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POTATO FLAKES. A NEW FORM OF DEHYDRATED MASHED POTATOES
REVIEW OF PILOT PLANT PROCESS[1]

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The purpose of this paper is to review the pilot-plant process for making a new form of dehydrated mashed potato which we have termed "potato flakes." In earlier papers we have described the operation of the double drum drier to produce this product (1), and also discussed in some detail the factors influencing the texture of the reconstituted product (2). A brief summary of these findings and some more recent developments will be included here.

Several forms of dehydrated mashed potatoes are already well-known. The potato granule, which is primarily unicellular in form, has been made by several methods (3). Other physical forms (including a shred and a hollow cylinder) have been made by various extrusion processes. The flake process has an inherent advantage in that it is an easily controlled, direct drying process utilizing familiar drying equipment. Problems of control of appearance and flavor are minimized because the potatoes are ready for drying immediately after mashing and the entire dehydration is accomplished in less than half a minute. A desirable subtle baked potato flavor is imparted during the short drying process.

The process described here is one in which the double drum drier was used. Recent work on a single drum drier of the type normally used in the production of potato flour has indicated its suitability for the flake process.

PILOT PLANT PROCESS

Raw potatoes are abrasive peeled, hand-trimmed and sliced into 5/8 inch thick slices. A pre-cooking step, a newly discovered method of control of texture, is then interposed after which the slices are finally cooked, usually in steam. The cooked slices are mashed immediately and diluted with a small amount of hot water to adjust the solids content and thereby improve adherence to the rolls of the drier. Sulfite salts or other additives may be easily incorporated during this step. The mash is applied to the drums and dehydrated under conditions of temperature time and roll clearance to yield a product of excellent quality at the required dryness. The product is removed from each drum as a thin continuous sheet of controlled thickness which is then broken and screened to yield flakes of the desired size.

RAW MATERIAL — CONTROL OF TEXTURE

Good appearance and flavor are essential requirements in a mashed potato but they are less difficult to achieve in a dehydrated product than the important attribute of good texture. A desirable product is one which

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has texture as near that of freshly mashed potato as possible. Preferences will vary geographically from smooth or creamy to mealy, but it must never be lumpy, pasty or gummy. By preventing cell rupture, both during manufacture and during rehydration, the release of free starch is mimimized and pastiness is avoided. However, a low solids potato, even though processed with little cell damage will still not yield an acceptable mashed potato texture due to the insufficient amount of starch contained in the potato cells.

Idaho Russet Burbanks are predominately used in making dehydrated mashed potatoes. High solids varieties have heretofore always been necessary in making dehydrated mashed potatoes to obtain good texture on reconstitution. In the flake process, however, the precooking step enables the use of several varieties of lower solids content. Katahdin, Kennebec and Cobblers grown in the East have been used to make a product of excellent quality.

Precooking

By the use of a two-stage cooking method, the texture of mashed potatoes reconstituted from potato flakes can now be varied as desired from smooth, through mealy, to excessively grainy. The method consists of a precook at a temperature high enough to gelatinize the starch, preferably in the range from 150° F. to 165° F. followed by a final cook at 212° F. The ⅝ inch thick raw slices usually require from 15 to 30 minutes precooking in either water or steam-air mixture.

After the precooking treatment, the slices are no longer crisp, as when raw but are tougher, resilient, and somewhat translucent. After the final cooking in steam the slices are still tougher than those not precooked and when mashed yield a drier appearing, more mealy mash. The exact choice of conditions is determined by the type potato being processed and the texture desired in the reconstituted product. In general, the lower the precooking temperature (within the range cited) the more mealy the product. Also, as the precooking time is increased, the effect becomes more apparent. Experimental work has shown that precook temperatures below 150° F. or holding times of an hour produced too large a particle size in the mash to give an acceptable product. Obviously the shortest cook is the most economical. This is 15 minutes generally at about 160° F.

Although an understanding of the effects of precooking on product texture has been gained, further work is required to explain them. Studies regarding the nature of the changes taking place are in progress. Most investigations so far indicate that a modification of the starch within the cells resulting in an increased swelling power is the main factor. One fact which bears out this promise is the increased amount of liquid necessary for rehydration of flakes made by precooking to produce a typical mash. This may be 5.0:1 or even 5.25:1 compared to 4.5:1 for potatoes which were not precooked.

Cooking and Mashing

The shortest permissible cooking time for ⅝ inch thick slices is about 16 minutes in atmospheric steam. Precooked slices given this treatment are tough and rubbery and cannot be mashed between rolls. An extrusion type masher in which the potatoes are forced through holes of approximately 1/16 inch diameter produces a mash which can be dried either on a single or double drum drier.

Drying

Feeding.

If a mass of mashed potato is placed between the rolls af a 6-inch diameter double drum drier, the type used for our investigation, there will be practically no pickup on the rolls.

To obtain a uniform sheet on both drums the mash in the "V" must be kept in motion with an action which wipes it on the drum surfaces. This results in a thin film adhering to the hot surface before the drums converge at the pinch, and the rough surfaces thus created aid the acceptance at the pinch. This motion is accomplished in the pilot plant by manipulation of the mash with a paddle, but it can be simulated mechanically. It is expected that when a drier of larger diameter is used, the increased area of pinch resulting from the lesser angle of approach will aid the feeding of the mash. With a single drum the mash is applied the same way as in making potato flour—by spreader rolls placed about the periphery of the drying surface.

Roll Clearance.

With a double drum unit the clearance between the rolls has been found to be optimum in the range that produces films of substantially monocellular thickness. If the clearance is too small the individual potato cells are crushed and the flake reconstitutes to a pasty product. If the clearance is too large, the cells adhere in agglomerates, resulting in a product of high moisture content which may also be lumpy. In practice, a flake thickness of 0.005 inch to 0.009 inch produced with a drum clearance of about 0.007 inch to 0.010 inch is preferred. It has been demonstrated that a good product can also be made on a single drum unit of the type commonly used for potato flour. The condition for best operation are still being studied.

Dilution of Mash.

Dilution of the mash from high solids (above 20 per cent) potato prior to drying results in several improvements in the product. Among these are higher flake density, *i.e.*, more cells and less voids per unit area, and a greater resistance of the flake to shattering during breaking to the desired size. Both density and strength increase as high solids mash is diluted with water, reaching a maximum when the solids content has been reduced to approximately 20 per cent, and diminishing on further dilution.

Another important result of dilution is better adherence to the drum and lower product moisture for a given drying condition. Low moisture in the flake avoids too rapid rehyration thereby minimizing cell rupture and producing a better textured mash. Normally a flake moisture varying between 3 and 4 per cent is achieved when the drier is operated at 100 p.s.i. steam pressure with a residence time of roughly 10 seconds.

Additives

A solution of sulfite salts is used to lighten the color of the product and increase storage stability. Three parts of sodium sulfite to one part sodium bisulfite used as a 10 per cent solution has proven satisfactory. When incorporated in the mash prior to drying at the rate of 400 parts per million of sulfur dioxide about 200 parts per million are retained in the dried product. No detectable taste is imparted at this level.

Flake Size

The product of the drum drier is removed from each drum as a thin continuous sheet the full width of the drum. These sheets must be broken into flakes of a convenient size for packaging. When they are broken, cleavage occurs not only between the cells but through them as well, therefore some free starch is released at the periphery of the flake. If the flake is large the broken cells are insignificant compared with the number of undamaged cells in the flake. As the pieces become smaller the ratio of peripheral cells to enclosed cells increases and a size is eventually reached where a degradation in texture can be detected.

Many samples of potato flakes have been prepared and distributed to demonstrate the product. These have been made up of flakes ranging in sizes from 3/16 inch to 5/8 inch, having a package density of nearly 7 pounds per cubic foot. This relatively low density should be advantageous in the civilian market where the consumer is interested in "more for the money." In flakes of this size the amount of free starch is insignificant and contributes no noticeable pastiness to the reconstituted product. Recent work with precooked potatoes has shown, however, that flakes can be made as small as 7-mesh or about ⅛ inch without objectionable increase in pastiness on reconstitution. Flakes of this size have a bulk density of about 11 pounds per cubic foot and hence can be packaged more cheaply.

Potato flakes rehydrate easily on addition of water at temperatures ranging from 50° F. to boiling. Usually 4.5 to 5.25 parts of liquid at about 160° F. are used. This temperature is conveniently achieved by mixing 3 parts of boiling water with 1 part of cold milk. The liquid is poured over the flakes until the entire mass is moistened. Butter and salt are added to taste and the product lightly whipped if a creamy consistency is desired.

Work completed shows that flakes capable of being reconstituted to mashed potato of excellent texture, color and flavor can be made by that which appears to be a comparatively cheap process, on readily available and commonly used equipment.

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