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DEHYDRATION OF POTATOES BY DIFFUSION

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A non-exclusive, irrevocable, royalty-free license in the invention herein described, for all governmental purposes, throughout the world, with power to grant sub-licenses for such purposes, is hereby granted to the Government of the United States of America.

This invention relates to the dehydration of cooked, mashed potatoes.

An object of the invention is to provide an improved method for production of dehydrated potato. A particular object is to provide a method for dehydration of cooked, mashed potatoes whereby a white, free-flowing, granular product is obtained, which product is easily rehydrated to yield edible potato of pleasing color, texture, and flavor.

According to the invention, cooked, mashed potatoes are mixed with a water-miscible, volatile organic solvent such as a lower saturated aliphatic alcohol or ketone to make a slurry. This is then placed in a plastic container made of a thin sheet or film of regenerated cellulose and the container exposed to air, preferably at a somewhat elevated temperature.

Both water and the organic solvent diffuse through the container wall and evaporate, though not in the same ratio as they exist within the container. We have found that under proper conditions the diffusate consists almost wholly of water and the loss of organic solvent is very small.

After about 60 percent of the water originally present in the slurry has been evaporated the slurry may be filtered and the cake broken up and dried in any convenient manner to yield a free-flowing granular product in which most of the potato cells are intact and which, therefore, is easily rehydrated to yield mashed potato having a color, flavor, texture, and consistency closely resembling fresh mashed potato.

The preferred solvent in our process is ethanol, though we can also use methanol, propanol, isopropanol, tert-butanol, acetone or methyl ethyl ketone. The proportion of solvent used may be varied widely. In order to maintain the slurry in a semiliquid condition so that it flows readily, it is necessary to use at least about 0.5 part by weight of solvent per part of mashed potato. On the other hand, it is usually uneconomical to use more than about one part of solvent to one part of potato, especially since the dehydration proceeds at a lower rate when high solvent ratios are used.

The plastic container used in the dehydration step must be made of regenerated cellulose. Containers made of other plastics, such as cellulose acetate, cellulose nitrate, polyvinyl chloride, or polyethylene are inoperative in our process. The rate of dehydration is proportional to the surface exposed; hence it is desirable to use a container having a high ratio of surface to volume. Because of this, and because of the desirability of operating the process continuously, we prefer to use cellulose tubing. The slurry can then be circulated through the tubing, the length of tubing and rate of flow being adjusted to achieve the desired degree of dehydration during the passage of the material through the tube.

The wall thickness of the plastic container affects the results obtained in two ways. Increasing thickness reduces the rate of dehydration because of decreased rate of diffusion of water through the wall. At the same time, however, the rate of diffusion of the organic solvent is reduced even more; hence the net effect is to decrease

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the rate of water loss and to decrease the ratio of solvent to water lost. In the interest of minimizing the time required in the dehydration step we usually prefer to use the thinnest cellulose film that has sufficient mechanical strength. This thickness will vary somewhat depending on the size and shape of the container, but in the preferred form of a long tube we have found that a thickness of about 1 to 2 mils (0.001 to .002 inch) is satisfactory.

The time required in the dehydration step depends on the temperature, ratio of surface to volume, agitation of the slurry, circulation of air surrounding the plastic containers, etc. Of these factors, temperature is one of the most important. We have operated the process successfully at temperatures varying from about 25° to 80° C. and observed that the rate of dehydration is roughly proportional to the temperature, being about twice as high at 80° as at 40° C. The maximum operable temperature is that at which the slurry boils.

In addition to accelerating the dehydration, higher temperatures are also advantageous in that a lower proportion of solvent is lost by diffusion and evaporation. This is an advantageous and unexpected effect.

Table I summarizes the results of several experiments illustrating the effects of temperature and wall thickness on the rate of diffusion and composition of the diffusate. In these experiments cellulose tubing of two kinds was used. Under columns headed "A" are data obtained with tubing of 1½ inch diameter and one mil wall thickness, while under "B" is shown data obtained with tubing of 1½ inch diameter and two mil wall thickness. In all experiments the tubing was filled with slurry and suspended in a forced draft oven at the specified temperature for seven hours. The slurry was made up of equal weights of potato and ethanol.

Table I

Temp., ° C.	Conc. of water in diffusate, percent		Percent of original liquid lost by evaporation			
			Alcohol		Water	
	A	B	A	B	A	B
80.....	92.3	97.0	4.8	1.6	73.5	65.1
60.....	89.9	92.8	6.0	1.3	67.2	52.9
50.....	83.6	90.7	8.8	2.7	58.0	45.6
40.....	79.4	86.0	9.8	3.1	50.3	34.5
30.....						25.6

The entire process is illustrated by the following example of a typical experiment.

A slurry was made of 253 g. of cooked, mashed potatoes, of about 25 percent solids content, and 253 g. of ethanol. The slurry was placed in cellulose tubing of 1½ inch diameter and 2 mil wall thickness. The tubing was then left suspended in a forced draft oven at 60° C. for eight hours, during which time it lost 121 g. of weight. Analysis of the slurry then showed 15.7 percent solids, 20.6 percent water, and 63.7 percent alcohol.

The slurry was next filtered with suction to yield a cake weighing 109 g. and containing 62.4 percent solids, 9.7 percent water and 27.9 percent alcohol. The filtrate weighed 282 g. and contained 0.58 percent solids, 24.4 percent water, and 75.1 percent alcohol.

The filter cake was broken up and dried 2 hours in an oven at 65° C. to yield a loose, free-flowing powder of which 84 percent passed through an 80-mesh screen and 89 percent passed a 30-mesh screen.

From the above data it can be seen that of the water originally in the potato, 58 percent was removed by diffusion through and evaporation from the cellulose tubing; 32 percent was removed in the filtrate; 5 percent was found in wet filter cake; and 5 percent was unaccounted for.

It is obviously impractical to prolong the dehydration step in which the plastic container is used until complete dehydration is achieved. Fortunately, a considerable proportion of water can be removed in the filtration step with only very minor loss of dissolved solids, as is illustrated in the example above. It has been found desirable

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to remove about 60 percent of the total water in the diffusion step, after which an additional 25 to 30 percent is usually removed in the filtration step, thus yielding a filter cake that is readily crumbled and dried and which when dried yields a loose, free-flowing granular powder. It is desirable that the wet filter cake not contain more moisture than about 50 percent of the total solids; otherwise, lumps are formed in the final drying, thus reducing the yield of screened powder.

Instead of recovering the potato solids from the slurry by filtration, as described above, we can allow the solids to settle and then decant the liquid, or we can centrifuge the slurry. The wet cake can then be dried by any convenient method, such as, for instance, by spreading and exposing to dry air or by use of a hot air oven at a temperature not higher than about 80° C.

We claim:

1. A process of dehydrating cooked mashed potato comprising mixing the potato with about 0.5 to 1 part of ethanol per part of potato thus to form a semiliquid

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slurry, placing the slurry in a regenerated cellulose film container having a wall thickness of about 1 to 2 mils, exposing said container to a current of air for a sufficient time to permit diffusion through the walls of the container and evaporation of at least about 60% of the water in the slurry, and recovering the potato solids from the slurry.

2. The process of claim 1 wherein the diffusion and evaporation is conducted at a temperature in the range of about 25° to 80° C.

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