• *Technical*

The Production of Meat and Fat Products Through Centrifugal Rendering

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IN RECENT YEARS the meat-packing industry has seen radical changes come about in the processing of animal fatty tissues. The strong economic pressures that have faced this industry have fostered substantial technical changes in the processing of fatty tissues, both with respect to the production of protein by-products as well as lard and tallow. The industry has seen the conventional wet-rendering and dry-melting methods give way to the rapid processing techniques of centrifugal rendering. The continual competition from other sources of fats and oils has accelerated the trend toward the improvement in the quality of the fat produced by the rendering operation. A more startling change has been the emphasis applied to the recovery of the protein tissue in the raw fat as a meat by-product. The economic returns possible through the recovery of the protein tissue as an edible meat product are such that in many cases the protein tissue itself has become the main product and lard or tallow the by-product.

Fatty tissues from both beef and pork are composed of basically three materials: water, fat, and protein. It is the purpose of any rendering system to obtain as complete a separation as feasible of these three materials. The wet rendering system in conventional plants, through the application of high temperatures for prolonged periods, succeeds in breaking down the protein tissue and cell structure to the point where gravity separation will permit effective recovery of fat. The standard dry-rendering system again utilizes heat but removes water in the tissue through evaporation, normally under vacuum. In doing so, the protein is coagulated and crisped in the form of cracklings. The separation thus can be carried out readily through the use of screens and presses. The basic disadvantage of both wet rendering and dry rendering is that through the application of heat, either in the presence of water or dry, the fat and protein become sufficiently down-graded so that there is a definite limit on their subsequent consumption.

It has always been recognized throughout the industry that improvement in the quality of fat products could come only through rapid handling of the fatty tissue at low processing temperatures and utilization of mechanical disintegration instead of heat to break down the cell structure and release the fat.

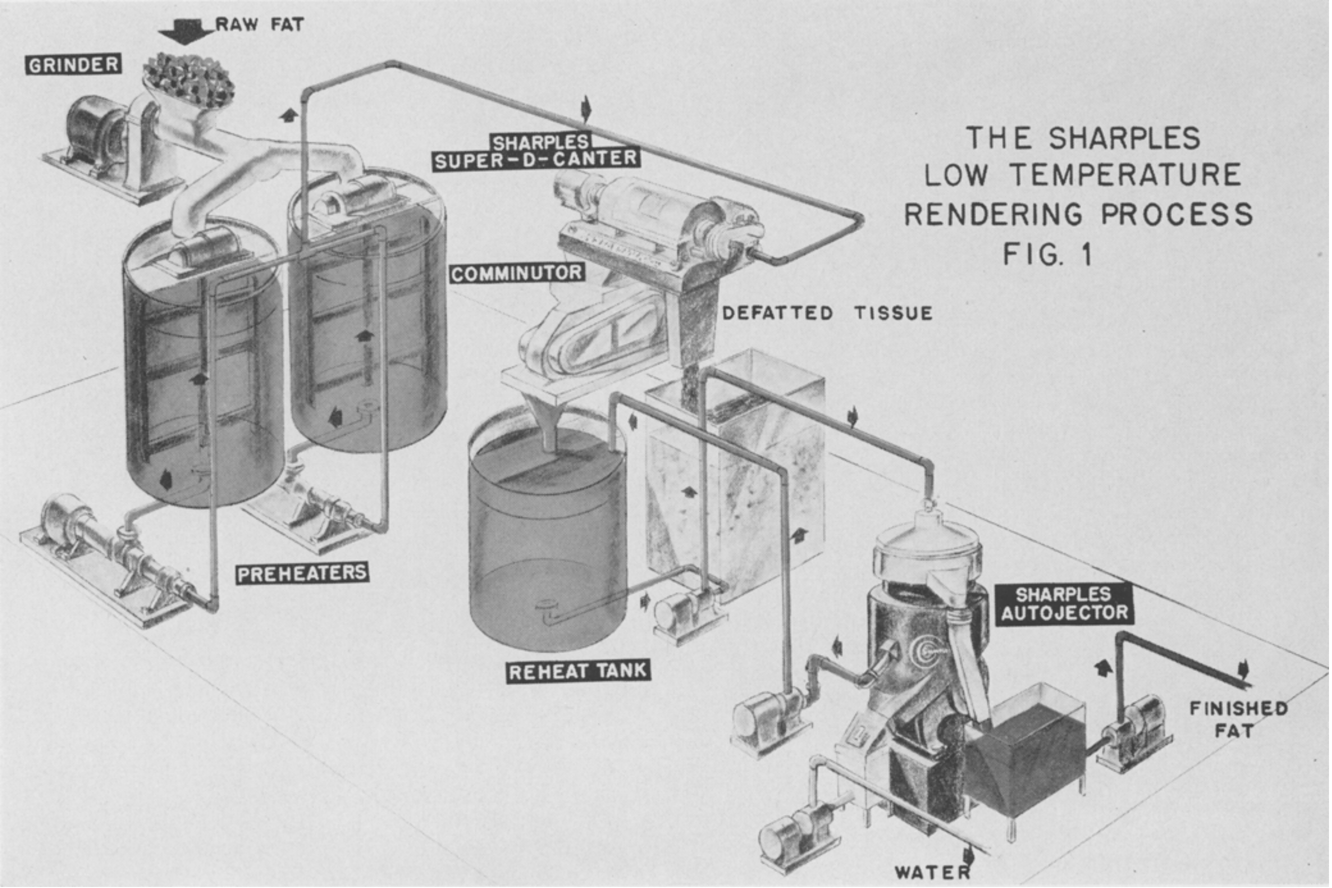
While the tissue can be readily reduced in particle size by grinding and comminution, there is the problem of effecting a rapid separation of the fat from the tissue and water without resorting to high temperatures for prolonged periods to ''cook'' the tissue. This separation is basically a natural application for the centrifuge. However for many years the centrifugal separation proved to be the major stumbling block in developing successful low-temperature rendering systems. The demands of the rendering industry required a separation system to handle the relatively large tonnages of a perishable material and to produce at all times a high-specification fat product. The separation had to be highly efficient to maintain yields and to be capable of adjusting itself automatically to the widely varying types of feeds normally handled during a day's operation. Nothing short of this could be acceptable to the meat packer or renderer.

THE PROBLEM facing the centrifuge approach was that of effecting a clean-cut separation to produce a polished, clarified fat and a protein tissue sufficiently low in fat to produce satisfactory yields. The feed produced by mechanical disintegration and low-processing temperatures can be broken down into various phases. A centrifuge system receives a feed that is composed of four distinct phases: clear fat, below which is an extremely stable emulsified layer, followed by a small water phase, and at the bottom a substantial amount of heavy protein tissue. The development work carried out by the Sharples Corporation was aimed at solving the separation problem by a two-stage centrifugal system. This development work utilized, first of all, a solid bowl, Super-D-Canter type of centrifuge, effectively to remove the bottom layer consisting of heavy protein tissue containing natural moisture and free-of-liquid fat.

It remained for the second-stage centrifuge to effect the clean-cut separation of the fat from the emulsion, water, and small amounts of tissue remaining. Extended tests were carried out with several of the conventional, self-cleaning separator centrifuges. The results indicated that the intermediate emulsion layer could only be compacted, not completely broken, under centrifugal force. This layer tended to build up in the bowl and invariably bled out with the clarified fat, producing a contaminated product. Dilution with water did not relieve the situation and created new problems of disposal and loss of fat.

The use of automatically-timed valve bowls offered a partial solution since the centrifuge bowl could be periodically dumped, removing the emulsion layer. However in this case it required constant supervision by an operator to see that the emulsion phase did not bleed out with the oil. With a bowl operating on a timed cycle, either the operator runs the risk of permitting the emulsion to bleed over with the fat or loses too much fat through too frequent openings of the bowl. This is greatly complicated by changes in the feed rate as well as by any changes in the composition of the feed itself.

The answer to the problem lay in the use of a self-cleaning centrifuge that would remove the heavy-phase matter, that is, the emulsion water and solids, only as it accumulated in the bowl. This centrifuge is the Sharples DG-2 Autojector Clarifier, employing hydrostatically controlled valves that remove the non-



fatty material only as it is deposited in the bowl. The Autojector adjusts itself to any variations in the rate and composition of the feed while discharging a highly clarified product at all times. Such a machine proved to be the heart of a successful separation system.

THE COMBINATION of the Autojector Centrifuge and the Super-D-Canter Centrifuge was utilized to produce the Sharples Low-Temperature Rendering Process, which is shown schematically in Figure 1. Basically the process utilizes a grinder to reduce the fat in particle size, jacketed heating tanks to bring the fat to processing temperatures, and a Super-D-Canter to remove substantially all of the protein tissue. The liquid effluent stream from the Super-D-Canter is comminuted and reheated to 200°F. prior to polishing in the Autojector centrifuge. The operation of this process has been described in more detail in published articles (1, 2). At the present time more than 17 plants of the Sharples Process are being operated in this country, with one additional one now being put into operation in Denmark. These plants are operating on beef as well as pork fat with some plants operating entirely on warm killing fat while others are taking both cutting fat and killing fat from standard pork operations. Plants are now operating at a million-pounds-per-week capacity. These plants have been proven to be completely reliable, handling the total tonnage requirement day in and day out through years of operation. The plants have produced a high yield and maintained low operating costs.

The fat product produced from these plants has been consistently distinctive in quality. The lard produced has been extremely low in free fatty acid, averaging between 0.15 and 0.2%, and extremely light in color. It has a distinctive lack of odor and flavor, being a relatively bland product. At the present time it has found uses in all phases of the shortening industry and has been proven in practical, day-to-day acceptance tests as superior to wet-rendered, dry-rendered, and kettle-rendered lards. The versatility of the process has been shown in its ability to produce high-quality oleo stock and edible tallow. In addition, the process has been operated commercially on chicken fat, producing a superior grade with a very low peroxide value.

While the installation of a large number of these plants was readily justified through the savings in yield, quality of the fat product, operational cost reduction, etc., it became apparent after a number of plants were in operation that one of the most significant factors of the process was the production of a new type of protein discharge. This tissue, removed by the Super-D-Canter, through quick processing techniques retained the characteristic of the raw fat feed. Almost immediately there existed a ready market for this material for use in dog food. The tissue had the appearance of partially cooked beef or pork, retaining the fluffy structural material of lean meat. It was prepared at the normal operating temperature of 160°F., which was maintained for the first-stage separation. The separated tissue from both beef and pork operations was substituted for horsemeat and other protein material in wet canned dog food.

Although the use of this tissue in dog food constituted a profitable market, further study indicated that there was a distinct possibility that such a tissue could enjoy widespread use in edible meat products

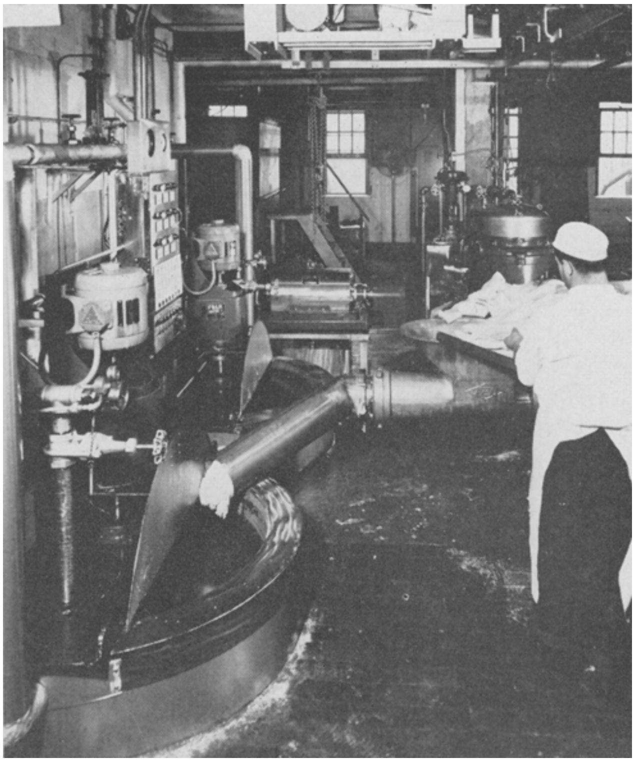


FIG. 2. Ground fat is fed to jacketed heating tanks. Sharples Super-D-Canter and Autojector are shown in the background.

at much higher values. However it was found that federal restrictions governing interstate operation, while classifying certain protein tissue prepared through centrifugal rendering at 160–180°F. as edible, definitely limited its end-use. The government restrictions held that for a tissue to be classed as a meat by-product suitable for use in processed meat products, it must be from edible fat, in the case of pork, free of skin and not coagulated. The point at which the protein coagulated in the raw ground fat was shown to be in a temperature range of 115–122°F. for a wide variety of materials. Therefore operation in the range of 115–120°F. in the preheating step was found to produce a material that was effectively noncoagulated.

IN SPITE of the fact that operation at "extra" low temperatures of 115–120°F. was found to be feasible for pork fat, it could not be readily translated to production operation. Extensive development work was carried out to determine means for satisfactory preconditioning of the feed tissue. Greater particle-size reduction was found to be necessary as well as new techniques required for maintaining close temperature control for production operation. Thermal equilibrium conditions in the fat tissue were found to be critical.

Operation at temperatures only a few degrees above the melting point of the fat imposed a very severe burden on the Super-D-Canter since it was required to make an efficient separation of the tissue on such a highly viscous feed. It was found however that by substantial modification of the Super-D-Canter centrifuge, both with respect to its internal construction and speed of operation, that a very satisfactory and operationally sound separation could be made.

Through "extra low-temperature" rendering many thousands of pounds of tissue have been produced. This material, called partially defatted tissue, has been classified according to government regulations as a meat by-product. The actual analysis of the defatted tissue will vary somewhat, depending upon the type of feed material being processed. The structure of the fatty tissue, with respect to the amount of fiber present, and the physical consistency of the protein have a great effect on the operation of the system. However a range of fat contents from 35–40% would be normal, with some materials giving fat contents considerably lower. The moisture content will normally run close to 50%, with protein contents as high as 17% or more. Its nutritional value, as indicated by amino acid analysis performed by independent laboratories, has been found to be high. Partially defatted tissue has been used in various processed meat products constituting 10 to 15% of the emulsion and has produced products of excellent physical appearance. In actual usage this material does not differ substantially from pork trimmings, which are used in many sausage and loaf emulsions.

Over the past year and one-half the Sharples Corporation has been working closely with a large number of meat packers in developing the techniques necessary to operate at these extremely low temperatures and preparing for packers many thousands of pounds of this tissue, which has been utilized in production runs of sausage and loaf products. Close liaison has been maintained with the government authorities who regulate such material. At the present time a portable, complete processing plant is being utilized by a number of packers throughout the East and Midwest to produce such material in quantities sufficient to establish its usage in their own particular types of product.

Thus the application of centrifugal rendering in the past five years has been seen to grow from an idea to a practical operating system to produce high-quality fat with a reduction of labor costs, increased yields, etc., and to extend even farther the production of a meat by-product of substantial value. Thus the basic concept of centrifugal rendering, that is, the processing of fatty tissue to maintain its fragile qualities and produce not only high-quality fat but protein tissue in an undamaged state has been obtained. We feel that the practical implementation of such an idea from concept to reality, such as presently in existence on a day-to-day plant operating basis, is a step forward for higher quality and increased profits.

REFERENCES

1. Orsi, L., National Provisioner, Oct. 5, 1957.
2. National Provisioner, Feb. 23, 1957.

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