THE INFLUENCE OF VARIOUS INGREDIENTS UPON COHESION AND BODY CHARACTERISTICS OF ICE CREAM

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THE INFLUENCE OF VARIOUS INGREDIENTS UPON COHESION AND BODY CHARACTERISTICS OF ICE CREAM

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INTRODUCTION

Ice cream is a frozen food product manufactured from a blend of various milk products, sugars, stabilizers, and flavor. The manufacturer is limited in his choice of ingredients only by quality, cost, and supply.

Consumer preference of the various types of ice cream exerts itself to the extent that manufacturers produce the type of product that is demanded.

Recognizing that consumer demand for bulk ice cream in many parts of the country is influenced by the fact that hand packed ice cream, pressed with considerable force into the container, contains low overrun. Considerable effort has been made by ice cream manufacturers to build up consumer demand for factory filled packages containing low overrun, heavy ice cream.

Within the last year many firms have placed a low overrun product on the market in a effort to encourage consumer preference to the factory filled package rather than the hand packed package and thus eliminate some of the expense and nuisance involved in hand packing. This practice has given rise to manufacturing problems which are more difficult to solve than many realize.

The practice of blending the standard or legal quantity of fat with a serum-solids-not-fat content which is well above that previously used has resulted in the development of sandiness after storage. The milk solids of commercial ice cream commonly vary from eight percent to 14 percent and the source may be from fresh fluid cream, milk, or skimmilk combined with one of the many sources of concentrated products adapted to

long time storage. The milk solids carry lactose which may crystallize during storage and cause a sandy product. The higher the content of milk solids used the more likely is this condition to occur.

The sugar content of ice cream will commonly vary from 12 percent to 16 percent and the sources of sugar are by no means limited. These sweeteners are, for the most part, not as sweet as cane sugar, therefore a greater weight must be used to replace a given amount of cane sugar thus increasing the carbohydrate content of the ice cream. The increased addition of sugar substitutes further decreases the moisture content by increasing the total solids content. This reduction of moisture further increases the hazard of sandiness but the increase in total solids increases the heavy character of the body.

Manufacturers have set standards of overrun for heavy ice cream which, according to their belief and experience, will yield the product desired. A survey of several manufacturers shows this to range from 45 percent to 75 percent overrun. The hand packed package will likely have 40 percent overrun since 20 quarts of bulk ice cream containing 100 percent overrun may be hand packed into 14 quarts. The practice of using an arbitrary standard for overrun is erroneous since a desirable overrun will vary depending on the total solids and moisture content.

REVIEW OF LITERATURE

Very few reports of research investigations which were primarily concerned with "chewy" ice cream have been published. However there is occasional mention of "chewy" or gummy ice cream and many investigations are indirectly related to this topic. Josephson and Dahle (28) observed chewiness in ice cream containing carboxymethylcellulose, and Tracy (60) suggests that excess air be pressed out of standard ice cream in order to simulate the hand packed ice cream. Tracy also points out that producing low overrun ice cream causes greater strain upon processing and refrigerating equipment as well as upon manpower. Erb (18) observed that, "The finer the dispersion of fat the smaller will be the dispersion of air cells and the more 'chewy' the body of the finished ice cream."

Observations and data concerning the merits of the different types of dry milk-solids-not-fat are in many cases controversial. Combs (6) reports that, "When drum process dried milk of good quality is used in ice cream as a source of milk-solids-not-fat and compared with an ice cream made containing spray process milk of like quality it is impossible to detect any difference in the finished ice cream." Jensen (27) found that, "The body and texture of the ice cream made from skimmilk powder and condensed skimmilk apparently were unaffected by the source of serum solids," but Dahle (11) and Dahle, Walts and Keith (16) contend that spray process and vacuum roller process powders are superior to atmospheric roller powder in ice cream from the standpoint of overrun, freezing time, and quality. Carithers and Combs (4) show that there is little difference

in the quality of ice cream containing spray process or atmospheric roller process powders, and Dahle (11) reports that, "From the standpoint of freezing time, the spray powder and vacuum drum powder proved very satisfactory and were superior to the condensed milk control." Jensen (27), and Lucas and Jensen (35) state that condensed skimmilk and spray process skimmilk powder are equally satisfactory for use in the ice cream mix. Coulter (8) clarifies the situation considerably in reporting, "Atmospheric roller process dry skimmilk has in general been less satisfactory for use in ice cream than spray or vacuum drum powder. This is true not because of the process itself, but because in many cases less care was taken in its manufacture. Much of the roller powder today, however, is excellent, and it is somewhat cheaper than the same grade of spray or vacuum drum powder."

The question of solubility of milk powder is many times relied upon as an important consideration in using these products, but Combs (6) points out that no appreciable losses occur as a result of solids which fail to go into solution. "Since this question of solubility may confuse the ice cream manufacturer it should be pointed out that the method commonly used in determining solubility of dried milks does not parallel the practice to which the dry milk is subjected in actual practice." Sommer (52) states almost this same opinion in his text. Price and Whitaker (43) report that, "The most important consideration in selecting dry skimmilk for use in ice cream is to obtain a product with the best possible flavor. These experiments have emphasized the fact that flavor of the dry skimmilk has more influence on the quality of the ice cream than has any other characteristic of the powder, with the possible exception of the solubility." Roberts (50) observed that the percent of overrun obtained was not significantly affected

by the milk solids-not-fat content, and Reid and Decker (48) found that, "A two percent increase in the serum solids content was more effective in reducing air cell size than a two percent increase in fat content." Lucas, Matsui, and Mook (36) conclude that increases in milk-solids-not-fat from six to 12 percent results in a corresponding increase in the score value of body and texture. It has been pointed out by Dahle (11) that mixes consisting of dry milk deteriorate less in storage than the condensed milk mixes. He continues with the statement that, "The atmospheric roller process causes greater viscosity in the mix than any of the other powder or the condensed milk control. The degree of fat clumping is also greatest when this powder is used." Masurovsky (40) reported that a reduction of milk-solids-not-fat, especially in chocolate mix, and a subsequent replacement with corn syrup solids aided materially in bringing out the true chocolate flavor. Thomas and Combs (57) found that, "Buttermilk powder tends to impart a richer flavor to ice cream than roller process skimmilk powder," but Coulter (8) reports that, "Dry skimmilk frequently has been objected to because it was said to impart a powdery flavor. This is not true of high quality fresh dry skimmilk".

Sommer (52) states that "Butter used in ice cream mixes should be made from cream of low acidity, thoroughly washed, worked and left unsalted. Such sweet unsalted butter when made with other necessary precautions such as avoiding solution of iron and copper in the cream from which the cream is made, pasteurizing the cream thoroughly, and avoiding overworking, has been found to have excellent keeping quality in storage at 0 to -15° F. It is generally recognized that sweet, unsalted butter, properly made, under-

goes less deterioration in storage than any other butter." Lucas and Jensen (35) found that by using butter to supply 80 - 100 percent of the fat content it was possible to incorporate overrun more swiftly and to a slightly greater degree, and Dahle, Walts and Keith (16), go further in stating that, "When butter and water were used together in the same mix, a large amount of dry skimmilk is needed. The samples containing the atmospheric roller process powder in connection with water and butter were decidedly inferior in freezing time and quality." Mack (37) observed in an investigation of high solids mixes that the use of butter, frozen cream, or plastic cream in place of all or part of the sweet cream needed to supply the butterfat produced a crumbly ice cream possessing an undesirable melting appearance. Schied, Lucas and Trout (51) found that whipping ability of mix is greatly retarded by the use of frozen cream as the source of fat.

The sugars in an ice cream are undoubtedly one of the very important ingredients because of their influence on flavor, body, and texture. Leighton and Williams (31) stated that, "The zone of satisfactory sweetness of from 13 to 16 percent sugar represents mixes containing sugar in the ratio to water of 1-5 to 1-4." Fouts (20) concluded that the degree of sweetness in ice cream is influenced by the amount of water in the ice cream mix, "since sugar is dissolved in the water." Erb (33) states that, "The relative sweetness depends upon the concentration being compared and also the supplementary effect noted when two or more sugars are present in the same solution."

Dextrose sugar may be used to replace as much as 33 percent of sucrose, as stated by Lucas (33) who also points out that this sugar de-

presses the freezing point about 0.75 of one degree. Dahlberg and Penczek (9), and Leighton (30) also point out that corn syrups and dextrose depress the freezing point of mixes. Sommer (52) states that the composition of hydrous corn sugar is almost pure dextrose and contains about eight percent moisture.

Corn syrup solids have a freezing point above that of sucrose, reports Hellwig and Buchanan (24), which means that the resultant ice cream would not be softened by its use. Dahlberg and Penczek (9) reports that the relative sweetning value of Frodex is 49. Dahle, Hankinson, and Meiser (15) found that sugars containing the largest amount of monosaccarides usually are associated with shrinkage. Frodex would be placed in that category and because of this manufacturers are hesitant to use large quantities of Frodex to replace sucrose. However, Dahle (12) reports that a plant with which he is familiar is using 44.4 percent Frodex replacement successfully. Several investigators, Hellwig and Buchanan (24), Erb (19), and Dahle (12), do not agree upon the composition of corn syrup solids. These report as follows.

Hellwig and Buchanan:

Dextrose	15
Maltose	43
Edible dextrines	42
	100.0

Erb:

Dextrose	20.8
Maltose	32.9
Dextrines	42.8
Moisture	3.8
	100.0

Dahle:

Dextrose	22.0
Maltose	20.8
Dextrine	37.0
Higher sugars	20.2
	100.0

Sweetose, sometimes referred to as an enzyme converted corn syrup, depresses the freezing point slightly. Erb (12) rates it as 77 percent as sweet as sucrose and states that it may be used to replace 33 percent of the total sugar. Horrall (26) rates it as 67 percent as sweet as sucrose. Erb (12) reports that its composition is 34.4 percent dextrose, 19.9 percent maltose, 27.4 percent dextrines, 0.3 percent ash, and 18 percent water. The percent corn sweetener replacements recommended by investigators are varied to some extent, but most of them come within the range of 25 to 33 percent. Gould (23) recommends 20 to 30 percent replacement and adds that, "replacement of sucrose with corn sweeteners yields a closer textured ice cream and one in which the solids content may be appreciably increased without danger of sandiness." Knechtges and Sommer (29) recommend the use of 25 to 33 1/3 percent corn syrup solids replacement. Dahlberg and Penczek (9) recommend 25 percent sugar replacement and state further that more than 25 percent replacement adversely affected the hardness of the ice cream and its melting rate. Their report includes a table of molecular weights of sugars. They are: Frodex, 404.7; Sucrose, 342.17; Sweetose, 258.4; and Dextrose, 180.1. Ramsey, Drusendahl and Leider (45) conclude that, "High sugar concentrations are conducive to shrinkage, as are the use of too much corn sugar or corn syrup, or in some cases invert sugar." This condition is apt to result in an ice cream which is reasonably soft even at hardening room temperatures. Matsui (42) found that a sugar content of 15 percent or more produced a smoother and closer texture than a sugar content of 13 percent or less. Dahlberg and Penczek (9) report that enzyme converted corn syrup apparently possesses anti-oxidative properties and that both corn syrup solids and

dextrose developed an oxidized flavor in eight weeks of storage and the color was bleached. Knechtges and Sommer (29) in a survey noted no consumer preference of any significance in 16 percent sucrose ice cream compared to 12 percent sucrose and five percent corn syrup solids ice cream. However, Masurovsky (40) reports that a reduction of serum solids in chocolate mix and the subsequent replacement with corn syrup solids will aid materially in bringing out the true chocolate flavor.

Stabilizers, even though used in very small quantities, are by no means unimportant in an ice cream. Ice cream made with too much stabilizer, as well as one which has no stabilizer, has undesirable characteristics. Masurovsky (41) states that, "Without gelatin or other stabilizers the texture of ice cream would be coarse and the air cells notuniform in size thus causing quick melting when subjected to room temperature." Turnbow and Milner (63) found that, "Gelatin seems to be the most important ingredient in obtaining viscosity as determined by the MacMichael Viscosimeter. Tracy, (59) in enumerating some of the functions of gelatin, reports that it holds the water of the mix in such a manner that mild heat shocking does not seriously effect the texture of the ice cream and there is less ice separation in the continuous freezer than when some other types of stabilizers are used. Bendixen (2) points out that, "The proper amount of gelatin to be used depends upon the amount of water in the mix, the gel strength of the gelatin, and to a certain extent the original size of the ice crystals as influenced by homogenizer efficiency and the speed of the freezing and hardening of the ice cream." Dahle (13) found that the proper amount of gelatin to use depends largely on Bloom strength and recommends:

0.50 percent for 150 Bloom strength gelatin
0.42 percent for 200 Bloom strength gelatin
0.35 percent for 250 Bloom strength gelatin.

Vesterine is the commercial name for a product on the market containing gelatin as well as monoglycerides and diglycerides (59). This type of stabilizer has the advantages of a good quality gelatin, and the emulsifying properties of the glycerides. Josephson and Dahle (28) report that carboxymethylcellulose enhances the whipping properties of ice cream mix; a characteristic which is extremely desirable when butter or frozen cream are among the mix constituents. They found that a concentration of 0.15 percent of carboxymethycellulose was as efficient a stabilizer as 0.4 percent of 250 Bloom gelatin and observed that, "Ice cream containing carboxymethylcellulose invariably exhibited a 'chewiness' and firmness not found in the control ice cream." They were using a formula consisting of 11 percent fat, 8.8 percent serum solids, and 15 percent sugar equivalent. Frodex was used to replace 40 percent of the sugar. Dahle and Collins (30) recommend that 0.15 to 0.18 percent carboxymethyl cellulose be used in ice cream and caution that this stabilizer may cause whey separation after long storage.

Tracy (59) states that sodium alginate is a colloidal carbohydrate found in kelp that grows on the Pacific Coast of this country. Several investigators, Anderson, Dowd, and Hemboldt (1), and Mack (39) agree essentially with Stebnitz and Sommer (39) who conclude that, "Sodium alginate as an ice cream stabilizer appears to possess all of the desirable properties of gelatin and in addition has some distinct advantages. Notably among these advantages are the uniformity of viscosity of the mix, the faster whipping, and desirable melt down of the ice cream."

Goodman (21) shares the opinion with others, Bendixen (2); Mock (38); Stebnitz, and Sommer (55); and Tracy and Tuckey (62) that, "Sodium alginate does not form a gel structure but merely binds the water by hydration. The mix acquires its maximum viscosity quickly, usually in about one hour after cooling, and will exhibit good whipping ability even when frozen fresh from the cooler." Stebnitz and Sommer (54) report that mix stabilized with sodium alginate has no tendency toward shrinkage. Tracy (59) states that 0.2 to 0.3 percent sodium alginate will provide sufficient stabilization. Dahle (13) recommends 0.22 to 0.3 percent, and later Dahle and Collins (14) found that 0.275 percent is most desirable. Andersen, Dowd, and Hemboldt (1) prefer the use of 0.3 percent, and Lucas and Gould (34) report that Dariloid used at the rate of 0.3 percent and gelatin at the rate of 0.4 percent produced ice cream of practically the same score value for body and texture. The manufacturers of Dariloid recommend that it be used according to the total solids of the mix. The following table shows the recommended usage.

30	percent	TS -	0.35	percent	Dariloid
33	"	" -	0.3	"	"
36	"	" -	0.26	"	"
39	"	" -	0.23	"	"
41	"	" -	0.2	"	"

Pectin is most commonly used in ices and sherbets and Dahle (13) recommends 0.2 percent for this purpose. Dahle and Collins (14) recommend 0.15 to 0.18 percent for use in ice cream mix. They also report that mix made with pectin has a very low viscosity.

Tracy (59) found that when Irish moss was used alone, about 0.12 percent is necessary to stabilize. Two tenths percent of extracted Irish moss, commercially called Krageleen is sufficient to stabilize a mix. Irish

moss mixes well with other stabilizers and eliminates some of the serious objections to the pure product.

Caulfield and Martin (5) reported that, "There was almost no difference in the quality of finished ice cream stabilized with the vegetable stabilizer used in this study as compared with that stabilized with gelatin," but that, "mixes containing the vegetable stabilizers did not freeze or whip as rapidly as the mix stabilized with gelatin."

Schied, Lucas, and Trout (51) found that the use of 0.35 percent egg yolk largely overcomes the whippability retarding effect of mix containing frozen cream as the sole source of fat. Reid (47) reveals that the use of egg yolk solids produces smaller air cells, gives a smoother texture and body than whole egg solids.

Knechtges and Sommer (29) reports that, "Corn syrup solids do not exert a stabilizer sparing action in ice creams with moderate stabilizer content, but in heavily stabilized ice creams the content may have to be reduced as much as 25 percent when four percent of the sucrose is replaced by five percent syrup solids."

The amount of overrun whipped into an ice cream materially affects the body and texture of the finished product. Ramsey, Drusenduhl, and Leider (45) published findings which are essentially the same as those previously published by Ramsey (44) stating that overrun is directly related to shrinkage inasmuch as this problem involves primarily the contraction and the escape of air. High overruns are apt to give a weak air cell structure which later on may cause collapsing and escaping of air and consequent shrinkage. Tracy and McCown (61) reports that, "Variations in overrun result

in differences in drawing temperature and amount of water per unit volume to be frozen. There was little difference in the hardening time of ice creams containing 85 to 115 percent overrun due to the balancing effect of differences in initial temperature and amount of water present per unit volume." Lucas (32) found that milk-solids-not-fat content of an ice cream mix or the viscosity do not significantly affect the percentage of overrun obtained, and Knechtges and Sommer (29) report that, "The whipping ability of mixes is not affected by replacement of sucrose by corn syrup solids." Thomas and Combs (57) conclude, after a study of buttermilk powder in ice cream, that the ice cream is characterized by a foamy melt down. The foam is finer in structure and more stable when the ice cream contains roller process buttermilk powder than when it contains skimmilk powder.

The use of a penetrometer to establish data on body characteristics is not new. The work of four previous investigators using this type of apparatus is cited here. The penetrometers were all used under slightly different conditions so it must be pointed out that this equipment may supply only an index or relative relationship.

All of the previous investigators used penetrometers which were activated by a magnetic release. Gould's (22) penetrometer had a 1/8 inch needle, adjustable height and weight, and the work was performed at 36 - 40° F. The penetrometer used by Holdaway and Reynolds (25) had three interchangeable needles, one of which was 1/4 inch in diameter. This piece of equipment was adjustable in both height and weight. The tests were performed at 0° F. Reid (46) used a penetrometer having a 1/4 inch needle which was constructed to allow adjustment in height and weight. The tests were performed

at 0.7 to -10.1° F. Sommer (53) used a New York testing laboratory standard type penetrometer, with the standard needle and with a load of 200 grams. The tests were made at approximately -8° F. Sommer found that there was little correlation between the measurement and the melting behavior of ice cream. This lack of correlation may involve differences in overrun and in the sugar concentration and freezing points of the samples, but the main factor was probably the manner in which air was retained at the surface of the melting ice cream. Reid (46) reported that there was a gradual increase in the depth of penetration with each additional two percent of sugar. The depth of penetration when 16 percent sugar was added to the mixture was nearly double that secured when eight percent sugar was used. Gould (22) concluded that variations were so great in many cases, and there was such a lack of correlation between similar samples, that results obtained by the use of the penetrometer appear to be of little value. Indications are that comparative firmness of ice cream cannot be measured accurately by apparatus of this type.

Melt down examinations are frequently used in experiments with ice cream since the results may be used as a standard to compare results and may be used as indication of resistance to melting. Jensen (27) found that, "The amount of melting during the first 60 minutes of exposure showed the most direct differences in melting resistance." Ice cream containing butter as a major fat source had low melting resistance as compared with the samples from the cream mixes. "At the end of the 120 minute period no relationship could be detected in regard to melting resistance and the fat source by considering the leakage record." Mack (37) reported that increasing the sugar content to 16 to 17 percent improves the meltdown appearance of high fat ice

creams and reduces the melting resistance of such ice creams. "A partial replacement of sucrose with different increments of dextrose and the application of different drawing temperatures had little effect upon the meltdown characteristics of ice cream," according to Reid (48).

Lucas and Jensen (35) found that when 50 to 100 percent of the butterfat was supplied by butter there was an increasing tendency toward coarseness in texture because butter mixes show greater clumping of the fat globules. Reid (49) points out that increased homogenizing pressures result in a corresponding increase in smoothness, body resistance, and closer texture. Small air cells in an ice cream are closely related to a smooth body and Reid (48) concludes that, "The average air cell size tends to decrease with an increase in the fat or serum solids content or with a decrease in the drawing temperature." Corbett and Tracy (7) report that partial replacement of sucrose with dextrose improved the body and texture and meltdown of high fat and high total solids ice cream. The use of corn sweeteners increases total solids content with an accompanying improvement in the body and texture of the finished ice cream, reports Leighton (30). Dahlberg and Penczek (9) report that the corn syrups possessed definite qualities which gave substance to the body and smoothness to texture.

Coulter (8) states, "Sandiness does not normally develop in ice cream if the temperature is maintained at 0 to -10° F. regardless of the lactose content, but will appear quite rapidly at higher temperatures if the lactose in water concentration of the mix is high enough." "Since five to seven days are required for sandiness to appear even under unfavorable conditions, a manufacturer able to regulate the turnover in the dealer's cabinets can use a high serum solids mix without trouble." Leighton and Williams

(31) found that, "About one part of milk-solids-not-fat to five parts of water is the most that could possibly be used under the most ideal conditions if sandiness were to be avoided." The development of sandiness was not materially affected by the corn sweeteners, according to Dahlberg and Penczek (9).

PURPOSE OF THE INVESTIGATION

Previous investigations have shown results which pointed toward a solution of the problem resulting from the need of an ice cream which compares favorably with the hand packed product. This investigation was begun with the intention of answering some of the complex problems resulting in attempts to manufacture a heavy ice cream. The purpose of this investigation has been:

1. To find the ingredient of ice cream which contributes the most toward a "chewy" body in an ice cream manufactured and packed at the freezer, similar to that found in the hand packed package.
2. To determine the optimum overrun for the development of "chewy" characteristics in a heavy type of ice cream.
3. To determine the adaptability of the penetrometer for use as an indicator of desirable body.

SCOPE OF INVESTIGATION

This investigation includes a study of the effects of varying quantities of serum solids, various sweeteners, and various stabilizing agents upon the overrun, resistance to penetration, meltdown, and body characteristics of ice cream.

Mixes were compounded to contain 8, 10, 11, 12, and 14 percent serum solids respectively. This portion of the investigation was to determine the effect of serum solids upon the character of the finished product when the milk-solids-not-fat content was varied from the lowest to the highest reasonable limits of concentration.

Commercial sweeteners or sugar substitutes were studied, as completely as facilities permitted, to determine their influence on the development of a cohesive or "chewy" bodied ice cream. The total sugar equivalent of each sweetener used was 12 percent and 15 percent. Whenever it was possible, the determinations of previous investigators of sweetening value or replacement ratios were used. Two exceptions to this rule were made because of no known previous determinations. The sweeteners used in the investigation were cane sugar (sucrose), Cerelose (dextrose, hydrate), Sweetose (enzyme converted corn syrup), Frodex (corn syrup solids), Puritose, and Super Sweet Syrup.

Stabilizing agents of various types were used. The reports of previous investigators were used to determine the correct amounts to use. In the absence of such information the recommendations of the manufacturer

were used. The stabilizers used were gelatin (275 Bloom strength), Vesterine, sodiun carboxymethylcellulose (C.M.C.), sodium alginate (Dariloid), Polycoid, pectin, Krageleen, and Gelox.

A final series of experiments were conducted, utilizing information found during the progress of this work. The total sugar equivalent used was 15 percent and the substitute sugar was Frodex. The milk-solids-not-fat of the mixes was varied using percentages of 8, 10, 12, and 14.

THE NATURE OF INGREDIENTS

The fluid portion of the mixes was fresh pasteurized whole milk containing 3.6 percent butterfat. In some cases a small amount of water was used in order to avoid material changes in mix constituents that were not being varied in that series.

The dry milk-solids-not-fat used was freshly made by the atmospheric roller drum process on a 120 inch roller from fresh skim milk. The skim milk used tested 0.16 - 0.17 percent acid and was preheated to 185° F. before drying.

Butter was the source of fat not provided by the fluid milk. The butter was taken from fresh churnings without salting and stored for short periods of time, at -10° F. until used.

Sweeteners

Refined granulated cane sugar was used as the source of sucrose and is universally used as the standard for determining the sweetening power of other sweeteners.

Dextrose as commercially made is about 99.5 to 99.8 percent pure dextrose. It is manufactured by hydrolysis of corn starch by the action of acid and heat under steam pressure. The sweetening value used for this sugar in this study was placed at 83, based on the work of Tracy (58) who established the sweetening value at 83 - 100.

Frodex is a spray dried form of corn syrup, hence the term corn syrup solids. A sweetening value of 49 (26) (9) was used for this sugar.

Sweetose is a high conversion corn syrup made by applying enzyme hydrolysis. Because of its higher dextrose content, its sweetening value is higher than that of corn syrup, from which it is made. Sweetose has a sweetening value of 67 according to Horrall (26) and Dahlberg and Penczek (9).

Super Sweet Syrup and Puritose are products which have not been studied extensively as yet. The sweetness of both of these syrups was placed at 50 as a result of examinations conducted by the author. The procedure of examining used was the "threshold taste test" described by Biester, Wood,and Waklin (3). The method described by Dahlberg and Penczek (10) in which sweetness was determined by checking the unknown with a known concentration of sucrose was also used. The results of both tests indicated that each sugar had a sweetening value of about 50.

Stabilizers

Gelatin is a water imbibing protein produced by processing calf skin, pork skin, trimmings, and bones. The processing includes hydrolysis of the proteins, collagen and ossein, and subsequent evaporation and drying of the product.

Vesterine, a commercial product, is produced by combining a good grade of gelatin with monoglycerides and diglycerides.

Sodium carboxymethylcellulose is a cellulose binding agent made by processing cellulose materials, especially cotton and wood.

Dariloid is a gum which is manufactured from Macrocystis pyrifera, the giant kelp of the Pacific Ocean. This product undoubtedly is the lead-

ing gum stabilizer used in ice cream .

Polycoid is the commercial name for a stabilizer which is a combination of carboxymethylcellulose, Carrageenin (Irish moss), Sorbitan Monostearate, and a corn sugar carrier. The stabilizing agents are the gums, carboxymethylcellulose and Carrageenin. The Sorbitan Monostearate is a stearic monoglyceride emulsifier.

Pectin is chiefly a commercial by-product of the citrus fruit industry. This product is usually considered as belonging in the broad classification of gums. It is not a very satisfactory stabilizer for ice cream, but finds extensive use in ices and sherbets.

Krageleen is a commercial product extracted by boiling water from Irish moss or carrageen, a red alga, Chondrus crispus, which grows along the rocky sections of the Atlantic coast of Europe and North America. The dried moss contains about 55 percent carrageenin.

Gelox is a combination of gelatin, vegetable colloids, monoglycerides, and diglycerides. This product has just recently been introduced to the ice cream trade and little is known of it as yet.

PROCEDURE

Composition of the Mix

Ice cream mixes containing 12 percent fat were used for the experiments reported herein. Composition of the 29 mixes used is given in Table I, and the factor being studied in each series is underlined in the table. Substitute sugars were used to replace 30 percent of the sucrose in all samples in order to simulate commercial mixes which utilize corn sweeteners regularly and to make an adequate comparison to samples in which the sweeteners were being studied. Dextrose and Sweetose were used to replace a total of 30 percent of the sugar equivalent in the samples which were not used for sugar studies. The dextrose and Sweetose each supplied 15 percent of the sugar equivalent.

Table II lists the sweeteners used in this investigation, the relative replacement value used in this study, and the authors of these replacement values.

Table III is presented to show the stabilizers used and an authority's recommendation of proper quantities to use. In the absence of a research recommendation the manufacturers recommendation is shown.

Mix Preparation and Freezing

Thirty-nine batches of ice cream mix composed of the components shown in Table I, and the ingredients shown in the appendix were made in ten gallon lots.

The ingredients not being studied in the series were mixed and

Table I. Composition of Mixes

No.	Sugar equivalent	Percent replacement by sweetener	M.S.N.F. content	Stabilizer and amount used	Total solids content
1	15 %	15 % dextrose 15 % Sweetose	8 %	0.35 % Vesterine	36.22 %
2	15 %	15 % dextrose 15 % Sweetose	10 %	0.35 % Vesterine	38.22 %
3	15 %	15 % dextrose 15 % Sweetose	11 %	0.35 % Vesterine	38.80 %
4	15 %	15 % dextrose 15 % Sweetose	12 %	0.35 % Vesterine	40.27 %
5	15 %	15 % dextrose 15 % Sweetose	14 %	0.35 % Vesterine	42.53 %
6	12 %	none (sucrose)	11 %	0.35 % Vesterine	35.48 %
7	12 %	30 % dextrose	11 %	0.35 % Vesterine	35.90 %
8	12 %	30 % Frodex	11 %	0.35 % Vesterine	38.96 %
9	12 %	30 % Sweetose	11 %	0.35 % Vesterine	36.29 %
10	12 %	30 % Puritose	11 %	0.35 % Vesterine	37.72 %
11	12 %	30 % Super Sweet Syrup	11 %	0.35 % Vesterine	37.50 %
12	15 %	none (sucrose)	11 %	0.35 % Vesterine	40.64 %
13	15 %	30 % dextrose	11 %	0.35 % Vesterine	39.01 %
14	15 %	30 % Frodex	11 %	0.35 % Vesterine	42.88 %
15	15 %	30 % Sweetose	11 %	0.35 % Vesterine	39.48 %
16	15 %	30 % Puritose	11 %	0.35 % Vesterine	41.27 %
17	15 %	30 % Super Sweet Syrup	11 %	0.35 % Vesterine	40.10 %

Table I - continued

No.	Sugar equivalent	Percent replacement by sweetener	M. S. N. F. content	Stabilizer and amount used	Total solids content
18	15 %	15 % dextrose 15 % Sweetose	11 %	0.35 % gelatin	38.90 %
19	15 %	15 % dextrose 15 % Sweetose	11 %	0.35 % Vesterine	38.90 %
20	15 %	15 % dextrose 15 % Sweetose	11 %	0.15 % C.M.C.	38.65 %
21	15 %	15 % dextrose 15 % Sweetose	11 %	0.22 % Dariloid	38.72 %
22	15 %	15 % dextrose 15 % Sweetose	11 %	0.35 % Polycoid	38.90 %
23	15 %	15 % dextrose 15 % Sweetose	11 %	0.15 % pectin	38.65 %
24	15 %	15 % dextrose 15 % Sweetose	11 %	0.15 % Krageleen	38.65 %
25	15 %	15 % dextrose 15 % Sweetose	11 %	0.30 % Gelox	38.85 %
26	15 %	30 % Frodex	8 %	0.35 % Vesterine	39.79 %
27	15 %	30 % Frodex	10 %	0.35 % Vesterine	41.83 %
28	15 %	30 % Frodex	12 %	0.35 % Vesterine	44.07 %
29	15 %	30 % Frodex	14 %	0.35 % Vesterine	46.28 %

* The underlined component was the one investigated.

Table II. Sweeteners Used and Their Relative Sweetness

Sweetener	Relative Sweetness	Authority
Cane sugar	100	—
Dextrose	83 - 100	Tracy
Frodex	49	Dahlberg and Penczek
Sweetose	67	Horrall
Puritose	50	Lankford
Super Sweet Syrup	50	Lankford

Table III. Stabilizers and Quantity Used

Stabilizer	Quantity	Authority
Gelatin (275 Bloom)	0.35 %	—
Vesterine	0.35 %	Manufacturer
C. M. C.	0.15 %	Josephson & Dahle
Dariloid	0.22 %	Dahle
Polycoid	0.35 %	Manufacturer
Pectin	0.15 %	Dahle and Collins
Krageleen	0.15 %	Manufacturer
Gelox	0.35 %	Manufacturer

heated in a large vat to a temperature of 110° F. to facilitate dissolving dry portions. In the series of stabilizers part of the dry sugar was kept out of the basic mix and added later, mixed with the stabilizer. After the basic mix was heated and completely dissolved, the required amounts were weighed into ten gallon milk cans.

The additional ingredients were stirred into the mix and pasteurization was completed by the use of a water driven agitator and hot water spraying on the outside of the cans. After pasteurizing at 150° F. for 30 minutes the mix was homogenized in a 200 gallon, single stage Union Steam Pump Company Viscolizer at a pressure of 2500 pounds and immediately cooled to 45° F. to 50° F. by running over a tubular surface cooler.

The completed mixes were stored at 40° F. for 24 hours and then frozen. Forty-five pounds of each mix was frozen in a 40 quart Creamery Package direct expansion batch freezer. The freezing of varying overrun ice cream samples was accomplished by first freezing to maximum overrun. Two pint packages were filled at this point. The overrun was then reduced in progressive steps by intermittent application of freezing medium which caused part of the overrun to be frozen out of the ice cream. At each step in the progressive reduction of overrun two pint samples were taken directly from the freezer. The freezer was rinsed out with cold water between each batch inorder that all batches would be frozen under as identical conditions as possible.

Immediately after samples were taken from the freezer they were placed in a hardening room where the temperature was maintained at -5° F. to

-10°F. When the ice cream was completely hardened, each sample was weighed to determine the percent overrun.

Scoring of Body

The samples of ice cream were scored 48 hours after freezing and again two weeks after freezing. Scoring was done on the basis of 30 being perfect. The samples to be scored were removed from the hardening room and allowed to temper for a few minutes before judging. The opinion of two judges was used to establish the score value and criticisms. The judges made no attempt to score flavor since the primary interest of this project was body

Testing the Ice Cream for Hardness

Hardness or firmness of the body was determined by the use of a penetrometer shown in plates 1, 2, and 3.

The operation of this equipment is based upon the physical laws of falling bodies. The depth of penetration depends upon the height of the falling body, the weight of the falling body, the size of the penetrating needle, resistance acting upon the body while falling, and temperature.

The penetrometer guide used consisted of a heavy glass casing, one inch in diameter, which acted as a drop tube. The tube was firmly held in a ring stand and adjusted so that the height of fall was maintained at 72 centimeters.

The penetrometer was constructed of steel and had an outside diameter of 15/16 of an inch. This provides a 1/16 inch clearance between the penetrometer and the glass tube. The possibility of error by friction was

reduced by the use of three bearing surfaces, which may come into contact with the casing during falling instead of the full length of the mechanism making contact. These bearing surfaces obviously do not eliminate all friction but do reduce it since the maximum surface area which may come in contact is materially reduced. The friction is a material consideration and the construction of this apparatus does not eliminate all of it. However, it should be pointed out that the results of this equipment were used as an index of comparison, and that friction exists in every trial. Therefore the error due to friction is thus materially eliminated. The penetrating needle, attached to the falling body had a diameter of 1/4 inch, and the total weight of the falling body was 785 grams. The needle was calibrated in millimeters on the side to provide for direct readings of depth of penetration.

This method of releasing the falling body was manual. A key, shown in photographs, supported the penetrometer at the top of the glass casing. When a trial was to be made the key was removed in a direction perpendicular to the penetrometer, thus allowing the penetrometer to drop through the casing.

The samples to be tested were held in a hardening room where the temperature was -7.8° F. (-22° C.) to -9.6° F. (-23° C.). The pint packages were placed beneath the penetrometer and three penetrations made of each sample.

Meltdown Testing

The melt down tests were performed with a Cenco forced ventilation incubator with the temperature regulated at 70° F., plus or minus one degree. A pint of each sample of ice cream was cut in half with a sharp cheese knife

before removal from the hardening room and one half reserved for meltdown testing. When melting was to begin all samples were removed from the hardening room at once, by the use of a tray and each sample was placed on a wire screen in the incubator, which was supported by a six inch glass funnel. A large nail was soldered to each screen so that it could be forced into the sample of ice cream and prevent the sample from sliding during melting. The drippings were funneled into glass cylinders during the melting period of sixty minutes and then weighed for final results which was termed grams of meltdown.

The temperature of 70° F. was used in preference to higher temperatures because it was considered more representative of room temperature.

The forced ventilation incubator was used because the temperature changes were less than might occur if testing in an open room. The forced ventilation provided a constant, mild, indirect circulation of air and thus prevented an accumulation of cool air around each sample and eliminated the possible factor of undetermined air currents which may occur in an open room.

Determination of Sweetening Value

The sweetening value of the sweeteners, Puritose and Super Sweet Syrup, was determined by two different methods.

In the first determination of sweeteners a dilution of the unknown syrup was prepared to equal the sweetness of a 15 percent sucrose dilution or simple syrup. Small quantities of the unknown was weighed into 100 grams of distilled water and after each addition the two syrups were tasted to determine if equal in sweetness. When the concentration of the unknown was great

enough to equal the sweetners of the known, the percent of concentration was calculated, using the total weight of the additions. A second dilution of the unknown was made to the percent concentration found necessary in the previous determinations. This syrup was tasted once again to verify its correlation in sweetness to the sucrose dilution. When the check dilution corresponded to sucrose dilution the relative sweetness was determined by dividing the weight of cane sugar used into the weight of substitute sweetener required.

The second method of determining sweetening value was to find the weight of sweetener required in 100 grams of water to produce the first trace of sweetness. These two weights were then used to calculate the sweetening value as described previously. The most desirable method of tasting the dilutions was to first rinse the mouth with distilled water and then place a drop of solution on the tongue by the use of a medicine dropper. This method prevented confusion of flavors and helped make the first occurrence of sweet flavor apparent.

RESULTS

The Effect of Varying Milk-Solids-Not-Fat Upon Meltdown and Body Score

The first series of samples consisted of ice creams containing 8, 10, 11, 12, and 14 percent milk-solids-not-fat. The sugar content was 15 percent sugar equivalent. Dextrose and Sweetose were each used to supply 15 percent of the total sweetness so that the ice cream would correspond with commercial composition. Vesterine was used as the standard stabilizer.

Charts 1 and 2 show that the use of eight or 10 percent milk-solids-not-fat is not as desirable as the use of higher percentages of serum solids. The score value of freshly frozen ice cream containing eight and 10 percent milk solids had maximum body score values of 28.50 and 29.25, respectively. The ice creams containing 11, 12, and 14 percent serum solids had maximum score values of 29.50 in each case.

Table IV shows the comparison between percent overruns and the average score values of fresh samples taken within each range of overrun. This table shows that the maximum score values of all groups occur at overruns between 50 and 79 percent. The maximum of overrun of ice cream containing 12 and 14 percent milk-solids-not-fat occurs at slightly less overrun than samples containing 8, 10, or 11 percent overrun.

Table V shows the comparison of meltdown and percent overrun. The meltdown values were averaged in cases where more than one sample was taken within the range of overrun. There was no regularity in the meltdown of

this series and thus no indication that any increased or decreased percentage of M.S.N.F. causes increased or decreased melting. However it is noted in this, as well as other series, that the grams of melted ice cream collected increased as the overrun was increased. This condition undoubtedly was due to a greater mass of ice cream and less air in a low overrun product and thus more heat energy was required to induce melting. Also, the foam adhering to the surface of high overrun samples was more abundant and acted as an insulator against the transfer of heat. The table also shows no indication of increased or decreased rate of overrun resulting from changes in the milk-solids-not-fat content.

Table IV. Optimum Overrun with Varied M.S.N.F. Mix 12 Percent Fat, 11.5 Percent Sucrose, 2.25 Percent Sweetose, 2.25 Percent Dextrose (Equivalent).

	Scores at various overruns*						
M.S.N.F. Content	40-49	50-59	60-69	70-79	80-89	90-99	100-109
8 %	27.50	27.50	27.62	<u>28.25</u>	27.75	27.50	
10 %		27.50	28.50	<u>28.87</u>	28.25	27.87	
11 %	27.00	28.00		<u>29.25</u>	28.75	28.00	27.50
12 %		<u>29.12</u>		29.00	28.50		27.00
14 %		28.00	<u>29.25</u>	28.75	28.50	28.50	28.00

*Maximum score value is underlined.

The judges noted that the entire series of eight percent serum solids samples were coarse and icy. The group of 10 percent serum solids

samples, while more desirable than eight percent samples, still had a tendency to be coarse and icy. The 11 percent serum solids samples were an improvement over the previous group. The samples of 12 percent serum solids were found to be the most desirable. This ice cream was largely free of the criticisms previously found. The 14 percent serum solids ice cream had a more chewy and resistant body but was criticised for a powdery flavor, which covered the richness of the fat, and some sandiness. Also, these samples were not as smooth as the 12 percent serum solids samples.

The reader may note that the score value of body in most series studied was lower after two weeks storage than when the sample was fresh. This was not the case, however, for all samples.

Table V. Average Meltdown with Varied M.S.N.F. Mix 12 Percent Fat, 11.5 Percent Sucrose, 2.25 Percent Sweetose, 2.25 Percent Dextrose (Equivalent).

	Meltdown at Various Overruns						
M.S.N.F. Content	40-49	50-59	60-69	70-79	80-89	90-99	100-109
8 %	13	11	27.5	34	40	46	
10 %		38	57.5	37	35	46.5	
11 %	13	26.5		49	55.5	49	48
12 %	24	28.5		29	33		40
14 %	12	17.5	26	33	18	33	34

The Effect of 12 Percent Sugar Equivalent Upon Meltdown and Score Value of Body

In this series various commercial sugar substitutes were used in sufficient quantities to supply 30 percent of the sweetening power in a 12 percent sugar equivalent mix. The source and nature of the substitute sweetener was the only variable in this series. The milk-solids-not-fat content was 11 percent and all other constituents were the same as described in the previous series.

A comparison between percent overrun and average body score value of fresh samples of ice cream is shown in Table VI. The maximum body score value of these samples ranged from 28.50 to 29.25. The sample having maximum score value occurred at overruns between 50 and 89 percent.

Table VI. Optimum Overrun with Various Sweeteners Used in Conjunction with Sucrose, 12 Percent Sugar Equivalent.

	Scores at Various Overruns*							
Sweeteners	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119
Sucrose	27.75	28.00	<u>28.5</u>	28.25	28.00	27.50	27.25	
Dextrose	28.12	28.75	<u>29.25</u>		29.00	28.75	27.50	
Frodex	28.00	28.12	<u>29.0</u>	28.75	28.50	28.25		
Sweetose	28.50	<u>29.0</u>	28.25	17.62				27.00
Super Sweet Syrup	27.25	27.75	28.25	<u>28.50</u>	27.75		27.25	
Puritose	27.62		28.25		<u>28.50</u>		27.37	

* Maximum score is underlined.

All 12 percent sugar equivalent samples yielded hard icy body and an undesirable product. The score values of the body were consequently lower than would be expected in a good commercial ice cream. The mix containing Frodex was noticeably more chewy than any of the other ice creams, and the mix with Puritose was critized for a syrupy flavor. The mix containing Super Sweet Syrup was criticized for a syrupy flavor, and for a caramel flavor, which is typical of the syrup itself.

Table VII shows that the ice creams containing dextrose and Super Sweet Syrup had no meltdown. The samples containing all sucrose and those containing Sweetose melted at a rather slow rate. Puritose samples melted at an average rate and samples containing Frodex melted very rapidly. This may be noted again in the last series.

Table VII. Maximum Meltdown with Various Sweeteners Used in Conjunction with Sucrose, 12 Percent Sugar (Equivalent).

	Meltdown at Various Overruns								
Sweeteners	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119
Sucrose	0	0	4	7	10	8	14	12	
Dextrose	0	0	0	0		0	0	0	
Frodex	38	40	43	54	57	58	65		
Sweetose		6	7	12	18	12			14
Super Sweet Syrup	5	0	0	0	0	0		0	
Puritose		20.5		18		18	20	30	29

The Effect of 15 Percent Sugar Equivalent Upon Meltdown and Score Value of Body

In this series various commercial sugar substitutes were used in sufficient quantities to supply 30 percent of the sweetening power in a 15 percent sugar equivalent mix. The ingredients studied in this ice cream were substitute sweeteners. All other ingredients remained the same. This series was the same as the previous except that this one made use of 15 percent sugar equivalent instead of 12 percent sugar equivalent.

Charts 12 to 17 show that 15 percent sugar equivalent produced a much superior product to the 12 percent product, shown in charts 6 to 11. The use of 15 percent sweetener increased the maximum score value of the same ice cream from 1/4 to 1-1/4 points above the 12 percent sugar series. Table VIII shows that maximum body score value of ice cream in the 15 percent sugar equivalent series was in no case below 29.00. The samples containing all sucrose and those containing Frodex had maximum score values of 29.75, which is almost a perfect score.

The increased score value is a result of a finer and smoother body which resulted from the use of 15 percent sweetener. The samples containing Frodex sweetener showed the largest increase in body score due to the marked increase in firmness and chewiness or cohesion of the body. Sucrose and Puritose produced ice cream of equal score value. The judges found that the Frodex samples were gummy and had body characteristics which confused any attempt to estimate overrun. This is further illustrated in Table VIII which shows the maximum body score of fresh ice cream containing Frodex occurred at

an overrun between 80 and 99 percent. The actual overruns of these samples were 83 and 93 percent, respectively. These two samples were placed higher in score value than any others in the entire investigation which contained an equal amount of overrun. This suggests the possibility of obtaining a smooth, chewy product which has an overrun of 80 to 90 percent overrun by the use of sweeteners such as Frodex. Sweetose and Puritose were found to produce some chewiness but not to the extent of Frodex. The ice cream containing cane sugar and no substitute was criticized for shrinkage. These samples were very smooth and some were slightly chewy.

Table VIII. Optimum Overrun with Various Sweeteners Used in Conjunction with Sucrose 15 Percent Sugar Equivalent

	Scores at Various Overruns*							
Sweeteners	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109
Sucrose	28.50	28.75	28.62	<u>29.75</u>		29.50		29.00
Dextrose		28.25	29.00	<u>29.50</u>	28.75		28.50	
Frodex		29.00	29.25	29.50		<u>29.75</u>	<u>29.75</u>	
Sweetose		<u>29.00</u>	<u>29.00</u>	<u>29.00</u>	28.00		28.50	
Super Sweet Syrup	28.50	28.75	29.00	<u>29.25</u>	28.50		28.00	27.75
Puritose	27.75	28.00	28.62	<u>29.25</u>		28.50		27.50

*Maximum score value is underlined

The meltdown results of this series, presented in Table IX, shows that ice cream containing 15 percent sugar equivalent melted at a more rapid rate than when sugar content was 12 percent. The basis for this statement

is given in Charts 7 and 9. The increased rate of melting of the 15 percent sugar samples was due in part to the reduced freezing temperature resulting from the use of some sugars. Also, the use of three percent more sugar equivalent lowered the freezing point and resulted in a softer ice cream.

Table IX. Maximum Overrun with Various Sweeteners Used in Conjunction with Sucrose, 15 Percent Sugar Equivalent

	Meltdown at Various Overruns								
Sweeteners	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119
Sucrose	5	2	9	14		12		20	
Dextrose		0	0	0	0		0		
Frodex		40	58	55		60	72		
Sweetose		0	5	7	4		6		13
Super Sweet Syrup	10	8	7	6	4	2		3	
Puritose	16	10	10	14		9		15	

The samples containing dextrose did not melt at all during the 60 minute melting period, However, this cannot be considered an indication of stabilizer sparing action on the part of dextrose since previous experimental investigations show conclusively that dextrose has no stabilizer sparing action. The ice cream samples containing 15 percent sugar equivalent with Super Sweet Syrup melted a small amount during the meltdown test period. The ice cream containing all sucrose, Sweetose, and Puritose melted at a moderate rate. The samples containing Frodex melted very rapidly compared to other trials. However, the rapid rate of melting displayed by this product was not extensive enough to be considered objectionable from the viewpoint of consumer acceptance.

The Effect of Various Commercial Stabilizers Upon the Meltdown and Body Score

In this series various commercial stabilizers were used as the only varied ingredient of the mix. The remainder of the mix composition was 12 percent fat, 11 percent milk-solids-not-fat, and 15 percent sugar equivalent. Dextrose and Sweetose were each used to replace 15 percent of the total sweetness required.

The ice cream containing gelatin was found to be considerably better than any other stabilizer investigated. Table X shows that the maximum body score value of fresh ice cream containing 275 Bloom strength gelatin was 29.75. This score occurred at an overrun of 70-79 percent and the score value was higher than for any other sample in the stabilizer series of study. All samples stabilized with gelatin were very smooth and in some cases slightly chewy.

Table X. Optimum Overrun with Various Stabilizers Used in Mix with 12 Percent Fat and 15 Percent Sugar Equivalent

	Scores at Various Overruns								
Stabilizer	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119
Gelatin		28.50	28.75	29.50	29.75	29.50	28.75		28.25
Vesterine		28.75	29.00		28.25	27.75		27.50	
C.M.C.	27.50	27.50		28.50	28.25	28.00	27.50	27.25	
Dariloid		27.75	28.50	27.50	27.50	27.37		27.00	
Polycoid	28.00	29.25	28.50	28.00	28.00	27.50	27.00		
Pectin			27.00		27.87	27.50	27.00		27.00
Krageleen	27.25	27.66	28.50		28.25	27.50		27.50	
Gelex		28.62	29.00		27.75	28.75		28.50	

Vesterine compared favorably with the gelatin samples. The maximum body score value of Vesterine samples was 29.00. The use of Vesterine resulted in ice cream which was somewhat chewy but had a tendency to be coarse. The use of Gelox was criticized the same as Vesterine. It had a maximum score value of 29.00 as shown in Table X.

The use of sodium carboxymethlcellulose (C.M.C.) as a stabilizer resulted in an ice cream which was chewy at very low overruns and slightly chewy at overruns of 60 to 79 percent.

The use of Dariloid, Polycoid, or Krageleen as stabilizers resulted in ice creams which showed no unusual advantages or disadvantages.

Pectin proved poorest in producing good body scores, as may be expected of this type of stabilizer. As previously pointed out, pectin is better adapted to use in sherbets and ices than in ice cream. The criticisms of the samples were iciness and coarse body.

Ice cream samples containing gelatin and Vesterine stabilizers melted less than did any other samples as shown in Table XI. One possible explanation is the water imbibing action of gelatin.

Further inspection of Table XI reveals that the only evident correlation between meltdown and overrun is that the rate of meltdown increases as overrun is increased. The average meltdown of samples containing other stabilizers, except pectin, shows no significance. Melting of samples in the pectin group occurred more rapidly than with other stabilizers. This is to be expected because of the poor stabilizing qualities of pectin.

Table XI. Grams of Meltdown with Various Stabilizers Used in Mix with 12 Percent Fat and 15 Percent Sugar Equivalent

	Average at Various Overrun								
Stabilizer	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119
Gelatin		0	7	9	9	8	10		12
Vesterine		3	5		4	7		9	
C.M.C.	14	19		32	41	27	29	41	
Dariloid		10	14	8	12	25.5		36	
Polycoid	7	8	11.5	10	33	34	49		
Pectin			32		43	42	44		54
Krageleen	6	20	32		18	30		53	
Gelex		7	19		10	21		14	

The Effect of Varying Milk-Solids-Not-Fat and Frodex Replacement of Sugar Upon Meltdown and Body Score

The results of previous series indicated that Frodex was responsible for chewy and smooth body. Consequently, Frodex was used with varying milk-solids-not-fat in further observations. Mixes containing 15 percent sugar equivalent were made and Frodex used to supply 30 percent of the total sweetening value. The mixes contained serum solids in amounts of 8, 10, 12, and 14 percent. The remaining constituents were 12 percent fat, 11 percent milk-solids-not-fat, and 0.35 percent Vesterine.

The body score value, presented in Table XII, shows that the maximum score value of all groups, except the 14 percent M.S.N.F. group, occurred an an overrun of 70 to 79 percent. The maximum score value of the 14 percent

M.S.N.F. group occurred at an overrun of 70 to 89 percent.

Table XII. Optimum Overrun with Varied M.S.N.F. Mix 12 Percent Fat, 11.5 Percent Sucrose, and 4.5 Percent Frodex (Equivalent).

	Scores at Various Overruns*								
M.S.N.F. Content	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119
8 %		28.00	28.37	28.75	<u>29.00</u>		28.00		27.00
10 %		28.50	28.75		<u>29.37</u>	28.00		27.75	27.25
12 %		28.25	29.00		<u>29.50</u>		28.50	27.75	
14 %		28.25		28.75	<u>29.50</u>	<u>29.50</u>		29.00	

* Maximum score value is underlined

The body of the eight percent serum solids samples was quite satisfactory but not quite as high as the other samples. The 10 percent serum solids ice cream had a score value for body which was as high as either the 12 or 14 percent groups. This group was satisfactory in every way including flavor. The 12 percent serum solids samples compared equally with those containing 10 percent milk-solids-not-fat and was quite smooth. These two groups were thought to be the most desirable in every respect. The 14 percent serum solids group was chewy and smooth but had a tendency to be too heavy and to have a powdery flavor.

The meltdown record of the samples presented in Table XIII, shows that they melted more rapidly than the previous series of 15 percent sugar equivalent. This cannot be attributed to a lower freezing point since Frodex has a freezing point slightly above that of sucrose. However, the use of

Frodex greatly increases the carbohydrate content since two times as much Frodex is required to equal the sweetness of sucrose. Even though the use of Frodex lowers the freezing point of a mix slightly less than sucrose, it will lower the freezing point of a water solution and as more carbohydrate is added the freezing point is further reduced. Another factor which increases the rate of melting is the increased total solids which occurs when Frodex is used. The increased total solids results in less moisture which will be held in a frozen state.

Table XIII. Maximum Meltdown with Varied M.S.N.F. Mix 12 Percent Fat, 11.5 Percent Sucrose and 4.5 Percent Frodex (Equivalent).

	Meltdown at Various Overruns							
M.S.N.F. Content	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119
8 %	19	19	30	28		21		22
10 %	46	50		59	53		67	69
12 %	34.5	35		47		37	38	
14 %	40	57	60	49	52		46	

Results of Penetration Tests on Ice Cream

Penetrations were made three times on each of the 212 different samples of ice cream made for this study. The cumulative results show that the depth of penetration is directly related to the percent of overrun. A low overrun ice cream results in a shallow depth of penetration and a high overrun ice cream results in greater depth of penetration. Charts 30 to 33 are presented as typical examples of this relationship. This correlation

was not so close that the percent of overrun could be determined by the use of a penetrometer.

There is no apparent correlation between maximum score value of body and any optimum penetration index. In fact there seems to be no relation to body of an ice cream. This is contrary to the theory held at the outset of this work.

There was evidently no correlation between total solids and depth of penetration. The total solids of each of the mixes shown in charts 30, 31, 32, and 33 were 38.90, 38.90, 39.79, and 46.28 percents, respectively.

The Effect of Age Upon the Score Value for Body of Ice Cream

The score value for body of all series of ice creams when fresh and after two weeks storage were averaged for comparison to determine the effect of two weeks storage upon ice cream. The results are presented in Table XIV.

The results show that the difference in composite average body score value was very small. This indicates that the storage of ice creams for two weeks causes only slight decreases in the score value of body. Comparison of the first five samples shows that the average body score value increased progressively as the milk-solids-not-fat is increased up to 12 percent. The average score value of the 14 percent milk-solids-not-fat group declined slightly. The table shows that the average score values of samples containing 12 percent sugar equivalent was lower than those containing 15 percent sugar equivalent. The 15 percent sugar samples containing Frodex had an average score value above all other groups of samples. Ice cream con-

taining gelatin had the highest average body score value in the stabilizer series. Gelox and Vesterine ranked second and third, respectively. The last four groups of samples show that the average body score value of ice cream with Frodex replacement, increased progressively as the milk-solids-not-fat was increased.

Table XIV: Average Body Score Value of Ice Cream When Fresh and After Two Weeks Storage

Series	Group	Age when scored	Percent overrun									Average		Difference
			30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119	Fresh	Aged	
M.S.N.F.	8%	Fresh		27.00	27.25	27.62	28.25	27.75	27.50			27.66		
		Aged		27.00	27.25	27.62	27.87	27.50	27.25				27.50	-.16
	10%	Fresh			27.50	28.50	28.87	28.25	27.87			28.23		
		Aged			27.12	28.42	28.75	28.00	27.37				27.98	-.25
	11%	Fresh		27.00	28.00		29.25	28.75	28.00	27.50		28.28		
		Aged		27.00	27.75		29.12	28.50	27.75	27.25			28.08	-.20
	12%	Fresh		29.50	29.12		29.00	28.50	27.00			28.71		
		Aged		29.00	28.87		28.75	28.00	27.00				28.42	-.29
	14%	Fresh		28.00	28.62	29.25	28.75	28.50	28.50		28.00	28.61		
		Aged		28.00	28.37	29.25	28.50	28.25	28.25		27.50		28.42	-.19
14% sugar equivalent	cane sugar	Fresh	27.50	27.75	28.00	28.50	28.25	28.00	27.50	27.25		27.84		
		Aged	27.50	27.50	27.75	28.50	28.00	27.75	27.50	27.00			27.66	-.18
	Dextrose	Fresh		28.12	28.75	29.25		29.00	28.75	27.50		28.50		
		Aged		28.12	28.75	29.25		29.00	28.75	27.50			28.50	0

Table XIV: (Cont'd)

Series	Group	Age when scored	Percent overrun									Average		Difference
			30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119	Fresh	Aged	
14% sugar equivalent	Frodex	Fresh	27.50	28.00	28.50	29.00	28.75	28.50	28.25			28.36		
		Aged	27.50	27.75	28.25	28.50	28.00	27.75	27.50				27.89	-.47
	Sweet-ose	Fresh		28.50	29.00	28.25	27.62				27.00	28.07		
		Aged		28.25	29.00	28.00	27.50				27.00		27.93	-.14
	Puri-tose	Fresh		27.62		28.25		28.50		27.37		27.89		
		Aged		27.50		28.00		28.25		27.25			27.71	-.18
	Super Sweet Syrup	Fresh	27.00	27.25	27.75	28.25	28.50	27.75		27.25		27.68		
		Aged	27.00	27.25	27.50	28.00	28.50	27.75		27.25			27.61	-.07
15% sugar equivalent	Cane sugar	Fresh	28.50	28.75	28.62	29.75		29.50		29.00		28.96		
		Aged	28.50	28.75	28.62	29.75		29.50		29.00			28.96	0
	Dext-rose	Fresh		28.25	29.00	29.50	28.75		28.50			28.71		
		Aged		28.25	29.00	29.50	28.75		28.50				28.71	0
	Frodex	Fresh		29.00	29.25	29.50		29.75	29.75			29.38		
		Aged		29.00	29.25	29.50		29.75	29.75				29.38	0
	Swee-tose	Fresh		29.00	29.00	29.00	28.00		28.50		27.50	28.50		
		Aged		28.00	28.50	29.00	28.00		28.50		27.50		28.25	-.25

Table XIV: (Cont'd)

Series	Group	Age when scored	Percent overrun									Average		Difference
			30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119	Fresh	Aged	
15% sugar equivalent	Puritose	Fresh	27.75	28.00	28.62	29.25		28.50		27.50		28.34		
		Aged	27.75	28.00	28.62	29.25		28.50		27.50			28.34	0
	Super Sweet Syrup	Fresh	28.50	28.75	29.00	29.25	28.50		28.00	27.75		28.54		
		Aged	28.00	28.50	28.75	29.00	28.50		28.00	27.75			28.36	-.18
Stabilizer	Gelatin	Fresh		28.50	28.75	29.50	29.75	29.50	28.75		28.25	28.97		
		Aged		28.00	28.62	29.25	29.50	29.00	28.50		28.00		28.69	-.28
	Vesterine	Fresh		28.75	29.00		28.75	27.75		27.50		28.22		
		Aged		28.75	29.00		28.75	27.75		27.50			28.22	0
	C.M.C.	Fresh	27.00	27.50		28.50	28.25	28.00	27.50	27.25		27.69		
		Aged	27.00	27.25		28.00	28.00	27.00	27.25	27.00			27.34	-.35
	Dariloid	Fresh		27.75	28.50	27.50	27.50	27.37		27.00		27.57		
		Aged		27.50	28.00	27.25	27.25	27.25		27.00			27.36	-.21
	Polycoid	Fresh	28.00	28.25	28.50	28.00	28.00	27.50	27.00			27.97		
		Aged	28.00	28.25	28.50	28.00	28.00	27.50	27.00				27.97	0
	Pectin	Fresh			27.00		27.87	27.50	27.00		27.00	27.32		
		Aged			27.00		27.87	27.50	26.60		26.50		27.11	-.21
	Krageleen	Fresh	27.25	27.57	28.50		28.25	27.50		27.50		27.75		
		Aged	27.00	27.17	28.00		27.50	27.50		27.00			27.31	-.44

Table XIV: (Cont'd)

Series	Group	Age when scored	Percent overrun									Average		Difference
			30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119	Fresh	Aged	
Stabilizer	Gelox	Fresh		28.62	29.00		27.75	28.75		28.50		28.54		
		Aged		28.12	28.50		27.25	27.50		27.50			27.83	-.71
Frodex and M.S.N.F.	8%	Fresh		28.00	28.37	28.75	29.00		28.00		27.00	28.21		
		Aged		27.50	28.12	28.50	28.75		28.00		27.00		28.00	-.21
	10%	Fresh		28.50	28.75		29.37	28.00		27.75	27.25	28.43		
		Aged		28.00	28.50		29.12	28.00		27.50	27.00		28.18	-.25
	12%	Fresh		28.25	29.00		29.50		28.50	27.75		28.54		
		Aged		28.25	29.00		29.50		28.00	27.75			28.46	-.08
	14%	Fresh		28.25		28.75	29.50	29.50		29.00		28.86		
		Aged		27.75		28.62	29.50	29.25		28.50			28.57	-.29
											Composite average	28.267	28.075	-.20

CONCLUSIONS

1. The milk-solids-not-fat of normal commercial ice cream proved a minor factor in the development of unusually cohesive body.

2. A milk-solids-not-fat content of 8 or 10 percent did not produce as desirable body as 11 and 12 percent. The use of 14 percent milk-solids-not-fat produced a desirable body but tended to add powdery flavor.

3. A sugar content of 15 percent produced an ice cream with higher score value for body than one containing 12 percent sugar.

4. Ice cream mix containing 15 percent sugar equivalent had the most desirable body when the milk-solids-not-fat content was 11 or 12 percent.

5. Frodex produced a chewy body in ice cream when used to supply 30 percent of the sweetness in a 15 percent sugar equivalent mix.

6. When Frodex was used to replace 30 percent of the sweetness in a 15 percent sugar equivalent mix, the ice cream was chewy at overruns as high as 80 to 90 percent.

7. The optimum overrun of a heavy bodied ice cream containing 12 percent fat, 11 percent milk-solids-not-fat, and 15 percent sugar equivalent was 60 to 75 percent.

8. Gelatin was found to produce a finer textured ice cream than any other stabilizer studied.

9. The rate of meltdown increased as overrun was increased because , it is believed, the thicker layer of foam insulates high overrun ice cream from heat changes.

10. Penetration by the penetrometer was correlated only to the percent overrun in ice cream. The depth of penetration increased as the percent overrun was increased.

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A P P E N D I X

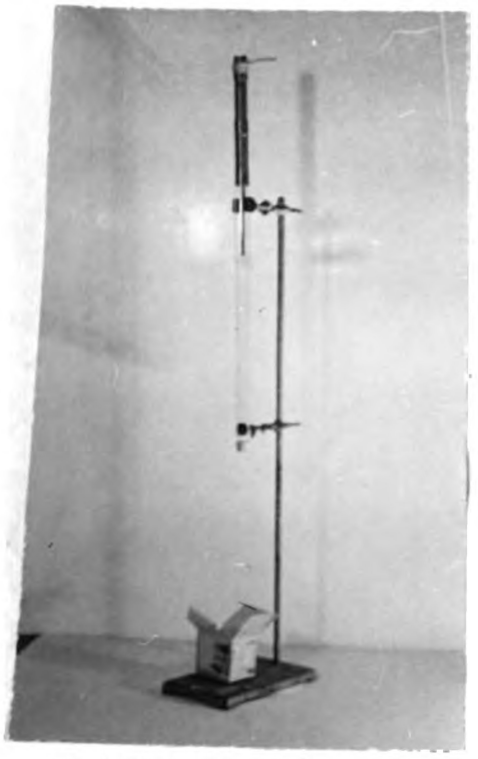


Plate 1. Complete Penetration Assembly

Plate 2. Penetrometer Support and Manual Release

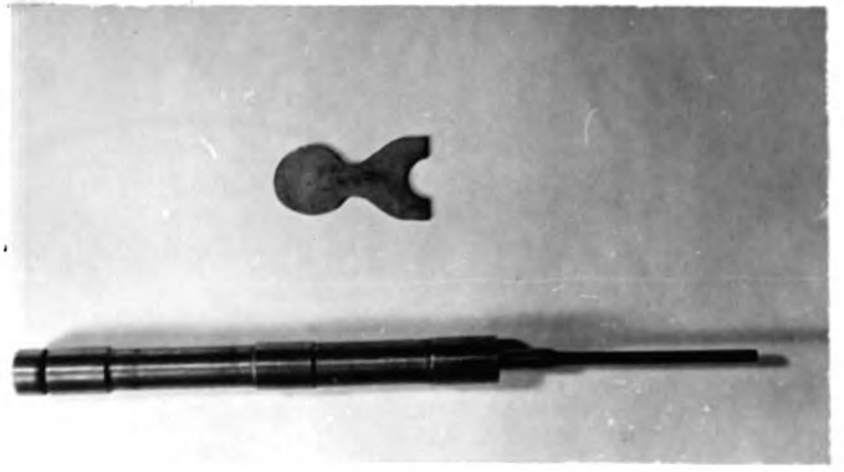


Plate 3. Penetrometer and Manual Release Key

Table XV : Results of Varying Overrun Using an Eight Per Cent S. S. Mix

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	47	17.6	13	27.00	Solid Coarse Icy	27.00	Solid Icy
2	56	19.6	11	27.25	Solid Coarse Icy	27.25	Solid Icy
3	60	18.3	28.	27.00	Solid Coarse Icy	27.50	Solid Icy
4	67	22.6	27	28.25	Sl. Icy Sl. Coarse	27.75	Icy
5	70	20.3	30	28.50	Sl. Icy Sl. Coarse	28.00	Icy
6	75	23.0	38	28.00	Light Sl. Icy	27.75	Light Sl. Icy
7	80	27.0	40	27.75	Light Sl. Icy	27.50	Light V. Icy
8	95	28.0	46	27.50	V. Light Sl. Icy	27.25	V. Light V. Icy

Penetrations in mm

1-	17, 18, 18	17.6	5-	20, 20, 21	20.3
2-	17, 18, 18	17.6	6-	23, 23, 23	23
3-	18, 18, 19	18.3	7-	27, 27, 27	27
4-	22, 23, 23	22.6	8-	28, 28, 28	28

Composition

Fat - - - - - - - 12 % Sugar - - - 15 %
Serum solids- - 8 % Stabilizer- .35 %
Total solids - - 36.22 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	12.15	pounds
Milk 3.5% - - - - - - - -	48.41	"
Dry milk solids not fat -	3.90	"
Sweeteners - - - - - - - -	.	"
Cane sugar - - - - -	10.50	"
Dextrose - - -	2.71	"
Sweetose - - -	3.36	"
Stabilizer - (Vesterine)- - -	.35	"
Water - - - - - - - - - -	18.60	"
	100.02	pounds

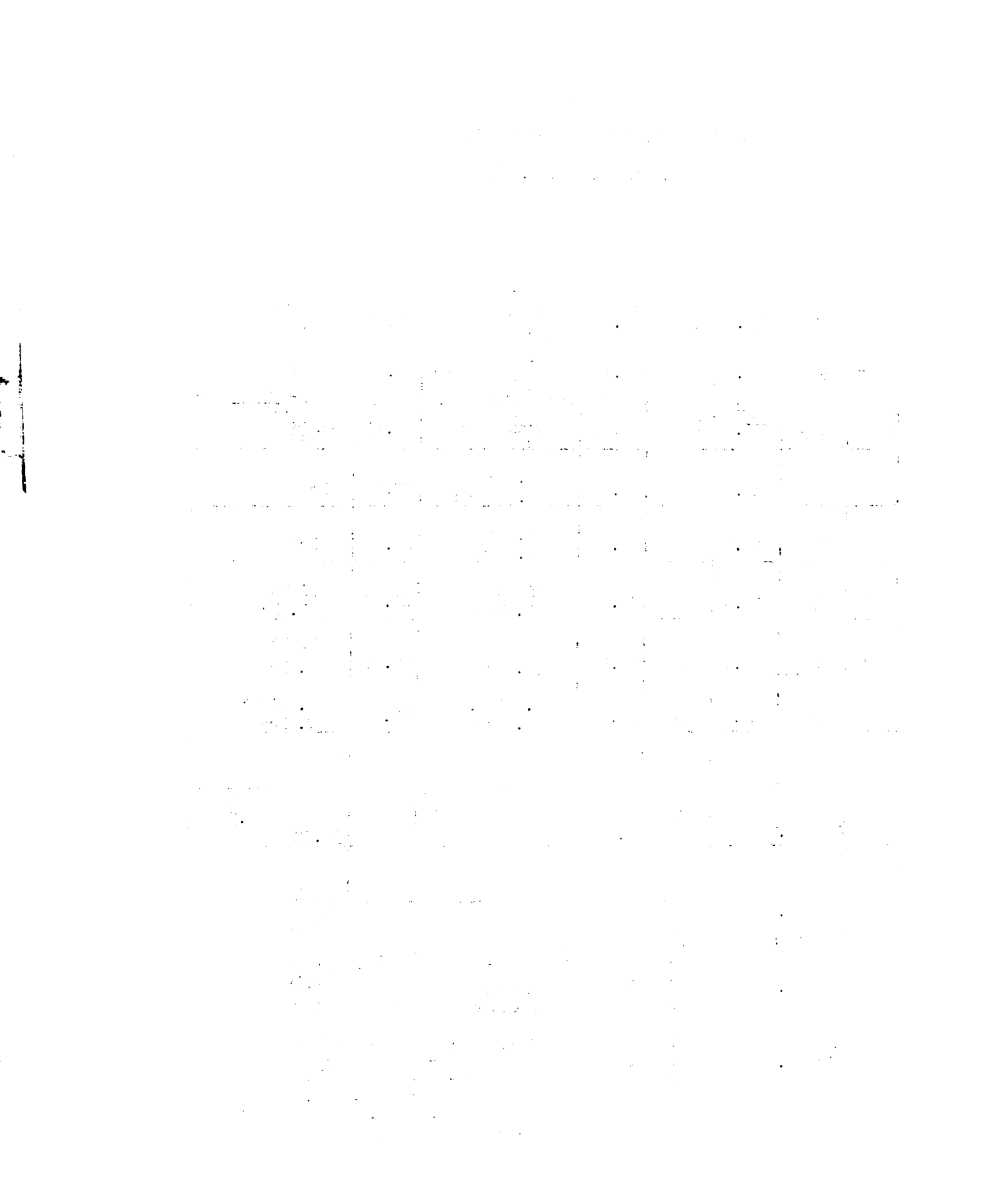


Table XVI: Results of Varying Overrun Using

A Ten Per Cent S.S. Mix

Sample No.	Per cent over-run	Ave. mm of penetration	Melt-down im gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	53	17.6	40	27.50	Heavy Sl. Icy	27.00	Heavy Sl. Icy
2	56	17.0	36	27.50	Heavy Sl. Icy	27.25	Sl. Heavy Sl. Icy
3	60	19.6	48	28.00	Sl. Heavy Smooth	28.00	Sl. Heavy
4	63	16.6	23	28.50	Smooth	28.50	Smooth
5	67	21.0	44	29.00	Sl. Chewy Smooth	28.75	Sl. Chewy Smooth
6	70	20.0	32	29.25	Sl. Chewy Smooth	29.00	Sl. Chewy Smooth
7	75	22.0	42	28.50	Smooth	28.50	Smooth
8	85	24.3	35	28.25	Sl. Coarse	28.00	Sl. Icy
9	90	24.3	45	28.00	Sl. Light Sl. Coarse	27.50	Sl. Light Sl. Coarse Sl. Icy
10	95	25.6	48	27.75	V. Light	27.25	V. Light Sl. Coarse

Penetrations in mm

1- 17, 18, 18 → 17.6

- 17, 17, 17 → 17

19, 19, 20 → 19.3

16, 17, 17 → 16.6

21, 21, 21 → 21

6- 20, 20, 20 → 20

7- 22, 22, 22 → 22

8- 24, 24, 25 → 24.3

9- 24, 24, 25 → 24.3

10- 25, 26, 26 → 25.6

Composition

Fat - - - - - - - 12 % Sugar - - - 15 %
Serum solids - - 10 % Stabilizer - .35 %
Total solids - - 38.22 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - - - -	11.80 pounds
Milk 3.5% - - - - - - - - - - -	60.00 "
Dry milk solids not fat - - -	4.80 "
Sweeteners	
Cane sugar - - - - - - - -	10.50 "
Dextrose - - - - -	2.71 "
Sweetose - - - - -	3.36 "
Stabilizers	
(Vesterine)- - -	.35 "
Water - - - - - - - - - - - - - -	6.50 "
	100.02 pounds

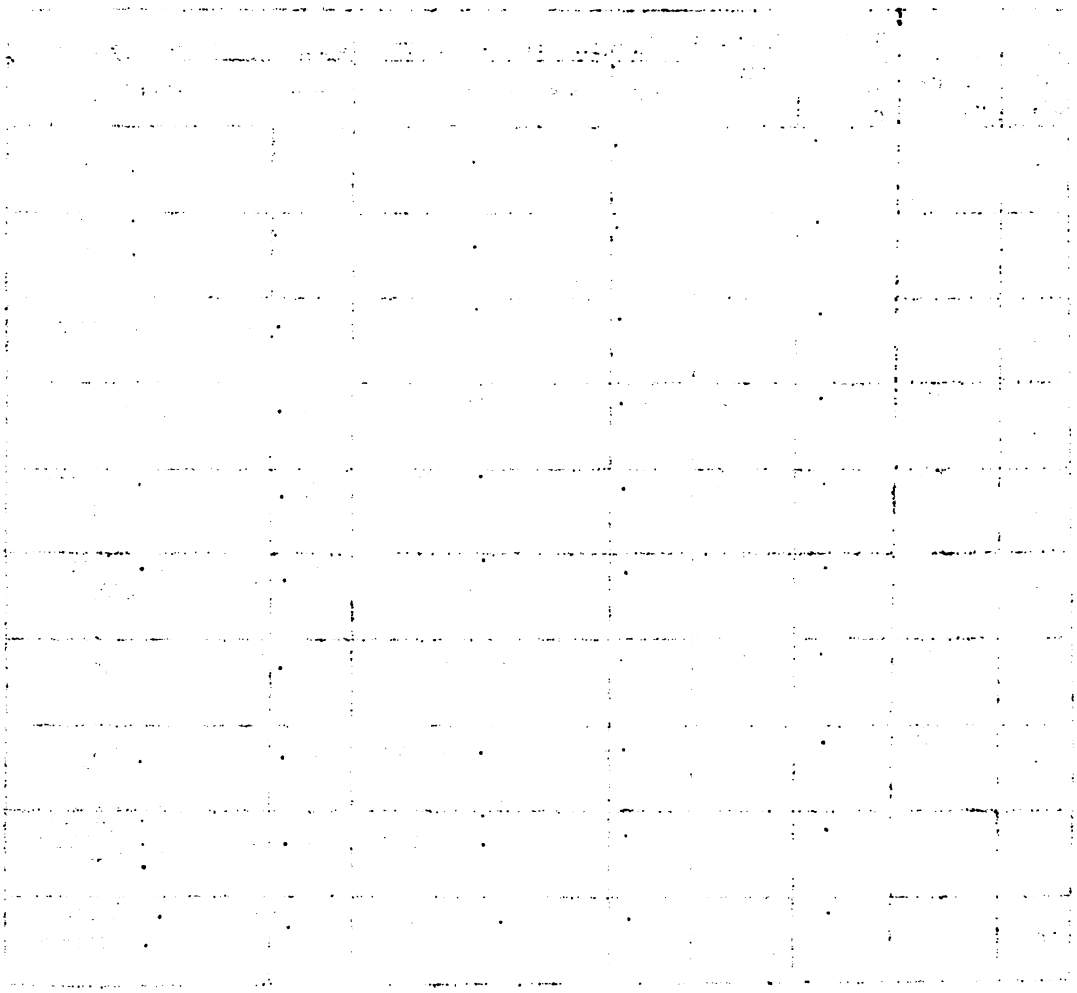


Table XVII: Results of Varying Overrun Using an Eleven Per Cent S. S. Mix

Sample No.	Per cent over-run	Ave. mm of penetration	Melt-down im gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	49	13.3	13	27.00	Sl. Hard Soggy	27.00	Sl. Hard V. Icy
2	56	9.3	9	27.50	Sl. Hard Sl. Soggy	27.25	Sl. Hard Sl. Icy
3	59	9.3	38	28.50	Sl. Hard Sl. Soggy	28.25	Sl. Icy Sl. Soggy
4	74	10.3	58	29.00	Smooth	29.00	Smooth
5	78	12.6	40	29.50	Smooth	29.25	Smooth
6	83	14.6	61	29.00	Smooth	29.00	Smooth
7	88	14.6	50	28.50	Smooth Sl. Coarse Sl. Light	28.00	Sl. Coarse Sl. Light
8	98	15.3	49	28.00	Sl. Light	27.75	Sl. Coarse Sl. Light
9	109	19.6	48	27.50	Sl. Coarse V. Light	27.25	Sl. Coarse V. Light
10							

Penetrations in mm

1- 13, 13, 14 → 13.3

2- 9, 9, 10 → 9.3

3- 9, 9, 10 → 9.3

4- 10, 10, 11 → 10.3

5- 12, 13, 13 → 12.6

6- 14, 15, 15 → 14.6

7- 14, 15, 15 → 14.6

8- 15, 15, 16 → 15.3

9- 19, 20, 20 → 19.6

10-

Composition

Fat - - - - - - 12 % Sugar - - - 15 %
Serum solids - - 11 % Stabilizer - .35 %
Total solids - - 38.80 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - - -	11.40 pounds
Milk 3.5% - - - - - - - - - -	66.41 "
Dry milk solids not fat - - -	5.30 "
Sweeteners	
Cane sugar - - - - - - - -	10.50 "
Dextrose - - - - -	2.71 "
Sweetose - - - - -	3.36 "
Stabilizers	
(Vestenine)- - -	.35 "
Water - - - - - - - - - - - - - -	. "
	100.03 pounds

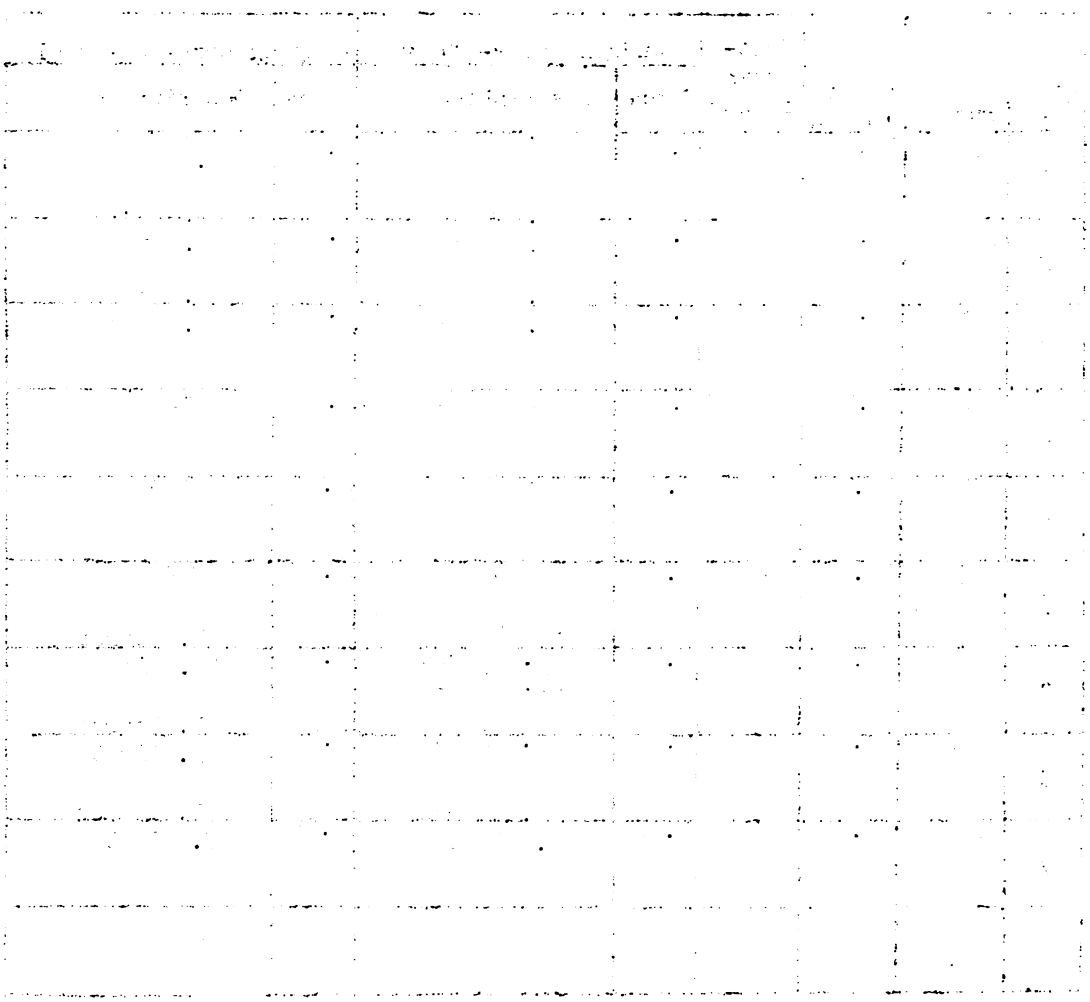


Table XVIII: Results of Varying Overrun Using a Twelve Per Cent S. S. Mix

Sample No.	Per cent over-run	Ave. mm of penetration	Melt-down in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	47	19.6	24	29.50	Heavy Chewy Smooth	29.00	Heavy Chewy Sl. Icy
2	56	20.3	29	29.25	Chewy Smooth	29.00	Chewy Sl. Icy
3	59	21.6	28	29.00	Icy Coarse	28.75	Icy Coarse
4	70	24.0	29	29.00	Icy Coarse	28.75	Icy Coarse
5	83	26.0	33	28.50	V. Light Coarse	28.00	V. Light Coarse
6	109	25.6	40	27.00	V. Light Coarse	27.00	V. Light Coarse
7							
8							

Penetrations in mm

1-	19, 20, 20	19.6	5-	26, 26, 26	26
2-	20, 20, 21	20.3	6-	25, 26, 26	25.6
3-	21, 22, 22	21.6	7-		
4-	24, 24, 24	24	8-		

Composition

Fat	12 %	Sugar	15 %
Serum solids	12 %	Stabilizer	.35 %
Total solids	40.27 %		

Ingredients per 100 pounds

Butter 85%	11.44 pounds
Milk 3.5%	65.15 "
Dry milk solids not fat	6.53 "
Sweeteners	. "
Cane sugar	10.50 "
Dextrose	2.71 "
Sweetose	3.36 "
Stabilizer - (Vesterine)	.35 "
Water	. "
	100.04 pounds

Table XIX: Results of Varying Overrun Using a Fourteen Per Cent S. S. Mix

Sample No.	Per cent over-run	Ave. mm of penet-ration	Melt-down im gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	49	13.0	12	28.00	V. Heavy Powdery	28.00	V. Heavy Powdery
2	52	14.3	16	28.50	Heavy Sl. Coarse	28.25	Heavy Sl. Coarse
3	59	15.3	19	28.75	Sl. Heavy	28.50	Sl. Heavy
4	62	15.6	30	29.50	Sl. Heavy	29.50	Sl. Heavy
5	66	18.0	22	29.00	V. Sl. Chewy Smooth	29.00	Sl. Sandy
6	70	23.0	33	28.75	V. Sl. Chewy Smooth	28.50	V. Sl. Chewy Smooth
7	88	25.0	18	28.50	Sl. Chewy Smooth	28.25	Smooth Sl. Coarse
8	93	24.6	33	28.50	Sl. Light Smooth	28.25	Sl. Light Sl. Coarse
9	109	26.3	34	28.00	V. Light	27.50	V. Light
10							

Penetrations in mm

1- 13, 13, 13 } 13

2- 14, 14, 15 } 14.3

3- 15, 15, 16 } 15.3

4- 15, 16, 16 } 15.6

5- 18, 18, 18 } 18

6- 22, 23, 24 } 23

7- 25, 25, 25 } 25

8- 24, 25, 25 } 24.6

9- 26, 26, 27 } 26.3

10-

Composition

Fat - - - - - - 12 % Sugar - - - 15 %
Serum solids - - 14 % Stabilizer - .35 %
Total solids - - 42.53 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - - -	11.80 pounds
Milk 3.5% - - - - - - - - - -	62.48 "
Dry milk solids not fat - - -	8.80 "
Sweeteners	
Cane sugar - - - - - - - -	10.50 "
Dextrose - - - - - -	2.71 "
Sweetose - - - - - -	3.36 "
Stabilizers	
(Vesterine)- - -	.35 "
Water - - - - - - - - - - - - - -	. "
	100.00 pounds

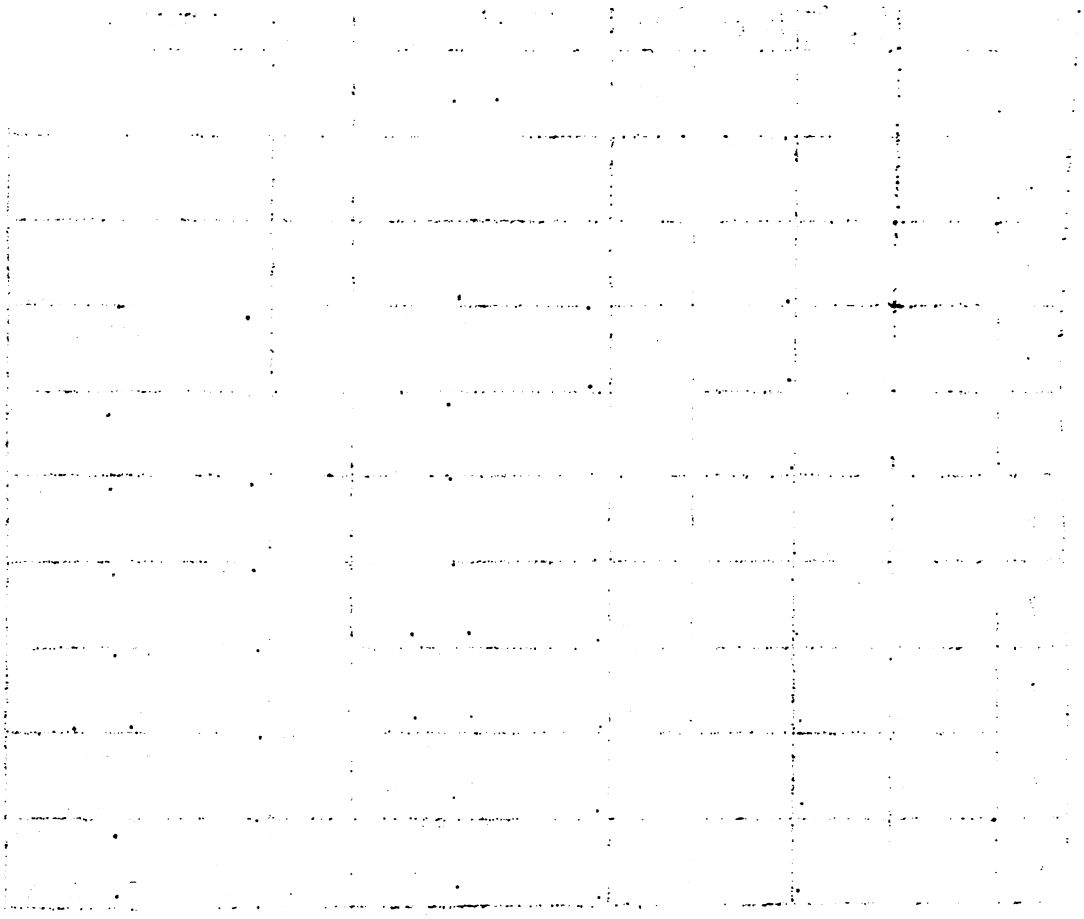


Table XX: Results of Varying Overrun Using Mix Containing Twelve Per Cent Cane Sugar

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	39	7.0	0	27.50	V. Heavy	27.25	Hard V. Sl. Icy Chalky
2	49	8.0	0	27.75	V. Heavy	27.50	Sl. Icy Hard
3	52	10.0	4	28.00	Heavy	27.75	Sl. Icy Heavy
4	66	12.0	7	28.50	Sl. Heavy	28.50	Sl. Icy Sl. Heavy
5	74	12.0	10	28.25	V. Sl. Icy	28.00	Icy
6	83	16.3	8	28.00	Sl. Coarse Sl. Light	27.75	Icy Sl. Light
7	93	14.6	14	27.50	Sl. Coarse Light	27.50	Icy Light
8	109	16.0	12	27.25	Coarse V. Light	27.00	V. Icy V. Light

Penetrations in mm

1-	7		5-	12	
	7	7		12	12
	7			12	
2-	8		6-	16	
	8	8		16	16.3
	8			17	
3-	10		7-	14	
	10	10		15	14.6
	10			15	
4-	12		8-	16	
	12	12		16	16
	12			16	

Composition

Fat - - - - - - - 12 % Sugar - - - 12 %
Serum solids- - 11 % Stabilizer- .35 %
Total solids - - 35.48 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	11.64	pounds
Milk 3.5% - - - - - - - -	60.28	"
Dry milk solids not fat -	5.94	"
Sweeteners		"
Cane sugar - - - - - -	12.00	"
- - -	.	"
- - -	.	"
Stabilizer -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	9.73	"
	100.00	pounds

Table XXI: Results of Varying Overrun Using Mix Containing Twelve Per Cent Sugar Equivalent With Dextrose

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	43	11.0	0	28.00	Coarse Heavy Powdery	28.00	Coarse Heavy Sl. Icy
2	49	12.0	0	28.25	Coarse Heavy Powdery	28.25	Coarse Heavy Sl. Icy
3	56	13.0	0	28.75	Powdery Sl, Coarse	28.75	V. Sl. Icy Sl. Coarse
4	62	10.0	0	29.25	Sl. Powdery	29.25	Sl. Powdery
5	83	20.0	0	29.00	Sl. Powdery	29.00	Sl. Powdery
6	93	21.0	0	28.75	Powdery Coarse	28.75	Powdery Coarse
7	103	23.0	0	27.50	Coarse V. Light Powdery	27.50	Coarse V. Light Powdery
8							

Penetrations in mm

1-	11		5-	20	
	11	11		20	20
	11			20	
2-	12		6-	21	
	12	12		21	21
	12			21	
3-	13		7-	23	
	13	13		23	23
	13			23	
4-	14		8-		
	14	14			
	14				

Composition

Fat - - - - - -	12 %	Sugar - - -	12 %
Serum solids- -	11 %	Stabilizer-	.35 %
Total solids - -	35.90 %		

Ingredients per 100 pounds

Butter 85% - - - - - - - -	11.64	pounds
Milk 3.5% - - - - - - -	60.28	"
Dry milk solids not fat -	5.94	"
Sweeteners		"
Cane sugar - - - - -	8.40	"
Dextrose - - -	4.34	"
- - -	.	"
Stabilizer -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	9.05	"
	100.00	pounds

Table XXII: Results of Varying Overrun Using Mix Containing Twelve Per Cent Sugar Equivalent With Frodex

Sample No.	Per cent over-run	Ave. mm of penetration	Melt-down in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	36	6.6	38	27.50	Heavy Smooth Sl. Gummy	27.50	Heavy Icy Gummy
2	47	8.3	48	28.00	Heavy Sl. Gummy	27.75	Heavy Gummy Icy
3	52	8.3	43	28.50	Heavy Sl. Gummy	28.25	Heavy Sl. Gummy
4	62	11.0	45	29.00	V. Smooth Sl. Gummy	28.50	V. Smooth Sl. Gummy
5	74	11.0	52	28.75	Smooth	28.00	Smooth
6	88	14.0	58	28.50	Smooth Sl. Light	27.75	Smooth Sl. Light
7	98	17.0	65	28.25	Light	27.50	Light
8							

Penetrations in mm

1-	6, 7, 7	6.6	5-	11, 11, 11	11
2-	8, 8, 9	8.3	6-	13, 14, 15	14
3-	8, 8, 9	8.3	7-	17, 17, 17	17
4-	11, 11, 11	11	8-		

Composition

Fat	12 %	Sugar	12 %
Serum solids	11 %	Stabilizer	.35 %
Total solids	38.96 %		

Ingredients per 100 pounds

Butter 85%	11.64 pounds
Milk 3.5%	60.28 "
Dry milk solids not fat	5.97 "
Sweeteners	"
Cane sugar	8.40 "
Frodex	7.35 "
	"
Stabilizer - (Vesterine)	.35 "
Water	6.01 "
	100.00 pounds

Table XXIII: Results of Varying Overrun Using Mix Containing Twelve Per Cent Sugar Equivalent With Sweetose

Sample No.	Per cent over-run	Ave. mm of penet-ration	Melt-down in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	41	7.0	6	28.50	Smooth Gummy V. Hard	28.00	Sl. Icy Gummy V. Hard
2	47	8.0	10	28.50	Smooth Gummy Hard	28.50	Gummy Hard
3	52	7.6	7	29.00	Sl. Light	29.00	Sl. Light
4	66	11.0	12	28.25	Light	28.00	Light
5	70	11.6	18	28.00	Smooth Sl. Light	27.75	Smooth Sl. Light
6	78	12.0	12	27.25	Smooth Light	27.25	Smooth Light
7	115	18.0	14	27.00	Smooth V. Light	27.00	Smooth V. Light
8							

Penetrations in mm

1-	7, 7, 7	7	5-	11, 12, 12	11.6
2-	8, 8, 8	8	6-	12, 12, 12	12
3-	7, 8, 8	7.6	7-	18, 18, 18	18
4-	11, 11, 11	11	8-		

Composition

Fat - - - - - - - 12 % Sugar - - - 12 %
Serum solids- - 11 % Stabilizer- .35 %
Total solids - - 36.29 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	11.64	pounds
Milk 3.5% - - - - - - - -	60.28	"
Dry milk solids not fat -	5.97	"
Sweeteners		"
Cane sugar - - - - -	8.40	"
Sweetose - - -	5.38	"
- - -	.	"
Stabilizer -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	7.98	"
	100.00	pounds

Table XXIV: Results of Varying Overrun Using Mix Containing Twelve Per Cent Sugar Equivalent With Puritose

Sample No.	Per cent over-run	Ave. mm of penetration	Melt-down in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	41	13.0	21	27.50	Heavy Hard Gummy	27.25	Heavy Hard Gummy
2	49	13.6	20	27.75	Heavy Hard Gummy	27.75	Heavy Hard Gummy
3	66	17.6	18	28.25	Sl. Heavy Gummy	28.00	Sl. Heavy Gummy
4	83	21.3	18	28.50	Sl. Gummy	28.50	Sl. Gummy
5	88	21.0	20	28.50	Sl. Icy Sl. Coarse	28.00	Sl. Icy Sl. Coarse
6	100	27.3	30	27.75	Icy Coarse Light	27.50	Icy Coarse Light
7	109	27.0	29	27.00	Icy Coarse V. Light	27.00	Icy Coarse V. Light
8							

Penetrations in mm

1-	13		5-	21	
	13	13		21	21
	13			21	
2-	13		6-	27	
	14	13.3		27	27.3
	14			28	
3-	17		7-	26	
	18	17.3		27	27
	18			28	
4-	21		8-		
	21	21.3			
	22				

Composition

Fat - - - - - - - 12 % Sugar - - - 12 %
Serum solids- - 11 % Stabilizer- .35 %
Total solids - - 37.72 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	11.64	pounds
Milk 3.5% - - - - - - - -	60.28	"
Dry milk solids not fat -	5.97	"
Sweeteners		"
Cane sugar - - - - -	8.40	"
Puritose - - -	7.20	"
- - -	.	"
Stabilizer -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	6.16	"
	100.00	pounds

Table XXV: Results of Varying Overrun Using Mix Containing Twelve Per Cent Sugar Equivalent With Super Sweet Syrup

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	39	11.3	5	27.00	Gummy Hard	27.00	Gummy Hard
2	43	11.0	0	27.25	Gummy Hard	27.25	Gummy Hard
3	52	16.3	0	27.75	Gummy Hard	27.50	Gummy Hard
4	66	16.0	0	28.25	Gummy Hard	28.00	Gummy Hard
5	74	17.6	0	28.50	Sl. Gummy	28.50	Sl. Gummy
6	88	20.6	0	27.75	Light	27.75	Light
7	109	25.0	0	27.25	V. Light	27.25	V. Light
8							

Penetrations in mm

1-	11, 11, 12	11.3	5-	17, 18, 18	17.6
2-	11, 11, 11	11	6-	20, 21, 21	20.6
3-	16, 17, 17	16.6	7-	25, 25, 25	25
4-	16, 16, 16	16	8-		

Composition

Fat - - - - - - - 12 % Sugar - - - 12 %
Serum solids- - 11 % Stabilizer- .35 %
Total solids - - 37.50 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	11.64	pounds
Milk 3.5% - - - - - - - -	60.28	"
Dry milk solids not fat -	5.97	"
Sweeteners		"
Cane sugar - - - - -	8.40	"
Super Sweet Syrup - -	7.20	"
- - -	.	"
Stabilizer -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	6.16	"
	100.00	pounds

Table XXVI: Results of Varying Overrun Using Mix Containing Fifteen Per Cent Cane Sugar

Sample No.	Per cent over-run	Ave. mm of penetration	Melt-down in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	37	7.3	5	28.50	V. Heavy Smooth	28.50	V. Heavy Smooth
2	43	7.3	2	28.75	V. Heavy Smooth	28.75	V. Heavy Smooth
3	56	10.0	2	28.00	Heavy Smooth	28.00	Heavy Smooth
4	59	10.3	16	29.25	Heavy Smooth	29.25	Heavy Smooth
5	66	12.0	14	29.75	Smooth Sl. Chewy	29.75	Smooth Sl. Chewy
6	83	13.6	12	29.50	Smooth Sl. Chewy	29.50	Smooth Sl. Chewy
7	100	15.0	20	29.00	Coarse Sl. Light	29.00	Coarse Light
8							

Penetrations in mm

1-	7, 7, 8	7.3	5-	12, 12, 12	12
2-	6, 8, 8	7.3	6-	13, 14, 14	13.6
3-	10, 10, 10	10	7-	15, 15, 15	15
4-	10, 10, 11	10.3	8-		

Composition

Fat	12 %	Sugar	15 %
Serum solids	11 %	Stabilizer	.35 %
Total solids	40.64 %		

Ingredients per 100 pounds

Butter 85%	11.64 pounds
Milk 3.5%	60.28 "
Dry milk solids not fat	5.97 "
Sweeteners	"
Cane sugar	15.00 "
	"
	"
Stabilizer -	
(Vesterine)	.35 "
Water	6.76 "
	100.00 pounds

Table XXVII: Results of Varying Overrun Using Mix Containing Fifteen Per Cent Sugar Equivalent With Dextrose

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	41	14.0	0	28.00	Sl. Icy Heavy	28.00	Sl. Icy Heavy
2	49	15.6	0	28.50	Smooth Sl. Heavy	28.50	Smooth Sl. Heavy
3	52	17.0	0	29.00	Smooth Sl. Heavy	29.00	Smooth Sl. Heavy
4	66	21.0	0	29.50	Smooth	29.50	Smooth
5	78	22.0	0	28.75	Smooth Sl. Coarse	28.75	Smooth Sl. Coarse
6	98	27.0	0	28.50	Sl. Coarse Light	28.50	Sl. Coarse Light
7							
8							

Penetrations in mm

1-	14		5-	22	
	14	14		22	22
	14			22	
2-	15		6-	27	
	16	15.6		27	27
	16			27	
3-	17		7-		
	17	17			
	17				
4-	21		8-		
	21	21			
	21				

Composition

Fat - - - - - - - 12 % Sugar - - - 15 %
Serum solids- - 11 % Stabilizer- .35 %
Total solids - - 39.01 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	11.69	pounds
Milk 3.5% - - - - - - - -	60.28	"
Dry milk solids not fat -	5.97	"
Sweeteners		"
Cane sugar - - - - -	10.50	"
Dextrose - - -	5.42	"
- - -	.	"
Stabilizer -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	5.89	"
	100.00	pounds

Table XXVIII: Results of Varying Overrun Using Mix Containing Fifteen Per Cent Sugar Equivalent With Frodex

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	41	11.0	35	29.00	Gummy Heavy	29.00	Gummy Heavy
2	43	10.3	42	29.00	Gummy Smooth V. Heavy	29.00	Gummy Smooth V. Heavy
3	56	11.6	58	29.25	Gummy Smooth V. Heavy	29.25	Gummy Smooth V. Heavy
4	66	12.3	55	29.50	Gummy Smooth	29.50	Gummy Smooth
5	83	15.0	60	29.75	Gummy Smooth	29.75	Gummy Smooth
6	93	16.6	72	29.75	Gummy Smooth	29.75	Gummy Smooth
7							
8							

Penetrations in mm

1- 11, 11, 11 } 11

2- 10, 10, 11 } 10.3

3- 11, 12, 12 } 11.6

4- 12, 12, 13 } 12.3

5- 15, 15, 15, 15 } 15

6- 16, 17, 17 } 16.6

7-

8-

Composition

Fat - - - - - - 12 % Sugar - - - 15 %

Serum solids- - 11 % Stabilizer- .35 %

Total solids - - 42.88 %

Ingredients per 100 pounds

Butter 85% - - - - - - - -	11 .64	pounds
Milk 3.5% - - - - - - - -	60.28	"
Dry milk solids not fat -	5.97	"
Sweeteners		"
Cane sugar - - - - -	10.50	"
Frodex - - -	9.18	"
- - -	.	"
Stabilizer -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	2.08	"
	100.00	pounds

Table XXIX: Results of Varying Overrun Using Mix Containing Fifteen Per Cent Sugar Equivalent With Sweetose

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	47	8.0	0	29.00	Gummy Smooth	28.00	Gummy V. Icy
2	52	9.3	5	29.00	Gummy Smooth	28.50	Gummy Icy
3	66	12.0	7	29.00	Gummy Smooth	29.00	Gummy Smooth
4	70	12.0	4	28.00	Sl. Coarse Sl. Gummy	28.00	Sl. Coarse Sl. Gummy
5	93	14.6	6	28.50	Smooth Chewy	28.50	Smooth Chewy
6	115	18.3	13	27.50	Smooth V. Light	27.50	Smooth V. Light
7							
8							

Penetrations in mm

1-	8		5-	14	
	8	8		15	14.6
	8			15	
2-	9		6-	18	
	9	9.3		18	18.3
	10			19	
3-	12		7-		
	12	12			
	12				
4-	12		8-		
	12	12			
	12				

Composition

Fat - - - - - - 12 % Sugar - - - 15 %
Serum solids- - 11 % Stabilizer- .35 %
Total solids - - 39.49 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	11.64	pounds
Milk 3.5% - - - - - - - -	60.28	"
Dry milk solids not fat -	5.97	"
Sweeteners		"
Cane sugar - - - - -	10.50	"
Sweetose - - -	6.72	"
- - -	.	"
Stabilizer -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	4.54	"
	100.00	pounds

Table XXX: Results of Varying Overrun Using Mix Containing Fifteen Per Cent Sugar Equivalent With Puritose

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	39	15.0	16	27.75	Gummy Heavy	27.75	Gummy Heavy
2	47	16.3	10	28.00	Gummy Heavy	28.00	Gummy Heavy
3	52	18.0	8	28.50	Gummy	28.50	Gummy
4	59	18.3	12	28.75	Gummy	28.75	Gummy
5	66	21.6	14	29.25	Gummy	29.25	Gummy
6	83	25.3	8	29.00	Light	29.00	Light
7	88	26.3	10	28.00	Light Coarse	28.00	Light Coarse
8	109	30.6	15	27.50	Light Coarse	27.50	Light Coarse

Penetrations in mm

1-	15, 15, 15	15	5-	21, 21, 22	21.3
2-	16, 16, 17	16.3	6-	25, 25, 26	25.3
3-	18, 18, 18	18	7-	26, 26, 27	26.3
4-	18, 19, 19	18.6	8-	30, 30, 32	30.6

Composition

Fat - - - - - - - 12 % Sugar - - - 15 %
Serum solids- - 11 % Stabilizer- .35 %
Total solids - - 41.27 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	11.64 pounds
Milk 3.5% - - - - - - - -	60.28 "
Dry milk solids not fat -	5.97 "
Sweeteners	"
Cane sugar - - - - - -	10.50 "
Puritose - - -	9.00 "
- - -	. "
Stabilizer -	
(Vesterine)- - -	.35 "
Water - - - - - - - - - -	2.26 "
	100.00 pounds

Table XXXI: Results of Varying Overrun Using Mix Containing Fifteen Per Cent Sugar Equivalent With Super Sweet Syrup

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	39	13.0	10	28.50	Gummy V. Heavy	28.00	Gummy V. Heavy
2	43	15.0	8	28.75	Gummy Heavy	28.50	Gummy Heavy
3	52	17.3	7	29.00	Sl. Gummy	28.75	Sl. Gummy Sl. Icy
4	66	19.3	6	29.25	Sl. Gummy Smooth	29.00	Sl. Gummy Smooth
5	78	24.0	4	28.50	Smooth Sl. Light	28.50	Smooth Sl. Light
6	93	27.3	2	28.00	Light	28.00	Light
7	109	29.0	3	27.75	V. Light	27.75	V. Light
8							

Penetrations in mm

1-	13		5-	24	
	13	13		24	24
	13			24	
2-	15		6-	27	
	15	15		27	27.3
	15			28	
3-	17		7-	28	
	17	17.3		29	29
	18			30	
4-	19		8-		
	19	19.3			
	20				

Composition

Fat	12 %	Sugar	15 %
Serum solids	11 %	Stabilizer	.35 %
Total solids	41.00 %		

Ingredients per 100 pounds

Butter 85%	11.64 pounds
Milk 3.5%	60.28 "
Dry milk solids not fat	5.97 "
Sweeteners	"
Cane sugar	10.50 "
Super Sweet Syrup	9.00 "
	. "
Stabilizer -	
(Vesterine)	.35 "
Water	2.26 "
	100.00 pounds

Table XXXII: Results of Varying Overrun Using Mix Containing Gelatin Stabilizer

Sample No.	Per cent overrun	Ave. mm of penetration	Melt-down in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	47	13.0	0	28.50	V. Smooth Sl. Heavy	28.00	Sl. Powdery Sl. Heavy
2	52	13.3	6	28.50	Smooth Sl. Chewy	28.25	Smooth Sl. Chewy
3	56	14.6	8	29.00	Chewy Smooth	29.00	Chewy Smooth
4	62	15.0	9	29.50	Sl. Chewy Smooth	29.25	Sl. Chewy V. Smooth
5	74	18.6	9	29.75	Sl. Chewy Smooth	29.50	Sl. Chewy Smooth
6	83	20.6	8	29.50	Smooth Sl. Light	29.00	Smooth Sl. Light
7	98	23.0	10	28.75	Light Smooth	28.50	Light Smooth
8	115	23.3	12	28.25	Sl. Coarse Light	28.00	Sl. Coarse Light

Penetrations in mm

1-	13		5-	18	
	13	13		19	18.6
	13			19	
2-	13		6-	20	
	13	13.3		21	20.6
	14			21	
3-	14		7-	23	
	15	14.6		23	23
	15			23	
4-	15		8-	23	
	15	15		23	23.3
	15			24	

Composition

Fat - - - - - -	12 %	Sugar - - -	15 %
Serum solids- -	11 %	Stabilizer-	.35 %
Total solids - -	38.90 %		

Ingredients per 100 pounds

Butter 85% - - - - - - - -	11.40	pounds
Milk 3.5% - - - - - - -	66.46	"
Dry milk solids not fat -	5.30	"
Sweeteners		"
Cane sugar - - - - -	10.50	"
Dextrose - - -	2.71	"
Sweetose - - -	3.36	"
Stabilizer -		
(Gelatin)- - -	.35	"
Water - - - - - - - - -	.	"
	100.08	pounds

Table XXXIII: Results of Varying Overrun Using Mix Containing Vesterine Stabilizer

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	41	10.0	0	28.50	Sl. Heavy Sl. Soggy	28.50	Sl. Heavy
2	47	11.0	3	29.00	Sl. Chewy Heavy	29.00	V. Chewy
3	52	13.3	5	29.00	Sl. Chewy Sl. Heavy	29.00	V. Chewy
4	70	15.3	6	28.50	Coarse	28.50	Sl. Chewy
5	74	16.6	2	28.00	Sl. Coarse	28.00	Coarse
6	88	24.0	7	27.75	Sl. Coarse	27.75	Sl. Coarse
7	100	23.0	8	27.50	V. Light Smooth	27.50	V. Light Sl. Coarse
8	109	25.3	10	27.50	V. Light Smooth	27.50	V. Light Sl. Coarse

Penetrations in mm

1-	10	10	5-	16	16.6
	10			17	
	10			17	
2-	11	11	6-	24	24
	11			24	
	11			24	
3-	13	13.3	7-	23	23
	13			23	
	14			23	
4-	15	15.3	8-	25	25.6
	15			25	
	16			26	

Composition

Fat - - - - - - 12 % Sugar - - - 15 %
Serum solids- - 11 % Stabilizer- .35 %
Total solids - - 38.85 %

Ingredients per 100 pounds

Butter 85% - - - - - - - -	11.40	pounds
Milk 3.5% - - - - - - - -	66.41	"
Dry milk solids not fat -	5.30	"
Sweeteners - - - - - - -	.	"
Cane sugar - - - - -	10.50	"
Dextrose - - -	2.71	"
Sweetose - - -	3.36	"
Stabilizer -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	.	"
	100.03	pounds

Table XXXIV: Results of Varying Overrun Using Mix Containing Carboxymethylcellulose Stabilizer

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	39	15.0	14	27.00	Smooth Powdery Heavy	27.00	Coarse Powdery
2	43	15.3	20	27.25	V. Chewy Heavy	27.00	Coarse Powdery
3	49	18.3	18	27.75	Chewy Heavy	27.50	Coarse Powdery
4	62	20.6	32	28.50	Sl. Chewy	28.00	Sl. Shewy V. Sl. Coarse
5	78	24.3	41	28.25	Sl. Chewy	28.00	Sl. Chewy V. Sl. Coarse
6	88	25.6	27	28.00	Sl Light Resistant	27.00	Sl. Light Resistant
7	98	28.3	29	27.50	Light	27.25	Light
8	109	29.6	41	27.25	V. Light	27.00	V. Light

Penetrations in mm

1- 15, 15, 15 → 15

2- 15, 15, 16 → 15.3

3- 18, 18, 19 → 18.3

4- 20, 21, 21 → 20.6

5- 24, 24, 25 → 24.3

6- 25, 26, 26 → 25.6

7- 28, 28, 29 → 28.3

8- 29, 30, 30 → 29.6

Composition

Fat - - - - - - - 12 % Sugar - - - 15 %

Serum solids- - 11 % Stabilizer- .15 %

Total solids - - 38.65 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	11.40 pounds
Milk 3.5% - - - - - - - -	66.46 "
Dry milk solids not fat -	5.30 "
Sweeteners - - - - - - -	. "
Cane sugar - - - - -	10.50 "
Dextrose - - -	2.71 "
Sweetose - - -	3.36 "
Stabilizer - (C. M. C.)- - -	.15 "
Water - - - - - - - - - -	. "
~~100.0~~ 99.88	pounds

Table XXXV: Results of Varying Overrun Using Mix Containing Dariloid Stabilizer

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	47	17.3	10	27.75	Hard Coarse	27.50	Hard Coarse
2	59	19.3	14	28.50	Smooth Sl. Hard	28.00	Smooth Sl. Hard
3	62	20.3	8	27.50	Sl. Coarse Sl. Hard	27.25	Sl. Coarse Sl. Hard
4	74	25.0	12	27.50	Sl. Coarse	27.25	Sl. Coarse
5	84	24.6	21	27.50	Sl. Coarse	27.25	Sl. Coarse
6	88	21.6	30	27.25	Sl. Coarse	27.25	Sl. Coarse
7	109	28.0	36	27.00	Coarse V. Light	27.00	Coarse V. Light
8							

Penetrations in mm

1-	17		5-	24	
	17	17.3		25	24.6
	18			25	
2-	19		6-	21	
	19	19.3		22	21.6
	20			22	
3-	20		7-	27	
	20	20.3		28	28
	21			29	
4-	25		8-		
	25	25			
	25				

Composition

Fat - - - - - - 12 % Sugar - - - 15 %
Serum solids- - 11 % Stabilizer- .22 %
Total solids - - 38.72 %

Ingredients per 100 pounds

Butter 85% - - - - - - - -	11.40	pounds
Milk 3.5% - - - - - - - -	66.46	"
Dry milk solids not fat -	5.30	"
Sweeteners		"
Cane sugar - - - - -	10.50	"
Dextrose - - -	2.71	"
Sweetose - - -	3.36	"
Stabilizer -		
(Dariloid)- - -	.22	"
Water - - - - - - - - -	.	"
~~100.0~~		pounds
99.95		

Table XXXVI: Results of Varying Overrun Using Mix Containing Polycoid Stabilizer

Sample No.	Per cent over-run	Ave. mm of penet-ration	Melt-down in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	39	9.3	7	28.00	Smooth Soggy	28.00	Smooth Soggy
2	47	10.0	8	28.25	Soggy Heavy	28.25	Soggy Heavy
3	52	15.3	5	28.50	Sl. Soggy	28.50	Sl. Soggy
4	56	15.6	18	28.50	V. Smooth	28.50	V. Smooth
5	66	18.0	10	28.00	Smooth	28.00	Smooth
6	70	18.6	33	28.00	V. Sl. Light	28.00	V. Sl. Light
7	88	24.3	34	27.50	Light Fluffy	27.50	Light Fluffy
8	93	25.6	49	27.00	Light Fluffy	27.00	Light Fluffy

Penetrations in mm

1-	9, 9, 10	9.3	5-	18, 18, 18	18
2-	10, 10, 10	10	6-	18, 19, 19	18.6
3-	15, 15, 16	15.3	7-	24, 24, 25	24.3
4-	15, 16, 16	15.6	8-	25, 26, 26	25.6

Composition

Fat - - - - - - - 12 % Sugar - - - 15 %
Serum solids- - 11 % Stabilizer- .35 %
Total solids - - 38.90 %

Ingredients per 100 pounds

Butter 85% - - - - - - - -	11.40	pounds
Milk 3.5% - - - - - - - -	66.46	"
Dry milk solids not fat -	5.30	"
Sweeteners - - - - - - -	.	"
Cane sugar - - - - -	10.50	"
Dextrose - - -	2.71	"
Sweetose - - -	3.36	"
Stabilizer - (Polycoid)- - -	.35	"
Water - - - - - - - - - -	.	"
	100.03	pounds

Table XXXVII: Results of Varying Overrun Using Mix Containing Pectin Stabilizer

Sample No.	Per cent over-run	Ave. mm of penetration	Melt-down in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	56	11.3	32	27.00	Coarse Sl. Icy	27.00	Icy
2	74	17.0	36	28.00	Sl. Hard	28.00	Sl. Hard
3	78	16.6	50	27.75	Hard	27.75	Hard
4	88	17.3	42	27.50	Hard	27.50	Hard
5	93	18.6	40	27.00	Coarse	26.50	Icy
6	98	21.0	49	27.00	Sl. Coarse	26.50	Icy
7	115	22.3	54	27.00	Sl. Coarse	26.50	Icy
8							

Penetrations in mm

1-	11		5-	18	
	11	11.3		19	18.6
	12			19	
2-	17		6-	21	
	17	17		21	21
	17			21	
3-	16		7-	22	
	17	16.6		22	22.3
	17			23	
4-	17		8-		
	17	17.3			
	18				

Composition

Fat	12 %	Sugar	15 %
Serum solids	11 %	Stabilizer	.15 %
Total solids	38.65 %		

Ingredients per 100 pounds

Butter 85%	11.40	pounds
Milk 3.5%	66.46	"
Dry milk solids not fat	5.30	"
Sweeteners		"
Cane sugar	10.50	"
Dextrose	2.71	"
Sweetose	3.36	"
Stabilizer - (Pectin)	.15	"
Water	.	"
~~100.0~~		pounds
99.88		

Table XXXVIII: Results of Varying Overrun Using Mix Containing Krageleen Stabilizer

Sample No.	Per cent over-run	Ave. mm of penet-ration	Melt-down in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	39	11.3	6	27.25	Heavy Powdery	27.00	Coarse
2	41	12.0	10	27.50	Heavy Powdery	27.00	Coarse
3	43	13.0	29	27.50	Heavy Powdery	27.25	Heavy Coarse
4	49	13.3	22	28.00	Sl. Chewy Sl. Powdery	27.25	Sl. Chewy Sl. Powdery
5	59	18.0	32	28.50	Sl. Chewy	28.00	Sl. Coarse
6	78	20.0	18	28.25	Sl. Light	27.50	Sl. Light
7	88	21.3	30	27.50	Light	27.50	Light
8	100	24.3	53	27.50	V. Light	27.00	V. Light

Penetrations in mm

1-	11		5-	18	
	11	11.3		18	18
	12			18	
2-	12		6-	20	
	12	12		20	20
	12			20	
3-	13		7-	21	
	13	13		21	21.3
	13			22	
4-	13		8-	24	
	13	13.4		24	24.3
	14			25	

Composition

Fat - - - - - - -	12 %	Sugar - - -	15 %
Serum solids- -	11 %	Stabilizer-	.15 %
Total solids - -	38.65 %		

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	11.40	pounds
Milk 3.5% - - - - - - - -	66.46	"
Dry milk solids not fat -	5.30	"
Sweeteners - - - - - - -	.	"
Cane sugar - - - - -	10.50	"
Dextrose - - -	2.71	"
Sweetose - - -	3.36	"
Stabilizer - (Krageleen)- - -	.15	"
Water - - - - - - - - - -	.	"
	~~100.0~~ 99.88	pounds

Table XXXIX: Results of Varying Overrun Using Mix Containing Gelox Stabilizer

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	41	9.3	2	28.50	Smooth V. Solid	28.00	Smooth V. Solid
2	49	11.0	12	28.75	Smooth V. Solid	28.25	Smooth V. Solid
3	59	12.3	19	29.00	Smooth	28.50	Smooth
4	74	15.3	10	27.75	Sl. Coarse Sl Light	27.25	Sl. Coarse Sl. Light
5	88	16.3	21	28.75	V. Light Dry	27.50	V. Light Dry
6	109	18.3	14	28.50	Sl. Spongy V. Light	27.50	Sl. Spongy V. Light
7							
8							

Penetrations in mm

1-	9		5-	16	
	9	9.3		16	16.3
	10			17	
2-	11		6-	18	
	11	11		18	18.3
	11			19	
3-	12		7-		
	12	12.3			
	13				
4-	15		8-		
	15	15.3			
	16				

Composition

Fat	12 %	Sugar	15 %
Serum solids	11 %	Stabilizer	.35 %
Total solids	38.85 %		

Ingredients per 100 pounds

Butter 85%	11.40	pounds
Milk 3.5%	66.46	"
Dry milk solids not fat	5.30	"
Sweeteners		"
Cane sugar	10.50	"
Dextrose	2.71	"
Sweetose	3.36	"
Stabilizer - (Gelox)	.30	"
Water	.	"
	100.03	pounds

Table XXXX: Results of Varying Overrun Using Mix Containing Eight Per Cent S. S. and Fifteen Per Cent Sugar Equivalent With Frodex

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	47	11.6	19	28.00	V. Heavy	27.50	V. Heavy Icy
2	52	12.3	20	28.25	V. Heavy	28.00	V. Heavy Icy
3	59	13.3	18	28.50	V. Heavy Sl. Gummy	28.25	V. Heavy Sl. Icy
4	66	15.0	30	28.75	Heavy Gummy	28.50	Heavy Gummy
5	74	18.6	28	29.00	Smooth Chewy	28.75	Smooth Chewy
6	93	18.0	21	28.00	Light Sl. Coarse	28.00	Light Coarse
7	115	22.0	22	27.00	V. Light Coarse	27.00	V. Light Coarse
8							

Penetrations in mm

1-	11		5-	18	
	12	11.6		18	18.6
	12			20	
2-	12		6-	18	
	12	12.3		18	18
	13			18	
3-	13		7-	22	
	13	13.3		22	22
	14			22	
4-	15		8-		
	15	15			
	15				

Composition

Fat - - - - - - - 12 % Sugar - - - 15 %
Serum solids- - 11 % Stabilizer- .35 %
Total solids - - 39.79 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	12.15	pounds
Milk 3.5% - - - - - - - -	48.45	"
Dry milk solids not fat -	3.90	"
Sweeteners		"
Cane sugar - - - - -	10.50	"
Frodex - - -	9.18	"
- - -	.	"
Stabilizer -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	15.47	"
	100.00	pounds

Table XXXXI:
Results of Varying Overrun Using Mix Containing Ten Per Cent S. S. and Fifteen Per Cent Sugar Equivalent With Frodex

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	49	14.0	46	28.50	Gummy V. Heavy	28.00	Gummy V. Heavy
2	59	14.0	50	28.75	Gummy Heavy	28.50	Gummy Heavy
3	70	17.0	60	29.25	Gummy Smooth	28.75	Gummy Smooth
4	74	18.0	58	29.50	Sl. Gummy Smooth	29.50	Sl. Gummy Smooth
5	83	18.6	53	28.00	Chewy Smooth	28.00	Chewy Smooth
6	100	20.0	67	27.75	Chewy Sl. Light	27.50	Chewy Sl. Coarse Sl. Light
7	115	21.6	69	27.25	Chewy V. Light	27.00	Chewy Sl. Coarse V. Light
8							

Penetrations in mm

1-	14		5-	18	
	14	14		19	18.6
	14			19	
2-	14		6-	20	
	14	14		20	20
	14			20	
3-	17		7-	21	
	17	17		22	21.6
	17			22	
4-	18		8-		
	18	18			
	18				

Composition

Fat	12 %	Sugar	15 %
Serum solids	10 %	Stabilizer	.35 %
Total solids	41.83 %		

Ingredients per 100 pounds

Butter 85%	11.80	pounds
Milk 3.5%	60.00	"
Dry milk solids not fat	4.80	"
Sweeteners	.	"
Cane sugar	10.50	"
Frodex	9.18	"
	.	"
Stabilizer - (Vesterine)	.35	"
Water	3.37	"
	100.00	pounds

Table XXXXII: Results of Varying Overrun

Using Mix Containing Twelve Per Cent S. S. and Fifteen Per Cent Sugar Equivalent With Frodex

Sample No.	Per cent over-run	Ave. mm of penet-ration	Melt-down in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	43	12.3	35	28.00	V. Gummy V. Heavy	28.00	V. Gummy V. Heavy
2	47	12.3	34	28.50	V. Gummy V. Heavy	28.50	V. Gummy V. Heavy
3	59	13.3	35	29.00	Gummy	29.00	Gummy
4	78	18.6	47	29.50	Gummy	29.50	Gummy
5	93	20.0	37	28.50	Gummy Sl. Light	28.00	Gummy Sl. Light
6	100.	18.0	38	27.75	Chewy Sl. Light	27.75	Chewy Sl. Light
7							
8							

Penetrations in mm

1- 12, 12, 13 } 12.3

2- 12, 12, 13 } 12.3

3- 13, 13, 14 } 13.3

4- 18, 19, 19 } 18.6

5- 20, 20, 20 } 20

6- 18, 18, 18 } 18

7-

8-

Composition

Fat - - - - - - - 12 % Sugar - - - 15 %

Serum solids- - 12 % Stabilizer- .35 %

Total solids - - 44.07 %

Ingredients per 100 pounds

Butter 85% - - - - - - - - -	11.69	pounds
Milk 3.5% - - - - - - - -	61.25	"
Dry milk solids not fat -	7.03	"
Sweeteners - - - - - - - -	.	"
Cane sugar - - - - -	10.50	"
Frodex - - -	9.18	"
- - -	.	"
Stabilizer -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	.	"
	100.00	pounds

Table XXXXIII:
Results of Varying Overrun Using Mix Containing

Fourteen Per Cent S. S. and Fifteen Per Cent

Sugar Equivalent With Frodex

Sample No.	Per cent overrun	Ave. mm of penetration	Meltdown in gms	Judging body- fresh		Judging body- 2 wks old	
				Score	Description	Score	Description
1	41	13.0	30	28.00	V. Heavy Chewy	27.50	V. Heavy Chewy Sl. Icy
2	49	15.3	50	28.50	Heavy Chewy	28.00	Heavy Chewy Sl. Icy
3	62	17.6	57	28.50	Chewy Smooth	28.25	Chewy Smooth
4	66	17.3	60	29.00	Gummy Smooth	29.00	Gummy Smooth
5	74	17.0	49	29.50	Gummy Smooth	29.50	Gummy Smooth
6	83	20.0	52	29.50	Gummy Smooth	29.25	Gummy Sl. Coarse
7	100	20.0	46	29.00	Chewy Smooth Sl. Light	28.50	Chewy Smooth Sl. Light
8							

Penetrations in mm

1-	13 13 13	13	5-	17 17 17	17
2-	15 15 16	15.3	6-	20 20 20	20
3-	17 18 18	17.6	7-	20 20 20	20
4-	17 17 18	17.3	8-		

Composition

Fat ------- 12 % Sugar --- 15 %
Serum solids- - 14 % Stabilizer- .35 %
Total solids -- 46.28 %

Ingredients per 100 pounds

Butter 85% - - - - - - - -	11.69	pounds
Milk 3.5% - - - - - - - -	59.13	"
Dry milk solids not fat -	9.15	"
Sweeteners		"
Cane sugar - - - - - -	10.50	"
Frodex - - -	9.18	"
- - -	.	"
Stabiliser -		
(Vesterine)- - -	.35	"
Water - - - - - - - - - -	.	"
	100.0	pounds

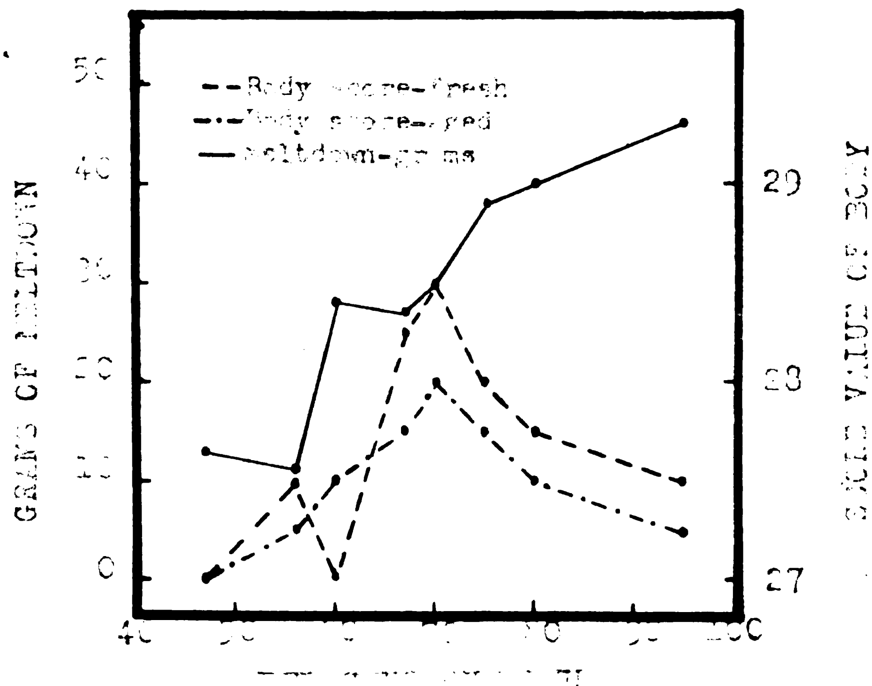


Fig. [illegible] The effect of eight per cent [illegible] fat and [illegible] per cent overrun upon the [illegible] of ice cream and the rate of [illegible].

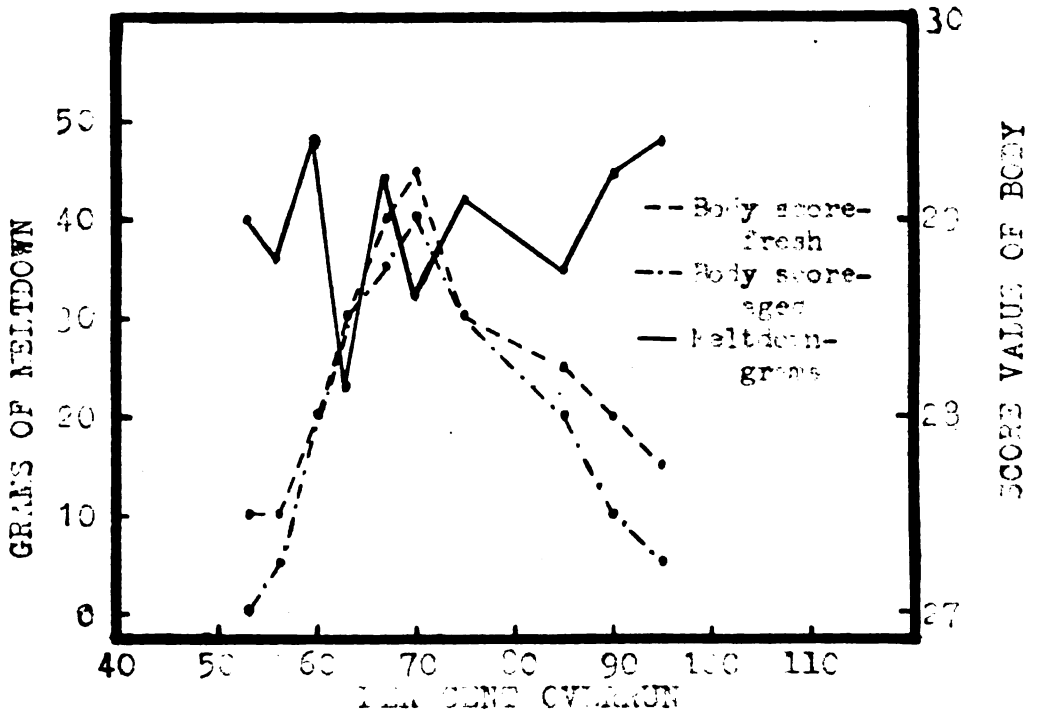
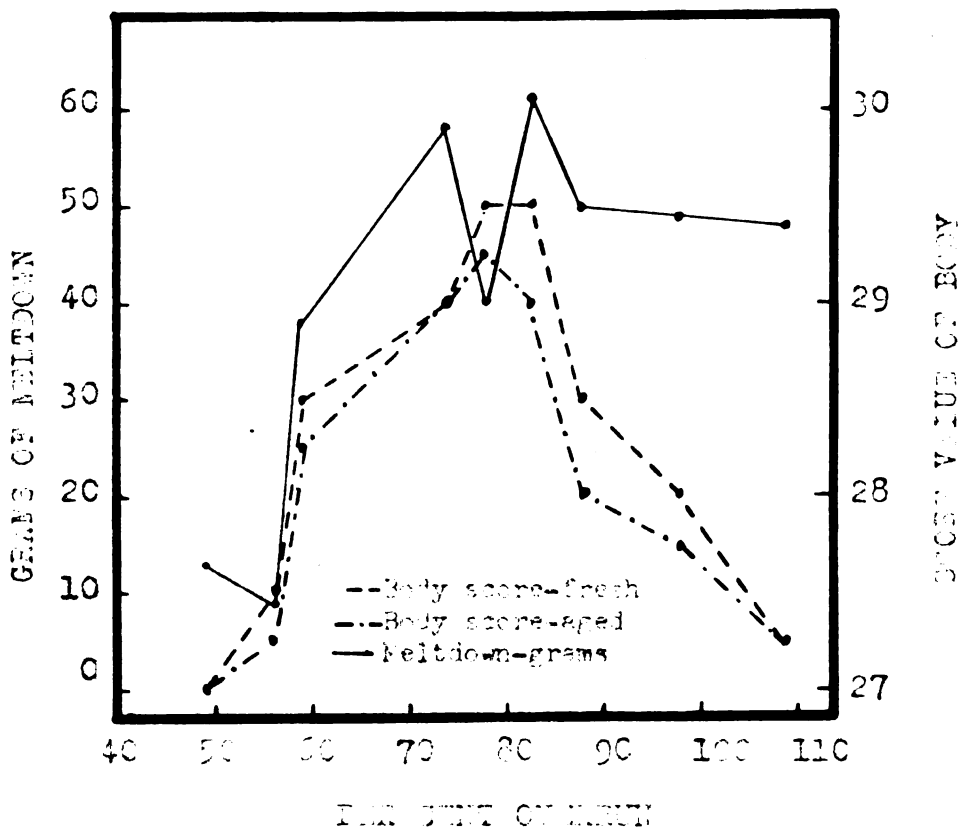


Fig. 2. The effect of 10 per cent milk-solids-not-fat and per cent overrun upon the body score of ice cream and the rate of meltdown.


60
50
40
30
20
10
0
30
29
28
27
40
50
60
70
80
90
100
110
--Body score-fresh
-.-Body score-aged
—Meltdown-grams

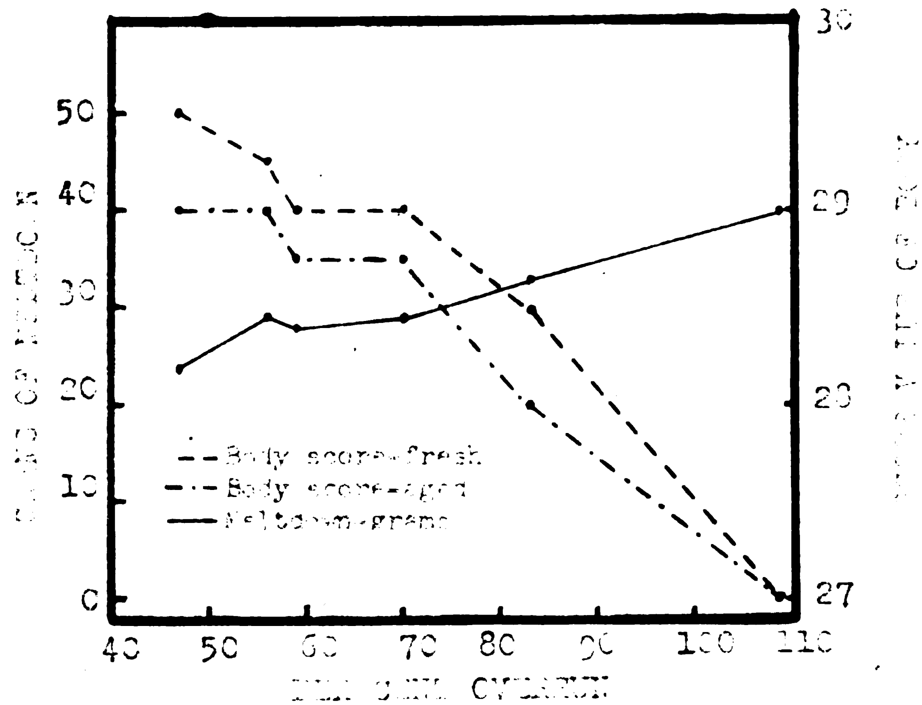
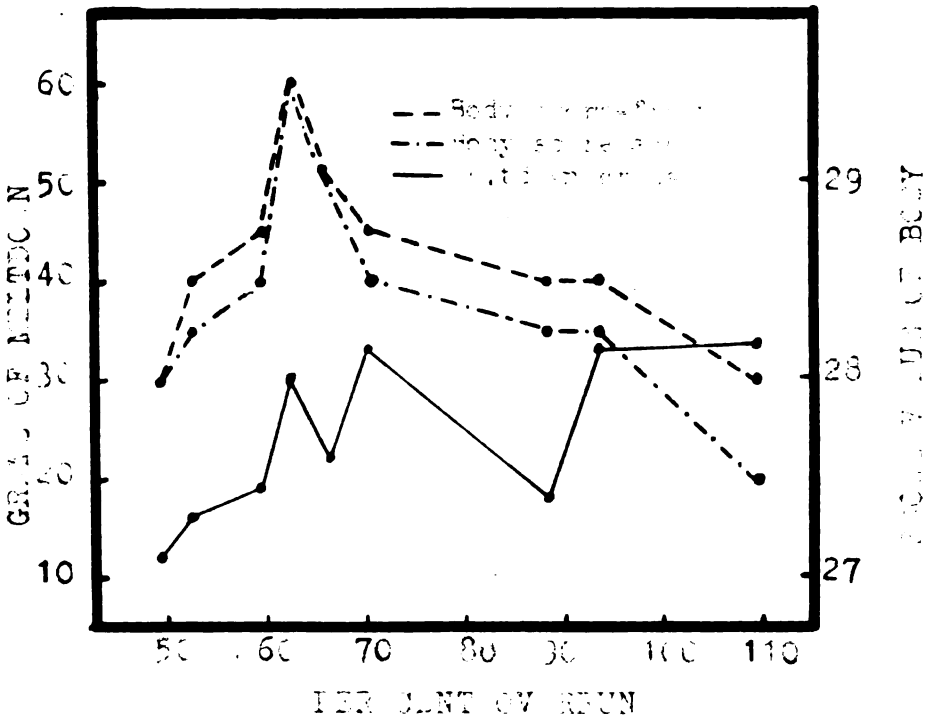
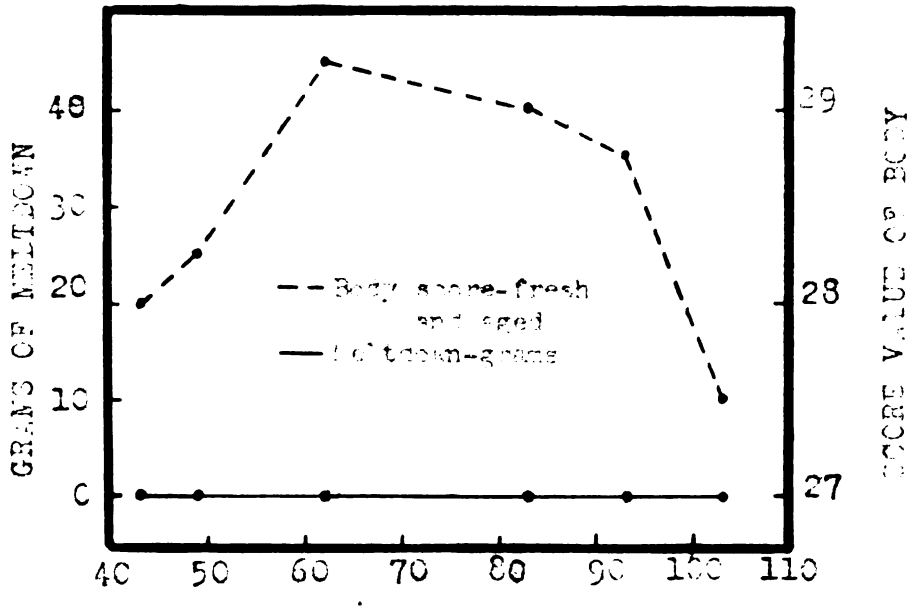
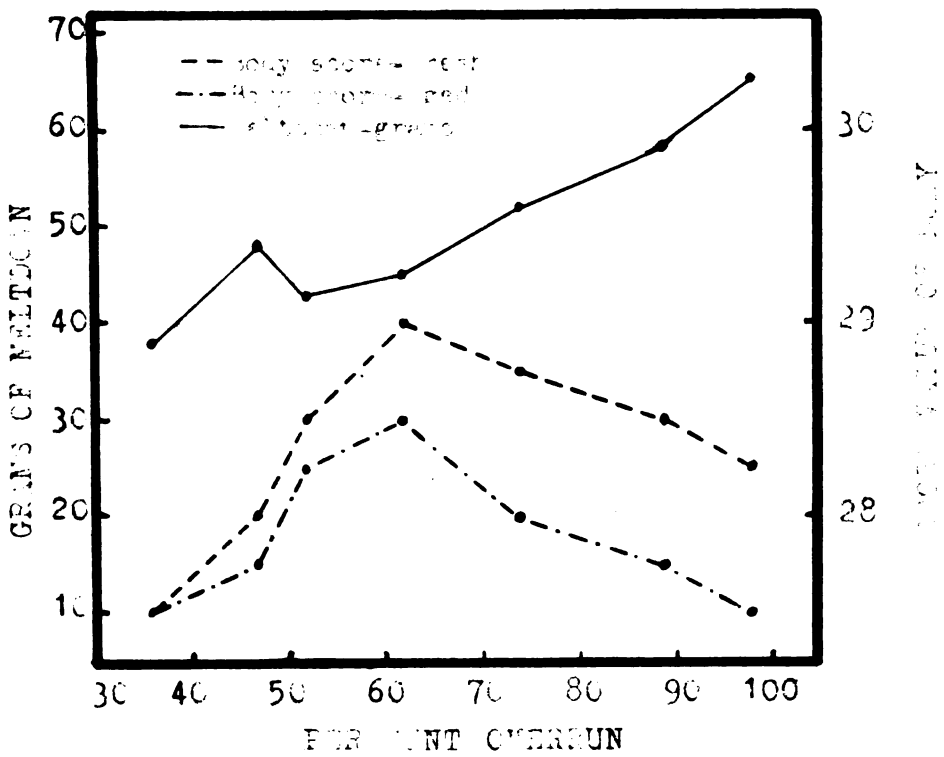


Fig. 4. The effect of [illegible] per cent [illegible] and per cent overrun on the body score of [illegible] and the [illegible] of meltdown.


60
50
40
30
20
10
29
28
27
50
60
70
80
90
100
110

PER CENT


GRAMS OF NITROGEN
40
30
20
10
0
29
28
27
40
50
60
70
80
90
100
110
PER CENT OVERRUN


70
60
50
40
30
20
10
30
20
28
30 40 50 60 70 80 90 100
PER CENT OVERRUN

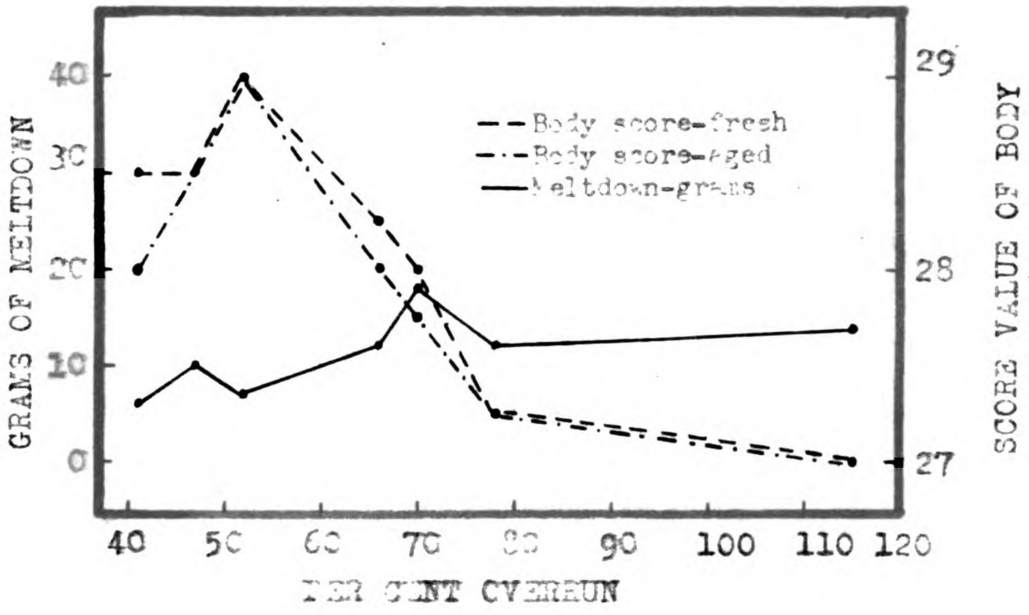


Fig. 9. The effect of 12 per cent sugar equivalent with 30 per cent Sweetose replacement and per cent overrun upon the body score of ice cream and the rate of meltdown.

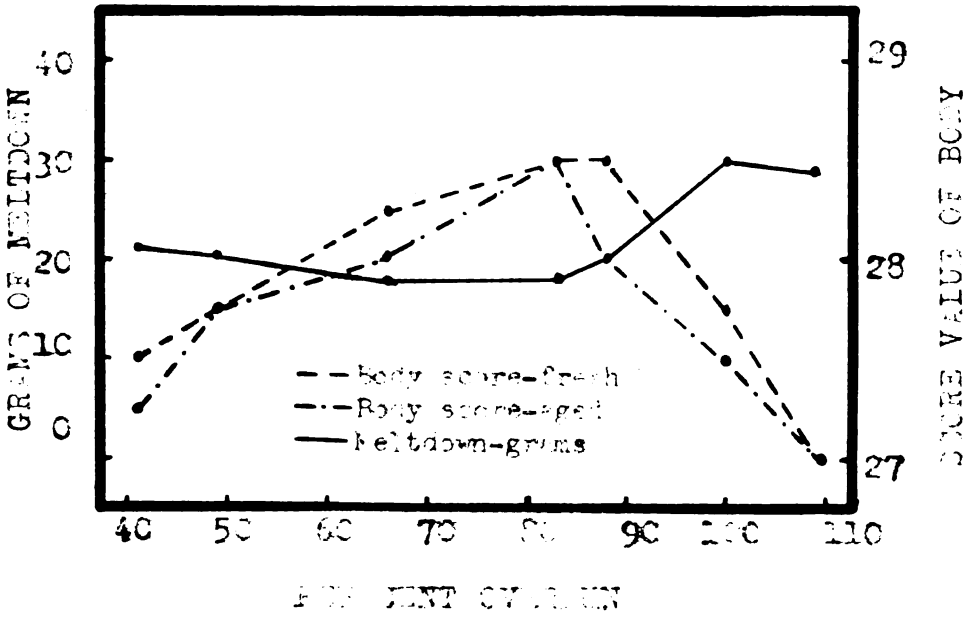
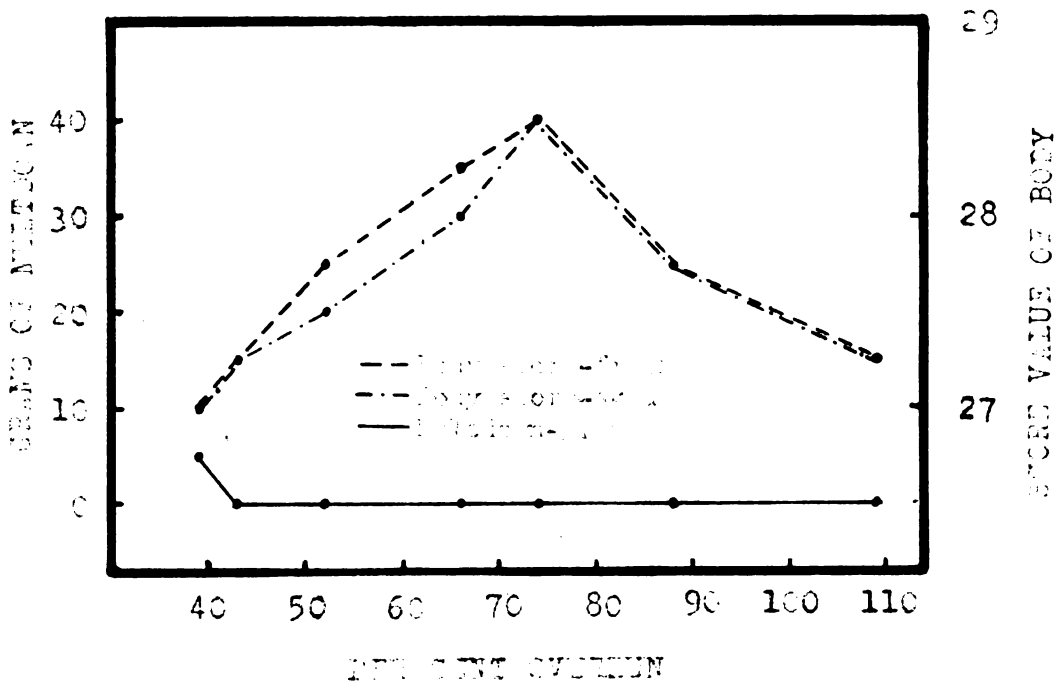


Fig. 10. The effect of 12 per cent sugar equivalent with [illegible] per cent xylitose replacement and per cent overrun upon the body score of ice cream and the rate of meltdown.


40
30
20
10
0
29
28
27
40
50
60
70
80
90
100
110

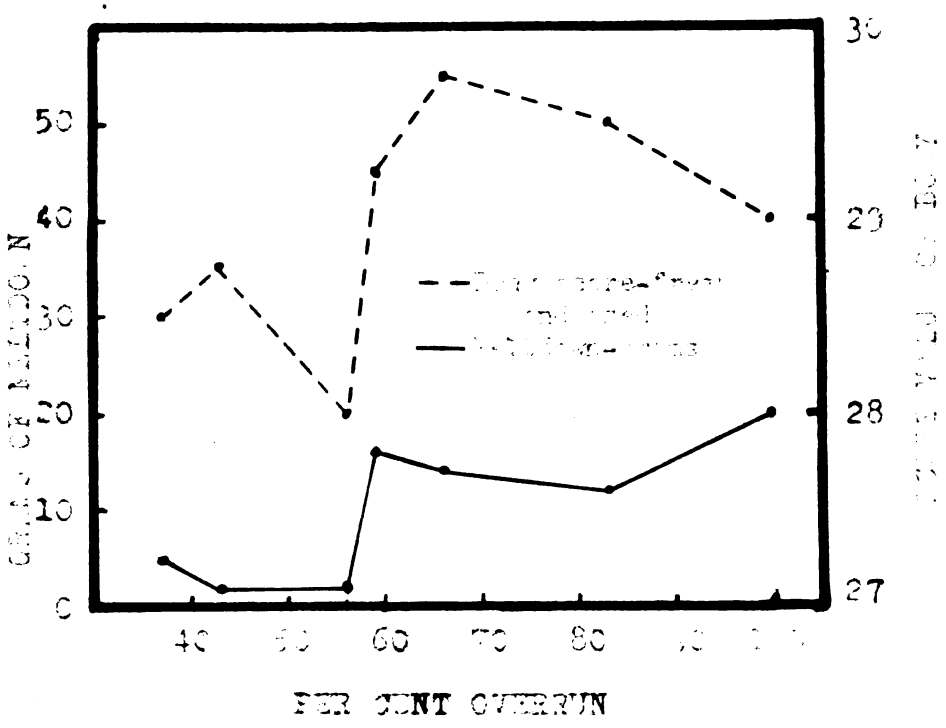
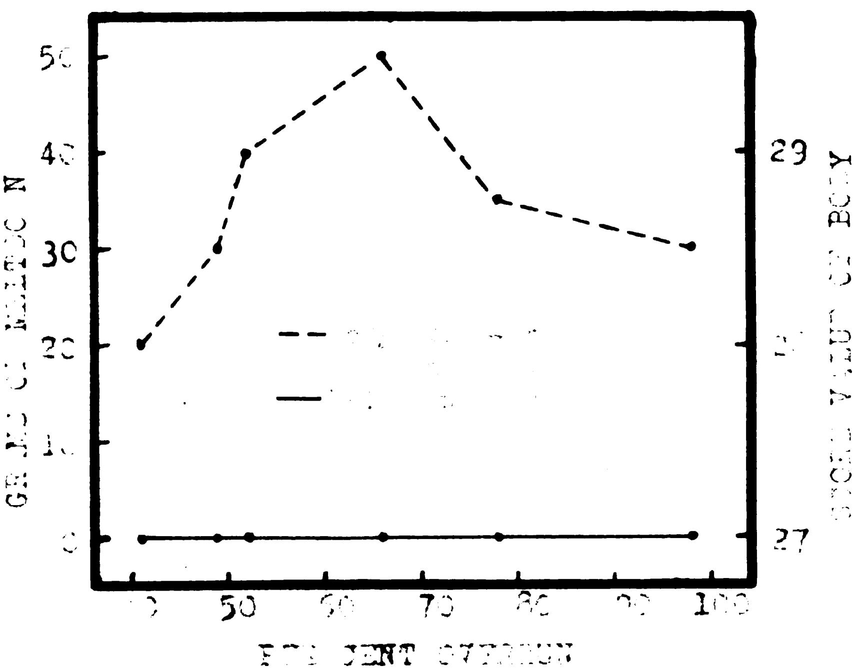
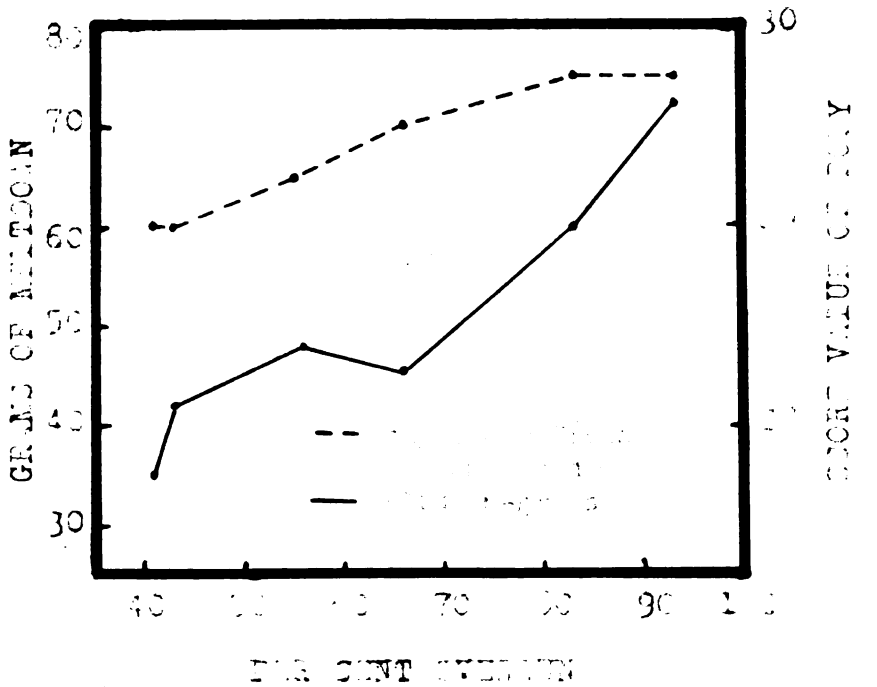
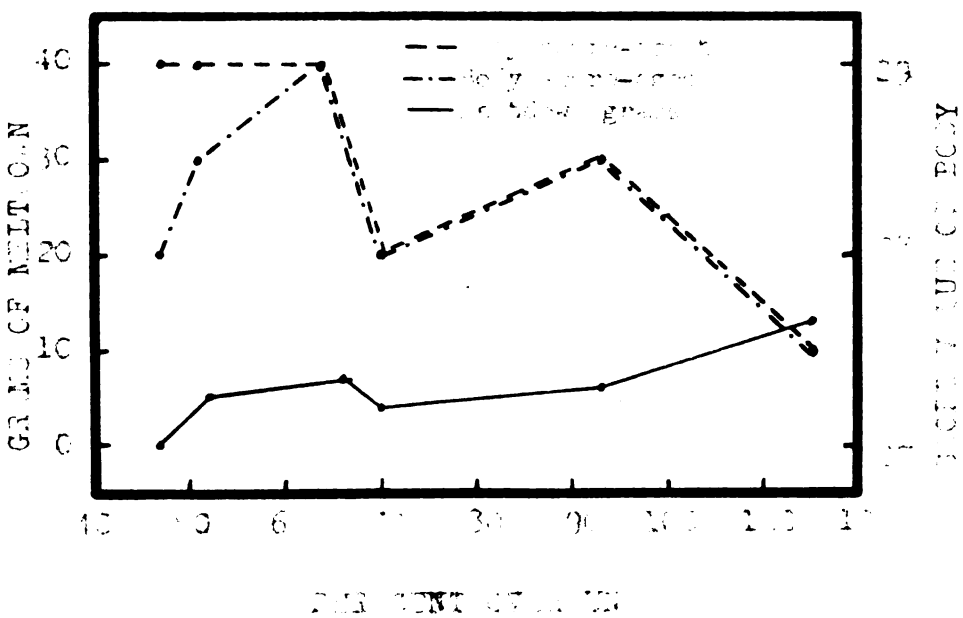


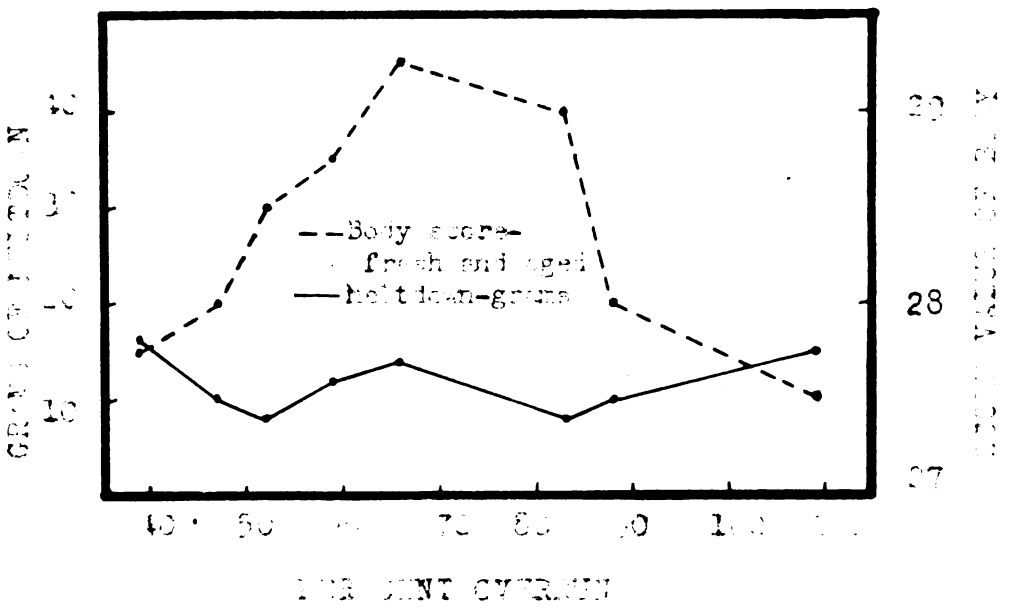
Fig. 1. The effect of [illegible] per cent overrun and [illegible] upon the [illegible] of ice cream on the [illegible].

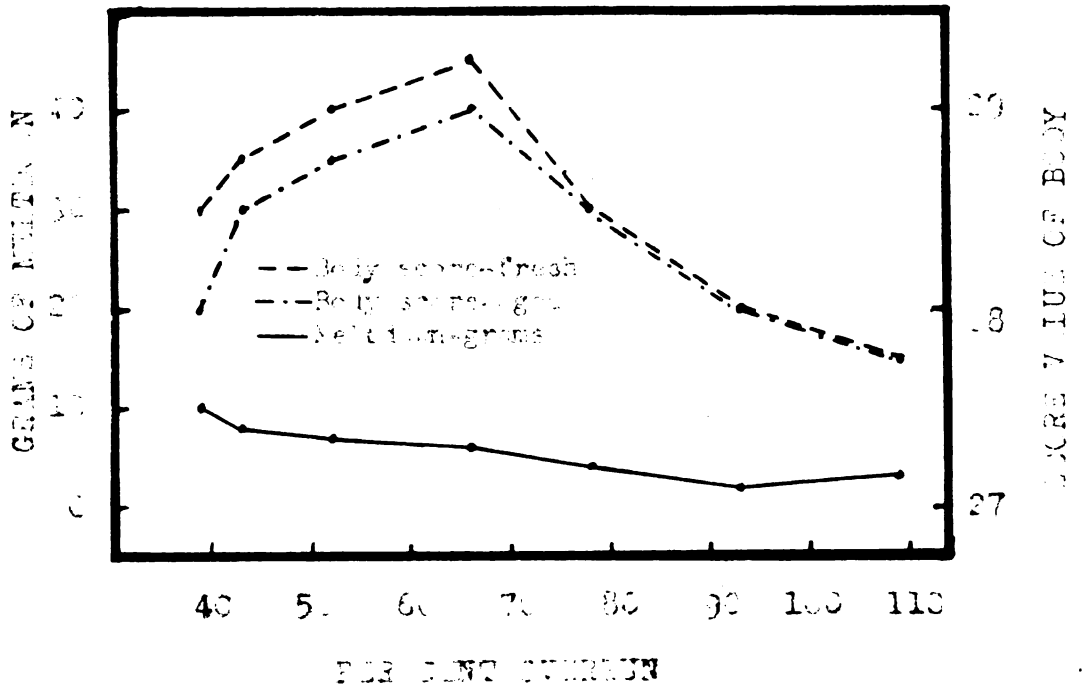


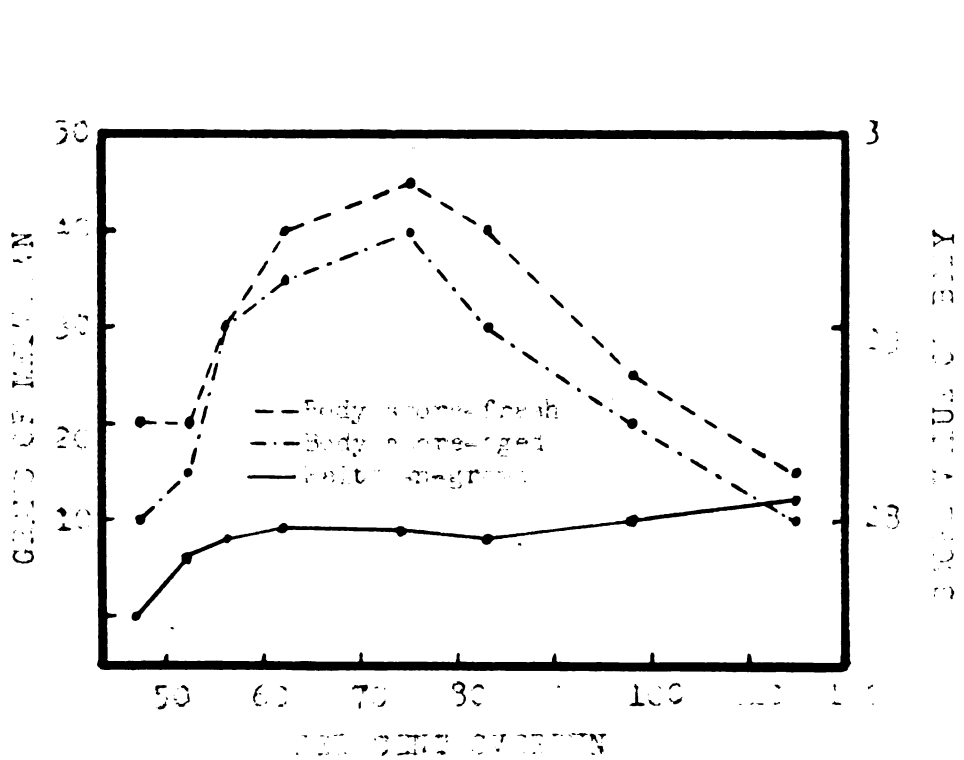
[illegible] The effect [illegible] per cent sugar equivalent with [illegible] per cent [illegible] and [illegible] per cent overrun upon [illegible] body score [illegible] the [illegible] melt [illegible].

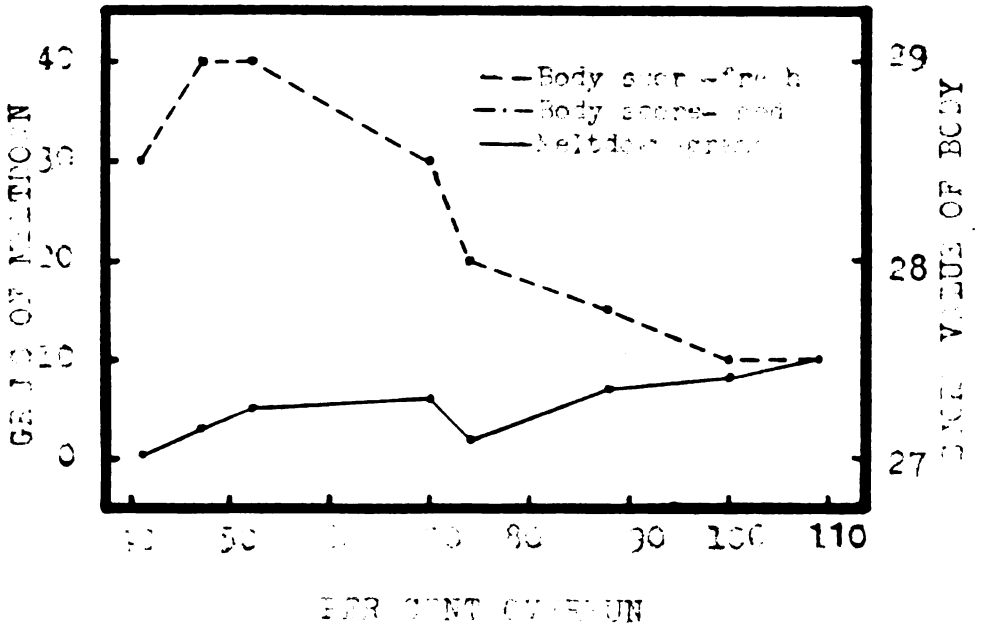

80
70
60
50
40
30
30
40
70
90

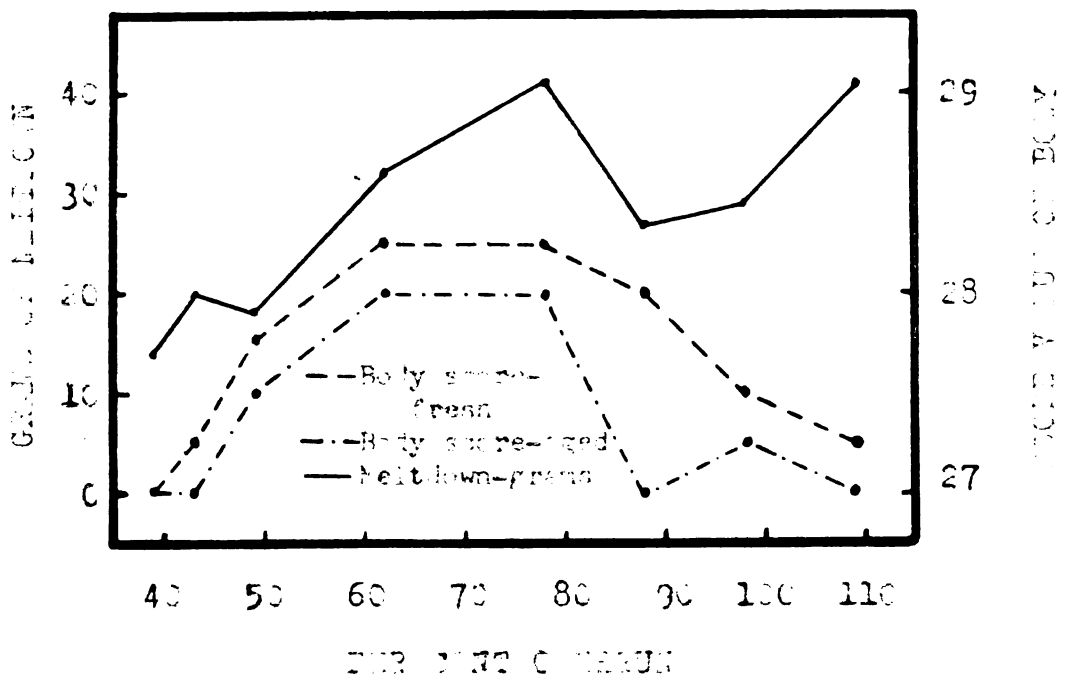

40
30
20
10
0

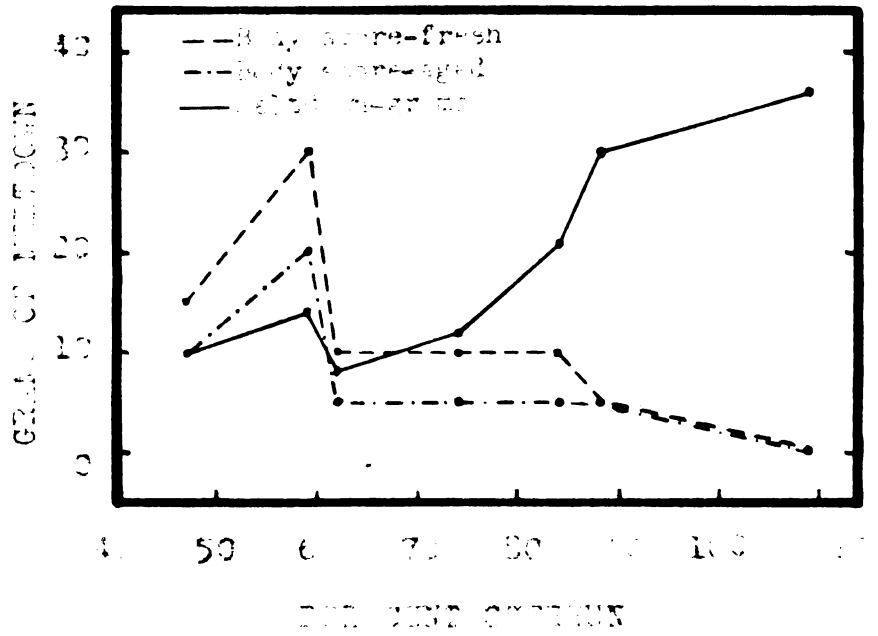

Body score-
fresh and aged
Moldboard-grams
28

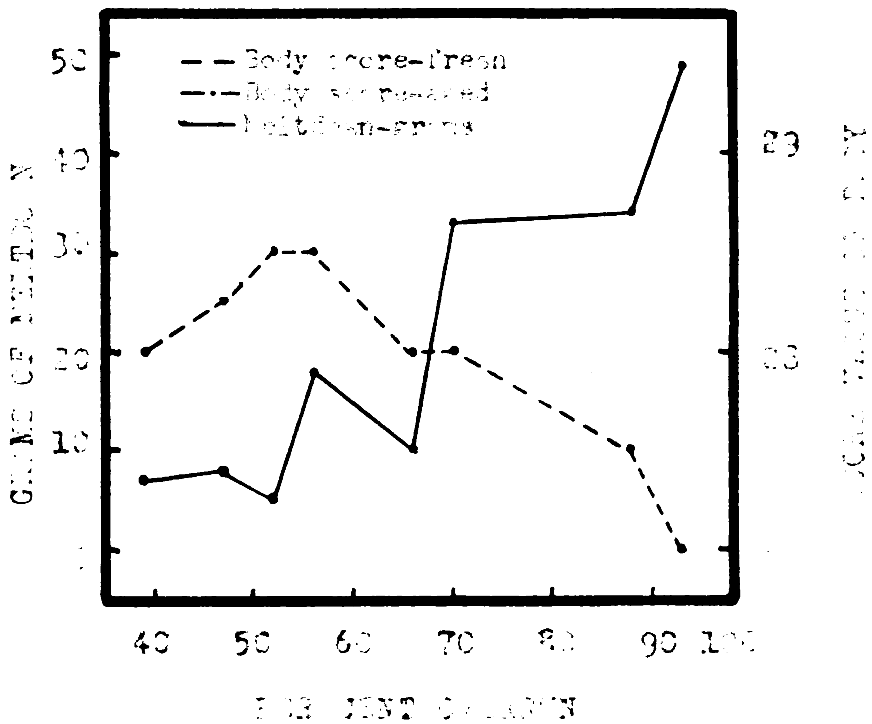

40
5.
6(
7(
80
90
100
110
27
.8

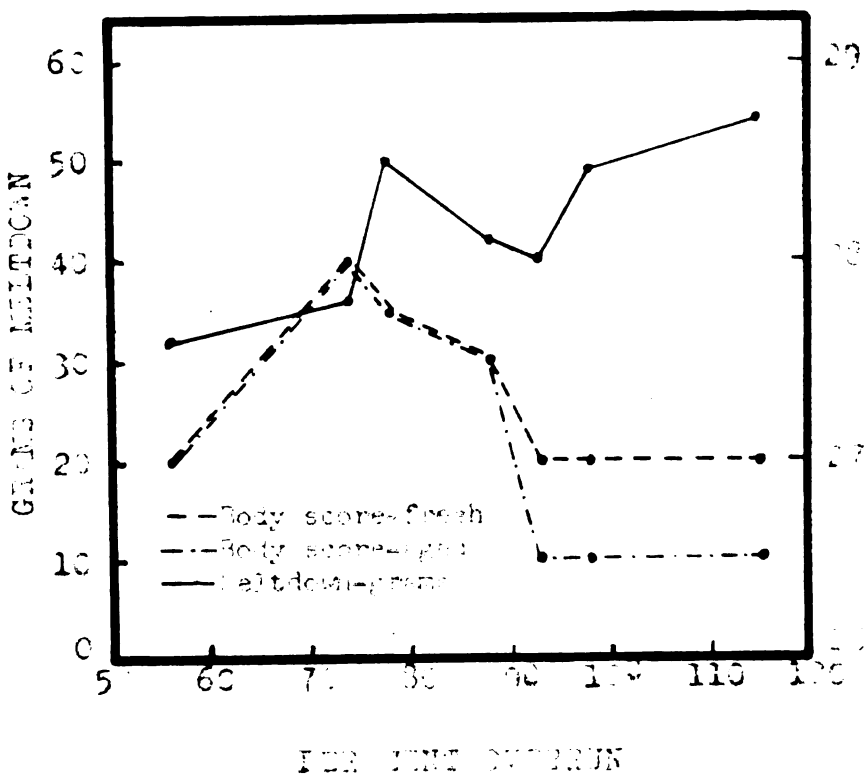

30
3
50
60
70
80
100


40
30
20
10
0
29
28
27
110

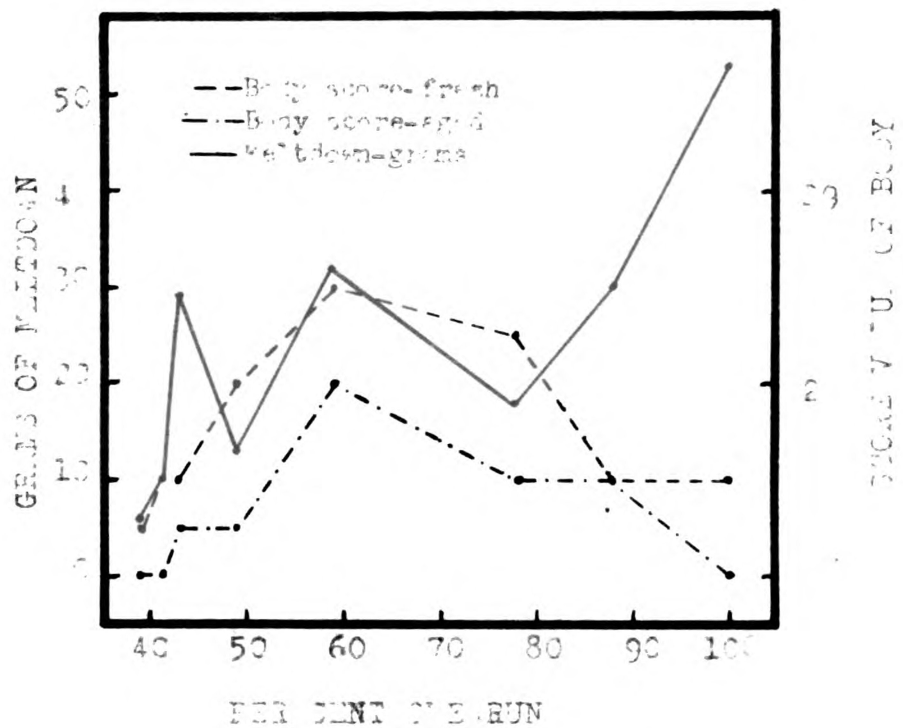

40
30
20
10
0
29
28
27
40
50
60
70
80
90
100
110
Body temperature
Body temperature
Meltdown-grams


40
30
20
10
0
50

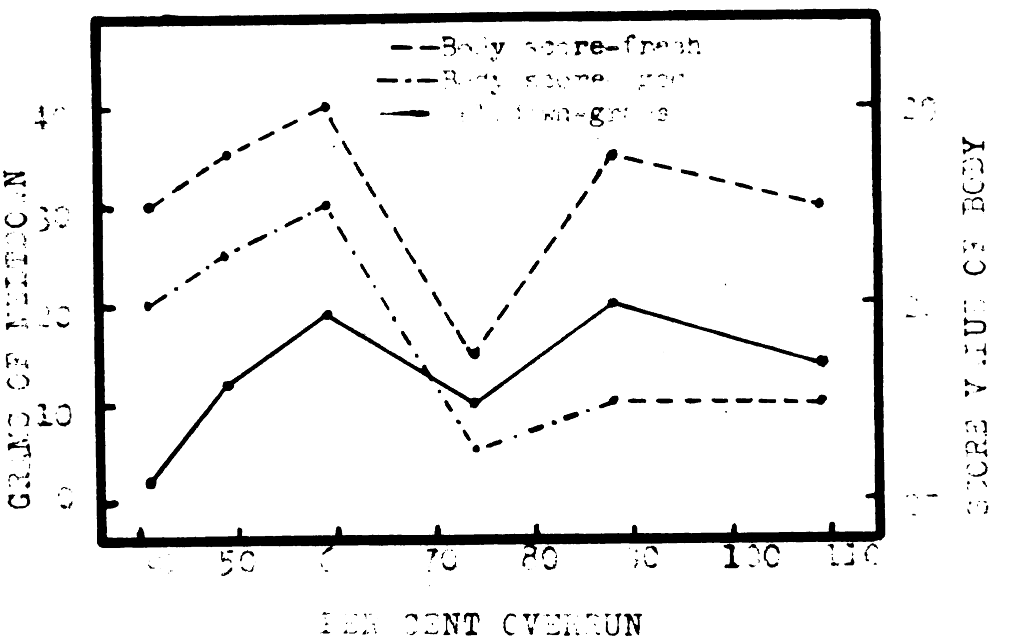

50
40
20
10
40
50
60
70
90

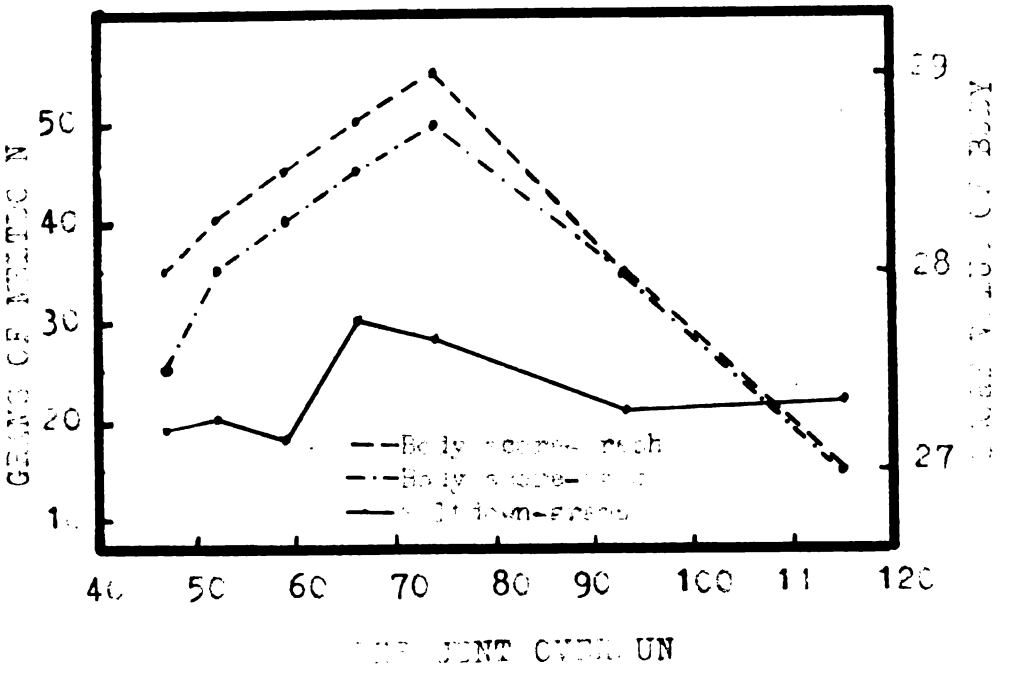


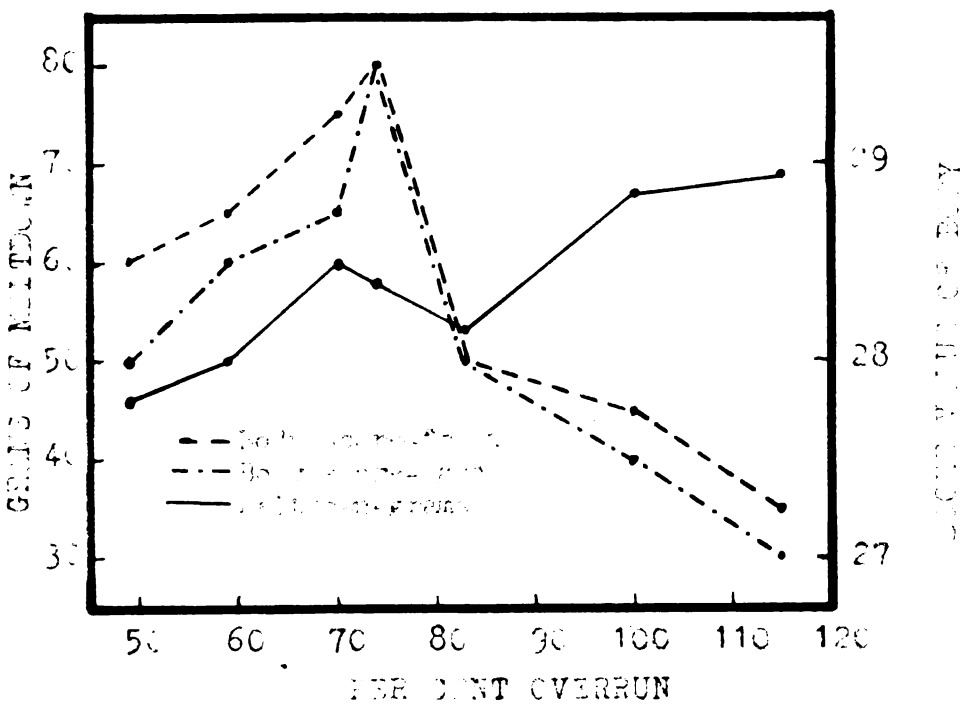
Body score-fresh
50
110
0

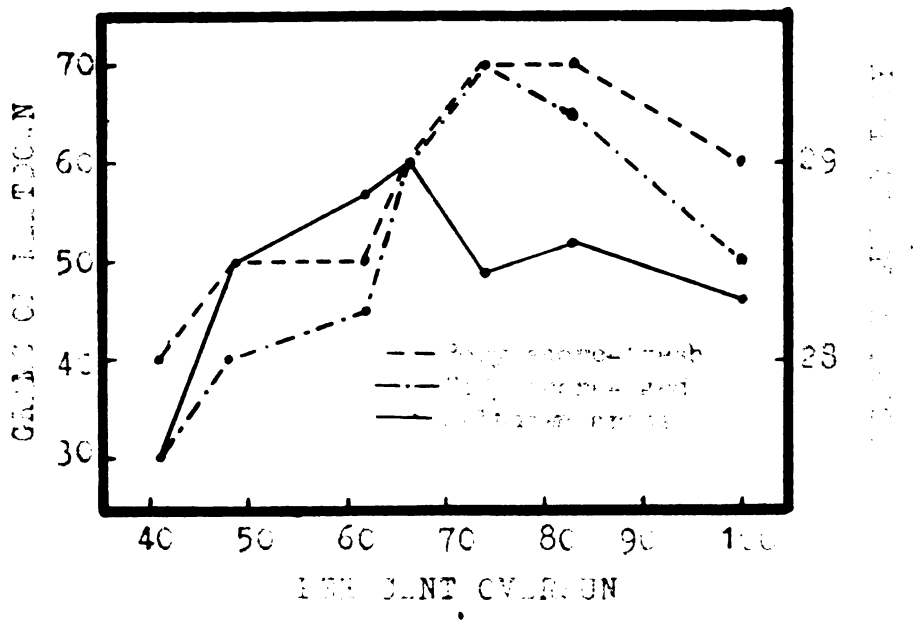


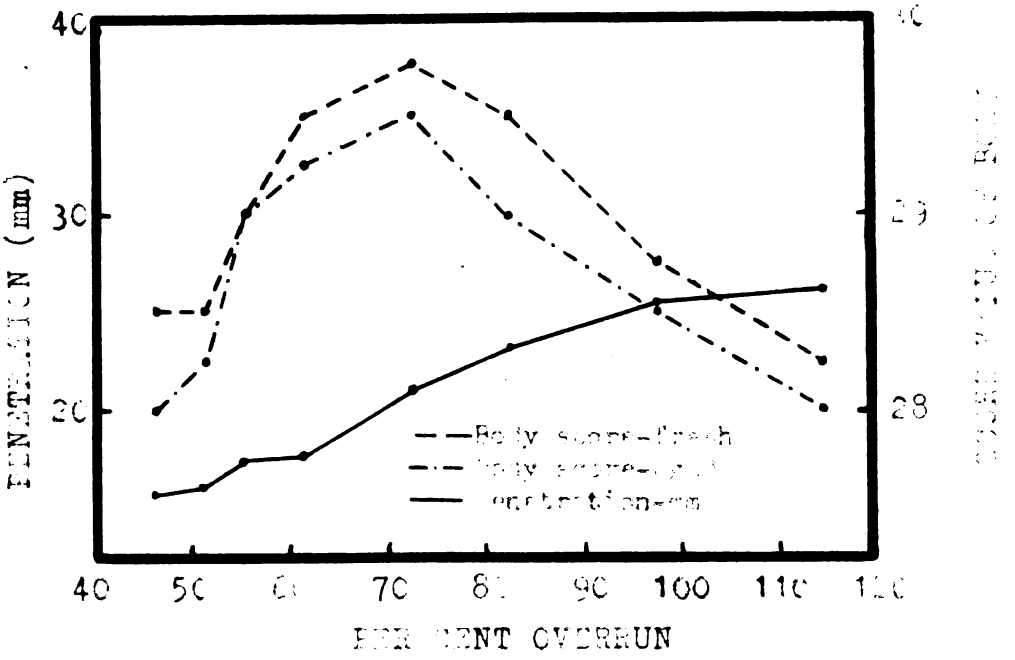
50
2
40
50
60
70
80
90

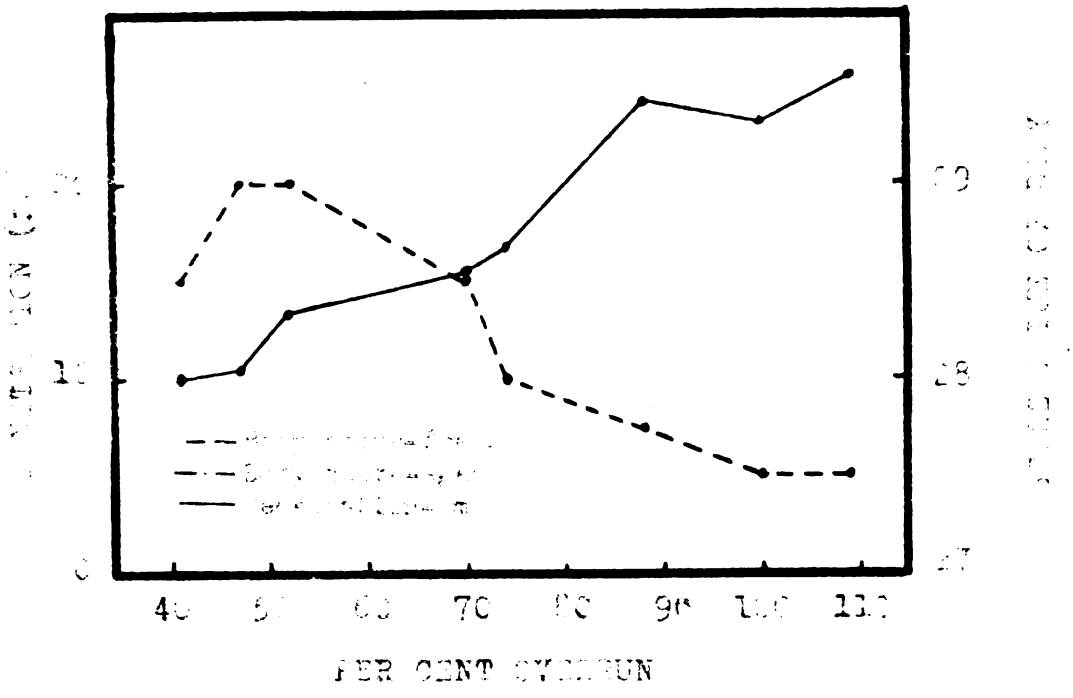

50
70
80
100
10

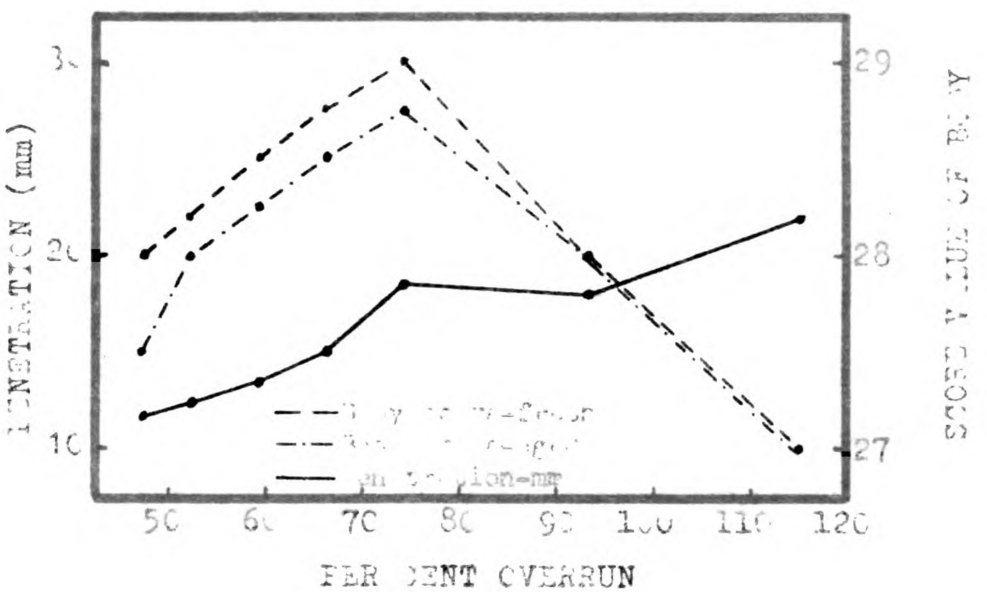

50
40
30
20
28
27
40
50
60
70
80
90
100
120


80
7
6
5
4
3
29
28
27
50
60
70
80
90
100
110
120
PER CENT OVERRUN


70
60
50
40
30
40
50
60
70
80
90
100


40
30
20
28
40
50
70
100
110
PER CENT OVERRUN


PER CENT CYCLOPUN


PENETRATION (mm)
29
28
27
50
70
PER CENT OVERRUN