Restructuring beef, pork and lamb into portion controlled meat products offers a large new area for merchandising meat. If through restructuring, pork could capture a greater portion of the institutional market, pork consumption could be increased. Check a restaurant menu and see how seldom pork appears. Pork has not captured the same stature as beef in the institutional market. This is important as the institutional market accounts for approximately 40% of the meals eaten daily. Cafeterias, hospitals, airlines, fast food outlets and restaurants want meat products uniform in both size and quality. Explanations offered for the poor showing of pork in these food operations have been: (1) religious and medical reasons; (2) prestige and stature; (3) lack of uniform portion control; (4) lack of uniform quality to include juiciness, tenderness and flavor; and (5) proper preservation to preserve quality. The last three items on the list offer opportunities for the meat scientist to make suitable refinements.

Research has been under way in our laboratory for over three years to develop restructured pork products. This research has been funded by the National Pork Producers Council through their nickel for profit check-off program, the University of Nebraska Agriculture Experiment Station and equipment grants from Bettcher Industries of Vermilion, Ohio, and Urschel Laboratories of Valparaiso, Indiana. The results of this combined team effort are discussed in this paper.

Restructured fresh pork products, as well as cured and smoked pork products, have been developed (plates 1 and 2). The total concept involves the intact pork muscles. Boneless pork loins and other lean masses such as boneless hams can be used in this phase, as shown in figure 1. These cuts are removed from the carcass, boned and trimmed of excess fat, frozen, tempered to 24 to 26°F, pressed into uniform "logs" and cut on a power cleaver into uniform portion controlled fresh pork products from intact muscles (Goldner et al., 1974). Also shown in figure 1 are the other pork cuts, such as bacon, spare ribs and neck bones which are removed and processed in a conventional manner. Shown in a shaded color in figure 1, is the flow diagram for the fresh pork products to be flaked-formed-sectioned.

Plate 1  FFS Cured and Smoked Ham

Plate 2  Pork Chops and FFS Pork
RESTRICTURED PORK PROCESSING - FLOW DIAGRAM

FIGURE 1
A wide array of meat ingredients have potential use in restructured meat products. Pork trimmings can be used based on their visual or chemical composition. Blending of more than one type of trimmings is possible. Pork shoulders could be boned and used as a sole source of meat for the products. By-products from the slaughter and breaking operations offer considerable potential for use in restructured pork products where final costs can be reduced by their inclusion.

The research has shown that the use of two different temperatures of meat ingredients offers certain advantages over a single temperature. The 36°F tempered meats are excellent for the emulsion component of the flaked-formed-sectioned product. This temperature would usually be used for the fat source component and would be used with the finer flake sizes. The colder tempered meat, 24°F, is used for the leaner meat components as well as the coarser flake sizes. By combining the two temperatures, different fat levels and flake sizes, texture, fat visibility, color and overall appearance can be changed and controlled.

Following flaking through the Comitrol high speed cutter (Urschel Laboratories, plate 3) the meat ingredients are mixed. Additives such as water, salt, sugar, phosphates, cure, soy and flavorings can be added at this time. Mixing time is very important and is currently receiving considerable attention in our laboratory.

After mixing, the products are removed and retempered at 22 to 24°F before pressing. Retempering is necessary to have the proper temperature for pressing and forming. Salt content will dictate the temperature needed. Pressing (plate 5) is done in a hydraulic press (Bettcher Industries) at pressures between 250 and 400 psi. A variety of shapes can be used as long as sharp, narrow points are avoided. Several diameters of any one shape can be used so thickness can remain constant while portion weight can be varied.

Immediately following pressing, the "logs" of pressed meat are placed in the Power Cleaver (plate 6--Bettcher Industries) and cut to portion controlled weights. The upright hoppers hold the "logs" of meat and rotate into a circular knife. The conveyor carries the meat away from the cutting edge for packaging. Fresh restructured pork products will be distributed in a frozen state for cooking in a partially defrosted state.

Temperature and Blending

The temperature of the trimmings and meat ingredients as they are flaked are extremely important with respect to the texture and appearance of the finished products. Cold flakes (24°F) are important in providing the "bite" or texture of the finished product. One of the original criteria placed on this process is that the cooked finished products should have textures and consistencies as near to the intact muscle products as possible. The system has no particular appeal if the finished products have the texture and eating qualities of ground meat.
Plate 5  Press

Plate 6  Cleaver
Blending ingredients of different fat contents permits control of the visibility of fat and lean. When the fat component is flaked through fine flaking heads, the fat content is not readily discernable in the finished product. Conversely, should the marbled effect be desired, fat flaked through coarser heads at colder temperatures (24°F vs 36°F) will accomplish this objective. Additionally, the lean component can be flaked through coarser heads and will increase the mouth feel or texture of the product. Plate 7 illustrates the visual differences between products made with 100% of the meat component flaked at 25°F and at 35°F. Plate 8 illustrates the response to blends of 25°F and 36°F meat components. Plates 9 and 11 show two of the fresh pork products made using the restructured pork concept. The Pork Broil is a 6 ounce pork chop shape product suitable for broiling or grilling. The Fresh Pork Roast is a variation made in foil pans and weighs 2 pounds. This is an oven roasted product.

Cured and Smoked Restructured Pork Products

The cured and smoked variation of flaked-formed-sectioned pork is shown in figure 2. At the point in the flow diagram during mixing, the necessary curing ingredients are added. Following mixing, the meat is stuffed into fibrous casings and cooked and smoked using a typical processing cycle. After cooling, these products can be sliced and used as Breakfast Bacon (plate 10) similar to Canadian Style bacon, Pizza Dollars, Boneless Buffet Style Hams or thin sliced for the ham and cheese sandwich (plate 12).

Current Research

Several studies are in progress which will answer specific questions on several phases of the total program.

1. Shelf life study on cured and smoked pork products--stability and panel evaluations.
2. Mixing time studies--to determine the impact of mixing time on physical and chemical measurements.
3. Shelf life and stability study on fresh products--evaluation of a long term frozen shelf life study.
4. Cooking performance--wide array of cooking devices and conditions will be evaluated with respect to performance of the product.
5. Mechanical tenderization and portion control of boneless fresh pork loins.
RESTRUCTURED PORK PROCESSING - FLOW DIAGRAM

FIGURE 2
Plate 7 Comparison 25° vs 35° F

Plate 8 Comparison of Blends
Plate 9  Pork Broil

Plate 10  FFS Canadian Style Bacon
Plate 11  Fresh Pork Roast

Plate 12  Shaved Ham and Cheese
Summary

1. Flaking temperature of 22°F is more desirable than 36°F based on product performance and chemical analysis (Popenhagen and Mandigo, 1974).

2. Blends of flake size and temperatures are more desirable than single sizes or temperatures (Chesney and Mandigo, 1974; Popenhagen and Mandigo, 1974).

3. Medium size flakes are preferred over very fine or coarse in non-blended samples (Chesney and Mandigo, 1974).

4. Panelists prefer flaked over ground pork products (Chesney and Mandigo, 1974).

5. Panelists prefer salted formulations (Mandigo et al., 1972).

6. Flaked products have greater water-holding capacity and cohesiveness (Chesney and Mandigo, 1974).

7. No effect of flaking on proximate analysis (Mandigo et al., 1972; Chesney and Mandigo, 1974; Popenhagen and Mandigo, 1974).

8. Flaking temperature effects water-holding capacity and emulsion stability (Hansen and Mandigo, 1972; Chesney and Mandigo, 1974).

9. Mixing time effects water-holding capacity and emulsion stability (Belohlavy and Mandigo, 1974).

10. Increasing salt and triply phosphate increases texture and appearance of cured products (Neer and Mandigo, 1974).

11. A wide array of fresh and cured products can be produced.

BIBLIOGRAPHY


H. F. Bernholdt: Will all the speakers come forward. Do we have any questions for any of these gentlemen?

Dale Huffman: A question for Mr. Peoples. Are you troubled by yellow fat covering?

J. Peoples: No, not really; not lately. If you mean, do my customers accept it--no, they don't. They don't like it. It is not acceptable to them, I'll put it that way. It is not desirable, but I am not currently plagued with it and I don't think we have had as much trouble in this area with yellow fat as we have had in years past.

Question: I have a question for Max Judge. Have you done any work on acceptable levels of these soy products through taste panels, and so forth?

M. D. Judge: No, we use the levels that the manufacturer recommended on these products and we haven't gotten into the question of flavor which you may be thinking of particularly, and I have a feeling that that could be a problem--maybe at the high level we were working at here. We have no data to talk about.

Question: I have a question for Roger. Do you have any advice on the binding properties of these various flaked products and, if so, what standpoint are you looking at for texture--is it cohesiveness or bite, amount of fat percentage?

R. Mandigo: To get at the texture problem we called it cohesiveness, I don't know if it is the right word or not--but the overriding criteria for all of the products that we have made--particularly the fresh ones--we don't want you to put a fork on it and crumble it or break it like you would a pork sausage patty for breakfast. We are after a product that you have to put a knife on and have to cut and when you get through cutting it, we want it to look like intact muscle. As far as the binding properties go, that is a real can of worms. The slightest variation in formulation can change binding properties of these products considerably. We are getting to the point now where every time we try and make a particular product it comes out essentially the same. At one point in time you got something different every time--mixing time, mixing temperature, level of salt, all of the various additives are going to affect this bind very much. We are working, I shouldn't say it that way, we are in the process of setting up a study to go into the soy products and look at those things, with that in mind also. I'm not sure I answered your question really though.

Question: You kept using the word emulsion in your slides, is it an emulsion?

Roger Mandigo: We have one fraction that is definitely an emulsion. There is no way around it, and this is the fraction that makes part of the texture come out the way it really is.
G. H. Wellington: Max, your slides appear to be printed and I was wondering if this material is available or do we have to wait for them to come out in the appropriate journal?

M. D. Judge: It is published in the Journal of Food Science in 1974.

Question: Max, you indicate in your slide that you got a decrease in shrinkage when you added soy flour. Did you determine whether it was due to decreased loss of moisture or decreased loss of weight in the soy product compared to the all-meat product?

M. D. Judge: No, we didn't look at that and afterward we wished we had--but we had no reason to say that we could see any difference in thickness or in the apparent change in the weight.

Question: Were the products containing soy flour dryer?

M. D. Judge: I would say there was a textural difference and yet I don't think you could characterize it as dryer--in fact, some of the panelists—not panelists—some of the workers felt that they seemed a little more juicy, and I think they were, because of the bind that the flour gave us. We did not do taste panel work on these, so I can't be very definite on that.

D. H. Kropf: I have a question for Roger Mandigo. You indicate 22°F. was best for flaking. Under commercial conditions you may not get 22°F. If there is a critical temperature above which you get lousy results?

R. W. Mandigo: We get a lot of lousy results. No, seriously, we say 22 or we say 24—we use most of that range. The real problem you get is as you get up into the 25-26°F range, you start getting a lot of smearing, call it smearing in the flakes. Again, one part of the fraction, we want this to happen. The other side of the thing is that you get down to around 21°F and instead of flaking, you get explosions. Think of it as like snow. This particular flaking machine—one way you clean it—in fact one recommended way to clean it is to put ice in it. And it just makes snow cones like crazy and just a real high fluffy flake. So you can make lean trimming explode and to answer your question I think you were saying 22-24-25°F in the way of a range.

D. H. Kropf: You also indicate medium size flake. What size would they be?

R. W. Mandigo: Well, the problem we have with it is that the nomenclature of the machinery is all in thousandths. That head that you saw there is a .005 thousandths head. They run in the ones we have—we have all the way from .030 thousands up to 1600 and some odd thousandths. When you try and convert these over to some other system—you don't get the same measurements. Put it in millimeters. Help me. They don't want to help me today. Okay. You are going to let me die on my own up here.
Question: Do you use just one head?

**R. W. Mandigo:** Do you use just one head? I want you to use a relatively coarse head for the frozen meat, the colder meat. And I want you to use a very fine head for the fatter meat, because that is what I want, I want to hide the fat and I want to make the emulsion come out of that part too.

**Question:** Roger, on that product where you add 3/4% salt, how does this affect shelf life stability of that product as compared to normal fresh product?

**R. W. Mandigo:** Of course its bound to reduce shelf life. No alternatives. Now the fresh products that we are working with which is where the 3/4 of 1% is at, they are vacuum packed and they, well we don't know how long they are going to hold up. We have some indications in some of the products that we have 8 months to a year already in them. There was some problems at the outset with color, but some technology changes, and I'm not even sure I can identify a couple of the technology changes that we must have done plus vacuum changes has removed that problem essentially. We upped the pressure on the press—we changed the mixing time around and we got rid of metmyoglobin we were looking at in some of the earlier products. We have a cured study we are looking at right now, frozen cured products, they are in their 16th week and many of the formulations are being evaluated by the taste panel just as good as they were the first time. Some of them, of course, have deteriorated. We have some fresh products now that have been laying around the freezer for over a year; some of them are good and some of them aren't. So I think we have no great problem of shelf life with these products. You get to packing them a lot sloppier and you are going to cut shelf life down quickly.

**H. F. Bernholdt:** Apparently, there is a lot of interest in the Comitrol and the reason we are getting these terms is in thousandths of inches is that Joe Urschel is an engineer basically, and I would comment that if you are interested in the equipment, contact Joe Urschel. It is a fine piece of equipment. We use it not only in meat products but also in peanut butter manufacture. It is quite a versatile piece of equipment.

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R. J. Epley: The Educational Services Committee was charged with a triplicate role, not necessarily limited to extension education, but also one that could cover, if we so desired, resident instruction as well as other programs. I would like to thank the members of my committee for their excellent cooperation and suggestions as to program content: Jim Acton, Clemson University; John Grossbeck, The State University of New York; Ken Johnson, the National Livestock and Meat Board; Quin Kolb, University of Wisconsin; Don Kropf, Kansas State University; Rod Plimpton, The Ohio State University; Bob Reddish, University of Florida; Bob Rogers, Mississippi State University; and Bill Stringer, University of Missouri.

As I am sure most of you are aware, Educational Service is a very, very broad topic and we did have many, many topics suggested for coverage at this session. We had well over 120 topics, every one of them very important, so it was a very difficult task for the Committee to decide exactly what we would like to present. We would, of course, have liked to have more time to go into more areas. Nonetheless, we have two excellent speakers that will cover the two topics indicated in your programs.

First with us is Dr. Billy Powell from Auburn University. Dr. Powell received his B.S. from Auburn University and his Ph.D. from Auburn, and Billy is in charge of all Food Science Extension work at Auburn University. The title of his presentation is "Successful, Industrial Education Objectives and Methods."