A STUDY OF THE INFLUENCE OF VARIATIONS IN THE INGREDIENTS USED ON VISCOSITY, VOLUME, AND BODY AND TEXTURE OF MALTED MILK DRINKS

By

RUSSELL E. PROPHET

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THESIS AND ABSTRACT APPROVED:

H. C. Olson
Thesis Adviser

Morrison Loewenstein
Faculty Representative

D. C. McIntosh
Dean of the Graduate School

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PREFACE

Malted milk drinks have been consumed for a number of years. A large volume of the ice cream made goes into the making of malted milk drinks. It has been observed that there is not much uniformity in the making of malted milk drinks. Some fountain clerks use too much ice cream while others do not use enough. Also, the clerks in many instances, more or less guess as to the amount of milk that should be used. There is also a variation in the amount of fat used in making malted milk drinks. One organization, which serves several other organizations, makes a malted milk base that is composed of ice milk. The majority of the malted milk drinks are made with ice cream which contains 10 percent fat. The object of this research was to determine the best combination of ingredients for the base and the best combination of the base with milk to give the best malted milk drink.

STATEMENT OF PROBLEM

The malted milk drinks which are very popular throughout the whole United States seem to be variable in quality from the standpoint of flavor, body and texture, and other factors. There appears to be no standard procedure for making malted milk drinks and many firms dispensing these drinks seem to have their own ideas as to how these drinks should be prepared. There apparently has been very little research reported on the various factors affecting the qualities of these drinks. The work herein reported was concerned with the influence of variations in the compostion of ice milk and ice cream bases on the quality of malted milk drinks. An attempt was also made to develop a malted milk drink which would be satisfactory for the general consuming public.

REVIEW OF LITERATURE

While the origin of the art of making malted milk drinks is vague, it is reported by Hunziker (4) that the process for making malted milk was invented by William Horlick of Racine, Wisconsin, in 1833. He further stated that there were two phases used in the manufacture of malted milk, and that these phases are the malting of the barley grain and the manufacture proper of the malted milk. McCray (9) reported that the true purpose of malted milk is to add flavor and nutritive value to fresh whole milk or skimmed milk in order to make it a more pleasing beverage. Lampert (6) reported that the uses of malted milk are: soda fountain drinks and other beverages, confections, baby foods, and food for invalids. From general observations, it appears that the most common use of malted milk is in the making of malted milk drinks, chocolate malted milk drinks, and frosted malted milk drinks.

Henderson (3) stated that chocolate malted milk drinks should be the first concern of the soda fountain operators because they are the most popular of the drinks containing milk and ice cream. Parks (11) reported in 1938 that "chocolate malted milk" had the greatest public favor. Henderson (3) reported that the popularity of "chocolate malteds" is due to their delicious taste, high food value, and the quick energy they provide. McCray (9) stated that a high grade malted milk beverage has a creamy color like that of whole grain.

Parks (11) reported that there are only four fundamentals to be observed in the making of any good malted milk. These four fundamentals are that all ingredients must be fresh and pure, enough of each ingredient must be used, the milk must be very cold, and the drink must be allowed to mix a suitable length of time.

Henderson (3) stated that the problem of the fountain operator who wants to increase his business is to make "chocolate malteds" the way people in his community like them best. According to Parks (11), the cause of most faulty malted milks is due to the fact that dispensers do not allow enough time for each ingredient to be absorbed so that the finished product will have that rich, smooth flavor that means more sales.

MacIntosh (8) stated that all guesswork must be eliminated from the mixing of malted milk. Gundlach and Esmond (2) reported that education, guidance, and supervision of soda fountain clerks must be thorough, continuous, and intelligent. They further reported that providing manuals, giving demonstrations, and showing pictures of how to do it and how not to do it will help in the education of fountain clerks. The cornerstone of the educational program should consist of the sales representatives of the wholesale manufacturer who personally teach, demonstrate, counsel, admonish, inspire, and follow through with individual clerks serving in the stores of their dealers. Much of the educational work can and should be done en masse in groups or classes, but some individual tuition is necessary for individuals at their work.

Landess (7) stated that in making a malted milk one should put $1\frac{1}{2}$ ounces of syrup in a shaker can, add one No. 24 dipper of ice cream and six ounces of whole, cold milk, add two medium heaping teaspoonfuls of malt, and put the can and ingredients on the mixer and let stir for one minute. While the mixer is running, take a 12-ounce soda glass, and put in one No. 24 dipper of ice cream and add one heaping soda spoon of whipped cream. Malted milks made in this manner will please the customers and make them come back for more, provided the proper ingredients are used in the making. The best merchandising idea is for the dispenser to make a quality drink and serve it in a clean, sanitary way.

MacIntosh (8) reported that a thin blown glass of 12-ounce capacity will make an impression that will do much toward building up the trade. Since malted milk drinks must be served cold, all glasses should be pre-iced.

Landess (7) reported that if a dealer will make his own syrups in small quantities and keep them fresh, he will serve a better drink. If it is not possible to do this, one should use some well advertised manufactured syrup.

Jones (5) stated that a drink mixer is used to properly blend the flavoring, milk and ice cream, to aerate or fluff the drink to a smoothness of texture, and to create the greatest taste appeal.

Henderson (3) reported that with the chocolate syrup under refrigeration, the ice cream between 5°F. and 10°F., and the milk at 32°F., conditions are ideal for obtaining the maximum volume and smoothness.

Jones (5) reported that while the temperature of the milk and ice cream have a marked effect on the finished drink, the type and speed of mixing is the real secret. A too violent agitation breaks down the ice cream too rapidly and does not permit proper and thorough aeration. The air pockets are broken down faster than they are formed and causes the drink to taste flat.

It was stated (1) that the violent high speed agitator whirls the liquid around and around, which wears down the hard ice cream. The agitator creates a vortex which draws the ice cream and the other ingredients in contact with the rotating buttons. There are two distinct movements of the mix which may be observed. The rotation in a horizontal plane is caused directly by the rotation of the agitator following the round walls of the container and advantageously disturbed by the vertical ribs in the container. The rotation in a vertical plane is caused by the vortex, down along the agitator shaft, outwards from the agitator buttons towards the wall of the container and up along the side of the container wall. A corresponding rotation takes place underneath the lower agitator button.

It was also reported (1) that in making a malted milk drink, that the mix constitutes the film material and the action of the agitator makes the air bubbles small or large and with walls of varying thickness and stability.

The character of the malted milk depends upon these factors. It is smooth or coarse, creamy or slushy, weak or stable in texture, fast or slow whipping, and a desirable or undesirable product. A malted milk aerated to the maximum is a structure with as many bubbles as it can have and bubbles of such size that the surrounding liquid films stand up and do not give away. A malted milk drink of such quality will be creamy and foamy, will have a long, lasting "head," and will fill bigger glasses without an increase in the quantity of ingredients used.

Jones (5) stated that the mixing time of malted milk drinks will vary as the relative amount and temperature of the ice cream and milk varies. It has been reported (1) that the maximum volume depends on low temperature and is reached at about 30°F. Since the milk quantity is the greatest in comparison with the quantities of the other ingredients, the milk naturally exerts the greatest influence as far as whipping ability of the mix is concerned. Jones (5) reported that because of the overrun in ice cream, it cannot be aerated during the mixing process, and that the aeration takes place entirely in the milk. When a larger amount of milk is used, it is possible to obtain greater aeration and a greater increase in volume of the finished drink. Milk mixed at 32°F. will show the greatest percentage of overrun or aeration and the greatest smoothness. Jones (5) further reported that a rise in the temperature of the milk from 32°F. to 40°F. will decrease the possibilities of aeration about 13 per cent. When the milk is at room temperature it will seldom "give over a 20 per cent increase in volume while milk around 32 degrees will run up as high as 90 per cent."

It has been reported (1) that as far as the "time required to mix" is concerned, one must distinguish between the "time required to break down the ice cream to obtain a homogenous mix without lumps," and the "time required to aerate the mix to a maximum." It depends, along with other factors, mainly on the relative quantity, texture, and temperature of the ice cream used, and whether or not the "time required to break it down" is equal to the "time required to aerate the mix to a maximum." All of the factors must be considered simultaneously and never individually. When the "maximum quantity obtainable" is concerned, one must be aware that the amount of aeration obtainable depends on many factors and that no fixed relationship between the "maximum quantity obtainable" and any of the influencing factors has been established. When "maximum quantity" is desired, a mixing time of at least 90 seconds will be required, and the consistency will be creamy, finely aerated, and the temperature will be about 32°F. When a thick or slushy mixture is desired, 30 to 45 seconds are sufficient to break down the lumps of ice cream, the volume will be about 12 ounces, and the temperature will be between 26°F. and 28°F.

It was reported (1) that when cold milk and cold hard ice cream are used the container should not be chilled but should be at room temperature. The closing of the container during the mixing process has no effect on the quantity obtainable nor on the time required to aerate to a maximum. As far as the time required to mix and greatest aeration is concerned, no particular speed for mixing a malted milk drink can be pointed out as being the most advantageous one. However, the speed of the agitator must be great enough to fold in as much air as the mix is able to retain, it must be great enough to create a violent agitation to wear down the lumps of hard ice cream, and it must create enough heat to raise the temperature of the mix to the point at which the mix is able to hold the most air. When the speed is too great, the agitator will not get in proper contact with the mix; it will destroy the whipping qualities of the mix, and it will be too violent for a light drink with a large amount of liquid. Ten thousand to 14,000 R.P.M. is the most desirable range in speed.

METHODS

A. Preparing the Mixes

The ingredients used in the making of these ice milk and ice cream mixes were: fresh cream and milk, plain condensed skim milk 30%, sugar, stabilizer (Dariloid), vanilla, and water. These ice milk and ice cream mixes were made in 50 pound lots. The ingredients used in the different mixes were weighed out and placed in clean and well-tinned, ten-gallon milk cans. These cans, containing the ingredients, were placed in can-wash vats and water was put in the vats to above the level of the contents in the cans. This water was then heated by steam injection so that the pasteurization process could be accomplished. All of the ice milk and ice cream mixes were pasteurized at 155°F. for 35 minutes. A Taylor Cleanliner thermometer, 45 inches long, was placed in the can farthest from the steam injection pipe to indicate when the pasteurization temperature had been reached. After pasteurization, the mixes were homogenized, using a Gaulin two-stage homogenizer with a capacity of 125 gallons per hour, at 2,500# pressure per square inch. The ice milk and ice cream mixes were then cooled to approximately 55°F. by running over a surface cooler. The cooled ice milk and ice cream mixes were collected in clean cans and stored at a temperature of about 36°F. for approximately 16 hours. A Cherry-Burrell 40-quart Duo-Dash batch freezer was used to freeze the mixes. The vanilla was added to the mixes at the time of freezing. In freezing the mixes, the mix with the smallest percentage of either the fat, serum solids, sugar, or stabilizer content was frozen first and the other mixes were frozen as the percentage of fat, serum solids, sugar, and stabilizer content was increased. The mixes were frozen in this manner so as to eliminate the necessity for flushing the freezer after freezing each batch. Also, in freezing the mix that had the next highest percentage of either fat, serum solids, sugar, or stabilizer content, there would not remain enough of any of these ingredients in the freezer to materially change the composition of the next batch of ice milk or ice cream frozen. An attempt was made to obtain 100% overrun for all of the mixes. After freezing, the ice milk and ice cream bases were put in 30#-capacity cans that had been cleaned and steamed. The cans were then labeled as to the contents contained and stored at 0°F. to -5°F. in the cold storage vault for hardening.

B. Method for Making the Malted Milk Drinks

The malted milk drinks were made from a mixture of chocolate syrup, ice milk or ice cream, whole milk, and malt powder.

1. Preparing the Chocolate Syrup

A chocolate syrup was made with the following composition:

Water	22.8 %
Corn syrup	35.6 %
Sugar	24.7 %
Cocoa (Van-Houten)	8.25 %
Salt	.044%
Plain condensed skim milk 30%	8.31 %
Vanilla (Four-fold)	.082%

The sugar, cocoa, and salt were mixed together. The water, corn syrup, and plain condensed skim milk were placed in a stainless steel container, and the mixture of sugar, cocoa, and salt was added to the ingredients in the container. The container with the ingredients was then put in a water bath which was equipped with a steam coil, a cold water line, and an overflow pipe. The water was heated by the steam coil until the temperature of the chocolate syrup in the container reached 200°F., and the water bath was then adjusted to a temperature of 200°F. by running in cold water. This temperature was maintained for 15 minutes. The chocolate syrup was stirred intermittently during the heating and holding and then cooled to about 80°F. by running cold water into the water bath. The vanilla was then added by stirring it in with the syrup. The chocolate syrup was chilled overnight in a room which was maintained at approximately 36°F., and then placed in quart-glass jars, which had previously been cleaned and sterilized, and stored in a room which was maintained at approximately 50°F.

2. Preparing the Milk

The milk used in making the malted milk drinks was secured from the college creamery, and it had been previously standardized, pasteurized, and homogenized. Fat tests using the Babcock method were made on the milk, and when the milk was found to contain more than 3.5% fat it was restandardized with fresh skimmed milk and again pasteurized at 143°F. for 30 minutes by placing in a 1,000 ml. Erlenmeyer flask, covering the opening of the flask with parchment secured by a rubber band and heating in a water bath equipped with a steam coil, a cold water line, and an overflow pipe. The container of the milk used in making the malted milk drinks was placed in a water bath, a clean thermometer was put in the flask and the water bath containing the flask of milk was then put in the cold storage vault at a temperature of 0°F. to -5°F. until part of the water was frozen so that the temperature of the milk could be lowered to 32°F. When the temperature of the milk reached 32°F., the water bath was removed from the cold storage vault. As it became necessary to again lower the temperature of the milk, the water bath was again placed in the cold storage vault.

3. Equipment Used

The mixer cup and glassware used for making the malted milk drinks were kept in a room at a temperature of approximately 50°F. and the malted milk drinks were also made in this room. A No. 30 Hamilton Beach mixer was used to mix the malted milk drinks.

4. Making the Malted Milk Drinks

The following amounts of ingredients were used in making the malted milk drinks.

$1\frac{1}{4}$ oz.	chocolate syrup	(36.967 grams)
$\frac{1}{2}$ oz.	malt powder	(14.175 grams)
	ice milk or ice cream	(92.0 grams)
6 oz.	3.5% milk	(177 ml.)

The ice milk or ice cream used was tempered to 12°F. and the chocolate syrup used was tempered to 50°F. In making the malted milk drinks, the chocolate syrup, ice milk or ice cream, and malt powder were weighed out on balances which were accurate to within 1/10 of a gram. The milk was measured in a 250 ml. graduated cylinder. The chocolate syrup was first placed in the mixer cup, followed with the ice milk or ice cream, milk, and the malt powder in the order named. The malted milk drinks were mixed for one minute.

C. Determining the Viscosity

The viscosity of the malted milk drinks was determined by measuring the time required for 50 ml. of the drink to pass through a device similar to the Borden-Body Flow Meter (10). The homemade version of the Borden-Body Flow Meter was constructed in the following manner: A piece of glass tubing $8\frac{1}{2}$" long with 3/8 of an inch inside diameter was inserted through a No. 7 rubber stopper so that one end extended one inch beyond the small diameter of the stopper. A smaller glass tube was inserted as an air vent. An 8-oz. Mojonnier sample bottle was obtained and filled nearly full with distilled water. A mark was made with a file approximately $1\frac{1}{2}$" from the bottom of the bottle in the upright position. The bottle was then inverted and the water allowed to flow from the bottle through the 3/8 inch glass tube until the level of the water reached the mark on the bottle. A graduated cylinder was used to catch the outflowing water and when a quantity of 50 ml. had flowed through the tube a second mark was made on the bottle. This was repeated several times so that the measurement could be checked.

The viscosity of the drinks was determined by filling nearly to capacity the 8-oz. Mojonnier sample bottle, inserting the No. 7 rubber stopper fitted with the glass tubes, inverting the bottle, and holding in a vertical position by a large clamp attached to a ring stand. The malted milk drink was allowed to flow through the discharge tube and the time required to discharge 50 ml., measured by the distance between the two marks, was determined with a stop watch.

D. Determining the Volume

The volume of the malted milk drinks was measured in a 1,000 ml. graduated cylinder immediately after removal from the mixer.

A 100 ml. quantity of each malted milk drink was poured into a 100 ml. graduated cylinder and held at room temperature, which ranged from 72°F. to 91°F., in order to observe the rate and extent of separation or stratification and shrinkage in volume. These observations were made at time intervals of 2, 4, 8, 12, 16, and 20 minutes.

EXPERIMENTAL

This work was concerned with the influence of variations in the composition of ice milk and ice cream bases on the viscosity, volume, and body and texture of malted milk drinks. Accordingly, ice milk and ice cream bases were prepared to contain varying percentages of fat, serum solids, sugar, and stabilizer.

The base mix used in these experiments had the following composition:

fat	12.0%
serum solids	11.0%
sugar	14.0%
stabilizer (Dariloid)	0.4%

From this base mix, variations were made in the various constituents as follows:

Fat content: 4.0%, 6.0%, 8.0%, 10.0%, 12.0%, and 14.0%

Serum solids content: 8.0%, 9.5%, 11.0%, 12.5%, 14.0%, and 15.5%

Sugar content: 9.5%, 11.0%, 12.5%, 14.0%, 15.5%, and 17.0%

Stabilizer content: 0.2%, 0.3%, 0.4%, and 0.5%

A. The Influence of the Fat Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks.

The detailed data on the influence of variations in the fat content of the ice milk or ice cream bases used in making malted milk drinks on the viscosity, volume, and body and texture of the drinks are shown in Table I. A summary of the data on the five trials in Table I is presented in Table II. The data are presented graphically in Graphs A and B.

1. Viscosity

The data shown in Tables I and II and presented graphically in Graph A indicate that when the fat content of the bases used in making the malted milk drinks ranged from 4.0% to 8.0% there was no significant variation in

TABLE I. The Influence of the Fat Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks

Fat Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial I									
4.0	71	555	99 1/2	98	95	93 3/4	90 1/2	84	sl. lumpy; small air cells predominate; sl. creamy; not enough ice crystals
6.0	85	570	94	93 1/2	91 3/4	90 1/2	88 1/2	83 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
8.0	50	550	99	97	95 1/2	93 3/4	90	83	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
10.0	54	545	98	96	94 3/4	93	88 3/4	82 1/2	sl. lumpy; small air cells predominate; sl. creamy; not enough ice crystals
12.0	56	520	98 1/2	97	96	94	91	83 1/2	lumpy; small air cells predominate; sl. creamy; not enough ice crystals
14.0	47	525	97 1/2	96 1/2	95	93	89 1/2	83	lumpy; small air cells predominate; sl. creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE I. (continued)

Fat Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial II									
4.0	81	580	99 1/2	99	98	95	86	77 1/2	all ice milk dissolved; small air cells predominate; not enough ice crystals
6.0	72	575	95	92 1/2	91	88	83	74 1/4	sl. lumpy; small air cells predominate; not enough ice crystals
8.0	84	570	97	96	95	93	88	79	sl. lumpy; large air cells predominate; creamy; not enough ice crystals
10.0	55	545	90	88	86	83 1/2	79 1/2	71 3/4	sl. lumpy; large air cells predominate; creamy; not enough ice crystals
12.0	61	540	94 1/2	93	90 1/2	88 1/2	84 1/2	75 1/2	sl. lumpy; small air cells predominate; creamy; many ice crystals
14.0	56	540	97	92	89 1/2	88	85	76	sl. lumpy; small air cells predominate; creamy; many ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE I. (continued)

Fat Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
					Trial III				
4.0	80	580	95 1/2	95	94	93	89 3/4	84 1/2	all ice milk dissolved; small air cells predominate; sl. creamy; not enough ice crystals
6.0	68	565	93	92 1/2	91 1/2	88 1/2	83	76	all ice milk dissolved; small air cells predominate; creamy; not enough ice crystals
8.0	78	555	93 1/2	92 1/2	91 1/2	89 1/2	86	79 1/2	all ice milk dissolved; small air cells predominate; very creamy; many ice crystals
10.0	69	545	96 1/2	94 1/2	93	90 1/2	86	77 1/2	sl. lumpy; small air cells predominate; very creamy; many ice crystals
12.0	50	527	93 1/2	92	90 1/2	89	85	74	sl. lumpy; large air cells predominate; creamy; many ice crystals
14.0	68	535	95 1/2	94	93	91 3/4	88 1/2	80	sl. lumpy; small air cells predominate; very creamy; many ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE I. (continued)

Fat Content of Base - %	Viscosity Seconds[a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial IV									
4.0	63	575	95	94	93 1/2	92 1/2	91	88	all ice milk dissolved; small air cells predominate; creamy; not enough ice crystals
6.0	75	550	96	95 1/2	94 3/4	93 1/2	91 1/4	87	sl. lumpy; small air cells predominate; creamy; many ice crystals
8.0	90	575	93	92 1/2	91 3/4	90 1/2	86 1/2	81 1/2	all ice milk dissolved; small air cells predominate; creamy; many ice crystals
10.0	91	535	95 1/2	94 1/2	93 1/2	92	89	84	sl. lumpy; small air cells predominate; creamy; many ice crystals
12.0	58	535	94	92	90 1/2	88	86 1/2	79 1/2	sl. lumpy; small air cells predominate; creamy; not enough ice crystals
14.0	50	540	93	90 1/2	88 3/4	87	83	73	lumpy; small air cells predominate; creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE I. (continued)

Fat Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial V									
4.0	41	545	89 1/2	87	85 1/2	84	82	78 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
6.0	47	545	91	89 1/2	89	87 1/2	84	77 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
8.0	36	530	90	87 1/2	86	84 1/2	82 1/2	78	all ice milk dissolved; large air cells predominate; sl. creamy; not enough ice crystals
10.0	52	525	89 1/2	87 1/2	86	84 1/2	81 1/2	75 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
12.0	31	500	94	90	88 1/2	86 3/4	84 1/2	79	sl. lumpy; small air cells predominate; sl. creamy; not enough ice crystals
14.0	44	525	90	86	84	82 1/2	80 1/2	76 3/4	sl. lumpy; small air cells predominate; sl. creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE II. Summary of the Influence of the Fat Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks

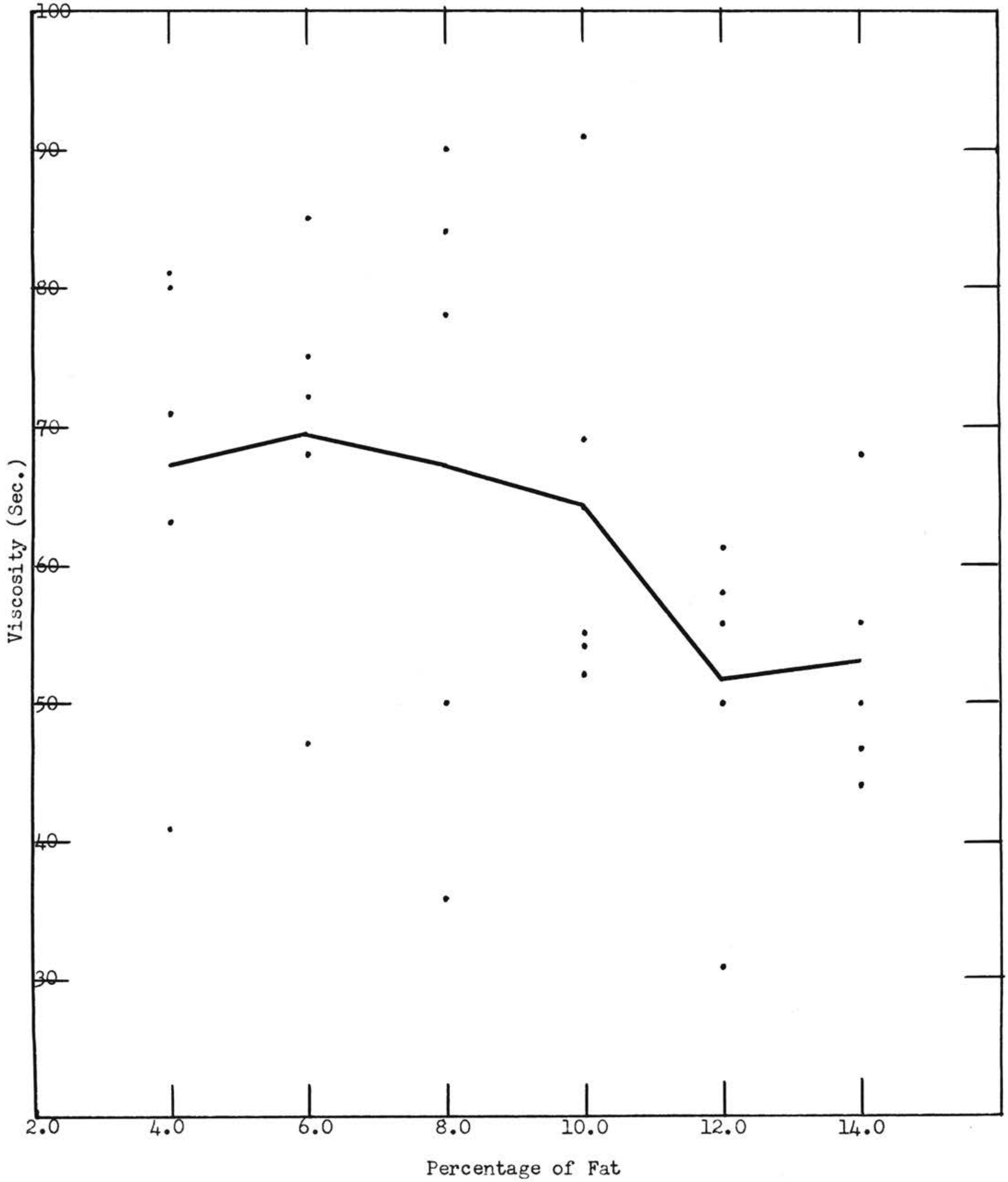
(Average of Five Trials)

Fat Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for:						Volume of Non-Whipped Portion					
			2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	2 min.	4 min.	8 min.	12 min.	16 min.	20 min.
4.0	67.2	567	95.8	94.6	93.2	91.65	87.85	82.5	.6	1.35	4.85	9.5	12.15	15.9
6.0	69.4	561	93.8	92.7	91.6	89.6	85.95	81.65	.85	1.5	4.7	9.05	11.9	16.0
8.0	67.6	556	94.5	93.1	91.95	90.25	86.6	80.2	.75	1.4	5.1	9.2	12.1	15.75
10.0	64.2	539	93.9	92.1	90.65	88.7	84.95	78.25	.6	1.15	4.05	8.35	11.4	15.3
12.0	51.2	525.4	94.9	92.8	91.2	89.25	86.3	78.3	.6	1.2	4.15	9.1	12.45	17.4
14.0	53	533	94.6	91.8	90.05	88.45	85.3	77.75	.45	1.05	4.3	8.8	11.8	16.6

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

GRAPH A.

The Influence of the Fat Content of Ice Milk or Ice Cream on the Viscosity of Malted Milk Drinks



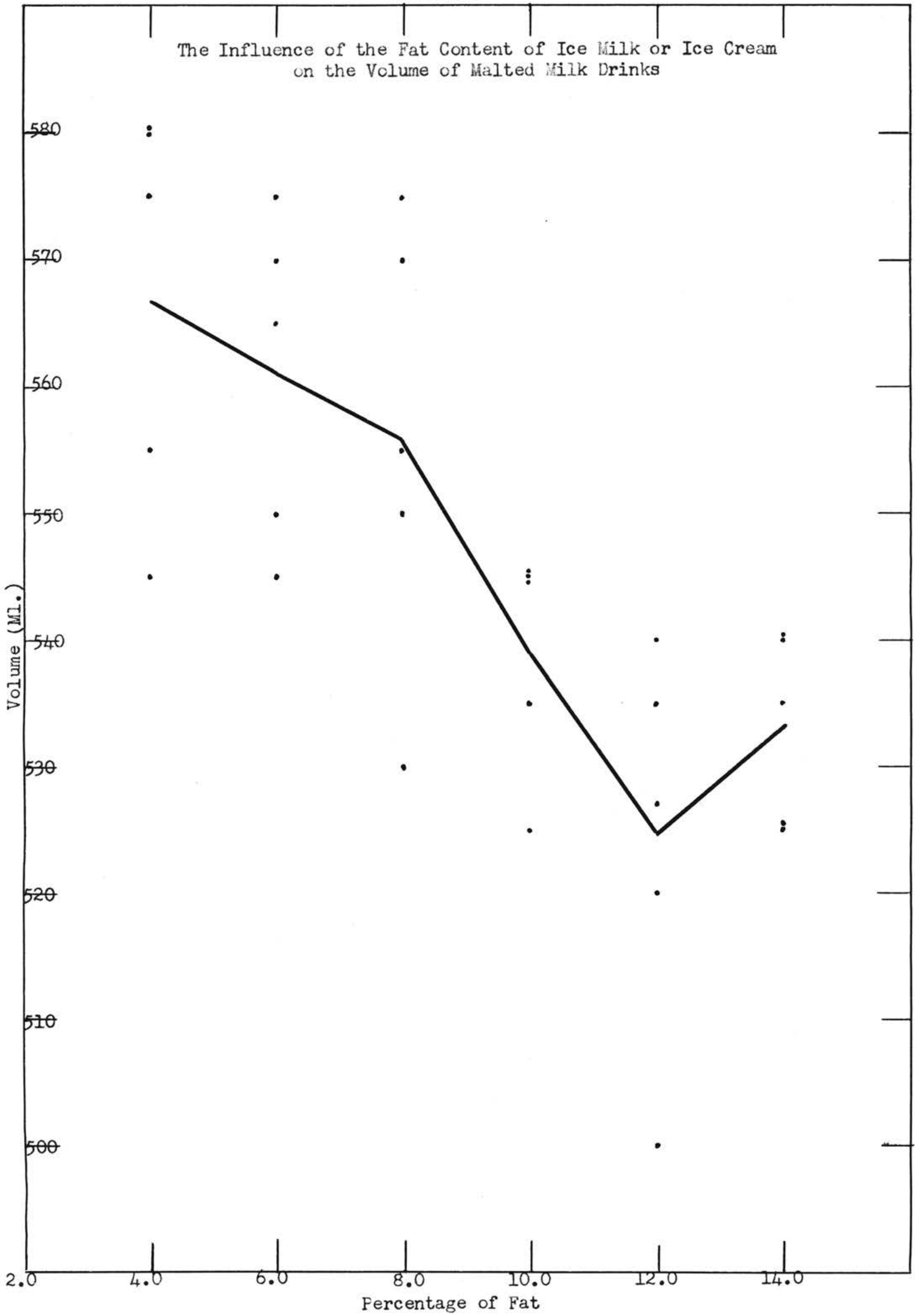
the viscosities of the drinks. It appeared that where 10.0% or more fat was present in the base the viscosity of the drinks tended to decrease as the fat content increased. It should be noted that the average viscosity of the drinks made from the base containing 14.0% fat was slightly higher than that of the drinks made from the base containing 12.0% fat.

2. Volume

The data in Tables I and II and presented graphically in Graph B indicate that as the fat content of the bases increases the volume of the drinks decreases with bases containing from 4.0% to 12.0% fat, inclusive. The malted milk drinks made from the base containing 14.0% fat showed a definite increase in volume over the drinks made from the base containing 12.0% fat. This appears to be significant since this situation prevailed in all trials except trial two, and in this instance the volumes obtained were the same. There appears to be a rather close correlation between an increase in fat content and a decrease in volume of the malted milk drinks. However, in trial four the volume obtained with the 8.0% fat base was considerably greater than the volume obtained with the base containing 6.0% fat. The increase in the volume obtained for this one drink is apparently the cause of the upward surge of the average curve (Graph B) at this point. No definite explanation can be offered for this discrepancy. The volumes obtained for the drinks made in trial five were below the volumes obtained for the other drinks with the exception of the drink made in trial one with 14.0% fat. No reason can be given for this apparent discrepancy.

The fat content of the bases used in making malted milk drinks appeared to have no significant influence on the volume of the drinks after holding at room temperature for various intervals. The average volume in the five trials shown in Table II indicates that the drinks made with the base containing

GRAPH B.


The Influence of the Fat Content of Ice Milk or Ice Cream
on the Volume of Malted Milk Drinks
580
570
560
550
540
530
520
510
500
Volume (Ml.)
2.0
4.0
6.0
8.0
10.0
12.0
14.0
Percentage of Fat

4.0% fat apparently maintained the greatest volume throughout the 20-minute holding period but there were no great differences between the volumes of the various drinks.

The fat content of the bases used in making the malted milk drinks appeared to have no significant influence on the rate of separation of the whipped portion and non-whipped portion of the drinks. The data indicate that the drinks made with the base containing 12.0% fat showed the greatest amount of the non-whipped portion after holding 20 minutes. There may have been a tendency for the drinks with the higher percentage of fat to show a little less separation between the whipped and the non-whipped portion but the differences are too small to be significant.

B. The Influence of the Serum Solids Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks.

The detailed data on the influence of variations in the serum solids content of the ice milk or ice cream bases used in making malted milk drinks on the viscosity, volume, and body and texture of the drinks are shown in Table III. A summary of the data on the five trials in Table III is presented in Table IV. The data are shown graphically in Graphs C and D.

1. Viscosity

The data in Tables III and IV and presented graphically in Graph C indicate no definite correlation between the viscosity of the drinks and the bases containing the different percentages of serum solids. In Table IV the data show that no great variation exists in the average viscosities for the drinks. It may be significant that the greatest viscosities were generally obtained in the drinks made with the base containing 12.5% serum solids. No explanation can be given for the low viscosity of the drinks made in trial five.

TABLE III. The Influence of the Serum Solids Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks

Serum Solids Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for:						Body and Texture
			2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	
Trial I									
8.0	65	535	91	89 1/2	87 3/4	86 1/2	82 1/2	77 1/2	all ice cream dissolved; large air cells predominate; creamy; many ice crystals
9.5	63	528	96	94 1/2	93	92	88 3/4	83 1/2	all ice cream dissolved; large air cells predominate; creamy; many ice crystals
11.0	56	520	98 1/2	97	96	94	91	83 1/2	lumpy; small air cells predominate; sl. creamy; not enough ice crystals
12.5	65	550	90 1/2	89 1/2	88 3/4	87	84 3/4	80 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
14.0	63	530	91 1/2	89	87	85 3/4	82 1/2	76	lumpy; large air cells predominate; thin body; slightly creamy; not enough ice crystals
15.5	54	530	97	95	94 1/2	93	89	81 1/2	sl. lumpy; large air cells predominate; thin body; sl. creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE III. (continued)

Serum Solids Content of Base - %	Viscosity Seconds[a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial II									
8.0	75	550	93	92	91	88 1/2	85	80	all ice cream dissolved; small air cells predominate; very creamy; many ice crystals
9.5	71	530	97 1/2	96 1/2	95	93 1/2	90	84 1/2	all ice cream dissolved; small air cells predominate; very creamy; many ice crystals
11.0	61	540	94 1/2	93	90 1/2	88 1/2	84 1/2	75 1/2	sl. lumpy; small air cells predominate; creamy; many ice crystals
12.5	86	575	94	93	91 1/2	89	84	76 1/2	sl. lumpy; small air cells predominate; very creamy; many ice crystals
14.0	56	540	92	91	89 1/2	87 1/2	82 1/2	75	sl. lumpy; large air cells predominate; creamy; many ice crystals
15.5	64	550	92	87 1/2	86	84 1/2	78	72	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE III. (continued)

Serum Solids Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial IV									
8.0	70	530	96 1/2	95	93 1/2	91 1/2	88 1/4	80 1/2	sl. lumpy; small air cells predominate; creamy; many ice crystals
9.5	78	530	97 1/4	96 1/2	94 3/4	92 3/4	90	85	sl. lumpy; small air cells predominate; creamy; many ice crystals
11.0	58	535	94	92	90 1/2	88	86 1/2	79 1/2	sl. lumpy; small air cells predominate; creamy; not enough ice crystals
12.5	92	560	96 1/2	94	93	92	89	83	sl. lumpy; small air cells predominate; very creamy; many ice crystals
14.0	73	530	93	91 3/4	90 1/2	89	86 1/2	81 1/2	sl. lumpy; small air cells predominate; very creamy; many ice crystals
15.5	67	545	93	91	89	87 1/2	83	73 1/4	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE III. (continued)

Serum Solids Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial III									
8.0	64	525	94	92 1/2	91	89 1/2	86	81 1/2	sl. lumpy; small air cells predominate; very creamy; many ice crystals
9.5	54	545	94	93	91	89 3/4	86 1/2	80	sl. lumpy; large air cells predominate; very creamy; many ice crystals
11.0	50	527	93 1/2	92	90 1/2	89	85	74	sl. lumpy; large air cells predominate; creamy; many ice crystals
12.5	61	555	92 1/2	90 1/2	88 1/2	86 1/2	83 1/2	76	sl. lumpy; large air cells predominate; very creamy; many ice crystals
14.0	58	535	93	90 1/2	90	88 1/2	85 3/4	80	sl. lumpy; large air cells predominate; creamy; many ice crystals
15.5	57	537	91 1/2	89 3/4	88	86 1/2	82 1/4	72	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE III. (continued)

Serum Solids Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
					Trial V				
8.0	37	515	93	91	89	87	84 1/2	80 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
9.5	42	535	90	87 1/2	86	84	81	76 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
11.0	31	500	94	90	88 1/2	86 3/4	84 1/2	79	sl. lumpy; small air cells predominate; sl. creamy; not enough ice crystals
12.5	34	517	86	85	83	81 1/2	78 1/2	74 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
14.0	47	535	93	91 1/2	89 3/4	88	85	81 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
15.0	42	530	90 1/2	88	86	84	81	76 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

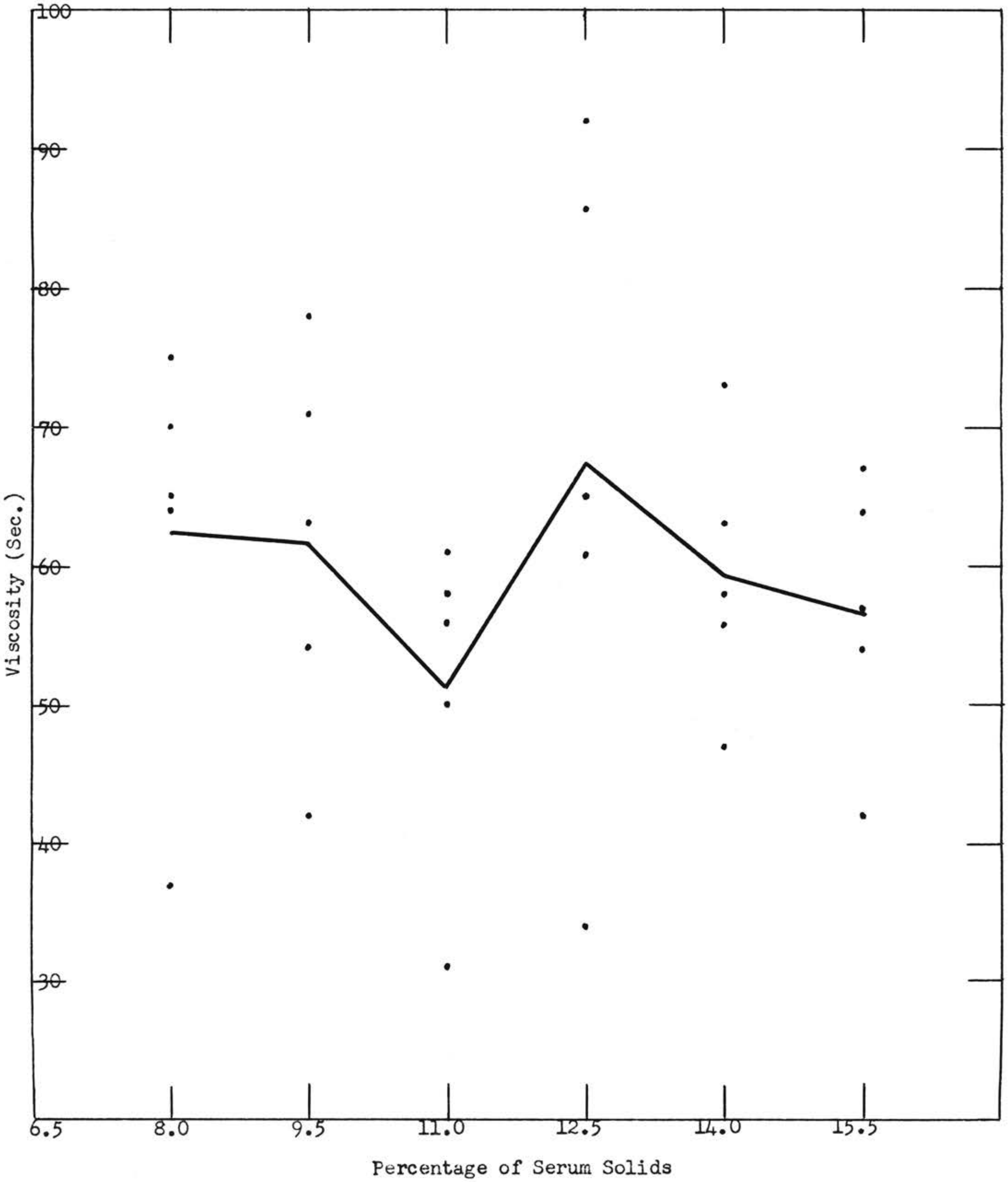
TABLE IV. Summary of the Influence of the Serum Solids Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks
(Average of Five Trials)

Serum Solids Content of Base - %	Viscosity Seconds[a]	Initial Volume Ml.	Volume After Holding at Room Temperature for:						Volume of Non-Whipped Portion					
			2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	2 min.	4 min.	8 min.	12 min.	16 min.	20 min.
8.0	62.2	531	93.5	92.0	90.45	88.6	85.25	80	.7	1.45	4.55	9.8	13.2	17.25
9.5	61.6	533.6	94.95	93.6	91.95	90.4	87.25	81.9	.65	1.3	4.35	9.35	11.95	16.35
11.0	51.2	524.4	94.9	92.8	91.2	89.25	86.3	78.3	.6	1.2	4.15	9.1	12.45	17.4
12.5	67.6	551.4	91.9	90.4	88.95	87.2	83.95	78.1	.8	1.75	5.6	9.5	12.2	16.25
14.0	59.4	534	92.5	90.75	89.35	87.75	84.45	78.8	.7	1.1	4.2	8.25	11.05	14.85
15.5	56.8	538.4	92.8	90.25	88.7	87.1	82.65	75.05	.7	1.35	4.9	8.55	11.35	16.05

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

GRAPH C.

The Influence of the Serum Solids Content of Ice Milk or Ice Cream on the Viscosity of Malted Milk Drinks



2. Volume

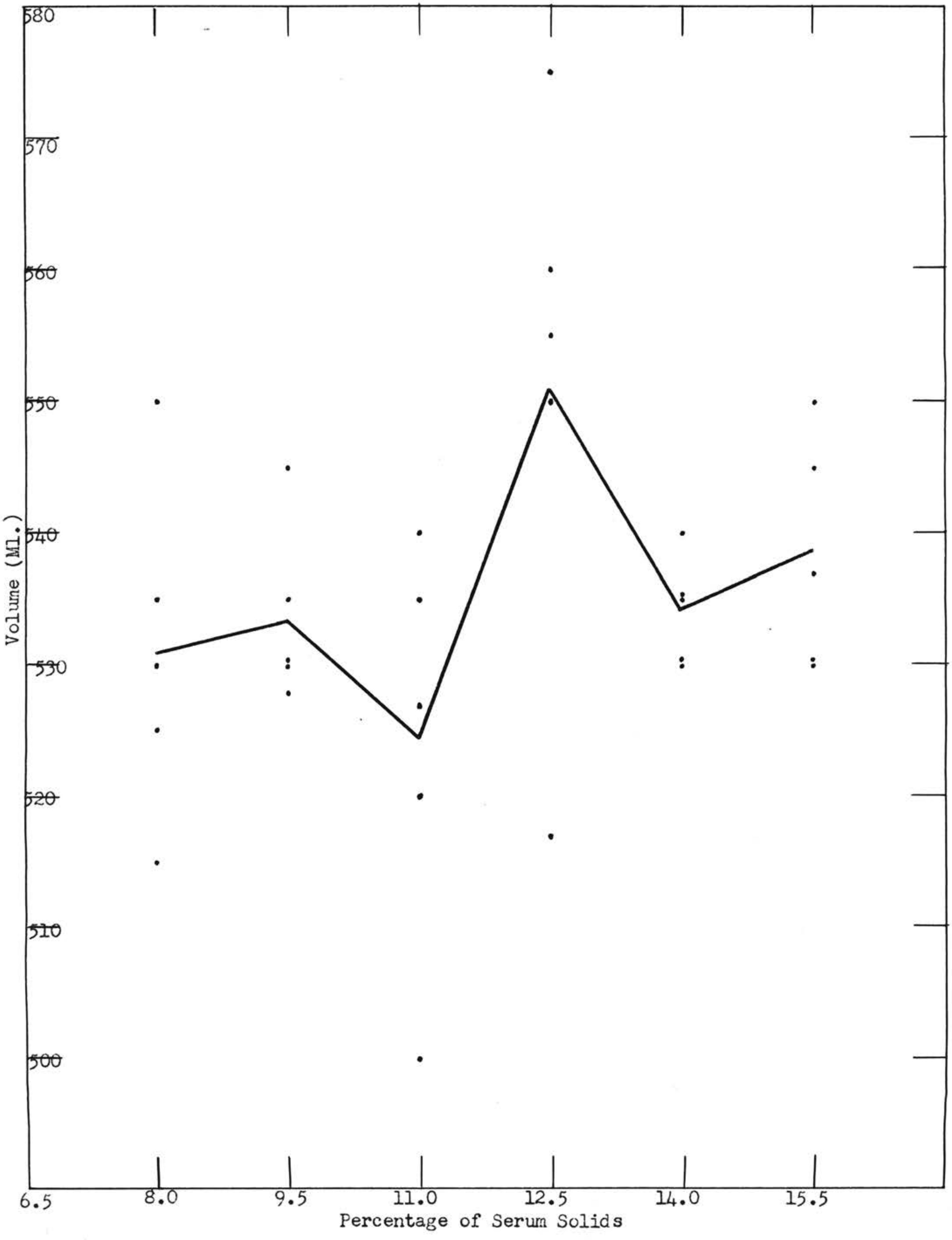
The data in Tables III and IV and presented graphically in Graph D indicate no definite correlation between the volume of the drinks and the bases containing the different percentages of serum solids. The data show that there were no great variations in the volume of the drinks but that the maximum volume was obtained for those drinks made with the base containing 12.5% serum solids. It is significant that in all trials the volume of the drinks made with the base containing 12.5% serum solids had more volume than the drinks made with the base containing 11.0% serum solids. The drinks made with the base containing 11.0% serum solids had a lower average volume than the bases containing either 9.5% or 12.0% serum solids. In trial five, however, the volume obtained for the drink made from the base containing 11.0% serum solids was very low and this had considerable influence in lowering the average volume for the drinks made from the base containing 11.0% serum solids.

The serum solids content of the bases used in making malted milk drinks appeared to have no significant influence on the volume after holding at room temperature for various intervals. The average volume of the five trials shown in Table IV indicates that the drinks made with the base containing 9.5% serum solids apparently maintained the greatest volume throughout the 20-minute holding period but there were no great differences between the volumes of the various drinks.

The serum solids content of the bases used in making the malted milk drinks appeared to have no significant influence on the rate of separation of the whipped portion and non-whipped portion of the drinks. The data show that the drinks made with the base containing 11.0% serum solids showed the greatest amount of the non-whipped portion after holding 20 minutes. There were no great variations in the non-whipped portion of the drinks.

GRAPH D.

The Influence of the Serum Solids Content of Ice Milk or Ice Cream on the Volume of Malted Milk Drinks



C. The Influence of the Sugar Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks.

The detailed data on the influence of variations in the sugar content of the ice milk or ice cream bases used in making malted milk drinks on the viscosity, volume, and body and texture of the drinks are shown in Table V. A summary of the data on the five trials in Table V is presented in Table VI. The data are shown graphically in Graphs E and F.

1. Viscosity

The data in Tables V and VI and presented graphically in Graph E indicate that as the sugar content of the bases increases the viscosity of the drinks decreases with bases containing from 9.5% to 15.5% sugar, inclusive. The data also indicate that there were no significant variations in the viscosities of the drinks. From the data presented in Table V, it should be noted that in trial four the viscosity of the drink made from the base containing 14.0% sugar was greater than that of the drinks made from the bases containing 12.5% and 15.5% sugar. However, in trial five the situation is reversed in that the drinks made from the base containing 14.0% sugar had the lowest viscosity of all the drinks. No explanation can be given for these apparent discrepancies. The data in Table VI and presented graphically in Graph E indicate an increase in the average viscosity of the drinks made with the base containing 17.0% sugar over the drinks made with the base containing 15.5% sugar.

2. Volume

The data in Tables V and VI and shown graphically in Graph F indicate no definite correlation between the volume of the drinks and the bases containing the different percentages of sugar. The data show that the greatest average volume was obtained for drinks made with the base containing 12.5% sugar. No

TABLE V. The Influence of the Sugar Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks

Sugar Content of Base - %	Viscosity Seconds[a]	Initial Volume Ml.	Volume After Holding at Room Temperature for:						Body and Texture
			2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	
Trial I									
9.5	63	538	98 1/2	92 1/2	91	85	74	68	sl. lumpy; small air cells predominate; creamy; many ice crystals
11.0	52	535	93	91 1/2	90	88	85	76	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
12.5	56	545	91 1/2	88 3/4	86 1/2	82	69 1/2	65	sl. lumpy; large air cells predominate; very creamy; not enough ice crystals
14.0	56	520	98 1/2	97	96	94	91	83 1/2	lumpy; small air cells predominate; sl. creamy; not enough ice crystals
15.5	57	530	90 1/2	87	85 1/2	81 1/2	70	64	sl. lumpy; small air cells predominate; creamy; not enough ice crystals
17	55	545	88	86 1/2	85	83	77	71	sl. lumpy; large air cells predominate; creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE V. (continued)

Sugar Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial II									
9.5	76	560	93	91 1/2	90	88	81 1/2	70 1/2	sl. lumpy; small air cells predominate; very creamy; not enough ice crystals
11.0	70	560	93	90 1/2	88 1/2	87	80	71	sl. lumpy; small air cells predominate; sl. creamy; not enough ice crystals
12.5	64	565	94	93	91 1/2	88 1/2	79	70	sl. lumpy; small air cells predominate; very creamy; not enough ice crystals
14.0	61	540	94 1/2	93	90 1/2	88 1/2	84 1/2	75 1/2	sl. lumpy; small air cells predominate; creamy; many ice crystals
15.5	68	550	91	89	87 1/2	86	82 1/2	75 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
17.0	67	555	90 1/2	88 1/2	87	85 1/2	81 1/2	74	sl. lumpy; large air cells predominate; creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE V. (continued)

Sugar Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
					Trial III				
9.5	66	538	93 1/2	92	91 1/2	90	84 1/2	74	sl. lumpy; small air cells predominate; creamy; many ice crystals
11.0	72	525	97 1/2	96 1/2	95	93	89 1/2	83 1/2	sl. lumpy; small air cells predominate; very creamy; many ice crystals
12.5	61	535	94 1/2	93	92	90	85	75 1/2	sl. lumpy; small air cells predominate; very creamy; many ice crystals
14.0	50	527	93 1/2	92	90 1/2	89	85	74	sl. lumpy; large air cells predominate; creamy; many ice crystals
15.5	45	505	96 1/2	95	93	91	88 1/2	82 1/2	sl. lumpy; small air cells predominate; very creamy; many ice crystals
17.0	65	545	94	92 1/2	91 1/2	90	86 1/2	80 1/2	sl. lumpy; small air cells predominate; very creamy; many ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE V. (continued)

Sugar Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for:						Body and Texture
			2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	
				Trial IV					
9.5	40	530	91	89 1/2	87 1/2	86	80	70	sl. lumpy; large air cells predominate; very creamy; not enough ice crystals
11.0	39	530	93	91	89 1/2	87 1/2	80	71	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
12.5	40	535	93	91 1/2	90	88	83	72 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
14.0	58	535	94	92	90 1/2	88	86 1/2	79 1/2	sl. lumpy; small air cells predominate; creamy; not enough ice crystals
15.5	36	515	92	89	88	85 1/2	79 1/2	71 1/2	sl. lumpy; large air cells predominate; creamy; not enough ice crystals
17.0	36	515	92 1/2	90 1/2	88 1/2	87	84 1/2	78 3/4	sl. lumpy; small air cells predominate; creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE V. (continued)

Sugar Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial V									
9.5	50	515	92	90	88	87	83	79 1/2	lumpy; large air cells predominate; very creamy; many ice crystals
11.0	55	505	95	93	91 1/2	90	86 1/2	81	sl. lumpy; large air cells predominate; very creamy; many ice crystals
12.5	67	525	95 1/2	93 1/2	92	90	85	78 1/2	sl. lumpy; large air cells predominate; very creamy; many ice crystals
14.0	31	500	94	90	88 1/2	86 3/4	84 1/2	79	sl. lumpy; small air cells predominate; sl. creamy; not enough ice crystals
15.5	43	505	92 1/2	90 1/2	89	87 3/4	85	81	sl. lumpy; large air cells predominate; creamy; not enough ice crystals
17.0	41	517	92	90	87 3/4	86 1/2	85	81	sl. lumpy; large air cells predominate; very creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE VI. Summary of the Influence of the Sugar Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks

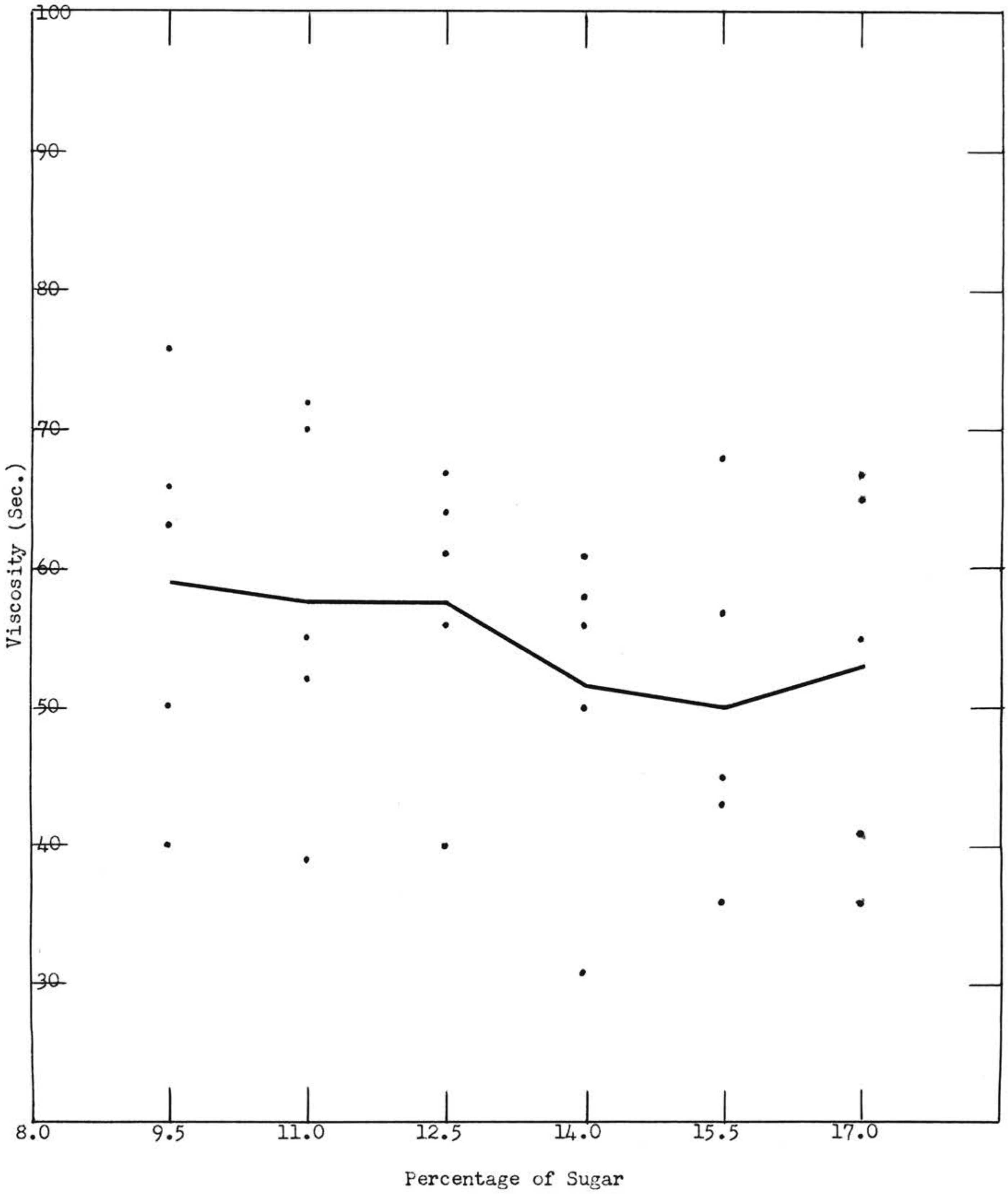
(Average of Five Trials)

Sugar Content of Base - %	Viscosity Seconds[a]	Initial Volume Ml.	Volume After Holding at Room Temperature for:						Volume of Non-Whipped Portion					
			2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	2 min.	4 min.	8 min.	12 min.	16 min.	20 min.
9.5	59	536.2	93.6	91.1	89.6	87.2	80.6	72.4	.95	1.45	5.45	10.25	14.3	21.0
11.0	57.6	531	94.3	92.5	90.9	89.1	84.2	76.5	.6	1.5	5.05	10.3	14.0	19.1
12.5	57.6	541	93.7	91.95	90.4	87.7	80.3	72.3	.65	1.45	5.0	9.55	13.8	20.3
14.0	51.2	524.4	94.9	92.8	91.2	89.25	86.3	78.3	.6	1.2	4.15	9.1	12.45	17.4
15.5	49.8	521	92.5	90.1	88.6	86.35	81.1	74.9	.85	1.7	5.4	9.6	13.45	18.85
17.0	52.8	535.4	91.4	89.6	87.95	86.4	82.9	77.05	.55	1.25	5.7	9.2	12.45	16.85

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

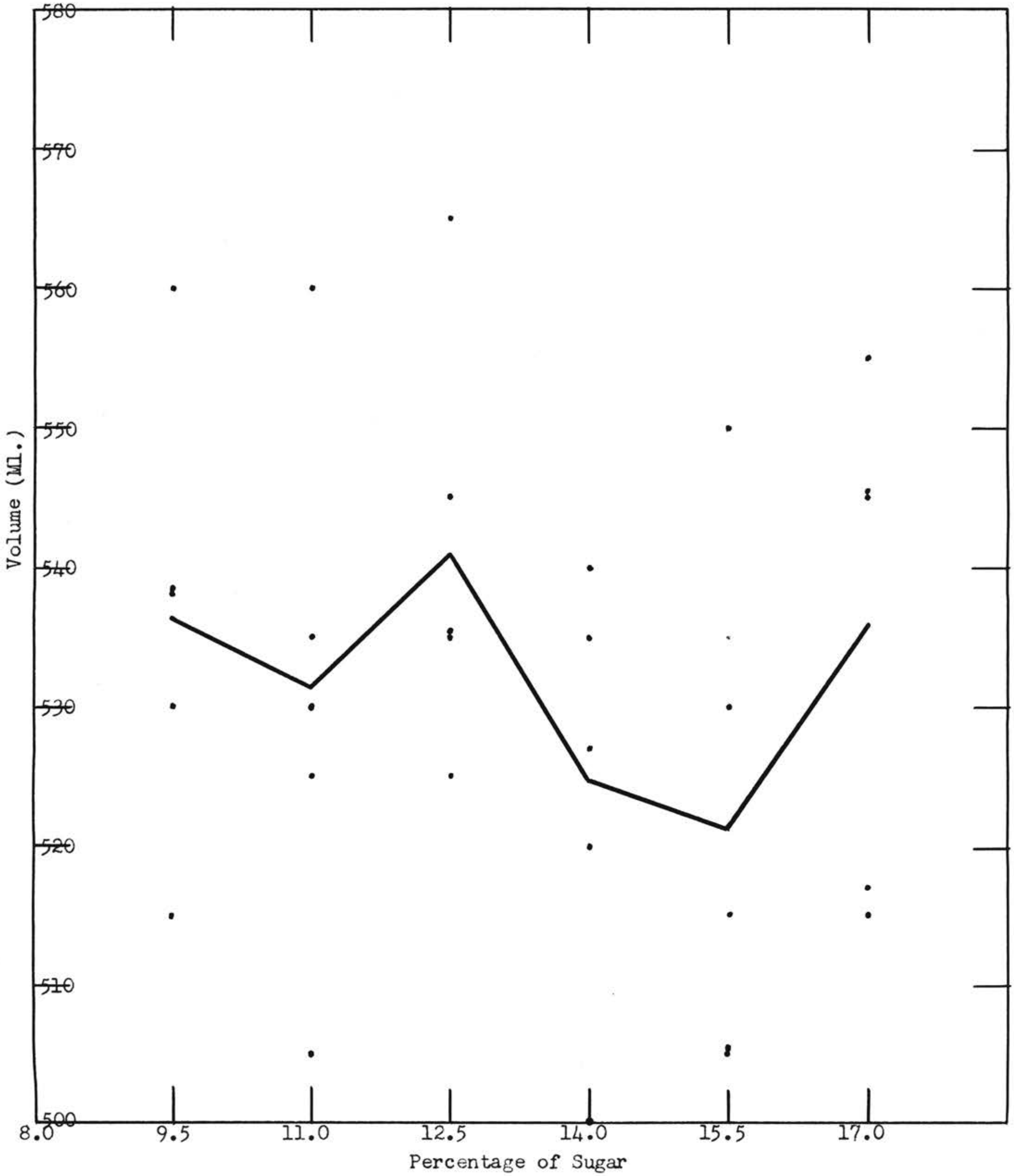
GRAPH E.

The Influence of the Sugar Content of Ice Milk or Ice Cream on the Viscosity of Malted Milk Drinks



GRAPH F.

The Influence of the Sugar Content of Ice Milk or Ice Cream on the Volume of Malted Milk Drinks



explanation can be given for the generally large volumes obtained in trial two, nor for the generally small volumes obtained in trial five.

The sugar content of the bases used in making malted milk drinks appeared to have no significant influence on the volume after holding at room temperature for various intervals. The average volume of the five trials shown in Table VI indicates that the drinks made with the base containing 14.0% sugar apparently maintained the greatest volume throughout the 20-minute holding period but there were no great differences between the volumes of the various drinks.

The sugar content of the bases used in making the malted milk drinks appeared to have no significant influence on the rate of separation of the whipped portion and non-whipped portion of the drinks. The data show that the drinks made with the base containing 9.5% sugar showed the greatest amount of the non-whipped portion after holding 20 minutes. It appears that the drinks made with bases containing a lower percentage of sugar show more separation between the whipped and the non-whipped portion.

D. The Influence of the Stabilizer Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks.

The detailed data on the influence of variations in the stabilizer content of the ice milk or ice cream bases used in making malted milk drinks on the viscosity, volume, and body and texture of the drinks are shown in Table VII. A summary of the data on the five trials given in Table VII is presented in Table VIII. The data are shown graphically in Graphs G and H.

1. Viscosity

The data in Tables VII and VIII and presented graphically in Graph G indicate that as the stabilizer content of the bases increases there is a

TABLE VII. The Influence of the Stabilizer Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks

Stabilizer Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial I									
0.2	52	530	97 1/2	95 3/4	94	92 3/4	89 3/4	86	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
0.3	75	550	95 1/2	94	92 1/2	91	88 3/4	85	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
0.4	56	520	98 1/2	97	96	94	91	83 1/2	lumpy; small air cells predominate; sl. creamy; not enough ice crystals
0.5	58	555	97 1/2	96 1/2	95 1/2	93 3/4	92 1/2	87	lumpy; small air cells predominate; creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE VII. (continued)

Stabilizer Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial II									
0.2	51	510	93 1/2	91 3/4	90	88	85 1/2	82 1/2	sl. lumpy; large air cells predominate; sl. creamy; not enough ice crystals
0.3	85	545	94 1/2	92 1/2	91	90	86	79 1/2	sl. lumpy; small air cells predominate; very creamy; not enough ice crystals
0.4	61	540	94 1/2	93	90 1/2	88 1/2	84 1/2	75 1/2	sl. lumpy; small air cells predominate; creamy; many ice crystals
0.5	69	560	91	89 1/2	88	86	82	75	sl. lumpy; small air cells predominate; creamy; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE VII. (continued)

Stabilizer Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial III									
0.2	73	555	92	91 1/2	90 1/2	89	86 1/2	82 3/4	sl. lumpy; small air cells predominate; sl. creamy; not enough ice crystals
0.3	33	530	89	87 1/2	86	84 1/2	81	75 1/2	sl. lumpy; large air cells predominate; very thin; not enough ice crystals
0.4	50	527	93 1/2	92	90 1/2	89	85	74	sl. lumpy; large air cells predominate; creamy; many ice crystals
0.5	32	470	94	92 1/2	91	89 1/2	86	81 1/2	sl. lumpy; large air cells predominate; very thin; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE VII. (continued)

Stabilizer Content of Base - %	Viscosity Seconds[a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
					Trial IV				
0.2	38	525	90 1/2	88	86	84	76 1/2	71	sl. lumpy; large air cells predominate; very thin; not enough ice crystals
0.3	45	516	92	90 1/2	89 1/2	87	83 1/2	78 3/4	sl. lumpy; small air cells predominate; thin; not enough ice crystals
0.4	58	535	94	92	90 1/2	88	86 1/2	79 1/2	sl. lumpy; small air cells predominate; creamy; not enough ice crystals
0.5	48	530	95 1/2	95	93 1/2	91 1/2	87	81	sl. lumpy; small air cells predominate; thin; not enough ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

TABLE VII. (continued)

Stabilizer Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Body and Texture
Trial V									
0.2	72	538	93	92	90 1/2	89	87	82	sl. lumpy; small air cells predominate; creamy; many ice crystals
0.3	60	550	95 1/2	94	93	92	89 1/2	85	sl. lumpy; small air cells predominate; very creamy; many ice crystals
0.4	31	500	94	90	88 1/2	86 3/4	84 1/2	79	sl. lumpy; small air cells predominate; sl. creamy; not enough ice crystals
0.5	95	555	96	94 1/2	94	92 1/2	90 1/2	85 1/2	sl. lumpy; large air cells predominate; very creamy; many ice crystals

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

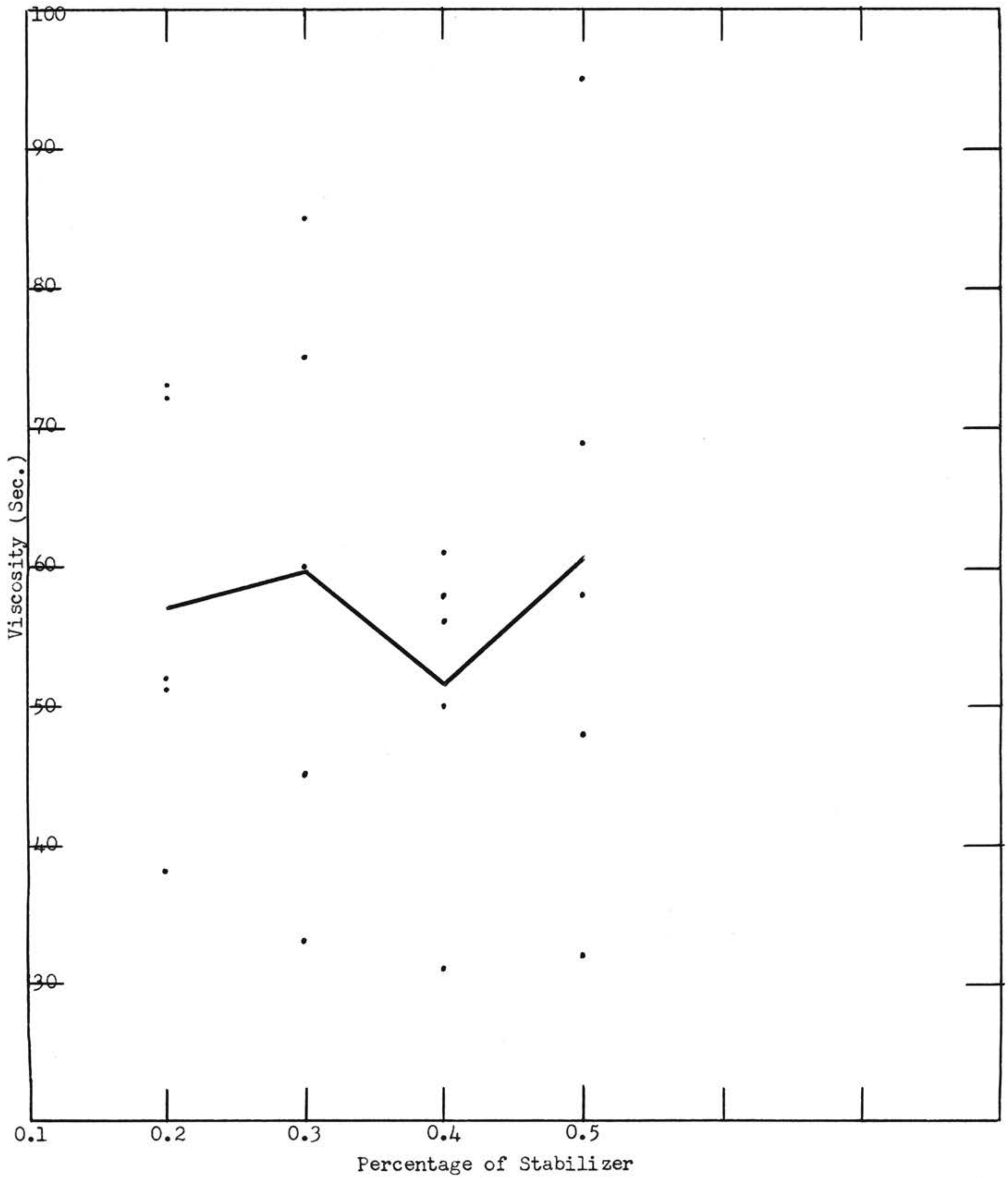
TABLE VIII. Summary of the Influence of the Stabilizer Content of Ice Milk or Ice Cream on the Viscosity, Volume, and Body and Texture of Malted Milk Drinks
(Average of Five Trials)

Stabilizer Content of Base - %	Viscosity Seconds [a]	Initial Volume Ml.	Volume After Holding at Room Temperature for:						Volume of Non-Whipped Portion					
			2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	2 min.	4 min.	8 min.	12 min.	16 min.	20 min.
0.2	57.2	531.6	93.3	91.8	90.2	88.55	85.05	80.85	.8	1.4	5.15	9.5	12.9	16.8
0.3	59.6	538.2	93.3	91.7	90.4	88.9	85.75	80.75	.95	1.35	4.75	9.2	12.75	16.65
0.4	51.2	524.4	94.9	92.8	91.2	89.25	86.3	78.3	.6	1.2	4.15	9.1	12.45	17.4
0.5	60.4	534	94.8	93.6	92.4	90.65	87.6	82.0	.5	1.25	4.75	9.85	12.55	16.75

[a] Time required for a 50 Ml. portion to flow through a homemade version of the Borden-Body Flow Meter

GRAPH G.

The Influence of the Stabilizer Content of Ice Milk or Ice Cream on the Viscosity of Malted Milk Drinks



tendency for the viscosity of the drinks to increase. The data indicate that the drinks made with the base containing 0.4% stabilizer were less viscous than the other drinks. No reason can be given for this apparent discrepancy. The data also indicate that there were no significant variations in the average viscosities of the drinks.

The data indicate that in trial five the viscosity of the drink made with the base containing 0.5% stabilizer was greater than the viscosity of the drink made with the base containing 0.4% stabilizer. In trial three the viscosity of the drinks made with the bases containing 0.3% and 0.5% stabilizer was less than the viscosity of the drink made with the base containing 0.2% stabilizer. No explanation can be given for these apparent discrepancies.

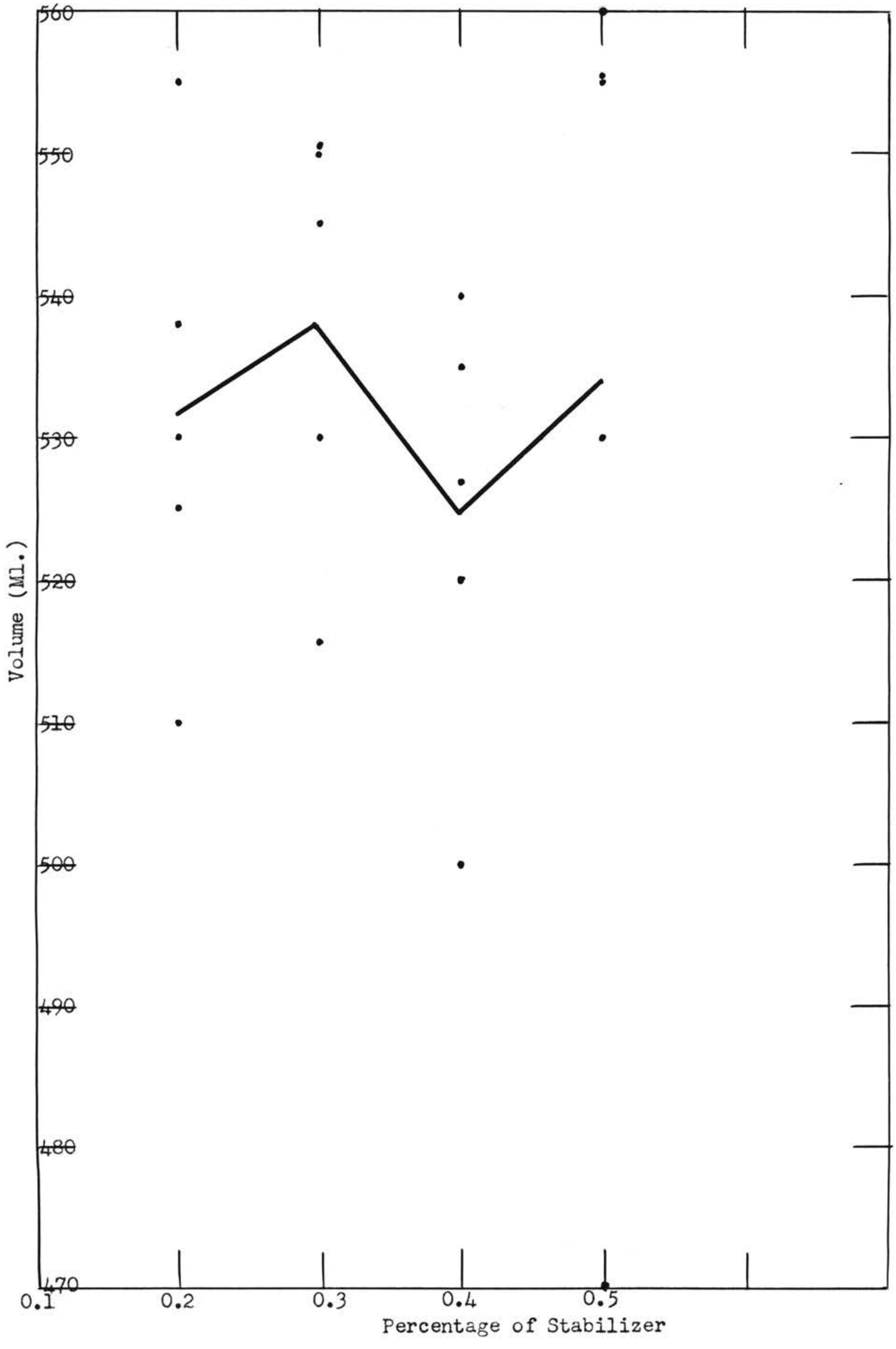
2. Volume

The data in Table VII and presented in Graph H indicate no definite correlation between the volume of the drinks and the bases containing different percentages of stabilizer. In trial three the volume obtained for the drink made with the base containing 0.5% stabilizer was less than the volume obtained for the drink made with the base containing 0.4% stabilizer. In trial five, the volume of the drink made with the base containing 0.4% stabilizer was less than the volumes obtained for the drinks made with the bases containing 0.3% and 0.5% stabilizer. No explanation can be given for these apparent discrepancies.

The data summarized in Table VIII indicate that the stabilizer content had no significant influence on the volume of malted milk drinks. The data also show that the stabilizer content of the bases used in making malted milk drinks appeared to have no significant influence on the volume after holding at room temperature for various intervals. The average volume of the five trials shown in Table VIII indicates that the drinks made with the base

GRAPH H.

The Influence of the Stabilizer Content of Ice Milk or Ice Cream on the Volume of Malted Milk Drinks



containing 0.5% stabilizer apparently maintained the greatest volume throughout the 20-minute holding period but there were no great differences between the volumes of the various drinks.

The stabilizer content of the bases used in making the malted milk drinks appeared to have no significant influence on the rate of separation of the whipped portion and non-whipped portion of the drinks. The data show that the drinks made with the base containing 0.4% stabilizer showed the greatest amount of the non-whipped portion after holding 20 minutes but there were no great variations in the non-whipped portion of the drinks.

DEVELOPMENT OF A MALTED MILK DRINK

The results obtained in the preceding work indicated the need for some additional work, therefore it was decided to attempt the development of a malted milk drink that would be satisfactory to the majority of the consuming public. The factors that were considered in the development of the drink were: Viscosity, volume, body and texture, color, and sweetness.

In this work, the bases used were made in small quantities, 123 to 1,105 grams. The chocolate syrup was incorporated as part of the base so that under practical conditions a measured quantity of the base together with a measured quantity of milk could be used in preparing malted milk drinks. It was thought that if malted milk drinks could be made with a minimum of time and operations involved and each ingredient could be packaged in units of some selected weight or volume, the variations commonly occurring among malted milk drinks would be largely eliminated and greater uniformity in the drinks would result.

The ingredients used in making ice milk bases were: Fresh whole milk and cream, cocoa, sugar, salt, stabilizer (Dariloid), plain condensed skim milk 30%, skim milk powder, vanilla, and water. The quantities of these ingredients desired were weighed out, pasteurized, and cooled. To harden the bases, they were placed in the cold storage room at a temperature of 0°F. to -5°F. The milk used in making the malted milk drinks was standardized and homogenized milk processed in the Oklahoma A. and M. College dairy plant. Fat tests using the Babcock method, were run on the milk and when found to contain more than 3.5% fat the milk was restandardized with fresh skim milk and again pasteurized and cooled. The milk used was tempered to 32°F. and the ice milk base used was tempered to 12°F.

In making the malted milk drinks, the required amount of the base was weighed out and put in a mixer cup, the required amounts of the milk and malt powder were added to the base and the drink was allowed to mix for one minute.

The amounts of the ingredients used in making the malted milk drinks and the calculated composition of the finished drink are shown in the following table:

TABLE IX. Composition of Experimental Malted Milk Drinks Made in Small Lots

Ingredients used for the drinks:	Trial I	Trial II	Trial III	Trial IV
Ice milk base (Grs.)	123	293	129	138
Whole Milk (oz.)	6	6	8	8
Malt powder (Grs.)	14	18	14	14

Calculated Composition of finished drink:	Trial I	Trial II	Trial III	Trial IV
Fat	3.2 %	3.0 %	3.15%	3.17 %
Serum solids	9.4 %	9.13 %	8.69%	8.86 %
Sugar	14.5 %	8.24 %	6.04%	4.3 %
Stabilizer	.14%	.18 %	.07%	.1 %
Malt powder	4.5 %	3.69 %	3.68%	3.6 %
Cocoa	1.2 %	.31 %	.80%	.75 %
Water	67.04%	75.44 %	74.08%	79.2 %
Salt	.01%	.01 %	.01%	.003%
Vanilla	.01%	.01 %	.01%	.01 %
Glucose			3.48%	

The freshly prepared experimental malted milk drinks made in each trial were sampled by two or three individuals for their comments and criticisms in order to gain some idea as to the qualities of the various drinks.

The drink made in Trial one was criticized as being too sweet and as not having enough ice crystals. The color of this drink appeared to be representative of that desired in a chocolate drink.

The drink made in Trial two was criticized as not having enough ice crystals, and as being too thick. It was also criticized as containing too much malt, and the color of this drink was considered as being too light for a chocolate drink.

The drink made in Trial three was criticized as being slightly too sweet, as not having enough ice crystals, and as being slightly thin. The color of this drink was considered as being too light for a chocolate drink.

The drink made in Trial four was criticized as lacking in sweetness, and as being too light in color. The body and texture of this drink was very desirable.

From the results obtained in the four trials, it appeared that a finished drink containing 8.0% sugar and 1.0% cocoa would apparently be acceptable from the standpoint of sweetness and color. Accordingly, a 50 pound ice milk base was prepared with the following ingredients: Fresh milk and cream, sugar, stabilizer (Dariloid), plain condensed skim milk 30%, cocoa, salt, vanilla, and water. This special base mix had the following calculated composition:

Fat	2.89 %
Serum solids	9.91 %
Sugar	22.6 %
Stabilizer (Dariloid)	0.19 %
Cocoa	2.8 %
Water	61.5 %
Salt	0.014 %
Vanilla	0.024 %

These ingredients, except the vanilla, were weighed out and put in a clean and well-tinned, ten-gallon milk can. The can was placed in a can-wash vat and water was put in the vat to above the level of the contents in the can. This water was then heated by steam injection so that the pasteurization process could be accomplished. The ice milk mix was pasteurized at 160°F. for 30 minutes. A Taylor Cleanliner thermometer, 45" long, was placed in the can to indicate when the temperature reached 160°F. After pasteurization, the mix was homogenized, using a Gaulin two-stage homogenizer with a capacity of 125 gallons per hour, at 2,500# pressure per square inch. After being homogenized, the ice milk mix was put in a clean and well-tinned, ten-gallon milk can and stored in a room maintained at approximately 40°F. for 24 hours. The vanilla was added to the ice milk mix, stirring it in thoroughly before freezing. The ice milk mix was frozen in a Cherry-Burrell 40-Quart Duo-Dash batch freezer. An attempt was made to obtain 90% overrun. After freezing, the ice milk base was put in five-gallon ice cream can that had been cleaned and steamed. The cans were then labeled as to the contents contained and stored at 0°F. to -5°F. in the cold storage vault for hardening.

The milk used in making the malted milk drinks was prepared in the same manner as the milk used in the four trials previously mentioned. The base used was tempered to 12°F. before using and the milk was tempered to 32°F.

The amounts of the ingredients used in making a malted milk drink were:

Ice milk base	138 grams
Whole milk	8 ounces
Malt powder	14 grams

The calculated composition of the finished malted milk drink was as follows:

Fat	3.16 %
Serum solids	8.82 %
Sugar	8.02 %
Stabilizer	0.08 %
Malt powder	3.6 %
Cocoa	1.0 %
Water	75.32 %
Salt	0.005 %
Vanilla	0.008 %

The drinks made in the manner indicated above whipped very well and were considered to be desirable from the standpoint of body and texture, sweetness, flavor, and color.

In order to determine what amount of the base would be most acceptable for making malted milk drinks, a series of drinks were prepared in which 8 ounces (½ pint) of 3.5% whole milk and 14 grams of malt powder were used together with different amounts of the ice milk base, varying from 118 grams to 158 grams in five gram increments. These drinks were made in the manner indicated above.

Determinations of the volume, body and texture were made for these drinks in the manner used for the preceding work. The data on the average volumes immediately after whipping, after holding for various intervals, and of the whipped and non-whipped portions obtained in the two trials are shown in Table X.

Since only two trials were completed in this work, the results obtained must be considered as inconclusive. However, the data indicate that generally the volumes decreased as the amount of the base used increased. The volumes varied from 537.5 ml. (18 oz.) when 153 grams of base were used to 607.5 ml. (20.5 oz.) when 138 grams were used. However, between the range of 118 to 148 grams, inclusive, there were no definite trends in the volume of the drinks, but when amounts greater than 148 grams were used there appeared to be a decrease in volume as the amount of base used was increased. The data also indicate that when using different amounts of the base in making the drinks there appeared to be no significant differences in the rate of shrinkage or in the rate of separation of the whipped portion and non-whipped portion of the drinks during holding at room temperature for various intervals. Since the data obtained are incomplete, it is obvious that further work needs to be carried out on the development of a malted milk drink that will be satisfactory to the majority of the consuming public.

It should be borne in mind that malted milk drinks are usually served in 12 oz. (355 ml.) or 16 oz. (473 ml.) cups and therefore the actual volume of the drinks usually approximate 10 oz. or 14 oz., respectively. In the foregoing trials an attempt was made to use a convenient quantity (½ pint of milk) along with a measured volume of the base which included the chocolate

TABLE X. The Influence of the Amount of Base Used with 8 Ounces of Milk on the Volumes of Malted Milk Drinks
(Average of Two Trials)

Amount of Base Used Grams	Initial Volume Ml.	Volume After Holding at Room Temperature for: 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.	Volume of Non-Whipped Portion 2 min.	4 min.	8 min.	12 min.	16 min.	20 min.
118	595	97.5	96	94.5	91.5	88.5	85.5	.75	4	8.5	12.5	15.5	19.5
123	572.5	98	96.5	95	94	91.5	88	1.0	2	8.5	12	15.5	19.5
128	552.5	99	98.25	97	95	92.5	90	1.5	3.25	8.5	12.5	16.5	20.5
133	580	98.5	97	96	94	90.5	86	1.0	2.25	5.25	11.0	15.5	19.5
138	607.5	98.75	97.5	96.5	94.5	92.75	89	.75	3.0	8.5	12.5	15.5	19.5
143	590	98.25	97	95.75	93.75	90.75	85.75	1.0	3.0	8.25	12.5	16.0	21.0
148	577.5	98.5	97.75	96.75	95	93	89	1.25	2.0	6.0	11.5	15.0	19.25
153	537.5	99	98.5	98	96.75	94.5	91	.5	1.75	6.0	10.5	15.0	19.5
158	542.5	99.5	99	97.75	96.5	94.25	91.25	.75	2.5	7.75	12.5	17.25	21.5

syrup. This method of making a malted milk drink involved only the placing of a measured quantity of the base together with a measured quantity of milk and malt powder in the mixer cup and mixing properly. With such a procedure the variations, commonly noted among malted milk drinks would not occur. If the milk could be packaged in 4-oz. bottles and a malt base could be packaged in pre-cut portions of approximately 70 grams each, approximately 10-oz. drink could be prepared very conveniently.

From the work reported in the preceding trials, it appeared that the most satisfactory malted milk drink could be prepared from an ice milk base containing the following calculated composition:

Fat	3.0 %
Serum solids	10.0 %
Sugar	23.0 %
Stabilizer (Dariloid)	0.2 %
Cocoa	2.8 %
Water	60.962%
Salt	.014%
Vanilla	.024%

A malted milk drink made with 138 grams of this base plus 8 ounces of 3.5% whole milk and 14 grams of malt powder appears to be satisfactory from the standpoint of body and texture, color, flavor, and sweetness.

CONCLUSIONS

In making malted milk drinks from the ice milk or ice cream bases in which the fat content of the bases ranged from 4.0% to 12.0%, inclusive, it appeared that there was a decrease in viscosity and volume of the drinks as the fat content of the bases used increased. However, malted milk drinks made from an ice cream base containing 14.0% fat had greater viscosity and volume than the drinks made from a base containing 12.0% fat.

The serum solids content of the ice cream bases used in making malted milk drinks appeared to have no significant influence on the viscosity or volume of the drinks. In the bases used in which the serum solids content was varied from 8.0% to 15.5%, inclusive, the greatest viscosity and volume were obtained for malted milk drinks made with the base containing 12.5% serum solids.

In making malted milk drinks from ice cream bases in which the sugar content of the bases ranged from 9.5% to 15.5%, inclusive, it appeared that there was a decrease in the viscosity of the drinks as the sugar content of the base used increased. However, malted milk drinks made from an ice cream base containing 17.0% sugar had greater viscosity than the drinks made from a base containing 15.5% sugar. The sugar content of the ice cream bases used in making malted milk drinks appeared to have no significant influence on the volume of the drinks. In the bases used in which the sugar content was varied from 9.5% to 17.0%, inclusive, the greatest volume was obtained for malted milk drinks made with the base containing 12.5% sugar.

The stabilizer content of the ice cream bases used in making malted milk drinks appeared to have no significant influence on the viscosity or volume of the drinks. In the bases used in which the stabilizer content was varied from 0.2% to 0.5%, inclusive, the greatest viscosity was obtained with the malted milk drinks made with the base containing 0.5% stabilizer, while the greatest volume was obtained with malted milk drinks made with the base containing 0.3% stabilizer.

Variations in the amounts of fat, serum solids, sugar, and stabilizer used in the bases appeared to have no significant influence on the volume of the drinks or on the separation between the whipped portion and the non-whipped portion of the drinks during holding at room temperature for 20 minutes.

From the data reported herein, it appears that a satisfactory malted milk drink can be prepared from an ice milk base containing the following calculated composition:

Fat	3.0 %
Serum solids	10.0 %
Sugar	23.0 %
Stabilizer (Dariloid)	0.2 %
Cocoa	2.8 %
Water	69.96 %
Salt	.02 %
Vanilla	.02 %

A malted milk drink made with 70 grams of this base plus 4 ounces of 3.5% whole milk and 7 grams of malt powder for a 12 ounce drink or proportionate amounts for a 16 ounce drink appears to be satisfactory from the standpoint of body and texture, color, flavor, and sweetness.

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Typist: Norma Te Selle Prophet