MIRINZ
MEAT RESEARCH

No. 26

November 1994

BULLETIN

Cold-Set Binders

Cold-set binders are used to make raw, chilled restructured meats. This Bulletin gives MIRINZ' findings on the different types available in New Zealand.

Restructured meats are made by binding meat pieces together into products such as "logs" that can then be cut into "steaks". Thus, low-value cuts, which would normally end up as mince or sausages, can be upgraded into a variety of forms.

The way products are formulated allows consistent composition, shape and portion size, making them ideal for the catering and food service industries. As well, these attributes can be easily changed, by changing the way a restructured product is made, to meet different customer requirements.

The meat pieces are usually held (bound) together by forming gels that act like organic glues.

In "hot-set" binding the meat pieces are tumbled with salt and phosphate to extract muscle proteins, which set when heated. This works well, but:

- Products must be marketed either precooked or frozen.
- Salt can cause discoloration, and off flavours due to oxidative rancidity.
- Salt and phosphate are health concerns for some consumers.
- Precooked products can have a "warmed-over" flavour.

COLD-SET BINDING SYSTEMS

Recently, several systems that work at chill temperatures have been developed with the following advantages over hot-set binding:

- Products look more like whole-tissue chilled meats and can be used as an alternative to them.
- Products can be marketed raw (most consumers prefer to buy raw meat rather than frozen).
- Flavour and colour stability are better because the products are uncooked and little or no salt is used.
- Health-related consumer perceptions are better because no salt or phosphate is used.
- Products can be flavoured and cooked like fresh meat

Four commercial "cold-set" binding systems have been studied at MIRINZ over the past few years:

ALGINATE SYSTEMS

Alginate is a polysaccharide extracted from brown seaweed.

When calcium ions are added to a solution of alginate, its polymer chains align into a three-dimensional structure shaped like an egg box (see figure). The result is a heat-stable gel that binds meat pieces together.

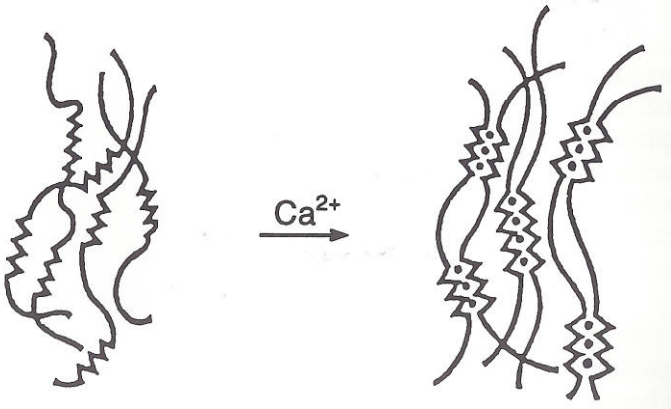
There are several alginate binding systems. These all use very small quantities of relatively inexpensive ingredients including an alginate salt and a calcium source. Most also use an acidulant to lower pH, and sometimes a sequestrant to slow gel formation.

How fast the gel forms depends on the availability of free calcium ions, which in turn depends on the solubility of the calcium salt used and the pH of the solution.

The most common calcium salts used for meat products are calcium carbonate and encapsulated calcium lactate (a powder with a palm oil coating). These compounds do not taste very nice, and so are used in minimum amounts.

Acidulants and sequestrants modify the reaction rate, and so control the gel setting time.

Acidulants lower the pH, making more calcium ions available to



Alginate binding system

react with the alginate. If calcium is released too rapidly, however, a poor-quality gel could be formed, and the gel may set too fast for other processing operations to occur.

Thus, using the right amount of acidulant is critical to achieving the desired product hardness and bind strength while still allowing enough time for product manufacture and forming. Common acidulants are glucono-delta-lactone and encapsulated lactic acid.

Sequestrants bind the calcium ions during mixing and act as a calcium carrier during gelation. In this way they control gel hydration and setting time. So using a sequestrant is one way to slow gel formation. Common sequestrants are pyrophosphates and trisodium citrate.

MIRINZ' findings
Our food technologists used alginate to make restructured steaks from both comminuted (coarse minced) and diced beef.

Steaks made with either form of meat had good bind strength and an acceptable taste. They were more juicy and tender than intact muscle steaks, and had higher cook yields.

Any water in the formulation was bound, so product yield increased.

Using the alginate system did not increase either initial microbial levels or the growth of spoilage bacteria on the restructured steaks during storage at 3°C or -1.5°C under vacuum or carbon dioxide.

Freezing and thawing weakened the bind strength of the restructured steaks a little, but the bind was still acceptable. Acid marination strengthened the bind.

PEARL MEAT BINDERS

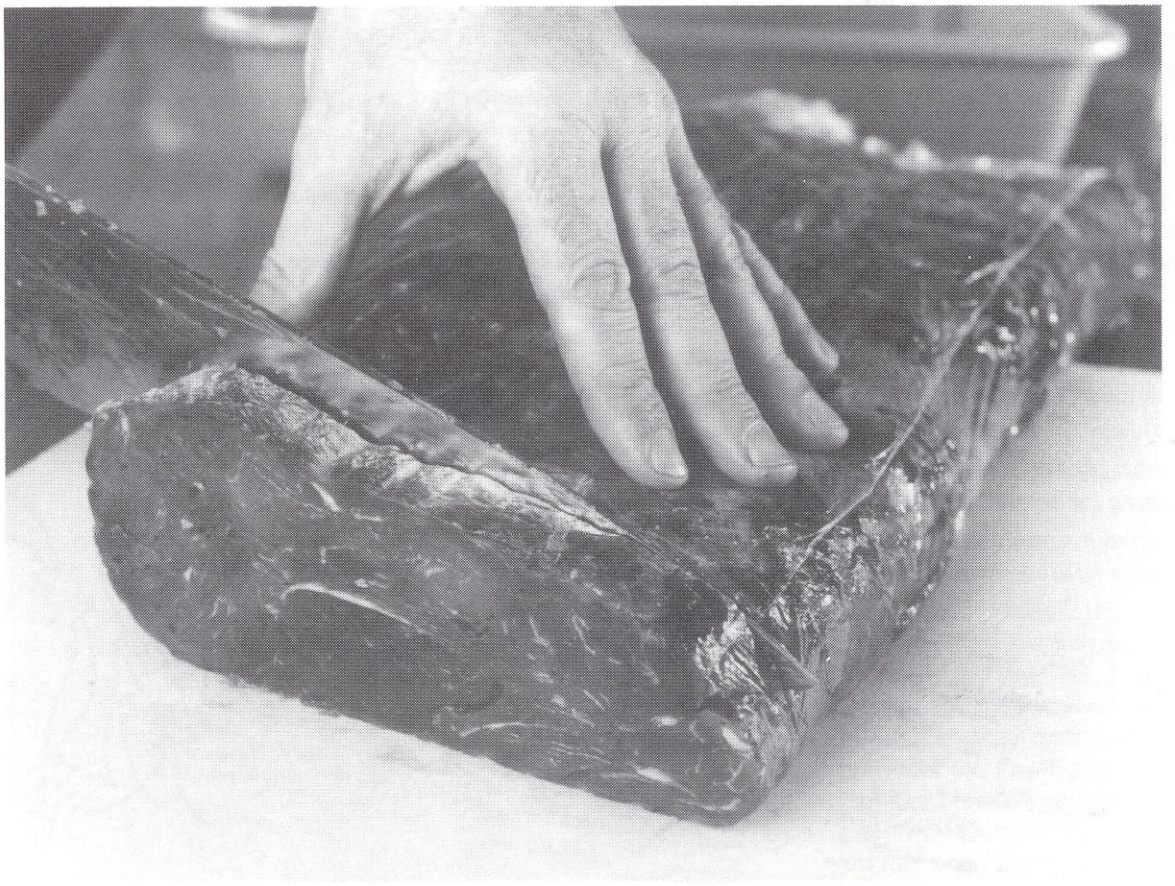
Pearl binders are fine white powders made from a mixture of carbohydrate, protein and bone ash. Their Japanese manufacturer has not as yet disclosed how binding is accomplished.

Two types of Pearl binder cam be used to make restructured meats—Pearl F and Pearl MX-30. Which type is used depends on the size of the meat pieces to be bound.

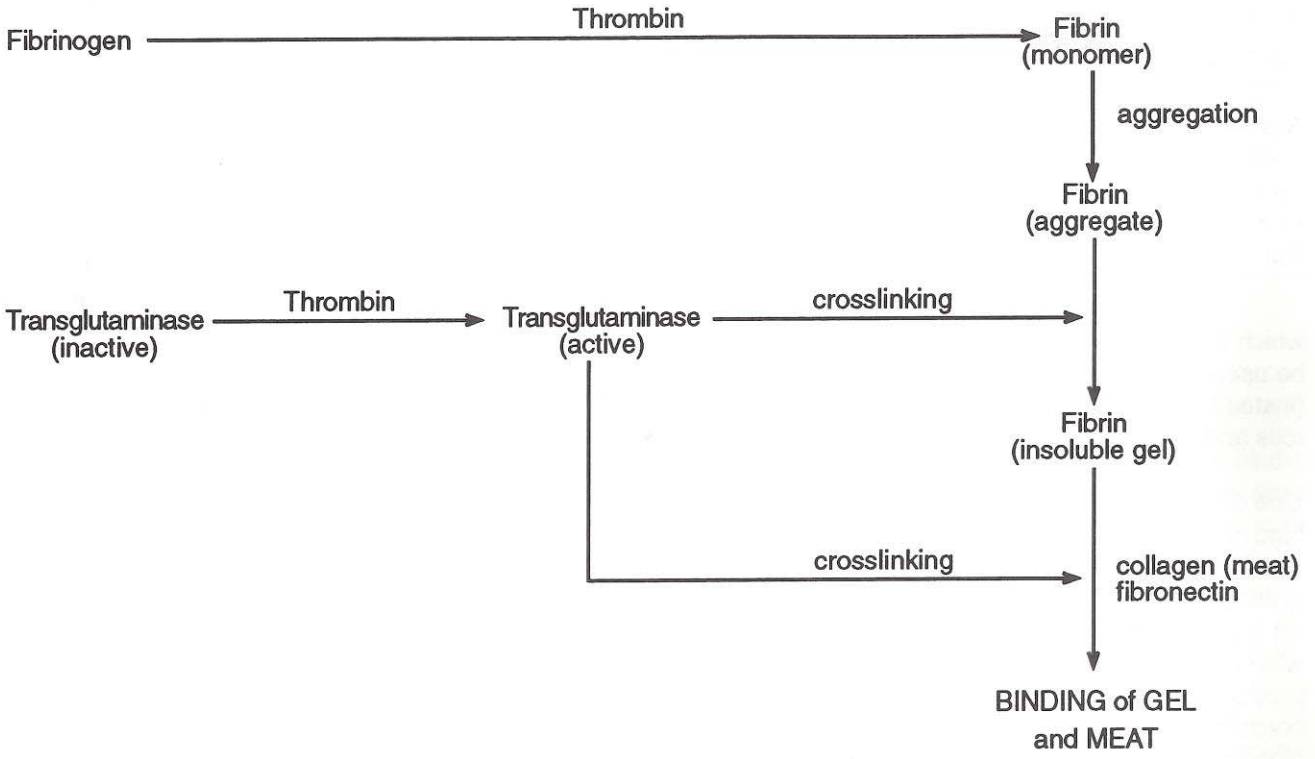
Pearl F is used for binding large meat pieces (e.g. seam-boned muscles). The pieces are coated in Pearl F by being pressed into it, and then they are held tightly together using moulds, casings, or plastic wrap. This application of pressure seems to be important for a successful outcome. The amount of powder used is about 1% to 2% of the meat weight, depending on the surface area.

Pearl MX-30 is used for binding smaller pieces of meat. The manufacturer recommends adding 2-4% MX-30 and 4-8% water.

MIRINZ' findings
Pearl F restructured steaks looked like intact muscle steak, bound strongly, and had an acceptable taste and aroma. The bind juncture looked like fine connective tissue. These steaks had better initial



Example of a cold-bound restructured test product made at MIRINZ



Fibrimex system: Binding of raw meat pieces by an enzymatically formed gel

colour that lasted longer than alginate-bound steaks made from comminuted meat.

The use of Pearl F had no adverse effects on the microbial quality or shelf life of the product, and the steaks held together well after acid marination, freezing and thawing.

Pearl F was also successfully used to bind different types of meat (e.g. beef and chicken) to form a roll, and to bind fish slices.

A disadvantage of using Pearl F is the labour involved in pressing each piece of meat into the powder. Also, operators must be careful not to inhale the powder.

Pearl MX-30 restructured steaks did not look natural when raw because the binder formed a visible edge around the meat pieces. Also, these steaks developed off-flavours.

FIBRIMEX

Fibrimex is a blood-based protein product that gels at low temperatures.

The Fibrimex system, which was developed in the Netherlands, uses the blood clotting reaction between fibrinogen, thrombin and transglutaminase to bind meat pieces together.

In the reaction, thrombin converts fibrinogen to fibrin and activates a stabilizing agent (the enzyme transglutaminase). This enzyme causes the fibrin to crosslink and gel, and it also encourages crosslinks forming between the fibrin, which helps to hold the meat pieces together.

Fibrimex comes in the form of separate fibrinogen and thrombin powders or frozen solutions.

Fibrimex can be used to bind low-collagen lean meat, but meat with a high collagen (connective tissue) content binds better.

With high-collagen meats, a fibrinogen/thrombin ratio of 20:1 is used . With low-collagen meats more thrombin is needed to create enough cross-links with the available collagen, and a ratio of 10:1 is used.

The weight of Fibrimex used ranges between 1% and 10% of the meat weight, depending on the size of the meat pieces.

The final gel strength depends on the fibrinogen concentration, but the rate of gel formation can be controlled by selecting a suitable concentration of thrombin — the more thrombin, the faster the rate.

MIRINZ' findings

Fibrimex performed better with diced meat pieces than with comminuted meat.

The products looked more natural than the alginate steaks but their bind strength, although acceptable, was weaker than that of alginate and Pearl F bound steaks. Some taste panellists detected a slight "liver" flavour in the steaks made from comminuted meat, perhaps because of the greater amount of binder needed for binding them.

Products made with Fibrimex did not stand up to acid marination, and bind strength decreased with freezing and thawing. However, bind strength increased on cooking,

Overview of the binding systems studied at MIRINZ and the most appropriate type of meat for each system.

Binding system (type of binder)	Works well with	Manufacturer
Alginate (polysaccharide)	Both comminuted and diced meat	Several
Pearl F (carbohydrate, protein, bone ash)	Large meat pieces	Chiba Flour Milling Co.
Pearl MX-30 (carbohydrate, protein, bone ash)	Smaller meat pieces	Chiba Flour Milling Co.
Fibrimex (blood protein)	Small meat pieces, small muscles	Harimex
Surimi (fish protein)	Both comminuted and diced meat	Several

which suggests that Fibrimex could be used as a hot-set binder (instead of salt and phosphate) in rolls and roasts.

One disadvantage of the Fibrimex binding system is its fast setting speed (10 to 15 minutes). Another is the fact that the label ingredient list would include the word "blood", which could give the restructured product a negative image to some consumers. (Note, however, that blood is classified as meat in some countries, so a Fibrimex-bound restructured product would be "100% meat".)

SURIMI

Surimi is another protein concentrate that forms a gel at low temperatures.

Surimi is white and low in fat, and consists of a protein product made by washing the flesh in water. If surimi is mixed with salt and left at a low temperature, the proteins form a gel.

Surimi is readily available, can be relatively inexpensive, depending on the amount and grade used, and can be stored frozen for long periods.

The benefit of using surimi/meat blends is that consumers perceive the products to be lower in fat, cholesterol, calories and cost than all-meat products.

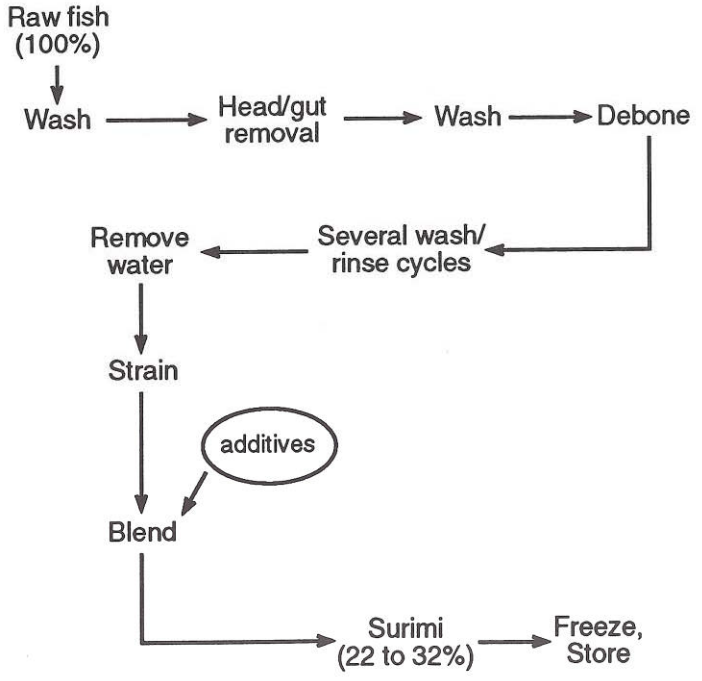
American studies indicate that surimi and red meat proteins combine to give a higher gel strength than can be achieved with either protein alone. In these studies, restructured steaks and roasts were made, and surimi levels in the products ranged from 1-5%, with higher levels showing giving higher bind strengths.

MIRINZ' findings

MIRINZ has done only preliminary studies on surimi and more work is needed before any recommendations can be made.

WHICH BINDER TO USE?

The binder that is best for your purpose will depend on the raw material characteristics, the desired product attributes, the market, and other factors. Contact the Processed Meats Section for advice.



Commercial process for manufacturing surimi

Production of this bulletin was funded by the New Zealand Meat Research and Development Council.

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