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APPLE FLAKES

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Each day the responsibilities of the United States in the World War are increasing. Along with the great task of feeding our own ever-increasing number of soldiers in Europe, we have fallen heir to the supplying of much food for our Allies.

Meat and grain have been rushed to Europe, but very little fruit. Our fruits have not been offered to our Allies, not because of scarcity or lack of supply, but because we could not export them. Where Europe needs fruit the most today is in the trenches. It is in the trenches that life is most strenuous, where a balance of ration is most needed, as only highly concentrated foods are available in most instances. Men in the trenches are begging for fruit, not as a luxury, but as a source of fruit sugar, fruit esters, and acids, to aid in digestion and give a balance of ration.

With this idea of supplying fruit for the army foremost, it was resolved to find a method whereby the apple could be put to use in the trenches in a practical way as an army food.

INEFFICIENCY OF THE SULFUR-BLEACHED APPLE AS A WAR FOOD

The present sulfur-bleached commercially dried apple has fallen so short in retention of natural flavor, color, cell structure, and adequate keeping quality, that it has not even warranted consideration as an army food. On account of the thick slicing, sulfur bleaching, and high moisture content, dried apples, as offered to the public in their present form, are a leathery product, the outer layers of cells having dried first, making it impossible to lower the original percentage of moisture in the inner layer of cells without destroying the chemical and physiological construction of the outer cells. The ready spoiling of the sulfur-bleached apple is doubtless due to fermentation or chemical rearrangement within the cells of the inner layers of the dried fruit, a result of insufficient dehydration accompanied by an increase in temperature.

PLAN OF EXPERIMENT

At the beginning of this work it was recognized that the four factors of vital importance to be controlled were: (1) percentage of moisture, (2) cell structure, (3) flavor, and (4) color. These

factors were taken up in order of their importance as influencing the use of the product as an army food in Europe.

CONTROL OF MOISTURE CONTENT AND CELL STRUCTURE

Apples were sliced and dried in a large-sized tin drier heated by a gas burner placed in the fire box. A current of air was forced thru the drier by one electric fan running continually. The temperature was held at approximately 120° F.; a second fan was connected thru a make-and-break box and pilot lamp, with a thermostat in the drier set at 120° F. to prevent the temperature from running up and causing changes that would prevent the material from ever regaining its original consistency.

Apples in the following forms were put into the drier: whole, halved, quartered, whole-peeled, peeled and halved, peeled and quartered, and peeled and sliced. After two days of constant drying it was found that only the surface layers of cells were dried in each instance. The thickness of the dried surface was approximately the same in all cases, the inner portion of the tissues having retained the original moisture content. As was expected, the portion left covered with the epidermis had dried but little, since the epidermis is almost impermeable to moisture. The difference in the rate of drying is also evident between different varieties, the Ben Davis, for example, drying much more readily than the Winesap under the same treatment.

It was self-evident that the slicing of the apples must be done in such a way as to permit the escape of the cell water of all the layers of cells and yet leave the material capable of taking up water readily and assuming approximately its normal consistency, without marked chemical changes having occurred. In this work an ordinary apple peeler was used, the peeling process being continued until the entire apple was cut into thin, narrow strips. This method, it will be observed, eliminates slicing and coring, and, when operated on a large scale, will greatly reduce labor and the use of extra machinery. Several series, prepared in the manner described, were dried from twelve to fourteen hours under mechanical conditions corresponding to those used in commercial drying. The result was a product dried to a moisture content of 5 to 8 percent, a crisp, flakelike form easily powdered in a mortar. The flakes, when allowed to absorb water equal to the amount driven off, regained approximately their original form, thickness, and consistency.

The keeping quality of the flakes has been demonstrated in two ways. The product has been kept in open packages in a crisp form, at room temperature, for a period of four weeks, without appreciably

absorbing moisture or losing flavor. In closed receptacles, similar samples have been preserved for ten to twelve months without alteration. The low moisture content, in itself, makes it probable that the product will keep, under reasonable conditions, more or less indefinitely. When to this is added the preservative effect of the sugar, the keeping quality of the product seems assured.

CONTROL OF COLOR AND FLAVOR

The browning, or undesirable coloring, of apples dried without being bleached, is doubtless due to the naked cell walls and the intercellular spaces coming into contact with the oxygen of the air.[1] By accelerating the action of the enzymes on the disaccharides, the oxygen of the air is in part responsible for the change in the flavor of the product. It follows, therefore, that any control of browning by a method which protects the exposed cell walls and intercellular spaces from the air will also tend to prevent to a marked degree the change in flavor, or chemical rearrangement of the cell, which otherwise results. In preserving the color of the commercial sulfur-dried apples by bleaching rather than by the protection of the exposed intercellular spaces and cells, there is a marked loss of flavor.

In previous investigations by the writer, no difference in coloring was observed whether drying took place in the light or in the dark. However, a photo-chemical change occurs when the fruit is dried in direct sunlight: there is first a slight browning, then the photo-chemical change, which gives the original light color, the product later turning brown again.

The use of a one-percent solution of commercial salt as a dip to prevent discoloring in drying has been recommended for some time in vegetable drying. Dipping the apples in various solutions of salt was therefore first tried. It was found that the original color of the fruit could be retained by dipping the apple, when prepared for the drier, in a salt solution. Starting with a one-percent solution of salt, it was found that as the concentration of solutions increased, the degree of browning decreased in inverse proportion. With a solution of 30 percent or above, the original apple color was retained.

When distilled water was used it was found that the cell structure was destroyed and a leathery product was obtained which was unable to absorb an amount of moisture equal to that given off. This showed that dipping the product in a less concentrated solution than the cell sap had brought about osmosis and the cells had at

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[1]Whether the browning is due directly to oxidation or to the activating of an oxidative enzyme that acts upon a glucosidal flavone, is of little importance at this time.

first taken up moisture, thus altering the cell content and destroying the tissue structure. By the use of a solution of equal concentration with the cell sap, osmosis would not occur. Then, to use a higher concentration than the cell sap, the osmotic reaction would be reversed, and would seal over the intercellular spaces, and exclude the air. The use of a high percentage solution of salt makes the food of no commercial value, as it gives the undesirable salt taste to the product.

To obtain the same desirable effect on color and to avoid the unpleasant concentrated saline taste, sugar solutions were next tried instead of salt. Different concentrations of sugar solutions gave parallel results with those of salt. A solution ranging from 20 to 30 percent retained the original color of the apple. An acidity test, based on dry matter, showed that the apple had undergone no appreciable change in acidity thru the drying processes.

The use of a sugar solution was therefore immediately taken up as the basis for the control of coloring and the prevention of acidity changes. The sugar of course added to the food value of the product; and as any sugar left in the discarded solution was distilled and recovered, there was no waste whatever. The method of dipping was as follows: The apples were prepared for drying, then placed in the solution of sugar and stirred in order to get the surfaces of all the pieces into contact with the solution, and removed and spread on a drying pan. Enough of a 5-percent solution (5 grams of sugar per 100 cc. of distilled water) was used to give one-tenth of a gram of solution for each gram of prepared apple tissue.

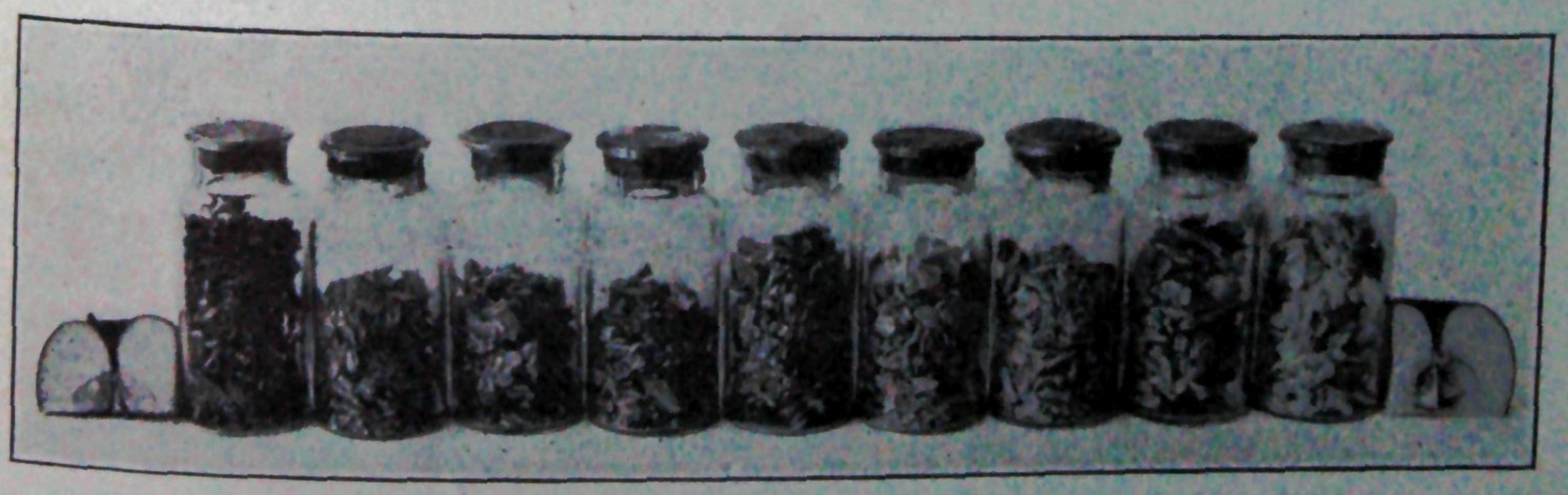

FIG. 1.—LEFT TO RIGHT: COLOR COMPARISON SHOWING THE DECREASE OF BROWNING AS THE PERCENTAGE OF SUGAR USED WAS INCREASED. THE SAMPLE ON THE EXTREME LEFT WAS NOT TREATED

Later a method was discovered whereby the process of dissolving the sugar and then dipping the apples in the solution could be eliminated. When the sugar, in the dry form, was added or mixed with the prepared apple tissue just before the apple was placed in the drying trays, enough cell sap was liberated from the ruptured cells of the apple to dissolve the sugar in a very short time. Even in the case of varieties with low moisture content, as the Grimes, enough

cell sap was present to dissolve 2 grams of sugar per 10 grams of apple tissue. No sugar was lost by dripping, as was the case when sugar was used in solution as a dip. The use of dry sugar had the same effect as dipping upon the color, flavor, and structure of the finished product. The time required for drying was not affected. Another advantage of this method of dry sugaring over the dipping method was that the spreading on the trays was simplified. The sugar did not all dissolve immediately, but part of it adhered to the tissues in the granular form until it went into solution. Then as the sugar went into solution it was equally distributed over the surface of the pieces of apple, even when a very low percentage was used.[1]

Thruout the first part of the work only Grimes apples were available, but later Ben Davis, Winesap, and Jonathan varieties were used. The distinctive flavor of each variety was readily detected in the flakes. The snappy, high-acid, and fruit-ester taste of the Winesap greatly contrasted with the low-flavored taste of the Ben Davis.

UTILIZATION OF THE PRODUCT

The product having been obtained, what is the most practical way of handling this food for the army?

As the flakes came from the drier, a carton measuring 3x2x1 inches, with paraffin wrapper, was used to hold the crisp and dried product of one apple of the 125-box pack size. It was found that the product from four such apples could be placed in one of these small boxes by breaking up the flakes. The flakes are at present being put up in sample form in these boxes, with 30 grams per box. This is equivalent to approximately 300 grams of apples, without the core or peeling. Thirty grams of dried product in these 3x2x1-inch boxes is equivalent in food value to 492 grams of apples in the bulk, or 4.8 apples measuring 8 inches in circumference. This estimate is based upon comparative weights of peeling, core, and meat as obtained by the use of a small-sized commercial type of peeler.

The question is, How can the apple flakes be used in the trenches or back of the trenches by our armies in Europe at present? Where mess shacks are possible, the product can be utilized either raw—eaten directly from the box—as a breakfast dish, requiring only

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[1]The writer hopes later to make out a percentage table stating the amounts of sugar required to give the different degrees of color and sugar coating desired, basing the computations of the table upon the amount of sugar required per unit weight of bulk apple and taking into consideration the different sized apples as determined by commercial grading. The relative-size phase must necessarily be considered, as the ratio of core and peeling to size of apple decreases as the size of apple increases. Consideration of this phase, as well as of others noted in this work, has been postponed as being of relative unimportance; present effort is directed toward making the product available for army use.

three minutes for the flakes to soften in milk or cream, or it may be used as a sauce, stewed, or in other forms of cooking. Stewing requires practically the same amount of time as the stewing of fresh apples. Put up in small packages containing from 8 to 30 grams, this product may be distributed to the men at the front and eaten direct from the box. With the use of 20-percent sugar solutions the intercellular spaces are filled with sugar; the first taste is of the sugar, followed by the original apple taste or flavor. A 20-percent solution gives a slightly candy-coated product.

FIG. 2.—QUANTITATIVE COMPARISON OF FRESH, FLAKED, AND POWDERED FORMS OF FOUR JONATHAN APPLES, EACH FORM AS ILLUSTRATED CONTAINING THE SAME TOTAL DRY WEIGHT OF APPLE

Tho the flake form seems at present the most logical for army use, as it retains some bulk, three other more highly concentrated forms have been prepared. One is in the form of powder, the flakes being ground into powdered form similar to powdered sugar. This, put up in vials, may be used as a seasoning for puddings, pies, cakes, etc. It is, however, very concentrated. The second form is obtained by pressing the powdered flakes into small capsules similar to the commercial junket capsules. The pectic bodies in the apple cells, which at least in part cause the gelatinizing of concentrated aqueous extract of the apple, retain enough of their former mucilaginous state to cause the particles of the powder when compressed to adhere, and the sugar further aids as an adhering agent. The product of one 125-size apple, when powdered, may be compressed into the form of a small tablet, the size depending upon the amount of pressure used. The third form is that of a small cake, compressed only enough to give it shape and stability. This form can be made about the size of the small chocolate bar. Dipped in a sirup to give a candy coating, or coated with powdered sugar, and wrapped in tinfoil, a very desirable product for confectionery trade is obtained.

APPLE FLAKES AS A COMMERCIAL PRODUCT

The new product meets the requirements of a successful dried apple product in the following ways:

1. *Control of Moisture Content.*—The low moisture content appears to insure long keeping of the product. By sealing the paraffined cartons, even a slow change in moisture content is prevented; thus we have a product of high keeping quality sufficient to stand the adverse conditions which a successful war food must meet.

2. *Cell Structure.*—The physical structure of the tissues on being dried permits the product to absorb water readily up to the original content, and so regain approximately its original form.

3. *Coloring.*—The coloring, or browning, is controlled without bleaching the tissues or inducing marked chemical changes.

4. *Flavor.*—The flavor, the sugar, the acid, and probably the original food constituents are not appreciably affected by the processes used in this method of drying.

5. *Use of Sugar.*—By the use of sugar there is an addition of food value to the product. A concentration as low as 5 percent will give satisfactory results as far as the structure, flavor, and keeping quality are concerned. Higher concentrations may, however, be desirable from the standpoint of attractiveness and food value.

6. *Economical Production.*—The expense of production should be less than that of the production of the present form of sulfur-dried apple. The expense of sulfuring, slicing, and coring are eliminated, with only the addition of sugaring and the time required to run the entire apple thru the peeler, which is negligible as compared with the time eliminated in the slicing, coring, and sulfuring. The addition of the sugar can be accomplished mechanically as the prepared tissue is being mechanically transferred to the drier room.

7. *Transportation.*—In its highly concentrated form the expense of transporting this product is reduced to the minimum. To put 1,000 bushels of fresh apples, or approximately 50,000 pounds, into the trenches in Europe, would require the handling of only about 5,500 pounds of the dried product; that is, twenty-five tons of fresh apples would make approximately two and three-quarters tons of dried product.

With an abundant supply of storage apples in the United States, with only slight changes necessary in the present facilities for the drying of apples in commercial driers, and with the urgent necessity for fruit in the trenches, this product can be transported to Europe in large quantities, as food for the soldiers, within a short period, if properly handled.