LARD RENDERING BY THE AMERICAN MEAT PACKER

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In general terms, we are all quite familiar with the process of lard rendering. As with many familiar things, we may not be able to quickly give a good, concise definition. I went to the font of all official definitions:

The Webster International Dictionary gives seventeen different definitions for the word "render". One fits quite well: "To melt down; to extract or clarify by melting; to treat so as to extract the fat." In order to adapt this general definition to the specific process of rendering lard, I propose the following as a working definition for this presentation. "To treat edible, raw pork fatty tissue so as to extract the fat." I will have an addition to this definition to suggest a little later.

Why is Rendering Conducted?

The rendering of animal fat is certainly as old as the meat packing industry. Soon after man discovered the use of fire in the treatment of meat from the hunt, he probably made use of the fat rendered out for preparing other foods. There is the key. When the oil is separated from the fatty tissue it has many additional uses. Also, it will keep, comparatively, much better than the raw fat.

The rendered fats are so broadly useful that it would be very difficult to catalog more than a few of the everyday uses. Consider household frying, commercial and home baking, confection making and deep fat cooking.

Why all the Fuss about Rendering at this Time?

Industrial users of lard found that they could use vegetable oil shortenings to better advantage than lard. Housewives all but forgot how to use lard. The domestic market diminished to bread bakers and only a portion of the pie bakers. Lard was defeated in the market place.

The young, imaginative vegetable oil industry introduced caustic refining, hydrogenation and deodorization. They kept up continuous research and marketing programs.

The older, ponderous, meat packing industry, with many problems other than lard, did not change to meet the new competition rapidly enough.

We managed to get involved in wars often enough to empty out the lard warehouses occasionally. These spurts of demand by munition makers came just often enough to allow meat packers to remain in their lazy, lackadaisical frame of mind.

Finally, after World War II and more definitely after the Korean Conflict, a number of packers evidently decided that they should no longer depend upon wartime demand to clean up the supplies of fats in warehouses. Machinery makers took the initiative to investigate improved methods. Research was at last applied to making lard good enough to compete effectively with the vegetable oil shortenings which only a few years ago were classed as "lard substitutes".

The Principle Methods of Rendering Lard.

The preponderance of lard rendered in American meat packing plants is by one of three principle methods: 1. Prime steam rendering, 2. Open kettle rendering, and 3. Dry rendering. Of these, prime steam rendering accounts for well over half the total volume.

All rendering methods have the one objective of liberating the lard from the cells of the animal fatty tissue. These cells are all closed like a capsule and the oil is inside. The proteinacious cell walls must be broken by heat, chemical or mechanical means. Once the cells are opened, very mild warming to only 110° F. or so will melt the oil and make it free flowing. Basically that is all there is to the rendering process.

Prime Steam Rendering. I have a model here of the basic equipment of a prime steam rendering plant. (Show saucepan) Prime steam rendering is primarily a boiling process in which moist heat is used to denature the protein of the fatty tissue cell walls. Thus weakened, the cell walls break and the lard separates. Part of the protein dissolves in the water and part remains as a rather gelatinous solid. When subsequently dried, the proteinacious solids are known as tankage.

Consider the saucepan expanded in size to accommodate ten to thirty thousand pounds of raw fat and you have the prime steam tank as it is used in a packing house. The heat is supplied by the direct injection of live steam. From this the process gets its name, prime steam rendering.

Most typically a closed tank is used and the operation is conducted under steam pressure so this might be a better model (Show pressure saucepan).

In operation some water is put into the tank. Fat from the hog dressing floor or from the pork cutting department are charged into the tank from the top. Usually the whole chunks are put in without any grinding. When the tank is loaded a pressure tight head is fixed in place and the cooking is started. Temperatures vary from plant to plant. Usually at least 15 pounds pressure and 245° F. is used. After cooking, the load must be settled and cooled to less than 212° F. The lard is then run off.

The tank water may be discarded where sanitary disposal regulations permit or it may be concentrated in steam heated evaporators to give "stick water". The gelatinous solids are dried in another type of steam heated machine to give "tankage". The stick is sometimes added to the dry tankage. Quite an assortment of expensive equipment is required to process the protein residues into salable product after the rendering itself is over.

Since the lard tankage is not used for edible purposes it is frequently combined with the tankage from inedible rendering operations for drying and processing.

The cooking cycle may take nearly 24 hours. In plants with a large daily production of raw fat for rendering, this often makes it necessary to employ a dozen or more cooking tanks.

Open Kettle Rendering. This is probably the simplest of the three common methods. I have here a model of a kettle rendering plant. (Show iron skillet) This skillet and this spoon to stir it are all of the essential features.

Just expand this kettle in your mind's eye to the point where it will hold three to five thousand pounds of raw fat. Put in a mechanical agitator in place of the spoon. Supply the heat by means of a steam jacket. You now have a kettle rendering plant as it is usually found in a packing plant. In practice the raw fats are frequently put through a mincer or sausage grinder before cooking.

In use, the raw fat is charged into the kettle directly from the mincer with the agitator going and the steam applied to the jacket. Steam pressures may vary from 15 to 150 pounds with plant practice. Heat is maintained until substantially all of the moisture is boiled off. The process is essentially frying. After settling, the lard may be drawn off. The dry protein residue is called "cracklings". It is frequently pressed to remove the excess of fat. The pressed cracklings are "meat meal" or "meat scrap".

Dry Rendering. This is really a special type of kettle rendering in which a closed cooker is used. Consider this model. (Show pressure saucepan and spoon) It is a frying process conducted in a closed vessel where either a pressure or vacuum may be applied.

Plant sized cookers are typically of five to ten thousand pound capacity. Usually they are horizontal cylinders with agitator blades that sweep close to the shell wall. Heating is by steam in a jacket. The pressure used varies widely as in open kettle cooking.

Fats are usually charged into the cooker in whole chunks. No water is added and no live steam is injected into the cooker with the fat; hence, the name, dry rendering. The first part of the cooking is done at high temperature by building up a pressure in the cooker just as would occur in the model. This high temperature and the action of the agitator break up the chunks of fat.

After the pieces are well broken up, the steam is vented and cooking is continued until essentially all of the moisture has been evaporated. A vacuum may be applied to the cooker to hasten the boiling and to permit finishing at a lower temperature. A load will take from two to four hours to complete.

The lard is drained away from the crackling and the crackling is pressed to remove most of the excess lard. The pressed crackling from dry

rendering may be called "dry rendered tankage" or "meat meal" or "meat scrap".

These three methods, prime steam, kettle rendering, and dry rendering are the main ones in use. Each is typified by the simple kitchen utensil I have shown as a model. The prime steam method is a boiling technique employing pressure cookery to hasten the process. (Show pressure saucepan). The open kettle method is a simple frying process. (Show skillet). The dry rendering method is frying plus the use of pressure cookery to speed things up. (Show pressure fryer). To think of any of these processes as anything more complicated than this is to make the rendering of lard more difficult to understand than is necessary. These simple kitchen pots and pans are capable of producing product identical to that made in their packinghouse sized counterparts.

How do these Methods Compare?

As might be expected, the lard from each of the three methods is slightly different. Because of the water used in prime steam rendering, the lard is washed quite free of non-fat residues. It is usually the lightest in color of any of the three. Generally it has a boiled pork flavor and odor. Because of the high temperature treatment in contact with an excess of water, there is ample opportunity for hydrolysis of the fat. This leads to a higher free fatty acid content.

From either kettle rendering or dry rendering the lard is usually darker and redder in color. This is to be expected from a frying process where local temperatures may become very high. There is no water washing effect as in prime steam rendering. Non-fat materials may dissolve in the lard to some extent. These contribute color, odor and flavor to the lard. The typical flavor and odor of kettle rendered or dry rendered lard is that of fried pork. The average of all kettle rendered lard is darker and of stronger flavor than the average of all dry rendered lard.

If only the rendering process is considered, the prime steam method is very simple; requiring only a pressure tight tank and a steam supply. When it is considered along with the auxiliary equipment needed to process the tank water and tankage it is not nearly so simple or inexpensive.

Open kettle rendering requires only an agitated, jacketed tank. This is a little more expensive to build than a prime steam unit. The required auxiliaries are a mincer to grind the raw fat and a press to take the excess lard from the cooked cracklings. Together these are much less expensive than the complete prime steam rendering plant. Grinding the raw fat is the major drawback as it is laborious.

Dry rendering requires the most expensive type cooker with its steam jacket, pressure tight cooking chamber and pressure tight agitator fittings. Much of this is offset by the elimination of the mincer to grind the raw fat since whole chunks can be loaded. A press is the only auxiliary required to bring both lard and protein residue into salable form.

Yields of finished lard, as a percent of the theoretical amount in the raw fat, will run from 98% to 99% from either prime steam of dry rendering. Kettle rendering yields are somewhat less.

Considering capital investment, labor, other operating costs, maintenance and product yield, dry rendering is the least expensive of the three ways to produce lard and a salable protein residue product from raw fat.

Newer Rendering Methods.

A number of interesting new methods of rendering have been offered to the meat packing industry in the past few years. All purport to do a better job than the existing methods. The situation is in a state of flux. Still newer methods are being introduced regularly. There is no general agreement on the best basic approach but there are two points toward which all seem to be aiming:

First. Milder processing conditions are being employed. This means lower temperatures in most cases, not just lower average temperatures but freedom from local high temperature spots that cause browning, deepening of the lard color and intensification of the flavor.

Second. Shorter processing times are being employed. From nearly a day for the prime steam method and several hours for the kettle or dry method, rendering time is being cut to a few minutes.

These changes make it possible to make lard which is more nearly like the natural oil in the fatty animal tissue with a minimum of deterioration due to the process itself. The natural oil is bland, odorless and very pale yellow. This ultimate has not quite been achieved as yet.

Size Reduction.

There is one way in which all of the newer processes known to me seek to make these milder and shorter processing times possible. That is preliminary size reduction by mincing or grinding the raw fat to a small particle size. I will mention a number of the processes that I have in mind when I make this statement: The Titan process, the Kinghan process, the Deatherage, the Pavia, the Protease, the Sharples, the De Laval and the Carver-Greenfield. So far this has been accomplished by means of a sausage grinder type of machine. Such a machine has trouble grinding warm fats directly from the dressing floor and will not handle any amount of skin at all.

My personal opinion is that this size reduction step is the real key to mild, fast rendering. The sausage grinder is only a stop-gap answer. A better machine must be developed before there will be any major shift to any of the newer processes. We must depend more on mechanical disintegration of the fat cell walls and less on heat, the enemy of fat.

Quick, Uniform Heating. The next feature that most of the newer processes have in common is quick, uniform heating of the ground fat to melt

the oil and finish the liberation of the oil from the protein. Rapid mixing against extensive heating surfaces, with or without added water or direct steam injection is generally employed.

Wet Separation. With only one exception, all of the processes I mentioned earlier proceed to separate the lard from the protein without any attempt to evaporate the water out of the mixture. When the separation is made, lard goes one way and wet protein goes another.

The Titan process uses a screen and small screw press to separate the wet solids from the liquid, and centrifuges to separate the lard from the mixed liquid. There are losses of fat and protein in the waste water. Not all of the fat is recovered from the solids which are in the form of a wet gelatinous mass.

The Kinghan process does not recover any of the protein. It is all lost in the waste water. The waste water may, of course, be evaporated in a conventional stick water evaporating system if one is available. Generally this KP process is limited to use with fats containing very little protein.

The Deatherage and Protease process largely solublize the protein so that it is inseparable from the water present. No specific recovery procedure is suggested by the literature I have seen.

The Pavia process separates the wet solids from the lard by simple straining through a screen or cloth. The solids contain considerable fat with resultant low lard yields. The lard may contain excess moisture unless treated to remove it.

The Sharples and De Laval processes make use of horizontal centrifuges to separate the wet solids from the lard and free water. A second centrifuge is then used to separate the lard from the water and a small amount of fine solids that escapes the first centrifugal separator. There is some loss of protein in the waste water. There is some lard left in the wet solids with consequent reduced yield of lard.

A Big Job Remains. In each of these methods employing a wet separation, the protein is left in a wet form without any specific way of disposing of it. Some, but only an insignificant fraction of it can possibly be used in low cost sausage and loaf products. Generally it must be further processed to give a salable product.

The wet protein can be added to material being charged into prime steam tanks or dry rendering kettles in order to recover the remaining fat and to produce tankage or meat scrap from the protein. These extra steps cost money and prevent the complete elimination of the prime steam and dry rendering plants by users of the newer processes.

Our own experience is that the wet protein can be handled in dry rendering cookers only with great difficulty and at high cost. Users of prime steam plants would probably have difficulty with emulsion formation. In short, these newer processes are not complete processes --- they leave a

big job to the imagination and ingenuity of the user. This problem must be solved to permit widespread use of the systems.

I mentioned one exception to the wet separation technique. This is the Carver-Greenfield process which dries the ground fatty tissue at low temperature under high vacuum. The free lard is separated from the dry protein solids by filtration in a special Carver filter press. Much of the lard trapped in the solids is subsequently squeezed out by hydraulic pressure applied to the special type Carver press. Thus the lard and protein are both in usable form at the end of the system. The present drawback to the Carver-Greenfield process is the high cost of the equipment used.

Good Lard. That is the one admirable product of these newer processes. Generally it is of lighter color and free of objectionable quantities of not-fat materials. It is low in free fatty acid and has good keeping qualities compared to older methods. For use as lard it should satisfy almost all lard users and be preferred over lard produced by the older methods at equal or very slightly higher prices. As a raw material for shortening or food chemicals it should be accepted as superior since it will require less drastic preparation for use and consequently will give better yields. For "as is" use as household or baker's shortening, it won't compete with the vegetable oil products in performance.

Conclusions.

Good lard can be produced by either prime steam or dry rendering. A real determination on the part of the producer to do the job well is needed - - not just lip service. A careful study of the proper operation technique, thorough employee training and a management backed quality control program are all that is needed in many cases.

The newer processes all raise production costs as well as lard quality and may add difficulties to the protein processing that would eliminate them as practical methods.

Most of the newer methods so far developed do not permit the complete discard of the older methods because they either are not able to handle all of the types of fatty raw material that originate in a pork packinghouse, or they need one of the older methods to process the wet protein residue produced.

Most of the newer methods give inferior yields of either lard or protein as compared with the older methods.

There is only a limited market for better lard "as is". The premium value of better lard as a raw material for shortening or food chemicals is small and can easily be offset by higher production costs or poorer yields.

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MR. SULZBACHER: Thank you, John.

I think that we have been doing very well in keeping up with Vern's aim to work on time, and George Wilson is happily on hand to direct and keep the questions in order.

MR. GEORGE D. WILSON: Thank you, Bill.

There is one thing which Bill did not mention in connection with our speaker that I think is very worthy of mention. That is his fine example in furthering his education and not saying, "I have had it. I am president of a packing company and that is good enough for me." Many of you may know that Mr. Thompson is working on his Ph.D. in addition to his full-time responsibilities and perhaps a few years in the future when you may have occasion to have him back he will be Dr. Thompson.

I don't have a lot to add to Mr. Thompson's remarks. I think he has covered this subject extremely well.

There is one question I have to ask Mr. Thompson myself and that is with regard to these newer methods. I think perhaps without actually saying so in so many words, he inferred that these newer methods, lower temperature rendering primarily, do increase the stability of the resulting fat or the resulting lard, and there are, as some of you know, countries that object to the use of antioxidants in our export lard. I wonder if perhaps the increased stability that is derived from these newer methods is a factor in this or does he feel that present methods, properly administered, are sufficient for the market? I don't know whether you care to comment on that.

MR. THOMPSON: I will try. You are certainly correct that the stability of the lard produced by most of these newer methods is better. For emphasis I should like permission to rephrase that, and that is that the newer methods deteriorate the stability of the natural fat a little less than the more drastic present methods.

It is also true that some of our international market customers do require lard which has not had an antioxidant added. I don't believe that the difference between well handled lard produced by the newer methods and well handled lard produced by either prime steam or dry rendering is sufficient to overcome the present high cost and lower yields involved.

MR. WILSON: I think that is about the only comment I have.

I wonder if there are questions from the audience to be directed to Mr. Thompson.

MR. A. M. PEARSON (Michigan State University): My question is not to Mr. Thompson; it is to Mr. Brockmann. It is relative to using TBA values for measuring rancidity. I should like to know whether you personally omitted them because of experiences with them or whether they are very useful.

MR. BROCKMANN: No, they are very useful. Ordinarily we have used those although not exclusively with fat but just call it tissue generally. I mean that this method is quite useful in determining in a rough way, say, the quality of trimmings going into frankfurters or something like that. It is not used exclusively for fats. No, I would say it is a very useful method.

MR. WILSON: Isn't it also true that you don't actually measure such things as peroxide by the TBA? I mean its precursor.

MR. BROCKMANN: That is right. Of course, we could have mentioned that we have this old Christ test that measures the hydrate. It is a specific aldehyde. A lot of these procedures are specific, or more or less specific, for the types of carbonyl compounds which develop as a result of a deterioration process.

MR. SULZBACHER: If I could put in a word here, George, the problem has been what to measure, and we don't know at the moment too much about just what it is that we want to measure because we don't know chemically what it is that creates rancidity. The nose and taste buds are still the best measures we have. We have been doing work at Beltsville now for a couple of years, and it is just beginning to appear in publication, that we hope will tell us what it is we want to measure. Those papers have been coming out now in Science and in Analytical Chemistry and one will appear shortly in Food Research that will pretty much show, we think, all the carbonyl compounds that can be recovered from rancid fat.

But if I could get back to John Thompson's presentation, John, would the advantages of a continuous process, such as I imagine would be possible with the Carver-Greenfield process, tend to offset the price of the equipment?

MR. THOMPSON: I think the question needs to be asked, what are the benefits of continuous processing? They usually, of course, are that the size of the plant employed may be smaller and the demand on utilities consequently smaller. My own impression is that a Carver-Greenfield plant operating continuously and sized to replace, say 20 prime steam tanks would cost a great deal more than the combined cost of the prime steam tanks, the stick water evaporators and the tankage driers, or at least as much. There would be or there should be an improvement due to the use of modern sanitary construction, stainless steel and the like.

There is another consideration. Fats do not originate in a continuous fashion from the dressing operations. A typical packing plant operation does not dress and cut hog carcasses all day long. Usually over an 8 or 10 hour period at the most. In many plants like ours one crew does the cutting first and then goes to the dressing floor to take care of the current day's livestock. I don't think that is an unusual procedure. The use of a continuous process which requires 20 hours to complete the rendering of this much fat would require storage

tanks and storage facilities for raw fat in which the fat would be very likely to deteriorate and offset the advantages of the milder processing.

MR. AUTTIS MULLINS (Louisiana State University): I should like to direct a question to Mr. Brockmann with regard to the molecular rearrangement of fats on the glycerol molecule; that is, what is involved and to what extent is it being used in the packing industry today.

MR. SULZBACHER: George, could we defer that question because it will be the subject pretty much of one of the later talks?

MR. D. L. MACKINTOSH (Kansas State College): Is there a tendency within the industry, at least where new installations are being made, to replace the prime steam method with the dry method?

MR. THOMPSON: I know of one such change but I cannot say there is a tendency.

MR. WILSON: Are there further questions?

MR. L. J. BRATZLER (Michigan State University): I have just heard rumors about the U.S.D.A. antioxidant question as regards bakery products. What is the status of that at present, I should like to ask?

MR. THOMPSON: I am not well enough informed to comment.

MR. BROCKMANN: John, do you see any possibility of these continuous processes yielding an edible product such as gelatin from the rendering of fatbacks?

MR. THOMPSON: We have been trying to coax gelatin out of our process for the last three years and so far have not been overwhelmingly successful. I think it is one of the real possibilities that by the milder heat treatment the protein would be left in a condition that it could be used to produce gelatin. Maybe by that time, though, we will be producing so much gelatin that we will not know what to do with it. (Laughter)

MR. WILSON: Are there any further questions? If not there may be some others that will come along following the discussion of the next two papers, and I am sure that Mr. Thompson and Mr. Brockmann will be here if you want to bring up some questions then.

MR. SULZBACHER: Now we have the fat produced by the hog. We have learned a little about its chemistry and we have rendered it. We have it in some sort of form in which it might be used, but in recent years, as Mr. Thompson has indicated, the users of this product have changed and the purveyor of the product now has the job of recapturing some of the users that he has lost. There is a good bit of chemistry,

as you might imagine, involved in this sort of thing. Some years ago we started to do a little work on rendering at Beltsville which unfortunately we have not kept up with. We began to think then of the fellows who are known in the circles that talk of this thing as fat chemists and we began looking around for a fat chemist. Except for myself most of the members of my group are rather on the lean side. However, there was one of these fat chaps down at New Orleans who worked for a long time with oils, not so much with lard, and he had quite a reputation. He was one of the more potent of the fat chemists in the business.

We induced him to move to Beltsville, which was not hard because he is an old Washingtonian. Since then he has gotten somewhat sidetracked and he is not as fat as he used to be and he has gotten to be somewhat of a protein chemist, but his memory is good and he has kept up with the subject, Mr. Clifton Swift who, as you will see, is pretty much of a fat chemist, will tell us something about the chemistry of food uses of meat fats.

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