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THE EFFECT OF NONFAT MILK SOLIDS ON THE STORAGE PROPERTIES OF POTATO FLAKELETS

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ABSTRACT

This publication describes a series of experiments which demonstrated that in the absence of sulfites and antioxidants the keeping properties of air-packed potato flakelets can be enhanced by the addition of nonfat milk solids. To be effective the dry skim milk first should be forewarmed to develop natural antioxidants as is now commercially done in the spray drying of skim milk.

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THE EFFECT OF NONFAT MILK SOLIDS ON THE STORAGE PROPERTIES OF POTATO FLAKELETS

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SUMMARY

Tests were made to determine the effect of added dry skim milk solids on the storage properties at room temperature of potato flakelets (a dense form of dehydrated mashed potatoes). Two types of dry milk were used. In one, protein reducing substances had been developed by severe heat treatment prior to spray drying. The other type had been given only sufficient heat treatment for pasteurization and had been vacuum dried, thus minimizing development of protein reducing substances. In one case the flakelets contained SO_2 and in the other none.

Samples were air-packed in cans without antioxidant and stored at 73°F. for 6 months.

No significant difference occurred among samples containing SO_2. In the absence of SO_2 the powder made from heat-treated milk improved flavor shelf life. The low heat milk containing a low level of protein reducing substances afforded no protection and appeared to develop off-flavors of its own.

INTRODUCTION

The experience of some manufacturers in Europe has suggested that dried milk solids improve the keeping properties of dehydrated mashed potatoes. To obtain information on this point a series of tests was made in the Engineering and Development Laboratory of the Eastern Utilization Research and Development Division near Philadelphia, Pa.

Potato flakelets were chosen for this test because of the ease with which milk solids can be incorporated. In making potato flakes, it is not feasible to add significant amounts of milk to mashed potatoes, because drum drying contributes a cheeselike flavor to the product. In making flakelets, however, the milk can be added to the flake-mash mixture just before final drying is done in a vibrating bed drier without impairment of flavor.

Potato flakelets are a dense form of modified flakes.[2/] A flow sheet of the process is shown in figure 1. All the operations up to the drum drier are the

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1/ Grateful acknowledgement is made to Joe N. Boyd, Biometrical Services, for his valuable guidance in analyzing the statistical data.

2/ Claffey, J. B., Eskew, R. K., and Drazga, F. H. Estimated Cost and Equipment for Commercial Production of Potato Flakelets. U.S. Dept. Agr., Agr. Res. Serv., ARS 73-36. 1961. 36 pp.

Drazga, F. H., Eskew, R. K., and Talley, F. B. Storage Properties of Potato Flakelets. Food Technol. 18 (8): 91-94 (1964).

Eskew, R. K., and Drazga, F. H. Potato Flakelets--A New Dense Product from Flakes. Food Technol. 16 (4): 99-101 (1962).

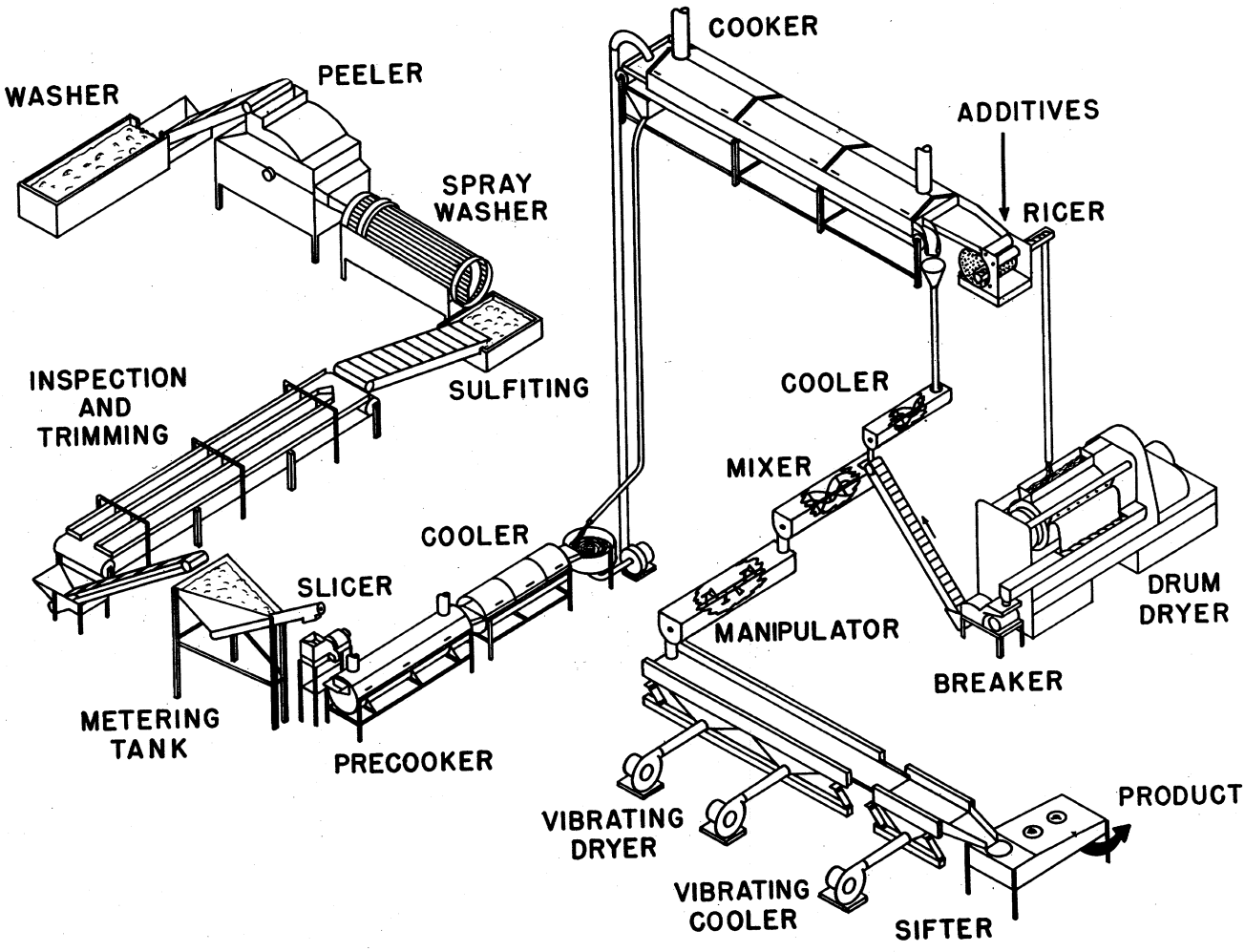

Figure 1.--Potato flakelet process

same as those in the commercial manufacture of potato flakes. However, only a portion of the mash is dried on the drum. Approximately 10 percent of it is cooled and then intimately mixed with broken flakes in proportions to give about 30 percent moisture. This product is then compacted and further reduced in size in the manipulator. It is at this point, near the end of manipulation, that dry milk, if used, would be added. The coarse, free-flowing moist flakelets are dried on a vibrating bed drier to about 6 percent moisture under conditions that do not impair the flavor of any added milk.

The European investigators, who reported that dried milk improved stability, used drum-dried or spray-dried milk. It is customary in making these products to forewarm the milk before drying it; for example, for about 15 minutes at 195° F. This modifies the lactoglobulins to form sulfydryl compounds with antioxidant properties. The authors thought that it might be the presence of these reducing substances in the milk which improved the keeping properties of the dried mashed potatoes, rather than milk solids per se. For this reason in one part of the experiments "high heat," spray-dried milk was used and in another part, milk that had been pasteurized only 16 seconds at 165° F. and then vacuum dried was used. This mild heat treatment develops substantially no reducing substances.

The experiments were divided into two main parts--one containing added SO_2 and the other, none. Each of these parts was subdivided to permit the use of the two types of dry milk solids--"high heat" and "low heat." Each of the subdivisions was further divided to permit in one case adding the nonfat milk solids during processing and in the other case merely adding it to the dried potato product in the can. The pattern is shown in figure 2. Dried skim milk was used

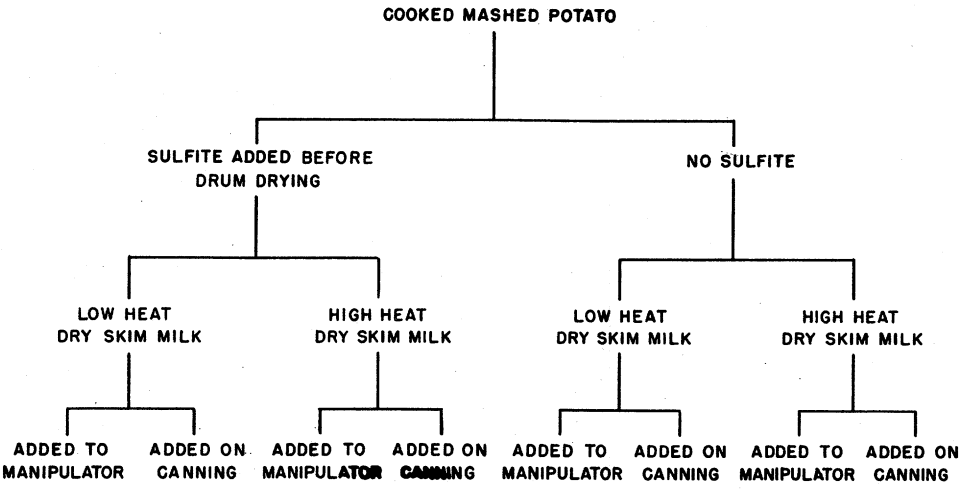

Figure 2.--Samples used in evaluating the effect of added milk solids to potato flakelets.

because of flavor changes in the milk itself which invariably take place when dry whole milk is stored at room temperature. The "high heat" milk was commercial, non-instant, spray-dried skim which contained 0.21 percent protein reducing substances.[3/] The "low heat" product was made by vacuum drying a nitrogen-impregnated skim milk concentrate following procedures developed for whole milk.[4/] It contained 0.04 percent protein reducing substances.

The potatoes were all from one blended lot comprising 3,200 pounds of Idaho Russets with an average specific gravity of 1.089 (21.84 percent solids). In the series containing SO_2 the lye-peeled, washed potatoes were dipped in a solution of one-half percent sodium bisulfite plus one-half percent citric acid. to prevent discoloration. In the series without SO_2, a one-half percent citric acid dip was used. The sliced potatoes were precooked at 168° F. for 20 minutes and then cooled for 30 minutes at 45° F. The precooked and cooled slabs were cooked in atmospheric steam for 30 minutes to make them soft enough for mashing. After mashing, additives were incorporated in an 80-quart planetary mixer. An

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3/ Choi, R. P., Koncus, A. F., Cherrey, G., and Remaley, R. J. Determination of Protein Reducing Value of Milk as an Indication of the Presence of Nonfat Dry Milk Solids. J. Milk and Food Technol. 16: 241-246 (1953).

4/ Sinnamon, H. I., Aceto, N. C., Eskew, R. K., and Schoppet, E. F. Dry Whole Milk. I. A New Physical Form J. Dairy Sci. 40: 1036-1045 (1957).

emulsion of glycerol monostearate (Myverol 18-07)[5/] sufficient to give 1 percent in the dried sheet was added. In the series containing SO_2, for each pound of mash there was added 8/10 of a ml. of a solution consisting of 450 ml. water, 12.5 g of $NaHSO_3$, and 37.5 g of NA_2SO_3. Whether or not sulfite was added, citric acid was added by using per pound of mash 0.2 ml. of a solution containing 4.4 g. citric acid per 100 ml. of water.

The mash was drum-dried at between 3.5 and 4.0 r.p.m. to give sheet moistures between 5.6 and 8.1 percent. After breaking the sheet through a hammermill equipped with a screen having 1/4-inch diameter holes, the material was mixed in a ribbon blender with sufficient undried mash to give a moisture of approximately 30 percent. Additional glycerol monostearate emulsion was added at this point to obtain 1.5 percent in the finished flakelets. Additional sulfite solution was added (in the "sulfite series") to achieve between 150 and 200 p.p.m. in the final product.

After incorporation of the ingredients, mixing was continued for 20 minutes to compact particles and reduce their size. Where dry milk was used during processing it was added near the end of this manipulating step. The product was dried in a vibrating bed drier using air at approximately 240°F. Table 1 shows the composition and some attributes of all samples comprising the test.

Table 1.--Composition and some attributes of potato flakelet storage samples (All samples air-packed in 4-oz. cans without antioxidant and stored at 73° F.)

Item	Bulk density	Product moisture	SO_2 content	Dry milk addition
	Lb. per cu. ft.	Pct.	P.p.m. m.f.b.	
High heat milk added during processing:				During manipulation
With sulfite	43.9	5.3	131	
Without sulfite	45.1	5.7	0	Do.
High heat milk added on canning:				
With sulfite	42.8	5.6	150	On canning.
Without sulfite	45.1	5.2	0	Do.
Low heat milk added during processing:				During manipulation.
With sulfite	47.1	6.0	198	
Without sulfite	46.5	5.7	0	Do.
Low heat milk added on canning:				
With sulfite	46.4	5.8	156	On canning.
Without sulfite	44.8	5.4	0	Do.
Control:				
With sulfite	48.5	5.7	194	None.
Without sulfite	42.5	5.6	0	Do.

5/ Reference to certain products or companies does not imply an endorsement by the Department over others not mentioned.

RESULTS AND DISCUSSION

Mashed potatoes reconstituted from the samples were tasted monthly and ranked on the basis of flavor only, by a panel averaging 16 persons. Four samples and the control (without milk) were in each test. Thus, 560 individual judgments were involved in the 6-month period in the sulfite series and also in the series containing no sulfite. There was no significant difference at the 5 percent level among any of the samples containing sulfite. However, in the samples containing no sulfite, significant differences appeared among the samples as shown in table 2 where a Duncan Multiple Range Test has been applied to the average of the individual monthly tests. The first three samples are significantly superior to the last two. Although there is no difference among the first three at the 5 percent level, the sample containing high heat milk added during processing is superior at the 9 percent level over low heat milk added at the same stage of processing. This trend is further supported by the results in table 3.

Table 2.--Effect of dry milk solids on stored dehydrated mashed potatoes
(Tested monthly for 6 months at 73° F.)

Sample	Average rank	Difference at 5 percent level*
High heat milk added during processing.	2.51	
High heat milk added on canning.	2.85	
Low heat milk added during processing.	2.97	
Control	3.14	
Low heat milk added on canning.	3.55	

* None if bracketed together.

Table 3.--Effect of dry milk solids on stored dehydrated mashed potatoes
(Tested after 6 months and 11 months at 73° F.)

Sample	Average Rank	Difference at 5 percent level*
Standard	1.82	
High heat milk added during processing.	3.28	
High heat milk added on canning.	3.30	
Control	3.34	
Low heat milk added during processing.	4.46	
Low heat milk added on canning.	4.47	

* None if bracketed together.

This table combines the results of tests after storage of 6 and 11 months. The standard sample which contained no milk but was nitrogen-packed and kept at 0° F. was preferred to all the others. This is not surprising when it has

been shown that even at room temperature nitrogen-packed flakelets store well.[6/] It should be noted that both the high-heat samples were preferred to both the low-heat samples. The fact that the control was also superior to the products containing low-heat milk suggests that off-flavors develop in this type of milk on storage.

These results showed that if potato flakelets are to be air-packed without the use of either SO_2 or antioxidants in their manufacture, improvement in keeping properties can be had by adding high-heat skim milk powder during processing. It appears that the improvement arises from the antioxidant properties resulting from the protein reducing substances formed during heat treating the milk prior to drying. Low heat skim milk powder may actually impair stability by contributing off-flavors when stored at room temperature.

6/ See footnote 2, second citation.