Seafood Restructuring Using Cold-set Binding Technology

by

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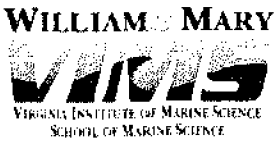

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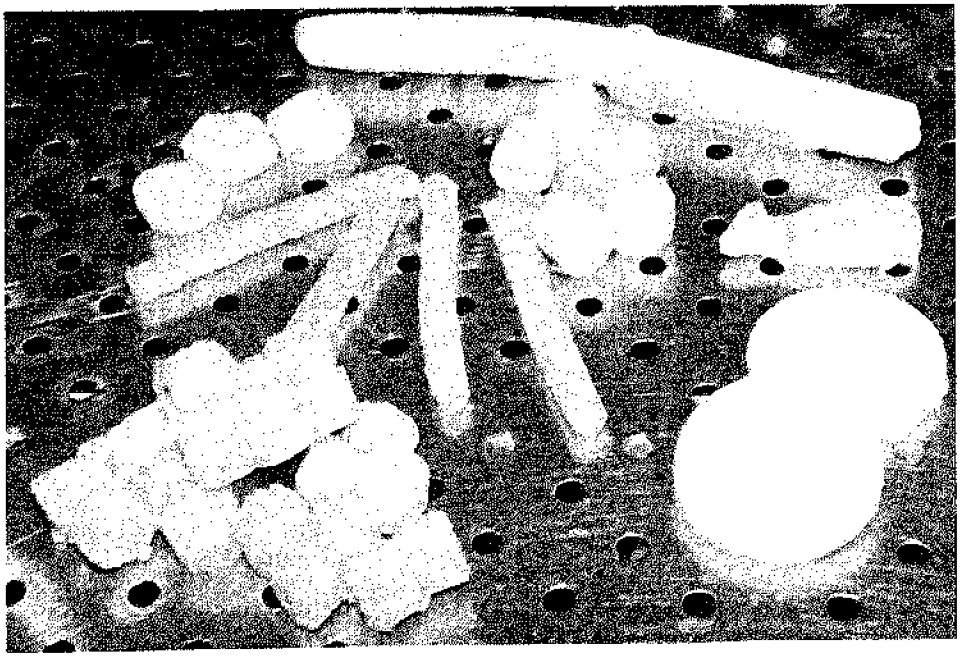
Introduction

Within the seafood industry, many commodities are graded by size, as are scallops and shrimp, with the larger sizes commanding a higher market value. The value disparity between sizes is not necessarily based on perceived quality differences (small scallops and shrimp maintain a strong market share), but more so on the consumer perception that bigger is better. Consequently, larger, more uniform items are targeted for the higher valued items within the food service industry. Additionally, institutions, caterers and restaurants rely heavily on portion control and prefer uniformly sized products.

Food restructuring is a term used to identify a process where pieces of raw material are bound together to form a single larger food item, typically resembling a natural product form. Restructuring may be achieved by various processes including forming, pressing, molding, and stuffing the product into casings. Restructuring an available resource—such as small and/or, non-uniform sea food pieces—to simulate a more marketable commodity adds value to that product. Market advantage is increased for restructuring if the targeted market form is in high demand. Case in point: of the domestically landed sea scallops, the 20-30 meats per pound size is the most marketable; in 1996-97 landings of that size scallop were drastically reduced, creating a high demand for the product. Two cooperating industry members filled the market void by restructuring 80-120 count imported scallops into 20-30 count scallops, and marketing them as "Scallop Medallions." In effect, the processors added value to the small scallops by merely increasing product size, while providing the food service industry with an alternative scallop product of consistent size and quality.

Traditionally, various hydrolyzed proteins, in conjunction with salts (including phosphates), have been used as binders in restructured and formed products. Those binders require a heat process to form a gel matrix, either via a par-cook to set the gel for further processed products, or a full cook in heat-n-serve products. If a heat process is not used, the product generally requires immediate freezing upon forming to maintain its desired shape and integrity until the binder is



On the left are restructured seafood products in the form of medallions, sticks, patties, shapes, and nuggets.

set by a heat process, which is usually administered by the end user. Either way, using "heat-set" binders limits the finished product to the frozen market. Thermal applications needed for heat-set binders commonly result in product toughening through moisture loss. Further, these binders work best on comminuted raw material, not on whole muscle pieces as described here for restructured and formed seafood products.

The ability to restructure raw material and retain the product in a raw, fresh state provides market flexibility and, therefore, a market advantage. A restructured raw fresh product provides the processor with multiple marketing choices, including additional added-value product development.

To produce a restructured raw product, a binder which gels at or below room temperatures ("cold set" binder), is needed.

Three main types of commercially available cold-set food binders, or blends of various proteins, are available for use with seafood raw material to produce restructured and formed products: enzyme activated protein binders, hydrocolloid protein and carbohydrate polymers, and sodium alginate. Enzyme activated binders rely on natural enzymes to catalyze the formation of a protein gel matrix and subsequent gel-raw product protein cross linking. thrombase and transglutaminase are the enzymes currently used in commercial cold-set binders. The second type of binder(s) employs hydrocolloid proteins, as hydrolyzed gelatin and milk proteins, solely or in conjunction with modified starches and/or phosphates to form a cold gelling polymer. These form a gel matrix (soft to hard gel) at room temperature or below. The third type of binder, sodium alginate, uses hydrated food grade gums (alginates) as the gel forming substrate. Gelation requires the introduction of calcium ions, most commonly from calcium sulfate or dicalcium phosphate. Simply adding calcium to the alginate provides too rapid of gel formation for most applications, not allowing for adequate product handling (forming, stuffing) to occur. The use of a calcium sequestrant (sodium hexametaphosphate), added with the calcium source to the alginate, helps prevent premature gelation by competing for the available calcium. For practical applications of sodium alginate in the restructuring of foods, the calcium needs to be introduced at the time of molding or stuffing. This may be accomplished with commercial stuffing machines which can introduce the calcium solution at the horn location, just prior to the time the product enters the casing.

The binders employing hydrocolloid proteins and alginates are best used in restructured product formulations using comminuted raw material, with the finished product being breaded and frozen. These differ from the enzyme activated binders which provide functional binding on a wide range of raw material piece sizes, from large whole muscle pieces to very small, even comminuted material. The potential food applications for these enzyme binders is far reaching. This report focuses on results generated from sea food restructuring using enzyme activated protein binders.

Selection of Raw Material

Success in restructuring seafood products begins with the thoughtful selection of raw material. A thorough investigation into raw material resources, and their predicted future availability—prior to development—is imperative. Selecting a resource with highly variable sensory characteristics, or one with an unstable or limited supply should be avoided. Selection of the highest quality resource possible is vital to the success, and consumer acceptance of the finished product. The appropriate resource is one which will result in a near mimic of the targeted restructured product and/or is most acceptable by the consumer. In the case of "Scallop Medallions," the initial resource used in developing that product were small scallops (*Chlamys patagonica*) harvested in the Southwest Atlantic ocean off the coast of Argentina. These

scallops possess an soft texture which made them a good candidate for restructuring into simulated sea scallops because the elastic component of the binding agent did not detract from the soft texture. Since the initial marketing of Scallop Medallions, other scallop resources have been used, resulting in varying product quality parameters in terms of texture, taste, color and overall appearance.

In shrimp, some species were found to bind successfully while others would not. This could be the result of varying levels of a natural endogenous enzyme (i.e. a cathepsin enzyme), which is known to inhibit protein binding. Deactivation of this enzyme can be performed through heating or altering product pH; however, product appearance and overall quality can be compromised.

Nature of Raw Material

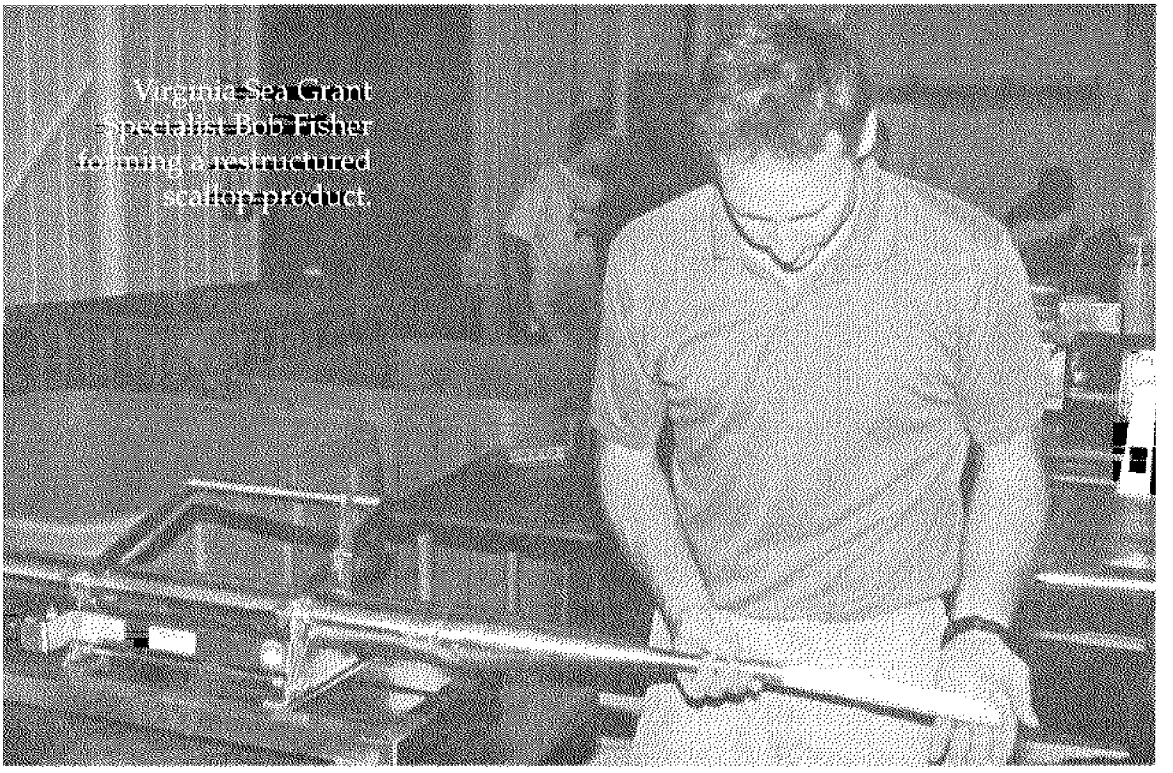
Forming large scallops from small ones is successful largely because the natural texture of scallop adductor muscles is similar for different scallop sizes and species. The overall "bite" or texture of a properly formed scallop product using small scallops is uniform and therefore perceived as a single unit by the consumer. Taking small shrimp species and forming them to mimic large shrimp or formed products is more challenging. The natural, rounded and crescent shape of shrimp tails, together with their more dense muscle fiber/bundle arrangement (as compared to scallops), creates textural problems in formed products. Individual small shrimp, when successfully bound together, will tend to contract during cooking, independently of the formed product as a whole. This results in physical distortion of cooked product, lack of product integrity, and a non-uniform "mouth feel," or texture, to the consumer. However, by breaking up the natural shape and muscle fibers configuration of small shrimp, uniform structured products are possible. After numerous trials of grinding (chopping) small shrimp into smaller (12, 9, 6, and 3mm) pieces prior to binding, improved cooked product appearance and integrity was demonstrated but texture remained a problem. The chopped pieces of shrimp still displayed the independent nature of the whole shrimp pieces upon cooking, resulting in a negatively perceived grainy mouth-feel to the bite. This problem was corrected by flattening out the small, rounded shrimp prior to binding instead of chopping/grinding. Flattening constitutes breaking apart the muscle bundles, but leaving the individual, longitudinally-oriented muscle fibers intact. By keeping the elongated muscle fibers intact, a layering network occurs between flattened shrimp during blending with binder, resulting in a more structurally uniform finished product. The tendency for individual flattened shrimp to contract independent from the whole product during cooking is reduced. This results in the structured product cooking more as a single unit, thus improving the overall texture. Moderate flattening tends to work best for products marketed un-breaded, such as patties, where the individual shrimp integrity is lost but the general shrimp form visually remains.

Enzyme Activated Binders

Two commercial enzyme activated cold-set binders were tested for this study: Fibrimex, a plasma binder developed in the Netherlands and currently being produced in Canada, and ACTIVA, a sodium caseinate-transglutaminase binder developed and currently produced only in Japan. Both enzyme activated cold-set binders reported here are natural products federally approved for use in food applications. They impart little to no odor or flavor to the restructured product. Upon setting, the color of these binders blend well with most sea foods. Both binders are readily available in the United States, with ACTIVA only recently becoming available, while the production of Fibrimex began in 1991 for use in the red-meat industry.

Fibrimex

There are two components to Fibrimex which, when mixed together, form an insoluble protein gel and provide protein cross-



linking between the gel and the raw material. Both components are derived from the plasma component of beef blood. The main component is fibrinogen, a natural soluble protein produced by the liver in animals and found in blood plasma. The second component is the enzyme thrombin, or thrombase. Both are in liquid form. When added to the fibrinogen, thrombin converts fibrinogen to fibrin, the insoluble protein gel which provides the basis for binding. This process is the same as in blood coagulation, or clotting. Though thrombin is the major enzyme involved in this process, it should be noted that thrombin is reported to activate a transglutaminase enzyme also found in the plasma which contributes to gel-meat cross-linking in the binding process (Winjngaards and Paardekooper 1989). These authors also report that fibrin concentration of the resulting gel largely determines its strength. The fibrin concentration is therefore controlled by the manufacturer by isolating additional fibrinogen from the plasma and re-introducing it back into the fibrinogen solution of the commercial binder. Fibrimex uses beef plasma fluid as the solvent for the fibrinogen solution because it already contains some fibrinogen and transglutaminase.

Fibrimex solutions are distributed and stored frozen. The manufacturer suggests storage at -20°C to -40°C. The fibrinogen comes in plastic, hermetically-sealed bags containing 2.2 lbs of fibrinogen solution. Thrombin comes in plastic, screw-capped bottles containing 1.75 oz of thrombin solution. The two solutions are thawed in a water bath (20-25°C) until they are completely free of ice crystals and the fibrinogen protein is visibly dissolved in solution. From research generated during the development of Fibrimex, the mixing ratio of fibrinogen to thrombin was determined for commercial applications to be 20:1. This ratio generally provides for both adequate product handling time prior to gel formation and good gel strength. As commercially packaged, mixing one plastic pouch of fibrinogen solution with one bottle of thrombin solution, provides a 20:1 ratio. The combined solutions are then

added to chilled (2-5°C) raw material and thoroughly mixed to ensure complete distribution to all pieces. The coated meat pieces are then delivered to casings or molds, with care to exclude air voids, and transferred to a refrigerated area (2-4°C) for cold-setting (6-8 hrs). Once mixed at this ratio, handling should be completed within 15 minutes. Handling the restructured or formed product after this period and during setting will compromise binding. Freezing directly from forming, not allowing for a refrigerated setting period, can provide functional binding if the product passes from the frozen state directly to the cooked state, or if a refrigerated set period is allowed after a slow thaw period. Freezing inhibits enzyme activity, which is reactivated upon thawing. Set-time is directly related to the mixing ratio, with decreasing set time correlated to increasing thrombin use. By altering the fibrinogen to thrombin ratio, from 20:1 to 15:1 to 10:1, set time can be reduced from 6 hrs to 4 hrs to 2 hrs, respectively, with little compromise to product quality parameters (see "Texture"). Product binding is also affected by pH, with optimal enzyme activity, and therefore functional binding, occurring between pH 7-7.5.

The initial production of "Scallop Medallions" used Fibrimex for binding small scallops. The Fibrimex coated scallops were stuffed into 36 inch plastic, 1.25-1.5 inch diameter, perforated, tubular casings and refrigerated overnight to allow setting. Upon setting, the casings were stripped, and the formed scallop logs were sliced at predetermined lengths to mimic large scallops.

ACTIVA

The principle component of ACTIVA is the enzyme transglutaminase (TG). It is a naturally occurring protein substance found in organs and tissues of mammals, fish, shellfish and plants, as well as in microorganisms (Seki et al 1990). The TG enzyme in ACTIVA is derived from a fermentation process, where TG is produced by microorganisms associated with the fermentation of starch and other raw materials. The TG produced from microorganisms is calcium independent (does not require the addition of calcium for functionality), which differs from the calcium dependent TG derived from mammalian sources, thus expanding its use in food applications (Kuraishi et al 1996). Under the trade name ACTIVA, several formulations of TG containing protein binders are commercially produced. Though the principle component of ACTIVA products is the enzyme TG, the bulk of the product consists of a protein substrate, either sodium caseinate (milk protein) and/or carbohydrates (dextrin, maltodextrin, starches), depending upon its food application. The product tested for the present study on sea food binding was ACTIVA TG-RM, a blend of sodium caseinate (60%), dextrin (39.5%), and TG (0.5%). The casein provides the protein substrate for TG binding reaction. Protein sources from gelatin and soy may also serve as good substrates. The commercial product is a fine, white to off white powder, distributed in vacuum packed pouches and does not require refrigeration. The reasoning for the vacuum pack is that TG is susceptible to oxidation, which reduces enzyme activity.

Gel formation and protein cross linking is initiated with the introduction of water. ACTIVA products can be either pre-hydrated (wet application) prior to mixing with raw product to be bound, or applied dry (dry application) by sprinkling over the meat surfaces. The amount of water used for hydration in the wet application can vary from 2.5-4 parts of water to one part of dry binder. A 2:1 ratio or less produces a "paste" too thick for adequate distribution onto meat pieces. If more protein substrate (sodium caseinate) is added to the commercially available pre-blended product, more water will be needed to acquire proper hydration. In dry applications, moisture from the meat surfaces initiates binding. For applications requiring high ACTIVA usage rates (1.75-2%), the wet application (3-4:1, water:binder) is advised over dry application method in order

to facilitate meat surface coverage and to avoid clumping associated with dry applications. TG catalyzes the gelling and cross-linking of proteins through the formation of strong chemical (covalent) bonds between individual protein molecules (Motoki and Nio 1983). Binding begins within the protein substrate and continues between this substrate and the proteins from the raw material. As with the plasma binder, once initiated, handling time is short before setting occurs. Unlike the plasma binder, however, temperature is more important to set time than other processing parameters. In trials forming shrimp patties, setting time was observed to range from 3.5 hrs at 3-5°C, down to 1.5 hrs at 20°C. TG is reported by the manufacturer to be active over a wide pH range. All experimentations were conducted with sea foods within the neutral pH range, with functional binding achieved.

Once mixing binder with raw material, handling (stuffing, molding, forming) needs to be completed within 15 minutes to ensure proper binding. To provide for better binding of raw material, applied pressure during setting and the exclusion of air pockets is important. Though set time can be highly manipulatory by controlling temperature, it is advised to follow established industry Good Manufacturing Practices (GMP) as to food refrigeration. Raw material should always be kept chilled (2-5°C throughout the restructuring process. Inactivation of TG is reported by the manufacturer to occur at 75°C, and thought to occur upon freezing. However, these parameters were not tested. Continuation of protein cross-linking in fresh refrigerated restructured products, and its effect on product texture during a typical shelf-life period, was addressed and is presented in the following section.

Binder Effect on Quality Parameters

Both enzyme activated binders effect certain quality characteristics such as texture, drip loss and overall appearance of the restructured product, with the degree of impact largely dependent upon binder usage levels. For testing these effects, formed scallops were produced using varying levels of Fibrimex and ACTIVA TG-RM. Thirty pounds of frozen 120-150 count bay scallops from China were completely thawed, thoroughly mixed together then divided for use with both binders. Usage levels tested for Fibrimex included 10%, 8%, 6%, 4%, and 2%. Levels for ACTIVA TG-RM included 2% (wet application), 1.5% (dry application), 1.5% (wet application), 1.0% and 0.5% (dry applications.)

Texture

In food restructuring, sea foods are considered to have a softer, more delicate texture than red meats, poultry and pork products. The addition of a protein binder, which most often results in an insoluble, elastic polymer, will therefore effect sea food texture more than other meat products. Restructured products should be formulated to provide a near mimic of the natural product, with texture being a key component of success.

Usage level of Fibrimex and ACTIVA to raw material is largely dependent on piece size. Functional binding is only achieved if the binding solution is distributed over the surface area of adjoining pieces of raw material. Structured products using large pieces of raw material have less surface area for coverage than products using small pieces. Therefore, more binder is generally needed when using smaller pieces. The resulting polymer formed from gel formation and protein cross-linking is a very elastic structure, which in most seafood restructuring applications should be incorporated at the minimal amount, only to which functional binding is achieved. Too much binder causes a tough, chewy texture and affects moisture retention. Further, excessive usage results in a visual demarcation of pieces within the restructured product, and increases production costs. The type of raw material used, distribution

method (wet verses frozen), retail handling/ display (re-hydration from contact with thaw drip), and possible further added-value processing, can make the binder-piece interface more noticeable.

In the development of restructured sea foods, maintaining textural quality is of major importance. Shear strength, a measurement of texture, was evaluated for formed scallops using Fibrimex and ACTIVA TG-RM. A Food Technology Corporation Texturepress (model T-1200-G) was used to measure shear press units, the amount of force required to compress, shear and extrude a food product through a shear-compression cell. The lower the shear press units, the softer the texture. Since the product tested is formed with numerous individual whole scallops with random orientation, individual texture readings varied from sample to sample. Trial runs indicated that with consistent orientation of a single formed scallop in the press cell, five replications (N=5) for a given treatment provided the least variation, and therefore the most consistent average sheer press values. All products tested for cooked shear strength were broiled at the same time for the same duration. Cook time was determined by trial runs where the product's internal temperature was monitored by thermocouples and reached 70°C.

The addition of either binder imparts a degree of added elasticity to the formed products' textural profile (Figures 1, 2), and is observed to increase with increased usage levels. The texture difference between the restructured product and the targeted natural product should be as minimal as possible without sacrificing binding strength. In a trial run using 80-120 count frozen/thawed bay scallops from China (*Argopecten irradians, Chlamys farreri*) and varying the usage levels of both binders, formed scallops were made and compared to domestic sea scallops (*Placopecten magellanicus*). Fibrimex at 6% and TG-RM at 1.5% was observed to provide the closest match of formed scallop texture to that of the various sea scallop products tested, without compromising binding strength (Figure 3).

Figure 1. Texture changes in formed scallops with varying Fibrimex levels.

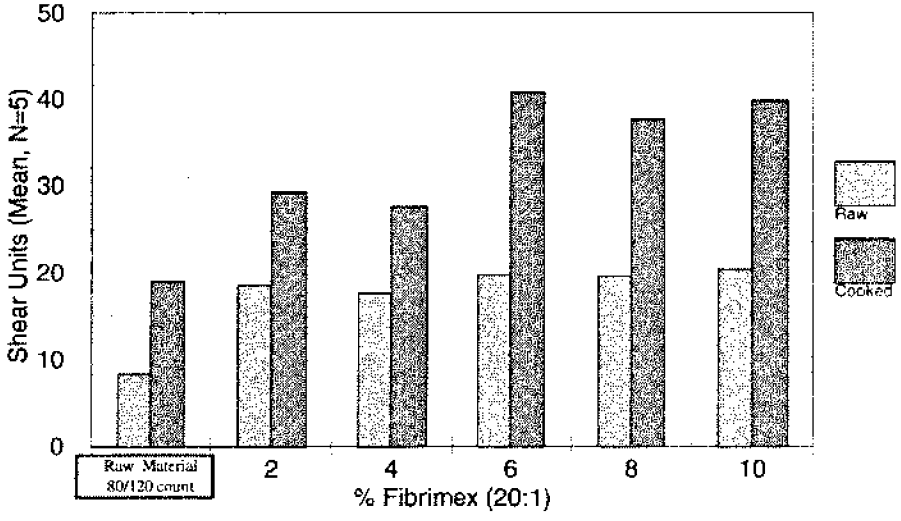


Figure 2. Texture changes in formed scallops with varying ACTIVA levels.

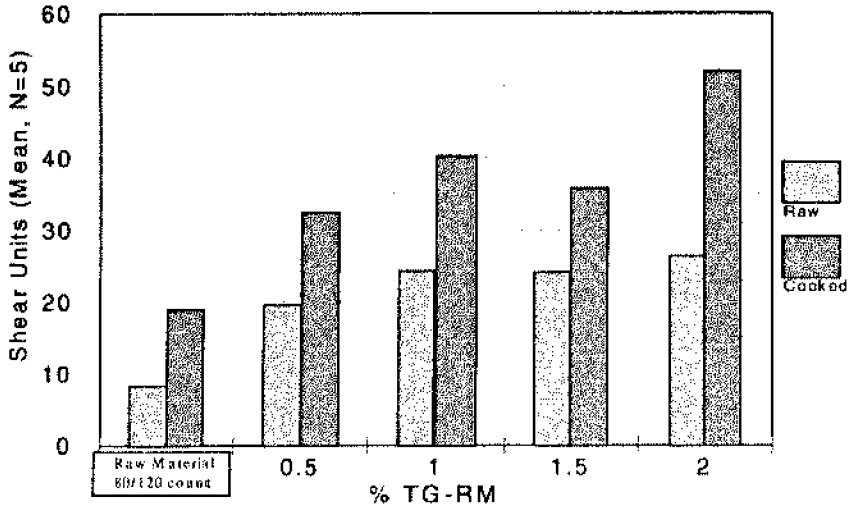
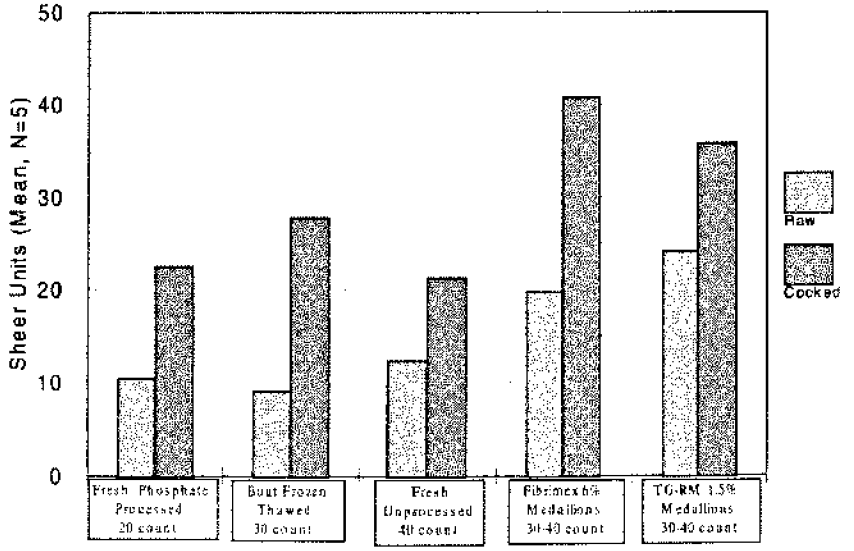


Figure 3. Texture comparison between formed and natural scallops.



As with all food quality characteristics, product consistency is important for both the processor and the end user. Since texture in formed products is vital, variations occurring in product texture should be considered during product formulation. The coefficient of variation (standard deviation/mean x 100) was calculated on formed scallops (N=5) using both binders (Figures 4,5). The amount of variation generally increased at both the low and high usage levels for both binders, indicating less product consistency when too much or too little binder is used. A difference between binders was observed when comparing the texture variation occurring upon cooking. Texture became more variable upon cooking with Fibrimex at all usage levels, while TG-RM provided less variability in cooked texture for all usage levels. When TG-RM was used, texture variation is observed between application methods (Figure 6). Since moisture is added to the system with the wet method, corresponding moisture content and drip loss is increased. The addition of moisture (water) results in less variation in raw product texture, but more variation in cook texture. One could theorize that moisture addition aids in TG distribution during forming, providing a more consistent scallop-binder interaction, while elevated moisture loss upon cooking provides for more variation in resulting texture.

Flexibility in usage levels without greatly impacting texture and other quality attributes can be achieved by altering the ratio of protein substrate to enzyme. Manipulating the ratio in Fibrimex is straightforward since the two components are distributed as a two-part process. ACTIVA products come pre-blended, thus limiting the user to acquiring specialized blends, or obtaining separate ingredients (proteins as sodium caseinate, soy or gelatin) and altering the amount of protein substrate. By altering the recommended fibrinogen to thrombin ratio of 20:1 in Fibrimex, total usage level for a given product was observed to remain the same without

Figure 4. Variation in texture (N=5) in formed scallops using Fibrimex.

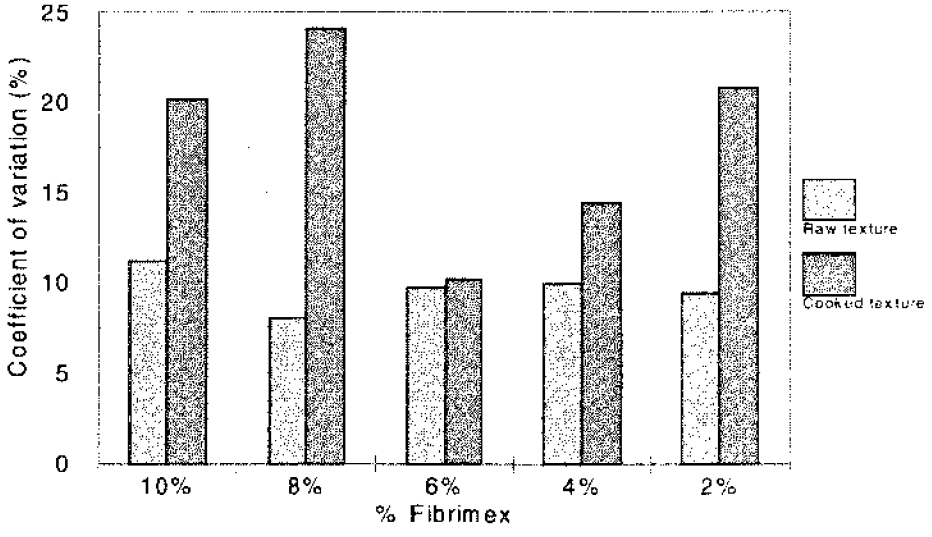


Figure 5. Variation in texture (N=5) in formed scallops using TG-RM.

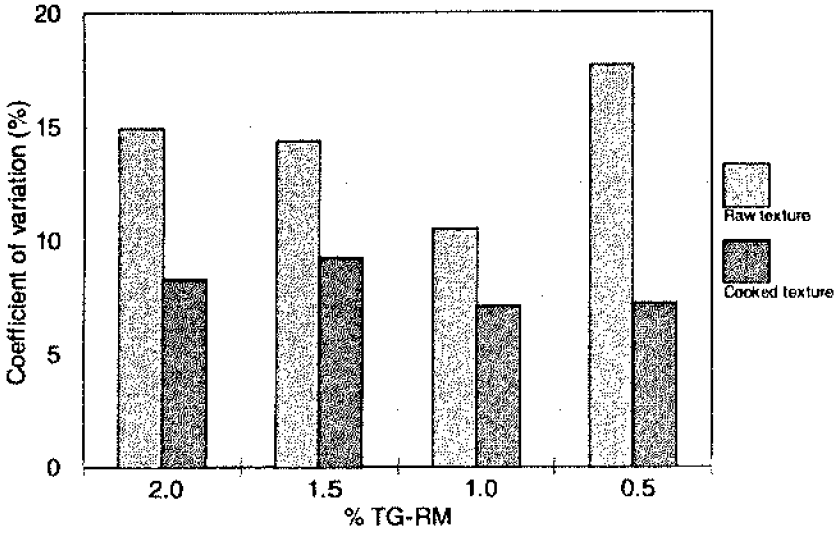
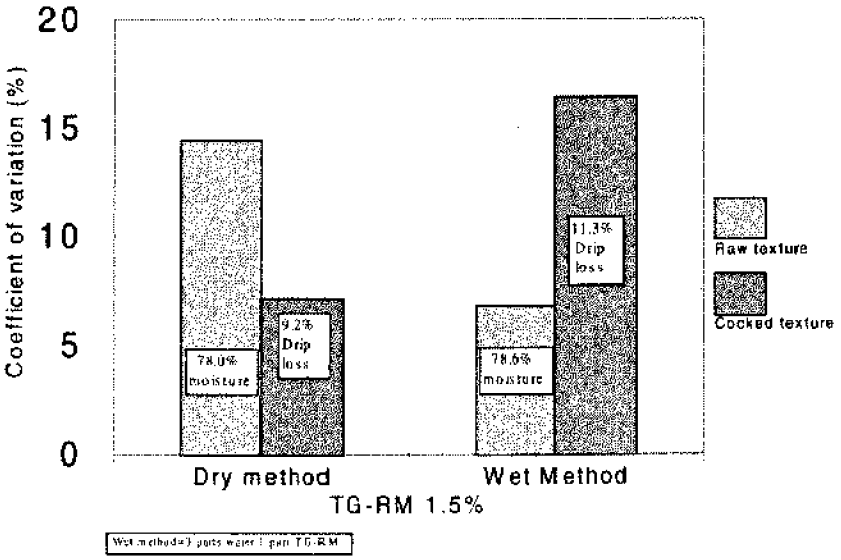


Figure 6. Variation observed in texture (N=5) of formed scallops.



effecting binding strength. Initial research in the development of scallop medallions used 60-80 count scallops. An optimal usage level of 4.5% was determined using a 20:1 Fibrimex ratio. Industry is progressively using smaller scallops of varying species. Typically, the smaller the scallops, the larger the surface area to be bound, the more binder needed. Therefore, substituting 120-150 count scallops for the 60-80 count scallops should dictate a higher usage level. However, by reducing the amount of fibrinogen to thrombin while maintaining the total usage level of 4.5%, functional binding was achieved with the smaller scallops without significantly effecting texture (Figure 7). Increasing the thrombin enzyme concentration also reduces setting time, which can be used to a processor's advantage.

Enzymes are inactivated with heat, and generally thought to be inactivated, or at least inhibited under freezing conditions. These binders rely on enzyme activity during refrigerated conditions for functional protein cross-linking. It was proposed to what extent this cross-linking would continue during refrigeration, and, most importantly, its effect on texture if held for extended periods required for shipping and handling. In comparing fresh formed scallops made by both enzyme activated binders to frozen-then-thawed domestic sea scallops, no increase in texture was evident through a 14 day refrigerated period (Figure 8). Fluctuations observed in shear units during this period were consistent to each test sample, implicating other factors, such as natural autolytic decomposition.

Moisture Retention

Successful binding depends largely on thorough coverage of the raw material with the binder. In products formed by stuffing into casings, raw material surfaces which are not bound to each other are also covered with

Figure 7. Formed scallops using 4.5% Fibrimex and 120/150 count scallops.

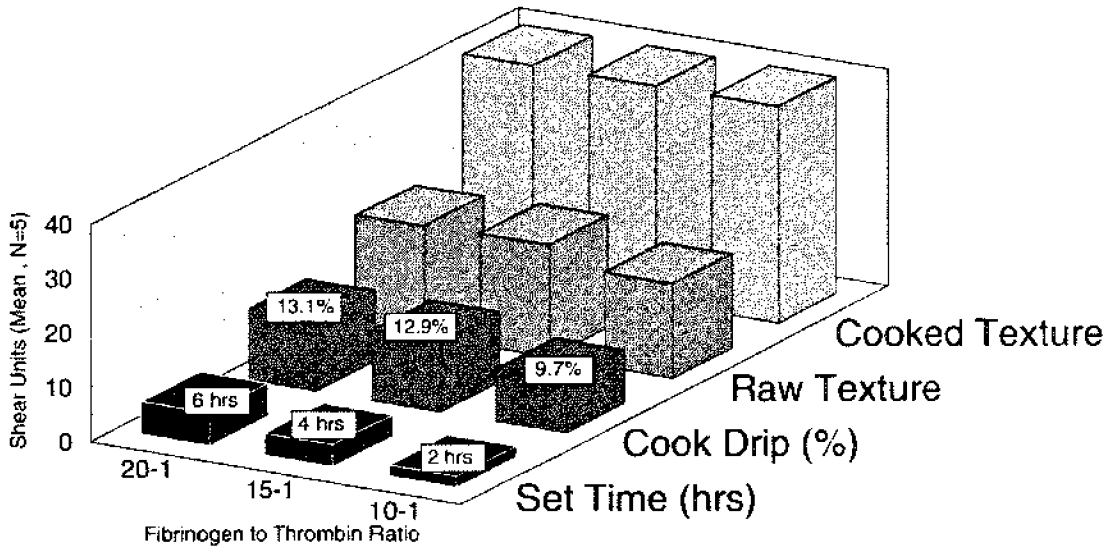
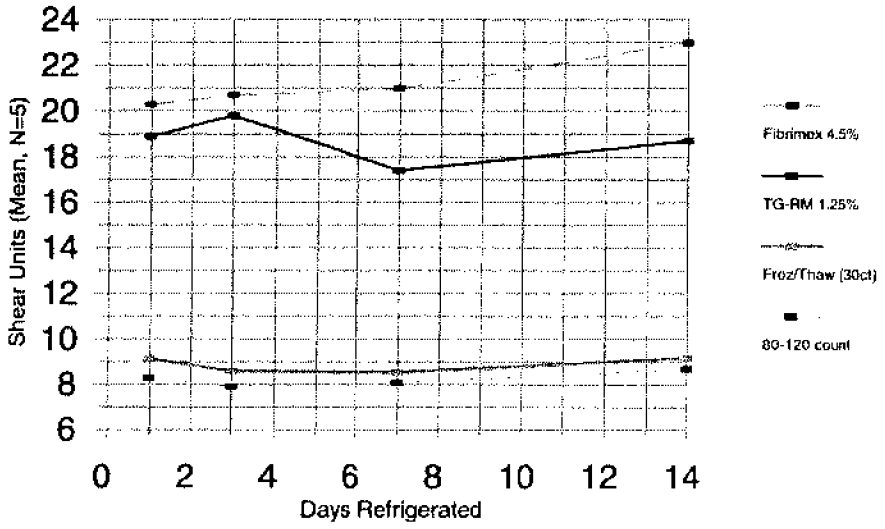


Figure 8. Texture Change over refrigerated shelf-life



the binding matrix. Once set, the binder provides a moisture barrier which serves to minimize drip during fresh refrigerated storage, and through the freeze/thaw cycle and cooking. The moisture retention capacity of Fibrimex and ACTIVA was observed in cooked formed scallops (Figures 9 and 10, respectively). The usage level of both binders affected moisture retention. It is of interest that Fibrimex introduces more moisture into the product (volume of fibrinogen solution) than ACTIVA, but maintains a better moisture retention capacity at all usage levels. The high moisture loss associated with ACTIVA at the 2% level may have been due to a lack of uniform coverage as a result of the binder caking (thick paste) when hydrated at 3:1 (water:ACTIVA).

Appearance

Differences in the overall appearance of restructured products using the enzyme binders are largely attributed to improper usage levels for a particular application. If too little binder is used, the raw material (especially whole muscle material as scallops and shrimp) will be weakly bound, resulting in a physical distortion of the formed product. This distortion is further accentuated with cooking. At low usage levels, the individual scallops partially separate from each other, resulting in the loss of the desired scallop shape. At the other extreme, using too much binder can cause the visual demarcation of the individual raw material pieces within the restructured product.

Depending upon the raw material used, product color may also be influenced by the type of binder used. The fibrinogen component of Fibrimex has a slight reddish-orange hue, an artifact of being derived from red blood. At usage levels recommended for sea food restructured products, this slight coloring may only be detected in white flesh products, such as scallops. When noticed, it is strictly in the raw state. Fibrimex becomes opaque upon cooking and blends in with the various shades of white typical of cooked

scallops. The whitish color of ACTIVA-RM is observed to be transferred to the restructured product, however, it is somewhat diminished at proper usage levels. It also blends in with the white shades of light fleshed product upon cooking. In formed scallops, ACTIVA may have a slight whitening effect when compared to those formed with Fibrimex; however, it may only be discernible in a side-by-side comparison.

Potential Limiting Factors

The use of cold-set binders with sea foods is not without potential processing and marketing limitations. A potential limitation is with formed fresh products using conventional continuous forming equipment. Many forming machines utilize a "knock-out" step to remove the product from the forming plate. The combination of a required period of refrigeration for protein binding and the inherent low fat content of sea foods (fat provides some product adhesion) means that the formed product will not stay together upon knock-out. Experimentation with specialized processing equipment, preparation of raw material, and the use of other ingredients with these binders will need to be explored to develop processes which deviate from the use of casings or stationary molds.

Limitations also exist with both of these binders when using "wet," or extensively processed raw material. These binders rely on protein-to-protein interaction. Excess water reduces protein-to-protein interaction, thereby interfering with binding. Raw material should be non-processed and sufficiently drained to maximize functional binding. Scallop medallions formed with phosphate processed bay scallops did not achieve adequate binding strength for slicing during the normal setting period. After an extended refrigeration period of 2-3 days, product would then hold up to slicing, though binding strength was obviously compromised.

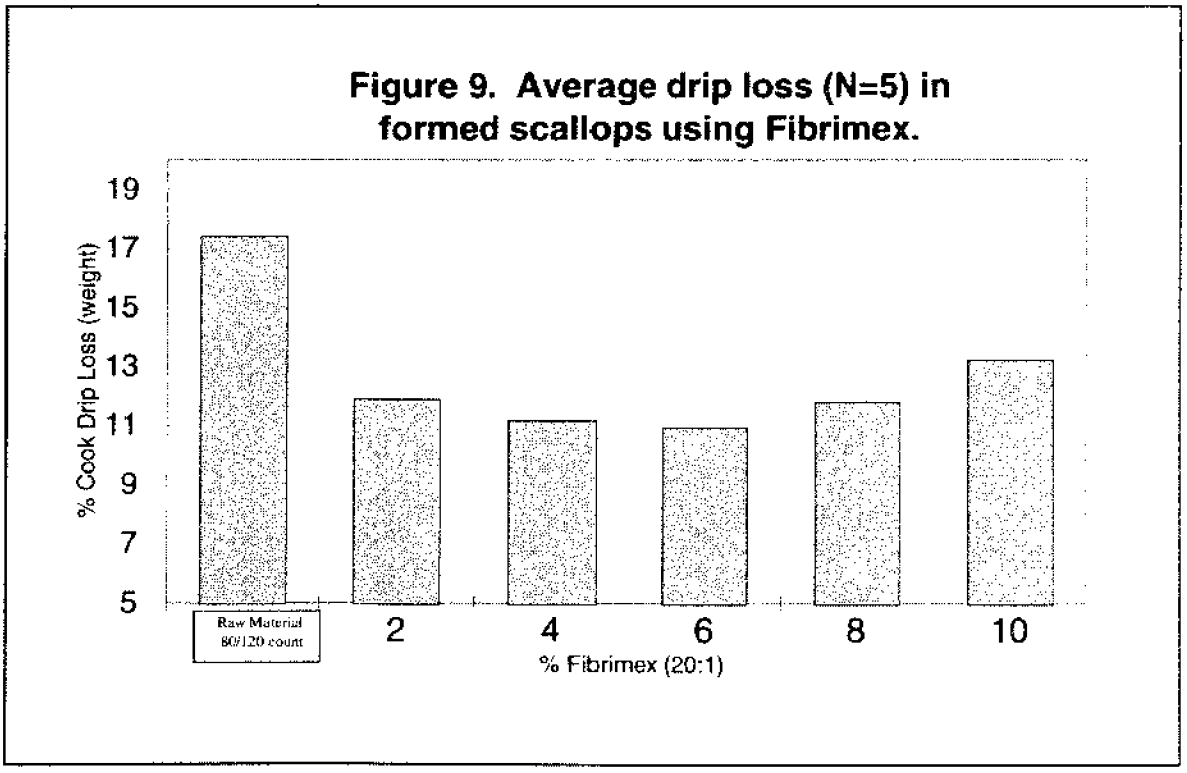
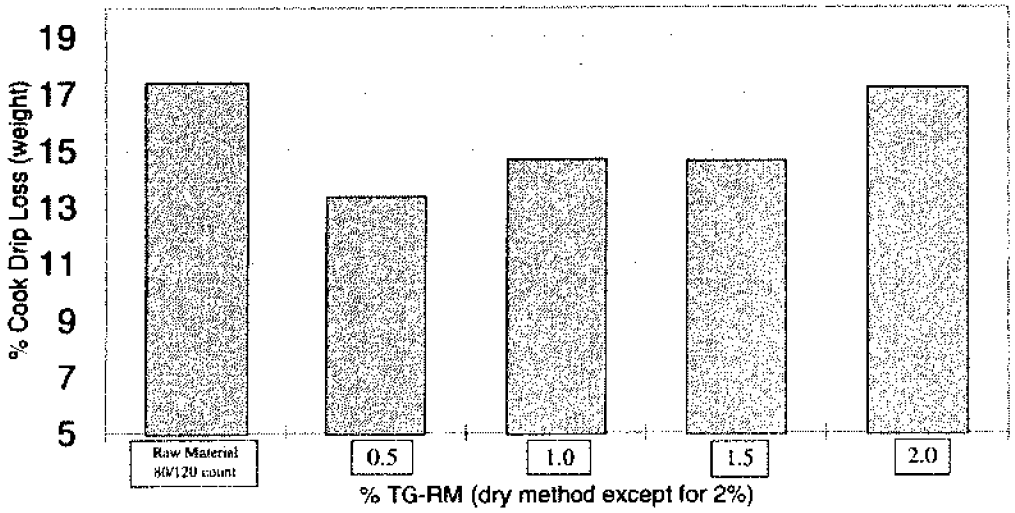


Figure 9. Average drip loss (N=5) in formed scallops using Fibrimex.

Figure 10. Average drip loss (N=5) in formed scallops using ACTIVA TG-RM.



The use of ACTIVA in the stuffing process may create problems in the filling and subsequent stripping of the plastic casings. Applying the binder by both dry and wet application methods (but more so with dry method) results in the product mixture acquiring a tacky consistency, which causes the mixture to adhere to the casings during stuffing. This creates a back pressure within the stuffer which could result in whole muscle breakage (smear), therefore altering the appearance of the finished product. Further, the raw material mixture using ACTIVA does not seem to contract within the casing, as does Fibrimex, which makes stripping of the casings difficult. Special casings with a lubricant on the inside surface has been used with some success in preventing these problems.

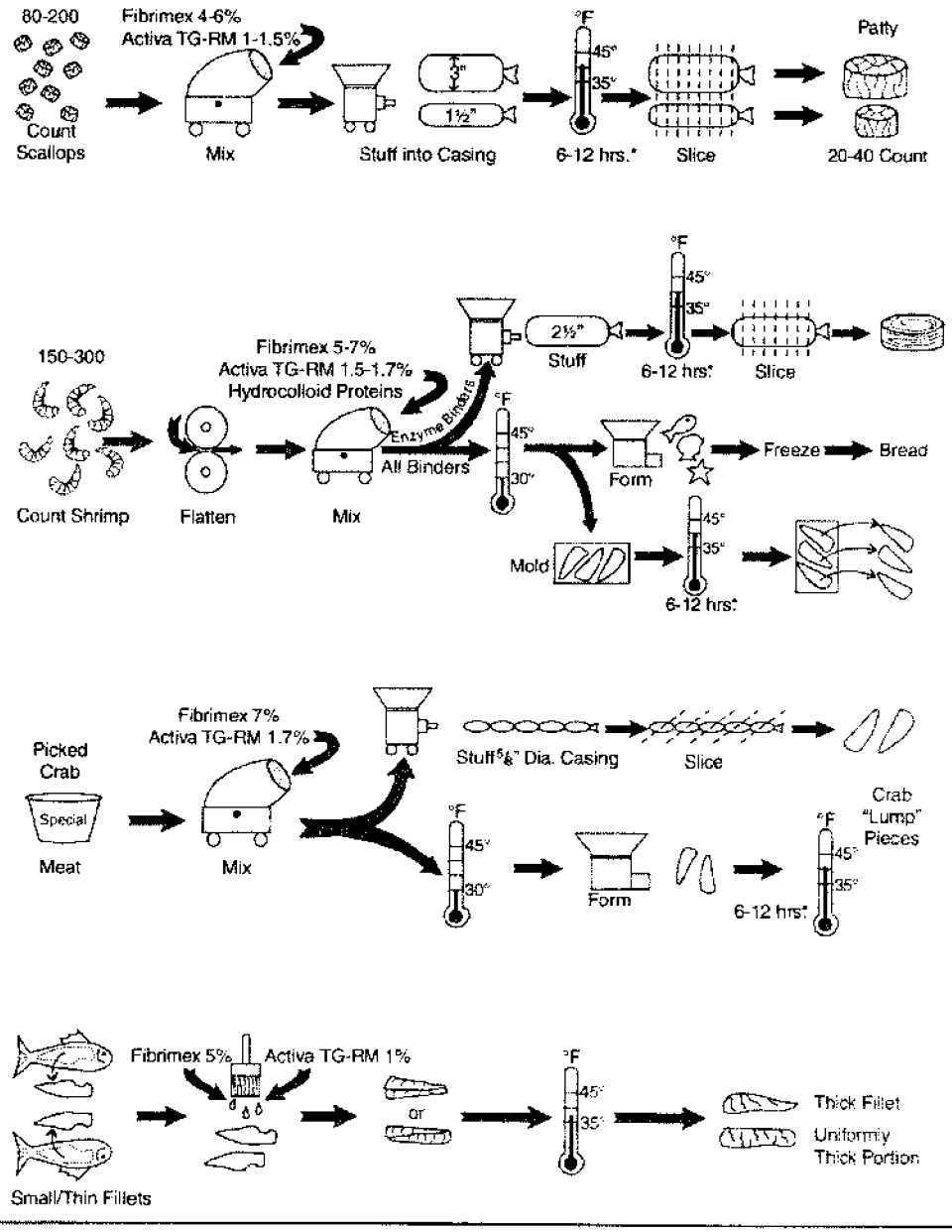
Marketing limitations may be related to the labeling declaration of a product which uses Fibrimex. Federal food labeling agencies are currently requiring that a statement such as "bound with beef plasma protein" be prominently displayed on the front label just after the product name in font size half that of the product name. Such an identifier must also be listed in the ingredients list. As far as marketing is concerned, identifying beef plasma within a seafood product may not be favorable. During market development efforts within the first year of scallop medallion production, many wholesalers and chain retail outlets based their decision not to carry medallions because of potential consumer rejection due to the beef plasma statement. However, as Fibrimex increases its distribution and use within the food service industry, its acceptance in seafood products should also increase.

Applications

Applications for cold-set binders in sea food product development are rapidly being realized. These binders work best when the raw material is confined within a rigid mold or casing under some degree of pressure during the refrigerated setting period. How-

ever, experimentation with other processing equipment together with manipulating processing parameters, should reveal other applications. Most restructured sea foods formed with these binders may also be used for further value-added processing without loss of product integrity. Examples of further processing includes marinading, smoking and breading. Incorporation of dry spices, or spice blends (with salts), for flavored products can be done at time of binding without interfering with the binding process. Some applications using the binders for seafood restructuring are illustrated in Figure 11.

Figure 11. Seafood product applications using cold-set binders.



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