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WHITE PAPER

OPTIMIZING SHREDDING CONSISTENCY AND QUALITY OF FULLY COOKED CHILLED MEAT AND POULTRY PRODUCTS

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INTRODUCTION AND OVERVIEW

Fully cooked, ready-to-eat (RTE) shredded meat and poultry products have seen rapid growth over the last several years and provide variety and convenience for consumers in both the retail and foodservice segments. As with any RTE meat product, quality and safety controls include thorough cooking to ensure pathogens are destroyed, proper chilling to inhibit bacterial growth as well as prevention of post processing contamination. The production volumes now required by processors to meet consumer demands for these products can make shredded meat and poultry products more susceptible to contamination and/or bacterial growth when products are "hot shredded" (80 - 130°F) if conditions are not well controlled.

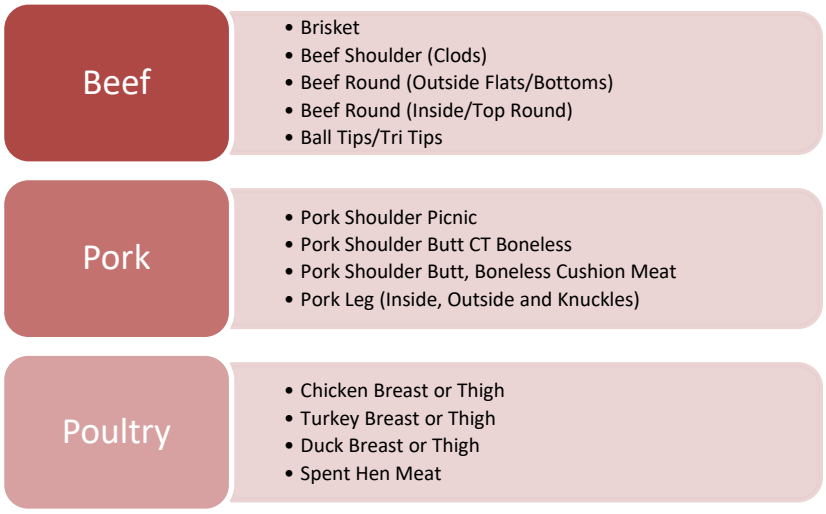
The above noted temperatures at which shredding often occurs is so critical, the United States Department of Agriculture, Food Safety and Inspection Service (USDA-FSIS), provides Appendix B, Compliance Guidelines for Cooling Heat-Treated Meat and Poultry Products (Stabilization) to assist establishments in meeting the requirements necessary to ensure adequate cooling of heat-treated meat and poultry products. Expected food safety of commercially prepared cooked meat and poultry product relies not only on "lethality" (time/temperature combination during the cooking process), but also effective cooling in a timely manner.

Due to the safety implications, many processors have elected to shred meat and poultry products following the stabilization period. This shift to "cold shredding" often results in unacceptable finished product if the processing conditions are not properly controlled. Therefore, when developing a successful processing protocol for cold shredded (≤40°F, ≤5°C) meat and poultry products, it is essential to not only consider the equipment set-up, but also the raw material selection and processing. This document reviews raw material selection, preparation/thermal processing and equipment parameters that should be considered in order to achieve safe, high quality, consistent cold shredded meat and poultry products.

RAW MATERIAL SELECTION

Shredded meat and poultry products are typically developed to provide the consumer with "barbeque style" products that may or may not contain sauce. Traditionally, barbecue style products are cooked for long hours at low temperatures and utilize tougher or less desirable cuts from the carcass, which allows processors to add value to cuts with lower consumer demands. The most commonly used muscles/cuts are shown below in Figure 1.

Figure 1 – Commonly Shredded Meats



RAW MATERIAL SELECTION (continued)

It is important to discuss raw material/muscle selection as cuts will perform differently under cold shredding based on species and location of the muscle selected for processing. Many of the cuts that are listed in Figure 1 have high connective tissue content. Collagen is the most abundant connective tissue protein and is a contributing factor to the variation in tenderness and ultimately the shredding consistency, especially under cold processing conditions.

Collagen molecules are bound together by cross-links which provide the muscles with structure and strength. In general, younger animals have fewer cross-links, but as the animal matures over time, the cross-linking becomes more stable and less soluble. In addition to age of the animal, the location of the muscle has an impact on the amount of collagen that is present in the raw material as well. Muscles used by the animal for movement or extended periods of time (shoulder/thigh) have significantly more collagen than muscles used for posture (loin/breast). Having a solid understanding of the nature and proportion of the collagen present is critical when formulating and developing thermal processing schedules. Remember: the key to successful shredding at cold temperatures is complete degradation and solubilization of the collagen protein.

In addition to connective tissue, fat content should also be considered when selecting raw materials for cold shredding applications. Many of the muscle cuts in Figure 1 must be trimmed to control the fat in the finished product. Ideally enough fat should remain during cooking to allow for flavor, texture and juiciness, while minimizing fat globules present after the shredding process. When shredding at hot temperatures, product with a higher fat content can be more readily used because fat on the warm product will distribute evenly over the meat prior to cooling.

In cold shredded meat products, if high levels of fat are present, globules remain and distribute unevenly. Because leaner cuts are often used for cold shredded applications, processors may need to change the non-meat ingredients as well as the cooking methods to ensure the same level of juicy tenderness that is achieved in a hot shredded application.

NON-MEAT INGREDIENTS

While some ingredients (sauces/broths) are added following cooling and shredding, the majority of non-meat ingredients are added prior to thermal processing. Seasoning mixes and marinades will vary greatly depending on the desired finished product characteristics; however, in general most will contain salt, sugar (or other sweeteners), pepper and other spices. Antimicrobials are often added in the form of lactates/diacteates to provide an additional safety hurdle and meet alternatives for the control of pathogens like *Listeria monocytogenes (Lm)*. The addition of natural vinegar powders for control of *Lm* has become increasingly popular in recent years to provide clean label alternatives for processors and consumers alike. Improved safety through the use of vinegar powders may require minor changes to the ingredient statement, especially if barbeque sauces are used because vinegar is typically a sauce component. Barbecue sauces can be added in the final package or during the marinating process. If the latter is chosen, processers can see some benefit of increased tenderization of the muscle from the acidity present in the sauce or other non-meat ingredients. While tenderization from sauces is minimal, enzymes such as papain and bromelin can be added to spice rubs and marinades. Upon cooking, these enzymes can aid in tenderization through the breakdown of collagen, improving the tenderness of the finished product and ease of shred. Please note that these ingredients should be used in moderation as they can accumulate in muscle tissues and breakdown the lean protein during cooking, which may result in a softer, finer shredded product texture.

PRODUCTION PROCESS

Size Reduction

Often times, large muscle pieces are reduced to smaller portions to improve cooking uniformity as well as to achieve the desired final shred characteristics. Product that has undergone slicing or dicing to improve cooking uniformity will in turn provide a more consistent product throughout the process. It is important to note that the thickness of the muscle/cut will have an impact on the length of the final shred. If a shorter shred is desired, running the product through a dicer with a 2-inch blade set-up will provide a finished shred that is no more than 2-inches in length. Size reduction may not be needed when targeting a coarser product that has a more natural "hand pulled" appearance.

Injection and Tumbling

The addition of spices, marinades or solutions is most commonly achieved through mechanical injection and/or tumbling/massaging methods. Injection and tumbling not only provides a means to introduce the non-meat ingredients, it also aids in the early stages of breaking down the collagen connective tissue. Both are forms of mechanical agitation where the connective tissues are weakened by friction and impact, disrupting cell structures.

Thermal Processing

Cooking is considered the most critical step in the production of fully-cooked cold shredded meat and poultry products. During the heating process, chemical and physical changes occur that will impact tenderness and the ability to effectively shred muscle cuts at cold temperatures. The main goal during thermal processing is to denature and solubilize the collagen present to result in a product that is extremely tender prior to chilling and properly prepared for shredding post stabilization.

The denaturation of collagen is most effectively accomplished for cold shredded products through the use of cook-in bag technology. Once product is placed into cook-in bags, it can be processed in a batch oven through steam cooking or water cook and chill systems. This type of cooking technology provides moist conditions that lets the collagen become fully hydrated and easily solubilized, allowing the product to achieve maximum tenderization and subsequently suitable to shred at cold temperatures. When the product reaches 140°F (60°C) the collagen will begin to shrink, but is not completely solubilized. The complete denaturation and gelatinization does not occur until product reaches 176 - 194°F (80 - 90°C). These temperatures are critical when products that contain high amounts of collagen are used for the production of cold shredded meats. Many failures in cold shredding occur when products do not reach temperatures necessary to solubilize the collagen and/or are not held at those temperatures for the time necessary for complete denaturation to occur.

PRODUCTION PROCESS: Thermal Processing (continued)

The photos in Figure 2 show an example of product that was not adequately processed in the cook-in-bag system to achieve complete breakdown of the collagen.

Figure 2 – Impact of Inadequate Cooking of Cold Shredded Beef Shoulder Clods

The product in the left photo was processed to an internal temperature of 180°F (82°C) and held for 3 hours. The product on the right was processed to an internal temperature of 180°F (82°C) and held for 5.5 hours. These photos illustrate the most common failure observed during cold shred processes, inadequate breakdown of collagen during thermal processing. Product on the left still contains large chunks of insolubilized connective tissue/collagen following cooking that continues to hold the muscle fibers together, resulting in an inconsistent shred.

Product can also be placed uncovered and roasted directly on racks if desired, however, this type of thermal application is better suited for a product that will be shredded under hot conditions as smoke is typically applied and a "bark" forms, making it difficult to shred at cold temperatures in a consistent manner. If a bark-like appearance is desired, par-frying product prior to cook-in bag processing is a viable option that provides a smoked appearance without negatively impacting the shredding capabilities of the product. Typically increased amounts of dextrose or other simple sugars that enter into the Maillard browning reaction are added to the spice blend or marinade to achieve a desired surface appearance and flavor profile.

Cooking cycles for water bath and steam cook-in bag technology are listed in the below examples (see Tables 1 and 2). Regardless of the thermal processing method, processors must ensure that adequate time is allowed for complete collagen breakdowns per the above noted temperatures. Typically, poultry can be processed in 3-4 hours, pork in 4-5 hours, and beef in 5-6 hours, depending on the raw materials selected for processing. These cycles can be used as guidelines when developing schedules specific to your application.

Table 1 – Example: Steam Cook-in Bag Thermal Processing Schedule

Cook-In Bag Technology for Shredded Meats - Batch Oven					
Step	**Time (Min)**	**Dry Bulb(°F)**	**Wet Bulb°(F)**	**%RH**	**Blower**
Steam Cook	60	142	142	100	High
Steam Cook	300	200	200	100	High
Cold Shower	30	5 min on	5 min off	0	High

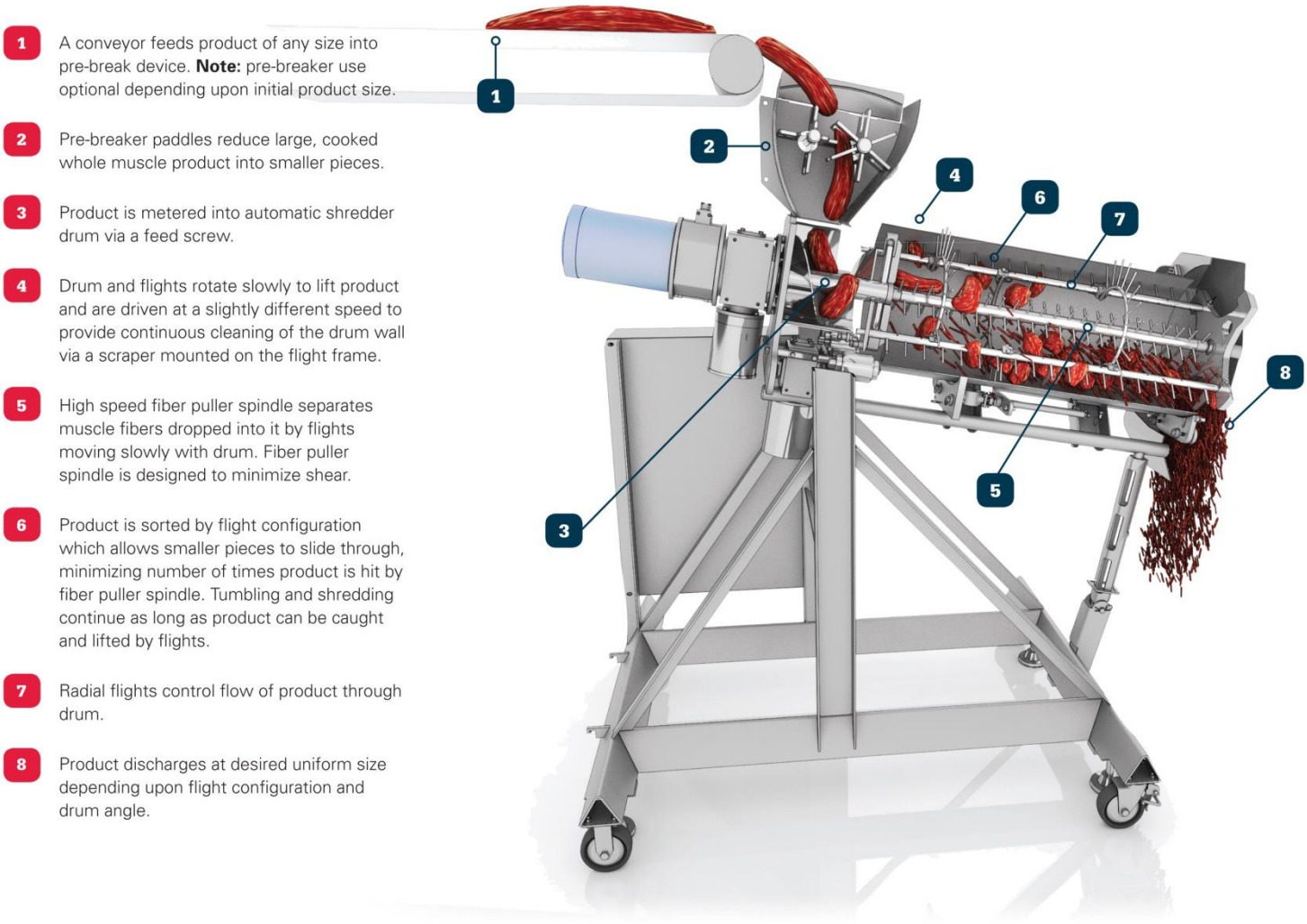
Table 2 – Example: Water Cook-in Bag Thermal Processing Schedule

Cook-In Bag Technology for Shredded Meats - Water Cook			
Step	**Time (Min)**	**Water Temp (°F)**	**Internal Temp °(F)**
Water Cook	210	200	180

AUTO-SHREDDER EQUIPMENT ADJUSTMENTS

Even if all of the aforementioned parameters are followed, consistent shredding is impossible if the auto-shredding equipment is not set-up for cold shredding conditions. Figure 3 depicts a basic overview of the features and operations of an Auto-shredder. This schematic can be used as a 'guide' for necessary adjustments to automatic shredding equipment prior to cold shredding of meat and poultry products.

Figure 3 – Basic Overview of Auto-Shredder Operations



Pre-Break

When cold shredding meat and poultry products, a pre-break should be used to start the initial size reduction process with the cold (≤40°F, ≤5°C) fully cooked muscle cuts. While the pre-break is often not needed on poultry meats, it is needed on products such as beef and pork to accomplish consistent shredding.

Flight Pins

To achieve the desired shred, Auto-shredders are designed to accommodate various flight configurations – 5, 19 or 37 pins. For example, a 37-pin flight set up results in more mechanical action and thus a more uniform shred of cold product.

AUTO-SHREDDER EQUIPMENT ADJUSTMENTS (continued)

Puller Spindle

A puller spindle maximizes contact between cold product and the drum's flights which allows for maximum shear of the muscle fibers. Adjustable speed control of the puller spindle also accommodates higher speeds required for cold shredding.

Radial Flight Configuration

Cold product is firm and requires more contact time with the puller spindle and flight pins to achieve a shred similar to that of hot processed product. In order to achieve this, an increased number of radial flights are added to the drum. These radials are placed closer to product entry to allow the muscle pieces to stay in the drum longer, resulting in increased contact with the pins and spindle.

Drum Angle

As with hot shredded products, the angle of the auto shredder's drum determines the shredding consistency. For a coarser shred, the muscle pieces need to travel faster through the drum. This is achieved by increasing the angle or tilt of the drum. Vice versa, if a finer shred is desired, reduce the angle of the drum and increase the time the product has in contact with the flight pin configuration.

SUMMARY

When developing new products or changing production processes, we often focus solely on the equipment and fail to recognize that changes may be needed upstream to ensure that the ideal product is delivered to a properly functioning machine. Cold shredding fully cooked meat and poultry products require a careful analysis of the raw materials and processing methods to deliver safe, high quality, consistent results. Remember: the key to successful shredding at cold temperatures is providing appropriate conditions (time and temperature) for complete breakdown of connective tissue proteins.

About Marlen

Recognized as a global manufacturer of highly engineered food processing equipment and systems, Marlen designs and builds innovative solutions for the food processing industry. Our premium products have long set the standard for quality and performance in vacuum stuffing and pumping, portioning, size reduction, thermal processing, and food handling. Marlen is a Duravant Company.