CERTAIN USES OF A WHITE SAUCE MIX

by

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Diploma of Home Science,
University of Otago, New Zealand, 1956

A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Institutional Management

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1961

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INTRODUCTION

Convenience foods have preparation completed in varying degrees and include almost every item on the menu. Extensive use of frozen precooked entrees, cake and quick-bread mixes, canned and dehydrated foods, and instant beverages already has established a trend in the food service industry. Convenience foods which are more than original products or new schemes of food preparation, are part of a movement toward labor-saving, cost-saving operations aimed at maintaining consistent high quality.

Commercially made mixes have become increasingly popular in the last decade. When preparation time, cost, and acceptability were determined in a study based on household amounts, Asp et al. (1957) obtained better products more often with mixes than with individual ingredients. Lowe (1958) pointed out some of the advantages offered by a mix as (1) economy of time in preparation and possibly of storage space, (2) acceptability and palatability of the product, and (3) comparison of cost favorable with that of the homemade product.

Until recently the use of mixes has not enjoyed the same popularity in food services as in households. Problems, such as the lack of certain pieces of equipment, the absence of properly trained staff, and insufficient preparation time, may be minimized through the introduction of mixes and other convenience foods. West and Wood (1955) stated that "the use of prepared mixes in quantity food production is conducive to the economical utilization of the worker's time and effort, and to the standardization

of products."

Labor-saving devices and convenience foods are not as readily available in New Zealand as in the United States. However, because the labor problem is similar to that experienced in America, the introduction of methods guaranteeing consistent quality and ease of preparation at lower costs would be appreciated by dietitians and food service operators. Over the past five years, a gradual increase in the use of household mixes has been evident, although even now, such foods are practically unknown in New Zealand food services.

Development of the instant form of nonfat dry milk has increased opportunities for its use in mixes in quantity food preparation. Improved keeping qualities, dispersibility, and flavor insure products similar to those using fluid milk. Advantages of dry milk as compared to fluid milk include lower cost, easier handling, less storage space, and no refrigeration if stored in the original container with the seal intact. In the case of special diets in hospitals, milk nutrients may be augmented when the proportion of powder to water is increased. Generally in New Zealand, conventional nonfat milk solids which are recognized as an inexpensive substitute for fluid milk, are used only for therapeutic reasons.

White sauce, a basic part of many recipes used in food services, varies in consistency, according to its use. Ordinarily, thin white sauce is used in sauces and cream soups; medium white sauce in casseroles, entrees, and creamed vegetables; thick white

sauce in souffles; and very thick white sauce in croquettes and cutlets. In New Zealand, white sauces also appear on menus frequently as accompaniments for meat, fish, and vegetables.

The usual method of making white sauce involves considerable time and labor. A roux is incorporated into heated milk, and the mixture cooked to doneness. The addition of a mix, consisting of conventional nonfat milk solids, fat, and flour, to water was proved by Longrée and Felt (1954) to be an efficient and accurate method of preparing white sauce. In recent work, Peterson (1961) adapted for use with instant milk powder, the white sauce mix developed by Longrée and Felt (1954). Instant nonfat dry milk, in amounts equivalent to fluid milk in thin white sauce, was substituted for conventional nonfat milk solids in Peterson's study (1961).

The versatility of a basic white sauce mix could be increased by the addition of different ingredients to the cooked sauce. For example, a variety of milk puddings and cream pie fillings might be made using specific amounts of such a mix with sugar, eggs, and flavorings.

The objectives, therefore, of this study were to (1) compare thick white sauces made with homogenized milk with those made from mixes incorporating instant nonfat dry milk; (2) determine the palatability of white sauces made from the two types of milk; and (3) determine the effect of the addition of three levels of light brown sugar to thick white sauce using the white sauce mix.

REVIEW OF LITERATURE

History of Mixes

Cline (1946) reported that from 1889, when the first nationally distributed pancake mix was introduced, until 1930, only a few such preparations were available. An excellent biscuit mix appeared on the retail market in 1931. Since that time, other products of good quality have been created. Through extensive investigation and scientific development, mixes are constantly being improved and their uses extended.

Household Use of Mixes

Cost and acceptability of bakery goods made from mixes have been determined through research. Paul et al. (1954) compared preparation time, cost, and palatability of yellow and white cakes, made from fresh ingredients, made from frozen batters, and made from mixes. Commercial mix white cakes rated superior in palatability and preparation time, whereas yellow cakes made from fresh ingredients were of higher quality than those made from the mix.

Cost of individual ingredients was found to be greater than cost of mixes in a study by Asp et al. (1957), whereas Morr (1951) discovered the opposite to be true. Both workers reported lesser preparation times with mixes than with individual ingredients.

Mixes in Institutional Food Services

Cline (1946) found that the use of mixes in restaurants reduced preparation time by as much as 66 percent, decreased the number of utensils used, eliminated dangers of failure, and assured consistently uniform products. By use of ready-mixes, fluctuating ingredient costs were replaced with one known cost, thus simplifying financial control. When made up in quantity before use, commercial pie crusts and mixes of dry ingredients saved time, labor, and were easy to use, according to Freeman (1951). West and Wood (1958) suggested that ingredients for a basic mix could be made in slack work periods for use at a later time.

The satisfactory use of a white sauce mix was reported by Longrée and Felt (1954). Cost of sauce made from the mix was considerably less than that made from fluid milk. Information concerning white sauce mixes developed by commercial companies, is limited to nonscientific publications.

White Sauces and Variations

White sauce is considered a basic sauce because a wide range of savory sauces can be made by varying the liquid and seasonings used in the original sauce. Usual ingredients of white sauce are fat, flour, salt, and milk (Department of Foods and Nutrition, Kansas State University, 1956). Although homogenized milk is the liquid most often used in white sauces, dry milk reconstituted

with water to fluid milk proportions, may be substituted for use in these sauces.

The form of dry milk depends upon the manufacturing method. Spray drying and atmospheric roller drying have been used extensively. Introduction of "instant" forms of dry milk has increased the utility of this dairy product. Controlled moistening and redrying of nonfat dry milk resulted in a powder having an open structure formed by large aggregates of small particles (Peebles, 1956). This powder was called instant nonfat dry milk to differentiate it from the old type which was referred to as conventional nonfat dry milk. The history and development of the dry milk industry has been reviewed by several workers in recent years. These include articles by Coulter (1956), Johnson (1956), and Choi (1959).

Conventional Nonfat Milk Solids. The use of conventional nonfat milk solids in food preparation was studied by Morse et al. (1950a). An increase in viscosity of pastes made with flour, water, and nonfat milk solids appeared with increased levels of dry milk solids. Viscosity was adjusted with a decrease in the amount of flour used.

Paul and Aldrich (1953) reported favorable acceptance of white sauce made from conventional dried milk. When the preparation of various foods using conventional nonfat milk solids was undertaken by Morse et al. (1950b), an acceptable white sauce was obtained.

Husseman (1951) determined the effect of specific concentrations of milk solids on the acceptability of certain foods. A more viscous sauce, a browner crust, and curdling were observed with increased levels of nonfat milk solids in scalloped potatoes prepared with thin white sauce. A satisfactory product was obtained when medium white sauce was used in scalloped salmon and peas.

Instant Nonfat Dry Milk Solids. Directions for substitution of instant nonfat milk were given by Aldrich and Miller (1958). Instant nonfat milk solids replaced conventional milk solids in quantity recipes on a weight basis. Because of a lesser density, an increased amount of instant nonfat milk was required when substituting by measure.

Peebles (1956) stated that instant milk powder assumed a spongy, porous texture; and when viewed under a microscope, large aggregations of particles were apparent. According to Bockian et al. (1957), the phenomenon of the instantizing process caused the particles to become bigger and by agglomeration, aggregates of particles were formed. Increase in particle size was demonstrated by these workers to increase the rate of dispersion. Heavier particles and the distance between them gave more rapid breaking of surface tension, allowing each particle to receive sufficient solute to go into solution.

Stuart and Martin (1959) explained that the solubility of milk powder could be affected by the nature of the water used for reconstitution. Permanently hard water caused poor solubility

and increased the amount of sediment deposited, particularly if reconstitution was at a high temperature. Bockian et al. (1957) produced evidence that the ionizable portion and the lactose of conventional nonfat dry milk were distributed equally throughout the particle; whereas in instant milks, these more soluble components were oriented towards the surface of the particle, thus greatly aiding dispersibility. Protein and insoluble calcium ions were translocated to the interior of the particle and dissolved more readily after the salt and lactose were in solution.

Homogenized Milk. Tracy (1948) claimed that in homogenized milk sauces the tendency to curdle was the result of destabilization of milk proteins during the homogenizing process of the milk. Slight curdling of the white sauce using homogenized milk was encountered also by Towson and Trout (1946). These workers reported that as the amount of fat was increased in white sauce, the fat separation became greater. Homogenized milk sauces were more viscous than sauces prepared from nonhomogenized whole milk.

Jordan et al. (1958) found that cornstarch puddings made with homogenized milk were more viscous than similar ones made with nonhomogenized milk. The difference in viscosity was thought to be related to the relative surface area of the fat globules of two milks.

Flour. Mangels (1934) demonstrated that flours produced during hot, dry seasons differed in water-binding capacity from those produced under humid conditions. Varieties of wheat grown in different regions showed consistent variation in viscosity.

The rate of hydration and the capacity varied with different types of flour (Sundberg et al., 1953). Bailey (1925) declared that bleaching agents affected the water binding properties of flour. Wheat starch gels were stronger in hard wheats than soft concluded Knowles and Harris (1943).

Preliminary tests by Longrée (1953) suggested that cooking a roux by dry heat might result in decreased thickening power. This loss appeared to be caused by a partial dextrinizing of the starch. In the same study the author reported that soft wheat flour had a greater thickening power than all purpose flour.

When increasing the recipe size for cream pie fillings, Billings et al. (1952) noted that the ratio of flour to liquid must be increased also. As the batch size increased, the rate of heating was slower and there was a lower final temperature, thus reducing the thickening power of the flour. Results from studies on white sauces by Longrée (1953) substantiated these findings.

Fat. The type and ratio of fat commonly used in white sauce preparation depend on the final use of the sauce. For general purposes, equal amounts of either butter and shortening, or margarine and shortening may be employed. Longrée and Felt (1954) reported that when margarine was the only fat in white sauce, the texture was not smooth and an unpleasant odor was apparent.

Morse et al. (1950a) established that the effect of three levels of fat had no apparent effect on the viscosity and gel

strength of thin pastes prepared with flour, dry milk, and water. However, a decrease in gel strength of thick pastes was evident when fat was increased.

Salt. The quality of white sauce appears to be affected by the amount of salt added. In a study by Morse et al. (1950a) viscosity of thin pastes was greater when salt was included in the formula. Hollender and Weckel (1941) remarked that table salt inhibited the coagulation of homogenized milk in certain cooking procedures.

The amount of salt added to white sauce made with homogenized milk influenced the degree of fat separation according to Towson and Trout (1946). More separation was noticed if the salt was added at the beginning of the cooking period than at the end.

Brown Sugar. Brown sugar is not an ingredient of a white sauce. Nevertheless, as a possible means of extending the uses of a basic white sauce mix, the effect of different levels of brown sugar on sauces prepared from such a basic mix was investigated in the present study.

Brown sugars are used in a great variety of products because of their flavor and color. They are graded according to color and range from nearly white, number 1 to number 15 which is as dark as roasted coffee (Lowe, 1958; Rice, 1953). However, for consumer use, grades are not stated and the two types of brown sugar available on the retail market are light and dark brown sugar.

Krehl and Cowgill (1955) related the processes for manufacture of brown sugar. Raw sugar which is partially purified cane juice, is washed and dissolved in water and then treated with charcoal. By evaporation, several crops of pure white sugar crystals can be separated. The final crystallization process, however, yields brown crystals which are coated with a film of syrup containing salts, coloring matter, and flavoring substances.

Composition. The total sugar content of brown sugar varies from 91 to 95 percent, according to the grade. Natural moisture content of 4 percent contributes to the friable texture of brown sugar (Nelson, 1949). Ash content of brown sugar was found to be 1.76 percent by Krehl and Cowgill (1955).

The nature and proportions of nonsugars found in the molasses which coats brown sugar varies with the soil on which the cane is grown and the variety of cane, according to Hunt (1960). Rice (1933) asserted that invert sugar content and nonsugars increased with the color of brown sugar. The increase of invert sugar also was recognized by Lowe (1958). Sugar Information, Incorporated (1952) cited the composition of invert sugar as being a mixture of dextrose and levulose. Mixtures of sugar and invert sugar have greater solubility than sugar alone.

White Sauce Mixes

A basic white sauce mix for quantity food purposes was developed by Longrée and Felt (1954). Ingredients of the mix were conventional nonfat milk solids, fat, and pastry or all-purpose

flour. Viscosity of the sauces varied as to the proportion of mix to water. Palatability judges claimed that the thin white sauce, in which there was a decreased amount of milk solids, was lean in flavor. Acceptable sauces were prepared at the medium and thick white sauce levels. Difficulty was experienced in obtaining a very thick white sauce from a mix incorporating all purpose flour.

Peterson (1961) adapted Longrée and Felt's (1954) formula to a suitable mix for thin white sauce. In subsequent testing, those white sauces made from mixes using instant nonfat dry milk were superior to sauces prepared from homogenized milk or dry whole milk mixes. At refrigerator temperature, the shelf-life of the instant nonfat dry milk mixes was 12 weeks, whereas, at room temperature the shelf-life decreased to between six and eight weeks.

Cooking Time. Average cooking time for one-gallon batches of white sauces made from the mix was found by Longrée and Felt (1954) to be 36 minutes as compared to 53 minutes for the same amount of sauce using fluid milk. For sauces incorporating mixes, Peterson (1961) reported a cooking time of approximately one-half that required for sauces prepared from homogenizes milk.

Appearance. A tendency for homogenized milk sauces to curdle more easily than dry milk sauces was noted by Peterson (1961). The former sauces were significantly thicker than instant nonfat dry milk sauces. Scum which formed on dry milk sauces during the holding period was easily dispersed by beating

slightly. This was not the case with homogenized milk sauces. Fat separation was more pronounced in sauces made from the mix incorporating instant nonfat dry milk.

Flavor. Longrée and Felt (1954) related that white sauces prepared from mixes were scores "acceptable" or "very acceptable." After 12 weeks storage, a decrease in palatability was noted by the judges. Peterson (1961) obtained significantly higher flavor scores for sauces made from instant nonfat dry milk than from those containing homogenized milk.

Variability between brands of instant and noninstant milk powders was noticed in a study of flavor and chemical characteristics by Keeney and Bassette (1957a). Instant products were more susceptible to browning reaction than conventional spray dried products. This browning reaction, known as the Maillard reaction, was correlated with the degree to which the powder was wetted during the instantizing process. More heat and drying were required for a product wetted to 20 percent moisture than a powder which was wetted to 5 percent.

Studies by Kumetat et al. (1956) substantiated this evidence when high relative humidities and elevated temperatures, common to instantizing processes, were demonstrated to favor the initial reaction between lactose and milk protein. The Maillard reaction was described by Danehy and Pigman (1951) as specifically involving direct reaction of sugars with amino groups or catalytic effects of amino groups on sugars or their degradation products. End products of this process tend to have objectionable flavors

and are brown in color. Bassette and Keeney (1958) isolated carbonyl and methyl sulfide compounds which were identified as being involved in the cereal flavor of instant nonfat dried milk. The decomposition of cystine with liberation of a sulfide group was maintained by Bergsöe (1957) to be responsible for the typical cooked flavor of instant milks.

Viscosity. Longrée and Felt (1954) discovered slight decreases in viscosity of white sauces made from mixes which had been stored for eight weeks. When mixes incorporated all-purpose flour, the resulting sauces were thinner than those sauces made from a mix using pastry flour. White sauces made with instant nonfat dry milk were significantly thinner than sauces containing homogenized milk (Peterson, 1961).

The use of foods incorporating a white sauce mix depends partly on the final viscosity of the finished product. Waldt and Kehoe (1959) discussed the heating of flour with water. Above a certain temperature, starch granules swelled to a large size. Paste viscosity increased to a maximum which is known as maximum viscosity. Further heating caused rapid diffusion of starch from some granules and rupture of others, resulting in a decrease in viscosity. On cooling, association of granules and rethickening occurred. Work of a similar nature has been reported by Ankers and Geddes (1944), Caesar (1932), Kesler and Bechtel (1947), and Woodruff and Nicoli (1931).

Several factors have been found to affect viscosity of colloidal systems: addition of certain ingredients, pH, cooking

procedures, and agitation.

Added Ingredients. Properties of food products thickened with starch are influenced to varying degrees by other ingredients present. Sucrose has been reported to inhibit swelling of starch granules, resulting in a lowered maximum viscosity temperature, a decreased diffusion of soluble starch, and a more tender gel formed from the cooled paste (Campbell and Briant, 1957; Hester et al., 1956; Woodruff and Nicoli, 1931).

Bean and Osman (1959) studied the qualitative effects of different sugars and sirups on the viscosity of starch pastes. Lower concentration of sugars tended to increase maximum viscosity of flour and starch pastes, but in pastes containing high concentrations of sugar, an increase in viscosity not only was delayed but was also slower in occurring. The effects of disaccharides upon starch pastes were greater than those of monosaccharides, whereas, invert sugar had an in-between effect.

The effect of sugars on starch gels was explained by these workers (Bean and Osman, 1959) to be inhibition of the swelling of the granules. Sugar molecules competed with starch for the available water, leaving insufficient water to complete the swelling of the granules. No explanation could be offered for increased viscosity of pastes with small additions of sugar. Similar results were reported by Morse et al. (1950a).

pH. Effect of a lowered pH in thick pastes of flour, nonfat milk solids, and water or fluid milk was studied by Morse et al. (1950a). An appreciable decrease in viscosity was obtained and

believed attributable to partial hydrolysis of the starch. Whistler and Johnson (1948) described a decrease in viscosity of starch solutions undergoing acid hydrolysis. Fragmentation of starch granules was reported by Campbell and Briant (1957) when citric acid was an ingredient of wheat starch pastes.

Cooking Procedures. Variation in cooking procedures will cause differences in viscosity. Rate of heating was regarded by Kesler and Bechtel (1947) as being especially important in determining viscosity. When the rate of heating increased, the greater rupturing of starch granules resulted in a thinner paste than when a slower rate of heating was employed. On cooling, less reassociation of granules occurred in pastes which were heated at faster rates. These results were supported by studies by Longrée and Felt (1954), and Woodruff and Nicoli (1931).

Billings et al. (1952) recognized that final cooking temperature and time depended on the rate of heating, but considered tasting for the disappearance of raw starch a more reliable criterion for doneness than "final temperature." Longrée and Felt (1954) observed that maximal viscosity was reached before the disappearance of raw starch. In a study of temperatures during gelatinization of various pastes, Osman and Mootse (1958) recorded a maximum viscosity temperature of 83° C. for wheat flour pastes. These pastes were cooked to a final temperature of 95° C. which occurred 20 minutes later.

Agitation. The rate and amount of agitation during cooking of starch pastes are reflected in the viscosity values. Caesar

(1931) declared that the amount of disintegration of swollen granules in starch pastes was related directly to the character and severity of agitation during preparation. In the absence of mechanical agitation, Ankers and Geddes (1944) noted that little granule disintegration occurred. Agitation during the testing of viscosity was a disturbing factor. Stirring rate and the dimension of the stirrer were found to affect viscosity by Kesler and Bechtel (1947).

Nutritive Value. The amount of milk solids present in the thick white sauces was higher than in thin white sauces made from the mix (Longrée and Felt, 1954). Increasing proportions of dry milk to water is a practice frequently used to enrich the protein content of patients' diets in hospital food services (Bell, 1956).

Since additional processing occurs in the production of instant milk, workers queried whether the nutritive value was the same as that of conventional milk solids. Reports from several authors showed that no appreciable loss of nutritive value occurred during the instantizing process (Chapman et al., 1956; Hodson, 1956; Hodson and Miller, 1957; and Waits et al., 1956). Deterioration of nutritive value was found to depend on moisture content, length of storage, and type of package (Wearmouth, 1958).

Cost. Sauces made by the roux method were more expensive than those sauces prepared from a white sauce mix (Longrée and Felt, 1954). Peterson (1961) reported that costs for mixes incorporating instant nonfat dry milk were approximately 55 per-

cent less than for homogenized milk sauces at the time of the study.

EXPERIMENTAL PROCEDURE

Preliminary Work

Preliminary work was necessary to determine the ratio of mix to water required to prepare thick white sauce; to standardize the techniques of preparation and testing; to test the formula for thick white sauce to be made with homogenized milk; and to establish the levels of brown sugar to be added to the thick white sauce.

Ratio of Mix to Water. The basic formula for the white sauce mix was adapted from one developed and tested for thin white sauce by Peterson (1961). The amount of flour was less in the mix used in this study than in that used in Peterson's study (1961). Ingredients included in the present study were all-purpose flour, butter, hydrogenated vegetable shortening, and instant nonfat dry milk. Salt was omitted because the amount of mix required for thick white sauce resulted in a product which was too salty. The salt needed was added to the weighed mix, just prior to cooking.

Various quantities of mix and water were tested before an acceptable product was obtained. Separation of fat from the cooked sauce was observed when high proportions of mix to water were used.

Techniques in Preparation and Testing. During preliminary work, techniques to be used in the preparation and presentation of thick white sauces to the palatability committee were standardized. Billings et al. (1952) reported that tasting for the disappearance of raw starch in cream fillings was a more reliable criterion for determining the end-point of cooking than final temperature or length of time of cooking. For the present study, the length of cooking time necessary before the taste of raw starch disappeared in thick white sauce was ascertained.

The MacMicheal viscosimeter was tested for use with thick white sauces, and a size 30 gauge wire was found to be most suitable in recording viscosity. The speed of rotation of the turntable was adjusted to 20 revolutions per minute.

Scorecards were developed and tested (Forms 1 and 2, Appendix). The palatability committee of eight members was made familiar with the scorecards at two practice periods. Instruction sheets used at these times may be found in Form 3 (Appendix).

Recipe for Thick White Sauce using Homogenized Milk. The formula for thick white sauce using homogenized milk was based on the recipe published by Fowler and West (1950). The method of preparation of the sauce was adapted for this study. The roux was added to the hot milk, rather than the hot milk to the roux. This procedure used only one container for the heating of the milk and the making of the sauce.

Levels of Brown Sugar Added to Thick White Sauce. To evaluate the possibility of using the mix as a basis for milk puddings,

other ingredients were added: (1) white sugar and vanilla; (2) cocoa, white sugar, and vanilla; (3) baking chocolate, white sugar, and vanilla; and (4) light brown sugar and vanilla. Judges indicated that the products were acceptable and recommended future work to develop suitable menu items.

For the purpose of this investigation, only the effect of the addition of light brown sugar was considered. The amount of brown sugar to be added at three levels was determined. These levels of brown sugar were 12.5, 16.7, and 20.8 percent of the total formula. A grainy texture resulted when brown sugar was added to the mix before cooking, whereas the texture was smooth when brown sugar was added after approximately half the cooking time had elapsed.

Statistical Design and Methods of Analyses

The main study consisted of two parts. Part 1 was designed to compare thick white sauces containing homogenized whole milk with those made from the mix using instant nonfat dry milk and to determine the acceptability of thick white sauces made from the mix. Part 2 was designed to determine the effect of three levels of light brown sugar on thick white sauce prepared from the basic mix, as well as to determine the acceptability of the resulting products. Part 2 of the study was conducted first, since not all the mechanical facilities needed in Part 1 were connected in the new laboratory.

In Part 1, 30 sauces were prepared and tested in 15 periods. A testing period consisted of the preparation and testing of two white sauces. A paired comparison was used for the statistical design (Table 1). Thick white sauce utilizing instant nonfat dry milk was designated Treatment I and that using homogenized milk as Treatment H. At each testing period, members of the palatability committee scored two samples of white sauce.

In Part 2, 36 sauces were prepared in 18 periods; two sauces were made each period. A randomized incomplete block was used for the statistical design (Table 2). The sauces were designated B1, B2, and B3; B1 having the lowest level of brown sugar and B3 the highest.

Data were collected for the palatability factors of odor, appearance, color, consistency, texture, and flavor, and for viscosity as measured by the MacMicheal Viscosimeter. In Part I, Student's "t" test for paired observations was used to test the significance of differences between scores for white sauces made from homogenized milk and white sauces incorporating the basic mix.

In Part 2, the data collected were subjected to analysis of variance to study the effect of three levels of brown sugar on the palatability and viscosity of thick white sauce. When significant differences occurred among the three treatments, ordered arrays of means were analyzed by least significant differences.

Table 1. Statistical design for order of preparation and presentation of white sauce to the palatability committee.

Testing period	Sample number on scorecard	
	1	2
1	I	H
2	I	H
3	I	H
4	I	H
5	I	H
6	H	I
7	H	I
8	I	H
9	I	H
10	H	I
11	H	I
12	H	I
13	H	I
14	I	H
15	H	I

I - White sauce using instant nonfat dry milk.
H - White sauce using homogenized milk.

Table 2. Statistical design for comparison of brown sugar in white sauce.

Measurement Day (block)	Order of preparation 1st	2nd
1	B2	B3
2	B3	B1
3	B2	B1
4	B2	B3
5	B3	B1
6	B1	B2
7	B1	B3
8	B2	B1
9	B2	B3
10	B3	B1
11	B3	B2
12	B1	B2
13	B1	B3
14	B2	B3
15	B2	B1
16	B2	B3
17	B1	B2
18	B3	B1

B1 (level 1) - 1.5 lbs. (12.5%) brown sugar.
B2 (level 2) - 2.0 lbs. (16.7%) brown sugar.
B3 (level 3) - 2.5 lbs. (20.8%) brown sugar.

Procurement and Storage of Ingredients

Procurement. All ingredients, except whole milk and butter, were obtained in sufficient quantities for the entire experiment. Instant nonfat dry milk was purchased in vacuum-sealed cans, six cans to the case. Each can contained four and one-half pounds of dry milk. All-purpose flour was procured in 50-pound bags. Due to defective flour, two ten-pound sacks of additional flour were purchased and used in Part 1 of the study. Hydrogenated vegetable shortening was packed in 50-pound cans and non-iodized table salt in one-pound boxes. Light brown sugar was packed in 25-pound sacks.

Butter in one-pound blocks was purchased, in sufficient amounts for five testing periods, from the Kansas State University Dairy. Homogenized milk in five-gallon cans was purchased from the same source for the same length of time. Tap water was the liquid when dry milk solids were used.

Storage. The instant nonfat dry milk was stored in sealed cans in the laboratory storeroom. Homogenized milk and butter were stored in a walk-in refrigerator at a temperature of approximately 35-40° F. All-purpose flour and brown sugar were stored in covered stainless steel bins at room temperature in the laboratory. Hydrogenated vegetable shortening and salt were stored in the original containers at room temperature.

Preparation of Mix and Thick White Sauces

Preparation of Mix. The formula for the basic mix is given in Table 3. All ingredients for the mix were weighed and kept at room temperature for approximately three hours before mixing. A power mixer with a pastry blender attachment was used to combine the flour and milk solids in an 80-quart bowl. After mixing at low speed for 30 seconds, butter and shortening were added and blended for 25 seconds. After the motor had been stopped and the bowl lowered, the sides of the bowl and the blender were scraped down, using a rubber spatula. Twenty strokes were used in the process; one stroke was counted for either one straight movement across the bottom of the bowl, or one complete circular movement around the sides of the bowl. Mixing was continued at low speed for approximately 30 seconds, or until the mix appeared yellow in color and crumbly in texture. The scrape-down process was repeated.

The mix was placed in one-gallon glass jars, covered with metal lids, and stored at approximately 35-40° F. until needed. Sufficient mix was made in advance for five laboratory periods.

Preparation of Thick White Sauces. Standard equipment for the study included two electronically controlled trunnion kettles (14-quart capacity). The thermostats on the kettles were set to maintain a temperature of 90-95° C. during the cooking period. Balloon-type fine wire whips were used to stir the sauces. All other equipment used for preparation was similar to that found in any well-equipped institutional kitchen.

Table 3. Formulas for thick white sauces prepared from instant nonfat dry milk and homogenized milk.

Ingredients	Instant nonfat dry milk			Homogenized milk		
	Actual weight:	Approximate weight		Actual weight:	Approximate weight	
	g.	lb.	oz.	g.	lb.	oz.
Flour, all-purpose	1361	3		397		14
Shortening, hydrogenated vegetable	2041	4	8	227		8
Butter	2041	4	8	227		8
Salt	*			28		1
Milk	4082	9		3785	8	
Yield	24 quarts			4 quarts		

* - 28 g. (1 oz.) salt was added to 3½ lbs. mix prior to cooking.

Thick White Sauce Prepared from the Mix. In Part 1, for the preparation of thick white sauce from the mix, 3313 grams of water (7 pints) were heated in one of the trunnion kettles. Twenty-eight grams of salt (one ounce) were added to 1588 grams of mix (three and one-half pounds). When the temperature of the water reached 90° C., the mix was added to the water and stirred for 90 seconds. At five-minute intervals during the cooking period, the mixture was stirred for 30 seconds. Throughout the study, stirring was done at the rate of one stroke per second; one stroke was counted as one complete circular movement around the sides of

the kettle. The mixture was cooked for 45 minutes and the final cooking temperature recorded.

Thick White Sauce Prepared from Homogenized Milk. In Part 1, the formula for thick white sauce using homogenized milk is presented in Table 3. In the preparation of this white sauce, the milk was heated in one of the trunnion kettles. After butter and shortening were melted in a three-quart aluminum saucepan, over a low gas heat, they were removed from the burner and the flour and salt mixture added. The mixture was stirred with a metal spoon for 35 seconds, to form a roux. When the milk had reached a temperature of 90° C., the roux was added and stirred for 90 seconds. During the 45-minute cooking period, the mixture was stirred at five-minute intervals for 30 seconds each. The final cooking temperature was recorded.

Thick White Sauce plus Brown Sugar. The formula for thick white sauce plus brown sugar in Part 2 is presented in Table 4. In the preparation of this sauce, the procedure was similar to that for the thick white sauce made from the mix, Part 1, except that after 25 minutes of cooking, the brown sugar was added to the sauce and stirred for 30 seconds. As before, the mixture was stirred every five minutes during the cooking period. After 45 minutes, the heat was turned off and the vanilla stirred in for 30 seconds, and the final cooking temperature was recorded.

Testing Procedures

Viscosity. Parts 1 and 2. At the end of the cooking period, the viscosity of the sauces was measured using a MacMicheal

Table 4. Formula for thick white sauce plus brown sugar.

Ingredients	Actual weight : g.	Approximate weight : lbs.	: oz.
Water	3313.0	7	
Mix	1588.0	3	8.00
Vanilla	22.5		0.75
Brown sugar, light			
B1 (level 1)	680.0	1	8.00
B2 (level 2)	907.0	2	
B3 (level 3)	1134.0	2	8.00
Yield	1 gallon (approximate)		

viscosimeter at a temperature of 80° C. ± 1° C. Water was poured into the outer heating cup (weight of cup plus water, 650 grams). To insure the water reaching a temperature of 80° C. ± 1° C., the heating mechanism of the viscosimeter was turned on 20 minutes prior to use. The sauce (temperature 80° C. ± 1° C.) was poured into the heated inner cup (weight of cup plus sauce, 260 grams). A spindle plunger supported by a gauge wire (size 30) was immersed in the sauce, and the cup rotated for 10 seconds. The reading was recorded in MacMicheal units. This procedure was repeated on a total of three samples from each sauce, and an average computed for individual sauces. High readings indicated more viscous samples, and low readings less viscous samples.

Due to a mechanical failure which could not be repaired in time, the heating mechanism was used only in Part 2 of the study. A constant temperature was maintained in Part 1 with the use of

water heated on the gas burner. Temperatures were checked frequently and viscosity tests rerun as necessary. A smaller outer cup was used and the weight of the cup plus water was 500 grams.

Organoleptic Test. Immediately following the viscosity test in Parts 1 and 2, palatability factors were scored by a committee of eight judges. Each member was given one sample (three ounces, approximately) of both sauces which were served in small custard cups on a tray with spoons and a glass of iced water. Using a descriptive numerical scorecard, the judges scored the coded samples for odor, appearance, color, consistency, texture, and flavor. A five-point scale was used in scoring; five points representing an excellent product and one point an unacceptable one.

RESULTS AND DISCUSSION

Preparation of the Sauces

White sauce mix incorporating instant nonfat dry milk (Treatment I) was easier to combine with water than was roux with homogenized milk (Treatment H) in the preparation of white sauce. Sauces made from the mix tended to lump less than did those made by the conventional method.

Preparation time for the white sauce mix was 36 minutes. Because sufficient mix was made at one time to produce six batches of thick white sauce, of the total 36 minutes, six minutes preparation time was prorated for one batch of sauce. The mix for single batches of white sauce was weighed during the three minutes

needed to heat one gallon of hot tap water to 90° C.

One gallon of homogenized milk took eight minutes to reach 90° C. The average time to assemble ingredients for the roux was three minutes. These ingredients were weighed and mixed during the heating of the milk. All sauces were cooked for 45 minutes after the mix or roux had been added.

Average preparation time for one gallon of white sauce made from the mix was 54 minutes, whereas that prepared from the roux and homogenized milk was 56 minutes. The overall preparation time saved when the mix method was compared with the conventional method was not great. However, the mix could be made in slack work periods ready for instant use, whereas the conventional method required assembling, weighing, and mixing of individual ingredients immediately prior to each batch of white sauce. As a result, the actual preparation at time of use was 48 minutes for the mix method and 56 minutes for the conventional method.

The kettle used in Treatment H was easier to clean than that used in Treatment I. A tendency to brown on the sides of the kettle was observed for sauces made from the mix.

The temperature of all sauces was recorded at the end of the cooking period. In Part 1, little variation was noted; a final temperature for Treatment H was 90.2° C., and for Treatment I was 90.9° C. The addition of three levels of brown sugar, one and one-half pounds, two pounds, and two and one-half pounds, to the sauces in Part 2, did not influence the end-cooking temperatures of 90.3, 91.3, and 90.7° C. to any extent.

Part 1. Comparison of Two Thick White Sauces

Thick white sauce prepared using homogenized milk was compared with thick white sauces made using a basic mix incorporating instant nonfat dry milk.

Viscosity. Sauces in Treatment H appeared to be more viscous in the early stages of cooking than toward the end of the cooking period, whereas those in Treatment I became thicker as cooking progressed. At the end of the 45-minute cooking period, the thermostats on the trunnion kettles were lowered to 70° C. for the duration of testing. During this time, sauces containing homogenized milk tended to become thicker. The opposite was true for dry milk sauces.

As measured by the MacMicheal viscosimeter, high values indicated more viscous products than did low values. Average mean values for viscosity of thick white sauces in Treatments H and I were 199.6 and 105.2 MacMicheal units, respectively (Table 5). White sauces containing homogenized milk were significantly more viscous than those made with the mix (Table 6).

Palatability Scores. A committee of eight judges scored samples of thick white sauces for odor, appearance, color, consistency, texture, and flavor. A five-point scale was used; five denoted an excellent product and one an unacceptable product. Details of mean palatability scores may be found in Tables 8 and 9 (Appendix).

Odor. The odor of thick white sauce in Treatments H and I received average scores of 4.3 and 3.6, respectively (Table 5).

Table 5. Average mean scores for palatability factors[1], and viscosity values[2] for thick white sauces made with Treatment H and Treatment I.

Factors	Treatment H Homogenized milk	Treatment I Instant nonfat dry milk
Odor	4.3	3.6
Appearance	4.0	4.5
Color	4.3	4.1
Consistency	3.0	4.2
Texture	3.6	3.7
Flavor	4.1	3.5
Viscosity	199.6	105.2

1 - Scoring range, 5 to 1.
2 - MacMicheal units.

Table 6. Student's "t" test values for scores for Treatment H[1] as compared with scores for Treatment I[2].

Factors	t	D/F	Probability
Odor	7.108	14	.001 ***
Appearance	-3.689	14	.003 **
Color	1.739	14	.100 ns
Consistency	-6.848	14	.001 ***
Texture	-0.962	14	.400 ns
Flavor	5.014	14	.001 ***
Viscosity	20.809	14	.001 ***

1 - White sauce incorporating homogenized milk.
2 - White sauce incorporating instant nonfat dry milk.
** - Significant at the 1% level.
*** - Significant at the 0.1% level.
ns - Nonsignificant.

At the one-tenth percent level, a significant difference was found between mean odor scores for sauces made with homogenized milk and those mean scores of instant nonfat milk sauces (Table 6). The amount of milk solids was 40 percent greater in dry milk sauces than in homogenized milk sauces. The mix, when used at the thin white sauce level (Peterson, 1961), contained the correct proportion of milk solids and fat, whereas a thicker sauce requiring more mix to reach a suitable consistency, contained a higher amount of milk solids and fat. The amount of fat used in the white sauce mix for a thick white sauce was 50 percent more than that in the roux.

The judges often commented that the odor of the sauces made with the instant nonfat dry milk was malty and cereal-like, a description characteristic of dried milk. An odor similar to that of butter was noted also.

Appearance. Average mean scores for appearance are in Table 5. Sauces in Treatment I received higher scores than did those in Treatment H. Statistical analyses showed that this difference was significant at the one percent level (Table 6). On several occasions, the judges observed that sauces made with homogenized milk were on the verge of curdling.

Although the formation of scum was apparent in both treatments, that in Treatment I was readily dispersed on stirring. This was not true for scum formed on white sauces containing homogenized milk.

Color. Average mean color scores were 4.3 and 4.1 for Treatments H and I, respectively (Table 5). The color of instant nonfat dry milk sauces was more yellow than those made with homogenized milk. However, this difference was not statistically significant (Table 6). The increased amount of fat in the milk and the possibility of a browning reaction occurring with instant nonfat dry milk, might be responsible for this change in color.

Consistency. An average mean score of 4.2 for Treatment I was found to be significantly higher at the one-tenth per cent level than the score of 3.0 for Treatment H (Tables 5 and 6). The majority of judges indicated that the sauce produced in Treatment H would be suitable as a very thick white sauce only, and that a thinner consistency would be necessary for a thick white sauce. On some occasions the sauces incorporating the mix appeared thinner to the judges than at other testing periods.

Texture. No statistical difference was found in texture scores, 3.6 and 3.7, for Treatments H and I, respectively (Tables 5 and 6). White sauces made with the mix exhibited a grainy texture. Judges suggested that this characteristic might not be noticed if the sauce was incorporated in casseroles or entrees. Although thick white sauces made with homogenized milk were smooth, they were often "gluey" and "pasty" in texture. Lumps present in Treatment H were attributed to surface scum mixed into the sauce after stirring.

Flavor. Mean flavor scores for Treatments H and I were 4.1 and 3.5, respectively (Table 5). The higher scores received by

homogenized milk sauces were significant at the one-tenth percent level. These sauces had a milder flavor than those sauces incorporating instant nonfat dry milk. The stronger flavor might be attributed to the greater proportions of fat and milk solids in Treatment I than in Treatment H.

Comments received from the palatability committee described the flavor in Treatment I as similar to that of evaporated milk. A "buttery" flavor was found objectionable in these sauces by some panel members.

Part 2. Effect of Brown Sugar on Thick White Sauces

Three levels of brown sugar, designated Treatments B1, B2, and B3, were added to thick white sauce prepared from a mix incorporating instant nonfat dry milk. Treatment B1 had the lowest level (12.5 percent) of brown sugar and Treatment B3 the highest (20.8 percent). Differences occurring between Treatments B1, B2, and B3 were tested for significance using the F-test. When the F-test was significant, the means of the three treatments were separated by the Least Significant Difference Test (Table 7).

Viscosity. Brown sugar, added after 25 minutes of the cooking time had elapsed, combined easily with the sauce. A tendency was noted for the resulting mixture to stick to the sides of the kettle even more than did the dry milk sauces in Part 1.

Average mean values for viscosity of Treatments B1, B2, and B3 were 72.4, 54.3, and 44.1 MacMicheal units, respectively (Table 7). Statistical analyses showed that these differences were

significant at the five percent level. With increasing amounts of brown sugar, thick white sauces showed a decrease in viscosity. This decrease might be attributed to several factors: the moisture content of brown sugar (Nelson, 1949), the nature and proportions of nonsugars found in brown sugars (Rice, 1933 and Hunt, 1960), and/or the invert sugar present (Rice, 1935 and Lowe, 1958).

Palatability Scores. Mean palatability scores for Treatments B1, B2, and B3 are found in Tables 10 through 12 (Appendix).

Odor. Average mean scores of 4.2, 4.3, and 4.2 for Treatments B1, B2, and B3, respectively (Table 7) were not significantly different. Unlike Part 1, the judges did not notice any off odor. However, the presence of brown sugar might have masked any objectionable odor present.

Appearance. The appearance of the sauces received scores of 4.4, 4.5, and 4.5 for Treatments B1, B2, and B3, respectively (Table 7). Statistical analysis showed that the mean scores for appearance of Treatment B1 varied significantly from those for Treatment B2. No significant difference occurred between the mean scores for sauces made with the higher levels of brown sugar.

Color. The color of sauces darkened with the increased amounts of brown sugar. The difference in the average scores of 4.1 for Treatment B1, and 4.5 for Treatment B2, was found to be significant (Table 7). No significant difference was found between Treatments B2 and B3. Judges indicated that the paler color obtained in Treatment B1 was not as pleasing as the color of sauces with the two higher levels of brown sugar.

Table 7. Average mean scores[1] for factors related to the effect of three levels of brown sugar[2] on thick white sauce made from instant nonfat dry milk.

Factors	lsd[3]	Treatment B1		Treatment B2		Treatment B3
Odor	--	4.2	ns	4.3	ns	4.2
Appearance	.097	4.4	*	4.5	ns	4.5
Color	.247	4.1	*	4.5	ns	4.5
Consistency	.304	4.3	ns	4.3	*	3.9
Texture	--	3.7	ns	3.7	ns	3.7
Flavor	--	3.7	ns	4.0	ns	3.8
Viscosity[4]	7.623	72.4	*	54.3	*	44.1

1 - Scoring range, 5 to 1.
2 - Treatment B1 (12.5% brown sugar).
B2 (16.7% brown sugar).
B3 (20.8% brown sugar).
3 - Least significant difference.
4 - MacMicheal units.
* - Significant at the 5% level.
ns - Nonsignificant.

Consistency. Average mean scores for consistency may be found in Table 7. A significantly lower score was given to Treatment B3 than to Treatments B1 and B2. Judges commented that the consistency of this sauce was too thin, and might be attributed in part, to the fact that sauces were hot at the time of testing. Sauces cooled at refrigerator temperature for approximately one-half hour became thicker. The sauce containing the highest level of sugar (Treatment B3) was light and fluffy on the tongue, did not hold definite shape when cut with the spoon, and was of a more suitable consistency after cooling. The other

two sauces (Treatments B1 and B2) became too stiff.

Texture. When texture was considered (Table 7), average mean scores of 3.7 were obtained for all treatments. The grainy texture noted in all sauces was not found to be affected by the different levels of brown sugar. This characteristic was less obvious in cool sauces than in hot ones. The same score (3.7) for this factor was given for thick white sauces without any brown sugar added (Table 6).

Flavor. No significant difference was found in the mean flavor scores of 3.7, 4.0, and 3.8 for Treatments B1, B2, and B3, respectively (Table 7). Generally, the panel preferred sauces with the medium level of brown sugar. Comments indicated that the sauce with the lower level of brown sugar was not sweet enough, whereas the sauce containing the most sugar was too sweet.

Opinions of the palatability committee substantiated the belief that a basic white sauce mix could be used successfully for other food products, such as puddings and pie fillings. Amounts of mix to be added to water should be determined according to the effect of added ingredients and the desired consistency of the final product.

SUMMARY

This study was undertaken: (1) to compare thick white sauces prepared from a roux and homogenized milk with those made from a mix incorporating instant nonfat dry milk; (2) to determine the palatability of white sauces made from the two types of

milk; and (3) to determine the effect of the addition of three levels of light brown sugar to thick white sauce, using the white sauce mix.

White sauces were cooked in electronically controlled trunnion kettles for 45 minutes, and the end-point temperature recorded. A palatability committee scored samples of sauces for odor, appearance, color, consistency, texture, and flavor. A MacMicheal viscosimeter was used to measure the viscosity of the sauces. Student's "t" test for paired comparisons was employed to test the significance of differences between scores for white sauces made using homogenized milk and white sauces incorporating instant nonfat dry milk. Data collected in Part 2 of the study were subjected to an analysis of variance and, where appropriate, least significant differences were determined.

Preparation time at time of use for one gallon of white sauce prepared from the mix averaged 48 minutes, whereas preparation time for sauces made with the conventional method averaged 56 minutes. Types of milk, methods of preparation, and levels of brown sugar had little effect on the temperature of the sauces at the end of the cooking period.

In white sauces using instant nonfat dry milk, the amount of milk solids and fat was 40 and 50 percent higher, respectively, than in sauces made with a roux and homogenized milk. The mix used in this study was adapted from a formula developed originally for a thin white sauce. Therefore, the amount of mix required for a thick white sauce increased the milk solids and

fat content of the resulting product.

Thick white sauces incorporating homogenized milk were significantly thicker than sauces made with the mix. Statistical analysis showed that the higher appearance scores received by sauces using instant nonfat dry milk, were significant at the one percent level. Scum formation, curdling, and lumping were evident in homogenized milk sauces. In dry milk sauces, scum was readily dispersed by stirring. This was not true for scum formed on white sauces containing homogenized milk. The texture of white sauces made with the mix was grainy. Although sauces made with homogenized milk were smooth, they were also often declared "gluey" and "pasty" in texture.

Judges' scores for odor and flavor were significantly higher at the one-tenth percent level for homogenized milk sauces than for sauces incorporating instant nonfat dry milk. In the latter, malty or cereal-like odor often was apparent.

Three levels of brown sugar were added to thick white sauces prepared from the mix. With increasing levels of brown sugar, these sauces showed significant decreases in viscosity. These decreases were attributed in part to moisture content, proportion of nonsugars, and the presence of invert sugar in brown sugar.

Judges preferred the appearance and color of sauces with the two higher levels of brown sugar. Significantly lower scores were obtained for these characteristics in sauces with the least amount of sugar.

Odor and flavor scores were not significantly different for the three treatments. Brown sugar was thought to mask off-odors which occurred in dry milk sauces without sugar added. Generally, judges preferred the flavor of higher concentrations of sugar in the sauces. The scores for consistency of sauces containing the most brown sugar were significantly lower than scores for sauces with the two lesser amounts of sugar. However, on cooling, a more suitable consistency for puddings and cream pie fillings was observed in the former sauces. Sauces containing lower levels of brown sugar became too stiff when cooled.

The grainy texture, apparent in all sauces, was not affected by the levels of sugar. This characteristic was less obvious in cool sauces than in hot ones.

CONCLUSIONS

Under the conditions of this study, the following conclusions were drawn:

1. Thick white sauces prepared with a basic mix incorporating instant nonfat dry milk were superior in appearance and consistency, whereas thick white sauces made with a roux and homogenized milk were superior in odor and flavor, as judged by the palatability committee.

2. Thick white sauces prepared with a roux and homogenized milk were significantly thicker than those sauces prepared from dry milk mix.

3. Preparation time for sauces made from mixes was less than for sauces prepared by the conventional method.

4. Addition of brown sugar and vanilla to sauces incorporating white sauce mix resulted in a successful product.

5. In thick white sauces made from the mix, brown sugar masked flavors and odors resulting from high amounts of milk solids and fat.

6. With increasing levels of brown sugar, thick white sauces made from the mix showed decreases in viscosity.

ACKNOWLEDGMENTS

Grateful appreciation is expressed to Mrs. Marjorie M. Hemphill, Assistant Professor of Institutional Management, for her interest and guidance in planning this investigation and her patience and help in the preparation of this manuscript; to Miss Gweldolyn L. Tinklin, Associate Professor of the Department of Foods and Nutrition, for her valuable assistance and constructive criticism; to Dr. H. C. Fryer, Director of the Statistics Laboratory, for his help with the statistical analysis of the data; and to the members of the palatability committee for their cooperation.

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APPENDIX

FORM I

SCORECARD FOR WHITE SAUCES

NAME:_____ SERIES:_____

DATE:_____

CHARACTERISTIC	SCORE RANGE 1	SCORE RANGE 3 5	PRODUCTS 1	PRODUCTS 2	COMMENTS
ODOR	Malty or cereal-like. Caramel-like.	Pleasing			
APPEARANCE	Surface scum which does not lose its identity after stirring. Curdling evident.	No scum; or a scum which is lost on stirring. No curdling.			
COLOR	Unacceptable.	Pleasing.			
CONSISTENCY	Too thin. Too thick.	Pleasing.			
TEXTURE	Grainy. Lumpy.	Smooth; light and fluffy on the tongue. No lumps.			
FLAVOR	Caramel-like, stale or unpleasant	Pleasing, delicate.			

KEY: 5 - Excellent
4 - Good
3 - Average
2 - Poor
1 - Unacceptable

Would you consider either of these products unacceptable for service at a meal?

If so, which one?_____

FORM II

SCORECARD FOR WHITE SAUCE MIX PLUS BROWN SUGAR

NAME: _____ SERIES: _____

DATE: _____

CHARACTERISTIC	SCORE RANGE 1	SCORE RANGE 3 5	PRODUCTS 1	PRODUCTS 2	COMMENTS
ODOR	Malty, cereal-like or caramel-like odor.	Pleasing.			
APPEARANCE	Surface scum which does not lose its identity after stirring. Curdling evident.	No scum; or a scum which is lost on stirring; no curdling.			
COLOR	Unacceptable for food.	Acceptable: Pleasing if served at a meal.			
CONSISTENCY	Too thin. Too thick.	Pleasing; does not hold definite shape when cut.			
TEXTURE	Grainy, lumpy.	Smooth; light and fluffy on the tongue; no lumps.			
FLAVOR	Unacceptable.	Pleasing.			

KEY: 5 - Excellent
4 - Good
3 - Average
2 - Poor
1 - Unacceptable

Do you consider that either product could be developed into a successful food item, in future work? _____

FORM III

Instructions for panel members.

1. The panel will meet Monday through Friday at 10:30 a.m. Please be prompt.
2. At the start of the scoring period, a tray with samples for testing, iced water, scorecard and pencil will be given to each member.
3. Scoring will be done at work tables at the north end of the laboratory.
4. Please do not talk before, during or after scoring, in order to avoid influencing other panel members' scores.
5. Place your name and date on the scorecard.
6. Additional comments are encouraged.
7. When applicable, answer the questions at bottom of scorecard.
8. Colds and hay fever may affect the senses of taste and smell. These conditions should be noted on scorecard.
9. Please refrain from eating and drinking 30 minutes before the panel.

Table 8. Mean palatability scores[1] for thick white sauces made using homogenized milk, Treatment H.

Testing period	Odor	Appearance	Color	Consistency	Texture	Flavor	Viscosity[2]
1	4.7	3.7	4.2	2.7	3.2	3.8	203.0
2	4.0	4.0	4.2	3.0	3.6	3.8	205.0
3	4.2	3.8	4.5	3.0	4.0	4.0	199.7
4	4.1	4.1	4.0	2.9	3.6	4.0	184.0
5	4.1	4.0	4.0	2.3	3.0	3.6	198.3
6	4.4	4.3	4.1	3.1	3.6	4.0	179.7
7	4.1	4.3	4.4	3.7	3.3	4.4	171.7
8	4.6	3.6	4.0	2.6	3.8	4.0	221.0
9	4.5	3.8	4.3	2.7	3.8	4.0	203.3
10	4.6	4.6	4.6	4.2	4.2	4.6	173.7
11	4.4	4.3	4.5	2.8	3.6	3.8	220.0
12	4.3	3.8	4.3	3.5	3.5	4.2	199.3
13	4.4	4.0	4.4	3.0	3.0	4.6	222.7
14	4.2	3.8	4.0	2.4	3.4	3.6	216.0
15	4.3	4.1	4.6	3.4	3.9	4.4	196.0
Average	4.3	4.0	4.3	3.0	3.6	4.1	199.6

1 - Scoring range, 6 to 1.
2 - MacMicheal units.

Table 9. Mean palatability scores[1] for thick white sauces made using instant nonfat dry milk, Treatment I.

Testing period	Odor	Appearance	Color	Consistency	Texture	Flavor	Viscosity[2]
1	4.0	4.7	4.3	3.5	4.3	4.0	86.3
2	3.8	4.4	4.4	4.4	4.0	3.6	104.3
3	3.3	4.5	3.5	4.3	3.3	3.5	107.3
4	3.4	4.7	4.1	4.6	3.7	3.9	113.3
5	4.1	4.6	4.3	4.1	3.7	3.9	103.0
6	3.4	4.7	4.1	4.3	3.6	3.4	101.7
7	3.7	4.7	3.9	4.0	3.9	3.1	97.3
8	3.8	4.6	4.0	3.8	3.6	3.6	100.0
9	3.0	4.7	3.3	4.2	3.5	3.2	98.3
10	3.6	4.2	4.0	4.6	4.0	3.6	110.3
11	3.9	4.6	4.5	4.1	3.6	3.6	118.3
12	3.2	3.7	3.8	3.2	2.7	3.0	94.7
13	3.8	3.6	4.4	4.2	4.0	3.6	111.0
14	3.6	4.6	4.0	4.6	3.6	3.0	114.0
15	3.9	4.4	4.6	4.4	4.0	3.9	117.0
Average	3.6	4.5	4.1	4.2	3.7	3.5	105.2

1 - Scoring range, 5 to 1.
2 - MacMicheal units.

Table 10. Mean palatability scores[1] for thick white sauces containing 12.5 percent brown sugar, Treatment B1.

Testing period	Odor	Appearance	Color	Consistency	Texture	Flavor	Viscosity[2]
2	4.0	4.3	3.4	4.1	3.4	3.6	71.7
3	4.3	4.4	4.1	4.4	3.9	3.7	65.3
5	3.7	4.0	3.5	4.7	4.0	3.8	66.7
6	4.3	4.1	4.6	4.4	3.1	3.9	83.0
7	3.9	4.3	4.4	4.4	3.4	3.7	68.0
8	4.6	4.2	3.6	3.2	4.0	3.6	64.0
10	4.3	4.4	3.9	4.1	3.9	3.6	66.7
12	4.4	4.6	4.1	4.8	3.9	4.0	83.7
13	4.3	4.7	4.4	4.6	3.7	4.1	81.3
15	4.0	4.3	4.3	4.0	3.4	3.7	61.3
17	4.4	4.4	4.6	4.6	4.0	3.8	79.3
18	4.1	4.4	4.1	4.1	3.6	3.4	77.7
Average	4.2	4.4	4.1	4.3	3.7	3.7	72.4

1 - Scoring range, 5 to 1.
2 - MacMicheal units.

Table 11. Mean palatability scores[1] for thick white sauces incorporating 16.8 percent of brown sugar, Treatment B2.

Testing period	Odor	Appearance	Color	Consistency	Texture	Flavor	Viscosity[2]
1	4.2	4.0	4.6	3.8	3.4	3.8	55.3
3	4.2	4.6	4.6	4.1	3.6	3.7	58.7
4	4.5	4.4	5.0	4.6	3.6	4.0	45.7
6	4.4	4.4	4.6	3.9	3.7	3.9	50.3
8	4.4	4.6	4.2	4.2	4.2	4.0	58.7
9	4.6	4.6	4.7	4.6	3.9	4.0	68.7
11	3.8	4.5	4.0	4.0	3.5	4.0	54.3
12	4.3	4.6	4.6	4.5	3.8	3.9	58.7
14	4.3	4.6	4.6	4.3	3.7	3.9	50.7
15	4.0	4.4	4.6	4.1	4.0	4.3	48.3
16	4.0	4.6	4.4	4.4	3.8	4.0	60.7
17	4.4	4.6	4.4	4.6	3.7	4.2	41.7
Average	4.3	4.5	4.5	4.3	3.7	4.0	54.3

1 - Scoring range, 5 to 1.
2 - MacMicheal units.

Table 12. Mean palatability scores[1] for thick white sauces containing 20.7 percent of brown sugar, Treatment B3.

Testing period	Odor	Appearance	Color	Consistency	Texture	Flavor	Viscosity[2]
1	3.6	4.0	4.4	3.0	3.6	3.8	54.0
2	4.1	4.4	4.4	3.7	3.4	3.4	55.0
4	4.3	4.6	4.9	3.7	3.4	4.2	27.3
5	4.3	4.3	4.7	4.5	3.7	4.3	49.3
7	4.7	4.4	4.4	3.6	3.6	3.6	41.0
9	4.4	4.6	4.6	4.1	4.0	3.7	42.3
10	4.0	4.7	4.6	4.1	4.0	3.9	37.3
11	3.7	4.3	4.3	4.3	3.5	3.3	46.7
13	4.4	4.7	4.7	4.3	4.0	4.0	52.0
14	4.1	4.7	4.6	3.6	3.9	3.7	42.7
16	4.3	4.8	4.6	4.2	3.8	4.0	47.0
18	4.3	4.4	4.3	3.7	3.7	3.9	34.7
Average	4.2	4.5	4.5	3.9	3.7	3.8	44.1

1 - Scoring range, 5 to 1.
2 - MacMicheal units.

CERTAIN USES OF A WHITE SAUCE MIX

by

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Diploma of Home Science,
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AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Institutional Management

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1961

White sauce is a basic part of many recipes used in hospital food services. The conventional method of preparation involves considerable time and labor. Addition of a prepared mix to water has proved to be an efficient and accurate method of preparing white sauce. Versatality of a basic white sauce mix could be increased by combining certain ingredients with the cooked sauce. A variety of milk puddings and cream pie fillings might be possible with the inclusion of sugar, eggs, and flavorings.

This study was undertaken: (1) to compare thick white sauces prepared from a roux and homogenized milk with those made from a mix incorporating instant nonfat dry milk; (2) to determine the palatability of white sauces made from the two types of milk; and (3) to determine the effect of the addition of three levels of light brown sugar to thick white sauce, using the white sauce mix.

White sauces were cooked in electronically controlled trunnion kettles for 45 minutes, and the end-point temperature recorded. A palatability committee scored samples of sauces for odor, appearance, color, consistency, texture, and flavor. A MacMicheal viscosimeter was used to measure the viscosity of the sauces. Student's "t" test for paired comparisons was employed to test the significance of differences between scores for white sauces made using homogenized milk and white sauces incorporating instant nonfat dry milk. Data collected in Part 2 of the study were subjected to an analysis of variance and, where appropriate, least significant differences were determined.

Preparation time at time of use for one gallon of white sauce prepared from the mix averaged 48 minutes, whereas preparation time for sauces made with the conventional method averaged 56 minutes. Types of milk, methods of preparation, and levels of brown sugar had little effect on the temperature of the sauces at the end of the cooking period.

In white sauces using instant nonfat dry milk, the amount of milk solids and fat was 40 and 50 percent higher, respectively, than in sauces made with a roux and homogenized milk. The mix used in this study was adapted from a formula developed originally for a thin white sauce. Therefore, the amount of mix required for a thick white sauce increased the milk solids and fat content of the resulting product.

Thick white sauces incorporating homogenized milk were significantly thicker than sauces made with the mix. Statistical analysis showed that the higher appearance scores received by sauces using instant nonfat dry milk, were significant at the one percent level. Scum formation, curdling, and lumping were evident in homogenized milk sauces. In dry milk sauces, scum was readily dispersed by stirring. This was not true for scum formed on white sauces containing homogenized milk. The texture of white sauces made with the mix was grainy. Although sauces made with homogenized milk were smooth, they were also often declared "gluey" and "pasty" in texture.

Judges' scores for odor and flavor were significantly higher at the one-tenth percent level for homogenized milk sauces than

for sauces incorporating instant nonfat dry milk. In the latter, malty or cereal-like odor often was apparent.

Three levels of brown sugar were added to thick white sauces prepared from the mix. With increasing levels of brown sugar, these sauces showed significant decreases in viscosity. These decreases were attributed in part to moisture content, proportion of nonsugars, and the presence of invert sugar in brown sugar.

Judges preferred the appearance and color of sauces with the two higher levels of brown sugar. Significantly lower scores were obtained for these characteristics in sauces with the least amount of sugar.

Odor and flavor scores were not significantly different for the three treatments. Brown sugar was thought to mask off-odors which occurred in dry milk sauces without sugar added. Generally, judges preferred the flavor of higher concentrations of sugar in the sauces. The scores for consistency of sauces containing the most brown sugar were significantly lower than scores for sauces with the two lesser amounts of sugar. However, on cooling, a more suitable consistency for puddings and cream pie fillings was observed in the former sauces. Sauces containing lower levels of brown sugar became too stiff when cooled.

The grainy texture, apparent in all sauces, was not affected by the levels of sugar. This characteristic was less obvious in cool sauces than in hot ones.