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PUFFED FARINA AND METHOD OF MAKING SAME

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This invention relates to a puffed cereal and method of preparing same, and particularly to puffed farina.

The present application is a continuation-in-part of my copending application, Serial No. 296,963, filed July 2, 1952, now abandoned, which in turn is a continuation-in-part of my applications, Serial No. 40,630, filed July 24, 1948, now abandoned, and copending Serial No. 189,679, filed October 11, 1950, now abandoned. My application, Serial No. 189,679, filed October 11, 1950, was a continuation-in-part of my following applications: Serial No. 34,821, now abandoned; Serial No. 34,822, now abandoned; and Serial No. 34,823, now abandoned, all filed July 23, 1948; Serial No. 23,869, filed April 28, 1948, now abandoned; Serial No. 38,179, filed July 10, 1948, now abandoned; and Serial No. 40,630, filed July 24, 1948, now abandoned.

Reference is had to the related cases of John M. Baer and Frank B. Doyle, Serial No. 62,984, filed December 1, 1948; Allison and Carman, Serial No. 161,744, filed May 12, 1950, now abandoned; Carman and Allison, Serial No. 259,313, filed November 30, 1951, now abandoned; and Carman and Allison, Serial No. 275,458, filed March 7, 1952, now abandoned.

The problem of puffing organic cellular material such as farina involves a large number of interlocking variables. The farina cells are such as will trap expanding gas and thus provide the pressure differential necessary for puffing. A sudden drop in pressure must be provided of such amount to produce the pressure difference necessary not only to expand the cell walls but to do so in spite of the leakage that necessarily occurs. On the other hand, the pressure difference must be great enough to exceed the elastic limit of the material before puffing has occurred. The expansibility of the cell wall normally depends upon the moisture content of the product, the condition of that moisture as to being free or combined, the temperature of the article and its chemical condition, particularly as to whether it is cooked or uncooked.

Likewise, there must not only be the pressure difference required to institute puffing, but there must be a volumetric increase of the gases involved sufficient to maintain it.

I have now found that another factor involved, which has hitherto been completely overlooked but the accomplishment of which is inherent in the operation described in my previous applications referred to, is that once the farina has been puffed, the puffed condition must be maintained

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even after the pressure difference has been removed. One of the difficulties encountered in many instances of puffing in the prior art was that the farina could be puffed, but after puffing would collapse because of the weakened condition of the walls following the leakage out of the gas which produced puffing. This was particularly true if, after puffing, the pressure outside of the puffed farina was increased.

I have now found that by suddenly cooling and dehydrating the product so that its final temperature is below 150° F. and preferably well below 100° F.—as for example, from 32° F. or lower up to, say, 100° F., that the cell walls of the product on puffing are cold set so that on standing or on the application of pressure, even of a greatly increased amount, collapse does not occur.

These results are obtained automatically by following the procedures already outlined in my previous applications. In these procedures, the following points are important:

1. Substantially all of the air should be removed from the product and replaced by an atmosphere of steam prior to puffing.

2. The product should be cooked or moistened by steam or otherwise, preferably by the addition of substantially air-free steam at higher pressure and temperature until the condition of the material is proper for puffing and its moisture content is within the desired range. The use of the process permits the introduction of substantially more moisture than was permissible under the old processes.

3. It is preferred that the sudden release of pressure be into a maintained vacuum zone which is initially below 8 inches of mercury absolute. The conditions of the resulting explosion should be such as to cause cold setting of the puffed farina. This means that in actual practice, employing commercially practicable vacuum equipment, the pressure may ride up somewhat during the puffing step. It is preferred to continue evacuation of the vacuum zone during the puffing step so as to cause cold setting of the puffed farina. The expansion of air-free steam into a vacuum of 4 inches of mercury absolute will automatically reduce the temperature of the product to approximately 125° F. Reduction of the pressure to 2 inches reduces the temperature approximately to 100° F. Reduction to 1 inch reduces it to about 79° F. and reduction to 0.2 inches reduces it to approximately 34° F.

Furthermore, by puffing into a maintained vacuum, it is possible to obtain a greater temperature drop in number of degrees between the maximum and minimum than was ordinarily obtainable heretofore. The result of this greater temperature drop was to permit the evaporation of more water from the product by boiling into steam. This boiling not only maintained the pressure difference for puffing, but the removal of the water helped to cold set the cell walls by reducing plasticity and elasticity. The combination of the moisture reduction plus chilling, particularly below 100° F., has produced results not heretofore obtainable.

In a vacuum process, this reduction of temperature is of particular significance, since the lower the vacuum used the greater is the increase in pressure after the completion of the puffing operation when the material is taken back into the atmosphere. If it were not for the cooling and drying effect, many products would not be able to maintain their puffed condition when the pressure is increased, for example from 2 inches absolute to 30 inches absolute—an increase of fifteenfold.

The removal of the air from inside the farina particles in the first instance has a number of advantages. In the first place, the oxygen of the air has a deleterious effect on the farina particles, particularly when they are heated. Secondly, the removal of non-condensable gases increases the permeability of the farina particle to heat and to steam so that heating will occur uniformly and the steam will penetrate equally to all portions of the farina.

Thus, when it comes to introducing steam for increasing the moisture content of the product and for cooking it to the necessary chemical and physical conditions, the fact that air is not present inside the farina grains produces a rapidity and uniformity of steaming and cooking not otherwise possible. Because of this greater uniformity and speed, it is possible to go to higher temperatures and pressures than would otherwise be possible. Normally, however, it permits the use of lower temperatures and pressures than otherwise required.

The Doyle patent, No. 2,627,221, which issued February 3, 1953, shows a puffing apparatus particularly suitable for carrying out the processes herein described. In such an apparatus a steaming chamber is provided within which the product may be placed. This steaming chamber is connected by a triggered door to an expansion chamber. The expansion chamber is preferably kept at a very low pressure, means being provided to maintain a low pressure during the puffing. The steaming chamber is provided with evacuating means, steaming means, and usually with a purge line through which non-condensable gases can be eliminated as well as some condensed steam which is developed during steaming.

As an example of the process, farina was introduced to the steaming chamber. Air and other non-condensable gases were removed from the farina grains by reducing the pressure in the steaming chamber to about 0.2 inch of mercury absolute while withdrawing the generated steam. Saturated steam was then introduced and the pressure increased to 75 pounds per square inch gauge, and held at this point for two minutes to substantially completely cook the material without loss of cellular identity. The farina was then fired into the expansion chamber which in this instance was at a pressure of 0.2 inch of mercury absolute. This firing is done by suddenly releasing the triggered door of the expansion chamber and the resulting explosion ejects the farina into the expansion chamber.

The actual values of the variables in the cooking-puffing cycles of this method depend upon the condition and type of farina being used, as well as the degree of puffing desired.

The farina grains in their normal dry state may be employed without moistening. However, in some instances, it may be desired to supply flavor and/or moistening, and/or nutritional values to the grain, prior to, during, or after puffing. This may be done by the use of a liquid carrier, such as water, under high temperature and pressure which is exploded into the vessel maintaining the product under high vacuum in an atmosphere of steam. By using water under a pressure and temperature corresponding to that, of say, 100 pounds gauge of steam, the particles may be exploded into a fine mist which will penetrate the grains, particularly after they have been puffed. In this way moisture, sugar, salt, certain vitamins, and nutritional salts may be supplied to the material with or without other flavoring agents. This may be done immediately following the initial evacuation (i. e., during cooking) or immediately following the puffing. It is less economical to do it at some intermediate stage.

The farina should be thoroughly cooked for desirable puffing. I have found that cooking at from about 40 to 100 pounds steam pressure gauge for a period of about 2 minutes produces satisfactory results. Following cooking, the steam pressure was adjusted to from 40 to 100 pounds gauge, after which the pressure was then immediately reduced to sub-atmospheric, preferably below 8 inches of mercury absolute and particularly to about 0.2 inch of mercury absolute. This was done by opening the triggered door of the puffing apparatus and firing the farina into the expansion chamber. The pressure within the expansion chamber was maintained at a low point by continuing the evacuation during the puffing and normally the pressure in that chamber was not permitted to exceed 4 inches of mercury absolute and preferably not permitted to exceed 2 inches of mercury absolute. In some instances, however, I have operated successfully with the pressure in the expansion chamber following the explosion riding up to as high as 4 to 8 inches of mercury absolute as measured on a standard mercury manometer, but in most instances the pressure was reduced below 4 inches of mercury absolute within a few minutes and before reimposition of atmospheric pressure.

The resulting vacuum puffed farina has a volume of from about 3 to 8 times the original farina particles as determined by cup weights. Put conversely, the specific gravity as determined by cup weights is from about 12½% to 33⅓% of the specific gravity of the original farina particles. The shape of the original particles is roughly maintained although the outer surface of the puffed material is rough. The product is not case hardened so far as can be observed. The vacuum puffed farina is not transparent but is translucent, having a milky-white appearance.

Examples of applying the method of this invention to farina are:

Example 1

Farina (5 pounds) was placed in the steam chamber and the pressure reduced to about 0.2 inch of mercury absolute for 2 minutes, the farina being at a temperature not less than about 40° F., to remove substantially all of the non-condensable gases. The farina was then quickly steamed to a pressure of 75 pounds per square inch gauge, held there for 2 minutes accompanied by continual purging of the steam, and then fired into the expansion chamber which was at a pressure of 0.2 inch of mercury absolute. Evacuation of the expansion chamber was continued during the puff until the farina particles were cold set.

Example 2

Farina (5 pounds) was placed in the steam chamber and the pressure reduced to about 0.2 inch of mercury absolute for 2 minutes, the farina being at a temperature not less than about 40° F., to remove substantially all of the non-condensable gases. The farina was then quickly steamed to a pressure of 60 pounds per square inch gauge, held there for 2 minutes accompanied by continual purging of the steam, and then fired into the expansion chamber which was at a pressure of 0.2 inch of mercury absolute. Evacuation of the expansion chamber was continued during the puff until the farina particles were cold set.

Example 3

Farina (5 pounds) was placed in the steam chamber and the pressure reduced to about 0.2 inch of mercury absolute for 2 minutes, the farina being at a temperature not less than about 40° F., to remove substantially all of the non-condensable gases. The farina was then quickly steamed to a pressure of 40 pounds per square inch gauge, held there for 2 minutes accompanied by continual purging of the steam, quickly steamed to 75 pounds per square inch gauge, and then fired into the expansion chamber which was at a pressure of 0.2 inch of mercury absolute. Evacuation in the expansion chamber was continued during the puff until the farina particles were cold set.

Example 4

Farina (5 pounds) was placed in the steam chamber and the pressure reduced to about 0.2 inch of mercury absolute for 2 minutes, the farina being at a temperature not less than about 40° F., to remove substantially all of the non-condensable gases. The farina was then quickly steamed to a pressure of 100 pounds per square inch gauge, held there for 2 minutes accompanied by continual purging of the steam, and then fired into the expansion chamber which was at a pressure of 0.2 inch of mercury absolute. Evacuation in the expansion chamber was continued during the puff until the farina particles were cold set.

Example 5

Farina (20 pounds) was placed in the steam chamber and the pressure reduced to about 0.2 inch of mercury absolute for 2 minutes, the farina being at a temperature not less than about 40° F., to remove substantially all of the non-condensable gases. The farina was then steamed to a pressure of 50 pounds per square inch gauge, held there for 2 minutes, quickly steamed to 70 pounds gauge, and then fired into the expansion chamber which was at a pressure of 0.2 inch of mercury absolute. Evacuation in the expansion chamber was continued during the puff until the farina particles were cold set.

Example 6

Farina (20 pounds) was placed in the steam chamber and the pressure reduced to about 0.2 inch of mercury absolute for 2 minutes, the farina being at a temperature not less than about 40° F., to remove substantially all of the non-condensable gases. The farina was then quickly steamed to a pressure of 40 pounds per square inch gauge in 30 seconds, held there for 2 minutes accompanied by continual purging of the steam, and then fired into the expansion chamber which was at a pressure of 0.2 inch of mercury absolute. Evacuation in the expansion chamber was continued during the puff until the farina particles were cold set.

Following puffing, the farina is preferably dried under the puffing vacuum without re-exposure to air. It is generally desirable to be below the normal equilibrium moisture content of the material. This usually means a drop of about 3% in the drying operation. Drying is preferably accomplished by radiant heat under the vacuum.

Vacuum puffed farina may be dried by other means—as by oven drying. Oven drying produces case hardening and some toasting. For some purposes a slight case hardening and toasting are suitable and may be desirable. The case hardening markedly slows down absorption of aqueous liquids.

When the vacuum puffed farina prepared in the manner described above is mixed with cold or hot milk, it is ready for consumption within ½ minute or less. Thus, this vacuum puffed farina is a ready-to-eat cereal.

A number of runs were made to determine the rate of hydration of the vacuum puffed farina of this invention. For each run, the hydration determinations were made using 180 gram samples. One sample of each run was placed in a container having one quart (946 grams) of water maintained at about 70° F. After 1, 5, 10, and 20 minute intervals, the water-farina mixture was poured into a strainer while substantially all of the free water passed into a measuring cup in from 10 to 20 seconds. After weighing the free water, it and the farina were again placed in the container. The difference in weight between the free water in the container just prior to placing the farina sample therein and the weight of free water at each time interval was the amount of water absorbed by the farina at that particular time.

It was found that the amount of water absorbed by the vacuum puffed farina was more than 400% of the original dry weight of the farina after 5 minutes. When compared with the hydration of commercial farinas, the farina product of this invention absorbs approximately 3½ times as much water at the end of 5 minutes than a commercial farina under the same conditions.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom for some modifications will be obvious to those skilled in the art.

I claim:

1. The method of puffing farina which comprises freeing farina particles from air and replacing the air with an atmosphere of steam, cooking the farina particles for a period sufficient to soften the cell walls and adapt them for puffing, then subjecting the farina particles to a sudden change from a high super-atmospheric pressure to a low sub-atmospheric pressure whereby they are puffed.

2. The method as set forth in claim 1 in which the farina particles are cooked under a pressure

of steam of approximately 40 to 100 pounds per square inch gauge.

3. The method as set forth in claim 1 in which the farina particles are cooked under a pressure of steam of approximately 40 to 100 pounds per square inch gauge, the pressure adjusted to from about 40 to 100 pounds per square inch gauge, and then instantaneously reducing the pressure by shooting the farina particles into a low sub-atmospheric pressure whereby they are puffed.

4. The method as set forth in claim 1 in which the farina is cooked for a period of about 2 minutes at a pressure of from about 40 to 100 pounds per square inch gauge.

5. The method which comprises cooking farina in an atmosphere of steam, suddenly reducing the pressure below 8 inches of mercury absolute to puff the farina, and then drying the puffed farina under the sub-atmospheric pressure.

6. The method as set forth in claim 5 in which the drying is accomplished while supplying heat to the farina.

7. The method which comprises puffing farina by a sudden reduction in pressure in an atmosphere of steam and concluding the operation at an absolute pressure substantially below 8 inches of mercury absolute, and then introducing a volatile liquid at a temperature sufficiently high to have an internal vapor pressure markedly above atmospheric, said mist containing additive flavoring or nutritive ingredients, whereby the liquid explodes into a fine mist and penetrates the farina.

8. In the puffing of farina, the steps of heating the farina in the presence of moisture to produce a super-atmospheric steam pressure thereon and then puffing the product into a maintained vacuum sufficiently low to cold set the product by evaporation of moisture from and consequent cooling of the product and reimposing atmospheric pressure upon the product while in cold set condition.

9. The process of claim 8 in which the puffing operation is carried out as a batch process, the puffing being into a vacuum which is initially at substantially absolute zero pressure and which rises during the puffing operation to a point not above an average pressure of 4 inches of mercury absolute.

10. The process of claim 8 in which the puffing operation is carried out as a batch process, the puffing being into a vacuum which is initially at substantially absolute zero pressure and which rises during the puffing operation to a point not above an average pressure of 2 inches of mercury absolute.

11. The method of claim 8 in which the product is dried after the puffing operation is complete but before reimposition of atmospheric pressure.

12. The method of claim 8 in which the temperature of the product is reduced below 100° F. before reimposition of atmospheric pressure.

13. The method of claim 8 in which the temperature of the product is reduced below 50° F. before reimposition of atmospheric pressure.

14. The method of claim 8 in which the temperature of the product is reduced below 150° F. before reimposition of atmospheric pressure.

15. A cold set, vacuum puffed, farina product produced by the method as set forth in claim 8.

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