EXCLUSIVE

THE NATIONAL PROVISIONER

THE AUTHORITY ON THE BUSINESS OF MEAT AND POULTRY PROCESSING

2008 TECH JOURNAL SERIES

SAUSAGE 101

Photo courtesy of Odom's Tennessee Pride

A supplement to *The National Provisioner*

SAUSAGE TECHNOLOGY JOURNAL

THE NATIONAL PROVISIONER
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2008 TECH JOURNAL SERIES

SAUSAGE TECHNOLOGY 101

A NATIONAL PROVISIONER RESEARCH PROJECT
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PART ONE: OVERVIEW

The sausage category consists of comminuted meats ranging from coarsely ground to fine emulsions such as hot dogs or bologna. Products may be cured, smoked or heat-processed. Categories generally include fresh; uncooked and smoked such as Italian pork sausage; cooked and smoked as in hot dogs; cooked such as liver sausage; dry, semi-dry or fermented such as summer sausage or pepperoni; and cooked meat specialties such as luncheon loaves. Each product in the category has its own processing method with intricacies and traditions dating back hundreds of years. The recipe for success in the 21st century concerning sausage processing often includes a blend of Old World traditions and tastes with modern processing equipment.

Technology is a key driver behind efficient sausage production, which is defined by sophisticated manufacturing techniques.

The National Provisioner is producing a series of technology journals covering various aspects of the processing side of the industry. These in-depth reports delve into the science and technology that support the business foundation of meat- and poultry-processing programs. This is the third in the series. The first two focused on bacon and ground beef, respectively. **NP**

PART TWO: PRODUCTION BASICS

During meat processing, salt plays a critical role in the formation of a stable emulsion, no matter what other flavors and seasonings are eventually added to the meat matrix.

Salt solubilizes the myofibrillar proteins — actin and myosin — which swell as they absorb water to form a gel matrix. This increases the viscosity of the mix, thereby adding stability by preventing moisture loss and fat coalescence during heat processing. The myofibrillar proteins also add stability to the matrix when solubilized by acting as emulsifying agents and coating the fat particles.

During blending, mechanical action aids in solubilizing and swelling the meat proteins. Several factors influence the meat emulsion's stability including temperature of the batter during blending, pH, the amount and source of salt-soluble proteins and viscosity of the batter. Moisture-to-protein ratios also factor into the meat's stability and performance, particularly since soluble proteins play such a key role in binding, both in water retention and fat stabilization during cooking.

Meat regulations in the United States specify a maximum of 30 percent fat in cooked sausages. The normal moisture-to-protein ratios for comminuted products is 4-to-1, although regulations allow for 10 percent in excess of this ratio in cooked sausages, and 3 percent in fresh sausage. Higher-fat meat portions and other ingredients including non-meat protein extenders, starches, seasoning and flavorings are blended in following the initial protein extraction from lean meat and salt.

Several of these extenders have been instrumental in textural and flavor improvements of low-fat sausages in recent years. Extenders such as soy protein concentrate, whey protein concentrate and starch serve a variety of beneficial functions from improvements in water-binding capacity to reduced shrinkage, all of which generally factor into cost savings. Advancements in textured soy protein concentrate provide products with meat-like qualities in both appearance and bite. **NP**

PART THREE: PROCESSING SYSTEMS

BY WESLEY N. OSBURN, PH.D., ASSOCIATE PROFESSOR,
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Making sausage products using a batch meat manufacturing concept requires using effective processing equipment. A well-designed system provides a consistently uniform coarse ground or emulsified sausage product. Particle definition (coarse-ground products) and emulsion stability (emulsion-type products) are critical objectives for designing a new batch system or in modifying an existing one.

A typical batch system to produce coarse or emulsified type sausage products usually consists of the following steps: pre-grinding, mixing, fat analysis, final grinding, chopping and/or emulsification, stuffing/filling and in most cases, thermal processing. Fresh and/or frozen meat is pre-ground to create a uniform particle size for blending or mixing. Mixers are used to ensure the uniformity of the product's chemical composition (e.g. fat). The basic mixer uses a hopper and a pair of agitators (e.g. ribbon, paddle or solid flight) to mix the "meat dough."

Once the proper fat content of the meat has been achieved, the meat is passed through a final grind to achieve a uniform particle size definition. If an emulsified product is desired, the meat can be chopped or emulsified to create a stable emulsion than can withstand thermal processing. The final stage involves stuffing or filling using a sausage stuffer. Next comes linking or clipping to close the product, including freezing or refrigeration, thermal processing, chilling, packaging and refrigeration.

■ GRINDING SYSTEMS

Grinders reduce the particle size of raw materials to create the desired final attributes of the product in terms of texture and visual appeal. Basic system components include a hopper or bin, the housing consisting of an auger or feed screw (may be attached to a second auger called the working auger), grinder blades or cutting knives and the grinder plate.

These components are contained within the housing or grinder head and are secured with a lock ring. Meat is fed through the hopper where the auger screw carries it to the cutting knives to be sliced by the rotating knives and extruded through the grinder plate. Commercial grinders are designed to handle fresh or frozen (minus 5° to minus 10°C) meat. Many systems can grind from 3,000 to as much as 25,000 kg/hour, depending upon the raw material used and number of revolutions of the grinder system.

It is essential to determine the properties of the raw material used to select the correct main drive, feed and working auger speeds. Several grinder manufacturers offer a mixer grinder option using an agitator as a feeder to pass product down to the feed auger and forward through the grinder assembly.

To prevent product grease-out or poor particle definition, it is important to ensure that cutting knives and plates are sharp and properly tightened with the grinder assemble. Available grinding technology allows the option of using a series of grinding plates and cutting knives to precut raw material to reduce or comminute the particle size of the meat to the final desired diameter.

Grinder plates and knives are available in a variety of hole diameters (normal range from 0.32 to 3.2 cm). Grinder manufacturers have also developed an outside cutting knife that can be attached to the last grinder plate to provide a uniform particle size. An outside cutting device that rotates independently of the working auger is available in producing variable lengths of ground product.

In coarsely ground and emulsified sausage products, it is important to remove bone chips and gristle from the finished product. Various bone collection systems have been developed for grinders using either a center or peripheral discharge system to remove unwanted bone and sinew. In the production of emulsified products, processors often

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PORK SAUSAGE INGREDIENTS
(7 of 44 meat block formulations)

MEAT BLOCK	AVERAGE VALUES: MOISTURE	FAT	PROTEIN	% COLLAGEN	BIND	COLOR	POUNDS FOR VARIOUS FORMULATIONS: A	B	C	D	E	F	G
Pork													
Backfat	5	93	1	95	0	0	34	34	33	30	30	25	25
Head meat	65	16	17	70	7	16				10			
Rind, emulsion	38	34	27	60	1	0				7			
Trim 80 (lean)	60	23	16	25	16	24	66	66	67	33	70	75	75
Trim 50	36	52	10	34	12	9				21			
Dry Ingredients													
Dextrose	.06	0	0	0	10	0						.4	
Rusk	5	9	14	0	16	0	19	15	18	18	20		18
Salt	.01	0	0	0	40	0	2	2	2	1.8	2.2	2	2.3
Moist Ingredients													
Water or ice	100	0	0	0	0	0	28	21	27	27	17		25
Fruits and Vegetables													
Pimiento	92	1	1	0	0	60			.1			.1	
Tomato puree	87	0	2	0	0	70					12		
Calculated composition - 2% shrink													
Moisture							46.1	44.6	46.4	43.8	47.6	44.1	48.6
Fat (Max. 50%)							33.2	35.6	33.7	35.9	39.9	40.3	29.5
Protein							9.3	9.6	9.4	9.5	9.8	12.2	10.4
Properties													
% Collagen (Max. 35)							21.8	22.8	22.1	33.3	21.2	26.4	21.9
Bind Points (Min. 1.8)							*1.4	*1.5	*1.5	*1.5	*1.5	1.9	1.8
Color Points (Min. 2)							*1.8	*1.9	*1.9	*1.2	2.0	2.9	2.1

* = value does not meet federal regulations or commonly accepted guidelines

PORK SAUSAGE SPICE FORMULATIONS
(8 of 45 spice formulations)

	AVERAGE VALUES: MOISTURE	FAT	PROTEIN	OZ. UNLESS INDICATED OTHERWISE PER 100 LBS. OF MEAT: 1	2	3	4	5	6	7	8
Curing Ingredients											
Na or K Nitrite	.1	0	0	.25	.25	.25	.25				
Na or K Nitrite	.1	0	0	1	1						
Na Erythorbate	.1	0	0	.87	.87						
Spices											
Allspice	8.5	8.7	6					8			
Anise	10	16	18						2		
Caraway seed	10	15	20	.5							
Cardamon	8	3.5	9							1	1
Coriander	5	18	15	1						2	2
Fennel seed ground	8	22	18	1	1.7						
Garlic, powder	6	1	17			.5					
Ginger	9	4	8.5				1				
Nutmeg	8	33	7	.5		1	1	6		1	1
Paprika	10	13	15		1				1		
Pepper, black	11	8.5	12	2.5	2.5				4		
Pepper, red	8	17	12	2							
Pepper, white	11	8.5	1.6			7	4	7		6.2	6.2
Sage	3	14	8.5				2			2	
Thyme	8	7	9				1				

PROCESSING PROCEDURES
(7 of 11 processing procedures)

A.
1. Mix
2. Grind
3. Fry, brown
4. Pack in jars while hot
5. Pour hot fat over
6. Close jar, turn upside down, cool
7. Store in a cool place

B.
1. Grind, ½"
2. Mix
3. Grind, 3/16"
4. Stuff
5. Sell fresh or frozen

C.
1. Chill meat, 32°F
2. Grind, ¼"
3. Mix
4. Stuff, link
5. Dry, room temperature
6. Heavy Smoke
7. Cook, internal temperature of 142°F
8. Shower to 110°F internal temperature
9. Dry, room temperature
10. Chill, 38°F, 18 hours

D.
1. Grind
2. Mix
3. Stuff
4. Cure, 36°F, 18 hours
5. Cold smoke, 4 hours
6. Cool, 36°F

E.
1. Boil meat
2. Chop
3. Grind fat, moderate fine
4. Mix
5. Add blood for color
6. Stuff

F.
1. Grind shank, ⅛"
2. Grind rest, 1"
3. Mix
4. Grind, 3/16"
5. Stuff
6. Dry, 70°F, 2 hours
7. Smoke house, cook to internal temperature of 142°F
8. Shower to 110°F internal temperature
9. Dry, 70°F, 2 hours
10. Chill, 45°F
11. Peel
12. Package
13. Refrigerate

G.
1. Cook meat
2. Chill meat
3. Grind
4. Chop
5. Mix
6. Stuff
7. Cook, internal temperature of 140°F
8. Dry, 70°F
9. Chill

Source: Sausage and Processed Meat Formulations by Herbert W. Ockerman, Ph.D, Professor, Animal Sciences, College of Food, Agricultural and Environmental Science, Ohio State University (contact information: ockerman.2@osu.edu)

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grind the lean and fat meat components or "meat blocks" separately and adjust the final fat content during the chopping process.

CHOPPING AND EMULSIFICATION

Completing the final grind prepares product for stuffing or further comminuting in a bowl chopper or emulsification system. The primary purpose of the system for producing emulsified product is to extract the salt soluble proteins from the lean to use as an emulsifier during the process of reducing the particle size of lean and fat meat blends.

This creates a meat emulsion or suspension by coating fat particles with a protein film created by the solubilized meat proteins. Comminuting and mixing are achieved via a revolving bowl that passes the meat through a set of vertical knives (knife head) mounted on a high-speed rotating arm.

Commercial bowl choppers are available with "state-of-the-art" technology offering flexibility in producing high-quality sausage products with various textural attributes. Bowl choppers are also offered with a cooking system using low-pressure steam to cook meat during the chopping process.

Thanks to technology, the capability exists to directly inject either water, nitrogen (to extend shelf life) and/or liquid nitrogen (to quickly cool pre-rigor meat) into the product during chopping. Bowl choppers also are available with loaders and ejectors to increase production efficiency before and after completing the chopping process. The development of a remote control device is another innovation that allows a single operator to control several bowl choppers for highly automated production systems.

BOWL CHOPPER APPLICATION

This system traditionally consists of variable bowl and knife speeds. Lower bowl and knife speeds are generally used for mixing or blending non-meat ingredients, such as spices and flavorings. The ability to draw a vacuum during the chopping process is critical to ensure optimum emulsification, better shelf life and reduction of product volume. Improved product performance during the stuffing/filling operation is the benefit.

Control panels: They display knife speeds, product temperature, chopping time and the amount of vacuum applied during chopping. More sophisticated control panels offer the ability to store up to 100 processing cycles — including chopping time, bowl and knife speed — with a manual override.

Knife head: This is a critical component in the bowl-chopping process. Some commercial manufacturers offer balancing unit or balancing clamps enabling the knife head to minimize vibration during high-speed chopping. Knife shape impacts the stability of emulsion and its ability to retain added water and to entrap the protein encapsulated fat particles during thermal processing. This minimizes or eliminates the risk of "grease-out" or "fat caps" that may occur in the final cooked product. Knife blades are available for specific product types, such as coarse ground and emulsified, or for universal applications.

EMULSIFIER APPLICATION

This system combines the principles of grinding and chopping to produce a fine emulsion, or medium and coarse particle-size reduction. The basic components of an emulsifier include hopper, rotor blade, plate, impeller and discharge pipe or orifice.

Most emulsifiers can create a vacuum to increase product density, improve color and lengthen shelf life. Several manufacturers offer either a variable or constant speed with or without a programmable computer control system to monitor knife speed and product pumping speed. Emulsifiers can create a significant rise in product temperature (4-8°C).

Development of a programmable computer control system provides the ability to monitor knife speed and vacuum levels and also adjust product pump speed to not exceed a specified final product temperature. Emulsion mills are available with a single or double plate and blade-cutting assembly to increase production efficiency and better control finished product temperature and particle definition. A bone and metal trap with the emulsion mill before the product reaches the cutting assembly is another unique innovation to ensure product safety and minimize maintenance costs.

STUFFING AND FILLING

Once the desired product texture is achieved, the meat is ready to be stuffed. Common sausage stuffers include piston, auger or screw and rotary vane. Basic components of auger or rotary vane stuffers include hopper, in-feed scroll, feed screw or auger, filling nozzle and stuffing horn. Piston models include moving piston, chamber, lid, stuffing lock and stuffing horn. A linking attachment is primarily used with auger or rotary vane type stuffers. The standard auger or rotary vane stuffer can create a vacuum while stuffing product to attain the desired product density and ease of product evacuation for filling.

An "in line" vacuum grinding system can be attached to a vacuum stuffer, which reportedly improves particle definition, increases shelf life, improves portioning accuracy and reduces casing usage. A separation device can also be attached to remove bone and sinew during grinding. Coextrusion technology is available to create innovative "filled" meat products. For example, a coextruder attachment can connect two vacuum stuffers. One stuffer pumps product that creates the "shell" of the final product. Meanwhile, the other stuffer pumps the "filler" portion of the product.

■ AUGER APPLICATIONS

This equipment uses a twin-screw auger system to convey product to the filling nozzle with a minimum friction or "recirculation" of meat prior to evacuation. Augers are available in a number of configurations to evacuate emulsion, coarse ground or restructured meat.

■ ROTARY VANE APPLICATIONS

These stuffers consist of a rotary vane pump, ideal for smaller applications involving frequent product changeovers while minimizing product loss. Rotary vanes also minimize product friction prior to evacuation.

■ CLIPPING/CLOSURE SYSTEMS

Various linking mechanisms are available to twist link sausages stuffed in either natural or synthetic (collagen, cellulose, fibrous, plastic) casings. A conveyor is used to assist in discharging the sausage product from the clipping machine.

Some type of closure is required for sausage products stuffed in unlinked synthetic casings to prevent leaking during subsequent processing steps, such as fermentation and thermal processing. High-speed automatic closure systems can stuff product into chub packages using roll stock plastic film and shirred fibrous or collagen casings.

Available systems include plastic and aluminum alloy clips for closing sausage chains of varying lengths — sausage loops and individual sausages stuffed in either natural or artificial casings. Most closure systems are pneumatically operated either manually, semi-automatically or automatically and contain a fixed knife to trim excess casing or packaging materials. Some systems with pneumatic cylinders allow the end of the casing to be "locked." The product is then further compressed by pneumatic cylinder into the casing prior to clipping.

Closing systems for shirred synthetic casings larger in diameter (fibrous, collagen and plastic) a variety of stuffing horns are available that attach to a vacuum stuffer, allowing greater efficiency in stuffing and handling of product. A device that attaches "hanging loops" for hanging products over smokehouse sticks for thermal processing is also available. State-of-the-art closure technology uses a programmable controller to adjust equipment during operation. An additional innovation cleans the casing ends before applying a preformed clip.

■ COEXTRUSION INNOVATION

Coextrusion is an innovative system for the manufacture of fresh, cooked or dry sausages where a collagen paste or dough is extruded into a casing that surrounds the sausage mixture as it exits the vacuum stuffer.

An advanced sausage manufacturing system is available in which the coextruded sausage is conveyed in a continuous rope through a brine solution to help crosslink the collagen casing. The sausage is then crimped or cut into the appropriate length and enters a drying step to strengthen the extruded collagen casing.

Cooked smoked sausages can be sprayed with liquid smoke to further crosslink the collagen casing, and then is precooked to a targeted temperature. They are vacuum-packaged before the next step of being cooked to a final internal product temperature "in the bag."

The texture or bite of the sausage casing can be controlled by the thickness of the extruded collagen layer, by adjusting the salt concentration of the brine solution, the application of liquid smoke or adjusting drying times to achieve the bite or snap one would find in sausages manufactured with natural casings. NP

PART FOUR: NITRATE/NITRITE CONNECTION

Nitrites in processed meat and poultry products became a suspicious practice in the 1970s when the scientific community suggested a link between nitrite and human cancer potential. Sodium nitrite, reportedly the most widely used additive in the production of cured meat products, acts as an antioxidant and is essential concerning efforts to contain the growth of harmful bacteria — especially *Clostridium botulinum* and *Listeria monocytogenes*.

Foodborne botulism was identified as a problem in sausage in the 1800s. Botulin, derived from the Latin word for sausage, is an insidious toxin as it can be present without detectable evidence such as a foul odor or other signs of contamination. Symptoms of poison — evidenced by such changes as blurred or double vision, droopy eyelids, dry mouth, slurred speech, vomiting, diarrhea, difficulty in swallowing and muscle weakness — usually appear suddenly within 18 to 36 hours after ingesting contaminated sausage. Death can occur without proper medical treatment.

Sodium nitrite is recommended in cures to prevent Botulin contamination in smoked sausage. The use of nitrites began hundreds of years ago. Historically, nitrate was identified as a naturally occurring contaminant in salt, prompting chemists to isolate that compound and intentionally add it in the form of saltpeter (potassium nitrate). Eventually, nitrite (NO_2) and not nitrate (NO_3) was recognized as a beneficial substance with color and flavor properties that enhance pork.

USDA initially authorized the use of sodium nitrite in cured meat in 1925. Federal scrutiny concerning nitrite toxicity only began in the 20th century. For example, federal safety concern focused on the presence of residual nitrite from the use of nitrogen peroxide used to bleach flour in a 1914 court case. Based on the government's finding, the presence of nitrite in the product was not harmful given that the mere presence of a toxin does not, in and of itself, pose an adverse health threat. The government's caveat, however, represented a reminder that "the dose makes the poison" (from Paracelsus, the 16th century father of modern toxicology). That being the case, caution is necessary when using nitrites.[1]

Concerning the nitrite/nitrate debate in the 21st century, scientific experts have determined that issues raised about the safety of using nitrate and nitrite for curing meat do not represent relevancy in light of current levels of use in processed meats.

A study released in November 2007 determined that nitrite/nitrate found in vegetables, cured meats and drinking water may be beneficial to heart attack victims. Based on a pre-clinical study led by a cardiovascular physiologist at The University of Texas Health Science Center at Houston, mice fed extra nitrite and nitrate fared much better following a heart attack than those on a regular diet. Mice with extra nitrite had 48 percent less cell death in the heart while those on low nitrite/nitrate diets had 59 percent greater injury. Moreover, mice with extra nitrite in their systems had a survival rate of 77 percent compared to 58 percent for nitrite-deficient mice.

"This is a very significant finding given the fact that simple components of our diets — nitrite and nitrate — that we have been taught to fear and restrict in food can now protect the heart from injury," reported lead author Nathan Bryan, Ph.D., an assistant professor at UT-Houston's Brown Foundation Institute of Molecular Medicine for the prevention of Human Diseases. "Simple changes in our daily dietary habits such as eating nitrite- and nitrate-rich foods such as fruits and vegetable and some meats in moderation can drastically improve outcome following a heart attack."

As Bryan explains, nitrite forms nitric oxide gas during a heart attack that reopens closed or clogged arteries, thereby reducing the amount of permanent injury to the heart muscle. Nitrite and nitrate are natural molecules in the human body. The primary source of circulating nitrite and nitrate in the body comes from vegetables, not cured or processed meats. "Vegetables have up to 100 times more nitrate than processed meats, so the amount of nitrite and nitrate consumed in processed or cured meats is far less than what is consumed by eating a spinach salad, for example," Bryan points out.

Bryan refutes the nitrite/nitrate link to cancer that surfaced in a report in the 1960s. "Many studies implicating nitrite and nitrate in cancer are based on very weak epidemiological data," he said. "If nitrite and nitrate were harmful to us, then we would not be advised to eat leafy vegetables or swallow our own saliva, which is enriched in nitrate."

Based on federal regulations, levels of nitrite and nitrate allowed in the United States depend upon the curing method and the product cured.

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"For comminuted products, the maximum ingoing concentration of sodium or potassium nitrite is 156 parts per million (ppm) or 0.25 oz per 100 lbs (7 g/45.4 kg), based on the green weight of the meat block (USDA, 1995). Maximum ingoing sodium or potassium nitrate for comminuted products is 1718 ppm. Sodium and potassium nitrite and nitrate are limited to the same quantity despite the greater molecular weight of the potassium salts. This means that the potassium salt contains less nitrite or nitrate than the equivalent weight of the sodium salt. For immersion cured, and massaged or pumped products, maximum ingoing sodium or potassium nitrite and nitrate concentrations are 200 and 700 ppm of nitrite and nitrate, respectively, again based on the green weight of the meat block. Dry cured products are limited to 625 ppm and 2187 ppm of nitrite and nitrate, respectively. If nitrite and nitrate are both used for a single product, the ingoing limits remain the same for each but the combination must not result in more than 200 ppm of analytically measured nitrite, calculated as sodium nitrite in the finished product."[2] **NP**

PART FIVE: BEST PRACTICES

A sampling of sausage-product manufacturers finds mutual agreement concerning the best strategies for developing wholesome products free of contaminations.

For Ray Barnes, plant manager for Simpsonville, Ky-based F.B. Purnell Sausage Co., quality raw meat is the first step in the right direction toward producing the best sausage products.

"We put out a wholesome product, which means making sure hogs are healthy first and foremost," Barnes says. USDA inspectors check the hogs, which are purchased in northern cities, for disease before carcasses head to boning tables.

F.B. Purnell Sausage Co., born in the 1930s as the brainchild of Fred B. Purnell, produces a variety of whole-hog sausage products including hot, mild hot, chorizo, 10-ounce links and fully cooked sausage and biscuits. The company manufactures 140,000 pounds of sausage each day.

Whole-hog sausage is made from carcasses — mostly sows or heavy market hogs — that are boned prior to chilling and final processing. It takes about 55 minutes at F.B. Purnell to process a 200-pound batch of meat with 700 pounds of seasoning before it goes to a chiller to reduce the temperature from 96°F to 23°F.

"Temperature is the most critical control for meat, with 43°F being the critical point," Barnes says. "You never want to take it above that or bacteria will set in."

Bob Evans Farms Inc., Columbus, Ohio, also operates with food-safety procedures as the basic first steps in its sausage processing system.

"The first step is the facility has to be 100-percent clean and sanitary to start the operation," confirms Earl Beery, senior vice president of operations. "We also depend on good equipment such as mixers, grinders, stuffers, linkers and slicers. It all needs to operate from a food-safety standpoint."

Bob Evans is a leading producer and distributor of pork sausage and a variety of complementary home-style convenience food items marketed under its *Bob Evans* and *Owens* brands.

Other food-safety initiatives include strict guidelines during the sausage cooking process. "We are always looking at modern cookers for effective cooking," Beery reports. "It is critical to meet time and temperature specs to avoid overcooking the product. The result would be unacceptable flavor, moisture and texture attributes."

Bob Evans food-production facilities operate in Michigan, Illinois, Ohio and Texas. The company's fiscal 2007 sales totaled more than $1.7 billion with 16 percent coming from food products and 84 percent from 600 company-owned and operated Bob Evans restaurants in 18 state areas.

Old World sausage meisters are known for their innovative product developments. German immigrant Frederick Usinger, who brought his sausage-making knowledge to the United States in the late 1870s, is among them. He owned his own business by 1880. Today Fred Usinger Inc., Milwaukee, known for its line of sausages crafted from old German recipes, sells its more than 70 varieties of sausage principally to delicatessens and gourmet shops. It also operates a landmark retail store in downtown Milwaukee. Sausage products include beerwurst, knackwurst, summer sausage, bratwurst and wieners (hot dogs). Usinger's was the official supplier of hot dogs to the 2002 Winter Olympics in Salt Lake City in 2002.

Although its traditional German-style recipes remain unchanged since 1880, Usinger's approach to meat processing is modern and up to date.

"The first rule of thumb is to begin with the best raw material," notes Fritz Usinger, the founder's great grandson and current company president. "Good condition means fresh, not aged material, and cold. You can't make good product from sub-standard raw materials."

Equipment must also be in the best shape. "If you are going to pregrind product, you need a machine that is well-maintained," Usinger advises. "That means knives and plates of grinders should be in good condition and well-maintained."

The key to business success for this 128-year-old family business is simple, according to Usinger.

"It is adherence to time-honored recipes and formulas, high-quality raw materials, attention to detail, consistency and not taking short cuts," he concludes.

Odom's Tennessee Pride of Madison, Tenn., is another family business with a long history of quality sausage-making. Although founded in 1943, the company prides itself on operating under modern concepts. That means taking sausage-making from art to science.

Odom's is about being a leader in changing the industry through technology. To that end, in 1994, the company recruited Jim Stonehocker, an engineer with experience at General Motors and Frito-Lay, to lead the charge. His approach is to look at man, methods and materials to determine the best way to combine the three to make quality sausage.

A recent project involved upgrading and expanding the company's plant in Dickson, Tenn., near Nashville. The plant produces cooked sausage, makes gravy and assembles and packages sausage sandwiches and sausage balls.

An infrared cooker — functioning with controllable wavelengths capable of yielding guaranteed temperatures — is a centerpiece innovation of the project. "Lightwaves are activated by sensors as meat continues down the belt," Stonehocker explains. "The system automatically shuts down when no product is there so it doesn't consumer extra energy. The advantages on this line are throughput and consistent quality." Another benefit, Stonehocker says, is that the ambient room temperature is cooler as the cooker generates no heat.

Capital improvements are essential at Odom's, but producing products under the best food-safety conditions is a priority.

"Food safety starts on the kill floor where we ensure meat is absolutely squeaky clean from a micro count," Stonehocker reports. "We don't scald our carcasses. A drum skinner removes hides that drop below the processing room through a hole [to keep them away from the processing area]."

Humane animal handling is critical and crucial, Stonehocker says. "We have taken it a step further recently by taking control of animals when they arrive on the property because our employees are well-trained on the process," he concludes.

Del Vecchio Foods Inc., Houston, offers raw ground sausage.

"The key to making good sausage is cold temperatures, this way meat grinds fresh and there is no smear or greasiness," reports Bill Blakeslee, president.

The optimal temperature of raw material is 32°F to achieve the best grind, Blakeslee continues. "From there you add ingredients and what goes into meat. The rest is sanitation with clean hands, clean raw materials and clean work surfaces. Achieving the grind consistency depends on time, mix and grind ingredients. The mixture is stuffed into casings. At that point, it is packaged for sale."

He also says having the right type of stuffer to achieve desired consistency, makeup of sausage and particle definition is important.

"Different stuffers do different things," he notes. "You don't want a machine to change the makeup of the sausage."

Nolechek's Meats of Thorp, Wis., produces 150 different types of processed sausages from brats to summer sausages and 40 varieties of fresh brats.

Kelly Nolechek says temperature control is crucial in the process. "As meat goes through production, we don't want rising temperatures to avoid bacterial and smearing problems," she says. "That is why we use partially frozen meat or ice to keep temperatures down."

On the equipment side, Nolechek says bowl choppers are preferred over grinders. "We have found you get a nice clean cut with the bowl chopper and you get more heat rise with grinders. You don't have that with the bowl chopper."

Overall, Nolechek says a combination of steps ensure ideal sausage-making.

"It is not just one thing, it is all critical as far as I'm concerned, from when the material comes in to how it's handled throughout the process," she emphasizes. "We are very small and not a high-volume operator, but we have state-of-the-art equipment that allows the proper product flow and quality. Our raw materials and our spices are of the highest quality." **NP**

PART SIX: HISTORICAL PERSPECTIVE

The art of making sausages evolved from the simple process of salting and drying meat to preserve it for later consumption to a modern meat manufacturing process. To be sure, sausage is a popular meat protein in contemporary times, which is a tribute to its survival over more than 5,000 years. History tells us that ancient Romans gave the world the sausage vernacular with the word salsus (the prefix "sal" being the word for salt).

Some scholars pinpoint the origin of the diverse sausage meat product as coinciding with the development of salt as an effective preservative. The Chinese began using salt to cure and preserve meat in the 13th century B.C. Meanwhile, other seasonings were later found to be effective sources of flavoring along with their preservative qualities.

Salt works to preserve meat by penetrating into the tissue and drawing out moisture. Increasing the amount of concentrated salt and decreasing the presence of moisture inhibits the growth of microorganisms in meat. The meat then can be stored with limited threat of spoilage.

The process begins with good quality raw meat. The domestication of pigs, the primary source of most sausages, is said to have begun in China and Egypt about 5000 B.C., triggering the fast spread of pig-raising throughout the Near East, Europe and Asia.

The origin of meat processing may be lost in antiquity, but the procedure for stuffing meat into casing has been well-documented. The ancient Babylonians reportedly developed a sausage version by wrapping pig intestine around meat to roast on an open flame. Sausage later became an efficient means of feeding large armies during the expansion of the Roman Empire into Western Europe.

History provides further insight into culinary traditions that led to the early development of sausage, also derived from the Latin word botellus. Boudin and pudding also came from "botellus." Food historians have determined that varieties of puddings can be seen as the multiple descendants of a Roman sausage.

Black pudding or blood sausages of the Middle Ages joined white pudding, also made in a sausage skin or a stomach lining to form a larger round product. In early times, pig intestines were used to make pudding after the animal was slaughtered. The intestines were washed clear in a running stream and left to soak overnight in spring water. Casings were cut into 15-inch lengths and tied at one end. The sausage recipe comprised salt, lard, oatmeal, finely chopped onions, spices, peppers, cloves and a cup of flour. The ingredients were mixed with pig's blood. The sausage was dropped into a pot of simmering hot water, cooked for about an hour before removal, cooled and consumed shortly thereafter.[3]

Haggis, a sausage that came from the Scots, was made of suet, spices, onions, oatmeal and the heart, liver and lights (lungs) of a sheep. The mixture was boiled in a sheep's stomach. Salted, packed into a stomach and boiled allowed these Highlanders to extend the shelf life of their sausage to a couple weeks.

Haggis survived in remote highland areas until modern times. Although haggis also included pork fat or suet, its taste and texture reportedly resembled the Jewish dish called derma created from chicken fat, flour, spices and onions baked in a steer's intestines. The onset of dry sausage paralleled the discovery of new spices that helped to enhance flavor and preserve the meat.

The global development of sausage followed a regional pattern. For example, Bologna originated in the town of Bologna in northern Italy and Berliner sausage came from Berlin, Germany. Sausage recipes were greatly influenced by the availability of ingredients and climate. Northern Europeans kept their fresh sausage without refrigeration thanks to its periods of cold weather. They also developed a process of smoking sausage to help preserve the meat during warmer months. Southern Europeans capitalized on their hot climate by developing dry sausage that needed no refrigeration. **NP**

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