

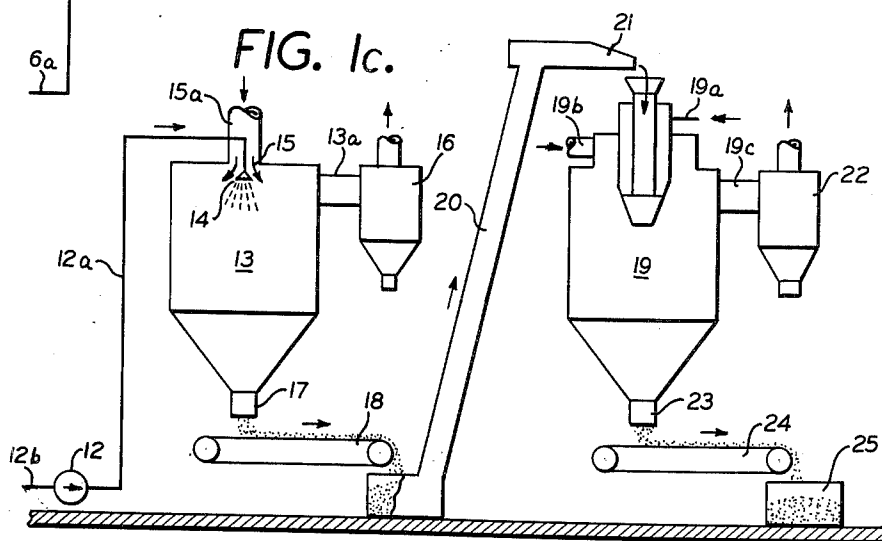
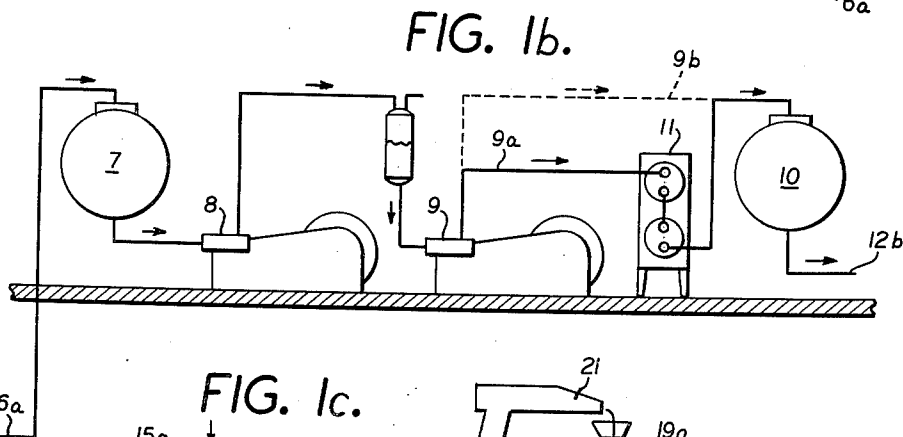
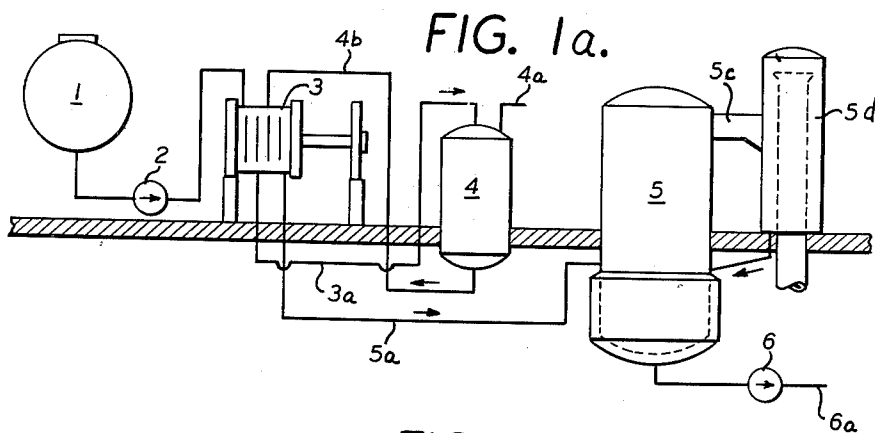
Nov. 20, 1962

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WHOLE MILK POWDER

3,065,076

Filed Sept. 3, 1959

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

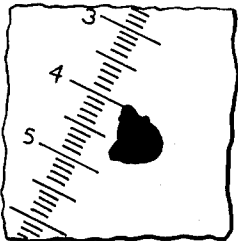


FIG. 2A

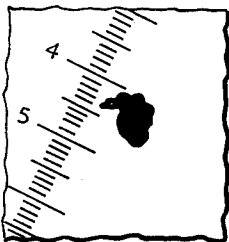


FIG. 3A

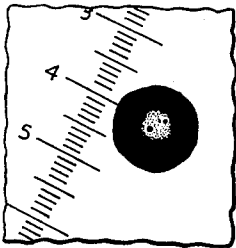


FIG. 2B

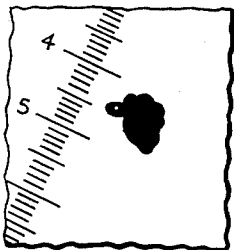


FIG. 3B

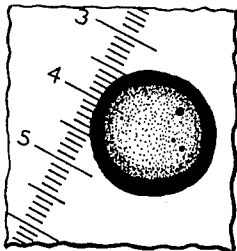


FIG. 2C

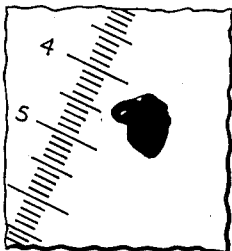


FIG. 3C

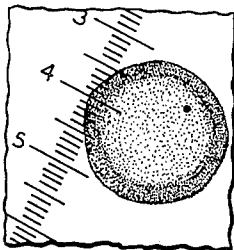


FIG. 2D

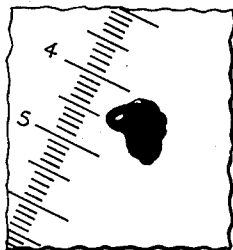
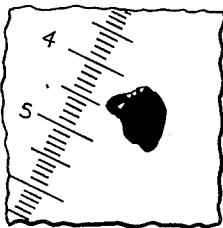


FIG. 3D

FIG. 3E



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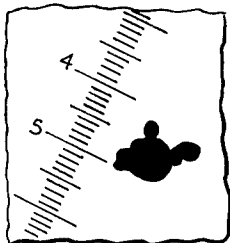


FIG. 4A

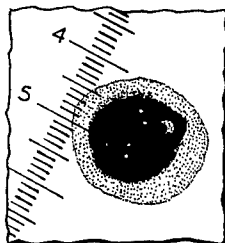


FIG. 4F

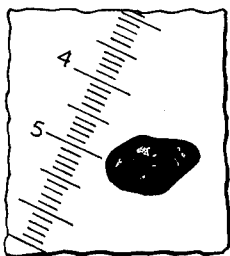


FIG. 4B

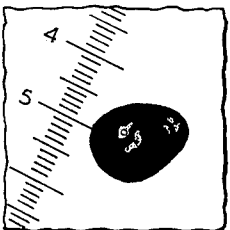


FIG. 4C

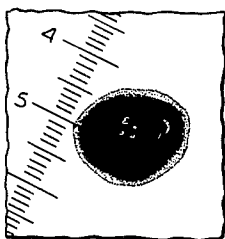


FIG. 4D

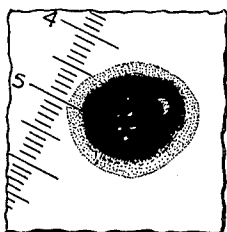


FIG. 4E

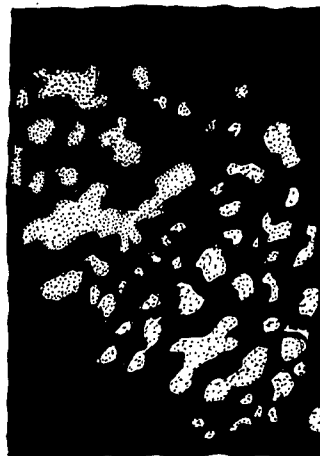


FIG. 5

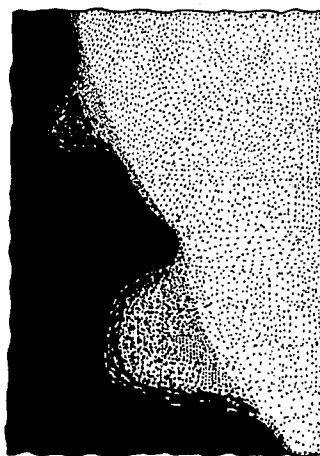


FIG. 6

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3,065,076

## WHOLE MILK POWDER

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Claims priority, application Switzerland Apr. 4, 1959

8 Claims. (Cl. 99—56)

This invention relates to preparing whole milk powder which is easily miscible with water and completely soluble therein.

Various drying processes for the production of whole milk powder have been suggested previously, of which the spray-drying process has found most extensive application due to its economic advantages.

However, the uses for whole milk powder are limited, because the powder dissolves poorly in water and because the beverage obtained by its solution is too much different in its character and taste from fresh cow milk. It is particularly difficult to dissolve the spray-dried powder, which consists of fine particles, in cold water, because lumps are thereby formed easily and such lumps disintegrate only upon strong and extensive stirring.

By suitable selection of the spraying conditions a coarse-grained powder can be obtained, which disintegrates in water more easily than the fine-grained powder. However, the individual powder grains dissolve in water poorly or not at all, and they form a precipitate on the bottom and at the walls of the container, or remain suspended in water in the form of a coarse-grained dispersion, instead of forming a milk-like emulsion.

During processing the milk particles are exposed to a more or less intensive action of heat, so that in the milk powders hitherto known, 80% and more of the protein substances of the serum are denatured, and the re-constituted milk has often an undesirable cooked taste.

According to the process of the present invention a whole milk powder—which contains at least 24% of fat—can be obtained from fresh, standardized whole milk. This powder is miscible with and soluble in water at 5° C. upon stirring by hand. It mixes with water at 20° C. without stirring and dissolves in such water without stirring in two minutes. The process included preheating, concentration under vacuum, homogenizing, spray-drying and agglomeration. The process is characterized in that the action of heat on the whole milk during the entire process of preparation, is kept within such limits which permit killing of injurious germs and rendering harmless ferments which affect stability, but do not cause denaturing of more than 35% by weight of the protein substances of the serum. Another feature consists in that the concentrated whole milk is homogenized to a particle size of the fat globules in the dried whole milk powder which does not exceed one micron and, furthermore, that the spray-drying, the agglomeration and packing into the shipping containers and the storage are carried out under such conditions that in the whole milk powder there is not more than 1% by weight of free fat (based on the total dry product), and the lactose is present in amorphous condition.

The concentrated whole milk is homogenized preferably at a temperature of 40° C.—60° C. and under a pressure of 150–300 atmospheres in excess of atmospheric pressure, and is subsequently homogenized a second time under a pressure of 30–300 atmospheres in excess of atmospheric pressure.

The process of preparation according to the present invention will now be described in connection with the appended drawings FIGS. 1a, 1b and 1c.

Subsequently, the most prominent characteristics of

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whole milk powder prepared according to the process described will be explained, in comparison with whole milk powders commercially available at present. Some of these characteristics will be illustrated by means of microphotographs.

FIGS. 2a–2d illustrate in chronological sequence the behavior of a whole milk particle produced according to the process described, in a “hanging water drop”—microscopic test;

FIGS. 3a–3e illustrate the behavior of a commercially available whole milk powder in an analogous test;

FIGS. 4a–4f illustrate the behavior of another commercially available whole milk powder in an analogous test;

FIG. 5 is a representation of a photographic enlargement of a microscopic picture of a commercially available whole milk powder particle; and

FIG. 6 is a representation of a whole milk powder particle, produced according to the process described.

The fresh cow's milk is standardized in container 1. From fresh milk container 1, the standardized whole milk is passed by means of pump 2 through the preheater 3. The milk flowing through the preheater 3 is brought within a very short period of time to pasteurizing temperature. This may be, for example 70° C. In this case, the milk is exposed to this temperature for about five minutes. The milk can also be heated to a higher temperature, for example, 90° C., whereby, however, it is exposed to this temperature for a very short time only, that is, 1–5 seconds. Any other temperature between 70° C. and 90° C. can also be used, whereby, however, the period of exposing the milk to the respective temperature, must be selected correspondingly. The milk to be pasteurized can pass through the preheater 3 in a continuous stream.

Under certain conditions it may become necessary to interrupt preheating of the fresh milk in order to degas the same. This becomes necessary, particularly, if certain undesirable odorous substances and substances having an undesired taste, which are derived from certain specific fodder materials fed to the cows, must be removed from the milk; and also in order to prevent tallowy character which, in certain season, adversely affects the quality of the end-product.

In order to bring about such degassing, the milk is discharged from an intermediate stage of preheater 3 and passed through pipeline 3a to the degassing chamber 4. Chamber 4 is connected through pipeline 4a with a suction device which makes it possible to reduce the pressure in the degassing chamber 4 up to a pressure of 50 millimeters of mercury. The degassed milk is then passed through pipeline 4b again to preheater 3, in which it is then heated to the desired final temperature.

The preheated and pasteurized milk is now concentrated, in a manner known in general, to a final concentration of 35–45% by weight of dry material. The temperatures are selected in such a manner that the milk particles are not damaged by heating. For example, in a one-step vacuum evaporator which is operated batch-wise, temperatures between 40° C. and 55° C. are used.

In the diagrammatic illustration according to FIG. 1a, a one-step vacuum evaporator 5 which is operated batch-wise is shown. However, a continuous one-step or multiple-stage evaporating process can also be used.

In the one-step process selected in the example, the preheated and pasteurized milk is passed from preheater 3 through pipeline 5a to the vacuum evaporator 5. The volume of the concentrated milk is approximately equal to 1/3 of the original volume of the whole milk.

The water vapor which is generated in the vacuum evaporator 5 flows through connection 5c to condenser 5d.

The concentrated whole milk is discharged at the bottom of evaporator 5 and pumped into intermediate tank 7 by means of pump 6.

In the use of a continuously operated multi-stage evaporating process (which is not illustrated in the drawings) the temperatures are reduced from stage to stage. For example, the temperature in the first stage may be 60° C.-75° C., and in the last stage said temperature may be 30° C.-45° C.

From the intermediate tank 7, the concentrated milk flows to the homogenizer 8. This homogenizer is of conventional construction, in which the milk is pressed under high pressure through a narrow slit which is provided with several sharp-edged projections in order to produce a high degree of dispersion of the milk. The temperature of the concentrated milk at the entrance into the homogenizer is 40° C.-60° C. and the pressure at the front of the homogenizing slit amounts to 150-300 atmospheres in excess of atmospheric pressure. If necessary, the concentrated whole milk has to be heated to the temperature above stated. The structure of the product is improved if the concentrate is homogenized a second time, whereby the pressure in front of the slit second homogenizer should amount to 30-300 atmospheres in excess of atmospheric pressure.

For this purpose, homogenizer 8 is followed by a second homogenizer 9. Instead of the two homogenizers 8 and 9, a homogenizing machine can be used which is provided with two homogenizing valves connected in series. The dispersion of fat in the finished powder depends considerably on the condition of the slit-forming elements of the homogenizer and has to be checked periodically.

From homogenizer 9 the milk may be passed through pipeline 9a to the top of a further intermediate tank 10 which serves as a balance tank or equalizing tank between the processing stages of the liquid phase and the subsequent drying processes.

The time of stay of the homogenized concentrate in tank 10 should be as short as possible. If this is not possible, then the milk should be cooled prior to its introduction into tank 10, to a temperature of 5° C.-20° C., preferably 10° C.-15° C. For this purpose, a cooling device 11 of conventional construction is inserted in pipeline 9a and a suitable cooling medium flows through said device.

The above described processing stages of the liquid phase are followed by the drying stage. The concentrate is supplied through pump 12 and pipeline 12a to the spray-drying device 13 of conventional construction. The liquid is discharged from nozzle 14 and is dried by dry air 15 which is passed through conduit 15a. Powder particles which are carried along by the discharged air current through conduit 13a are retained by dust separator 16.

Instead of the drying device 13 diagrammatically indicated in FIG. 1c, the drying device described in U.S. Patent No. 2,353,459 can be used, as an example. The dry air is introduced in this case with a temperature of 120° C.-350° C. The temperature is preferably selected in such a manner that the waste air, enriched with moisture, leaves the drying device with a temperature of 55° C.-75° C. In colliding with the jet of dry air, which must have a sufficient velocity, the liquid jets are atomized to finest droplets. Simultaneously with the atomizing of the liquid droplets, the moisture contained therein is vaporized almost instantaneously. Due to the cooling resulting from evaporation, the dry material of the milk particle is not damaged by the heat. Damage by heat of the protein substances at this point could have disadvantages in several respects. On the one hand, the materials damaged by heat would lose their solubility in water, and their taste would change. On the other hand, the protein coverings which enclose the fat particles would be destroyed, so that fat would be freed and could adversely affect the reconstitution of the whole milk powder in water.

The powder particles deposited at the bottom of drying device 13 are discharged by the discharge device 17 from the drying device 13 and deposited on a transport device 18. At the same time, transport device 18 serves for cooling of the dried powder. For this purpose, it is provided with a suitable cooling device. The whole milk powder should be subjected to as little mechanical strain as possible, in order to avoid damage to the protein coverings enclosing the fat particles.

The dry whole milk powder which is now in the form of very fine particles, and in this form easily forms lumps upon mixing with water, is then introduced into an agglomerating device 19, in which the individual powder particles are rendered adhesive by superficial moistening with water and are caused to agglomerate.

An elevator 20 passes the milk powder coming from drying device 13 mechanically or pneumatically to the charging device 21. The steam supplied through pipeline 19a may be saturated, have a temperature of about 100° C., and its pressure may be lowered to atmospheric pressure. It can also be mixed with finest droplets of water. By means of dry air supplied through conduit 19b, the agglomerated powder is dried to the final moisture content of 2-3%, which is suitable for storage. The hot air enters the agglomerating device 19 at a temperature of 90° C.-150° C., and it leaves the device, after taking up moisture, through conduit 19c and dust separator 22, which retains carried-along powder particles.

The agglomerated and dried powder is taken out from the agglomerating device through the discharge device 23 and transported by means of conveyor device 24 to storage tank 25. The conveyor device 24 serves simultaneously for cooling the product to room temperature and is provided for this purpose with a suitable cooling device. Here again easy handling is desirable.

From storage containers 25, the finished milk powder is filled as quickly as possible into the shipping containers which are filled with nitrogen. The pressure in the container can be somewhat higher than the external pressure. However there can be also a reduced pressure in the container in comparison with the external pressure.

Whole milk powder prepared according to this process retains in the nitrogen-filled containers, which are sealed from air and moisture, at storage temperatures up to 30° C., its good miscibility with water and its complete solubility in water for 6-12 months.

A novel characteristic of this whole milk powder consists in that, in addition to instant miscibility with warm water up to 80° C., it is instantaneously miscible also with cold water at 5° C.-20° C. and is easily and completely soluble in such water.

If this improved whole milk powder is stirred in water at 20° C. by hand with a spoon or a stirring instrument, said powder mixes with water immediately and dissolves in it without the formation of difficultly soluble lumps. However, the powder can be used also for the preparation of a cold milk beverage, in that it is possible to mix it with and dissolve it in water of 5° C.

In the laboratory, this characteristic can be checked by pouring 22 grams of said milk powder in a glass beaker upon 150 cubic centimeters of water at 5° C., and stirring by hand with a stirring instrument. Upon such stirring by hand, the powder does not form lumps which can be disintegrated or dissolved only with difficulty. In this experiment, the above-mentioned amounts of powder and water are so selected, that the resulting milk contains the same amount of dry solids as fresh milk.

If the above test is carried out with hitherto commercially available whole milk powders produced by spray-drying, the powder particles form lumps which can be distributed only with much trouble.

There is a difference between whole milk powder which contains the whole amount of fat of the original

cow milk, and skim milk powder which has a very low fat content and is, therefore, easily miscible with water even if it is produced according to one of the known processes.

Another conspicuous distinguishing characteristic, which is essential in practical use, of the novel powder, in comparison with the hitherto known whole milk powders, consists in that the powder prepared according to this invention automatically disperses and dissolves in water. This characteristic can be checked in the laboratory by pouring 22 grams of the powder onto the surface of 150 cubic centimeters of water, in a uniform layer, in a cylindrical glass beaker having an inside diameter of 60 millimeters. The temperature of the water should be 20° C. The whole milk powder which is the subject matter of this description, sinks below the surface of the water, without stirring the water and disperses in the water at once, without forming lumps. Within two minutes, all particles of the milk powder are dissolved in water. Practically all the powder particles are dissolved before they reach the bottom of the beaker. This result could not be obtained with the hitherto known milk powders produced on a commercial scale according to the spray-drying process.

The complete solubility of the milk powder prepared according to the above described process, can be demonstrated by a centrifuging test. Twenty-two grams of said powder are dissolved in 150 cubic centimeters of water at 20° C., by stirring by hand with a spoon for 20–30 seconds. The dissolved powder is centrifuged in a centrifuge for at least 30 minutes. The acceleration of centrifuging corresponds to 600 times the acceleration due to gravity. After 30 minutes' centrifuging, no undissolved particles are observed on the bottom of the centrifuging tube, by the naked eye or on microscopic examination of a sample at a magnification of 320. It has been found that none of the hitherto marketed whole milk powders is capable of meeting this test.

A characteristic of the above described milk powder, which is decisive for solution of said milk powder in water, can be microscopically observed by means of the so-called "hanging water drop" test.

In order to carry out this test, a few powder particles are placed on a hollow object carrier, which is covered by a cover glass, on the lower surface of which a drop of water hangs. However, the drop is not in contact with the powder particles and has merely the object of creating an atmosphere saturated with water vapor around the powder particles. The edges of the cover glass are sealed on all sides relative to the object carrier, so that the hollow space containing the powder particles and the hanging drop of water is sealed from the outer atmosphere. The temperature is kept between 20° C. and 30° C. In order to avoid rise of the temperature over said limits, during intensive illumination of the object, it is necessary to insert an infrared absorption filter in the path of rays in front of the object carrier. The microscope which is used in the test has a magnification of 150.

Due to the effect of the atmosphere saturated with water vapor, the powder particles take up moisture so that a bubble of water enclosing the particles is formed. The changes which take place in the agglomerated powder particles during the take-up of water permit making conclusions with regard to the re-solution of the whole milk powder in water.

At the start of the observation, when the powder still contains the normal storage moisture of 2–3% by weight, the irregular contours of the agglomerated powder particle can be seen. In whole milk powder prepared according to the above described process, the small bulges on the agglomerated powder particles are leveled after thirty seconds, and the individual powder particles, which originally adhered, become arranged to a loose spherical structure. After about one minute from the start of the

observation, a sheath of water can be seen around the spherical structure, which slowly loses its granular structure.

The water bubble contains lactose and milk salts in dissolved condition. Its dimensions increase slowly while the individual grains of the agglomerated powder particles separate from each other and become uniformly distributed in the water bubble. This condition is attained in the beforementioned powder in 2–3 minutes. The behavior of the powder particles in the "hanging drop of water" test is illustrated by a microscopic picture with a magnification of 100 in the appended drawings.

FIGS. 2a, 2b, 2c and 2d illustrate a whole milk powder produced by the above described process.

FIG. 2a shows the condition at the start of the test; FIG. 2b the condition after being 30 seconds under the "hanging drop of water"; and FIG. 2c shows the condition one minute after the start of the test. In FIG. 2c, the water sheath which spherically encloses the agglomerated powder particle, can be seen. FIG. 2d shows the powder particle two minutes after the start of the test and shows that the drop of the liquid around the powder particle has grown considerably and that the individual powder grains, which were stuck together previously, are now separated from each other and uniformly distributed in the drop of the liquid.

In comparison to the above-mentioned whole milk powder, FIGS. 3a, 3b, 3c and 3d, and 3e show the behavior of a particle of whole milk powder taken from a marketed product.

FIG. 3a shows again a milk powder particle at the start of the test. Its contours permit one to recognize that it is an agglomerate of several finer powder grains. FIG. 3b shows the condition 30 seconds after the start of the test; FIG. 3c after two minutes; FIG. 3d after four minutes; and FIG. 3e after eight minutes, beginning from the start of the test. The original agglomerated structure of the powder particle can be still clearly seen in FIG. 3e. A sheath of water has just started to form. FIG. 3e also shows that the agglomerated powder particle has not as yet disintegrated into individual grains, after eight minutes, in contrast to the previously described whole milk powder. As shown by further examination, in this old-style powder the lactose is present in crystalline form.

FIGS. 4a, 4b, 4c, 4d, 4e and 4f are representations of micro-photographs of a milk powder particle of another old-style whole milk powder which has been likewise taken from a marketed product. A water bubble has formed immediately around the powder particle. FIG. 4f, which is a representation of a powder particle which has been under the "hanging water drop" for 8 minutes, shows, in contrast to the improved milk powder produced according to the herein described process, that the agglomerated powder particle has not yet dissolved to individual grains, and still forms a compact core surrounded by an aqueous layer.

This different manner and velocity by which the agglomerated powder particles are dissolved in the "hanging water drop" test within the water bubble formed around these particles, indicates a different behavior of the various whole milk powders upon re-solution in water. The whole milk powder shown in FIGS. 2a–2d which has been produced according to the herein described process, mixes better with water and dissolves more quickly than the old-style whole milk powders made according to FIGS. 3a–3e and FIGS. 4a–4f.

The whole milk powder produced according to the herein described process is further distinguished by a low percentage of free fat. The term "free fat" is used here to denote fat which can be extracted by means of anhydrous ethyl ether according to the Soxhlet method described hereinafter.

In order to carry out this analytical method, a measured amount of 150–250 grams of whole milk powder is

extracted in a Soxhlet apparatus with ether which is free from water and peroxide, for 2½ hours, during which time the ether solution of the fat is kept at almost 40° C., by means of a water bath. This solution has to be protected from light during extraction as much as possible. About 100 cubic centimeters of anhydrous ethyl ether are used for the extraction of free fat from 150–250 grams of powder.

After the extraction has been completed, the ethyl ether is distilled off so that a residue of about 30–40 cubic centimeters is obtained. The residue is filtered into a previously weighed Erlenmeyer flask of 100 cubic centimeters volume. The filter and the extraction flask which contain said residue are washed twice with 5 cubic centimeters of anhydrous ethyl ether in order to dissolve all free fat. The washing liquids are added to the filtrate of the residue. The ethyl ether is then completely distilled off from the filtrate whereby the Erlenmeyer flask has to be heated in a water bath at a maximum of 60° C. of water temperature. The Erlenmeyer flask containing the residue is then kept in an exsiccator during a period of about one hour, under vacuum. The flask containing the residue is weighed and the weight of the free fat is thus determined.

Comparison of whole milk powder resulting from the herein described process, with old-style whole milk powder obtainable on the market shows that the new whole milk powder contains one-tenth percent to one percent by weight of free fat, in most cases two-tenths percent to five-tenths percent, based on the total dry substance.

In whole milk powders prepared according to the hitherto known spray-drying processes, one percent to ten percent free fat is found, and in whole milk powders dried under vacuum, five percent to twenty percent.

The solubility of the whole milk powder is affected also by the condition of the protein substances. The most sensitive protein substances are those contained in the serum of the milk. Damage by heat primarily affects the latter. The percentage of the protein substances which remains still dissolved in the serum is, therefore, an indication of the thermal damage of the dry milk substance by the procedure used for treating the milk. Whole milk powder produced according to the herein described process is distinguished from conventional products by a lower portion of denatured albumen substances. While it is possible according to the herein described process to obtain the casein in undamaged condition, the denaturation of those serum proteins must be accepted, because they are as sensitive as certain ferments which are deliberately destroyed in order to improve the stability of the end product. In the serum of reconstituted milk obtained from whole milk powder prepared according to the herein described process, about 65% by weight of the original serum proteins of fresh cow milk are preserved in non-denatured condition, while in conventional spray-dried whole milk powder not more than 20% by weight of the original serum proteins are found in a condition undamaged by heat.

Determination of the above described denaturation of protein substances in the serum of milk is based on the determination of protein nitrogen, whereby the amount of nitrogen is determined, which is chemically combined in the proteins dissolved in the serum of reconstituted milk.

The analytical methods used for this determination are described in the following literature:

S. J. Rowland: "The Determination of Nitrogen Distribution in Milk," *Journal of Dairy Research* 9, 42–46, 1938;

Shahani and Sommer: "The Protein and Non-Protein Fractions in Milk," *Journal of Dairy Science*, 34, 1003–1013, 1951.

Good dispersibility of the whole milk powder in water, depends to a great extent on the distribution of fat in the milk powder. In whole milk powder prepared according to the herein described process, the particle size

of the fat globules does not exceed one micron. This refers to the condition of the fat particles in the dry powder, because upon re-resolution of the milk in water, due to unsuitable stirring, the individual fat particles may unite to larger particles. In ordinary milk powder prepared from whole milk according to known methods, the particle size of the fat globules amounts to 2 microns and often more.

Dispersion of the fat particles in dry powder can be best examined microscopically by N. King's method with the application of fluorescence technics. This method is described in the *Journal of Dairy Research*, 22, 205–210, 1955; N. King: "Fluorescence Microscopy of Fat in Milk and Milk Powder."

In observing the milk powder particles under the microscope by fluorescent light, the fat particles appear to have a yellow color and the fat-free dry substance appears to have an orange-red color. In old-style whole milk powder particles prepared according to one of the hitherto known processes, at a magnification of 370, an orange-red network can be seen, which is caused by thermally damaged protein substances and in which the individual coarse-grained fat globules are embedded. An enlargement of a section of such milk powder particle is shown in FIG. 5. The total magnification of the milk powder particle represented by FIGURE 5 amounts to about 2200. The bright spots represented in FIGURE 5, correspond to the fat particles, while the albumen ingredients are represented as being dark.

In contrast to this example, in whole milk powder particles prepared according to the herein described process, no net structure can be seen at a magnification of 370 under fluorescent light. Fat and protein substances appear homogeneously distributed. FIG. 6 is a showing on the same scale as FIG. 5, of a powder particle obtained by the herein described process. The homogeneous distribution of fat in the undamaged protein substance can be easily seen.

In the herein described process, the lactose is present in the finished product in amorphous form. As the powder is kept in an atmosphere of inert gas in containers sealed from air and water vapor, the lactose does not change its condition.

An important characteristic of the whole milk powder according to the herein described process, consists in that the previously mentioned small particle size of the fat particles and the low percentage of free fat, are present simultaneously. This combination of characteristics, together with the low degree of denaturation of the protein substances and the amorphous condition of the lactose are responsible for the high miscibility with cold water and complete solubility in water.

The milk obtained by dissolving whole milk powder according to the herein described process, has only a slight or no cooked taste derived from processing. Its color is white like that of fresh milk.

The above described characteristics are preserved for 6–12 months while the milk powder is stored in sealed containers filled with nitrogen, at storage temperatures not exceeding 30° C. In contrast to this, the solubility and miscibility of "instant" whole milk powders produced according to hitherto known methods, are reduced very soon after their preparation.

The new process includes several factors for minimizing the denaturation of the proteins of the milk serum. This undesirable denaturation of the proteins of the serum of the whole milk is cumulative, and the entire process is regulated so as to minimize this undesirable effect, so that the proteins of the milk serum remain easily soluble in and miscible with cold water.

For example, in making a whole milk powder from cow's milk, the usual temperature of pasteurization of the liquid whole milk is between 90° C.–115° C. In the new process, the maximum temperature of pasteurization of the whole cow's milk is 90° C., and if the pasteurization

zation temperature is as high as 90° C., the period of pasteurization should be as short as possible, in order to minimize the denaturation of the protein of the milk serum.

The sensitivity of the protein of the milk serum to denaturation during the concentration of the milk depends upon the degree of concentration and upon the temperature of the concentration. These factors are selected so as to minimize the denaturation of the milk serum. Also, the temperature during homogenization is selected so as to minimize denaturation of the serum protein.

We claim:

1. A process for making from whole milk a whole milk powder which is easily miscible with water, which consists in the steps of preheating said milk at a temperature and during a period sufficient to kill noxious bacteria and to render harmless ferments of said whole milk which injure the stability of said powder, then concentrating said milk under vacuum, then homogenizing the concentrated milk, and then spray-drying the homogenized milk to particle form and aggregating the particles of spray-dried milk powder, and then packing said whole milk powder, said homogenizing being sufficient to provide said powder with fat globules whose maximum particle size in said powder is one micron, and controlling denaturation of the protein of the milk during said steps by limiting the heating thereof during said steps, whereby there is provided whole milk powder with not more than substantially one percent by weight of free fat calculated on the total solids of said powder, and in which the lactose thereof is in the amorphous condition.

2. A process according to claim 1 in which said preheating temperature and said preheating period are in a range of substantially 70° C. for five minutes and 90° C. in a period of one to five seconds.

3. A process according to claim 1, in which the preheated whole milk is concentrated in a single-stage concentration at a temperature of substantially 40° C.-55° C.

4. A method of making a powder from whole cows' milk, said powder having at least 24 percent by weight of butter fat; not more than substantially 1% by weight of free-fat calculated on the total solids of said powder, having at least about 65% by weight of the original serum protein of the whole milk present in the milk powder in

undenatured condition, and being easily miscible with water; which consists in pasteurizing said milk during a period of substantially five minutes at substantially 70° C.; evaporating enough water from said milk to produce a concentrated whole milk which has substantially 35% to 45% by weight of solids; said evaporation being conducted at a temperature of substantially 40° C. to substantially 55° C.; homogenizing said concentrated milk at substantially 40° C. to substantially 60° C. to provide a particle size of fat which is a maximum of substantially one micron; spray-drying said homogenized milk by spraying it into a spraying chamber while evaporating the water from said sprayed homogenized milk to provide substantially dry particles, by a current of hot air at an inlet temperature of 120° C.-350° C. which is passed through said spraying chamber to evaporate substantially all the water from the sprayed homogenized milk and an outlet temperature of 55° C.-75° C.; and agglomerating said powder particles and reducing their water content to a maximum of substantially 3% by weight by impinging a current of steam on said substantially dry particles and drying the steamed particles to said water content.

5. A process according to claim 2, in which the preheated whole milk is concentrated in a single-stage concentration at a temperature of substantially 40° C.-55° C.

6. A process according to claim 1, wherein denaturation of the protein is controlled so that at least about 65% by weight of the original serum protein of the whole milk is present in the milk powder in non-denatured condition.

7. Whole milk powder made by the method of claim 1.

8. Whole milk powder made by the method of claim 4.

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