Potato Flakelets—A New Dense Product from Flakes

SUMMARY

Drum-dried mashed potatoes, commonly called potato flakes, possess bulk densities of about 14–23 lb/cu ft, depending on piece size. Marked increase in bulk density to adapt them to military needs and further their institutional use has long been a research objective.

A product with densities of 48–52 lb/cu ft can now be had by manipulating for about 15 min a mixture of cooked potatoes and a fragmented drum-dried sheet of mashed potatoes using a critical range of about 28–34% moisture. This laminates, aggregates, and otherwise forms small globular particles that, when dried, can be readily reconstituted to give a mash of excellent flavor and texture.

Flakelets absorb water on reconstitution to such an extent that, for a given volume of mash, about 10% less weight is required than for most other forms of dehydrated mashed potatoes.

INTRODUCTION

Potato flakes, now a well known article of commerce, are so called because of their form, which results from fragmenting a drum-dried sheet (Cording *et al.*, 1954, 1955, 1957, 1959; Eskew *et al.*, 1956). The first flakes produced in the Agricultural Research Service Laboratory in Philadelphia, where the process was developed, were made on a double drum and had a bulk density of about 7 lb/cu ft (Cording *et al.*, 1954). By the use of a single drum dryer with applicator rolls this was raised to about 14 lb/cu ft for ½-in. flakes. Continued process improvements (Cording *et al.*, 1959; Anonymous, 1959) later yielded a product that could be broken to give still-higher bulk densities. Commercial flakes now range from about 14 to 23 lb/cu ft. Such bulk is well suited for the retail market. However, there has long been an incentive to make a dense product from flakes that would be better adapted to institutional and military use, that could be economically packed in nitrogen, and that would possess the good flavor and texture properties of flakes. This objective has now been achieved through the development of flakelets.

Attempts failed to increase the density of the dried sheet itself because of the limitations in sheet thickness imposed by drum drying. Grinding, or otherwise breaking, flakes into pieces small enough to obtain bulk densities significantly above 25 lb per cubic foot, results in products that have poor texture on reconstitution.

Potato flakes can be rehydrated to moistures of about 42–45%, at which they can be made to granulate, yielding a product of very high bulk density without the necessity for recycling of addback, as is now done in the conventional granule process (Eskew *et al.*, 1960). However, granulation is inherently a slow process and the necessity for holding the perishable moist material long enough to achieve granulation produces a characteristic flavor.

FLAKELETS

It has now been found that when a drum-dried sheet of mashed potatoes is fragmented, moistened to a range below that at which granulation takes place to any significant extent (28–34%), and then manipulated for a relatively short time, there results a product having a bulk density of about 45–50 lb/cu ft and possessing high-quality flavor and texture attributes. This product has been termed flakelets. Contrary to the implication of the name, the product is not simply small flakes. It comprises laminates, and aggregates of sheet fragments, a few individual potato cells, and cell agglomerates. Its consequent bulk density is far in excess of what can be obtained by merely breaking flakes to small size.

PROCESS

Up to the point of mashing the cooked potato, the process for making flakelets is the same as that used in making flakes. It is shown in Fig. 1. The potatoes are lye- or steam-peeled, trimmed, cut to ½-in. slabs, precooked and cooled to retrograde the starch, and are then steam cooked until just soft enough to mash. On leaving the cooker the stream of slabs is divided into 2 parts in the ratio of approx 9 parts to the drum drier and 1 part to the jacketed cooler. In the latter, slabs, after ricing, are cooled to below about 100°F, and the emulsifier is incorporated. When low solids or early-season potatoes are used, it may be desirable to add part of the emulsifier to the mash fraction that is to be drum-dried. The emulsifier so used can be blended with the antioxidant in Tank 18 (Fig. 1). The drum-dried product, after breaking through holes ¼-in. diameter, is mixed with the now-cooled mash to give a mix moisture of approx 30%. This moisture should be varied with the type of manipulating equipment used, the variety of potato, and the desired bulk density of the finished product. After being manipulated for 15 min, the now-dense moist material is dried on a vibrating bed drier, cooled, sifted, and packaged. At least 96% should pass a 12-mesh screen, and can be rehydrated in a manner similar to potato flakes to give a mash of good flavor and texture.

Because flakelets absorb more liquid on reconstitution than most other forms of dehydrated mashed potatoes, approx 10% less weight can be used to yield mash of a given consistency. Thus, a No. 10 can of flakelets may well yield the same number of mashed potato servings as can be had from a No. 10 can of a product having a bulk density of about 56 lb/cu ft. Fig. 2 illustrates the relative volumes of broken flakes, ½-in. flakes of commerce, and flakelets, all of which will yield the same volume of mash on reconstitution.

Drum drying. In drum drying to produce the flake component to be converted to flakelets, the moisture need be reduced only to about 8–10% and drum speed can be triple that used in making conventional flakes. These differences result in an increase of 100% in drum dryer capacity.

Cooling. This step is used to reduce the riced cooked slabs to a temperature below about 100°F, giving a crumbly mash and reducing the tendency to form balls.

Mixing. Before the drum-dried component is added to the mixer, the sheet is broken to pass through holes ¼ in. in diameter. In mixing, the dry component and mash are quickly and intimately blended in a ribbon-type mixer conveyor with "cut-in" fingers. Ideally, each sheet fragment is coated with a small amount of mash. To prevent the formation of mash balls, good blending is essential before the compacting forces of manipulation are applied.

Manipulation. The term "manipulation," to describe the operation wherein the moist mixture of fragmented sheet and mashed potatoes is acted upon to increase bulk density markedly, is less than definitive. It is difficult to find one word to describe the phenomenon responsible for the change in character produced in this step. Microscropic examination, screen analysis, and bulk-density measurements on the several fractions give some indication of what happens. Some of the moist pieces of flakes are inevitably separated into smaller fragments, but this is incidental and not essential to the increase in bulk density. Table 1 shows the screen analyses and bulk densities of a drum-dried sheet of mashed potatoes broken to pass through ⅛-in. holes, and of the potato flakelets made therefrom. One might suppose that the increase in bulk density from 25 to 51 lb/cu ft was simply the consequence of the much higher percentage of small fragments in the flakelets. This was shown to be untrue when a drum-dried sheet was broken to have the same screen analysis as flakelets. The bulk density of the ground product was only 26.8 lb/cu ft, in contrast to 50.7 lb for the flakelets.

Table 2 compares the bulk densities of different screen fractions of these two samples. It is apparent that increased density occurs in all the screen fractions, as a consequence of moist manipulation. When a drum-dried sheet is broken, the pieces change in two dimensions only; their thickness remains the same, about 0.010 inch. However, when converted to flakelets they change in three dimensions, acquiring an increased thickness through lamination and aggregation.

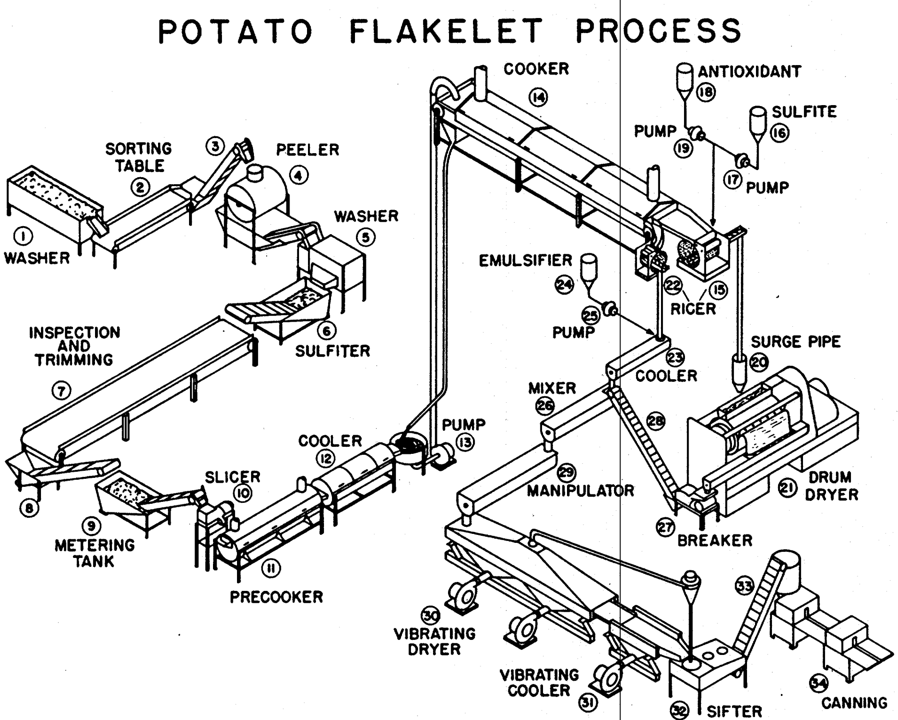

Fig. 1. Chart showing the process for making the new high-density potato flakelets.

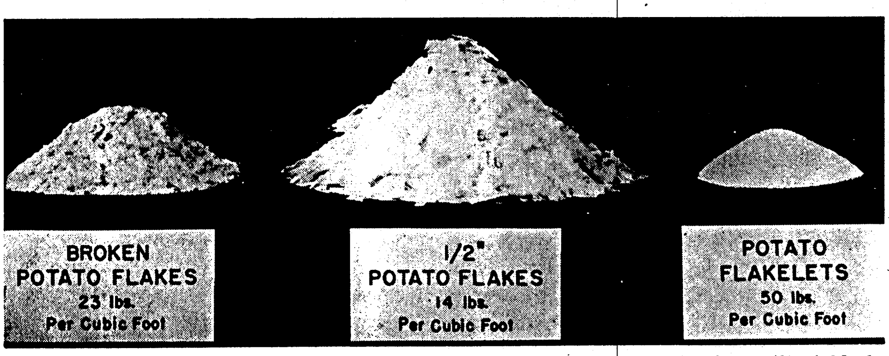

Fig. 2. Volumes compared of different types of potato products that will yield the same volume of mash on reconstitution.

Table 1. Screen analysis of broken drum-dried sheet and flakelets.

Material	% passing U. S. mesh: 12	16	20	30	70	100	Bulk density (lb/cu ft)
Drum-dried sheet[a]	94.3	65.3	35.1	19.4	2.9	1.7	25
Flakelets	99.6	96.5	85.1	68.0	24.8	13.8	51

[a] Broken through ⅛-in. diam holes.

Table 2. Bulk density of broken drum-dried sheet and flakelet fractions.

Mesh	% passing	Broken drum-dried sheet (lb/cu ft)	Flakelets (lb/cu ft)
12	99.6	26.8	50.7
20	85.1	34.1	51.1
30	68.0	34.4	50.6
70	24.8	41.0	53.0

What happens during the manipulation can be seen to some extent in Fig. 3. These two samples have the same screen analyses. At left are broken flakes having a bulk density of 26.8 lb/cu ft. At right is seen the laminated character responsible for the bulk density of flakelets of 51 lb/cu ft.

Proper manipulation is the crux of the process. The equipment to carry it out should produce a rubbing, compacting, and mixing action similar to that resulting in a batch Hobart mixer (no endorsement implied) operated for about 10 min at low speed, using what is generally termed the "mashing" paddle. Pilot-plant experiments have shown that this action can be easily accomplished in continuous equipment.

Table 3 illustrates the effect of mix moisture on the bulk density and quality of product. It is apparent that, using flakes made from Katahdins of about 20% solids, the best moisture range for manipulation consistent with both a dense product and one giving good texture on reconstitution, lies between about 27 and 30%. In judging the progress of manipulation it has been found convenient to determine the percent of the moist product passing a 20-mesh screen. This should generally

Table 3. Effect of mix moisture on bulk density of potato flakelets (Maine Katahdins, 20% solids; 5 min in ribbon mixer, plus 10 min in Hobart mixer).

Run no.	% moisture during manipulation	% moist product through 20-mesh	Bulk density dried product (lb/cu ft)	Quality of reconstituted mash
132	24.5	50	38.0	Very good
135	27.6	56	43.0	Very good
136	28.8	61	47.3	Very good
133	32.3	77	53.0	Lumpy

Table 4. Optimum mix moisture range for different potato varieties.

Variety	Percent solids	Optimum mix moisture range	Typical bulk-density range[a]
Delaware Katahdin	16	29–32	47–50
California White Rose	19	28–31	44–50
Maine Katahdin	20	27–30	43–50
Idaho Russet Burbank	21	30–33	42–48

[a] Depends partly on time of manipulation; generally about 20 min in Hobart mixer.

be at least 60% if the bulk density of the finished product is to exceed 45 lb/cu ft. Density will, of course, increase with increasing periods of mixing. As shown in Fig. 6, it also increases with moisture content, but if the moisture is too high the product will be unsatisfactory, because of hard balls of mash, difficult to disperse.

The best moisture range for manipulation will vary with the variety of potato used, as shown in Table 4. In general it is low for low-solids potatoes. In all cases the latitude is within a practical range.

Drying. Since the flakelets will contain about 30% moisture at the end of manipualtion, they have no tendency to cohere or compact during drying. Thus, air-lift drying is unnecessary. For example, they can be dried to 6% moisture or less on a vibrating bed dryer in about 90 sec, using air at 230°F.

Sieving. If mixing and manipulation are done properly, substantially all of the dry product should pass a U. S. standard 12-mesh screen. The small fraction of overs that may occur can be crushed to pass a 16-mesh screen and thus added to the product.

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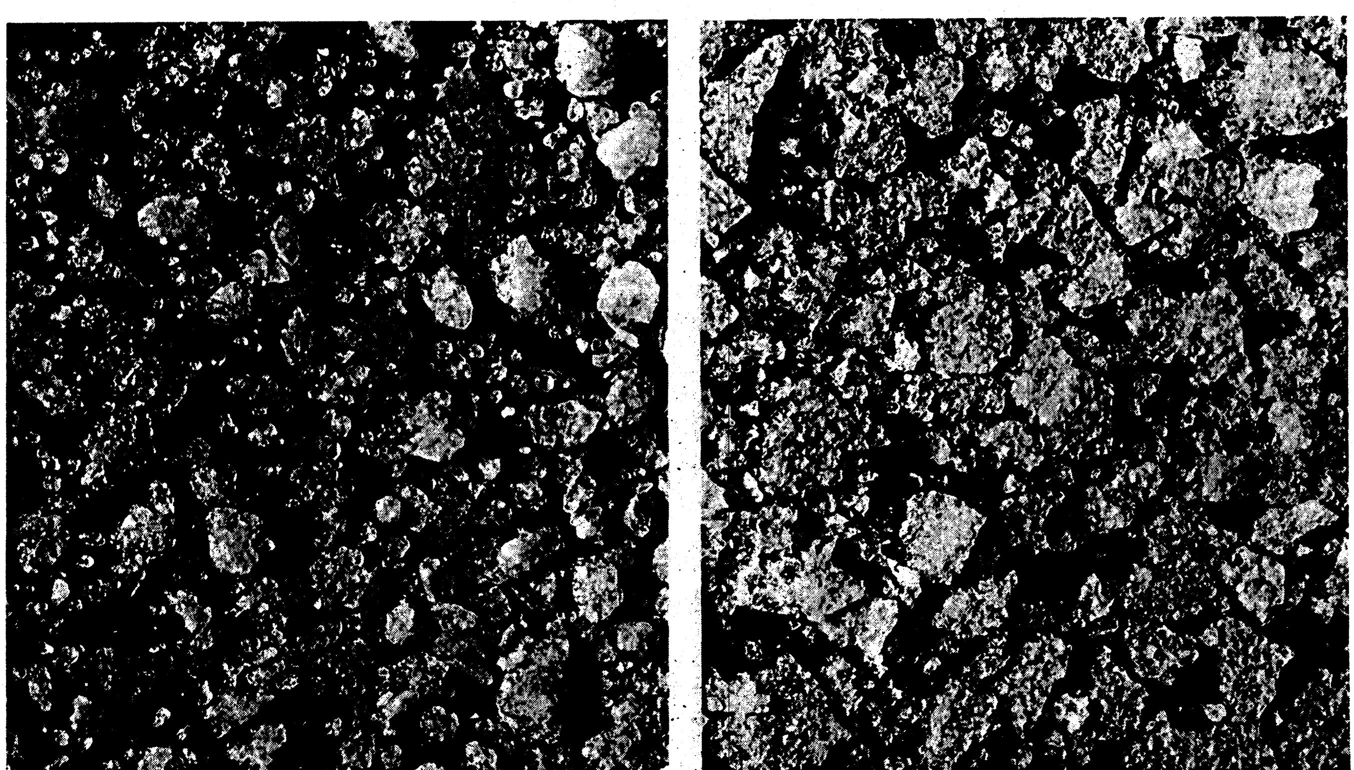

Fig. 3. Potato flakes (left) converted to flakelets (right). These two samples have the same screen analysis. Nevertheless, the former has a bulk density of 26.8/cu ft, and the latter, because of its laminated character, has a bulk density of 51 lb/cu ft.