Dry-Rendering of Animal Products

A description of the new process used in the production of edible and inedible fats.

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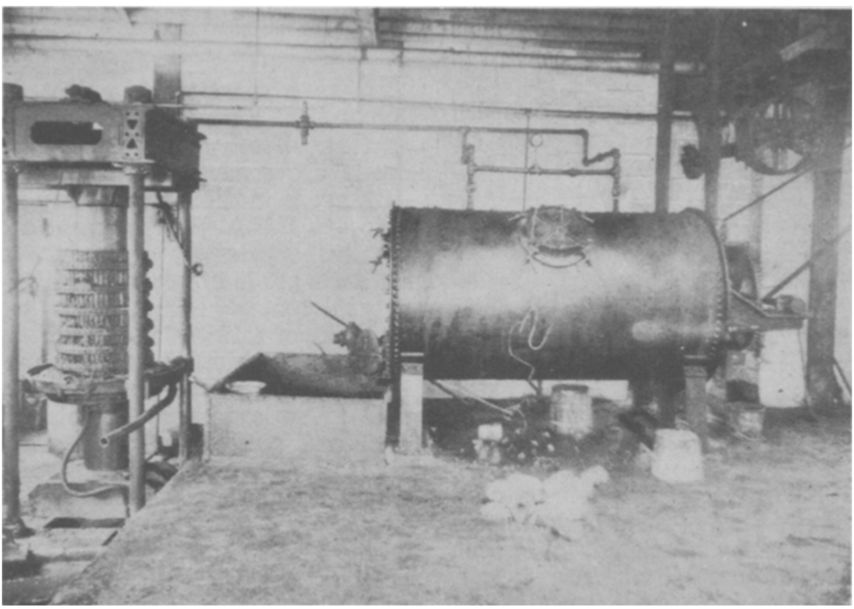
ANIMAL fats as they occur in the adipose tissues of the living animal are composed in the main of stearin, palmitin and olein in varying proportions. Chemically fats are neutral substances composed of carbon, hydrogen and oxygen.

If we could process these fats so as to preserve their natural fine qualities intact, we would confer an inestimable boon upon mankind. We are always striving toward this but never quite attaining it.



Dry-rendering plant in operation

Edible Fats

Fats, as they are taken from the freshly killed animal are neutral in flavor, odorless and contain no free fatty acid. They are white except for the straw color of certain beef fats, and are wholesome and sweet.

As these fats occur in the animal tissues they are closely associated with the proteins or essential constituents of all living cells so that to recover them it is necessary to separate them from these proteins and other substances. Since these proteins are of great food value it is equally necessary to recover them in as pure and wholesome condition, as possible.

Therefore, a process of separation with preservation is indicated and one such process is rendering—or the application of sufficient heat to effect such separation.

Unfortunately, the moment that life is extinct in the animal, bacterial action begins, which immediately operates on the fats to separate the glycerine from the fatty acids and produce free fatty acids. Free fatty acids never remain constant. They are perpetually increasing. When in the rendering process heat is applied, particularly in the presence of moisture, the free fatty acid content increases rapidly.

Again, the fat structure is delicate and easily broken down and when fats are rendered at high temperatures in the presence of water a chemical process of decomposition sets in known as hydrolysis.

Thus fats rendered by live steam introduced into them deteriorate to such an extent that perfectly neutral fats fresh from the killing floor will develop from ½ to 1½% of free fatty acid during the process of cooking by such a method.

Furthermore, fats have a great affinity for oxygen at high temperatures and oxidation is a forerunner of rancidity. The keeping qualities of fats, the flavor and the color are directly dependent upon the degree of oxidation.

When therefore, we are dealing with edible fats the rendering process employed must take into account all of the adverse factors above considered.

If the process employed will not deliver products low in acid, of good color, taste and keeping qualities, all within definite close limits, then our fresh fats have passed out of the edible class into the inedible.

Inedible Fats

When we come to inedible fats, we meet an entirely different set of conditions. The tallow or grease rendered from these is largely used in the soap industry and the solids or proteins for stock or chicken feed.

The raw fats entering into inedible come from a great variety of sources; from butcher shops, packing houses, dead animals, hotels, restaurants, etc., and since they are never strictly fresh the acid content will vary from 2 to 50%. It is customary therefore, to segregate these fats and render them to a considerable extent on the basis of a general average acid content. Fresh shop fats for example are rendered to produce a high grade inedible tallow running 4 to 5% F.F.A. Hotel greases are handled separately to produce a different grade of product of higher acid content. Each grade has its limits of acids, color and titre as related to market price; raw materials which might produce a low acid tallow can easily be mishandled and produce a lower grade product than would be the case where they properly processed.

Process Requisites

It is apparent therefore that certain general principles underlie any successful rendering process.

Briefly they are as follows:

1. The raw stock must be processed at the earliest possible moment after receipt of the raw material, to avoid any further increase in free fatty acid.
2. The raw materials should be processed in the shortest possible time—for prolonged exposure to heat, particularly in the presence of moisture, increases the fatty acid content.

3. The raw materials should be rendered at as low a temperature as possible to avoid increase in F.F.A., to prevent oxidation and to keep the oils from discoloration.
4. The raw materials should be rendered without admission of air.

Direct Steam Rendering

In order to appreciate the great advance in rendering processes exemplified by the dry-rendering system we must describe briefly the older system in use for so many years known as the direct steam system.

In this system fat, bones, carcasses or other raw materials were loaded into a vertical steel digester or rendering tank and live steam under 30 to 70 lbs. pressure was introduced directly into the material for from six to ten hours.

Then the content was allowed to settle for an hour, which resulted in three layers of material within the tank: at the top a layer of tallow or grease, next a layer of tankwater, then a layer of solids or wet tankage.

The tallow or grease was then drawn off as free from tankwater as possible. The tankwater was next run to vats for skimming such grease as was not drawn off in the first instance.

The solid matter in the bottom of the tank was then dropped out, pressed in a hydraulic tankage press and dried in a steam jacketed or direct heat dryer.

The tankwater, containing from 4 to 6% protein solids in solution and suspension was evaporated in vacuum pans to about 26°Be and either dried on a steam heated stick roll into concentrated tankage or mixed with the pressed tankage and the two dried out together in the tankage drier above mentioned. The cycle of this process was from 16 to 24 hours. In other words, cooking with live steam added water to the material and the rest of the process was devoted to getting that water out again. Diagram 1 below shows the products of this system and diagram II the equipment required.

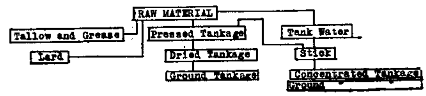


Diagram I

From the foregoing, it will be evident that many secondary products occur in the direct-steam rendering requiring a multiplicity of equipment.

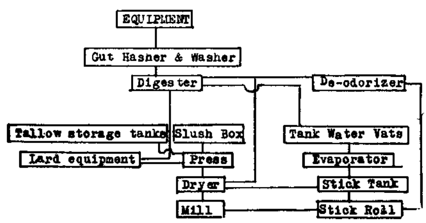


Diagram II

The raw materials are not processed in the shortest possible time; they are not rendered at the lowest temperatures possible. They are rendered in the presence of moisture and under conditions favorable to oxidation. The value of the resultant products does not equal the value of the products of the dry-rendering system, but the cost of production is greatly in excess of the costs under the dry-rendering system.

The Dry-Rendering System

In this system cooking is carried on in steam jacketed melters and no live steam comes in direct contact with the material. The resultant products and the main items of equipment necessary to produce them are shown below in Diagrams III and IV respectively.

Preparation of Raw Materials

When entrails, pecks, paunches, etc., are to be rendered it is first

Diagram III

necessary to hash and wash them in order that the contents, consisting of food in process of digestion be removed.

If this is not done the tallow or grease extracted will have a greenish tinge—be high in free fatty acids and M.I.U., that is, moisture, impurities and unsaponifiable matter taken as a unit and will suffer a material reduction in market value.

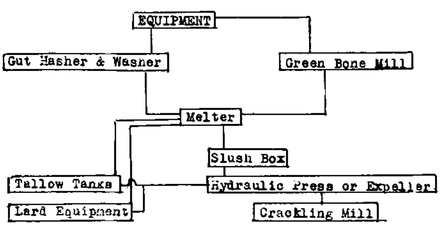
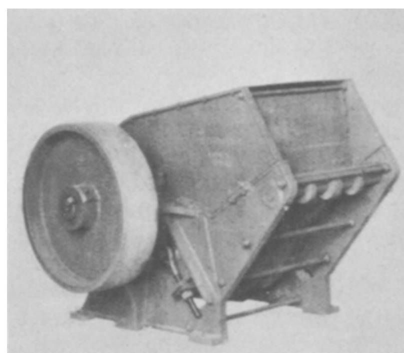


Diagram IV

To prepare offal for the melter a combined hasher and washer is employed. This machine has a set of circular saw tooth disks, rotating at different speeds. These tear and rend the material, automatically passing it into a rotating sloping perforated cylindrical metal screen. As it passes through this screen it is sprayed with water from a perforated pipe, so that the contents of the offal are washed through the screen perforations and the material to be rendered discharged in a clean condition at the end of the washer.

Bones—Carcass Meat

To prepare bones or carcass meat for the melter, a green bone mill or hog is employed. These machines are built in a variety of types and styles and most of them will take the raw material as rapidly as it can be fed and break it down into small pieces.



Green Bone Mill

Milling of the green bones and carcasses is one of the most important and necessary steps in the dry-melting system. We have already stated that one of the fundamentals of efficient rendering is rapidity of operation. If whole bones and large pieces of carcass meat were placed in the melter, a great increase in time of cooking would result, for the reason that the necessary heat could not penetrate such pieces rapidly and disintegration would be slow, thus subjecting the balance of the charge to excessive or over-cooking with resultant detriment to the tallow. The cooking would be uneven and the extraction of the fats incomplete as compared with extraction from ground material. Furthermore, large pieces of bone prevent satisfactory operation of either hydraulic press or expeller, with the result that the crackling cakes would show great irregularity in fat analysis.

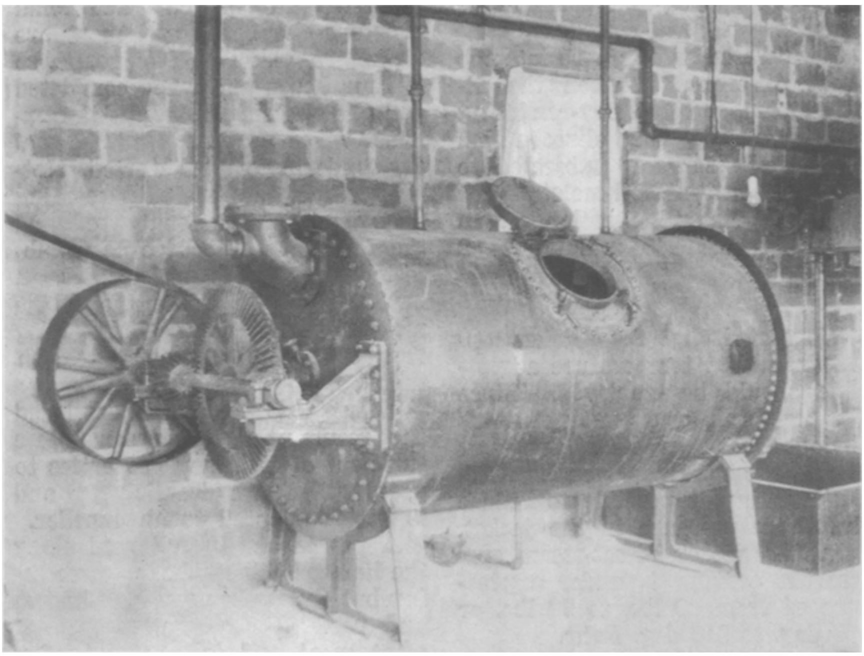
Fats

In the dry-rendering of hog fats for production of lard or in handling shop fats for production of tallow the bulk of a charge to the melter will be fats in pieces which do not require cutting or disintegration as this is accomplished in the melter. Where kidney or cod fats, leaf lard, etc., are received in large pieces they should be cut up, but in general the bulk of such fats needs no pre-treatment.

Melter

The melter is, of course, the heart of the dry-rendering process and upon its construction and method of operation, depend in a large measure the successful results of the process.

The accompanying cut shows the general construction of an efficient melter.



Melter for dry-rendering

The inner shell is built in one piece of heavy steel and there are no staybolts between the shells.

This construction insures a smooth polished inner shell to which no material can adhere and bake. Furthermore, the absence of staybolts means that no steam can leak into the material.

The large vapor outlet permits the immediate escape of the cooking vapors in great volume at low velocity—thus preventing entrainment of fats.

Lead gaskets are employed on loading discharge and testing doors so that no air can enter the melter, thus preventing oxidation.

This melter will cook a charge of straight fat in about 45 minutes, and bone in 1½ to 2 hours. Allowing 40 minutes for pressing a charge, it will be seen that the cycle of operation is approximately 2 hours.

Here we begin to appreciate the great difference between the direct steam and the dry-rendering methods. In the direct-steam method the fat was subjected to high temperature and moisture for 6 to 10 hours and often longer. In the dry-system 45 minutes to 2 hours.

Temperature

We stated that for efficient operation as low temperature as possible should be employed. Since the melter is vacuum-tight it is obvious that a vacuum pump or barometric condenser can be used, thus making it possible to reduce the steam pressure in the jacket.

In the wet or direct-steam system the cooking is under a pressure of from 40 lbs. to 70 lbs. or 287 deg. to 316 deg. Fahr.

In the dry-system 40 lbs. to 60 lbs. of steam is carried in the jacket and so long as any appreciable amount of moisture remains in the material, i.e., the inherent moisture in the tissues—the temperature will remain at about 212° Fahr. Only when the moisture has been driven off will the temperature start to rise—and when it does start to do so—the cooking is completed.

Variant

Occasionally a condition arises where it is inconvenient to install a bone mill or hog. In such cases the whole bone or large pieces of carcass meat may be placed in the melter without milling. A shut-off valve is introduced into the vapor exhaust line and closed sufficiently to permit the vapor driven off of the cooking material to build up a pressure within the tank. In other words a modification of the wet or direct steam process is effected and without additional moisture the bones and meat are disintegrated. This requires three to four hours and when completed and the pressure relieved, the exhaust valve is opened and the real dry-rendering system started. Naturally the total time of processing is proportionately lengthened and the fats have of course been subjected not only to prolonged heat, but to intimate contact with the moisture and vapors emanating from the solids associated with them.

Where this variant is employed the resultant cake does not lose sufficient of its gluey properties to press well in a hydraulic press and is better adapted to an expeller.

A patent has been issued along the lines of this method of processing but the system was well-known and used in the manufacture of meat meal and in rendering for years prior to the introduction of the real dry-rendering system.

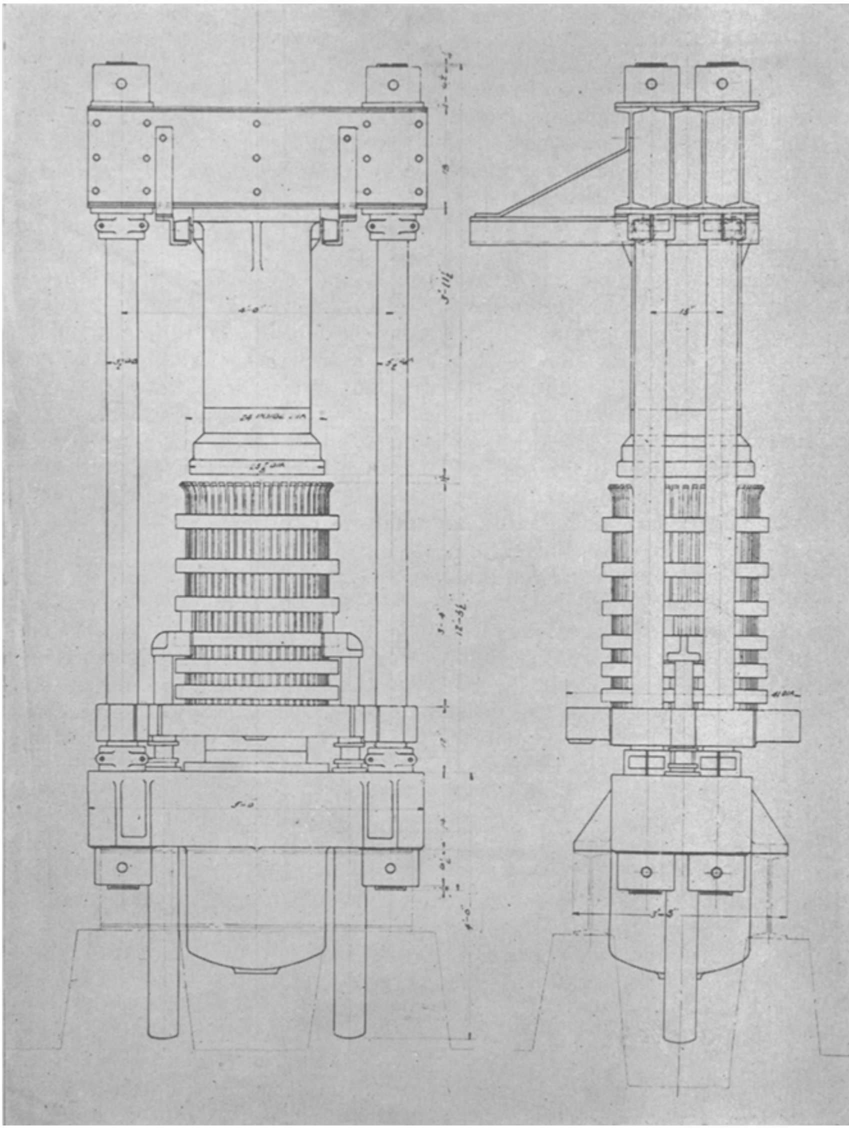
Draining

When cooking has been completed the tallow, lard or grease is drawn off and the solid matter automatically discharged into a false-bottom steel slush box, the free oil draining to the floor or storage-tank and the solid matter or unpressed crackling remaining in the box from which it is loaded into hydraulic press or expeller.

Hydraulic Press

From the standpoint of yield rather than that of quality of tallow or grease the hydraulic press is the most important unit in the dry-rendering system.

On its efficiency depends in large measure the total yield of fats and consequently, a large share of the renderer's profits.



Perfected type of hydraulic press for use in dry-rendering systems

The hydraulic press as used in dry-rendering is of the curb or basket type as illustrated. The drained crackling is loaded into the curb in small batches and while it is still very hot. Only enough material is loaded to make a cake 1″ to 1½″ in thickness when pressed. On top of each such batch a steel spacer plate is placed, another batch added, another plate inserted and so on until the curb is full.

Hydraulic pressure is then applied underneath the ram of the press by means of a steam or power driven hydraulic pump and the entire platen with its load of material is forced upward against the stationary head, which fits inside the curb.

As the pressure increases the fat is forced through narrow slots in the curb and runs down into the lip or trough of the platen and thence by pipe to the storage tank.

Within limits the general principle of pressing is that the greater the pressure the higher the yield. Unfortunately, this principle seems to have been absorbed in the main by the large packers and renderers and not by the small operators.

Good practice would show about 10% fat in ordinary beef cracklings, a result which can be obtained with 500 ton presses of reasonable cost. In general, it would be fair to assume that the smaller renderers will show an average of about 15%, though some will run 30% and above.

The importance of a good hydraulic press can be best appreciated by a study of the chart on next page.

The diagram represents an average 2500 lb. charge of raw material and shows the value of:

(1) The protein content of 312.5 lbs. at $.05 per lb. or $15.63.

(2) The total tallow content of 1187.5 lbs. at $.08 per lb. (no grease in cake) or $95.00.

(3) The various values of the tallow lost in the cakes corresponding to grease analysis of cake.

Ten percent grease in cake is considered good pressing practice. Example:

Suppose a crackling cake analyzes 20% grease. Then our protein value still remains $15.63, but we have lost almost $11.50 worth of tallow (distance from horizontal line to curve) in our cake leaving us only $95.00 minus $11.50 or $83.50 worth of salable tallow.

The curve does not follow the straight line variation because in addition to increased money loss with higher tallow percentages the weight of cracklings also increases materially.

Products from Pressing

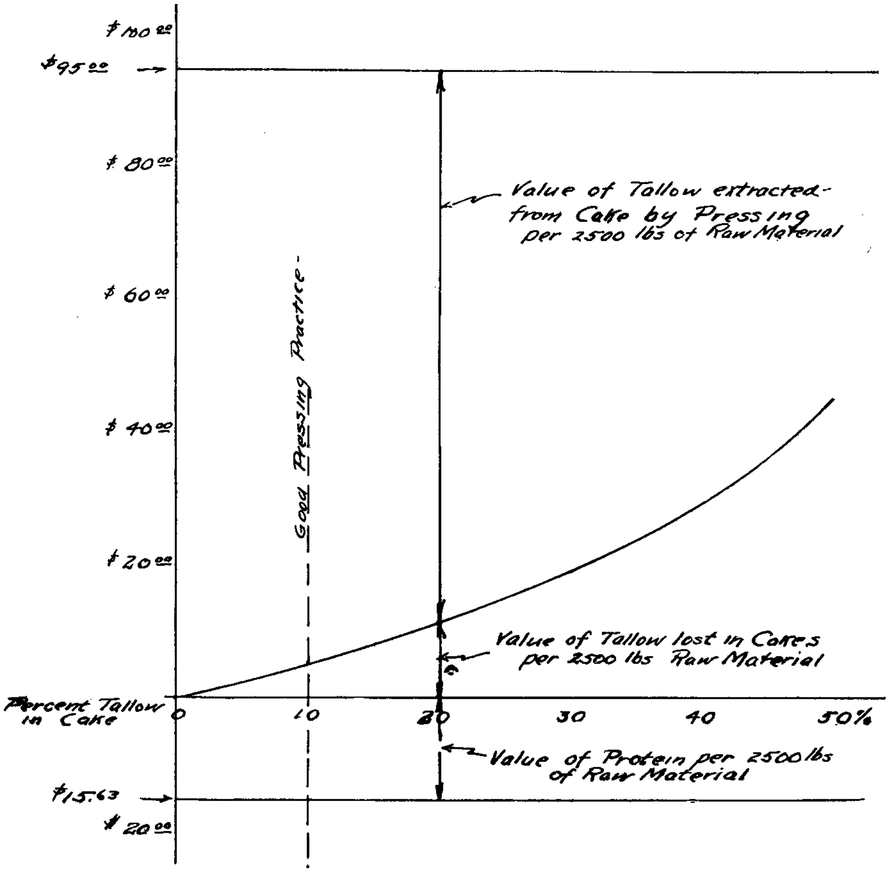
In the dry-rendering system the tallow or grease produced is practically moisture free—consequently, the oils from the melters and the press pass to the same receiver.

After a brief period of settling for precipitation of floating solid particles the tallow or grease is ready for tiercing.

The solid particles which settle to the bottom of the receiving tank are minute pieces of protein material which flow from the melter with the oil or squeeze through the slatted curb of press or expellers.

The volume of these depends on the fineness of raw material grinding; the speed and construction of the melter agitator, the width of opening between the slats of press or expeller curb and the proper cooking of the raw material.

This solid matter is removed from the settling tanks at intervals,



Graphic chart of recoverable values in dry-rendering operation

usually every two or three days, and added to a partially cooked charge of bone or to a charge of fat and bone after the first run of oil has been drawn off. Thus this material reappears in the cracklings and is entirely recovered.

Summary

In general—the dry-rendering process has the following marked advantages over the wet-rendering system, and for these reasons—has come into great popularity in a remarkably short space of time.

1. The dry system is far more rapid.
2. Its products are more valuable.
3. Its products are of higher grade.
4. It requires less labor.
5. It requires less machinery, power and steam.
6. It requires less floor space.
7. It requires less investment.
8. The entire process is tremendously simplified.
9. It is, when properly installed and operated—odorless.
10. It is clean.