Optimizing Cook-In-Package Comminuted Meat Products

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Today, approximately 35% of the fully cooked dinner / link sausages produced in the United States are processed using cook-in-package processing systems. Current practice for the majority of these systems is a pre-blend>final blend>grinding>stuffing >pre-dry> smoking>post dry >vacuum package>cook>chill process. The intention of this presentation is to provide the audience a look at the current state of the industry discussing current practices with premise why these practices provide successful production of cook-in-package comminuted sausage products. Furthermore, the presentation is intended to peak the audience's interest into questioning what we don't know to further advance the optimization of cook-in-package processes for comminuted meat products.

PRE-BLEND, FINAL BLEND AND FORMULATION

The primary method of preparing traditional meat batters for cook-in-package products is accomplished with pre-blend (pre-salting) and hold time prior to grinding and stuffing. Pre-blending coarse ground meats (3/8″ to 1″) with addition to hold time is a nondestructive avenue for solubilizing the salt soluble meat proteins for the primary purpose of increasing bind and fat stabilization of a finished meat product. Less mixing improves finished particle definition with less destruction of the adipose tissue. During hold time sodium or potassium phosphates improve bind characteristics of meat proteins as the pyrophosphate form can assist in the dissociation of actin and myosin. It is suspected the dissociated or relaxed muscle structure improves fat stabilization during the cooking process as fat content can typically increase 25% in the meat block with the use of phosphates with minimal fat out during cooking. This may also confirm why pre-rigor meat materials were successfully used in cook-in-package applications years ago.

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Is pre-blending only optimizing protein extraction or may there be other benefits such as pre-salting adipose tissue? Some past industry research suggests pre-salting may also strengthen adipose tissue cell structure to reduce tissue destruction during grinding and pumping processes. Experience suggests salting fat tissue is just as important as salting lean tissue when preparing meat batters for cook-in-package processes.

When preparing final blends with the full complement of non-meat ingredients, the use of shaved ice / chilled water or an inert liquid gas, such as, liquid nitrogen should be considered to achieve final blend temperatures between 28 to 34ºF. Subsequent grinding and stuffing delta temperatures should not raise more than 4ºF to attain the formation of a continuous protein matrix stabilizing the fat / adipose tissue particles in the non-continuous phase. Use of carbon dioxide snow should be avoided as it solubilizes in water in the form of carbonic acid and is difficult to remove with vacuum at refrigerated temperatures. Further hold time of final blends prior to stuffing provides the meat batter increased moisture equilibration optimizing water holding capabilities of meat proteins and functional ingredients.

Refining formulation techniques is critical to the success of cook-in-package products. Utilizing formulation programs that can predict water-holding capabilities of meat and non-meat ingredients is of major importance to the success of cook-in-package meat products. Managing an ingredient attribute database that reflects the true water holding capacities of meat and non-meat ingredients has been somewhat elusive for most formulators. Bench top testing methods can be devised to define water holding capacities of most ingredients incorporating textural characteristics of ingredients in the finished meat products.

GRINDING AND STUFFING

After sufficient hold time of final blends, final grind (1/8″ to 3/16″) with bone collection prior to vacuum stuffing is an option for final meat batter size reduction. A vacuum pump in-line grind system is a preferred method to reduce smear providing optimal particle definition. This method effectively removes air prior to pumping through an in-line grind system directly into a stuffing / linking apparatus. Effective vacuum includes de-aeration using a sheeting valve (1″ maximum spacing) increasing the surface area of the meat batter while entering an open vacuum chamber prior to the pumping system. Current practice suggests air removal requires at least -28 in. Hg vacuum with a minimum 180 CFM displacement. With proper deaeration, meat batter expansion during subsequent heating and vacuum packaging stages is significantly reduced.

The purpose of the casing as it seems traditional to sausage in actuality becomes the end network immobilizing the continuous protein / meat particulate phase around the discontinuous fat / adipose tissue phase of the meat batter. Meat batter can be stuffed into natural intestine, regenerated collagen or collagen gel co-extrusion casings. Other edible casings maybe considered as to their ability to bind to the meat batter.

PRE-DRY, SMOKING AND POST DRY

Once stuffed, the sausage is immediately transferred into a dry air heating chamber avoiding excessive movement as temperature of the sausage begins to rise. High temperature air with sufficient humidity reduction to achieve less than dew point sausage surface humidity, removes excess moisture from the casing of the sausage. When completely dried, the sausage is showered with a liquid smoke solution and again introduced to the drying chamber as a post dry step to set color but more importantly cross-link the casing and casing to the meat batter. Aldehydes inherent to the carbonyl fraction of liquid smoke condensates are responsible for the cross-linking of collagen casing proteins and meat proteins. Without cross-linking, further heat processing in the package will contribute to fatting out in the final package due to minimal bind of casing to the meat batter. Smoke condensate manufacturers can design specific cross-linking solutions with or without smoke flavor compounds.

The other important aspect of the pre-dry and post-dry steps is heat setting the meat batter to a solid state before exiting the heating chamber and prior to packaging. Any transfer causing bending of the sausage with meat batter in a fluid or semi fluid state will break the continuous protein structure created during the stuffing stage leading to moisture and fat voids in the finished product. Depending on meat batter composition, internal temperatures of 125 to 135ºF are typically sufficient to heat set internal meat batter.

VACUUM PACKAGING

Upon proper heat set and cross-linking of the sausage product, sausages are typically water rinsed to remove excess smoke residue and moisten the dried casing surface. With a moist and softened casing surface, the severe expansion and contraction during the vacuum packaging process reduces incidence of casing cracks in the sausage product. If casing cracking or expulsion of fat and moisture at ends of sausage is observed, it is generally attributed to excess air in the product not removed during the stuffing process. Minimizing the expansion and contraction of a sausage at warm temperatures is a new contemplation for many vacuum packaging film and equipment suppliers. When product failures arise, a keen sense of all process parameters prior to vacuum packaging should be considered in the root cause problem solving.

COOKING AND CHILLING

After vacuum packaging, packages are immediately transferred to a pasteurization system typically using a hot water medium. Time and temperatures sufficient to meet USDA FSIS Appendix A lethality performance standards are used to eliminate pathogens as required in the USDA facility HACCP plan. Alternate time and temperatures may be necessary to sufficiently reduce heat resistant vegetative micro-organisms for extended shelf life. Pasteurization temperatures of 174 to 183ºF for 14 to 30 minutes are currently practiced to achieve 162 to 175º internal product temperatures for varying meat species and product formulations.

Once product has achieved pasteurization time and temperature requirements it is immediately chilled according to USDA FSIS Appendix B stabilization performance standards as required in the USDA facility HACCP plan. Typical shelf life is 120 to 220 days at or below 40º F storage temperature.

Cook-in-package manufacturers should consult with their film packaging suppliers to determine optimum film structure heating requirements and optimum barrier properties for extended shelf life.

FUTURE OPTIMIZATION

Rapid blending methods: How can pre-blend and final blend hold times be reduced without sacrificing meat and non-meat ingredient performance? 24 to 48 hour hold times greatly increases storage requirements and raw materials in inventory.

Optimizing casing and cross-linking performance: How can casing cross-linking and adherence to meat batter be improved? How can casing texture and color be optimized to meet consumer demand? Can casing medium be modified to dry more efficiently with less heat energy?

Heat setting equipment: How efficiently can product be dried and set reducing heat energy consumption and dehumidification cost maintaining effective drying and heating with a smaller foot print reducing moisture shrink?

Pasteurization and Chilling systems: How efficiently can cooking and chilling equipment be optimized maintaining consistent lethality and stabilization treatments while reducing energy consumption and increased heat transfer?

Packaging: Should increased barrier properties be considered with increased shelf life? Can film structures be modified to increase heat transfer? Can exterior film surface be treated to increase water tension reducing excess moisture on packages exiting water chill?