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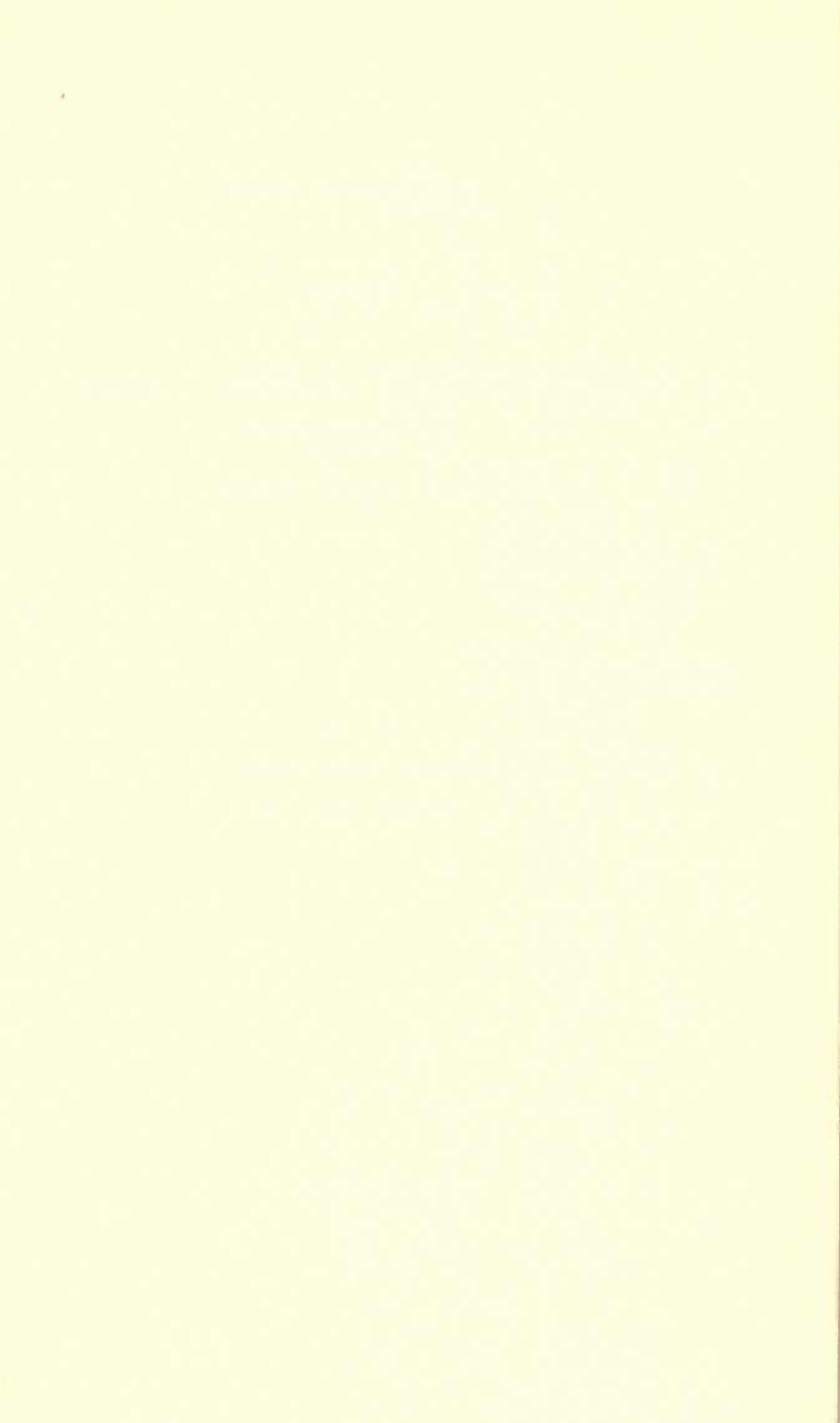
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Use of Honey in Ice-Cream Manufacture

BY P. H. TRACY, H. A. RUEHE, AND
F. P. SANMANN

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USE OF HONEY IN ICE-CREAM MANUFACTURE

By P. H. TRACY, H. A. RUEHE, AND F. P. SANMANN¹

HONEY has formed a part of the human diet for centuries, being the main source of sweetness until the advent of refined sugar. Supplanted somewhat by the cheaper cane and beet sugars, honey still remains a popular sweet because of its palatability and high food value.

The use of honey in commercial ice-cream manufacture has been rather limited. During the World War, when cane and beet sugars were expensive and difficult to obtain, ice-cream manufacturers had to look elsewhere for sweeteners, and considerable honey was used by them at that time. The National Association of Ice Cream Manufacturers, in reporting the results of a recent survey, lists the percentages of the different sugars used in commercial ice cream in the United States today but does not mention honey.² The literature contains practically no information regarding the merits or disadvantages of honey as compared with sugar for sweetening ice cream. It was to obtain such information that this study was made.

Composition of Honey

Honey has been defined as "the nectar obtained from flowers by worker bees, which, after modification in the honey-stomach of the latter, is stored in the cells of the comb, for nourishment of the young brood."³ It is a carbohydrate, being composed largely of the two sugars dextrose and levulose. In color it varies from water-white to dark, depending upon the sources of the bees' food. Its flavor also depends on the kind of flowers from which the nectar was taken.

Honey varies in both the kind and the proportions of its different constituents. Its average composition, as determined from 99 complete analyses by Browne,⁴ is as follows:

Ingredient	Percent	Ingredient	Percent
Water.....	17.59	Dextrin.....	2.09
Invert sugar.....	74.41	Undetermined.....	3.70
Sucrose.....	1.98	Free acid as formic.....	.09
Ash.....	23		

¹P. H. TRACY, Assistant Chief in Dairy Manufactures, H. A. RUEHE, Chief in Dairy Manufactures, and F. P. SANMANN, formerly Associate.

²*Dairy World*, June, 1928, p. 348. ³Root, A. I. and E. R. ABC and XYZ of bee culture, p. 398, 1929. ⁴Browne, C. A. Chemical analysis and composition of American honeys. U. S. Dept. of Agr., Bur. Chem. Bul. 110, 38. 1908.

In addition to the above, honey contains enzymes such as invertase, diastase, and sometimes inulase and catalase. Certain aromatic compounds add their flavor and odor. The vitamin content of honey is questionable. Some investigators have found none, while others report the presence of small quantities; it is likely that there are considerable differences in honeys in this respect.

The specific gravity of honey at 15° C. is 1.46; a gallon weighs about 12 pounds.

General Procedure for Commercial Ice-Cream Manufacture

Ice cream is made from such a mixture of milk, cream, condensed milk, or other dairy products, and sugar as will result in the desired proportion and concentration of the different solids. The butterfat content usually varies from 8 to 16 percent (by weight); the milk-solids-not-fat, from 9 to 13 percent; and the sugar, from 12 to 18 percent, depending somewhat on the kind of sugar used. A stabilizer such as gelatin is usually added for the purpose of improving the body of the ice cream.

The ice-cream mix is ordinarily heated to 145° to 160° F. for about 30 minutes for the purpose of destroying bacteria, and is then passed thru a high-pressure machine¹ in order to completely emulsify the butterfat. It is then cooled rapidly to about 40° F., at which temperature it is held until frozen. Holding the pasteurized mix at a low temperature is called *aging* and usually lasts for 24 to 48 hours.

In freezing ice cream it is the usual practice to lower the temperature of the mix in the freezer until the maximum amount of heat is removed that will permit the incorporation of the desired amount of air. The refrigeration is then shut off and the ice cream whipped until the desired increase in volume, or "overrun" as it is termed, is obtained. Ordinarily from 80 to 100 percent overrun is secured. Flavoring is usually added at the freezer.

The finished ice cream is drawn from the freezer into conveyors, cans, or pans for bricks, and is then placed in a room having a temperature of 0° F. or lower, where it is allowed to harden before being marketed.

OUTLINE OF THE EXPERIMENTS

The experiments reported herein were made in order to determine the effect of replacing a part or all of the sucrose (cane and beet sugar) in ice cream with honey. Special consideration was given to the effect

¹There are various types of machines on the market used for this purpose, such as the homogenizer and viscolizer.

of honey on flavor, on the body of the ice cream, on the freezing process, on the hardening of the ice cream and on its melting resistance.

Ice-cream mixes containing approximately 10, 13, and 15 percent of butterfat were used. The total solids contents varied from 35.5 to 42 percent. The control batches contained 14 percent cane sugar, whereas the honey mixes, because honey is less sweet than cane sugar, contained from 16 to 20 percent honey. Various combinations of honey and sugar were also tried. It was the usual practice to pasteurize and homogenize the milk products and gelatin mixture and then add the desired quantities of the sweetening products to the cooled mix.

The mixes were aged for 24 to 48 hours by storing at 40° F. Both power and hand freezers were used. Mix temperature and overrun determinations were made each minute during the freezing process when the power freezer was used.

The ice creams were judged by several persons, but no attempt was made to score the products. The samples were examined while fresh and again at different intervals during a two- or three-months storage period.

The honeys used were obtained from the Department of Entomology, University of Illinois, and from various commercial concerns. The total solids content of each of these honeys, as determined by the Mojonnier method, was as follows:

Variety of honey	Total solids perct.	Variety of honey	Total solids perct.
Sage.....	80.00	Cotton.....	82.44
Orange.....	81.66	Buckwheat.....	81.30
Alfalfa.....	82.89	Heartsease.....	75.37
Clover.....	81.70	Palmetto.....	78.50
White clover.....	82.34	Basswood.....	81.17
Sweet clover, No. 1.....	76.65	Clover and heartsease.....	78.90
Sweet clover, No. 2.....	91.36	Average.....	81.305
Tupelo.....	83.99		

RELATION OF HONEY SWEETENING TO QUALITY OF ICE CREAM

Flavor Ratings of 12 Kinds of Honey Ice Cream

The predominating flavor in honey ice cream depends entirely on the kind of honey used. To compare the relative merits of some of the more common honeys on the market, 12 of those listed above were used to sweeten and flavor ice cream. Eighteen percent of honey was added in each case.

In these tests a wide variety of flavors was obtained. *Buckwheat* honey gave the ice cream a caramel color and a flavor similar to

sorghum. *Basswood* honey produced a mint flavor in the ice cream. The flavors of the *palmetto* and *heartsease* lots were rather pungent and undesirable. *Sage* honey added an unpleasant flavor that lingered in the mouth. *Orange* honey gave the ice cream a mild yet pleasant flavor. The ice creams sweetened with *clover* and *alfalfa* honeys were very popular.

Five experienced judges sampled these ice creams and rated them on the basis of flavor, the maximum rating possible being 60 and the minimum, 5. The results were:

Honey used	Rating	Honey used	Rating
Sweet clover.....	58	Mixture (clover and heartsease.....	28
Alfalfa.....	53	Tupelo.....	25
Clover.....	51	Sage.....	24
Basswood.....	47	Heartsease.....	16
White clover.....	36	Buckwheat.....	10
Orange.....	35	Palmetto.....	7

Several varieties of honey ice cream, it is evident, can be made successfully. It should be kept in mind that the above ratings were only relative, so that some of the ice creams which had comparatively low scores within this group might still be quite acceptable to many people, especially where there is need for a change of variety.

Palatability of Honey Ice Cream

In order to obtain the opinions of a number of persons regarding the general desirability of ice cream flavored with honey, as well as to ascertain the relative desirability of ice creams having different proportions of honey, samples of the sweet-clover honey ice creams indicated in Table 2 were taken at 100 percent overrun, and after remaining in the hardening room for 7 days were judged for flavor by fifteen members of the clerical staff and faculty of the College of Agriculture. These people were not informed what the different ice creams contained, but were asked to place the samples in the order of their preference on the basis of flavor. The results follow:

Mix	Sugar perct.	Honey perct.	Order of preference				
			1st	2d	3d	4th	5th
1.....	14.0	....	0	0	3	1	11
2.....	10.5	4.5	1	2	2	8	2
3.....	7.0	9.0	3	5	5	2	0
4.....	3.5	13.5	7	2	4	1	1
5.....	....	18.0	4	6	1	3	1

The majority of the judges preferred the ice creams having the larger proportions of honey. The most popular sample was that containing 13.5 percent honey and 3.5 percent sugar. None of the lots were criticized as being too sweet or as lacking in sweetness. It is

interesting to note that no one placed the all-sugar ice cream either first or second.

At least 9 percent honey is required in the mix if an appreciable honey flavor is to be obtained. When honey is the only source of sweetening, 16 to 18 percent is necessary. The sweetening values of honeys vary somewhat, but ordinarily about 25 to 30 percent more honey than sugar is needed if the same degree of sweetness is to be obtained. However, when using as much as 20 percent honey in the mix, a slight wax flavor occasionally results, so that 18 percent honey is recommended as the maximum.

Flavor Combinations

Various flavor combinations were tried with ice creams sweetened with 16 to 18 percent sweet-clover honey. Pure vanilla extract did not blend well with the honey flavor, while chocolate covered it up almost entirely. Pineapple fruit was found to produce a very pleasing flavor. Cherry, peach, mint, and tutti-frutti made satisfactory combinations. Cold-pack strawberries did not blend so well as did some of the other fruits. One of the best combinations found was bisque made with grapenuts.

Storage Quality of Honey Ice Cream

Most of the ice creams containing honey retained their quality when stored in the hardening room for a period of several weeks. Some samples, however, seemed to store better than others. A few samples containing high percentages of honey developed an objectionable stale flavor. In some instances, only those samples containing a combination of sugar and honey developed this defect. In the experiment in which the different kinds of honey were tested for flavor ratings (pages 289 and 290) it was found that with the exception of the heartsease honey, all twelve honeys used resulted in a more pleasing flavor in the ice cream after being stored for seven weeks than when freshly made.

To determine whether or not the beeswax in the honey had any relation to the flavor developed in the honey ice cream, a series of mixes was prepared as follows:

Mix	Ingredients
1.....	4 lbs. 22% cream, .7 lb. sugar, .3 lb. water
2.....	4 lbs. 22% cream, .9 lb. sugar, .1 lb. water
3.....	4 lbs. 22% cream, .35 lb. sugar, .45 lb. honey, 2 lb. water
1a.....	Same as Mix 1 with 2 grams beeswax added
2a.....	Same as Mix 2 with 2 grams beeswax added
3a.....	Same as Mix 3 with 2 grams beeswax added

Mixes 1a, 2a, and 3a were heated to 160° F. in order to melt the

wax. All samples, both with and without the beeswax, were kept for six weeks and at the end of that time the following criticisms were recorded:

Ice cream sample No.	Criticism
1.....	Cleanest flavor of the series, body least desirable.
1a.....	Flavor not so clean as No. 1.
2.....	Body better than No. 1, but flavor not quite so clean.
2a.....	Waxy after-taste but best of the honey samples.
3.....	Poorest of the series, old stale flavor.
3a.....	Next poorest sample; old stale flavor, honey flavor more pronounced than No. 3.

Beeswax evidently has no relation to the stale flavor that sometimes develops in honey ice cream.

No "sand"¹ development was noted in any of the experimental lots. One series in which the ice cream contained approximately 10 percent fat and 12 percent serum solids was held three months without any lactose crystallization becoming apparent.

Pasteurization Not Detrimental to Honey-Sweetened Ice Cream

Inasmuch as manufacturers in some communities are required by law to pasteurize the entire ice-cream mix, a study was made of the effect of pasteurizing temperatures on the flavor of honey ice cream. Temperatures as high as 160° F. were used.

Pasteurization caused the ice cream to have a slightly sharper flavor, but no detrimental effects were noted. Heating the mix containing honey caused the wax present to melt and come to the surface. As the temperature increased, this wax, instead of being dispersed thruout the mix, ran together and formed larger droplets. These wax droplets lost their identity, however, in the subsequent cooling and freezing of the mix and were of no serious consequence.

Honey Changes Body of Ice Cream Slightly

The texture of honey ice cream has been criticised by Iverson²; this investigator, however, had replaced all the sugar in the mix with an equal weight of honey. Under such conditions the honey ice cream will not have as good a body as that containing sugar, because of the lower proportion of total solids. As stated on page 291 it is necessary to use 25 to 30 percent more honey (by weight) than sugar if the same sweetness is to be maintained in the ice cream. This proportion of honey gives the mix practically the same total solids as when cane

¹The term "sand" is used to describe the condition that exists when the lactose in ice cream becomes crystallized.

²*American Bee Journal*, July, 1928, p. 348.

sugar is used and the body of the ice cream will be more nearly like that made with sugar.

Because of its lower freezing point, honey ice cream seems to be somewhat smoother. In cutting slabs of honey ice cream the body appeared slightly crumbly and sticky but the objection was not serious.

EFFECT OF HONEY SWEETENING ON FREEZING AND HARDENING

The freezing point of an ice-cream mix is of considerable importance to the manufacturer. It has been found¹ that as the freezing

TABLE 1.—FREEZING POINT OF SUGAR AND HONEY MIXES

Mix	Fat	Total solids	Cane sugar (by weight)	Honey (91.36% t.s.) (by weight)	Freezing point
	<i>perct.</i>	<i>perct.</i>	<i>perct.</i>	<i>perct.</i>	
1.....	13.27	35.58	14.0	0	-2.06°C.
2.....	13.42	36.45	10.5	4.5	-2.57°C.
3.....	13.19	36.70	7.0	9.0	-2.95°C.
4.....	13.20	36.44	3.5	13.5	-3.11°C.
5.....	12.90	36.42	0	18.0	-3.47°C.

NOTE. Each batch contained .33 percent of gelatin by weight.

point is lowered by an increase in the sugar content of the mix, more time is required to complete freezer operations; also, lower temperatures are necessary to maintain the ice cream in a firm condition.

A mix containing 18 percent honey had a freezing point of -3.47° C., whereas another mix containing practically the same milk solids and 14 percent cane sugar has a freezing point of -2.06° C. (Table 1).

Effect on Freezer Operations

Since honey lowers the freezing point of a mix to a greater extent than does an amount of cane sugar of equal total solids, it might be expected that there would be some differences in the freezer operations. This relationship as outlined in Table 2 shows that as the proportion of honey was increased, the time required for the brine to be on was increased. There was also a tendency for the honey mixes to require a longer time to whip. Examination of the freezing curves, however, shows that when the ice cream was drawn at an overrun of less than 100 percent, the differences in the freezing periods became less. Some manufacturers limit the overrun in package ice cream to 80 percent. In these freezings 80 percent overrun would have been obtained at the following intervals:

¹Department of Dairy Husbandry, Illinois Agricultural Experiment Station. Unpublished data.

TABLE 2.—EFFECT OF HONEY SWEETENING ON FREEZER OPERATIONS

Mix	Fat	Total solids	Cane sugar (by weight)	Honey (sweet clover)	Time brine was on ¹	Total time to freeze (100% over- run)	Temperature when brine was shut off	Temperature at 100 percent overrun
	<i>perct.</i>	<i>perct.</i>	<i>perct.</i>	<i>perct.</i>	<i>minutes</i>	<i>minutes</i>	<i>° F.</i>	<i>° F.</i>
1.....	13.27	35.58	14.0	0	5	8.50	26.0	25.5
2.....	13.42	36.45	10.5	4.5	5½	11.25	25.1	24.6
3.....	13.19	36.70	7.0	9.0	6	11.75	23.5	23.2
4.....	13.20	36.44	3.5	13.5	6½	13.00	22.6	22.5
5.....	12.90	36.42	0	18.0	6¾	13.25	21.6	21.8

¹Brine temperature, -9° F.

Mix	Minutes to reach 80 percent overrun for drawing	Temperature at 80 percent overrun
1.....	6-7	25.5° - 25.4° F.
2.....	7-8	24.6° - 24.5° F.
3.....	8	22.8° F.
4.....	8-9	21.9° F.
5.....	8-9	21.2° F.

As 100 percent overrun was approached, the poorer whipping qualities of the honey mixes became more apparent. In a few freezings it

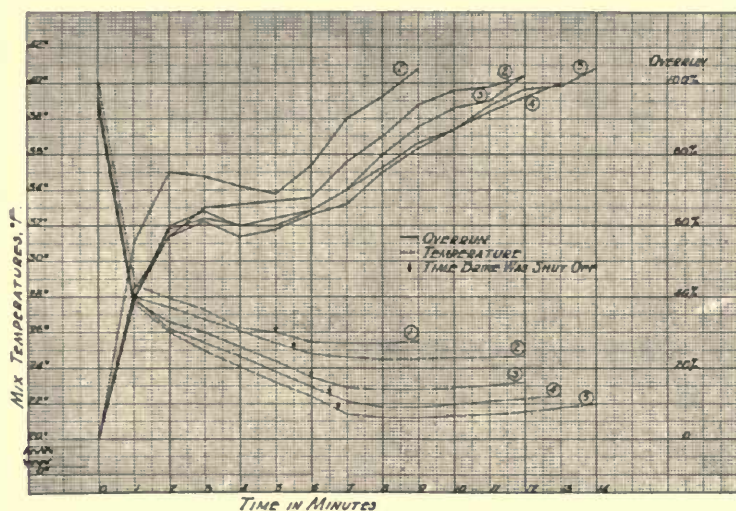


FIG. 1.—RELATION OF HONEY SWEETENING TO FREEZING OF ICE CREAM

The heavy, unbroken lines in the upper group represent the overrun of the different mixes taken each minute during the freezing process, whereas the light, broken lines in the lower group represent the mix temperature. The arrows indicate the point at which the brine was shut off. Numbers 1 to 5 represent the various mixes as described in Tables 2 and 3.

was impossible to obtain a maximum overrun of 100 percent. The ice cream, in these cases, developed a slightly greasy character.

Effect on Hardening of Ice Cream

In the hardening room further differences occurred between honey ice cream and sugar-sweetened ice cream. The ice creams containing honey were somewhat softer than those made with sugar unless rather low temperatures were maintained. At -18° F. no impression could be made with the finger upon the surface of any of the ice creams indicated in Table 2. At -15° F. sample No. 5 could be indented

slightly. At -12° F. sample No. 4 began to soften. At -8° F. sample No. 3 had softened somewhat and sample No. 2 was slightly affected. At -5° F. sample No. 1 could be impressed.

DIPPING LOSSES WITH HONEY ICE CREAM

Since honey ice cream is softer at cabinet temperatures than is ice cream containing sucrose, it might be expected that a greater dipping loss would occur with the honey ice cream. This is not necessarily the case, as was shown by dipping two lots of ice cream at the same temperature, one containing 14 percent sucrose and the other 18 percent honey, the milk solids being practically the same in the two ice creams.

The control lot dipped an average of 6.42 pints to the gallon, whereas the honey lot dipped 6.77 pints to the gallon. This difference was thought to be due to the consistency of the honey ice cream, since the honey ice cream became somewhat sticky as it warmed.

RELATION OF HONEY SWEETENING TO MELTING RESISTANCE OF ICE CREAM

The effect of honey on the way in which the ice cream melts was studied. Pint samples of the ice creams indicated in Table 2, drawn at 100 percent overrun, were subjected to melting tests. Triplicates of each lot were removed from their containers and placed on small glass jars in a room having a temperature of 72° F. The ice creams all had a temperature of -20° F. before being placed at room temperature. The drippings from each sample were caught in a pan and the weight recorded at stated intervals. The results are given in Table 3.

TABLE 3.—EFFECT OF HONEY SWEETENING ON MELTING RESISTANCE OF ICE CREAM

Sample	Sugar	Honey	Average percentage of ice cream melted after—		
			60 minutes	90 minutes	120 minutes
	<i>perct.</i>	<i>perct.</i>		<i>perct.</i>	<i>perct.</i>
1.....	14.0	0	None	13.97	35.14
2.....	10.5	4.5	None	15.28	39.06
3.....	7.0	9.0	None	20.36	40.13
4.....	3.5	13.5	None	22.06	43.56
5.....	0	18.0	None	23.30	42.32

The honey ice creams, as might be expected, melted faster than the control lots. The melted portions from the control lots were more liquid than those from the honey samples, which dropped in rather large masses.

COMPARATIVE COSTS OF HONEY AND SUGAR SWEETENING FOR ICE CREAM

Some objection has been made to the use of honey in ice cream because of its cost. This is probably due to the fact that the ice-cream manufacturer has regarded the honey merely as a sweetening agent. When, however, due consideration is given to the fact that honey ice cream is a distinct variety, and that its use dispenses with the need of vanilla extract, the cost comparison becomes more favorable to the use of honey. Assuming present market values to be 6 cents a pound for sugar and 10 cents a pound for honey, the following cost comparison is possible:

Cost of sugar in 100 pounds of 14 percent sugar mix.....	\$.84
Cost of ½ pound of good grade vanilla for 100 pounds mix.....	.50
Total cost to sweeten and flavor 100 pounds vanilla mix.....	<u>\$1.34</u>
Fruit cost when adding fruit'.....	2.00
Total cost 108 pounds fruit mix.....	<u>\$3.34</u>
Cost of honey in 100 pounds of 18 percent honey mix.....	\$1.80
Cost to sweeten and flavor:	
1 gallon of vanilla mix.....	\$.122
1 gallon of fruit mix.....	.278
1 gallon of honey mix.....	.164
<small>(¹Assuming the average cost of fruit to be \$2.00 when adding 8 pounds of fruit to 100 pounds of mix.)</small>	

Thus it would cost 4.2 cents more per gallon to use honey than it would cost to use sugar and pure vanilla, while as compared to the average fruit mix, the honey mix would cost 11.4 cents less a gallon.

These calculations do not make any allowance for the additional cost of the milk products in a honey-sweetened mix. A larger proportion of condensed milk must be used because of the smaller proportion of milk products. (Example: when using 15 percent sugar, vanilla, and gelatin, the percentage milk products will be 85, whereas when using 18.5 percent honey and gelatin, the percentage milk products will be 81.5.)

SUMMARY AND CONCLUSIONS

Honey can be used satisfactorily to replace 50 to 100 percent of the sugar in an ice-cream mix, and in these proportions gives so distinct a flavor to the ice cream that a new and pleasing variety is obtained.

A more pronounced honey flavor is obtained by the complete replacement of the sugar with honey, but because of freezing difficulties a 75 percent replacement is likely to prove more practical. The minimum amount of honey which will give an appreciable honey flavor to the ice cream is 9 percent, but a more desirable flavor will result

from the use of 14 to 18 percent. When used as the sole sweetening agent, 16 to 18 percent honey by weight is sufficient to sweeten and flavor the mix. Since honey is not so sweet as sugar, it must be used in greater proportions. Assigning a sweetening value of 100 to cane sugar, honey has a value of about 70 to 75 percent.

The average percentage of total solids in the fourteen samples of honey studied was 81.305, the minimum, 75.37, and the maximum, 91.36, as determined by the Mojonnier method.

Since ice-cream mixes containing honey have a lower freezing point than those containing sugar, they freeze and whip more slowly. Lower temperatures must be maintained in the hardening room for the honey ice cream in order to keep it in a firm condition. Ice creams containing honey melt more rapidly at room temperatures than do those containing sugar.

In comparing ice creams sweetened with cane sugar with those sweetened with honey, little difference could be noted in body when the total solids content of the mixes was the same. The honey ice cream seemed to be slightly smoother but had a tendency to be somewhat crumbly.

Mixes containing honey can be successfully pasteurized.

The flavor of honey ice cream varies with the flavor of the honey used. The ice creams in which alfalfa and clover honey were used were the most popular with the judges.

Most of the fruits commonly used to flavor ice cream combine successfully with honey. Vanilla extract, however, does not blend well with it.

Honey ice creams can ordinarily be stored for several weeks without serious injury to the flavor. There were a few instances, however, in these experiments when a stale flavor developed. The beeswax added in the honey did not seem to be a factor in this flavor defect.

On the basis of the ingredient costs assumed, a honey ice-cream mix costs about 4 cents a gallon more than a mix flavored with pure vanilla and sweetened with sugar. The cost, however, is about 11 cents less a gallon than that of the average fruit mix.

APPENDIX

FORMULAS FOR HONEY ICE CREAM

Variations in the kind of milk products available, differences in the proportions of non-milk products that can be used, and the large number of combinations of fat and milk-solids-not-fat possible in the finished ice cream make it impractical to give a complete set of honey ice-cream formulas. Those given in Table 4 will, however, provide the reader with a fairly comprehensive list to choose from.

The table lists four possible combinations of milk products under

TABLE 4.—FORMULAS FOR FOUR ICE-CREAM MIXES WITH HONEY USED FOR SWEETENING
(Expressed in pounds needed for 100 pounds of mix)

Percentage of non-milk products ¹	Mixes containing 10 percent fat, 12 percent serum solids				Mixes containing 14 percent fat, 10 percent serum solids			
	14.5	17.5	18.5	21.5	14.5	17.5	18.5	21.5
<i>Combination of milk products</i>								
A								
40-percent cream.....	19.54	19.24	19.14	18.85	31.30	31.00	30.90	30.61
Skim milk.....	38.68	34.49	33.09	28.89	35.71	31.52	30.12	25.93
Bulk condensed (8 percent fat, 27 percent serum solids).....	27.28	28.77	29.27	30.76	18.49	19.98	20.48	21.96
B								
32-percent cream.....	23.06	23.58	23.73	24.21	37.10	37.60	37.76	38.23
4-percent milk.....	49.92	45.76	44.56	40.72	37.41	33.60	32.32	28.56
97-percent powdered skim milk.....	4.52	5.16	5.21	5.57	2.99	3.30	3.42	3.71
Evaporated milk (7.8 percent fat, 17.7 percent serum solids).....	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
C								
83-percent butter.....	8.62	8.79	8.83	9.01	13.59	13.78	13.82	13.99
4-percent milk.....	71.11	67.61	66.50	62.95	67.90	64.45	63.23	59.76
87-percent powdered skim milk.....	5.77	6.10	6.17	6.53	4.01	4.33	4.45	4.75
D								
32-percent cream.....	26.61	27.32	27.43	28.03	39.89	40.49	40.69	41.30
4-percent milk.....	37.12	32.24	30.56	25.76	30.88	26.08	24.48	19.60
32-percent concentrated skim milk.....	21.77	23.04	23.51	24.71	14.73	15.93	16.33	17.60

¹The non-milk products include, in addition to the sweetening agent, gelatin and, if needed, water for dissolving the gelatin. Ordinarily about $\frac{1}{2}$ percent of gelatin is used, the exact amount depending upon its strength. About 3 pounds of water will be needed for dissolving the gelatin in 100 pounds of mix in case it is not added in the dry form.

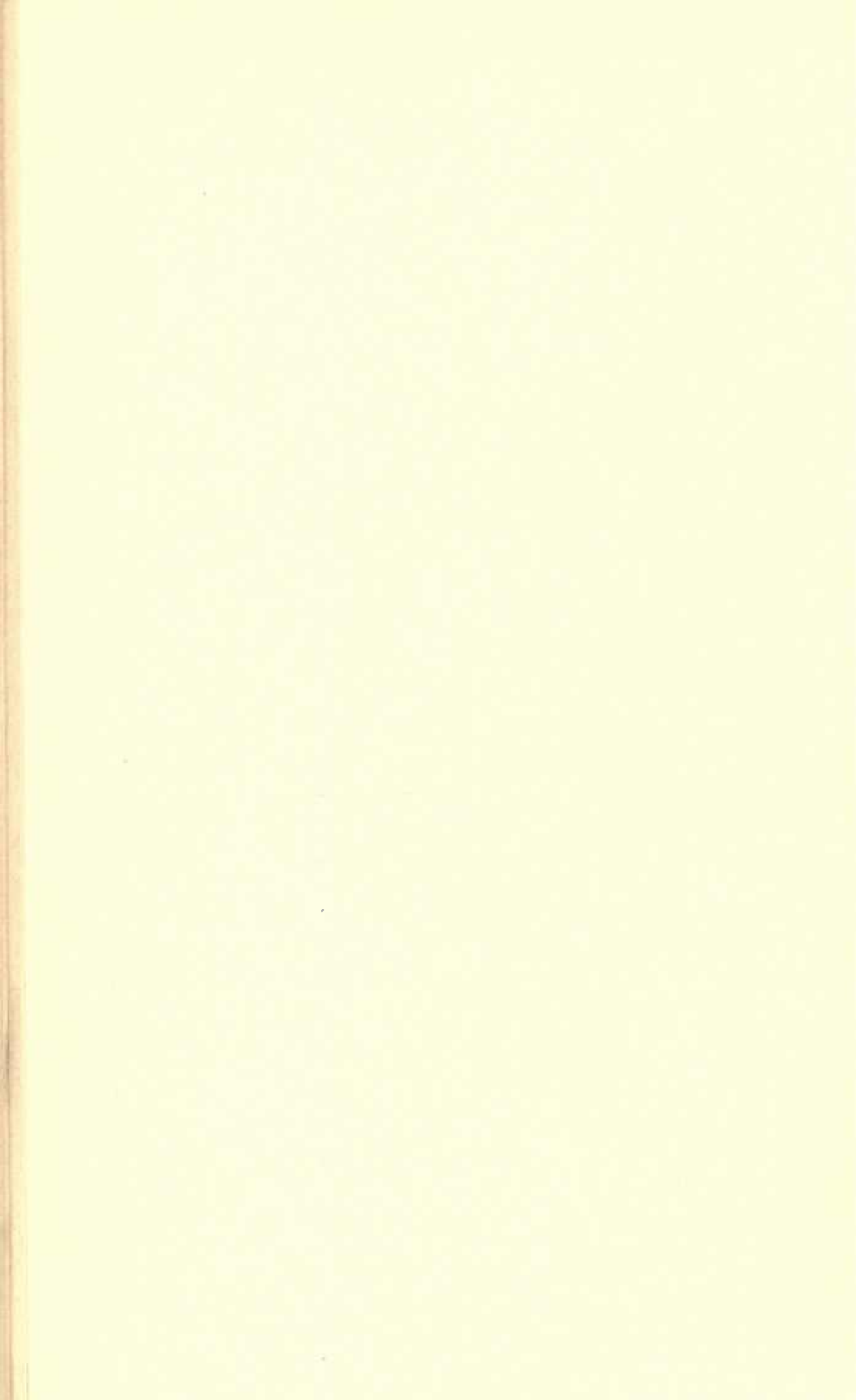
A, *B*, *C*, and *D* and shows how many pounds of each are needed in 100 pounds of mix when using either one of two combinations of fat and milk-solids-not-fat. These two groups are again divided into four, which vary in percentage of non-milk products from 14.5 to 21.5.

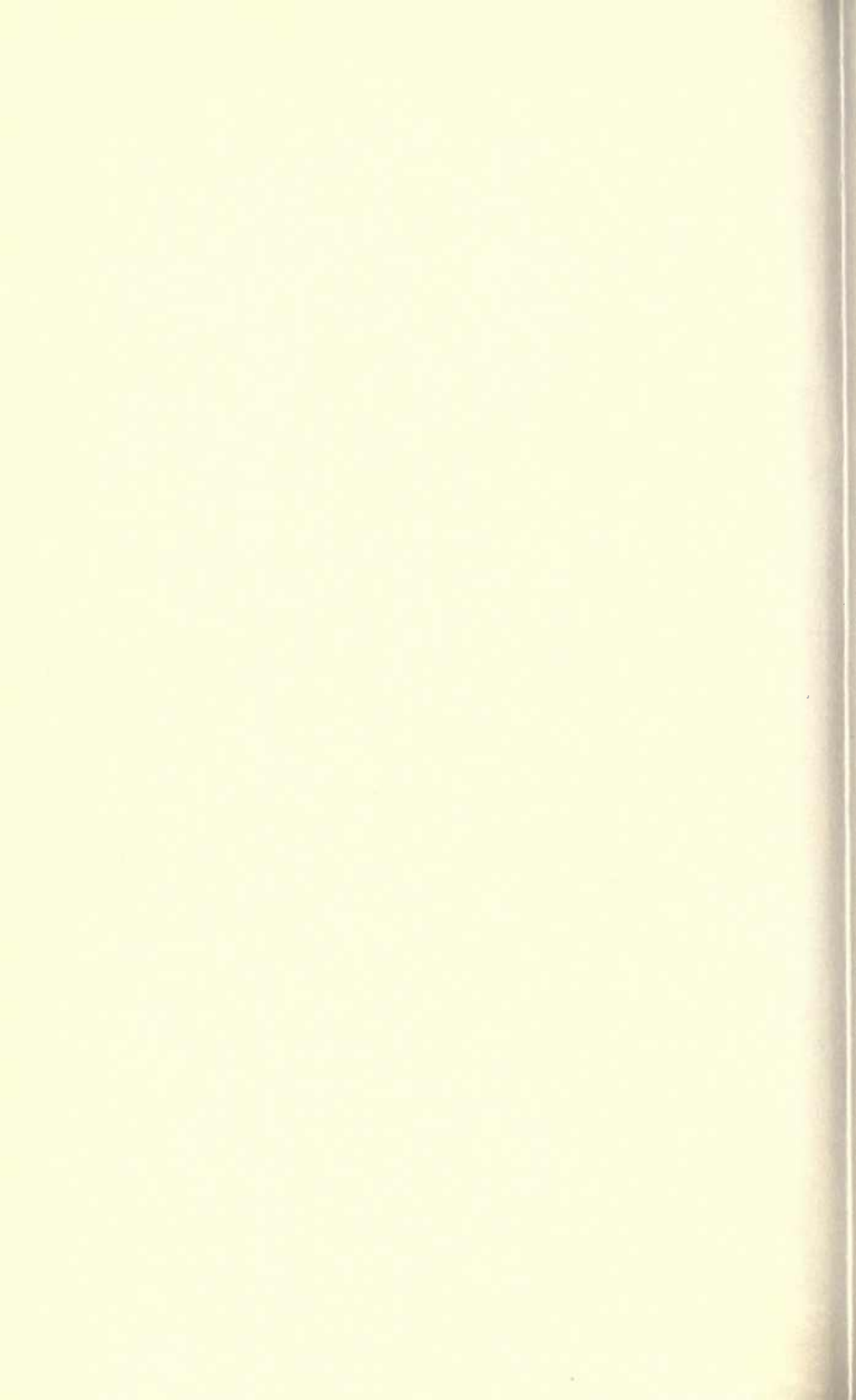
When a mix is desired the composition of which lies between the extremes listed in the table, the correct proportions can be calculated from the formulas given. For example, if the mix is to contain 12 percent fat, 11 percent m.s.n.f., and 14.5 percent non-milk products, and the milk products available are as listed under *A*, the formula can be calculated by averaging the values given for the 10-12 and 14-10 mixes as follows:

	10-12 mix	14-10 mix	Average (12-11 mix)
Cream.....	19.54	31.30	25.420
Skim milk.....	38.68	35.71	37.195
Condensed milk.....	27.28	18.49	22.885
Total milk solids.....	<u>85.50</u>	<u>85.50</u>	<u>85.500</u>

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Fourteen different honeys were studied in these experiments. Twelve of these honeys were actually used in making ice creams, thus giving a wide range in flavors. The authors are indebted to Mr. M. G. Dadant and Sons, Hamilton, Illinois, and to Professor V. G. Milum, Entomology Department, University of Illinois, for supplying the bulk of the honey used. Appreciation is also due Hoffman and Hauck, Inc., Ozone Park, New York, for samples of honey submitted.







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