Manufacturing Sausage Without Casings

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Typical sausage link production requires some type of casing to form and encase the sausage for handling, cooking and chilling. Although casings have been used from antiquity, today they are not only used as a meat container, but they also provide certain characteristics to sausage products as well. However, casings contribute a significant cost to sausage products. For this reason, technology has been developed to manufacture sausage links without the use of casing. This report is a brief overview of the most notable non-casing production systems.

The most common methods for forming casingless sausage links are by forming in a modified patty machine, or by extrusion. Extrusion may include something simple like the Colosimo Press (Colosimo's Inc., Magna Utah), or complex such as those developed commercially or privately for large-scale production. The links are formed and then are conveyed for further processing.

Two methods that are not so common include "Co-Extrusion" and "Sintered Mold" sausage link manufacturing.

"Co-Extruded" Sausage Links

Scientists with the Unilever developed a cheaper alternative to casing sausage products in the 1960's. This first system was developed with breakfast sausages, but those efforts failed. Unilever then partnered with the engineering efforts of Stork in Oss, the Netherlands, to develop a production system for smoked link sausages and frankfurters. In 1980, a license agreement between Unilever and Stork was established and Stork started selling co-extrusion systems outside Unilever. By the late 1970's, the system established manufacturing success in Spain and Japan, but it has had very limited success in the United States (only one company is presently using this system in the U.S.).

The system works by extruding a collagen batter around an endless rope of sausage batter. The product is then treated to make more traditional sausage products. A detailed process description is given below:

Step 1. Co-Extrusion

Meat emulsion is coated with a thin collagen layer at the co-extrusion nozzle (the heart of the system). It consists of a central tube which the meat emulsion is metered through and the outer co-extrusion nozzle that feeds the collagen batter. In the co-extrusion nozzle, the two conical elements rotate in opposite directions to align the collagen fibers in oblique orientation to the meat flow.

By this fiber orientation, the collagen skin is rendered a certain mechanical strength both in longitudinal and tangential directions. The rotation of the collagen filling cones generates a considerable amount of heat, therefore cooling water is circulated through the co-extrusion nozzle.

The co-extrusion nozzle produces a continuous, uniform rope of meat emulsion which is covered with a thin layer of collagen batter. At this stage, the collagen is in the acid swollen state which is paste-like; soft and sticky.

Step 2. Brine Bath

The continuous sausage rope is passed through a saturated salt solution which causes a migration of water from the collagen coating. The collagen is "unswollen" and is transformed into a fibrous structure, still delicate but with an improved mechanical strength.

Step 3. Crimping

After brine treatment, the ropes are crimped to form a consistent sausage length. The crimping wheel is equipped with a series of scissor-like blades. The blades and the wheel are designed to pull the collagen layer over the sausage ends so that the ends are also coated with collagen.

Step 4. Primary Dryer

The links are transferred to a dryer belt that is designed to reduce the initial moisture content of the collagen skin,

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Reciprocal Meat Conference Proceedings, Volume 49, 1996.

approximately 85% after the brine bath, to about 35%. The drying environment consists of low humidity (about 5% RH), high air speed (about 7 m/sec) and high air temperature (about 70° to 80°C). Pre-drying time is about 12 to 15 minutes.

Step 5. Liquid Smoke Application

The sausages are then diverted to a series of spray nozzles that apply liquid smoke. Liquid smoke not only creates desirable color and flavor but most importantly, it provides the collagen with an aldehyde source needed to achieve permanent cross-linking of collagen fibers.

Step 6. Secondary Drying

Drying environment conditions are similar to the pre-drying conditions. Dwell time is 4 to 5 minutes.

Step 7. Further Processing

After the secondary drying application, they can be further processed for cooking, packaging, canning or any other integrated process.

Reported advantages for co-extrusion include:

a. Reduction of casing costs of about 13¢/pound for traditional sausage product and much more for smaller diameter products such as cocktail wieners.
b. With a total integrated system, a co-extrusion line can be operated by one technician.
c. Processing time is greatly reduced. Time needed for drying and smoking is about 20 minutes. Cooking and chilling only requires another 40 minutes.
d. Reduced collagen waste.
e. Co-extrusion system does not require any handling, thus reducing food safety risks.
f. Product diameter and length are variable within limits.
g. Maximum throughput capacity is about 6,000 pounds/hour.

Disadvantages of co-extrusion include:

a. Very high initial capital investment, estimated at about $4 million.
b. Collagen batter supply may be difficult to source.
c. Consumer acceptance in the United States may be questionable for frankfurter and ring bologna-type products.

"Sintered Mold" Sausage Links

In the late 1980's, engineers at APV Baker in Peterborough, England, developed a system to make sausage links by denaturing the outer surface of the link, thus creating its own skin without the use of traditional casing. The system has since then found acceptance with several companies in England and France and limited use in the United states and Japan. Burke Corporation in Nevada, Iowa was the first in the U. S. to use this system in a commercial sausage manufacturing application.

The process involves pumping a meat batter through a rotary valve into portioning cylinders. The portioned meat is then segmented into fill nozzles that load into molds made of porous stainless steel (sintered molds). Depending on the product to be manufactured, 8 or 12 such molds are in each mold block. Five mold blocks on the machine are arranged in a pentagon configuration. The pentagon shifts one position with every fill cycle. While the portioned meat is in the mold, a modified acetic acid solution is injected through the porous walls of the stainless steel molds. This acetic acid solution denatures the surface proteins of the meat, thus creating a casingless natural protein skin sausage link.

With every shift in rotation, the pentagon of mold blocks has a specific function:

Pentagon

Station	Action
1	Meat is injected into molds.
2	Meat batter is lightly compressed and ends are formed both physically and chemically by tamps that inject the acetic acid solution.
3	Acetic acid impulses through the walls of the stainless steel molds and denatures surface proteins.
4	Dwell time with acetic acid and link surface.
5	Links are ejected out of molds onto conveyor belt.

After the links are formed, they are passed through a water rinse and air knife to rinse off excessive acetic acid and quickly dry the surface. This step is needed for marketing uncooked links, but is unnecessary if they are to be cooked soon after forming.

The reported advantages of casingless, natural-protein skin sausage links are:

a. No casing costs, which can add as much as 19¢/pound.
b. Reduction of direct labor costs.
c. Reduction of give-away via superior portion control.
d. Elimination of tough chewy skins.
e. Burst-ree sausage, even with frying conditions.
f. Skin thickness and strength can be controlled.
g. Possibilities of hand-off manufacturing from filler to retail packaging.

Disadvantages are:

a. High initial capital investment.
b. Material handling issues must be overcome for fresh or cooked sausage links.
c. Product appearance is different from sausages made with casing.
d. Limited maximum throughput of about 3,000 pounds/hour.

Discussion

Co-extrusion

European manufactures are experiencing 6½ days of production with ½ day of maintenance down time. Changeover time is short with computerized readjustments. Total shelf life result of "hurdle technology" with pH, water activity, nitrite control, smoke acidity as well as post-pasteurization to provide shelf-stable product. About 40% of the Spanish frankfurter market is made by co-extrusion. Acceptance is limited, due to high capital cost (which may be much greater than $4 million) relative to limited production capacity. The system is difficult to cost-justify in the U.S. based on casing and labor savings. The additional cost of retrofitting current sausage systems is also a deterrent to use.

Sintered Mold System

Different link sizes dramatically changes throughput. No flavor concerns are noted from acetic acid and acetic acid does not have to be listed on the ingredient statement. Shelf life of frankfurter type products is unknown, but should be similar to current products. Batter composition may be most critical for sintered mold process.

Overall Discussion

Texture for both methods are considered normal for existing casing products. Frozen stability is not well documented, but is assumed to be comparable to current casing items. None of these systems are able to accomplish the exact curved end appearance of links made in casings. Although consumers may view the need for curved frankfurter ends differently today, in the early 1960's, Swift electrostatic cooked products failed for reported consumer objection to their square ends.