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DEHYDRATED EXPLOSION-PUFFED CARROT DICE OF HIGH DENSITY

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ABSTRACT

Three-eighth-inch carrot dice were explosion-puffed in a steam gun and compressed between rolls at room temperature. The clearance between the rolls was set at 1/32 inch, 1/16 inch, or 3/32 inch. The dice were then dried in a through-circulation dryer to about 4-percent moisture. Compressing raised the bulk density of the explosion-puffed product significantly with no impairment of the rehydration property. Although the final-stage drying time was somewhat lengthened by compressing, there was no impairment in product quality. Packaging, shipping, and storage costs would be reduced as a result of compressing.

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INTRODUCTION

The explosion-puffing process developed at this Laboratory can effect substantial savings in both the drying and the rehydration time of many air-dried fruit and vegetable pieces (1, 2, 3, 4, 5, 6).* For instance, through explosion-puffing the drying time from about 20 percent moisture for 3/8-inch potato dice has been reduced from about 7 hours to 1-3/4 hours, and the rehydration time from 25 minutes to 4 to 6 minutes (2). With 3/8-inch carrot dice the final stage drying time (after explosion-puffing, from about 25 percent) has been halved (6), and the rehydration time reduced from about 40 minutes to 5 minutes (1). On the other hand, up to the present time the explosion-puffed product has been more bulky than its conventionally air dried counterpart. Now, however, it has been found that by compressing the explosion-puffed pieces before final drying, the bulkiness of 3/8-inch carrot dice can be reduced below that of the conventionally air dried with little or no loss in rehydration rate.

PROCEDURE

Each experiment was carried out as follows: The 3/8-inch carrot dice were prepared for puffing as previously described (1), and puffed in a steam gun, as reported by Sullivan and coworkers (6). The batch of puffed dice was divided into two fractions. One fraction was compressed by passing between the rolls of a small, unheated, double drum dryer. Roll clearance was preset and held constant for any one experiment at either 3/32 inch, 1/16 inch, or 1/32 inch. This half of the batch was called the "compressed fraction." The other half, called the "puffed fraction," was loaded to a depth of 5 inches in a tray of a through-circulation air dryer and the net weight of carrot dice was determined. An equal weight of the compressed fraction was then added to another tray of equal size, so that for each experiment the weight of dice per square foot of tray bottom was the same for each fraction.

Drying was carried out in a batch-wise through-circulation air dryer using air at about 150°F. dry-bulb, 300 feet per minute velocity, and 20 percent relative humidity. Drying was discontinued when the loss in weight of the dice in 30 minutes was less than 3 percent of their final weight. A moisture analysis was run on the dehydrated products by the Karl Fisher method.

The dehydrated fractions were tested for bulk density, rehydration ratio, and void volume. Bulk density was determined by weighing the dice contained in a cylinder 6 inches in diameter and 6 inches tall. Rehydration ratio, defined as the ratio of rehydrated weight to dry weight, was determined by simmering 50 grams of the dry product in 1 pound of water for 5 minutes, draining for 1 minute, and weighing. Void volume was determined with a Beckman Model 930 Air Comparison Pycnometer (7).*

RESULTS

Bulk Density

There was some variation in bulk density among different batches of explosion-puffed pieces used in the compression tests. This variation was reflected in the bulk density of the compressed products; higher densities resulted from compressing samples of higher initial density.

Figure 1 shows the effect of the bulk density of the explosion-puffed pieces on the bulk density of the same pieces after compression, using different roll clearances. Since the increase in density at 3/32 inch clearance was much lower than at 1/16 inch and 1/32 inch, further tests were confined to the latter clearances.

Figure 2 illustrates the differences in volume of equal weights of conventional, explosion-puffed and explosion-puffed dice compressed at a roll clearance of 1/16 inch.

Rehydration

The effect of compressing the explosion-puffed pieces is given in table 1. Bulk densities were increased on the average by more than 32 percent. Although porosities were reduced by about 40 percent, the rehydration ratio was not impaired by compressing either through a clearance of 1/16 inch or 1/32 inch. The variation in bulk density among the different samples before compressing arose primarily from different experimental conditions employed during puffing.

Fig. 1 (right)

Effect of compression on bulk density of dehydrated, explosion-puffed 3/8-inch carrot dice.

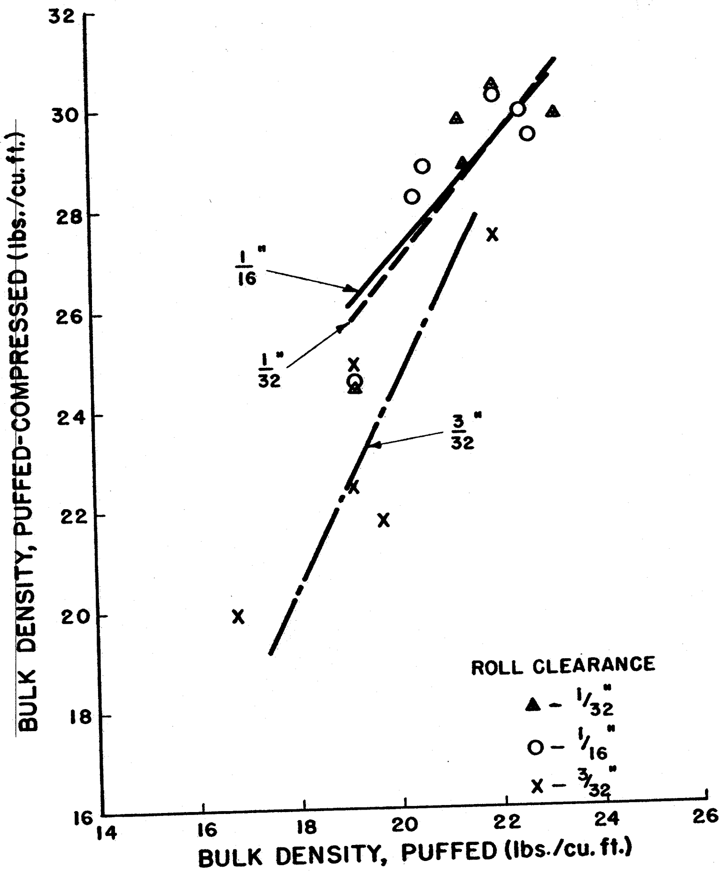


Fig. 2 (below)

Relative volume of puffed, compressed, and conventionally dried 3/8-inch carrot dice

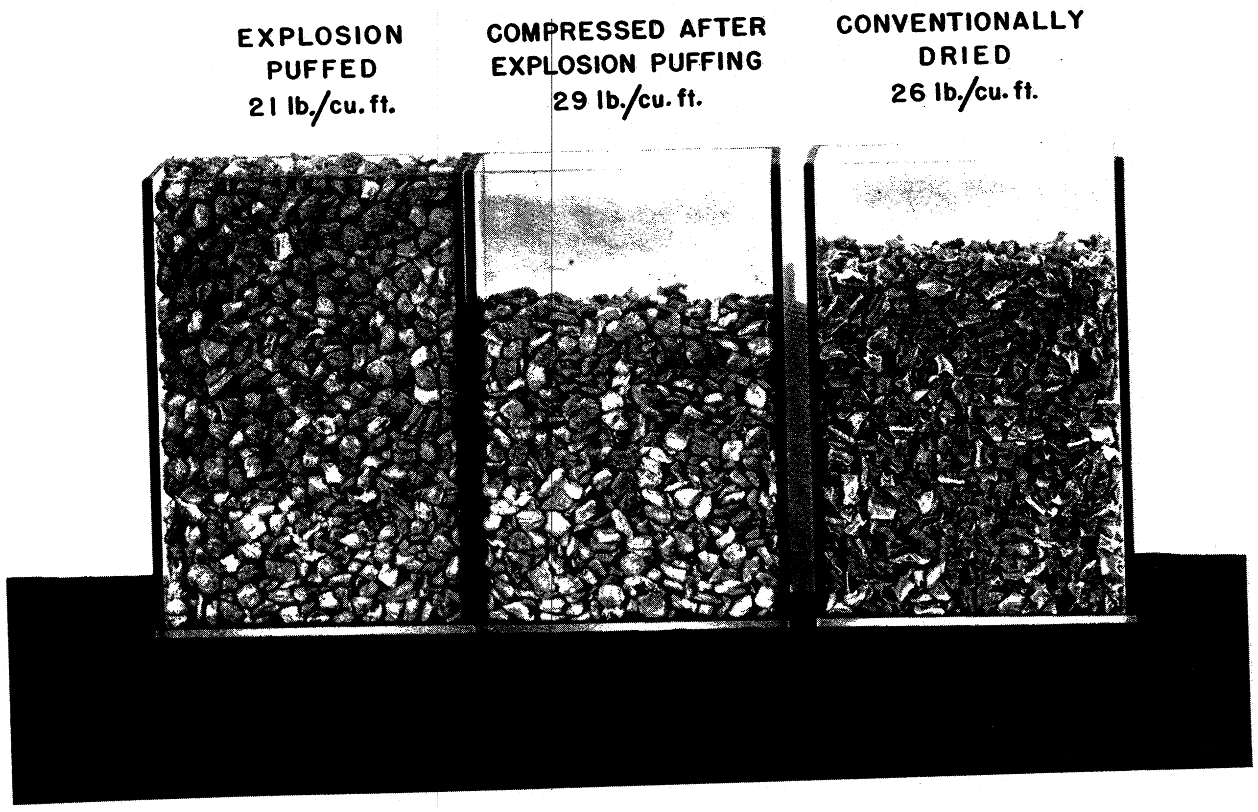


Table 1

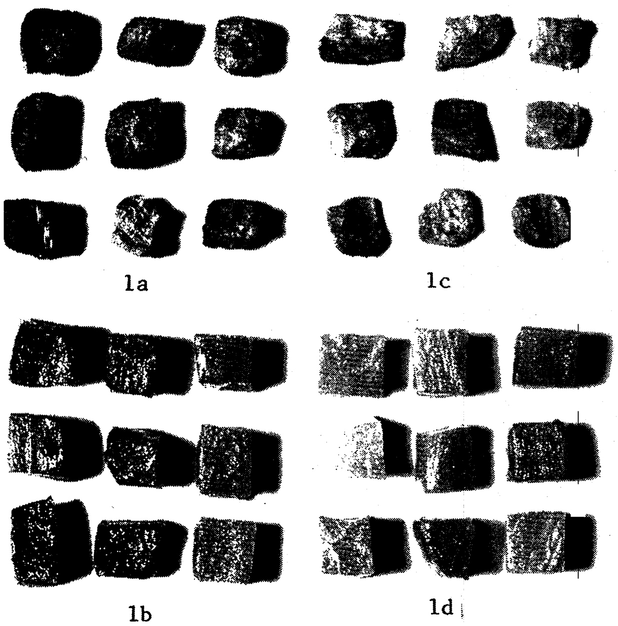
Table 1. -- Effect of compressing on properties of explosion-puffed carrots

Explosion-puffed			1/16" clearance			1/32" clearance		
Bulk density, lb./cu.ft.	Rehydra-tion ratio	Porosity, ml. per g.	Bulk density, lb./cu.ft.	Rehydra-tion, ratio	Porosity, ml. per g.	Bulk density lb./cu.ft.	Rehydra-tion ratio	Porosity, ml. per g.
19.2	5.0	--	24.5	4.7	--	24.4	4.5	--
20.4	4.4	0.91	28.2	4.3	0.64	--	--	--
20.6	4.1	1.04	28.8	5.1	.51	--	--	--
21.3	4.9	1.05	--	--	--	29.7	4.8	0.51
21.4	4.5	.94	--	--	--	28.8	4.7	.52
22.0	4.3	.85	30.2	4.1	.42	30.4	4.2	.39
22.5	4.6	.82	29.9	5.0	.46	--	--	--
22.7	4.5	.84	29.4	4.1	.55	--	--	--
23.2	4.9	.90	--	--	--	29.8	5.4	.40
Averages			Averages			Averages		
21.5	4.6	0.81	28.5	4.6	0.52	28.6	4.9	0.46

Figure 3 shows puffed 3/8-inch carrot dice before (1a) and after (1b) 5 minutes rehydration in boiling water. Samples 1c and 1d show the corresponding results with compressed dice.

Drying

Data were obtained to show the effect of compressing on the final stage drying rate of the explosion-puffed dice. Figure 4 gives the drying curves for one of those runs. As might be expected, closing of some pores during compression caused the compressed fraction to dry more slowly. About 25 percent increase in the time of final drying results.



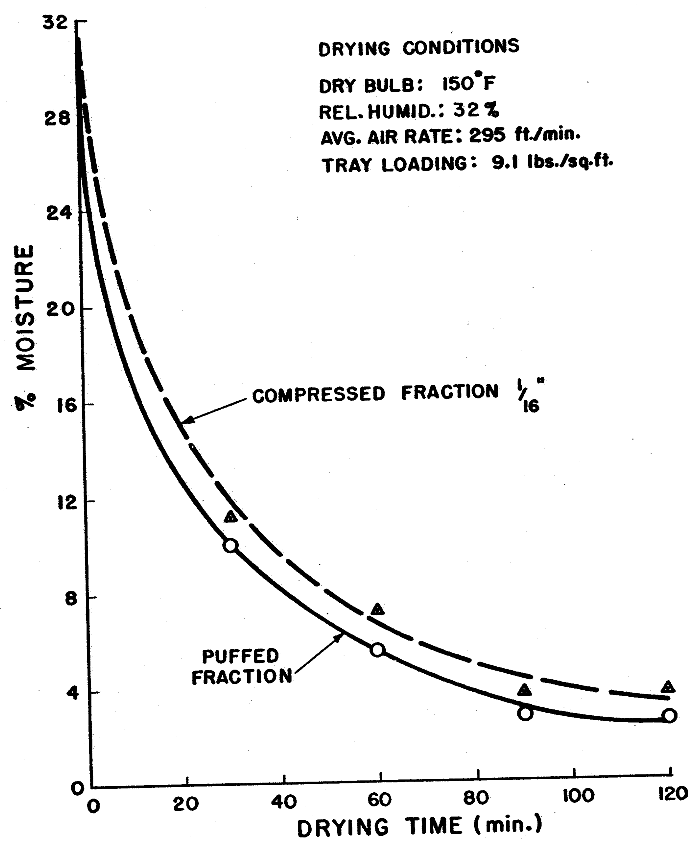


Fig. 3 (above)
Dehydrated 3/8-inch carrot dice before and after rehydration. Explosion-puffed (1a and 1b), and compressed at roll clearance of 1/16 inch (1c and 1d).

Fig. 4 (right)
Effect of compression on drying rate of 3/8-inch explosion-puffed carrot dice.

DISCUSSION AND CONCLUSIONS

One of the disadvantages of explosion-puffed dehydrated carrot dice is that they are more bulky than the conventionally air-dried product. The work reported here shows that this disadvantage can be overcome by merely compressing the dice after explosion puffing. Compressing results in a decrease in the porosity of the dice, but has little or no effect on the excellent rehydration rate of the explosion-puffed pieces. Compressing lengthens the time to reach 4-percent moisture by about 25 percent, but this still involves a shorter overall drying time than for unpuffed pieces of the same size.

Compressing has been attempted with good results on explosion-puffed apple slices, and may be equally applicable to other explosion-puffed commodities

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