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Sandiness in Nut Ice Creams

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Sandiness in Nut Ice Creams

W. H. E. REID AND M. E. POWELL*

ABSTRACT.—A study is reported of "Sandiness" in nut ice creams which shows that its presence reflects unfavorably upon several of their physical properties. The presence of nuts, heat shocking, and use of excessive increments of serum solids in ice cream accelerates "sandiness". The data show that "sandiness" in ice cream is retarded by the addition of chocolate paste, gelatinated nuts, sugared nuts, and a combination of nuts and fruits. The addition of grapenuts to ice cream does not affect "sandiness". Boiled and autoclaved nuts retard "sandiness"; however, their use in ice creams is not recommended.

"Sandy" ice cream may be described as ice cream in which the lactose or milk sugar crystals have developed to a sufficient size that they can be detected as gritty or sandy particles when eaten.

"Sandiness" has been an ever present problem since the introduction of the practice of using additional milk solids-not-fat in the preparation of ice cream mixtures, especially with ice creams which contain some kind of nuts. Investigations heretofore reported have failed to meet completely the needs of commercial ice cream manufacturers. This investigation was planned with the hope that the exact cause of and factors affecting "sandiness" in nut ice creams might be determined.

REVIEW OF LITERATURE

Bothell¹† credited with being the first investigator to offer real enlightenment on the subject of "sandy" ice cream, states that "sandiness" is the result of crystal growth at low temperatures.

Zoller and Williams² isolated "sand" crystals from ice cream and identified them as lactose-hydrate crystals. These modified shaped crystals were also noted by Evans³ who attributed the smaller and rather prismatic form of the lactose to forced crystallization rather than temperature effects.

Hunziker and Nissen⁴ state that lactose in crystallizing from solutions of high sucrose concentration is modified in shape, the crystal becoming short and blunt.

Hudson⁵ demonstrated that the solubility of lactose in aqueous solution is affected by the temperature.

Evans³ said to be the first investigator to study lactose solubility at low temperatures chose zero degrees Fahrenheit (-17.7 degrees Centigrade) a temperature corresponding to the temperature maintained in ice cream hardening rooms. He states that sucrose and glucose have an inhibiting effect upon lactose crystallization.

*The data presented in this bulletin were taken from a thesis submitted by the junior author in fulfillment of the thesis requirements for the degree of Master of Arts in the Graduate School of the University of Missouri, 1930.

†Reference by number to "Bibliography", page 19.

Miers and Isaac⁶ and Ostwald⁷ as reported by Leighton and Peter⁸ agree that with moderate supercooling nuclei sometimes fail to appear even after many weeks standing. Ostwald proposed the terms "metastable" for the condition wherein nuclei do not readily appear, and "labile" for that condition induced by a greater degree of supercooling wherein crystallization will, when once initiated, spread rapidly throughout the mass. In the metastable state crystallization is induced usually with a liberal seeding of the material itself or a substance isomorphous with it.

Leighton and Peter⁸ conclude that the important factors controlling lactose separation from milk products are concentration, temperature, seeding, and viscosity.

PROCEDURE

An ice cream mixture was chosen which would approach, as nearly as possible, an average commercial mixture. The formula chosen furnished an ice cream mixture which contained ten per cent fat, eleven per cent milk solids-not-fat, fourteen per cent sugar and one-half of one per cent gelatin. This mixture was later varied as the different phases of the investigation warranted.

Each batch of ice cream mixture was heated to 145 degrees Fahrenheit (62.7 degrees Centigrade) and was held at that temperature for thirty minutes. The mixture was homogenized at the pasteurizing temperature by the use of a Gaulin two-stage homogenizer with a pressure of three thousand pounds per square inch on the first valve and a pressure of one thousand pounds per square inch on the second valve. The mixture was then cooled immediately over a surface cooler to a temperature of 40 degrees Fahrenheit (4.4 degrees Centigrade) and aged at that temperature for twenty-four hours before being frozen.

A Cherry fifty-quart horizontal brine freezer was used for all freezings. With this freezer it was possible to determine the temperature of the ice cream and the per cent of overrun throughout the entire freezing process at one minute intervals. An attempt was made to freeze each batch of ice cream to as near a uniform temperature as possible, but variations were sometimes necessary because of the difference in composition of the ice cream mixtures.

Each batch of ice cream was withdrawn from the freezer at one hundred per cent overrun into chilled five gallon ice cream cans. The ice cream was then divided into smaller sized lots for the various treatments. The treatments consisted of stirring into them such products as various nuts and fruits. After treating each lot of ice cream it was placed into five gallon ice cream cans which were lined with paraffined paper in order to divide the area into two or three vertical compartments,

and the cans were placed in the hardening room. The ice creams were observed daily until "sandiness" was detected.

The standard vanilla flavor was selected for the ice creams with variations of maple, pineapple and chocolate flavors. Three varieties of nuts were chosen for use in making the nut ice creams, namely, almond, English walnut and pecan. These three varieties of nuts were selected for this study because they are the ones most commonly used by commercial ice cream manufacturers. The nuts were ground through a coarse burred food chopper unless otherwise specified. A variety of treatments was given the nuts before they were added to the ice creams. These treatments may be grouped as sugaring, gelatination, freezing, washing, boiling and autoclaving.

Other substances such as fruits and seeds were substituted for the nuts in the preparation of the ice creams. The fruits used were crushed pineapple and tutti-frutti mixture which contained crushed pineapple, crushed cherries, figs, apricots and peaches. Alsike clover seed, timothy seed and small glass beads were introduced into the various lots of ice creams to replace the different kinds of nuts.

Photo-micrographs of "sandy" ice cream were made from the ice creams which had been subjected to the various treatments. A drop of ice cream was placed upon a glass slide and allowed to melt and was then observed under the low power of a microscope through polarized light.

EXPERIMENTAL DATA

The Effect Upon "Sandiness" in Nut Ice Creams When Different Maple Flavorings Were Used

Since the majority of the criticisms received from ice cream manufacturers with regard to "sandiness" in the nut ice creams are concerned with the maple nut flavors, two series of ice creams were frozen in order to determine whether the cause of the "sand" was the result of the presence of the nuts or of the maple flavoring used.

Series I consisted of an ice cream mixture which contained ten per cent fat, eleven per cent milk solids-not-fat, fourteen per cent sugar and one-half of one per cent gelatin. This series was divided into three lots. Pure maple syrup was added to one lot of the above mixture at the rate of three pints of syrup to five gallons of ice cream mixture. Imitation maple flavoring was added to another lot of the ice cream mixture at the rate of one hundred cubic centimeters of flavoring to five gallons of the ice cream mixture. The third lot contained the standard vanilla flavoring which was used as a control throughout the entire project.

Ground nut meats were added to the ice creams at the rate of two pounds of nuts to five gallons of ice cream mixture. Table 1 shows the

length of time that elapsed after freezing before "sandiness" was detected in the ice creams.

TABLE 1.—THE OCCURRENCE OF "SANDINESS" IN NUT ICE CREAMS WHEN DIFFERENT FLAVORINGS WERE USED

Kind of Nuts Used	Number of Days After Freezing Before Detection of "Sandiness"		
	Vanilla	Imitation Maple Flavoring	Pure Maple Syrup
Control.....	None in 14	None in 14	None in 14
Almond.....	5	5	7
English Walnut.....	6	6	7
Pecan.....	6	6	7

The ice cream which contained the pure maple syrup was exceedingly sweet to the taste, very smooth in texture and heavy in body.

It is evident from the data presented in Table 1 that the "sandiness" of the ice creams was induced by the presence of the various nuts and not by the presence of the vanilla or maple flavorings. The ice cream which contained the pure maple syrup did not develop the "sandy" condition as soon as those creams in which the syrup was absent. The increased concentration of the sugars in the ice cream which contained the pure maple syrup may have been a factor in retarding the "sandiness".

A Study of "Sandiness" in Vanilla, Maple and Pineapple Nut Ice Creams

Three lots composed Series II. Lot I consisted of vanilla flavored ice creams, Lot II was an imitation maple flavored ice cream made by adding ninety cubic centimeters of maple flavoring to five gallons of ice cream mixture, while Lot III was a fruit ice cream made by adding one-half gallon of crushed pineapple to five gallons of ice cream mixture.

Grapenuts were substituted for pecan meats and were added to the ice creams at the rate of one-half pint to one gallon of ice cream.

TABLE 2.—THE OCCURRENCE OF "SANDINESS" IN VANILLA, MAPLE AND PINEAPPLE NUT ICE CREAMS

Kind of Nuts Used	Number of Days After Freezing Before Detection of "Sandiness"		
	Vanilla	Imitation Maple Flavoring	Crushed Pineapple
Control.....	18	None in 18	None in 18
Almond.....	12	13	13
English Walnut.....	13	12	15
Grapenuts.....	18	None in 18	None in 18

Table 2 shows that the maple flavoring did not enhance the appearance of "sandiness" but even retarded it. The use of crushed pineapple in the ice cream tended to retard the appearance of "sand". The presence of grapenuts in the ice creams apparently had no great effect on the appearance of "sand".

A Study of "Sandiness" in Ice Creams Which Contained Fruits and Treated Nuts

The ice cream mixture used in Series III contained ten per cent fat, eleven per cent milk solids-not-fat, fourteen per cent sugar and one-half of one per cent gelatin. This mixture was frozen with a brine of zero degrees Fahrenheit (-17.8 degrees Centigrade) and was withdrawn from the freezer at one hundred per cent overrun.

One and one-half gallon lots of ice cream were used as a basis to which various nuts and fruits were added. Except where otherwise stated all of the ice creams that were frozen in the commercial freezer were standard vanilla flavor.

This series, however, contained vanilla and chocolate ice creams. The nut meats were added to the ice creams at the rate of one and one-half pounds to five gallons of ice cream mixture.

One lot of ice cream in this series contained nuts which had been washed previous to grinding. The washing of the whole nut meats was accomplished by stirring them in hot water at a temperature of 150 degrees Fahrenheit (65.5 degrees Centigrade) for a period of one minute, and then two subsequent rinsings in cold water. The nut meats were dried and thoroughly chilled before they were ground.

In order to determine whether the size of the ground nuts affected the appearance of "sandiness" a quantity of almonds was ground through the fine burr of the food chopper and was then added to a lot of ice cream.

Another lot of ice cream in this series contained tutti-frutti mixture at the rate of one-half gallon to five gallons of ice cream mixture.

TABLE 3.—THE OCCURRENCE OF "SANDINESS" IN NUT ICE CREAMS WHICH CONTAINED FRUITS AND TREATED NUTS

Kind and Treatment of Nuts	Number of Days After Freezing Before Detection of "Sandiness"	
	Vanilla	Chocolate
Control.....	None in 34	None in 34
Tutti-frutti.....	None in 34	None in 34
Grapenuts.....	None in 34	None in 34
English Walnut.....	22	None in 34
English Walnut, Washed.....	26	None in 34
Almond, Coarse.....	20	None in 34
Almond, Fine.....	20	None in 34
Pecan.....	22	None in 34

The presence of cocoa paste in the ice cream retarded the appearance of "sandiness" (Table 3). The presence of grapenuts and tutti-frutti mixture in the ice creams did not induce "sandiness". There was no noticeable difference in the rate of crystallization of the lactose in the ice creams between the lots which contained the finely ground nuts and those in which the nuts were ground through the coarse burr. Washing the nuts before grinding tended to retard "sandiness". The samples of ice cream were depleted at the end of thirty-four days after freezing.

The Effect Upon "Sandiness" in Nut Ice Creams When Boiled or Gelatinated Nuts Were Used

In Series IV the ice cream mixture contained ten and six hundredths per cent fat, ten and eighty-nine hundredths per cent milk solids-not-fat, fourteen per cent sugar and one-half of one per cent gelatin. The mixture was prepared and frozen in the usual manner. The nuts that were used in this series were subjected to various treatments.

In order to arrest the possibility of enzymatic action from the nuts causing the accelerated appearance of "sandiness", a quantity of each variety of ground nuts was boiled in water for one-half an hour. The liquid was drained from the nuts and the latter were placed in an oven at 140 degrees Fahrenheit (60 degrees Centigrade) for one-half an hour to remove excess moisture. Before stirring the nuts into the ice cream they were thoroughly chilled by placing them in the hardening room at a temperature of zero degrees Fahrenheit (-17.7 degrees Centigrade) for a period of one hour.

By enveloping the nuts in a protective film the ability of the nuts to greatly hasten the appearance of "sandiness" in ice cream might be materially retarded. With this point in mind, a quantity of each nut was dipped into a warm five per cent gelatin solution. Upon removal from the solution the gelatinated nuts were chilled in the cooler in order to set the gel thoroughly before using the nuts in the ice creams. Table 4 shows the effect upon "sandiness" in the nut ice creams by boiling or gelatination of the nuts.

The samples were depleted in forty-one days at which time "sandiness" had not yet been detected in the lot which contained the gelatinated walnuts. Gelatination of the nuts used in the ice cream prolonged the storage period of those creams before "sandiness" was detected. However, care must be exercised in the gelatination of the nuts in order that large amounts of gelatin are not permitted to solidify around the nut particles. An excess of gelatin around the nut particles produces an undesirable rubbery feeling of the nuts when eaten.

TABLE 4.—THE OCCURRENCE OF "SANDINESS" IN NUT ICE CREAMS CONTAINING BOILED OR GELATINATED NUTS

Kind and Treatment of Nuts	Number of Days After Freezing Before Detection of "Sandiness"
Control.....	40
Almond.....	25
Almond, Boiled.....	36
Almond, Gelatinated.....	38
English Walnut.....	25
English Walnut, Boiled.....	38
English Walnut, Gelatinated.....	None in 41
Pecan.....	25
Pecan, Boiled.....	36
Pecan, Gelatinated.....	38

Boiling the ground nut meats for one-half an hour destroyed the flavor of the nuts. However, it lengthened the storage period of the ice creams before "sand" was detected, but this practice cannot be recommended.

The Effect Upon "Sandiness" in Nut Ice Creams When Autoclaved, Gelatinated or Sugared Nuts Were Used

In Series V an ice cream mixture was used which contained ten per cent fat, eleven per cent milk solids-not-fat, fourteen per cent sugar and one-half of one per cent gelatin. The ground nuts were added to the ice creams at the rate of one-half pint to one and one-half gallons of ice cream.

The nuts in this series were divided into three lots for treatments as follows: in one lot the nuts were gelatinated, in another lot they were sugared, while in the third lot they were autoclaved.

Gelatination of the nuts was performed in the same manner as in the previous series except that a two per cent solution of gelatin was used.

The nuts that were sugared were immersed in a cold can of sugar syrup for a period of thirty minutes. The sugar syrup was prepared by dissolving thirty pounds of cane sugar in seven quarts of boiling water. This syrup was cooled to 40 degrees Fahrenheit (4.4 degrees Centigrade) before the nuts were immersed.

Autoclaving of the nuts was performed by subjecting them to a steam pressure of thirteen pounds per square inch for a period of thirty minutes.

Table 5 shows the effect on "sandiness" of adding gelatinated, sugared and autoclaved nuts to ice creams. All of the samples of ice cream were depleted at the end of thirty-four days.

Autoclaving of the nuts retards "sandiness" slightly, but this method of treating the nuts is not recommended because the nuts impart a

burned taste to the ice creams. The gelatinated and autoclaved almonds were more effective in retarding "sandiness" than the sugared almonds. The gelatinated and sugared walnuts retarded "sandiness" longer than the autoclaved walnuts, whereas the gelatinated pecans were more effective in retarding "sandiness" than the sugared or autoclaved pecans.

TABLE 5.—THE OCCURRENCE OF "SANDINESS" IN NUT ICE CREAMS WHICH CONTAINED AUTOCLAVED, GELATINATED OR SUGARED NUTS

Kind and Treatment of Nuts	Number of Days After Freezing Before Detection of "Sandiness"
Control.....	None in 34
Almond.....	27
Almond, Gelatinated.....	31
Almond, Sugared.....	29
Almond, Autoclaved.....	31
English Walnut.....	29
English Walnut, Gelatinated.....	34
English Walnut, Sugared.....	34
English Walnut, Autoclaved.....	31
Pecan.....	29
Pecan, Gelatinated.....	None in 34
Pecan, Sugared.....	29
Pecan, Autoclaved.....	31

The Effect Upon "Sandiness" in Nut Ice Creams When Sugared or Gelatinated Nuts Were Used

Series VI was composed of an ice cream mixture which contained ten and one-tenth per cent fat, ten and thirty-five hundredths per cent milk solids-not-fat, fourteen per cent sugar and one-half of one per cent gelatin. The nuts used were gelatinated or sugared.

Gelatination of the nuts was accomplished by adding one hundred cubic centimeters of one per cent gelatin solution to one-half pint of the ground nuts. This gelatin-nut mixture was stirred gently until the gelatin had solidified.

The sugaring of the nuts was accomplished in the same manner by adding one hundred cubic centimeters of the standard sugar syrup to one-half pint of the nuts. Hot sugaring of the nuts was effected by adding one hundred cubic centimeters of the sugar syrup, at a temperature of 135 degrees Fahrenheit (57.2 degrees Centigrade), to one-half pint of the ground nuts. This mixture was permitted to cool gradually at room temperature.

The detection of "sandiness" in the group of ice creams, Table 6, on the forty-sixth day was the result of a severe "heat shocking" of all of the samples when a breakdown in the refrigeration system caused the hardening-room temperature to rise to 30 degrees Fahrenheit (-1.1 degrees Centigrade) for a period of two days.

TABLE 6.—THE OCCURRENCE OF "SANDINESS" IN NUT ICE CREAMS WHICH CONTAINED SUGARED OR GELATINATED NUTS

Kind and Treatment of Nuts	Number of Days After Freezing Before Detection of "Sandiness"
Control.....	46
Almond.....	33
Almond, Gelatinated.....	46
Almond, Cold Sugared.....	46
Almond, Hot Sugared.....	46
English Walnut.....	33
English Walnut, Gelatinated.....	46
English Walnut, Cold Sugared.....	33
Pecan.....	33
Pecan, Gelatinated.....	46
Pecan, Cold Sugared.....	46

All of the samples were judged on the forty-third day and again on the forty-sixth day after the ice creams had been rehardened for a period of twenty-four hours succeeding their softening. The effect of "heat shocking" of the ice creams on accelerating "sandiness" is strikingly evidenced from the above results.

The Effect Upon "Sandiness" in Nut Ice Creams When Treated Nuts Were Used

The ice cream mixture used in Series VII contained ten and five-tenths per cent fat, nine and three-tenths per cent milk solids-not-fat, fourteen per cent sugar and one-half of one per cent gelatin.

The nuts which were used in the ice creams in this series were divided into five groups: the whole nuts, the half nuts, ground gelatinated nuts, ground cold sugared nuts and ground hot sugared nuts.

The gelatination of the nuts was accomplished in the same manner as in the previous series except that a one and one-half per cent gelatin solution was used.

The method of cold sugaring the nuts also was similar to the method used in the previous series. In the hot sugaring process the nuts and syrup mixture was kept hot at 135 degrees Fahrenheit (57.2 degrees Centigrade) for one and one-half hours. The mixture was thoroughly chilled before it was stirred into the ice creams.

The ice creams in this series were treated similarly to those in Series VI in that they were severely "heat shocked" on the thirty-eighth and the thirty-ninth days after freezing. All of the samples were judged on the thirty-eighth day and again two days later after the ice creams had been rehardened for a period of twenty-four hours succeeding their softening.

TABLE 7.—THE OCCURRENCE OF "SANDINESS" IN NUT ICE CREAMS WHICH CONTAINED TREATED NUTS

Kind and Treatment of Nuts	Number of Days After Freezing Before Detection of "Sandiness"
Control.....	41
Almond.....	28
Almond, Gelatinated.....	41
Almond, Cold Sugared.....	41
Almond, Hot Sugared.....	41
Almond, Whole.....	30
Almond, Halves.....	26
English Walnut.....	28
English Walnut, Gelatinated.....	41
English Walnut, Cold Sugared.....	41
English Walnut, Hot Sugared.....	41
Pecan.....	41
Pecan Gelatinated.....	41
Pecan, Cold Sugared.....	41
Pecan, Hot Sugared.....	41
Pecan, Halves.....	36
Pecan, Quarters.....	26

Again in this series it was clearly demonstrated, Table 7, that "heat shocking" has a disastrous effect upon the ice creams which have been softened and rehardened.

The Effect Upon "Sandiness" in Nut Ice Creams When Treated Nuts Were Used

In Series VIII the ice cream mixture contained ten and one-tenth per cent fat, twelve and nine hundredths per cent milk solids-not-fat, fourteen per cent sugar and one-half of one per cent gelatin. The amount of ice cream used for each lot in the series was reduced from one and one-half gallons to one gallon. The quantity of nuts used for the nut ice creams was reduced accordingly, the amount used being one-third of a pint.

In the gelatination of the nuts a one and one-half per cent gelatin solution was used except for the English walnuts in which case a three per cent solution was used.

The hot sugared nuts were maintained at a temperature of 135 degrees Fahrenheit (57.2 degrees Centigrade) for a period of three hours after which time they were chilled in the hardening room for one hour before they were stirred into the ice creams.

TABLE 8.—THE OCCURRENCE OF "SANDINESS" IN NUT ICE CREAMS WHICH CONTAINED TREATED NUTS

Kind and Treatment of Nuts	Number of Days After Freezing Before Detection of "Sandiness"
Control.....	10
Almond.....	7
Almond, Cold Sugared.....	7
Almond, Hot Sugared.....	8
Almond, Gelatinated.....	None in 10
Almond, Whole.....	8
Almond, Halves.....	7
English Walnut.....	8
English Walnut, Cold Sugared*.....	10
English Walnut, Cold Sugared**.....	8
English Walnut, Hot Sugared.....	8
English Walnut, Gelatinated***.....	8
Pecan.....	7
Pecan, Cold Sugared.....	7
Pecan, Hot Sugared.....	10
Pecan, Gelatinated.....	8
Pecan, Halves.....	8
Pecan, Quarters.....	None in 10
Ground Mixed Nuts.....	7

*Sixty-six cubic centimeters of syrup used.

**Thirty-three cubic centimeters of syrup used.

***A three per cent gelatin solution used.

The presence of a high percentage of milk solids-not-fat greatly accelerated the crystallization of the lactose in this series, Table 8.

Gelatination of the almonds and hot sugaring of the pecans tended to retard "sandiness", whereas cold sugaring of the walnuts was also effective in retarding "sandiness".

PHOTOMICROGRAPHS

Photomicrographs were made of pure recrystallized lactose-hydrate and various "sandy" ice creams. Unless otherwise stated all of the exposures were taken through polarized light under the low power of a microscope (magnification 100 times). The ice creams when photographed were two months old. Figure 2 shows the control ice cream, which contained no nuts, and nut ice creams, while Figure 3 shows regular nut ice creams, and a chocolate nut ice cream. Figure 4 shows "sand" crystals clustered about a particle of nut; one exposure was taken through polarized light and the other through plane light.

Figure 5 shows a group of sucrose crystals in plane light (magnification 5 times).

The photographs of the "sand" crystals in the ice creams show the characteristic tomahawk shape of lactose-hydrate but they are quite blunt or truncated. There was a tendency for the crystals to group together, a characteristic which may have been due to the melting ice cream.

The presence of nut particles in ice creams which might act as a nuclei, thus causing the earlier development of "sandiness" is shown in the photomicrograph of lactose crystals clustered about a nut particle, Figure 4.

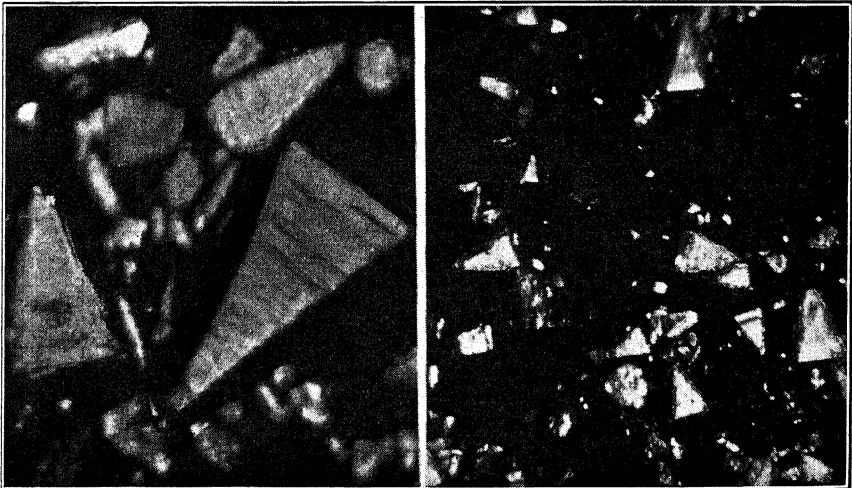
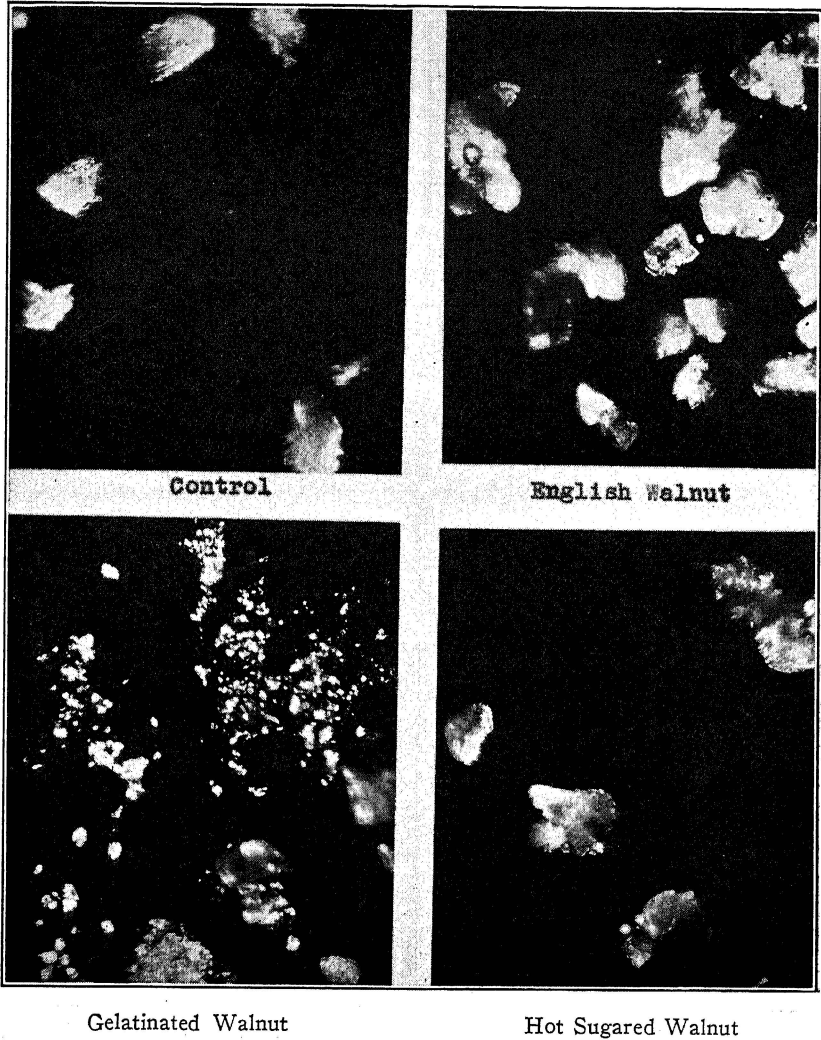


Fig. 1.—Photomicrographs of Recrystallized Lactose-hydrate. X70.



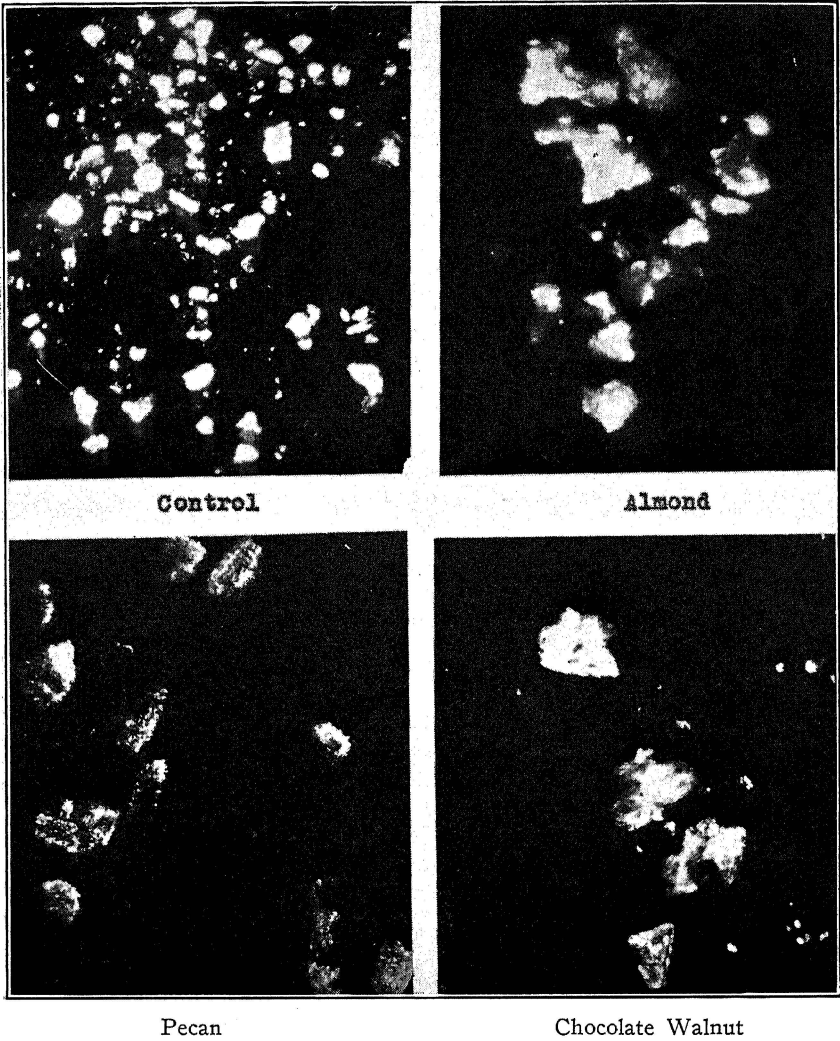
Control

English Walnut

Gelatinated Walnut

Hot Sugared Walnut

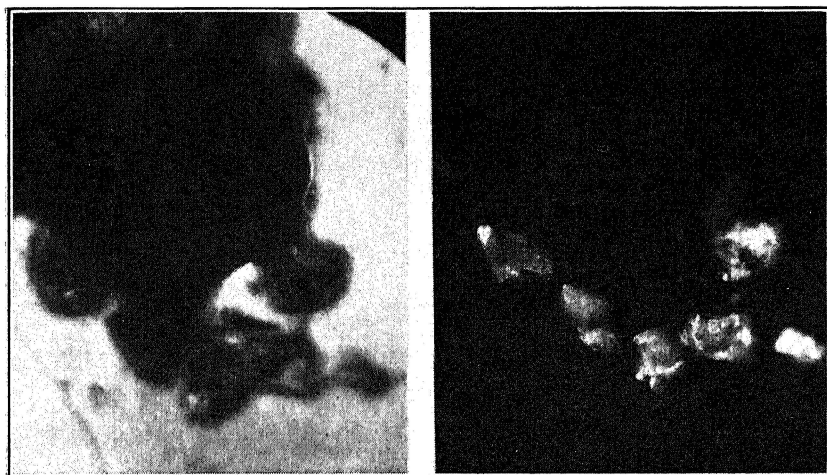
Fig. 2.—Photomicrographs of "Sandy" Ice Creams. X70.



Pecan

Chocolate Walnut

Fig. 3.—Photomicrographs of "Sandy" Ice Creams. X70.



Plane light

Polarized light

Fig 4.—Photomicrographs of "Sand" Crystals Clustered Around a Nut Particle. X70.

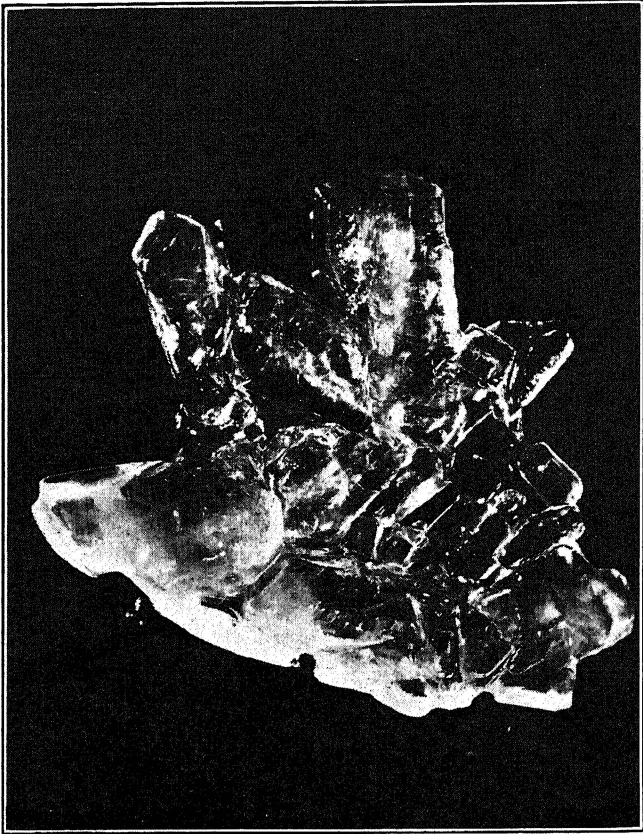


Fig. 5.—Photograph of Sucrose Crystals, X5.

CONCLUSIONS

The following factors were found to cause "sandiness" in ice creams:

1. The presence of nuts.
2. "Heat shocking".
3. Increasing amount of milk solids-not-fat.

The following factors were found to retard "sandiness" in ice creams:

1. Gelatinated nuts.
2. Nut-fruit ice creams.
3. Cocoa paste.
4. Sugared nuts.
5. Boiled nuts (not recommended).
6. Autoclaved nuts (not recommended).

The use of maple flavoring or grapenuts in ice creams had no influence upon "sandiness".

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