition of an encapsulated organic acid.

Adulterated products– Products containing any deleterious substance rendering it injurious to health or products produced using ingredients or processes that are inconsistent with their labels. See Federal Food, Drug, and Cosmetic Act Section 402 [21 U.S.C. 342] (USDA, 2016a).

Advanced meat recovery (AMR)– A high pressure mechanical process used to remove lean meat from bones. The AMR machinery cannot grind, crush or pulverize the bones to remove this tissue. Therefore, the meat cannot contain more than 130 mg of calcium per 100 g of tissue. Trimmings that exceed this calcium threshold are classified as mechanically separated (9 CFR 318.24; USDA, 2016b).

Alternative curing– The inclusion of plant or vegetable ingredients that contain a natural source of nitrate and/or nitrite to affect a cure reaction with the myoglobin in lean meat tissues.

Animal-derived gelatin– An edible protein product produced from the heat treatment of tissues containing extensive connective tissue, frequently hides or bones (Romans et al., 2001).

Battered and breaded– Raw meat products that are typically coated with pre-dust, a seasoned batter consisting of a blend of flour(s), starches and water, and/or a breading to produce a specific flavor, texture and/or mouth-feel. Products may be par fried to set the batter or fully-cooked.

Beef– Edible meat tissues generated from domesticated *Bos indicus* and *Bos taurus* cattle.

Brine– A solution of salt and other soluble ingredients that does not contain nitrite or nitrate (Shahidi et al., 2014a).

By-product– See inedible offal.

Bushmeat– Meat derived from wild animals that are hunted for subsistence or informal trade, most often illegally (Hoffman and Cawthorn, 2014).

Carbonyls– A class of organic compounds responsible for the browning reaction contained in smoke (Rozum, 2014).

Cell cultured/in vitro muscle– Muscle tissue grown from stem cells in a liquid medium outside of the animal.

Code of Federal Regulations– Codification of governmental rules and regulations published in the Federal Register by the executive departments and agencies of the federal government of the United States of America.

Co-extrusion– Extrusion of multiple layers of raw materials simultaneously, e.g., a process of forming sausage into a cylindrical shape while simultaneously coating the sausage with a layer of solubilized collagen or alginate. The collagen may be coagulated with an organic acid to cause adhesion to the surface of the sausage and serves as an edible casing (Lewicki, 2014).

Cold bonding– Enzymatic bonding of raw meat piece surfaces followed by molding to form shaped or restructured meat products. The bonding reaction does not require heat for coagulation.

Collagen– (See “animal derived gelatin”) A stromal protein that is the major component of tendons, animal skin, and intestinal tract (Rust, 2004).

Commercially sterile– Treatment of a food within a can, flexible pouch, or other hermetically-sealed vessel with heat, irradiation, high-pressure, or other processes, alone or in combination with other ingredients or treatments, to render the product free of microorganisms capable of growing in the product under non-refrigerated conditions (over 50°F or 10°C) at which the product will be held (FSIS, 2010).

Comminution– A mechanical process to reduce meat particle size by chopping, grinding mincing, or other means of physical reduction.

Conduction, thermal– Particle to particle heat transfer within a food product (Hanson, 2014).

Convection– Heat transfer from steam, air, or water to the surface of a product (Knipe, 2014).

Corned (beef)– The application of granulated or grain salt formerly called “corn” (from old Norse “korn”, meaning grain) to preserve a beef product (Pegg and Boles, 2014).

Curing (specifically the inclusion of nitrate or nitrite salts)– The application of salt (NaCl), nitrate/nitrite salts, and seasonings in meat, followed by heating (note that some long-term cured products are not heated) to produce a unique appearance, flavor, and texture, and enhance product safety and shelf-life. Nitrite is reduced to nitric oxide, which attaches to the sixth binding site of the reduced iron atom in myoglobin. When nitric oxide combines with myoglobin it forms nitrosylmyoglobin. When nitrosylmyoglobin

is heated, denaturation of the globin portion of myoglobin occurs and the bond between nitric oxide and myoglobin is stabilized resulting in a cured product.

Curing brine or pickle– A salt (NaCl) solution containing sodium or potassium nitrite that is used to cure hams and other processed meat products.

Desinewed– mechanical method of removing large amounts of connective tissue from meat cuts (Pearson and Gillett, 1996).

Dry cured– The direct application of dry ingredients (e.g., salt, nitrate/nitrite, sugar), in full concentration, to the surface of a meat product. The ingredients solubilize in the moisture derived from muscle tissues and migrate from the surface to the center of the product over a period of weeks to achieve the curing reaction and preserve the product. See curing.

Drying– A process where water is removed from a food product by evaporation or sublimation (Andres et al., 2007).

Dry sausage– A finely ground sausage made from any combination of meat sources which undergoes a pH reduction step during the manufacturing process by either fermentation of sugars with a bacterial starter culture or utilization of a chemical acidulant (i.e., an encapsulated organic acid) followed by an optional thermal processing step and final drying process to reduce the weight (i.e., water removal) of the product by approximately 25 to 50% of the starting weight (Rust, 2007).

Edible-offal– The portion of the non-carcass component of an animal that is determined wholesome, and sold as food for human consumption. Edible offal may include products such as organs, mammalian blood, glands, feet, tongues, poultry paws, etc. The term ‘edible offal’ is also commonly used interchangeably with ‘variety meat’ in the industry for the same product scope.

Emulsifier– A piece of high-speed fragmentation and homogenization equipment used to reduce meat particle size for comminuted meat products. It is used particularly on a meat mixture to produce a meat batter with very small to microscopic fat particle sizes. It may also be an ingredient used to improve the emulsification of a meat mixture having small particle sizes.

Emulsion– A mixture of two immiscible liquids, one of which is dispersed in the form of small droplets or globules within the other liquid (i.e., homogenized milk). A fat-in-water emulsion or meat batter is created when lean tissue and fat tissue are mixed together in the presence of salt via high-speed cutting. The resulting emulsion is often described as a batter, especially in raw form. Examples of emulsified products in final form include frankfurters and bologna.

Exsanguination– The act of removing the blood from an animal ultimately resulting in the animal’s death.

Exogenous enzymatic tenderization– The addition of enzymes (typically plant based) that are applied to the surface or injected into whole-muscle meats to degrade connective tissue and muscle fiber components and reduce toughness. These enzymes are usually heat activated and subsequently inactivated at very high cooking temperatures.

Extrusion– See co-extrusion.

Fabrication– Disassembly of carcasses by cutting into wholesale, subprimal, and retail cuts.

Farmed game– Land animals and birds that are not conventionally regarded as domesticated but are bred and reared in captivity (Hoffman and Cawthorn, 2014).

Fermentation– Bacterial metabolism (or conversion) of carbohydrates (sugars) to an organic acid (primarily lactic acid) under mild heat conditions to preserve a food and/or contribute unique flavors.

Fiber type– A muscle fiber classification system that categorizes muscle cells into 4 myosin isoforms. Categories differ in myoglobin content, fiber diameter, contraction speed, and mitochondrial density. Fiber types are related to the form and function of muscles.

Finely textured beef (FTB)– A process where high fat beef trimmings are desinewed, gently heated to liquefy the fat and the lean separated prior to freezing. This product is also referred to as lean finely textured beef (LFTB; Field, 2004).

Fresh meat– Meat that retains its original compositional properties and has not been subjected to freezing, heating, canning, salting, or drying. Regulatory definitions may allow the term fresh to be used for meat that has not been previously frozen, except in

the case of poultry where fresh poultry cannot reach temperatures below -3.3°C or 26°F (FSIS, 2005).

Fresh sausage– Uncured, uncooked sausage products that have salt and spices added but no curing agents. Examples include uncooked pork sausage and uncooked breakfast sausage from other species.

Giblets– Edible offal from poultry that includes the neck, heart, liver, and gizzard.

Grinding– A process of comminution to reduce meat particle size by cutting and pressing through specific sized orifices in a grinder plate.

Harvest– See slaughter.

Heterocyclic amines (HCAs)– A class of chemical compounds formed when muscle meat (beef, pork, fish, or poultry) is exposed to high-temperatures, especially above 150°C or 300°F , using cooking methods such as pan frying, grilling or open flames. The HCA compounds are formed when amino acids, sugars, and creatine react in the presence of high temperatures and are typically found in products such as grilled or barbecued chicken or steak (NIH, 2016). (Also see polycyclic aromatic hydrocarbons, PAHs).

Heme iron– The iron atom that is central to the heme ring within the planar porphyrin-globin complex found on the surface of myoglobin and hemoglobin molecules.

High-pressure processing (HPP)– The application of high hydrostatic pressure (HPP) or ultra-high pressure processing (UHP) to liquid and/or solid foods, with or without packaging at pressures between 100 and 800 megapascals (MPa) to inactivate microorganisms (Ockerman and Basu, 2014).

Inedible offal– The non-carcass portion or component of an animal that is not used as food for human consumption. Inedible offal may include items such as lungs, hides, horns, feathers, poultry blood, and other parts of the non-carcass component not consumed as food.

Irradiation– A food preservation method that exposes food items to controlled levels of ionizing radiation for a period of time to achieve DNA disruption of spoilage and pathogenic microorganisms such that they ultimately die. Irradiation does not use heat or chemicals and when applied within regulatory limits does not result in any residual radiation associated with the food.

Liquid smoke– Smoke condensates containing carbonyls, condensable and non-condensable gases, tars, and water that may be applied to or incorporated into a meat product (Rozum, 2014).

Live brine– An immersion brine used in production of Wiltshire cured bacon that is continually replenished with curing salts and re-used; this brine develops a characteristic salt-tolerant microflora as a component of the brine (Sheard, 2014).

Maillard reaction– A form of non-enzymatic browning similar to caramelization; a chemical reaction between an amino acid and a reducing sugar, usually requiring heat (Shahidi et al., 2014b).

Marination– The process of delivering a preservative or other flavor ingredients to a meat product by soaking the meat in a water-based solution for a defined amount of time.

Meat analog (Non-Animal)– Plant- (often soy and gluten) or fungal-based non-meat products produced to mimic animal-derived meat.

Mechanically separated meat (MSM)– A paste-like or batter-like raw meat product made by removing edible soft tissue from the bones of pork, poultry and fish. The soft tissue is separated from the bone through the application of high pressure that forces it through a sieve. Mechanically separated meat must be identified on a food label in the United States.

Nitrite– A pale yellow nearly white, crystalline sodium or potassium salt that is highly soluble in water, highly reactive and functions as an oxidizing, reducing, or nitrosating agent; it is converted to a variety of related compounds when added to meat (Sindelar, 2014).

N-Nitroso compounds– A group of compounds containing a nitroso group bound to a nitrogen atom. *N*-nitroso compounds include two chemical classes, nitrosamines, and nitrosamides, which are formed by the reaction of secondary amines and amides, respectively, with nitrosating agents derived from nitrite (Tricker, 1997).

Nitrosamine– 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.

Nitrosylhemeochrome– A cured pigment in meat that results from the binding of nitric oxide to the heme group associated with myoglobin. It is developed by denaturation of the globin portion of myoglobin during cooking. The heat stabilizes the bond between nitric oxide and the heme portion of myoglobin and results in the typical pink color associated with cured meats.

Non-meat ingredient– A component added to meat (e.g., salt, spices, nitrite) to improve quality, safety, and/or shelf-life of the product.

Offal– The portion of the live animal that is not considered a part of the carcass after the animal is slaughtered. Non-carcass components (e.g., bones, organs, skin and attached fat, blood, horns hoofs, feet, head, and intestinal contents). Offal can be further divided into edible (see definition) and inedible (see definition) offal.

Oxidation– The loss of an electron from a molecule. In myoglobin, the heme iron is converted from the red pigment ferrous (Fe^{2+}) state to the ferric (Fe^{3+}) state due to the loss of an electron resulting in the brown, metmyoglobin pigment (Cornforth and Jayasingh, 2004).

Pasteurization– The application of heat (approximately 60°C+) to a food as a means of destroying some spoilage and all pathogenic or disease-causing bacteria. The temperature necessary to destroy spore cells associated with disease-causing bacteria is not achieved with pasteurization.

Pathogenic microorganisms– Bacteria capable of causing disease. Meat items contaminated with pathogens usually appear no different than uncontaminated meats (Johnson, 1994).

Pickle or curing brine– A salt (NaCl) solution containing nitrite that is used to cure hams and other processed products (Knipe, 2014).

Polycyclic aromatic hydrocarbons (PAHs) [see also heterocyclic amines, HCAs]– A class of chemical compounds formed when meat (beef, pork, fish, or poultry) fat and juices from meat grilled directly over an open flame drip into the fire. The PAHs generated in the resultant flames adhere to the surface of the meat, typically in charred areas. The PAHs may

be present in natural smoke, but removed from liquid smoke condensates. One compound, benzopyrene, is typically measured as an indicator of PAHs. Of note, these compounds do not pass through cellulose casings and hence are generally not found in those types of sausages (NIH, 2016).

Pork– Edible meat tissues derived from domesticated pigs *Sus scrofa domesticus*.

Poultry– Domestic avian species that includes chickens, turkeys, geese, ducks, guinea, squab and in some cases ratites (ostrich, emu, rhea). (USDA-FSIS, 2012; Poultry Trends, 2015).

Proteolysis– Enzymatic breakdown of proteins to form peptides and free amino acids. Breakdown of specific myofibrillar proteins and some connective tissues occurs during refrigerated aging of meat to increase tenderization (Cilla et al., 2014).

Psychrotrophs/psychrophiles– Bacteria that prefer to grow in cold environments. True psychrophiles have an optimum growth rate at 15°C and cannot grow above 25°C, whereas, psychrotrophs (*L. monocytogenes*, *C. botulinum* type E) have optimum growth at 25°C and cannot grow above 40°C (Montville and Matthews, 2007).

Radiation, thermal– Mechanism for heat transfer. Electromagnetic radiation generated by the thermal motion of charged particles in matter (James and James, 2014).

Raw– Uncooked meats that have not undergone any thermal or drying treatment.

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.

Retorting– A process that uses heat at temperatures between 116 and 121°C and pressure to cook food in a sealed package. This is a commercial sterilization process that effectively kills all pathogenic microorganisms including *Clostridium botulinum*.

Seafood– Any form of animal sea life regarded as food by humans. Seafood predominantly includes fish and shellfish. Shellfish include various species of mollusks, crustaceans, and echinoderms. This category also includes fish, such as salmon, tilapia, and catfish.

Semi-dry sausage– A finely ground sausage made from any combination of meat sources in which it undergoes a pH reduction step during the manufacturing process by either fermentation with a bacterial starter culture or utilization of a chemical acidulant (i.e., encapsulated organic acids) followed by an optional thermal processing step and finally a drying process to reduce the weight (i.e., water removal) by approximately 10 to 20% of the starting weight (Rust, 2007).

Slaughter– The physical act of killing an animal for conversion into meat for food.

Smoking– The application of wood derived smoke during thermal heat treatment to impart a unique smoke flavor, aroma, and surface color. Smoking can be achieved through combustion-produced smoke from logs, woodchips, and sawdust, by drenching the product in a liquid smoke concentrate, or exposure to an atomized cloud of distilled liquid smoke.

Spoilage bacteria– Bacteria within or on the surface of food that induce unacceptable sensory and/or physical changes in food, but do not cause illness (Gill, 2004).

Spore– A primitive usually unicellular and often environmentally resistant dormant or reproductive body produced by plant, fungi, and some microorganisms that is capable of development into a new individual (Webster, 2016).

Starter culture– One or more strains of lactic acid bacteria that are added to a meat batter or mixture to induce meat fermentation of available sugars resulting in extended shelf-life, improved flavor, and desirable sensory characteristics.

Sterilize– A process of destroying or inactivating all microorganisms, spores, and their pathogenic products. Sterilization is achieved by heating meat products in hermetically sealed containers that exceed 121°C and high pressure levels that reach at least 0.082 MPa.

Tenderized– A meat product that has been subjected to a physical, chemical, or enzymatic processes to improve textural properties.

Thermally treated– A food product that has been subjected to heat processing to achieve a specified level of safety, prolong shelf-life, and enhance sensory characteristics.

Trimming– All raw skeletal muscle products used as a source of materials for making ground products such as hamburger, ground beef, or sausages.

Umami– A strong meaty taste imparted by glutamate and certain other amino acids. It is often considered to be one of the basic taste sensations along with sweet, sour, bitter, and salty (Pegg and Kerrihard, 2014).

Variety meat– The portion of the non-carcass component of an animal that can be inspected, determined wholesome, and sold as food for human consumption. Variety meat may include products such as organs, blood, glands, feet, tongues, etc. The term ‘variety meat’ is also commonly used interchangeably with ‘edible offal’ in the industry for the same product scope.

Warmed over flavor– An unpleasant flavor (rancid, stale) arising from heme-mediated lipid oxidation that develops in cooked meat that is subsequently refrigerated before reheating (Aalhus and Dugan, 2014).

Water activity (a_w)– The degree to which molecular water is associated with food molecules, entrapped in a food matrix and available for microbial growth; water activity (a_w) is expressed as a value from 0.0 to 1.0 and derived by the equation [vapor pressure of solution / vapor pressure of pure solvent (water)] (Romans et al., 2001).

Wiltshire bacon– Pork cured by immersion in brine (Sheard, 2014).

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