RESEARCH REPORT
INTERNATIONAL TRADE

Title: Pork fibrin used as a meat binder in pork variety and offal meats **NPB Project #13-250**

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Industry Summary

The objective was to conduct a proof of concept for the use of fibrin from pork blood to create value-added export items from various pork offal items and variety meats. Fibrin is a cold set binding product that is created by recombining the two blood components thrombin and fibrinogen. The fibrin can then be added to fresh meat to bind multiple products together into one. Fibrin is currently marketed as Fibrimex® by Sonac, however, the patent for producing fibrin has expired which leaves the potential for U.S. pork operations to begin to produce their own fibrin and add it to certain pork items to create their own value-added products.

A total of eight finished products were created in this study using only Fibrimex® and pork offal/variety meats. The products created include a boneless baby back made from pork jowl, a steak made from diaphragms, a boneless hock, a log of skinned pork tongues, a pinwheel with pork diaphragm and cheese, a steak made from course ground heart and back fat, fresh bacon made from pork jowl, and a bung roll stuffed with liver, heart, and kidneys.

These products are examples that show the binding capabilities of fibrin on different textured meats. All of the final products are believed to have potential as successful export items. It must be noted though that fibrin can be added to many other meats to create an endless number of products, including products that are of value within our country's own markets.

Keywords

Fibrin, Pork, Offal, Variety meats, Binder

Scientific Abstract

The objective was to conduct a proof of concept for the use of fibrin from pork blood to create value-added export items from various pork offal items and variety meats. Fibrin is a cold set binding product that is created by recombining the two blood components thrombin and fibrinogen. Fibrin naturally occurs when the protein fibrinogen is combined with the enzyme thrombin, thereby forming a strong bond of muscle tissues. Fibrin can be added to fresh meat to bind multiple products together into one. Fibrin is currently marketed as Fibrimex® by Sonac, however, the patent for producing fibrin has expired which leaves the potential for U.S. pork operations to begin to produce their own fibrin and add it to certain pork items to create their own value-added products.

A total of eight finished products were created in this study using only Fibrimex® and pork offal/variety meats. The products created include a boneless baby back made from pork jowl, a steak made from diaphragms, a boneless hock, a log of skinned pork tongues, a pinwheel with pork diaphragm and cheese, a steak made from course ground heart and back fat, fresh bacon made from pork jowl, and a bung roll stuffed with liver, heart, and kidneys. These products are examples that show the binding capabilities of fibrin on different textured meats. All of the final products are believed to have the potential to be successful export items. It must be noted though that fibrin can be added to many other meats to create an endless number of products, including products that are of value within our country's own markets.

Introduction

Fibrin is a cold set binding product that can be used on fresh meat. Fibrin is produced by combining two components extracted from blood. The first component is fibrinogen, which includes the primary binding contents, and the other component is thrombin, an enzyme that initiates the binding process. Fibrin naturally occurs when the protein fibrinogen is activated by the enzyme thrombin, thereby forming a strong bond of muscle tissue. Fibrin is effectively used in the meat and food industries to create value-added muscle foods. Fibrin is currently sold commercially in the U.S. as Fibrimex® by Sonac, a European company owned by Darling International. The patent held by Sonac for manufacturing fibrin from blood has expired; therefore, it is reasonable to believe that U.S. pork operations could begin to collect blood at the time of slaughter and isolate fibrinogen and thrombin from blood in house to create fibrin. Ultimately, fibrin has potential as a binding agent to create novel items for export markets using variety meats and offal items.

Objective

The objective was to conduct a proof of concept experiment for the use of fibrin from porcine blood to create export items from various pork variety meats and offal items.

Materials and Methods

A total of eight products were developed using pork variety/offal meats and fibrin purchased from Sonac. The list of meats that were available and are listed as commonly exported items can be found in Table 1. The fibrin received from Sonac was sold frozen in two separate containers; one containing fibrinogen and the other containing thrombin. The fibrinogen and thrombin must stay frozen before use.

On the day that the fibrin was made, the sealed fibrinogen and thrombin containers were submerged in 80°F water until they reached liquid form. It is essential that the fibrinogen and thrombin are thawed in water that starts out at 80°F in order to maintain the binding factors of the two components. To create the fibrin, the fibrinogen and thrombin are mixed together at a ratio of 10:1. The binding reaction doesn't actually start until

the fibrin is added to the protein source. Most of the products that were developed included fibrinogen at 10% and thrombin at 1% of the total weight of the meat. The ground products that were developed had a larger surface area which required a greater amount of fibrin.

Product Development

Diaphragm Steak

One of the products developed was a steak made using pork diaphragms and bound together using pork fibrin. The diaphragm is typically removed from the ribcage of the carcass and packaged in bulk by most large scale pork plants. A sensory test was conducted before the product was developed to assure the most ideal processing and cookery methods were used. The diaphragm was processed in two separate ways. The side of the diaphragm that touches the ribcage contains a thick piece of connective tissue that is not removed by the plant. The two samples tested included pieces of diaphragm that had the connective tissue on and a set of pieces that had the connective tissue removed. Both samples were then cooked on a grill and in a frying pan at approximately 400° F until a doneness level of medium-well was reached. The samples that had the skin on were described as being rubbery and tough. The samples that had the skin removed prior to cooking were more tender and easier to consume. Grilling was also determined to be the most ideal method of cooking.

After determining the ideal processing and cooking methods, the raw product was made. A 6” x 11 ¾” x 2 ½” pan was used as the mold to form a loaf with the diaphragm. A total of five pounds of diaphragm meat with the connective tissue removed, 0.5 (10%) pound of fibrinogen, and 0.05 (1%) pound of thrombin were thoroughly mixed by hand for one minute. The pieces of diaphragm were then layered in the pan quickly before the fibrinogen and thrombin begin to set. A piece of plastic wrap was placed over the top layer and a pre-cut cardboard cap was placed on the top of the plastic wrap. The pan was then placed in a vacuum sealable bag and a vacuum was drawn. The vacuum helps eliminate air pockets between the pieces of meat which ultimately maximizes binding area. The vacuum sealed product was then placed in the cooler for at least 12 hours to allow the binding process to complete.

The final product can be removed from the bag and the pan after the 12 hours of required setting time. The loaf was then sliced into 1" steaks and then grilled. After cooking the steaks it was determined that the fibrin held the meat together and there were no holes or weak binding points within the steak. Refer to figure 1 for pictures of the raw and cooked final product.

Boneless Baby Back (Jowl)

A boneless baby back was developed using jowl trimmings from pork carcasses. The jowls that are processed in the plant are skinless and appear to have a very minimal amount of fat trimmed off; therefore, the jowls used to make the boneless baby back had approximately 20% of their fat removed before being added to the final product in order to increase the lean point. Each individual piece was then placed in an electric meat tenderizer. A total of 30 pounds of tenderized jowl trimmings, 3.0 pounds (10%) of fibrinogen, and 0.3 pound (1%) of thrombin were thoroughly mixed for about one minute. The pieces were then layered in a 19 ¾" x 11 ¾" x 2 ½" loaf pan. A piece of plastic wrap was placed over the top layer and a pre-cut cardboard cap was placed over the top of the plastic wrap. The final product was then placed in a vacuum sealable bag and a vacuum was drawn. The product was then placed in the cooler for at least 12 hours to allow the binding process to complete.

After 12 hours of chilling, the product was placed in the freezer. The binding process must be complete before a product is frozen or weak points between the pieces of meat will develop. The frozen boneless baby back loaf was then tempered until the internal and external temperatures fell within the range of 24°F to 28°F. This temperature range reduces the chance of tearing the meat with the knife. The loaf was then cut into 1" thick pieces using a custom edged knife with a zig-zag design which will cut the meat to imitate the look of a traditional bone-in baby back rib. The final product was best when grilled. Refer to figure 2 for pictures of the raw and cooked final product.

Bung Roll (Liver, Kidney, Heart)

The bung roll was developed to test the binding capability of fibrin on offal meats that contained a high percent of water. Whole livers, hearts, and kidneys were selected from pork carcasses and then coarse ground together at a ratio of 1:1:1. Flushed pork bungs were tied off at one end, soaked in saltwater, and used as the casing for the ground livers, hearts, and kidneys. The ground offals were weighed and fibrinogen was added at 12% and thrombin was added at 1.2%. The mixture was thoroughly tumbled by hand for approximately one minute before being placed in the cylinder of a hand stuffer. A bung was placed over the stuffing tube and filled to a level where the bung could still be tied off at the open end. The bung roll was then placed in a vacuum sealable bag and a vacuum was drawn. The product was then placed in the cooler for at least 12 hours to allow the binding process to complete.

The bung roll was removed from the cooler after the required 12 hours of chilling. The roll was then further processed in three different ways. The first attempt involved slicing the chilled bung roll that had an internal temperature of 36°. The slicing did not work because it appeared as though there was too much purge to allow the fibrin to set appropriately. For the second processing method the bung roll was frozen, tempered to 26°F, and then sliced at ¼". The slices held together and remained one solid piece after frying for approximately 10 minutes. The most ideal processing method was to cook the bung roll in an oven set to 300°F and 100% humidity until an internal temperature of 180°F was reached. The offal meat within this bung roll stayed together when sliced with the knife. Refer to figure 3 for pictures of the raw and cooked final product.

Heart and Fat Steak

The heart and fat steak was developed to determine how well fibrin would hold a low moisture ground product together. Pork back fat and hearts that had large visible veins removed were coarse ground once and then mixed together by hand. A total of two pounds of heart and ¾ of a pound of fat were used to fill a 6" x 11 ¾" x 2 ½" loaf pan. Fibrinogen and thrombin were added at a rate of 12% and 1.2% respectively to the ground product and then mixed again thoroughly by hand for approximately one minute. A piece of plastic wrap was

placed over the top layer and a pre-cut cardboard cap was placed on the top of the plastic wrap. The final product was then placed in a vacuum sealable bag and a vacuum was drawn. The product was then placed in the cooler for at least 12 hours to allow the binding process to complete.

The final product was removed from the cooler after 12 hours and then taken out of the bag and pan. The loaf was sliced into 1" thick steaks and the steaks were then grilled. The steaks held together and had very few weak points between the meat and fat particles. Refer to figure 4 for pictures of the raw and cooked final product.

Boneless Hock

The boneless hock is an example of how a cut that is typically sold with the bone in can be deboned and bound together to form one solid piece that consumers may find more acceptable. Pork packers that sell the hocks market them as bone-in. To make the boneless hock, the bone was removed from the meat portion of the hock and a mixture of 10% fibrinogen and 1% thrombin was rubbed into the center portion of the hock. The hock was then folded back into its original shape, placed in a vacuum package bag, and finally sealed. The final product was left to chill in the cooler for 12 hours. Refer to figure 5 for pictures of the final product.

Sliced Tongue

A log containing skinned pork tongues was developed to show the binding capabilities of whole muscles within a synthetic casing. Sliced beef tongue is a popular Asian dish and the result of binding pork tongues together is a larger diameter product that is more similar in size to a beef tongue. A total of six pounds of skinned pork tongues were combined with a mixture containing 10% fibrinogen and 1% thrombin. The tongues and fibrin were tumbled by hand for approximately one minute before being layered into an Aligned Grain Stuffer (AGS). A 3" diameter perforated synthetic casing that was tied off at one end was placed over the mouth of the AGS. The perforated casing helps remove air pockets that may result and prevents the need for vacuum sealing. The air powered AGS was turned on and stuffed the aligned tongues into the casing. The casing was tied off and the final product was left to chill for 12 hours in the cooler.

The tongue log was removed after the appropriate chilling period and the casing was removed. The log was cut into 1/8” slices using a deli meat slicer and ¼” slices using a knife.

The slices were then cooked in a frying pan to 165°F. The slices held together well and did not have any weak points between pieces. Refer to figure 6 for pictures of the raw and cooked final product.

Diaphragm Pinwheel

The diaphragm pinwheel is a novelty item that shows fibrin will still bind meat even when other ingredients are incorporated. First, skinned diaphragms and a slurry containing 10% fibrinogen and 1% thrombin were hand-mixed together for approximately one minute. Two pieces of diaphragm were used to create each pinwheel. The two pieces were lined up and overlapped each other by 2”. The outside ingredients added to the pinwheels pictured above include cheese, orange bell pepper slices, and cilantro. These three ingredients were added to one side of the diaphragm strips and gaps between the ingredients were left in order to allow for the protein to protein contact that is necessary for binding. The now continuous diaphragm strip was then rolled up on itself to keep the added ingredients inside the pinwheel. The pinwheel was then placed in round plastic form, vacuum sealed in a bag, and then placed in the cooler for 12 hours to allow for the binding process to complete.

The pinwheel was removed from the bag and the plastic form after the appropriate chilling period. The pinwheel was then grilled to test the fibrins ability to continue to hold together both the meat and the added ingredients. The product stayed together and maintained its original structure through the cooking process. Refer to figure 7 for pictures of the raw and cooked final product.

Jowl Bacon

The jowl bacon is a product derived from the same form as the boneless baby back. The same procedures were used to make the bacon; however, the frozen jowl loaf was sliced using a vertical band saw at 1/8 of an inch. The same jowl loaf can be thawed and then sliced using a meat slicer as an alternative. Refer to figure 8 for pictures of the raw and cooked final product.

Results

A total of eight products were successfully developed using fibrin and the pork variety/offal meats listed in Table 1. The pork fibrin served as an effective binder in the development of the final pork products. The products that were developed are prime examples of potential export items that could be made in plants across the U.S. The pictures that are attached to the end of this document show both the raw and cooked form of the products. These results suggest that fibrin is a feasible naturally-occurring binder that could be utilized by the U.S. pork industry to create value-added products.

Table 1. List of products to be evaluated in this study.

Bladders	Hocks	Skins
Brains	Intestine	Spleens
Diaphragm (skirt) meat	Jowls	Stomachs
Ears	Kidneys	Tails
Esophagus	Lips	Tendons
Face Mask	Livers	Tongues
Fat- Back	Pancreas	Trachea
Fat - Leaf	Pizzles	
Salivary Glands	Rectum	
Hearts	Tunic	

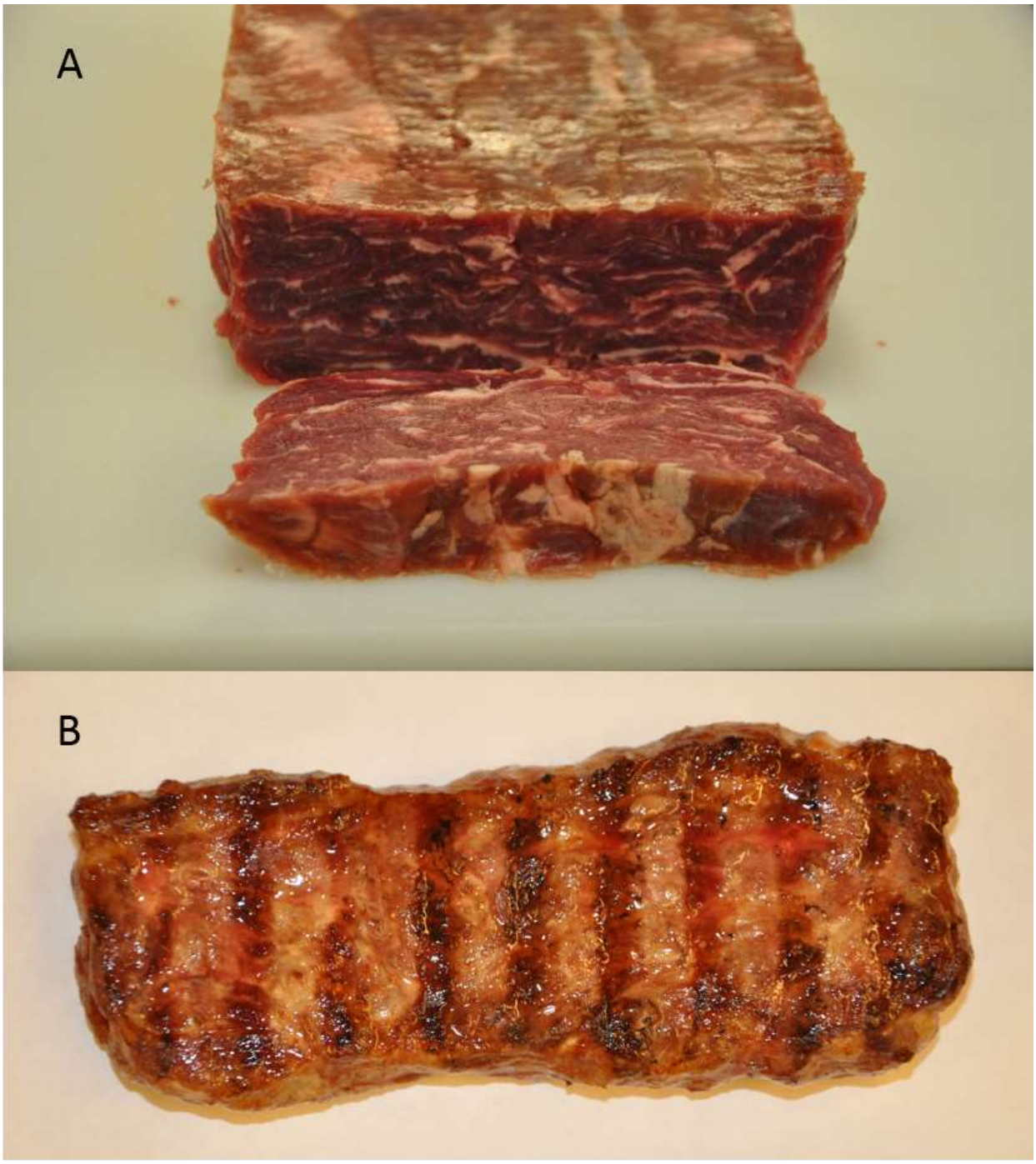

Figure 1. Diaphragm Steak. Raw (A) Cooked (B)

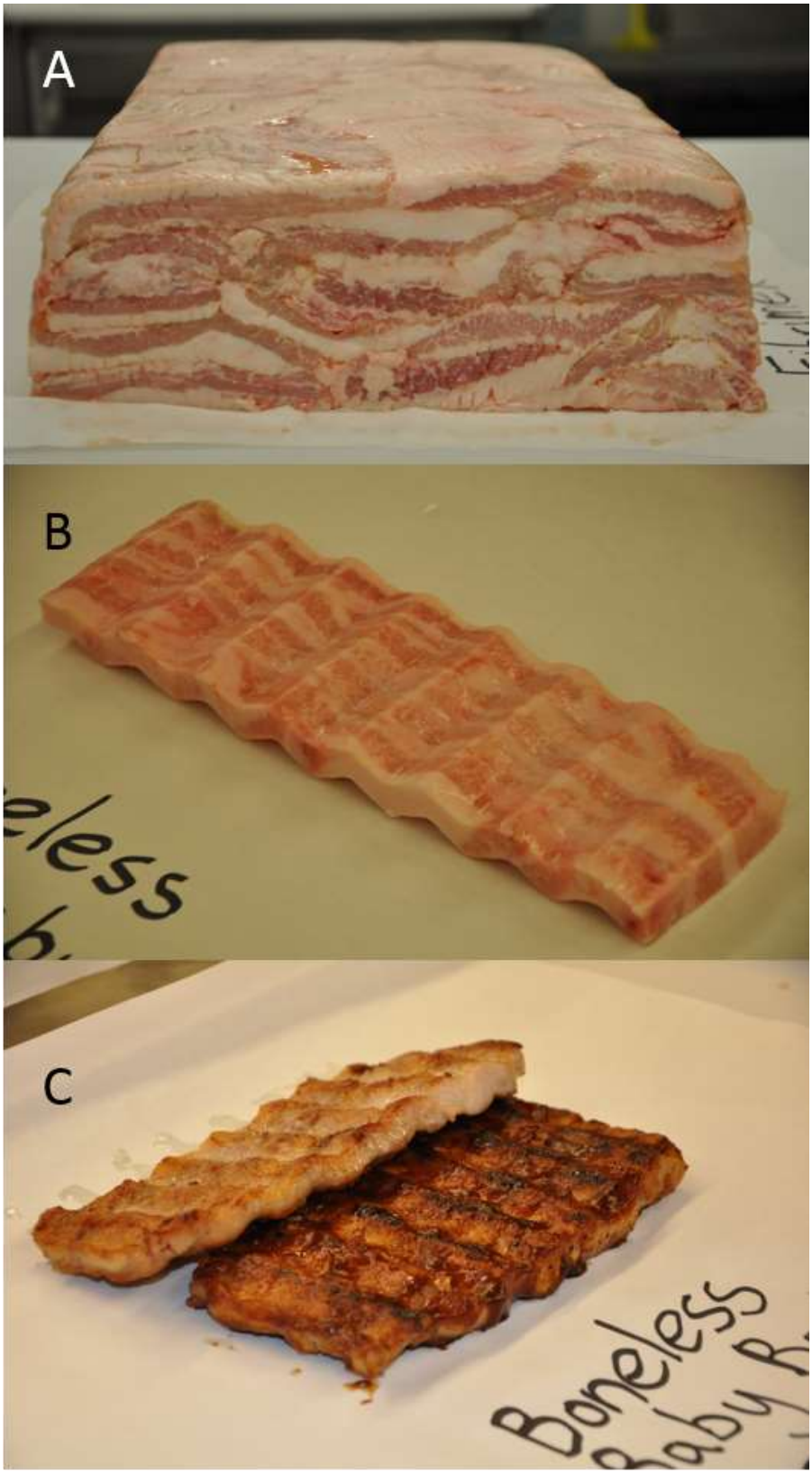

Figure 2. Boneless Baby Back. Raw Loaf (A) Raw (B) Cooked (C)

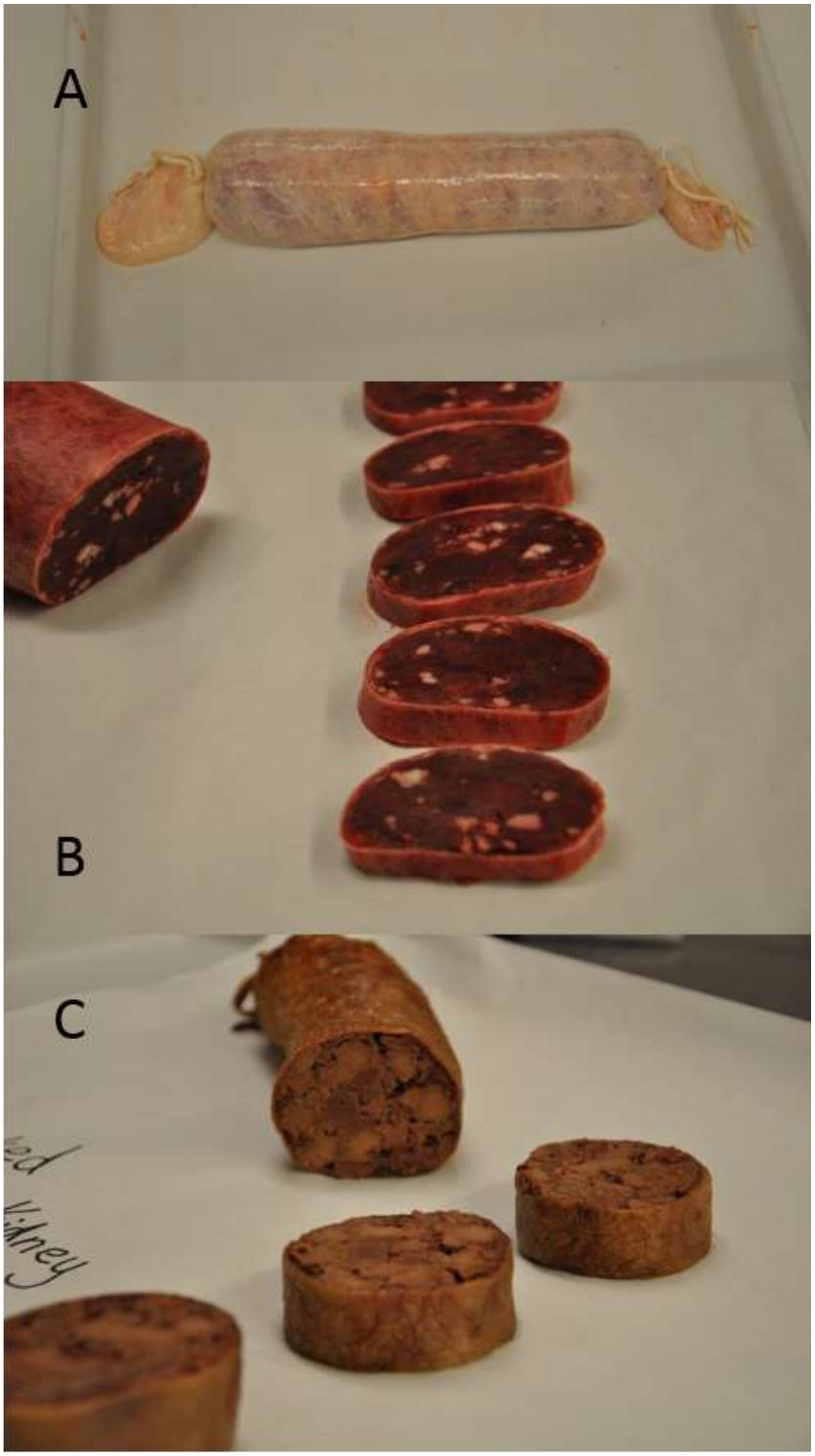

Figure 3. Bung Roll. Raw (A) Raw Slices (B) Cooked (C)

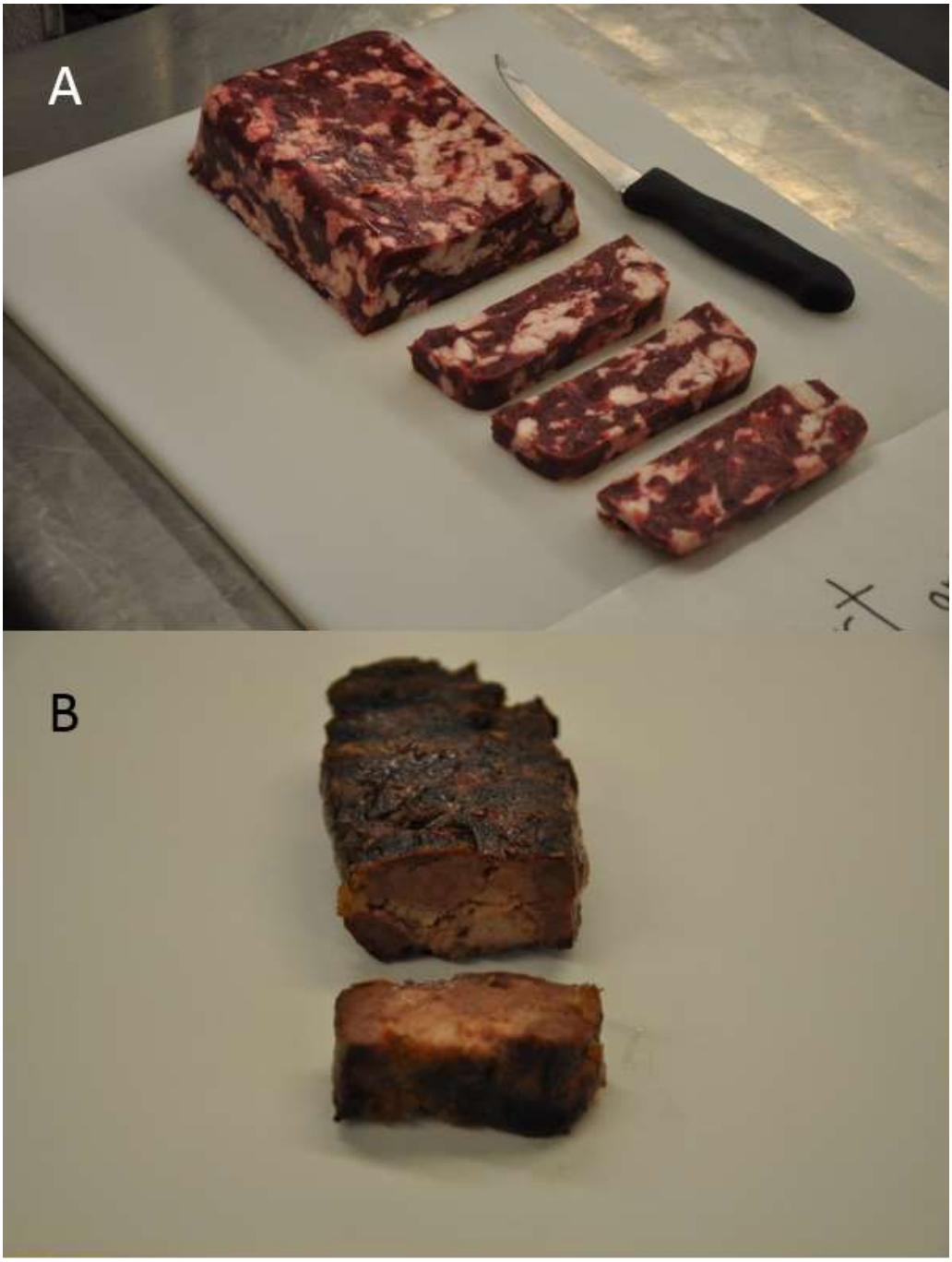

Figure 4. Heart and fat steak. Raw (A) Cooked (B)

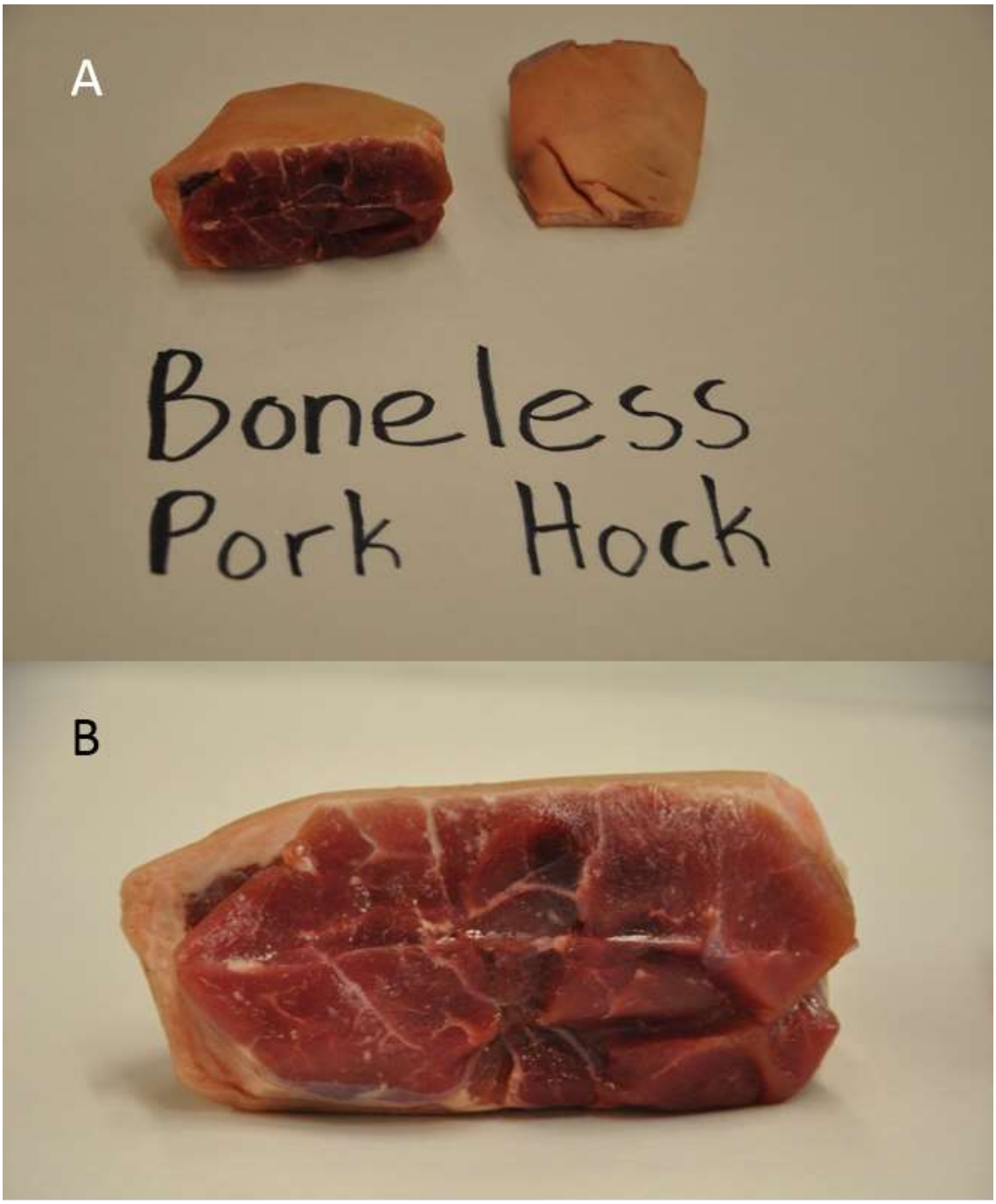

Figure 5. Boneless Pork Hock. Raw (A and B)

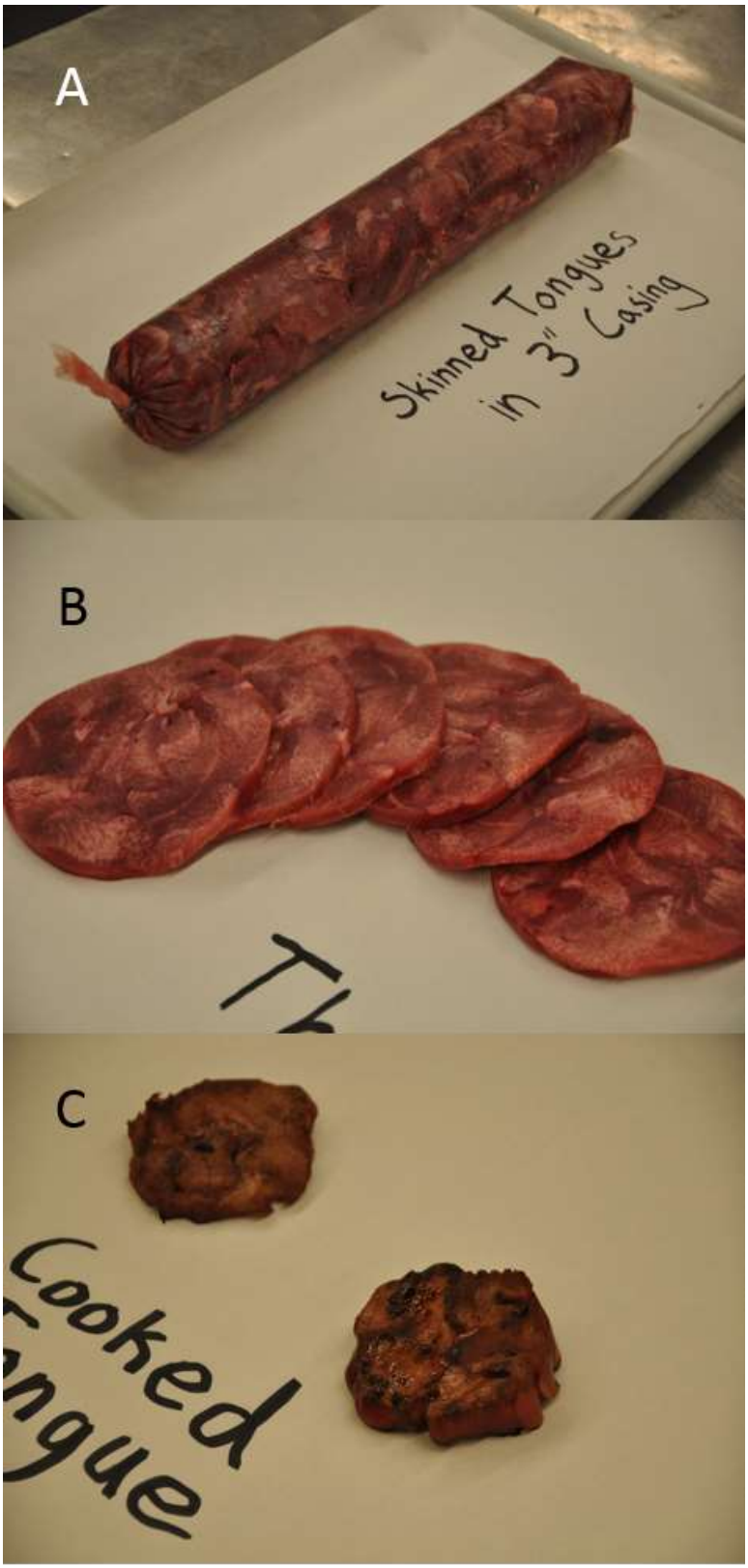

Figure 6. Sliced Tongue. Raw (A) Raw Slices (B) Cooked (C)

Figure 7. Diaphragm Pinwheel. Raw (A) Cooked (B)

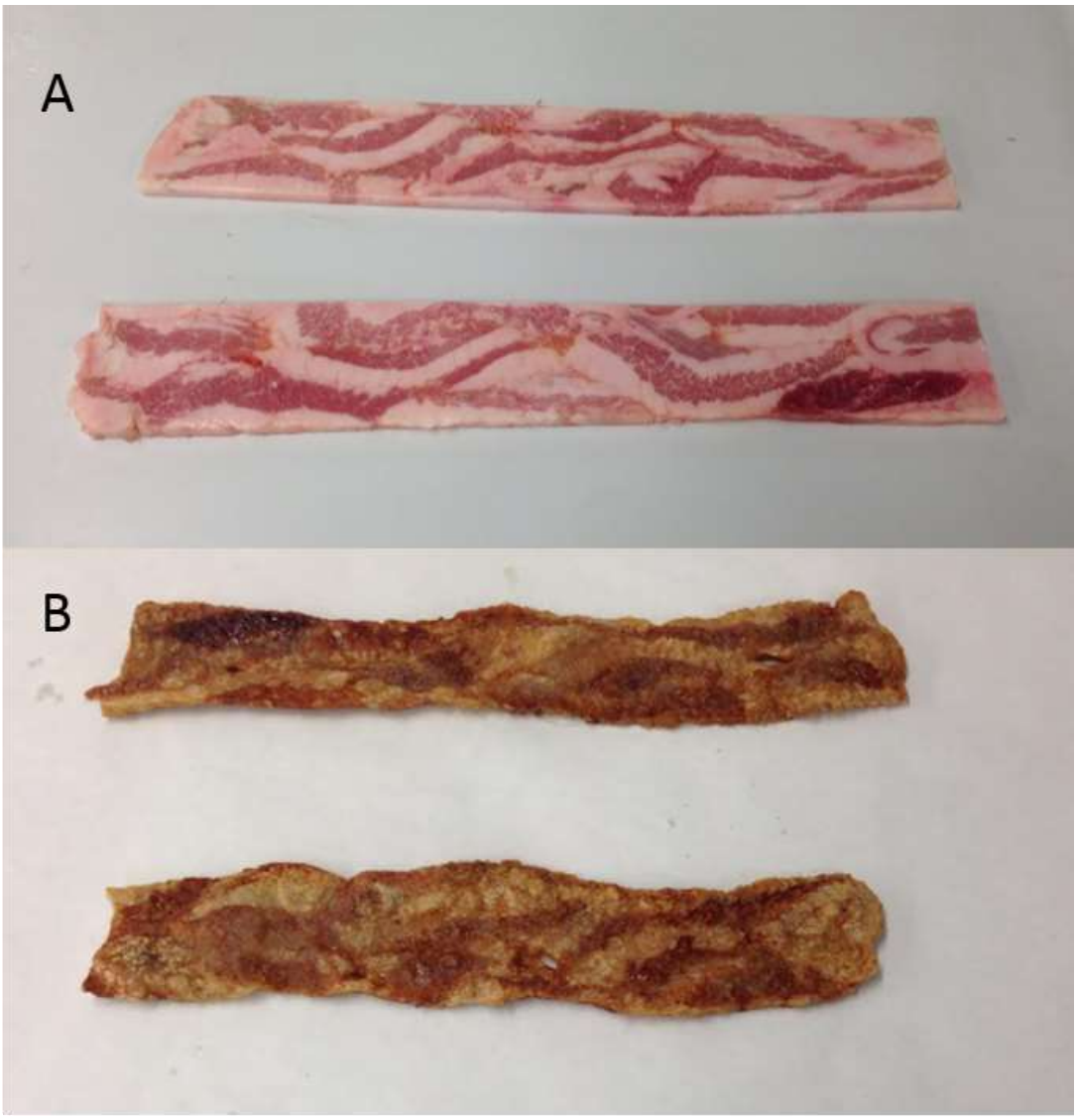

Figure 8. Jowl Bacon. Raw (A) Cooked (B)