Surimi

Jan E. Novakofski, Glenn Froning
and Larry W. Hand, Coordinator

Jan E. Novakofski

If you look over the period of about 10 years or so, you see that there's a tremendous increase in consumption of surimi products. No other meat product, poultry or fish, is growing this fast. Surimi is basically an ingredient, not a product. Surimi is available in 50-lb. chunks, as a commercial commodity-type product. The process starts with fish, which is ground and then washed with water. What you do with this dough of washed fish tissue is make a whole variety of products by adding salt, phosphate, whatever other additives you need, including flavoring. This mixture can be handled just like a meat batter. It can be molded or flavored, extruded and cooked. It is slightly different than a hot dog batter primarily because there is no fat in it. The kinds of products you see in this country are typically artificial crab legs or artificial lobster tails. Where most people here eat this product is in casseroles in restaurants.

Given that the concept of taking fish and washing it with water is pretty straightforward, a lot of people thought we should be able to do this with red meat products, too. Most of our work has been done with beef and pork. We take ground beef, chop it in a silent cutter with a lot of water. Typically, we use about 5 volumes of water and about 3 washes to end up with surimi. At this point, what comes out of the centrifuge has been dewatered to the same water content as the original ground beef of a dry batter basis. Now, if you look in a microscope, you see muscle fibers, striations and pieces of muscle. In the washing process, the insoluble proteins, i.e. the myofibrillar proteins and connective tissue proteins, all stayed in the muscle as well as membrane-bound cholesterol and lipids, because you actually have intact muscle fragments. Water basically diffuses into the muscle and water-soluble proteins, like myoglobin, wash out. To make the washed muscle into something, you add salt and phosphate and mix it like a meat batter. So this dough is sticky, just like a hot dog batter. If you freeze this material for six months or so, proteins denature and it doesn't make a very good batter.

One of the questions that you might have is: Can you make the surimi white? The answer is no. This material is probably as white as we can get it and the reason is that the residual pigment left in this muscle are things like mitochondria and other pigments that aren't soluble. We can only wash out things that are water-soluble, such as myoglobin. So, if we start with something like white pork muscle, which doesn't have a lot of mitochondria, we can remove all the myoglobin and it is pretty white. If you start with something like beef, which probably has more mitochondria, you don't get it really white. If you start with something like heart, that in fact has huge amounts of mitochondrial pigments, it never gets white. Obviously, fish doesn't have those things to start with.

Another question that arises is that when you wash something with water, do you alter the nutritional properties? As I've already mentioned, you don't remove cholesterol. In fact, if you aren't careful, you can concentrate the cholesterol a little bit, because you removed 25% to 30% of the protein (all water-soluble protein) but you haven't removed any membrane. So if you express your cholesterol on a protein basis, you have the same amount of cholesterol, less protein, so the concentration is higher. Amino acid profiles, on the other hand, don't change very much.

Glenn Froning

We'll talk about some of the work that we've been doing on poultry surimi. We sometimes call it surimi-like processing, because the name "surimi" came from fish.

The washing process removes most of the heme pigment and a substantial portion of the fat. More importantly, the sarcoplasmic type proteins are removed and we concentrate the myofibrillar proteins, which have good functional properties and can be utilized to our advantage. The efficiency of pigment removal and yield are important. We are going to see that one of the minus factors that we have with this process is the 35% to 40% yield. Of course, you do end up with a product that has excellent functionality. Whether it is practical or cost-effective to use in an industrial application, that's another situation.

When you wash the product, you use considerable water which may have some environmental impact. Can we use the washing water and residue in other ways? Perhaps washing residue may be used for animal feed? The collagen residue may have certain desirable functional applications as a fat substitute. In our work with mechanically-deboned meat, chicken meat or turkey meat, we've looked at phosphate and sodium-bicarbonate buffers as the washing media. We have also been utilizing a screen which separates the collagen from the product. Since mechanically-deboned chicken meat or turkey meat may have considerable collagen, it is important to remove it for desirable functional attributes in the final surimi-like product. When collagen is separated with a 20 mesh screen, the final surimi-like product will have a greater con-

J.E. Novakofski, Univ. Illinois

G. Froning, Univ. Nebraska

L.W. Hand, Oklahoma State Univ.

Reciprocal Meat Conference Proceedings, Volume 46, 1993.

centration of myofibrillar proteins. We've found, looking at different aspects of washing, that we remove most of the heme pigments during the first washing and more in the second, with very little in the third. Now we use a 1 - 3 ratio, 1 part meat, 3 parts of buffer or water. Washing yield is improved at colder washing temperatures.

Meat yield improves, when using higher pH buffers with yields ranging from 35% to 45%. With washed mechanically-deboned poultry meats and using two different buffer systems, .5% sodium bicarbonate and 0.1 normal NaCl, you end up with more moisture in the product. When calculating protein on a dry weight basis, protein concentration is drastically improved by the washing process. Fourteen percent fat content in unwashed mechanically-deboned meat ends up with about .98% fat in the final surimi-like product. Washing of mechanically-deboned poultry meat greatly improves the textural and gelation properties of the resultant surimi-like product.

There might be some advantage for using cryoprotectants in washed poultry meat; particularly polyphosphate, which is already used in some fish surimi products. When freezing without cryoprotectant, there is some loss of desirable functional properties of washed mechanically-deboned poultry meat. We have been recently looking at surimi washing of chicken skin. Washing of chicken skin removes most of the fat and concentrates the skin collagen. Chicken skin is a glut on the market. So can we take chicken skin, wash it and come up with a product that has some market possibilities? After washing, we end up with a product which basically is collagen. Fat content of unwashed skin can run all the way from 20% up to 35%, depending on what part of the skin you are using. We can wash out about 85% of the fat out of this product.

Questions

Can we make it economical?

Well, it depends entirely on two things. The first thing is the cost of raw materials relative to the cost of the fish; and I don't think there is anyone in this room who believes that in the next couple of years meat is going to be cost competitive with a 40% yield. You have to recognize that even starting with lean muscle, your theoretical maximum yield is going to be somewhere in the neighborhood of 50%, because 50% of the proteins are washed out of it. So if you wash it more than once to make it white, you remove half of the proteins. The second item is the political one. The question quickly becomes: If we can make heart surimi economically at a cost that's competitive with fish products, what do you call it? Basically, the USDA position is there will be no label statement until there is a product that is ready for use. So, we go in circles. No one is going to spend the money to put material into a product until there is a label and USDA is going to resist labeling until there is a product.

How successful have you been in using this in processed meats?

We've made this into hot dog batters at 50% beef or pork surimi and there's no real detectable difference. We've made it into hot dog batters or bologna-type products and even 6 months of storage is not a problem. Much longer than that, the stuff denatures.

If you are going to make a hot dog batter with fish surimi added, do you have to really control the chopping temperatures?

Yes. Fish surimi is very temperature-sensitive. Beef or pork surimi is much more stable.

What kinds of yields did you end up with in your process?

Thirty-five to 40% is a good yield. It doesn't matter how hard you centrifuge it, there is only so much protein there; and the more connective tissue you remove, the lower the yield. I really think that's probably where the critical factor affective yield is. How much of the connective tissue do you want to strain out, because all the fat and water-soluble proteins are going to go away? Then it's just a question; Do you move collagen around? We've done some things with the size of the screen that removes connective tissue, and yield goes down as you decrease the screen size, 40% heads down towards 20% with small mesh screens.

How dependent is, if at all, the source of fish and storage condition on flavor?

The surimi itself doesn't taste like fish, it tastes like potato starch, it's really pretty bland. At 50%, it tastes like very bland meat, so if you make a hot dog with 50% surimi, it is bland, because you've diluted your meat flavor by half.

You'd have thought that there's a greater possibility of rancidity development in a surimi process developing from chicken, now I guess I'm wondering "why?"

There are two things to consider; you've removed all the fat, but you haven't removed any membranes at all, and all the membranes are high in polyunsaturated fats, so the fraction of the lipid that remains, even the 1/2% that is there, is very susceptible to oxidation. Secondly, you've removed all the water-soluble antioxidants. Everything is gone, including all enzyme systems that function as antioxidants in intact muscle. There are also pro-oxidants in chicken bone. You probably concentrate some of the phosolipids, which makes it worse. Whatever fat is left, therefore, is going to be more susceptible.

So, has any of this been used in the industry and if so, do we have any idea of cost?

No red meat surimi products or poultry surimi products have been used in the industry in this country. These things have been used in test markets in Asian markets. The cost depends upon yield. Your theoretical maximum yield in this process, discounting collagen, is about 50%, because only about half the proteins and muscle are insoluble, and if you have any kind of fat content in your product, that's decreasing the yield too. So, you have to start with something cheap, like beef hearts, which unfortunately aren't very white when you're done. So you can't use them in traditional surimi-type products. If you are going to use it in a hot dog, beef heart cost you $ .20/lb, why would you use beef heart surimi, which costs $ .50/lb, to put it back into a hot dog that's worth $ .30/lb? But cost isn't the only issue. One of the advantages of using this material is that it's incredibly functional. So you might use it to improve a product.

Are there companies making this and exporting it?

Not that I'm aware of. The technology to make this stuff is off the shelf, every piece of equipment that needs to run has USDA approval. Nutritional composition is available, but no one is doing it in this country.

Are the fish products labeled surimi?

The fish products are labeled as to the fish of origin so that those crab sticks are called "white fish" on the ingredient label. However, if you don't put a cryoprotectant in the fish surimi product when the commodity is frozen, it becomes entirely unfunctional. But at the level they are used, at 5% or 10% sorbitol, the stuff has a sweet taste. The cryoprotectant, such as sorbitol, is on the label.

Have the Japanese done anything with the wash water?

I don't know if they have done anything with it or not. I think there are some real opportunities there to use it for animal feed or whatever, or maybe the fat could be utilized some way as in a food ingredient.