FOOD SCIENCE AND YOU: A PROJECT DEVELOPED FOR YOUTH

Thesis for the Degree of M. S.
MICHIGAN STATE UNIVERSITY
MARILYN MOOK
1973

ABSTRACT

FOOD SCIENCE AND YOU:

A PROJECT DEVELOPED FOR YOUTH

By

Marilyn Mook

A new 4-H project, "Food Science and You," has been developed for use with older 4-H members and adults. The project materials consist of a book of experiments, a record book, and a slide series with narrative.

The book of experiments includes simple experiences which test some of the principles of food preparation, food storage and food handling. The experiments have visually detectable results, and use utensils and ingredients found in the average kitchen. For each experiment, the principle to be tested is stated first, followed by a list of the equipment and ingredients required. The procedure is outlined, and a short explanation of the anticipated results is given. The record book facilitates maintaining a written record of the experimental procedure, the results, and the way the member shared his new knowledge. The slide series provides a visual demonstration of the function of an excess and a deficiency or lack of the ingredients in a one-egg butter cake system.

Twenty-five young people were asked to evaluate the experiments and return the questionnaire. Twenty 4-H'ers ranging in age from nine to 16 years evaluated the experiments and returned the questionnaire. Fifteen adult 4-H leaders also evaluated the experiments. All the adults and 19 of the young people received the project enthusiastically. They enjoyed doing the experiments and would like to test more experiments. The adults and young people also indicated that they would be able to use their new knowledge in future work with food.

FOOD SCIENCE AND YOU:
A PROJECT DEVELOPED FOR YOUTH

By

Marilyn Mook

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Food Science and Human Nutrition

1973

ACKNOWLEDGEMENTS

I wish to thank the members of the graduate committee for their support. Special thanks go to my major professor, Dr. Mary Zabik, for her time and interest in planning and directing my course work and writing. Dr. Dena Cederquist, Dr. Portia Morris and Dr. Carroll Wamhoff also gave me encouragement during this endeavor.

Recognition is also due to Mrs. Hester Fillmore and her Happy Hustlers 4-H club for their evaluation of the experiments in "Food Science and You."

Personal thanks also go to Bonnie Gregg and Claudia Arnold for their assistance in typing and printing this thesis.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION AND LITERATURE REVIEW

4-H Youth Development, the youth program of Cooperative Extension Service, maximizes the total potential of young people. 4-H has been recognized for its contribution to the development of social responsibility and personality through "real-life" experiences. Through projects in science and technology, 4-H teaches the scientific process of decision-making, and stimulates creative interaction. Ideally, 4-H fosters inventiveness and emphasizes better planning of what is to be learned, so that the participant may begin to set up his own life goals (1).

In 1915, Michigan Agricultural College first published a bulletin (2) outlining six club projects for boys and six for girls. The boys' projects were corn, potatoes, apples, livestock, poultry, and market gardening. The projects for girls included housekeeping, garment-making, canning and marketing, gardening and canning, poultry, and market gardening. These projects were designed to help the boys and girls acquire these skills. The bulletin states that boys' and girls' club work "reinforces the school at its weakest point; unites the home and school; is the kind of education that fits for the duties of life; teaches in terms of action; keeps boys and girls on the farm; vitalizes home and school work; and makes better citizens."

Extension's youth program continues to do many of these things for young people, but the type of skills taught changes as the population changes from rural to urban. Michigan is becoming an urban state. Michigan's metropolitan area increased 14.1% or 850,000 people in the ten-year period from 1960 to 1970. The non-metropolitan area increased 11.1% or 200,000 people in the same time span. Of Michigan's 8.8 million people, 6.8 live in metropolitan areas. The trend toward population centralization continues, with nearly half of Michigan's residents living in the Detroit area of Wayne, Oakland and Macomb counties (3).

Major population shifts to a highly urban and rural non-farm majority have resulted in corresponding shifts in needs and interests among young people. Along with population shifts have come tremendous advances in science and technology (4).

Until a few years ago, 4-H food and nutrition projects in Michigan, as well as in other states, promoted food preparation. Project participants learned cooking skills, and were expected to practice until they could make perfect cookies or pie crust or bread. With the development of food technology and the refinement of the distribution and marketing process, the food industry is able to provide prepared, pre-packaged and partially prepared foods at low cost to the consumer. Examples of perfect cookies, pie crust and bread may be found in supermarkets, and it is no longer necessary to bake these items at home.

The beginning of the shift to the "why's" of food preparation rather than the "how's" began in 1964 (5). A United States Department of Agriculture publication urged Extension workers and leaders to integrate more science into the learning experiences of 4-H members and adults. The publication stated that incorporating science is one major way of having an up-to-date and forward-looking program. Science in foods means understanding the properties and characteristics of foods as well as the proper means of preparing them. The Michigan foods project bulletins were revised to include more of the "why's" or scientific aspects of food preparation (6, 7, 8). One chapter of a bulletin published in 1965 is devoted entirely to Experimental Foods (9).

The next step was to prepare an entire project on the scientific aspects of food. A few states have already published bulletins in food science (10, 11, 12, 13, 14, 15). Although these bulletins have not been revised since they were written, they have been used successfully in state-wide youth programs.

"Exploring Dairy Food Science," from the National 4-H Service Committee, presents techniques and ideas for dairy foods demonstrations. Members are urged to use foods from the Milk Group in new and creative ways for planning and preparing meals for their families. A few experiments on making butter, making cottage cheese, and cooking with cheese are provided for the members to use (16).

Colorado's publication, "4-H Food Science," presents 25 experiments designed to demonstrate the changes that take place in cooking because of the properties of the food. Experiments are designed to demonstrate the effect of cooking on the flavor, color and texture of vegetables; the effect of cooking temperature on the texture of meat and eggs; and the effect of fat on the body, texture and flavor of ice cream (15).

"Adventures in Food Science" from California provides 18 experiments which show how scientific projects may be carried out with food. Experimenters may test various foods for starch, test the effect of enzymes on protein, and test different methods of cooking vegetables to determine the effect on color, flavor and texture. Members and leaders may then understand some of the reasons for their own food preparation successes or failures (13).

A series of leaflets also titled "Adventures in Food Science" was published in Florida. These leaflets include two or three experiments on color in vegetables, color changes in meats, leavening, gelatin, emulsions, and vegetable cellulose. The project leaflets are designed to acquaint the experimenter with scientific principles to improve the use of food in everyday meal preparation (12).

Pennsylvania has two publications, "Fun with Food Science" and "Food Science for Teen Leaders." "Fun with Food Science," a project for younger members, has three suggested experiments. The experiments provide information to demonstrate that scientific facts may be applied to daily food preparation (11).

"Food Science for Teen Leaders" is a book of activities demonstrating chemistry of food. Participants conduct experiments on the effect of oxidation, heat, pH and enzymes in food preparation (10).

"Adventures in Food-Nutrition" from South Carolina is also a book of experiments in food chemistry. The members learn the major and minor constituents of milk; the nature and properties of fats, proteins, lactose, wheat gluten and leavening agents; and color changes in cured meats, fruits and vegetables (14).

Although these states have had 4-H Food Science projects, Michigan did not have a project of this type. Enrollment of older teens in 4-H youth programs has been decreasing (17). In the 1960 fiscal year 13,400 youhg people aged 16 to 18 were participating in 4-H. By 1965 enrollment had dropped to 11,100, and in the 1972 fiscal year, 8,600 young people in the 16 to 18-year age range were members of 4-H. A project promoting the food science aspect of food and nutrition could help maintain interest and participation of older teens enrolled in the 4-H food and nutrition project area.

A food science project would emphasize the scientific aspects rather than the methods of food preparation. A project which uses simple experiments to test the principles of food preparation, food storage and food handling would have appeal to both boys and girls in the food and nutrition project area, as well as other project areas. The food science project could be considered a science experience as well as a foods project. In participating in this project, young people will learn some of the principles of food preparation, food storage and food handling. They will learn that the components of food systems work together to produce desired results, and they will be encouraged to share their new knowledge with others in some creative way.

After the experiment book is developed, the experiments will be evaluated by a selected group of young people and adult leaders. The participants will complete and return a questionnaire after they have concluded the experiments. Included in the questionnaire will be the age of the member, place of residence, if he liked doing the experiments, what he learned, if he could share his new knowledge with others, and if he would like to participate in further experiments. Comments and suggestions will also be solicited at the end of the questionnaire.

In addition to the experiment book, a record book will be included to facilitate data collecting in these scientific experiences. In the record book, the participant will note the time the experiment took, what principle was tested, what results were obtained, what he learned from this experiment, and how he shared this knowledge.

A series of slides and narrative will be developed that visually demonstrate the function of ingredients in a one-egg butter cake system. The slides will point out the effect of an excess and a deficiency or lack of each ingredient on the appearance of the cakes. These slides will be used for educational and promotional experiences for 4-H members and leaders in Michigan.

DEVELOPMENTAL PROCEDURE

The purpose of this study was to develop and to obtain a preliminary evaluation of a learning project in food science for 4-H youth. The project, "Food Science and You," consists of a book of experiments, a record book, and a set of slides with narrative. The objectives of this project are to test some of the principles of food preparation, food storage and food handling; to learn that the components of a food system work together to produce desired results; and to share knowledge in a creative way. It is hoped that through participating in this project, young people and their leaders will realize that food preparation is based on scientific principles, and will understand that the preparation of food is more than a skill.

Experiment Book

The experiment book includes 100 experiments testing some of the principles of food preparation, food storage and food handling (Appendix A). Experiments in measuring, ingredient function, proteins, carbohydrates, fats, freezing, and microbiology were developed. All of the experiments were pre-tested by the writer before inclusion in the experiment book.

The principles to be tested were first determined, then experiments were selected to demonstrate these principles. The criteria for the experiments were: (1) the experiment should require the use of ingredients and utensils found in the home kitchen or readily available; (2) the outcome of the experiment should be readily and easily discernible; (3) the principle tested should be applicable to ordinary food preparation situations.

Many of the experiments were adapted from those used in three undergraduate classes in the Department of Food Science and Human Nutrition at Michigan State University. Two of the classes, Experimental Foods 403 and Experimental Foods 404, provided the basis for the experiments on food storage and a majority of the experiments on food preparation. For the experiments on food handling, experiments were adapted and simplified from some of those used in Food Microbiology 440. Other experiments were adapted from the laboratory manuals (18, 19) for Food Preparation 100 and Food Preparation 200.

Some of the experiments used in Experimental Foods 403 and 404 classes indicated the use of measurement of ingredients by weight rather than volume, and heating to temperatures expressed in centigrade rather than Fahrenheit. To be included in "Food Science and You," the experiments were changed to require volumes of household units, and temperatures in Fahrenheit readings or a visually described end point.

The writer pre-tested all of the planned experiments. Several of the experiments which were originally planned were discarded before pre-testing. Some were changed after pre-testing to insure reproducible results by the 4-H'ers. Many of the experiments require the use of half-batches or half-recipes in order to conserve ingredients and to have smaller amounts of the experimental sample. Experiments on the function of sugar, acid, pectin and cooking time on the formation of jelly were discarded because of the difficulty encountered in obtaining accurate temperature readings using half-batches of jelly. The experiment on the coagulation of milk protein by rennin was also discarded because rennin tablets are not available in most of the areas of Michigan.

The experiment on the function of excess sugar in a cake system was also changed. It was originally planned to use double the amount of sugar, but the sugar tenderized the gluten in the system to the point where the batter ran over the pan during baking and burned onto the floor of the oven. The amount of extra sugar added to the cake system was decreased to the point where the cake batter rose to the edge of the pan, rather than running over the pan. The experiment on the function of excess baking powder in a cake system required three times the amount rather than twice added to the cake system in order to produce a visually acceptable product. The cooking time allowed in the experiment on the heat treatment of shellfish was also increased considerably. The original time of heating produced toughening that was discernible only by trained people. In order to provide a dramatic demonstration of heat toughening protein, the total cooking time was doubled. In the experiment on the development of gluten by liquid and manipulation, the muffin batter was originally stirred a total of 75 strokes. This was increased to a total of 105 strokes, so that the experimenter would be better able to see the changes in batter texture as the experiment progressed.

Each experiment as written in the experiment book has the same format: (1) presentation of the principle to be tested; (2) equipment and ingredients required to perform the test; (3) outline of the experimental procedure; (4) description of the anticipated outcomes of the experiment; (5) explanation of the experimental findings.

Record Book

A record book was developed to accompany the project (Appendix B), adapted from one used with Colorado's 4-H Food Science project (20). Since record-keeping is a part of any scientific experience, the book was designed to facilitate keeping accurate notes of the experimental procedure and results.

For each experiment, the member records the date on which he completed the experiment; the time required for completion; the principle tested; the way the experiment was designed; the results; the application of what has been learned; and ways the member has shared or hopes to share his new knowledge. One page of the record book is completed, so that the members may understand more easily how to use the record book.

Visual Learning Aids

A set of slides and accompanying narrative (Appendix C), visually pointing out the function of ingredients in a baked product, was developed as a learning aid as well as a promotional device. The ingredients demonstrated are flour, sugar, salt, baking powder, egg, shortening and liquid. The slides show the effect of an excess and a deficiency or lack of each ingredient on the appearance of a one-egg butter cake. The slides and narrative may be used to stimulate interest in the new 4-H food science project, as well as to present a visual explanation of the function of various ingredients in a cake system. These learning aids will be available on a loan basis for anyone to use, through the county extension offices.

Preliminary Evaluation

The experiment book and record book were presented at 4-H foods leaders' meetings in Eaton, Oakland and Kalamazoo counties early in the summer of 1972. Some 4-H members were present at the meetings. The project, "Food Science and You," was introduced as a new foods project in Michigan, and some of the experiments were explained. The leaders were asked if some of the members in their clubs might wish to be among the first to use the new food science project. Those leaders interested were given additional information and copies of the project book and record book. The names and addresses of the leaders, as well as the number of copies of the materials they requested, were taken in order to send the follow-up questionnaire.

The questionnaire (Appendix D) gathered information on the age of the member; where he lived (city or country); what experiments he conducted; what he learned; if he was able to share his new knowledge with others; if he liked doing the experiments; and what comments or suggestions he had for other young people who might participate in this project.

Sixty-five copies of the experiment book and record book were distributed in the three counties. After two months, questionnaires were mailed to the leaders along with self-addressed franked envelopes with enclosure slips for ease in returning the questionnaires. The two-month time lapse was allowed to give leaders time to organize their clubs, distribute the new project materials, explain the project, and for members to complete the experiments they chose.

No questionnaires were returned, despite letters to the leaders and county 4-H staff indicating that the data on the questionnaires were needed. It is possible that leaders lost interest in the new food science project, or felt uncomfortable with it if they were not able to answer members' questions. The meetings at which the project was presented were primarily for adult leaders, so the members did not hear the original explanation of the project and experiments. No date for the return of the questionnaires was given to the leaders at the meetings early in summer.

Early in the fall of 1972, the 4-H staff of Ingham County was requested to indicate a 4-H leader and club who would be interested in testing the new food science project. The experiment book and record book were given to selected members of the Happy Hustlers 4-H Club of Stockbridge, Michigan. Members who had shown interest in the new project at the club's organizational meeting were given additional information and instruction. Twenty-five members ranging in age from nine to 16 years agreed to complete assigned experiments by the requested deadline, complete the record book, and return the questionnaire. The members were given the questionnaires and self-addressed franked envelopes with enclosure slips at the time of the organizational meeting. They also received a written explanation of the project and what their responsibility was in returning the questionnaire.

Fifteen adult 4-H foods leaders in Big Rapids, Michigan also tested selected experiments. These leaders, participating in a leadership development workshop, completed experiments on liquid and dry measuring, and the function of ingredients. The adults also completed a short questionnaire, which gathered information on what experiments they tested; if they enjoyed doing the experiments; what they learned; if they could share their knowledge with others; and comments and suggestions for improving the experiments for use with young people. The adults were given the questionnaires at the beginning of the workshop, and they turned them in before they left.

RESULTS AND DISCUSSION

Food Science and You

One hundred experiments are included in the experiment book (Appendix A). The experiments require the use of ingredients and utensils found in the average kitchen, and are designed to result in readily detectable outcomes. These experiments allow the participant to test some of the principles of food preparation, food storage and food handling.

For ease in selecting the experiments, they have been grouped according to categories. The experiments differ in the degree of difficulty in order to meet the needs of varying age groups. Various levels of accomplishments are expected from the members in the different categories of experiments.

The format for each experiment is identical. The principle to be tested is presented first. A list of the equipment and ingredients required to complete the experiment follows. Then, the experimental procedure is outlined, and the anticipated outcome is described. Finally, an explanation of the experimental findings is given.

For example: one principle to be tested states, "Quality of shell eggs deteriorates with aging and is dependent upon storage conditions." Eggs are stored in the refrigerator in a covered container, in the refrigerator uncovered, and uncovered at room temperature. One egg from each group is broken out after one day or storage, then three days, and finally seven days.

During storage, the air cell of the egg becomes larger, the white becomes thinner, the yolk increases in size and its vitelline membrane weakens, and the egg becomes more alkaline.

When the egg is laid no air cell is present. As the contents cool, shrinkage occurs and air is drawn in through the porous shell, creating an air space at the large end of the egg. The air cell increases in size during aging because the egg loses moisture through the shell. Water continues to evaporate as aging progresses, and this evaporation is accelerated at higher temperatures and if the egg is not covered during storage.

The amount of thick white decreases during storage. Of the more than 15 proteins in egg white, ovomucin is the protein thought to be responsible for thick white. Ovomucin is a mucoprotein, and more mucin is found in thick white than in thin white. The increase in thinning is correlated with an increase in the alkalinity of the egg. Alkaline hydrolysis of the disulfide bonds of the ovomucin may be the reason for the increase in thin white. When an older egg is broken out onto a flat surface, the white does not stand up and it spreads out over a wider area than a fresher egg.

During storage, the egg also becomes more alkaline. Carbonic acid in the egg breaks down to form carbon dioxide. The carbon dioxide passes through the shell until equilibrium with the ambient air is reached, and the pH of the egg increases. The egg, when laid, has a pH of about 7.6. During the first few days the pH increases rapidly, to about 8.9. After further storage the alkalinity of the egg white increases to about 9.4. At higher storage temperatures, carbon dioxide is lost at a more rapid rate than if the egg is stored at lower temperatures.

The yolk increases in size because water moves from the white through the vitelline membrane surrounding the yolk. The greater osmotic pressure in the yolk draws the water through the membrane. Because the yolk size increases the vitelline membrane stretches and becomes more fragile. In some eggs stored for a long period of time, the yolk will break when the shell is cracked because of the fragility of this membrane. The yolk becomes less viscous and is flatter than the yolk of a fresh egg when broken out. The yolk may also move away from the center toward the shell wall, and may attach itself to the shell. This may be easily seen in extremely old eggs which are hard-cooked.

Although the experimenters cannot see all of these processes of aging, they may see some of the results of the increased deterioration in the quality of shell eggs stored under different conditions. The amount of thin white may be determined by measuring the spread of the white after the egg has been broken out onto a flat surface. The yolk of an old egg is also flatter and larger than that of a fresh egg. The size of the air cell may be noted by hard-cooking the egg, peeling off the shell, and noting the flatness of the egg at the large end. This flatness is an indication of the air cell. In hard-cooked eggs, experimenters may also note the position of the yolk. In older eggs, the yolk may be very close to the side of the shell, or even attached to the shell.

In the section on measuring, the members learn that measuring cups and measuring spoons are standardized, whereas tea cups, coffee cups and table flatware cannot be relied on for accurate measure. Sifted flour and firmly packed brown sugar give more reproducible results than unsifted flour and non-packed brown sugar. Sifting of flour and packing of brown sugar insures that the density of these ingredients will be constant when they are used in food preparation, and the volume of the amount required will be correct for the food system in which these ingredients are used.

There are several sections on the functions of ingredients in food systems. In the section on flour, the experiments are designed to illustrate the relative gluten strengths of different flours and grains. Wheat flour contains two proteins, glutenin and gliadin. Together with liquid, these two proteins form gluten. Cake flour has the lowest gluten strength because it is milled primarily from soft wheat which contains more starch and less protein. Bread flour has the most gluten because it is milled from hard wheat, which has more protein and less starch. All-purpose flour from Michigan has a high gluten strength also. There is a high proportion of hard wheat flour in the mixture as Michigan raises hard wheat.

The proteins in flour together with moisture and manipulation form the gluten framework for baked products. Over-manipulation or over-stirring develops the gluten to the point where tunnels form in the baked item. Excessive manipulation causes the gluten strands to collapse.

The section on sugar provides experiments to demonstrate that sugar contributes to browning, tenderness and flavor in baked items. The heat of baking caramelizes the sugar, causing the top crust to turn brown. Excess sugar in baked products causes tenderness because the sugar takes up the moisture present, leaving too little liquid to combine with the gluten in the flour. As sugar is increased, a sweeter flavor results in the finished baked product.

Sugar also contributes to the firmness of cornstarch pudding. Excess sugar competes with the cornstarch for the moisture present. The sugar binds the moisture so that there is not enough liquid to mix with the cornstarch and form a gel of the desired strength. In a gelatin gel, the presence of sugar also results in a softer product. The liquid is taken up by the sugar and too little moisture is available for the gelatin to form the proper structure.

In fudge, sugar contributes to the firmness of the product. When excess corn syrup is added to the fudge mixture, the product is softer than desirable because the invert sugar in the corn syrup interferes with the crystallization of the sugar.

In the leavening section the experiments demonstrate how carbon dioxide is liberated from the various leavening agents. With the application of heat, baking powder releases carbon dioxide when mixed with liquid. Baking soda liberates carbon dioxide in the presence of heat when mixed with acid substances such as vinegar and orange juice. Baking soda is alkaline in nature; baking powder is a mixture of acid and alkaline materials. Baking soda is used in baked items which have other ingredients which are decidedly acid, such as sour milk, buttermilk, or molasses.

Yeast yields carbon dioxide in the presence of sugar, liquid and heat. Liquid rehydrates the yeast. The sugar provides food for the yeast plants to grow and produce carbon dioxide.

Baking powder is the leavening agent in many baked items. A lack of baking powder results in a cake that does not rise, and excess baking powder results in a cake that is very porous. The carbon dioxide forms very large air cells, and may stretch the gluten strands too much so that they collapse. The cake may be sunken in the middle.

If participants select experiments from the salt section, they learn salt's role in contributing flavor to cakes. Elimination of the salt results in a cake that has little flavor. Excess salt in a cake results in a decidedly salty taste.

Salt water causes raw vegetables to become limp and soft because of osmotic pressure. Water in the cells of the vegetable is drawn out by the concentrated salt solution.

The stability of an egg white foam is also decreased by the addition of salt. Upon standing, the foam exhibits a greater amount of leakage than an egg white foam beaten without the addition of salt.

The section on eggs provides experiments that demonstrate the function of egg in a cake system. Egg adds some protein for structure, and the lecithin in the yolk probably helps to emulsify the mixture. An excess amount of egg tends to decrease the volume of the finished cake, and to make the crumb tough. Too little egg results in a cake with a dry crumb because less liquid is present when the egg is omitted.

Eggs coagulate when heated because of the denaturation of the proteins. The application of too much heat, too long a cooking time, or both, result in an overcooked and toughened egg.

The lecithin in egg yolk, in addition to emulsifying cake batter, also helps to form a mayonnaise emulsion. Without egg yolk, no emulsion is formed in a mayonnaise mixture. An emulsion does form when whole egg is used, but the mixture is softer than desirable because the egg yolk has been diluted by the egg white.

Experiments on fats demonstrate that fat contributes tenderness, moistness and flavor to cakes. With an excessive amount of fat the crumb is greasy, the volume may be small, and the cake is crumbly and too tender. A lack of fat in a cake system results in a cake that is dry and slightly tough. Butter and margarine add their distinctive flavors when used in cakes.

Solid and liquid fats have different smoke points. Butter has the lowest smoke point because of the water which is present naturally in butter. Solid shortenings have a higher smoke point, but lower than oils. The emulsifiers, which have been added to solid shortenings to improve their baking qualities, lower the smoke point. As oil has no emulsifiers added, the smoke point is the highest of the three fats.

Frying in fat heated to a temperature higher than that recommended results in food that is burned on the outside and underdone in the center. Food fried in fat heated to too low a temperature is grease-soaked.

Fat is one phase of food emulsions. In a permanent emulsion such as mayonnaise, the lecithin in egg yolk keeps the droplets of oil from coalescing. In a temporary emulsion such as French-type salad dressing, the spices and seasonings help keep the oil droplets separated during and shortly after agitation of the mixture.

In the section on building a muffin, the experimenters learn the functions of the various ingredients and amounts of ingredients in a muffin system. In this series of experiments, the 4-H'er begins with flour, water and salt; he adds other ingredients, one at a time, in succeeding experiments, until the muffin system is complete.

If members select experiments in the section on baking soda, they learn that alkali in the form of baking soda softens vegetable texture. The addition of baking soda to the cooking water for vegetables will hasten the softening process. This practice will, however, destroy much of the thiamine present in the vegetable. Baking soda also causes anthoxanthins to turn brown, orange or yellow.

Experiments on acid demonstrate that acid hydrolyzes gelatin proteins. When acid is added to a gelatin sol, the gelatin absorbs more water, resulting in a softer gel. An acid marinade used for soaking some meats will result in a more tender cut after cooking.

Acid also makes anthocyanins redder, and alkali turns these pigments purple or blue. The reaction is reversible, and acid added to food that has become bluish from an alkaline reaction returns the red color. Chlorophyll turns to pheophytin in the presence of acid. This olive green color results when green vegetables are cooked in a covered container. The volatile plant acids cannot excape and pheophytin forms.

Experiments in the section on cornstarch are designed to illustrate the effect of several ingredients on the firmness of a cornstarch gel. Sugar makes the gel soft or tender because of the competition for the liquid by the sugar and cornstarch. Sugar binds the water present and not enough is available to form a gel of the proper consistency. Additional liquid makes the gel softer because there is too much liquid for the sugar and starch to absorb. Acid added to the mixture results in a softer gel because the starch polymers are broken, and they are not able to bind the proper amount of liquid. Fat added to the cornstarch pudding interferes with gelation and makes the gel slightly softer with a silky mouth feel. An increase in the concentration of cornstarch increases the firmness of the gel. There are more starch granules to bind the available liquid, and the gel is firmer than desired. The strength of a cornstarch gel is weakened by stirring after the gel has been formed. The walls of the starch granules are broken and the liquid is released, thus making the mixture thinner. The gel is also softer when the mixture has been heated at a slower rate, such as over hot water, rather than over direct heat.

The egg white experiments help the participant learn what affects the stability of an egg white foam. Overbeating decreases stability, as too much air is incorporated, stretching the albumen until it is thin and loses elasticity. Liquid added to egg white during beating decreases the stability of the foam because the protein is diluted and loses its elasticity. Sugar and acid increase the stability of the foam. A longer time is required for beating to highest volume when sugar is added to the egg white foam. Sugar retards the denaturation of the egg white proteins. Acid in the form of cream of tartar also increases the beating time required, but makes the foam more stable.

In the section on protein the experimenters learn that muscle proteins are toughened by the application of high heat and extended heating times. Excessive heat treatment causes the proteins to shrink and increases drip loss. The surface of the meat becomes dry and tough.

Casein, one of the proteins in milk, is coagulated by the addition of acid. The curdled appearance that results when acid is mixed with milk indicates that the casein has been coagulated. The skin on the top of heated milk is lactoglobulin; the scum which forms on the sides and bottom of the pan is lactalbumin.

The strength of a gelatin gel is dependent on many factors. Increasing the concentration of gelatin results in a stiff gel, because more gelatin is available to bind the liquid present. Additional liquid decreases the gel strength because there is too much liquid for the gelatin to absorb. Enzymes present in the mixture hydrolyze the proteins and no gel is formed. A gel which is formed at a higher temperature, such as room temperature, will be softer than one formed at refrigerator temperature. However, the gel formed at the higher temperature will not melt as rapidly as the one formed at the lower temperature.

The section on storage includes experiments that demonstrate how correct wrapping helps foods maintain their quality. The experiments on refrigerator storage show that fresh shell eggs lose moisture and quality when stored uncovered in the refrigerator. The freezing experiments show the members that various wraps differ in their ability to prevent food from drying. As freezer air is dry air, food to be held in freezer storage should be wrapped in moisture-vapor-proof packaging in order to maintain highest quality.

Experiments in the section on microbiology show the members that proper handling of food and utensils reduces the possibility of microbial growth. In completing these experiments, the participants contaminate prepoured agar plates with the mishandled food and utensils. The plates are then incubated at room temperature for three days, and the members compare the microbial growth on the plates contaminated with the mishandled materials with those contaminated by properly handled items.

Project Evaluations

Attempts to evaluate the experiments and record book with leaders and members in Eaton, Oakland and Kalamazoo counties were not successful. Although 65 copies of the experiment book and record book were distributed, no response was derived from the three counties. Questionnaires and follow-up letters were mailed to the leaders who had requested the experiment books, but no questionnaires were returned.

A second attempt to evaluate the experiment and record books was made with one 4-H club in Ingham County. Young people from the Stockbridge, Michigan Happy Hustlers 4-H club were interested in evaluating the new food science project. Of the 25 members who had agreed to complete the experiments, 20 returned the questionnaire (Appendix D). Table I shows the responses of the young people who returned the questionnaires.

One was nine years old, five were 12, four were 13, three were 14, four were 15 and three were 16 years o-d. Twelve of the participants lived in the country and eight lived in the city. Fourteen enjoyed doing the experiments, one did not, and five felt that the experience was so-so. Seven were teen leaders and 13 were not, but 19 of the 20 felt they could use their new knowledge with other members and in their future work with food. Nineteen of the 20 also indicated that they would like to participate in more experiments.

The members of the Stockbridge club has been assigned specific experiments to complete; however, not all of the young people conducted the experiments assigned to them. All of the experiments were tested except numbers 87, 88, 89 and 90 dealing with refrigerator and freezer storage (Appendix A). These experiments were not done because the time for completion of some is more than the four weeks allowed for testing, and probably these experiments were omitted because they are near the back of the book.

The experiments on measuring and those on the function of ingredienrs were done by several members of the experimental group. These are simple experiments, require little time, and are at the front of the book.

There appeared to be no correlation between the ages of the young people and whether or not they enjoyed participating in the experience. The few who indicated that the experiments were so-so had completed many more experiments than they had been asked to do. Since they were asked to complete the project in four weeks, fatigue may have contributed to

Table 1. Responses of 4-H youth[a] to questionnaire evaluating "Food Science and You"

Age	No. of participants	Residence		Enjoy this project?			Teen leader?		Able to use knowledge?		Want to do more?	
		City	Country	Yes	No	So-so	Yes	No	Yes	No	Yes	No
9	1	0	1	1	0	0	0	1	1	0	1	0
10	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	5	3	2	3	0	2	0	5	5	0	5	0
13	4	1	3	3	0	1	0	4	4	0	4	0
14	3	2	1	3	0	0	2	1	3	0	3	0
15	4	2	2	1	1	2	3	1	3	1	3	1
16	3	0	3	3	0	0	2	1	3	0	3	0
Totals	20	8	12	14	1	5	7	13	19	1	19	1

[a]20 of 25 questionnaires were returned

their reaction.

Fifteen adult leaders of 4-H foods clubs tested experiments 1 through 17 and experiment 57 (Appendix A) at a one-day workshop in Big Rapids, Michigan. These experiments involve liquid and dry measuring, the function of ingredients in a cake system, and the effect of manipulation on gluten development.

The adults completed a questionnaire (Appendix D) about the experience before leaving the workshop. Table 2 shows the reactions of these leaders to the experience.

Table 2. Reactions of 4-H leaders to experiments on measuring, ingredient function and gluten development

No. of leaders	Enjoy this experience?		Able to use knowledge?	
	Yes	No	Yes	No
15	15	0	15	0

All of the adults indicated that they enjoyed completing the experiments, and that they were pleased with the new approach to foods projects. They all felt that they could use their new knowledge and could share it with the members of their own clubs. The leaders also viewed the slide series on the function of ingredients in a cake system. Several asked when it would be available for loan.

Discussion

Although this project was designed for older teens the young people evaluating the experiments ranged in age from nine to 16 years, with the median age 14 years.

Only one of the young people indicated that she did not enjoy participating in the experience, and was not interested in completing more experiments. She was the club leader's daughter, and although she had never been enrolled in a foods project she completed experiments on gelatin and measuring.

The members shared their new knowledge with their families and friends. They had not yet shared this knowledge with other members of the club and community because only four weeks were allowed to complete the experiments and return the questionnaires.

None of the members had suggestions for changing the experiments. A few made comments that the experiments were fun to do; the directions were clear; and the experiments would be fun to complete with a group of other young people.

The 4-H leaders also had no suggestions for changes in any of the experiments or directions. They indicated that they would be able to use the experiments with the members of their own clubs, and that their members would be interested in the new food science project.

SUMMARY AND CONCLUSION

A 4-H learning project in food science was developed for use with older members and leaders. The project consists of a book of experiments, a record book, and a slide series with narrative. The experiment book includes 100 experiments which test some of the principles of food preparation, food storage and food handling. The experiments require the use of ingredients and utensils found in the average kitchen, have visually discernible results, and can be applied to everyday food situations.

The format for each experiment is identical. The principle to be tested is given first, then a list of the equipment and ingredients required to complete the experiment. The experimental procedure is outlined, and the anticipated results are given. An explanation of the reasons the results can be expected completes the format.

The record book provides an appropriate form for noting the progress of the scientific experiments. The member is able to record the results of the experiment, what he learned, and how he shared or plans to share his new knowledge with others.

The slide series and narrative is a visual presentation of the function of the various ingredients in a one-egg butter cake system. The slides depict the appearance of cakes prepared with an excess and a deficiency or lack of each ingredient. The ingredients demonstrated are flour, sugar, salt, baking powder, shortening, egg and liquid.

Attempts to evaluate the experiment and record books with leaders and members in three Michigan counties were not successful. However, 20 young people from one 4-H club and 15 adult 4-H foods leaders agreed to evaluate the experiments. The 4-H members were assigned experiments to complete so that each experiment would be evaluated, but the experiments on food storage were not completed. The adult leaders evaluated selected experiments on liquid and dry measuring, the function of ingredients, and the effect of manipulation on gluten development.

All of the adults and 19 of the young people indicated that they enjoyed doing the experiments, would be able to use their new knowledge with others, and would like to participate in more experiments.

"Food Science and You" should be tested and evaluated with a larger group of young people and adults. Since the project was designed for older teens, a greater effort might be made to seek out this audience for participation in the project. As it was assumed that boys would be interested in a food science project, a particular effort should be made to contact boys and involve them in this new project.

The group of young people and adults who evaluated the experiments were a biased sample, as both groups were involved in foods, either as members of 4-H foods projects or as leaders of foods clubs. A more accurate indication of interest might be demonstrated by using a random sample of young people and adults from all 4-H project areas, or a group of young people and adults not involved in the 4-H program.

The evaluating groups were not representative of the Michigan 4-H audience. The young people were members of one club in one county, and the leaders were those who had elected to participate in the food science portion of a leader-training workshop.

"Food Science and You" will be introduced to Extension 4-H Youth Agents and 4-H foods leaders and members in the spring of 1973. The introduction and explanation of the project will be part of the agenda for the annual foods leader-training workshops which will be held in several areas of the state. Extension 4-H Youth Agents will be introduced to "Food Science and You" at the annual statewide spring conference.

LIST OF REFERENCES

List of References

1. Extension Subcommittee on 4-H Youth Development. Report and Recommendations of an Expanded 4-H Program. Submitted to the Extension Committee on Organization and Policy. Chicago, 1966.

2. Michigan Agricultural College. Club Bulletin #1. Extension Division, 1915.

3. Michigan State University. Population Growth and Redistribution. Agriculture Experiment Station, East Lansing, 1971.

4. Ad Hoc Committee for Intensive Study and Special Consideration to the Future Direction of 4-H and Other Youth Extension Program Development. Extension Youth Programs in the 20th Century: A Position Paper. Washington, D. C., 1965.

5. United States Department of Agriculture, Federal Extension Service. Science in Food and Nutrition: A Guide for Extension Workers. Washington, D. C., 1964.

6. Brink, Muriel S. Food For Fun. Extension 4-H Bulletin 155A. Michigan State University, East Lansing, 1967.

7. Brink, Muriel S. The Young Chef. Extension 4-H Bulletin 155E. Michigan State University, East Lansing, 1966.

8. Brink, Muriel S. Today's Girl, Tomorrow's Homemaker. Extension 4-H Bulletin 155D. Michigan State University, East Lansing, 1966.

9. Brink, Muriel S. Exploring Foods and Nutrition. Extension 4-H Bulletin 155K. Michigan State University, East Lansing, 1965.

10. Carroll, Ruthalee M. Food Science for Teen Leaders. The Pennsylvania State University, University Park, 1966.

11. Anonymous. Fun with Food Science. The Pennsylvania State University, University Park, 1970.

12. Camp, Susan and Williams, Izola. Adventures in Food Science. University of Florida, Gainesville, 1965.

13. Cook, Frances. Adventures in Food Science. University of California, Berkley, 1965.

14. Hindman, Marie S. Adventures in Foods-Nutrition. Clemson University, Clemson, South Carolina, 1967.

15. Stewart, May. 4-H Food Science. Colorado State University, Fort Collins, 1963.

16. National 4-H Service Committee. Exploring Dairy Food Science. Chicago, Illinois, 1965.

17. _____, Telephone conversation with Dr. Lowell Rothert, Program Leader, 4-H Youth Programs, Michigan State University, East Lansing. September 20, 1972.

18. Morr, Mary L. and Irmiter, Theodore F. Introductory Foods. New York: McMillan Co., 1970.

19. Coleman, Mary C. and Deskins, Barbara B. Introductory Food Preparation. Michigan State University, East Lansing, 1966.

20. Stewart, May. 4-H Food Science: Record Book. Colorado State University, Fort Collins, 1969.

APPENDICES

A. Experiment Book
B. Record Book
C. Slide Narrative
D. Questionnaire

APPENDIX A

Experiment Book

4-H BULLETIN 155J

MICHIGAN STATE UNIVERSITY

FOOD SCIENCE AND YOU

marilyn mook
food/nutrition specialist

IF YOU'RE INTERESTED IN...	...DO THESE EXPERIMENTS
What Ingredients Do	6 7 8 9 10 11 12 13 14 15 16 17
Measuring	1 2 3 4 5
Flour	1 6 13 56 57
Leavening	8 12 32 33 34 35
Salt	9 14 59 66
Eggs	10 16 52 58 59 60 87 89 100
Fat	11 17 38 44 51 52 53 54 55 63 80
Building a Muffin	18 19 20 21 22 23 24 25 26 27 28 29 30 31
Alkali (Baking Soda)	33 47 83 84 85
Cornstarch	36 37 38 39 40 41 42 43
Acid	40 45 48 64 69 73 79 81 82 83 85
Cellulose	47 48 49 50
Egg White	53 61 62 63 64 65 66
Protein	56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71
Gelatin	67 68 69 70 71
Enzymes	71 78
Color	80 81 82 83 84 85 86
Storage	87 88 89 90 98 99
Freezing	89 90
Microbiology	91 92 93 94 95 96 97 98 99 100

TABLE OF CONTENTS | PAGE

THINGS TO REMEMBER...

...about FOOD SCIENCE AND YOU

...This project is designed to help you find out what heppens when you change one of the parts of a food system. You get to do all the "don'ts."

...Some of the experiments are easier than others. But the easy ones are mixed in with the more difficult ones. Read through all the sections before you decide which experiments to do.

...Recipes (or formulas) should come from a standard cookbook. Use any basic cookbook you wish.

...A record book is included as part of this project. Records are an important part of any scientific project. The record book helps you keep track of what happened in each experiment.

...In most experiments a control is used for comparison purposes. The control is the standard or yardstick against which you compare the experimental food.

...When doing the experiments, keep everything the same as the control EXCEPT the one thing that changes. Use the same size pans, same bowls, mixing speeds. Be sure that just one thing changes each time. If the experiment calls for three cake pans the same size, for instance, and you don't have three, just use one three times. The cakes can be wrapped and frozen until you evaluate them.

...Be sure to label which food is which when conducting these experiments. Use a piece of tape, a marking pencil, a crayon, or anything that will help you remember which is which. In some experiments you'll have no trouble telling the foods apart. In others, the appearances may be the same.

...The experimental food is not meant to be a perfect product. The control is more apt to be perfect. Since you are deliberately doing something "wrong" you can't expect it to be perfect. So it's OK when something turns out "bad." That's what is supposed to happen. In most cases the experimental food will be edible anyway.

...All the experiments are set up in the same way. The principle to be tested is given first. Then a list of the equipment needed. Next, the procedure. And then the explanation of what happened and why.

...The experiments are written to help you learn the principles of food preparation, food storage and food handling, AND to have fun with food!

MEASURING

Proper and consistent measuring of ingredients will bring consistent results in food preparation. Standardized recipes call for standardized measurements. Deviation from these standard practices may produce unacceptable products.

Dry Measuring

Dry ingredients are more easily and accurately measured in standard measuring cups. Leveling off with the straight edge of a spatula gives accurate measurement.

EXPERIMENT # 1

Principle: Sifting flour before measuring breaks up lumps and makes the flour more uniform.

Equipment needed:
- flour
- 1-cup standard dry measuring cup
- flour sifter

Procedure: Measure 1 cup of flour without sifting. Sift this same cup of flour and measure again. Measure how much flour is left over.

Explanation: Sifting flour before measuring makes the density more uniform. The measurement is more accurate when flour is sifted each time before measuring.

EXPERIMENT # 2

Principle: Firm packing of brown sugar during measuring eliminates air spaces and gives consistent measurement.

Equipment needed:
- brown sugar
- 1-cup standard dry measuring cup

Procedure: Spoon brown sugar into measuring cup without packing. Level off with the straight edge of a spatula. Pack down the brown sugar. Observe the space left at the top. Add brown sugar to fill to the top, noting how much it takes.

Explanation: Brown sugar is very moist and cannot be sifted like flour. To insure uniform density, brown sugar is packed into the cup. Brown sugar should hold its shape when tipped out of the cup.

Liquid Measuring

Liquid ingredients are more easily and accurately measured in standard measuring cups. Measurement of liquid in the glass measuring cup should be checked at eye level to be sure the liquid is at the proper line on the cup.

EXPERIMENT # 3

Principle: Eye-level measuring produces more accurate liquid measure.

Equipment needed: standard liquid measuring cup (glass)
water

Procedure: With measuring cup below eye-level (on counter or in bottom of sink), pour in water to 1-cup line. Raise cup to eye-level and remove water by teaspoonfuls until water reaches the 1-cup mark. Note how much water must be removed.

> Explanation: Vision is distorted when looking down on an object. One cup of liquid becomes more than one cup.

Measuring Utensils

Measuring cups and measuring spoons have been standardized by the American Standards Association. Other cups and spoons are not standardized.

EXPERIMENT # 4

Principle: Standard measuring cups give accurate measure for dry and liquid ingredients.

Equipment needed: 1-cup standard dry measuring cup
1-cup standard liquid measuring cup (glass)
coffee cup or tea cup
sifted flour
water

Procedure: Spoon sifted flour into coffee or tea cup. Level with edge of a spatula. Transfer to standard dry measuring cup. Observe difference in measure. Note how much flour must be added or removed to make one standard cup full. Pour water into coffee or tea cup, filling to the brim. Transfer to standard liquid measuring cup. Note how much liquid must be added or removed to make one standard cup full.

> Explanation: Ordinary coffee and tea cups are not standardized, and often cannot be relied on for accurate measure.

EXPERIMENT # 5

Principle: Standard measuring spoons give accurate measure.

Equipment needed: salt
standard teaspoon and tablespoon measures
teaspoon for table use
tablespoon for table use

Procedure: Measure a teaspoon of salt in teaspoon for table use. Level with edge of spatula. Transfer to measuring teaspoon. Note how much salt must be added or removed to make one standard teaspoon full. Measure a tablespoon of salt in tablespoon for table use. Level with edge of spatula. Transfer to measuring tablespoon. Note how much salt must be added or removed to make one standard tablespoon full.

Explanation: Ordinary silverware is not standardized and often cannot be relied on for accurate measure.

WHAT INGREDIENTS DO

All of the ingredients in a batter or dough system work together to produce the desired product. Each ingredient has a particular purpose and performs a certain function. The ability of the ingredients to perform their functions properly depends on the proportion of the other ingredients in the system.

Flour helps to form the framework or the structure of the finished baked product. Two proteins in flour, glutenin and gliadin, form gluten strands when moistened with liquid and stirred. The starch in the flour also swells when moistened with the liquid. In a formula which has little liquid in proportion to the flour (like muffins) it is very easy to develop the gluten strands by stirring. If the formula has a high proportion of liquid to flour (as pancake batter) it is difficult to form the gluten strands by stirring. The liquid also makes the leavening agent (baking powder, baking soda or yeast) give off carbon dioxide gas. When the system is heated or baked, the gas rises through the gluten strands, making the product rise.

If there is too much flour for the system the liquid cannot moisten all of it, and the product will be heavy and compact. If there is too little flour there will not be enough gluten to form the proper framework and the product will be low in volume.

Liquid dissolves the sugar, salt and leavening, and moistens the gluten. If there is too much liquid the batter will be thin. The flour and egg proteins will be diluted too much, and the baked item will be low in volume. If there is too little liquid the gluten will not be moistened enough, and not enough carbon dioxide will be given off from the leavening. The baked item will be heavy and compact.

Baking powder will give off carbon dioxide in the presence of moisture and heat. Baking soda gives off carbon dioxide in the presence of moisture, acid and heat. If there is too much leavening, too much carbon dioxide will be produced and the product will have large holes. It will be low in volume because the gluten strands are stretched too much by the carbon dioxide and they collapse. Too little leavening means not enough carbon dioxide is produced, and the baked product will be heavy, compact and low in volume. Too much baking soda can give the baked item a soapy taste and a yellow color.

Fat makes a baked product tender. If the fat is butter or margarine it also contributes flavor and color. If there is too much fat the baked item will be too tender and crumbly. It can have a greasy feel and taste. The volume will be low. If there is too little fat, the baked item will be dry and tough.

Sugar adds flavor and tenderness, as well as contributing to the browning of the baked product. If there is too much sugar the item will be too tender and too sweet. The top crust will be sticky and very brown. If there is too little sugar, the baked product will be tough, not sweet enough, and have a pale crust.

Eggs add flavor, color and protein for structure. If there is too much egg, the item will be rubbery and low in volume. If there is not enough egg, the batter may curdle because the egg yolk keeps the fat from separating out. Too little egg also decreases the volume of the baked item.

Salt contributes to flavor. If there is too much salt, the baked item will have a decidedly salty flavor, and the volume may be less than normal. If there is too little salt, the flavor of the baked item will be very flat.

Experiments are given here to demonstrate the function of too little of various ingredients in a batter system. Use a standard 1-egg cake formula from a basic cookbook. Be sure to use only one variable per cake. Be sure to make the standard cake for comparison purposes, no matter how many variables you decide to test. If you make all the variables, you need to make only one standard cake for comparison.

EXPERIMENT # 6

Principle: Too little flour in a cake system gives a cake that is low in volume.

Equipment needed: standard 1-egg cake batter from basic cookbook
standard 1-egg cake batter, using half the flour
2 cake pans, same size and shape

Procedure: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix I). Bake cakes until done. [illegible], texture and flavor with standard cake.

Explanation: There is not enough gluten present to form the proper framework. The batter is thin and the finished cake has less volume because the flour proteins are diluted too much to form the structure.

EXPERIMENT # 7

Principle: Too little sugar in a cake system gives a pale crust, tough crumb, and little flavor.

Equipment needed: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix I). Bake cakes until done. Compare color, texture and flavor with standard cake.

Procedure: Prepare cakes as directed. Conduct line spread test on both batters (see Appendix I). Bake cakes until done. Compare color, texture and flavor with standard cake.

Explanation: Sugar attracts moisture in a cake system. When too little sugar is present, more gluten strands are formed and the cake is tougher. As sugar caramelizes when heated, a cake without sugar has a pale crust.

EXPERIMENT # 8

Principle: Too little baking powder in a cake system gives a heavy compact product.

Equipment needed: standard 1-egg cake batter from basic cookbook
standard 1-egg cake batter, using no baking powder
2 cake pans, same size and shape

Procedure: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix I). Bake cakes until done. Compare color, texture and flavor with standard cake.

Explanation: Most cake systems depend on carbon dioxide leavening from baking powder. Without baking powder the cake does not rise. A small amount of air is beaten into the batter but this is not sufficient to make the cake rise.

EXPERIMENT # 9

Principle: Too little salt in a cake system gives a product that has little flavor.

Equipment needed: standard 1-egg cake batter from basic cookbook
standard 1-egg cake batter, using no salt
2 cake pans, same size and shape

Procedure: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix I). Bake cakes until done. Compare color, texture and flavor with standard cake.

Explanation: Omitting the salt from a cake makes the flavor very flat.

EXPERIMENT # 10

Principle: Too little egg in a cake system gives a product low in volume.

Equipment needed: standard 1-egg cake batter from basic cookbook
standard 1-egg cake batter, using no egg
2 cake pans, same size and shape

Procedure: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix I). Bake cakes until done. Compare color, texture and flavor with standard cake.

Explanation: Egg yolk contains lecithin which acts as an emulsifier and keeps the fat from separating out. The volume of the cake is less than the standard, and the cake is pale in color.

EXPERIMENT # 11

Principle: Too little shortening in a cake system gives a tough, dry product.

Equipment needed: standard 1-egg cake batter from basic cookbook
standard 1-egg cake batter, using no shortening
2 cake pans, same size and shape

Procedure: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix I). Bake cakes until done. Compare color, texture and flavor with standard cake.

Explanation: Shortening coats the gluten strands and makes the cake tender. Without chortening, the cake is tough and dry, and often humps up in the middle.

Experiments are given here to demonstrate the function of too much of various ingredients in a batter system. Use yellow cake mixes, all the same brand. The cake mixes may be small mixes (making one layer) or half of larger mixes. Be sure to use only one variable per cake. Be sure to make the standard cake for comparison purposes, no matter how many variables you decide to test. If you make all the variables, you need to make only one standard cake for comparison.

EXPERIMENT # 12

Principle: Too much baking powder in a cake system gives a cake with large air holes and a low volume.

Equipment needed: yellow cake mix for one layer
yellow cake mix for one layer, sifted with 3 teaspoons baking powder
2 cake pans, same size and shape

Procedure: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix I). Bake cakes until done. Compare texture, flavor and color with standard cake.

> Explanation: Too much baking powder creates too much carbon dioxide gas, stretching the gluten strands too much. The cake has large air bubbles, a coarse texture, and may fall in the middle if the gluten strands collapse.

EXPERIMENT # 13

Principle: Too much flour in a cake system gives a heavy, compact product.

Equipment needed: yellow cake mix for one layer
yellow cake mix for one layer, sifted with 1/2 cup flour
2 cake pans, same size and shape

Procedure: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix I). Bake cakes until done. Compare texture, flavor and color with standard cake.

> Explanation: Extra flour makes the batter stiff. The liquid cannot moisten all the flour so the gluten does not develop properly. The cake is heavy and compact, and may have a floury taste.

EXPERIMENT # 14

Principle: Too much salt in a cake system gives a product with a salty taste and less volume.

Equipment needed: yellow cake mix for one layer
yellow cake mix for one layer, sifted with 2 teaspoons salt
2 cake pans, same size and shape

Procedure: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix I). Bake cakes until done. Compare texture, flavor and color with standard cake.

<u>Explanation</u>: Extra salt gives the cake a salty taste. The volume may be less than the standard cake, and the cake might sink a little in the middle.

EXPERIMENT # 15

<u>Principle</u>: Too much sugar in a cake system gives a too tender,too sweet cake.

<u>Equipment needed</u>: yellow cake mix for one layer
yellow cake mix for one layer, sifted with 1/4 cup sugar
2 cake pans, same size and shape

<u>Procedure</u>: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix I). Bake cakes until done. Compare texture, color and flavor with standard cake.

<u>Explanation</u>: A cake with too much sugar is too tender and too sweet. The cake may run over during baking. This happens when the sugar takes up the liquid faster than the flour does. There is not enough liquid left to form gluten strands, so the leavening action makes the cake run over instead of rise.

EXPERIMENT # 16

<u>Principle</u>: Too much egg in a cake system gives a produce that is rubbery and low in volume.

<u>Equipment needed</u>: yellow cake mix for one layer
yellow cake mix for one layer, with an extra egg
2 cake pans, same size and shape

<u>Procedure</u>: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix I). Bake cakes until done. Compare texture, color and flavor with standard cake.

<u>Explanation</u>: Extra egg adds more protein to the cake system. The heat of baking coagulates or toughens this protein. The cake is rubbery and tough. And the cake may be more yellow because of the additional egg yolk.

EXPERIMENT # 17

<u>Principle</u>: Too much fat in a cake system gives a cake that is grease and too tender.

<u>Equipment needed</u>: yellow cake mix for one layer
yellow cake mix for one layer, with 2 tablespoons oil
2 cake pans, same size and shape

Procedure: Prepare cakes as directed. Conduct line spread test on both cake batters (see Appendix 1). Bake cakes until done. Compare texture, color and flavor with standard cake.

Explanation: With too much fat, a cake is very tender and crumbly. It has a greasy feel and taste. The volume of the cake may be lower than standard.

The experiments given here demonstrate what ingredients do in muffins. Because of formula modifications, some muffins will not brown well. Do not use the degree of browning as indication of doneness. If you conduct all of the experiments, you will make 14 batches of muffins.

General procedure for each experiment:

1. Combine dry ingredients by sifting them together into a mixing bowl.
2. Make a well in the dry ingredients.
3. Mix liquid ingredients together in a glass measuring cup.
4. Add liquid to dry ingredients with just enough stirring to moisten all the dry ingredients. Do not stir until the batter is smooth; batter should be lumpy. Determine the number of stirs for you and use that number in each experiment you test.
5. Portion the batter into greased muffin cups, filling them 2/3 full.
6. Bake in preheated 425°F. oven for 20 minutes.

EXPERIMENT # 18

1 cup sifted all-purpose flour
1/2 teaspoon salt
1/2 cup water

EXPERIMENT # 19

1 cup sifted all-purpose flour
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1/2 cup water

EXPERIMENT # 20

1 cup sifted all-purpose flour
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1 1/2 tablespoons oil
1/2 cup water

EXPERIMENT # 21

1 cup sifted all-purpose flour
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1 1/2 tablespoons sugar
1 1/2 tablespoons oil
1/2 cup water

EXPERIMENT # 22

1 cup sifted all-purpose flour
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1 1/2 tablespoons sugar
1 1/2 tablespoons oil
1/2 cup water
2 tablespoons egg, well-blended

EXPERIMENT # 23

1 cup sifted all-purpose flour
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1 1/2 tablespoons sugar
1 1/2 tablespoons oil
1/2 cup milk
2 tablespoons egg, well-blended

EXPERIMENT # 24

1 cup sifted all-purpose flour
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1 1/2 tablespoons sugar
1/4 cup oil
1/2 cup milk
2 tablespoons egg, well-blended

EXPERIMENT # 25

1 cup sifted all-purpose flour
1/2 teaspoon salt
1 1/2 tablespoons baking powder
1 1/2 tablespoons sugar
1 1/2 tablespoons oil
1/2 cup milk
2 tablespoons egg, well-blended

EXPERIMENT # 26

1 cup sifted all-purpose flour
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1/4 cup sugar
1 1/2 tablespoons oil
1/2 cup milk
2 tablespoons egg, well-blended

EXPERIMENT # 27

1 cup sifted all-purpose flour
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1 1/2 tablespoons sugar
1 1/2 tablespoons oil
1/2 cup milk
1 egg, well-blended

EXPERIMENT # 28

1 cup sifted all-purpose flour
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1 1/2 tablespoons sugar
1 1/2 tablespoons oil
1/2 cup milk
2 tablespoons egg, well-blended

EXPERIMENT # 29

1/2 cup sifted all-purpose flour
1/2 cup cornmeal
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1 1/2 tablespoons sugar
1 1/2 tablespoons oil
1/2 cup milk
2 tablespoons egg, well-blended

EXPERIMENT # 30

1 cup sifted cake flour
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1 1/2 tablespoons sugar
1 1/2 tablespoons oil
1/2 cup milk
2 tablespoons egg, well-blended

EXPERIMENT # 31

1 cup sifted all-purpose flour
1/2 teaspoon salt
1 1/2 teaspoons baking powder
1/4 cup sugar
1 1/2 tablespoons oil
1/2 cup milk
1 egg, well-blended

LEAVENING

Leavening means increasing the surface area of a batter or dough by creating gas bubbles. This gas is mainly carbon dioxide, and it is produced by baking powder, baking soda or yeast. Air and steam are also used for leavening, and most batter and dough systems use a combination of carbon dioxide, air and steam for a perfect result. Yeast produces carbon dioxide in the presence of liquid and sugar.

EXPERIMENT # 32

Principle: The leavening action of baking powder is affected by liquid and heat.

Equipment needed:
5 pop bottles, same size
2 tablespoons each of vinegar, water, orange juice, milk and molasses
10 teaspoons baking powder
5 small balloons, same size

Procedure: Place the five liquids in the five pop bottles, one per bottle. Label which is which. Add 2 teaspoons baking powder to each. Cap each bottle with a balloon to trap the gas produced. Work fast. Some of the gas will escape. Shake the bottles and place in a pan of hot water. Observe the sizes of the balloons.

Explanation: Each of the balloons should show some trapped gas. The smallest is the molasses, because there is not much water present to react with the baking powder. When heated, the gas in the balloons increases.

EXPERIMENT # 33

Principle: The leavening action of baking soda is affected by liquid, acid.and heat.

Equipment needed:
5 pop bottles, same size
2 tablespoons each of vinegar, water, orange juice, milk and molasses
10 teaspoons baking soda
5 small balloons, same size

Procedure: Place the five liquids in the five pop bottles, one per bottle. Label which is which. Add 2 teaspoons baking soda to each. Cap each bottle with a balloon to trap the gas produced. Work fast. Some of the gas will escape. Shake the bottles and place in a pan of hot water. Obeserve the sizes of the balloons.

Explanation: Vinegar, orange juice and molasses have acid present to liberate carbon dioxide from baking soda. Water and fresh milk have no acid present. Sour milk or buttermilk would react like vinegar. Molasses has little water present because of the high concentration of sugar. The balloons expand even more when heated.

EXPERIMENT # 34

Principle: The leavening action of yeast is affected by the temperature of the liquid.

Equipment needed: 3 pop bottles, same size
3 envelopes dry yeast
1 cup ice water
1 cup warm water
1 cup boiling water
3 small balloons, same size.

Procedure: Label each pop bottle with the temperature of water used. Place the contents of one envelope of yeast in each pop bottle. Add the designated water. Cap each bottle with a balloon to trap the gas produced. Shake the bottles and place the ice water sample in the refrigerator. Let the other samples stand at room temperature. Observe the sizes of the balloons after 5 minutes, 15 minutes, 30 minutes and 1 hour.

Explanation: Yeast is a living plant. Freezing temperatures slow down the production of carbon dioxide by yeast. Warm temperatures are preferred for yeast to grow and produce carbon dioxide. Temperatures that are too hot will kill the yeast, and no dioxide will be produced.

EXPERIMENT # 35

Principle: The leavening action of yeast is affected by the presence of sugar.

Equipment needed: 3 pop bottles, same size
3 envelopes dry yeast
3 tablespoons sugar
1 cup ice water
1 cup warm water
1 cup boiling water
3 small balloons, same size

Procedure: Label each pop bottle with the temperature of water used. Place the contents of one envelope of yeast in each pop bottle. Add 1 tablespoon of sugar to each. Shake the bottles to mix the yeast and sugar. Add the designated water. Cap each bottle with a balloon to trap the gas produced. Shake the bottles and place the ice water sample in the refrigerator. Let the other samples stand at room temperature. Observe sizes of the balloons after 5 minutes, 15 minutes, 30 minutes and 1 hour.

Explanation: Yeast needs sugar in order to grow and produce carbon dioxide. Yeast and sugar in ice water will produce little carbon dioxide until the water warms up. Warm temperatures allow the yeast and sugar to produce the most carbon dioxide. Too hot temperature kills the yeast, and even with sugar present, little or no carbon dioxide will be produced.

CARBOHYDRATES

Carbohydrates are starches, sugars and cellulose. Starches are used in food preparation primarily for thickening as in soups and sauces; for molding or forming gels as in cornstarch puddings; and for binding as in the sauce base for croquettes. Some starchy substances such as flour also contribute proteins that form gluten, the framework of baked goods.

Sugar is used for tenderness and browning as in baked items; for preservation as in jellies and jam; and for forming highly saturated solutions as in candies.

Cellulose forms the structure of fruits and vegetables. Food preparation procedures can affect the softness of vegetable cellulose.

Starch

The starch molecule is a polymer, a long chain. When a starch mixture thickens, the molecule absorbs water. This molecule holds the liquid rather like a balloon holds water. The thickness and firmness of this starch paste depend on the proportion and kind of starch, the rate of heating, agitation, the proportion of sugar, and the presence of acid and fat.

Too little starch makes the mixture runny; too much makes it too thick. A high rate of heating gives a thicker mixture; a lower heating rate gives a thinner mixture. Excessive stirring makes the mixture thinner. Too little sugar makes a very thick mixture, while too much sugar makes a thin, almost syrupy pudding. Acid makes the pudding thinner; fat also makes the mixture thinner.

In conducting these experiments, use a standard cornstarch (or vanilla) pudding formula from a basic cookbook. Select a formula which contains cornstarch, sugar, milk, salt and vanilla, and no eggs. Prepare half-batches of pudding for comparison in each experiment. Cook this pudding in a heavy saucepan over direct heat (medium) no matter what the directions say. Note carefully the time it took to cook this pudding. Cook all the puddings this length of time. Cook all the puddings over direct heat unless the experiment says otherwise. If you decide to complete all the experiments on cornstarch puddings, you need to make only one batch for comparison purposes. Prepare half-batches of puddings for all experiments.

EXPERIMENT # 36

Principle: Firmness of a cornstarch gel is affected by the concentration of cornstarch.

Equipment needed: standard formula (half-batch) cornstarch pudding, for comparison purposes
standard formula (half-batch) cornstarch pudding, double the amount of cornstarch

Procedure: Cook both puddings until done. Observe thickness of each sample. Observe flavor and mouth feel. Conduct line spread test for each sample (see Appendix I).

> Explanation: Extra cornstarch makes a very thick pudding which tastes starchy and gooey. The additional cornstarch takes up the liquid and makes a pudding thicker than usual.

EXPERIMENT # 37

Principle: Firmness of a cornstarch gel is affected by the concentration of cornstarch.

Equipment needed: standard formula (half-batch) cornstarch pudding, for comparison purposes
standard formula (half-batch) cornstarch pudding, with half the amount of cornstarch

Procedure: Prepare both puddings and cook until done. Observe thickness of both samples. Observe flavor and mouth feel. Conduct line spread test for each sample (see Appendix I).

> Explanation. Too little cornstarch makes a very thin, milky pudding. There is not enough starch present to take up the liquid and give the proper consistency.

EXPERIMENT # 38

Principle: Firmness of a cornstarch gel is affected by the presence of butter or fat.

Equipment needed: standard formula (half-batch) cornstarch pudding, for comparison purposes
standard formula (half-batch) cornstarch pudding, with 1 tablespoon butter added

Procedure: Cook both puddings until done, stirring in butter after removing one sample from the heat. Observe thickness of each sample. Observe flavor and mouth feel. Conduct line spread test for each sample (see Appendix I).

> Explanation: Butter makes the pudding a little thinner because the butter interferes with the formation of the gel. The mouth feel of the pudding is silky.

EXPERIMENT # 39

Principle: Firmness of a cornstarch gel is affected by the rate of heating.

Equipment needed: standard formula (half-batch) cornstarch pudding, for comparison purposes
standard formula (half-batch) cornstarch pudding

Procedure: Cook one batch of pudding over direct heat until done. Cook second batch of pudding the same length of time but over hot water. Observe thickness of each sample. Observe flavor and mouth feel. Conduct line spread test for each sample (see Appendix I).

Explanation: The pudding cooked over hot water is thinner than the one cooked over direct heat. The rate of heating is slower over hot water. At a slower rate of heating, the starch granules swell more evenly. During rapid heating, some starch granules swell much more rapidly than others.

EXPERIMENT # 40

Principle: Firmness of a cornstarch gel is affected by the presence of acid.

Equipment needed: standard formula (half-batch) cornstarch pudding, for comparison purposes
standard formula (half-batch) cornstarch pudding, 2 tablespoons lemon juice added

Procedure: Cook both puddings until done. Observe thickness of each sample. Observe flavor and mouth feel. Conduct line spread test for each sample (see Appendix I).

Explanation: Acid, in the form of lemon juice, makes the pudding thinner. Acid breaks the polymer chain of the starch molecule. The starch is unable to take up as much liquid. In lemon pudding and pie filling, egg yolk adds the needed thickening as well as color.

EXPERIMENT # 41

Principle: Firmness of a cornstarch gel is affected by agitation.

Equipment needed: standard formula (half-batch) cornstarch pudding, for comparison purposes
standard formula (half-batch) cornstarch pudding

Procedure: Prepare both batches of pudding. As pudding cools, beat one sample with electric mixer for one minute. Observe thickness of each sample. Observe flavor and mouth feel. Conduct line spread test for each sample (see Appendix I).

> Explanation: Agitation, or beating, breaks the starch cells and releases liquid. This makes the pudding thinner.

EXPERIMENT # 42

Principle: Firmness of a cornstarch gel is affected by the concentration of sugar.

Equipment needed: standard formula (half-batch) cornstarch pudding, for comparison purposes
standard formula (half-batch) cornstarch pudding, with half the amount of sugar

Procedure: Cook both puddings until done. Observe thickness of each sample. Observe flavor and mouth feel. Conduct line spread test for each sample (see Appendix I).

> Explanation: Too little sugar makes a very thick pudding, with a pasty mouth feel. More liquid is available for the cornstarch to take up, making the pudding thick.

EXPERIMENT # 43

Principle: Firmness of a cornstarch gel is affected by the concentration of sugar.

Equipment needed: standard formula (half-batch) cornstarch pudding, for comparison purposes
standard formula (half-batch) cornstarch pudding, double the amount of sugar

Procedure: Cook both puddings until done. Observe thickness of each sample. Observe flavor and mouth feel. Conduct line spread test on each sample (see Appendix I).

> Explanation: Too much sugar makes the pudding very thin and very sweet. The sugar takes up the liquid and the cornstarch does not have enough liquid available to swell the starch granules and thicken the pudding.

Sugar

Sugar is used for sweetening many of our foods, and for keeping the color and texture of fruits when canned or frozen. Concentrated sugar solutions are especially tasty when colored and flavored and allowed to harden: this is candy.

Many things affect the sugariness of candy. Corn syrup and acid can make the candy mixture soft. Stirring keeps the candy from getting grainy. Butter also makes the mixture soft.

Note: In conducting these experiments, use a standard formula for chocolate fudge from a basic cookbook. Make half-batches for each experiment. A control sample should be prepared for comparison. If you choose to complete all the experiments on fudge, you need to make only one control sample.

EXPERIMENT # 44

Principle: Butter keeps fudge soft and creamy.

Equipment needed:
- 1/2 batch standard chocolate fudge formula from basic cookbook, for comparison
- 1/2 batch standard chocolate fudge formula from basic cookbook, double the butter
- 1/2 batch standard chocolate fudge formula from basic cookbook, omit the butter
- 3 heavy saucepans
- 3 pans, same size, for cooling the fudge.

Procedure: Prepare fudge as directed. Pour into pans to cool. Label which is which. When fudge is cool, observe softness by cutting with a knife. Observe graininess by tasting.

> Explanation: Fat interferes with the crystallization of the sugar in fudge. The fudge made without butter is grainy and brittle. With butter the fudge is soft and creamy, and buttery in flavor.

EXPERIMENT # 45

Principle: Acid delays sugar crystallization and makes fudge soft.

Equipment needed:
- 1/2 batch standard chocolate fudge formula from basic cookbook, for comparison
- 1/2 batch standard chocolate fudge formula from basic cookbook, add 1/8 teaspoon cream of tartar
- 2 heavy saucepans
- 2 pans, same size, for cooling fudge

Procedure: Prepare fudge as directed. Pour into pans to cool. Label which is which. When fudge is cool, observe softness by cutting with a knife. Observe graininess by tasting.

Explanation: Fudge made with cream of tartar is softer and creamier. The acid forms invert sugar from some of the sugar in the formula. Invert sugar delays crystallization, making the fudge soft.

EXPERIMENT # 46

Principle: Corn syrup delays sugar crystallization and makes fudge soft.

Equipment needed:
- 1/2 batch standard chocolate fudge formula from basic cookbook
- 1/2 batch standard chocolate fudge formula from basic cookbook, add 1/4 cup corn syrup
- 2 heavy saucepans
- 2 pans, same size, for cooling fudge

Procedure: Prepare fudge as directed. Pour into pans to cool. Label which is which. When fudge is cool, observe softness by cutting with a knife. Observe graininess by tasting.

Explanation: Fudge with corn syrup is softer and creamier. Corn syrup contains invert sugar, which delays crystallization, making the fudge soft.

Cellulose

Cellulose gives shape and firmness to fruits and vegetables. Pectic substances are also found in fruits and vegetables. They act as glue, to hold the cells together. Lignin and hemicellulose are two components found along with cellulose in the structural wall. Lignin is rather like wood; it doesn't change much when the vegetable is cooked. The amount of hemicellulose changes by cooking, and with acids and alkalis.

Methods of preparation and storage affect the cellulose structure, and make the food item soft or firm. Alkali added to the cooking water of vegetables makes them soft, almost mushy. Acid in the cooking water has the opposite effect: the vegetable is firmer and takes longer to cook.

Ice water can revive wilted fresh vegetables, and salt water will cause vegetables to become limp.

EXPERIMENT # 47

Principle: Alkali and heat soften vegetables.

Equipment needed: 2 saucepans
raw carrots
water
baking soda

Procedure: Clean carrots and cut into uniform pieces. Divide evenly between the saucepans. Add water to cover. Add 1/2 teaspoon baking soda to one sample. Label which is which. Cook over medium heat until both samples are tender. Observe tenderness by cutting with a fork.

> Explanation: Alkali in the form of baking soda softens the hemicellulose of the carrots and makes them mushy. Alkali also destroys the thiamine in vegetables when baking soda is added to the cooking water.

EXPERIMENT # 48

Principle: Acid and heat make vegetables firm.

Equipment needed: 2 saucepans
raw carrots
vinegar
water

Procedure: Clean carrots and cut into uniform pieces. Divide evenly between the saucepans. Add water to cover. To one sample, add 1-2 tablespoons vinegar. Label which is which. Cook over medium heat until tender. Record times for both samples. Observe by cutting with a fork.

> Explanation: When an acid such as vinegar is added to the cooking water, the vegetables take longer to cook. The texture is firmer and more solid because the acid firms up the pectic substances in the vegetables.

EXPERIMENT # 49

Principle: Wilted greens may be freshened in ice water.

Equipment needed: 2 wilted lettuce leaves
ice water
bowl

Procedure: Place one lettuce leaf in bowl and add ice water. Refrigerate. Place second leaf in refrigerator without ice water. Let stand overnight. Observe crispness of both lettuce leaves.

> Explanation: The lettuce leaf in ice water regains some of its crispness. Water again enters the cell structure of the lettuce, making it firm.

EXPERIMENT # 50

Principle: Salt water makes vegetables soft.

Equipment needed:
- 2 bowls
- water
- salt
- sliced cucumbers, celery sticks or lettuce leaves

Procedure: Place 1 cup water in each bowl. Add 2 tablespoons salt to one and stir until it is dissolved. Divide vegetables evenly between bowls. Label which is which, and refrigerate at least one hour. Observe the firmness of the vegetables.

> Explanation: The vegetables in salt water are softer, perhaps even limp. The cell membranes are "semi-permeable" and allow water to pass in and out. The concentration of salt is higher on one side of the membrane than on the other, so the water will go out of the cell.

FATS

Fats perform several functions in foods. They add flavor; they form one phase of many food emulsions. Fats are also used to fry or cook foods, and for making baked products tender and flavorful.

Emulsions

An emulsion is a mixture of oil and water, with something added to keep the oil and water from separating. French dressings and mayonnaise are two typical food emulsions. In French dressing, the spices help keep the mixture together. In mayonnaise, egg yolk keeps the oil from separating out.

EXPERIMENT # 51

Principle: Finely ground powders help form temporary emulsions.

Equipment needed:
- 1/2 cup oil
- 2 tablespoons vinegar
- 2 tablespoons lemon juice
- 1/2 teaspoon sugar
- 1/4 teaspoon salt
- 1/4 teaspoon dry mustard
- 1/4 teaspoon paprika
- dash of cayenne
- 2 jars with tight lids

Procedure: In one jar, place 1/4 cup oil, 1 tablespoon lemon juice and 1 tablespoon vinegar. In second jar, mix spices together. Add remaining oil, lemon juice and vinegar. Cap both jars and shake for 30 seconds. Observe the speed at which the salad dressings separate. Record this time.

Explanation: Finely divided powders such as spices help keep French dressings from separating for short periods of time. Spices also add flavor and color to the dressing.

EXPERIMENT # 52

Principle: Formation of a mayonnaise emulsion is dependent on the concentration of egg yolk.

Equipment needed: 1/2 batch standard mayonnaise formula from basic cookbook, for comparison
1/2 batch standard mayonnaise formula from basic cookbook, with whole egg instead of egg yolk

Procedure: Prepare mayonnaise as directed. Label which is which. Conduct line spread test on both samples (see Appendix I). Observe which mayonnaise is thinner.

Explanation: The mayonnaise made with whole egg is thinner than that made with egg yolk. Egg yolk contains lecithin, which emulsifies the mixture and makes it thick. With whole egg, the white dilutes the yolk so less lecithin is present and the mixture is thinner.

EXPERIMENT # 53

Principle: Formation of a mayonnaise emulsion is dependent on egg yolk.

Equipment needed: 1/2 batch standard mayonnaise formula from basic cookbook, for comparison
1/2 batch standard mayonnaise formula from basic cookbook, with whole egg instead of egg yolk

Procedure: Prepare mayonnaise as directed. Label which is which. Conduct line spread test on both samples (see Appendix I). Observe which mayonnaise is thinner.

Explanation: The mayonnaise made with egg white is very thin, and really isn't mayonnaise. Since egg yolk contains the emulsifier lecithin, it is necessary to form the emulsion and make mayonnaise.

Frying

When fats are used for frying, they prevent food from sticking, transfer heat, and produce a characteristic flavor and color. When the fats and oils used for frying start to break down, they begin to smoke. This smoke point is a temperature which is higher for some fats than for others.

Solid shortenings (except lard) contain an emulsifier which lowers the smoke point. Vegetable oils do not have an emulsifier. The presence of water in butter and margarine also lowers the smoke point.

The temperature of the fat in which the food is cooked gives food texture, flavor and color. If the fat is not hot enough, the food will be greasy and soft. If the fat is too hot, the food will be burned. Most foods are fried at 350 - 375°F.

EXPERIMENT # 54

Principle: Different fats have different smoke points.

Equipment needed:
small saucepan
fat thermometer
3/4 - 1 cup vegetable oil
3/4 - 1 cup solid shortening (not lard)
3/4 - 1 cup butter or margarine

Procedure: Position thermometer upright in saucepan. Add enough fat so that the bulb of the thermometer is covered during the entire experiment. Cook over high heat until the fat gives off a bluish smoke. Record the temperature. Repeat with the 2 remaining fats.

Explanation: The smoke point of a fat is the temperature at which the fat begins to decompose. Butter or margarine has the lowest smoke point because both contain water. Solid shortening smokes at the next highest temperature, because the emulsifiers which are added lower the smoke point. The oil smokes at the highest temperature. Oil is probably the best fat for deep-frying.

EXPERIMENT # 55

Principle: Frying temperature affects color and texture of food.

Equipment needed:
1 box or bag frozen french fried potatoes
oil for deep frying
heavy saucepan or french fryer
wire basket or slotted spoon
fat thermometer

Procedure: Divide potatoes into 4 equal portions. Heat oil to 275°F. Cook one portion of potatoes for the time indicated on the package. Drain and label. Heat the same oil to 325°F. Cook second portion of potatoes for the time given on the package. Drain and label. Again heat oil to 375°F. Cook third portion of potatoes for the indicated time. Drain and label. Heat the oil again to 425°F. Cook remaining potatoes for the indicated time. Drain and label. Observe crispness, color and flavor of all the samples.

Explanation: The potatoes cooked at the lowest temperature are pale, soft and greasy. Those cooked at the highest temperature are too brown and crisp. The ideal potatoes are probably those cooked at 375°F.

PROTEINS

Many foods are sources of proteins. The Meat and Meat Substitutes Food Group probably comes to mind first when you think of proteins. But the Milk Group and the Breads and Cereals Group also contain proteins. The proteins give these foods certain characteristics when these foods are prepared for us to eat.

Flour Proteins

The proteins in flour are "glutenin" and "gliadin." When these proteins mix with liquid and are stirred, gluten strands form. The amount of gluten formed depends on the type of grain from which the flour is milled. Wheat flour proteins form a lot of gluten; whole wheat flour proteins form little gluten because of the bran present; rye flour proteins do not form gluten. Refined wheat flour from hard wheat forms the most gluten, so this flour is used for the framework of baked prodicts. Refined wheat flour is used with whole wheat flour and rye flour so that the baked item has a good framework as well as the flavor and color of the other grains.

EXPERIMENT # 56

Principle: Flours vary in quality and quantity of gluten.

Equipment needed:
- 1/2 cup each of whole wheat flour, rye flour, sifted all-purpose flour, sifted cake flour, sifted bread flour
- cold water
- mixing bowl
- thin clean handkerchief
- cookie sheet

Procedure: To make gluten balls, add just enough cold water to each of the flours to form a stiff dough. Let dough stand for 10 minutes in a bowl of cold water. Place dough in handkerchief. Wash the dough in cold water by kneading and squeezing the dough in the cloth. Continue washing until the water is clear. This takes a long time. When all the starch is washed out, the dough ball is very stringy. Shape the dough into a round ball and place on a lightly greased baking sheet. Label which is which. Bake in a preheated 400°F. oven about 20 minutes. Reduce heat to 300°F. and bake another 10 minutes. Compare the sizes of the gluten balls.

Explanation: Flour from hard wheat will have more gluten than flour from soft wheat. Cake flour is milled from soft wheat, so this gluten ball is the smallest. Bread flour is milled from hard wheat so this ball is the largest. All-purpose flour is a mixture of hard and soft wheats. In Michigan, all-purpose flour has a high percentage of hard wheat because Michigan raises a lot of hard wheat. Rye and whole wheat have little gluten, and probably no gluten ball can be formed.

EXPERIMENT # 57

Principle: Gluten is developed by liquid and stirring

Equipment needed: muffin batter made from a standard formula from a basic cookbook (select a formula which has 2 cups flour, 1 cup milk, 2 tablespoons sugar)
greased muffin pans

Procedure: When preparing muffin batter, sift dry ingredients together into mixing bowl. Mix liquid ingredients together. Make a well in dry ingredients and add liquid.

1. Stir 15 strokes with spoon. Remove 2 muffins to greased muffin cups.
2. Stir another 10 strokes. Remove 2 muffins.
3. Stir another 30 strokes. Remove 2 muffins.
4. Stir another 30 strokes. Remove 2 muffins.
5. Stir another 30 strokes. Remove remaining muffins.

Label muffin cups according to the number of stirs. Bake in preheated 425°F. oven, about 20 minutes. Observe changes in texture of batter while mixing. Observe differences in shape and volume of the baked muffins.

Explanation: Stirring a flour-liquid mixture develops the gluten strands. Understirring does not develop the gluten and the baked item may be low in volume and have flour streaks showing. Over-stirring stretches the gluten strands and tunnels form. Excessive overstirring breaks the gluten strands and they collapse, so the baked item is small and compact.

Egg Protein

Egg protein coagulates or toughens during heating. The proteins in eggs form elastic films and incorporate air, used for leavening in products such as angel cakes.

EXPERIMENT # 58

Principle: Excessive heat treatment of egg protein results in curdling, weeping, and toughening of the protein.

A. Curdling

Equipment needed: standard custard formula from basic cookbook
2 bowls same size

Procedure: Cook custard mixture over hot but not boiling water, stirring occasionally until mixture coats a metal spoon. At this stage, the custard clings to the spoon in a coating about half the thickness of the chocolate coating in a candy bar. Record the time this took. Pour half the custard into a bowl and refrigerate. Continue cooking and stirring the remaining custard until it curdles or separates. It won't take long. Record how long. Pour into second bowl and refrigerate. When both custards are cold, compare appearance, texture and flavor.

Explanation: Heating too fast or for too long cooks the egg protein, toughening and shrinking it. An overcooked custard is curdled, watery, and has a curdy or lumpy mouth feel. The flavor is the same.

EXPERIMENT # 59

B. Weeping

Equipment needed: standard custard formula from basic cookbook
custard cups
baking pan with rack
cooling rack

Procedure: Pour custard mixture evenly into custard cups. Place half the cups in shallow pan with rack and pour hot water around the cups to a depth of about one inch. Place in preheated 350°F. oven. Place remaining cups in oven without hot water. Bake about 45 minutes. Remove onto a plate. Cut each in half to observe the interior. Note the firmness, and the presence of bubbles. Taste each and observe any difference in flavor, appearance and texture.

Explanation: Overcooked custards (those cooked without hot water) are watery, tough, and have more bubbles. The tops are browner and tougher. There is no difference in flavor.

EXPERIMENT # 60

C. Toughening

Equipment needed: 2 eggs, room temperature
2 saucepans with lids

Procedure: Place one egg in each saucepan. Add water to cover. Heat one to the simmering stage. Cover; remove from heat. Let stand 20 minutes. Place egg in cold water to stop the cooking process. Bring second saucepan to a boil. Boil 20 minutes. Place egg in cold water to stop the cooking process. Observe the condition of the shells. Peel each egg. Cut in half with a table knife. Look for a greenish ring around the yolk. Taste each and observe the tenderness of the white.

Explanation: The shells of eggs treated with excessive heat are often cracked. Boiling makes the white tougher, and a greenish ring may appear around the yolk. This ring is caused by a reaction between heat, the iron in the yolk and the sulfur in the white. The ring is iron sulfide.

EXPERIMENT # 61

Principle: Stability of an egg white foam is affected by the degree of beating.

Equipment needed: 2 egg whites from fresh eggs of the same size
2 mixing bowls, same size
beater or mixer

Procedure: Beat one egg white to foamy stage. Continue beating until maximum volume is reached. Record the time it took. Keep this egg white for comparison. Beat second egg white at same speed, for twice the time of the first one. Pour the foams into two clear drinking glasses of the same size. Label which is which. Let stand one hour. Pour off the accumulated liquid and measure it.

Explanation: The amount of liquid that leaks out of the egg white foam indicates the stability of the foam. The more liquid, the less stable the foam. Excessive beating increases the volume of the foam but decreases the stability because the protein becomes too thin and less elastic.

EXPERIMENT # 62

Principle: Stability of an egg white foam is affected by sugar.

Equipment needed: 2 egg whites from fresh eggs of the same size
1 tablespoon sugar
2 mixing bowls, same size
mixer or beater

Procedure: Beat one egg white to foamy stage. Continue beating until maximum volume is reached. Record the time this took. Keep this egg white for comparion. Beat second egg white, at the same speed, adding sugar gradually. Beat to maximum volume, recording the time it took. Pour the foams into two clear drinking glasses. Label which is which. Let stand one hour. Pour off the accumulated liquid and measure it.

> Explanation: The amount of liquid that leaks out of the egg white foam is an indication of the stability of the foam. The more liquid, the less stable the foam. The addition of sugar increases the time required for maximum volume, but the foam is more stable.

EXPERIMENT # 63

Principle: Stability of an egg white foam is affected by fat.

Equipment needed:
- 3 egg whites from fresh eggs of the same size
- oil
- 3 mixing bowls, same size
- beater or mixer

Procedure: Beat one egg white to foamy stage. Continue beating until maximum volume is reached. Record the time this took. Keep this egg white for comparison. Beat second egg white to foamy stage. Add 1 drop of oil. Continue beating until maximum volume is reached. Record the time. Beat third egg white to foamy stage. Add 2 teaspoons of oil. Continue beating until maximum volume is reached. Pour the foams into 3 clear drinking glasses. Label which is which. Let stand for one hour. Pour off the accumulated liquid and measure it.

> Explanation: The amount of liquid that leaks out of the egg white foam is an indication of the stability of the foam. The more liquid the less stable the foam. A drop of oil increases the stability of an egg white foam. Larger amounts of oil decreases volume and stability.

EXPERIMENT # 64

Principle: Stability of an egg white foam is affected by acid.

Equipment needed:
- 3 egg whites from fresh eggs of the same size
- 3 mixing bowls, same size
- cream of tartar
- lemon juice or vinegar

Procedure: Beat one egg white to foamy stage. Continue beating until maximum volume is reached. Record the time this took. Keep this egg white for comparison. Beat second egg white to foamy stage. Add 1/8 teaspoon cream of tartar. Continue beating at same speed until maximum volume is reached. Record time. Beat third egg white to foamy stage. Add 1 tablespoon lemon juice or vinegar. Continue beating at same speed until maximum volume is reached. Record the time. Pour the foams into clear drinking glasses, same size. Label which is which. Let stand one hour. Pour off the accumulated liquid and measure it.

> Explanation: The amount of liquid that leaks out of the egg white foam is an indication of the stability of the foam. The more liquid the less stable the foam. Acid, as cream of tartar, increases the beating time for maximum volume, but makes the foam more stable. Vinegar or lemon juice increases the beating time and decreases the stability.

EXPERIMENT # 65

Principle: Stability of an egg white foam is affected by liquid.

Equipment needed:
- 2 egg whites from fresh eggs of the same size
- cold water
- 2 mixing bowls, same size
- mixer or beater

Procedure: Beat one egg white to foamy stage. Continue beating until maximum volume is reached. Record the time this took. Keep this egg white for comparison. Beat second egg white to foamy stage. Add 1 tablespoon cold water. Continue beating at same speed until maximum volume is reached. Pour both foams into two clear drinking glasses, same size. Label which is which. Let stand one hour. Pour off accumulated liquid and measure it.

> Explanation: The amount of liquid that leaks out of an egg white foam is an indication of the stability of the foam. The more liquid, the less stable the foam. The presence of ice water increases the volume of the foam but lessens the stability because the proteins are diluted too much.

EXPERIMENT # 66

Principle: Stability of an egg white foam is affected by salt.

Equipment needed:
- 2 egg whites from fresh eggs of the same size
- salt
- 2 mixing bowls, same size
- mixer or beater

Procedure: Beat one egg white to foamy stage. Continue beating until maximum volume is reached. Record the time this took. Keep this egg white for comparison. Beat second egg white to foamy stage. Add 1/2 teaspoon salt. Continue beating at same speed until maximum volume is reached. Record the time. Pour both foams into two clear drinking glasses, same size. Label which is which. Let stand one hour. Pour off the accumulated liquid and measure it.

> Explanation: The amount of liquid that leaks out of the egg white foam is an indication of the stability of the foam. The more liquid, the less stable the foam. Salt decreases the stability of the egg white foam.

Gelatin Protein

Gelatin is obtained by heating connective tissues, tendons and cartilage of animals in water. After many processing steps the gelatin (protein) is left. It is pulverized and sold as unflavored gelatin. Gelatin dessert powders are a mixture of unflavored gelatin, sugar, and coloring and flavoring. A gelatin gel is formed when gelatin is dissolved in water.

Note: We suggest that a control sample, for comparison, be used in each set of experiments. However, if you plan to complete all the experiments on gelatin, only one control sample needs to be prepared. If you do all the experiments on gelatin, you will need 12 envelopes of unflavored gelatin.

Formula for control sample: Dissolve contents of 1 envelope of gelatin in 1/2 cup cold waterAdd 1 1/2 cups boiling water; stir until gelatin is dissolved. Pour into dish or pan and refrigerate until firm.

EXPERIMENT # 67

Principle: Firmness of a gelatin gel is affected by the concentration of gelatin.

Equipment needed: 3 envelopes unflavored gelatin
water

Procedure: Prepare control sample, using formula. Prepare second sample using 2 envelopes of gelatin. Observe both samples after 15 minutes, 30 minutes, 1 hour, 6 hours and 1 day. Observe firmness and tenderness by cutting with a table knife.

> Explanation: A higher concentration of gelatin makes the gel set faster because there is more gelatin to take up the water. The gel is very firm, almost rubbery.

EXPERIMENT # 68

Principle: Firmness of a gelatin gel is affected by temperature.

Equipment needed: 2 envelopes unflavored gelatin
water

Procedure: Prepare control sample, using formula. Prepare second sample according to control formula, but let gel form at room temperature. Observe samples after 15 minutes, 30 minutes, 1 hour, 6 hours and 1 day. Observe firmness and tenderness by cutting with a table knife.

> Explanation: A gelatin gel forms more slowly at higher temperatures. Once formed, however, the gel does not melt as rapidly as one formed at a low temperature.

EXPERIMENT # 69

Principle: Firmness of a gelatin gel is affected by acid.

Equipment needed: 3 envelopes unflavored gelatin
water
vinegar or lemon juice

Procedure: Prepare control sample, using formula. Prepare second sample, using control formula, but using 1/2 cup cold water, 1/2 cup vinegar or lemon juice, and 1 cup hot water. Prepare third sample using control formula, but using 1/2 cup cold water, 1 cup vinegar or lemon juice, and 1/2 cup hot water. Label which is which. Observe samples after 15 minutes, 30 minutes, 1 hour, 6 hours and 1 day. Observe firmness and tenderness by cutting with a table knife.

> Explanation: Acid breaks down or digests protein. Increasing amounts of acid will make a gelatin gel very soft and runny. Acid can prevent a gel from forming.

EXPERIMENT # 70

Principle: Firmness of a gelatin gel is affected by sugar.

Equipment needed: 3 envelopes unflavored gelatin
sugar
water

Procedure: Prepare control sample, using formula. Prepare second sample according to formula, but mix 2 tablespoons sugar with gelatin. Prepare third sample according to control formula, but mix 1/2 cup sugar with gelatin. Label which is which. Observe samples after 15 minutes, 30 minutes, 1 hour, 6 hours and 1 day. Observe firmness and tenderness by cutting with a table knife.

Explanation: Sugar makes a gelatin gel soft. Too much sugar can make a gelatin so soft that it cannot unmold. The sugar takes up the water and leaves too little for the gelatin.

EXPERIMENT # 71

Principle: Firmness of a gelatin gel is affected by enzymes.

Equipment needed: 5 envelopes unflavored gelatin
1/2 cup well drained canned pineapple
1/2 cup chopped fresh pineapple
1/2 cup frozen pineapple, thawed and drained
1/2 teaspoon powdered meat tenderizer

Procedure: Prepare control sample, using formula. Prepare second sample, using control formula and adding canned pineapple. Prepare third sample, using control formula and adding fresh pineapple. Prepare fourth sample, using control formula, and adding frozen pineapple. Prepare last sample, using control formula, and stirring in meat tenderizer. Observe samples after 15 minutes, 30 minutes, 1 hour, 6 hours and 1 day. Observe tenderness and firmness by cutting with a table knife.

Explanation: Enzymes digest protein. Pineapple contains an enzyme, bromelin, which digests protein and prevents a gel from forming. Canned pineapple has been heated during canning and this enzyme has been destroyed. Fresh and frozen pineapple have not been heat treated. Meat tenderizer is an enzyme which comes from a plant.

Milk Proteins

Milk contains three proteins, casein, lactoglobulin and lastalbumin. Fluid milk itself does not coagulate (become firm) with heat. Two of the proteins, lactalbumin and lactoglobulin, are coagulated by heat. Casein, the main protein in milk, is coagulated by rennin and acid, but not by heat.

EXPERIMENT # 72

Principle: Lactoglobulin and lactalbumin are coagulated by heat.

Equipment needed: small saucepans
1 cup each of fluid whole milk, fluid skim milk, reconstituted nonfat dry milk, and undiluted evaporated milk

Procedure: Keep 1/2 cup of each milk for comparison. Place 1/2 cup of milk in each saucepan. Label which is which. Cook over medium heat until scalding (small bubbles around the edge). Remove from heat and let stand until cool. Observe the skin on the surface of the milk, and the scum on the sides and bottom of the pan.

Explanation: The skin on the top of the milk is lactoglobulin. The scum on the sides and bottom of the pan is lactalbumin. The milk stays fluid.

EXPERIMENT # 73

Principle: Casein is coagulated by acid but not heat.

Equipment needed: vinegar or lemon juice
cold tomato juice
1 cup each of fluid whole milk, fluid skim milk, reconstituted nonfat dry milk, undiluted evaporated milk

Procedure: Keep 1/3 cup of each of the milks for comparison. To 1/3 cup of each milk, add 2 teaspoons vinegar or lemon juice. To remaining milk samples add 1 tablespoon cold tomato juice. Label which is which. Observe the thickness and curdling of the milks.

Explanation: Acid coagulates or thickens the casein (protein) in the milk. Tomato juice contains less acid than lemon juice or vinegar. The milks with tomato juice show less thickening than those with the vinegar or lemon juice. The coagulation of casein is desirable in products such as buttermilk and yogurt.

Meat Proteins

When meat is heated, the fat and connective tissues soften and the fibers ("meat" part) toughen. With prolonged heat, the fibers continue to toughen and shrink, and the meat juices are squeezed out. Fish and shellfish have very little fat and connective tissue, so they require little heat to toughen the fibers. Less tender cuts of meat have more connective tissue, so moist heat and a longer cooking time is required. Enzymes and acids break down or digest protein to make it softer and more tender.

EXPERIMENT # 74

Principle: Meat protein becomes tough with extended heat.

Equipment needed: 2 ground beef patties, same size and thickness
broiler pan and rack

Procedure: Preheat broiler. Adjust rack so that the tops of the beef patties are 3 inches from the heat. Broil one patty 6 minutes per side, turning once. Broil second patty 12 minutes per side, turning once. Remove to plate. Measure diameter and thickness of patties with a ruler. Taste both when warm but not hot. Observe color, tenderness, flavor and mouth feel.

Explanation: Longer cooking makes the beef patties dry, tough and less tasty. The diameter is less than the raw patties, and the center is thicker because the protein has shrunk. There is less flavor because the drippings are lost.

EXPERIMENT # 75

Principle: Fish and shellfish become tough and rubbery with extended heating.

A. Fish

Equipment needed: 4 fillets of fish (perch, sole, etc.) of the same size
or 1 box frozen fish cut into 4 equal size blocks
baking pan

Procedure: Place fish on lightly greased baking pan. Bake in preheated 350°F. oven about 25 minutes. Remove one piece of fish. Continue baking another 10 minutes; remove another piece of fish. Bake an additional 10 minutes; remove third piece of fish. Continue baking another 10 minutes; remove remaining fish. Flake each piece of fish with a fork. Taste the fish while warm but not hot. Observe dryness, tenderness and mouth feel.

Explanation: Prolonged heating toughens protein. The longer the fish is baked the tougher and drier it becomes. No much flavor is left.

EXPERIMENT # 76

B. Shellfish

Equipment needed: 1 box or bag of shrimp, fresh or frozen (not breaded)
large saucepan or kettle

Procedure: Bring salted water to a boil in saucepan and cook shrimp according to package directions. Remove 1/4 of the shrimp. Continue simmering another 10 minutes; remove another 1/4 of the shrimp. Simmer an additional 10 minutes; remove another 1/4 of the shrimp. Cook another 10 minutes; remove remaining shrimp. Observe tenderness by breaking with the fingers and cutting with a fork. Observe flavor and mouth feel.

Explanation: Prolonged heating toughens protein. The longer the shrimp is cooked, the tougher and more rubbery the pieces become. The outside layer of the shrimp is especially tough. The flavor does not change much.

EXPERIMENT # 77

Principle: Meat cooking losses increase with temperature and time.

Equipment needed: 4 ground beef patties, same size and thickness
heavy frypan or skillet

Procedure: Cook one beef patty at a time, using clean frypan for each, according to the following schedule:

1. Use medium heat, cook 5 minutes per side.
2. Use medium heat, cook 10 minutes per side.
3. Use high heat, cook 5 minutes per side.
4. Use high heat, cook 10 minutes per side.

Measure drippings from each. Observe the color and odor of the drippings. Measure thickness and diameter of each patty with a ruler. Taste each when warm but not hot. Note flavor and mouth feel.

> Explanation: The drippings from meat cooked over low heat are clearer and have a "meaty" aroma. Drippings from meat cooked over high heat are darker and more solid, and often burned onto the pan. The longer meat is cooked, the darker the drippings will be. Extended heat and time cause more drippings to be cooked out, and the meat patties are smaller and drier, with a tough, dry crust.

EXPERIMENT # 78

Principle: Enzymes and acids break down or digest protein.

A. Enzymes

Equipment needed: 2 pieces of meat, same size and thickness, from same cut, such as round
commercial meat tenderizer, not instant type
broiler pan and rack

Procedure: Sprinkle one piece of meat with meat tenderizer according to package directions. Leave second piece plain. Preheat broiler. Adjust rack so that top of meat is 3 inches from heat. Broil both pieces of meat to desired doneness, turning once. Taste each when warm but not hot. Observe mouth feel, ease of chewing and ease of cutting with a fork.

> Explanation: Commercial meat tenderizer is an enzyme extracted from a plant. Meat treated with this enzyme is softer and more tender then untreated meat. The outside of the treated meat is especially soft. If used on a tender cut of meat, meat tenderizer can make it mushy.

EXPERIMENT # 79

B. Acid

Equipment needed: 2 pieces of meat, same size and thickness, from same cut, such as round
marinade made of 1/4 cup salad oil, 2 tablespoons vinegar, 1/2 teaspoon salt, 1 teaspoon Worcestershire sauce
broiler pan and rack

Procedure: Soak one piece of meat in marinade. Refrigerate in marinade overnight. Refrigerate second piece of meat also, but without marinade. Preheat broiler. Adjust rack so that top of meat is 3 inches from source of heat. Broil until meat is of desired doneness, turning once. Taste each when warm but not hot. Observe mouth feel, ease of chewing, and ease of cutting with a fork.

Explanation: The acid in the vinegar of the marinade softens the meat and makes a little more tender and easier to cut and chew. The outside of the meat is softer than the inside. The oil in the marinade also keeps the meat from drying out during cooking. Marinating a less tender cut of meat is a good way to make it more tasty and tender.

COLOR IN FRUITS AND VEGETABLES

The color in fruits and vegetables is due to several color pigments. Most fruits and vegetables have more than one color pigment, but one is dominant over the others. Some have two pigments in fairly equal distribution. Red cabbage, for instance, has both red and white pigments.

Much of the appeal of fruits and vegetables is their varied colors. Changes that take place during cooking and storage can make these colors unattractive.

The color pigments in fruits and vegetables are:

Chlorophyll (KLOR-or-fill)..........green
Caratinoids (CARE-a-tin-oids).......yellow and orange
Anthycyanins (an-tho-SY-a-nins).....red, blue and purple
Anthoxanthins (an-tho-ZAN-thins)....white

Acid changes chlorophyll to a dull olive green color. Caratinoids dissolve in fat or oil. Alkali turns anthocyanins dark; acid turns anthocyanins redder. Anthocyanins also dissolve in water. Acid keeps anthoxanthins white; alkali turns them yellow or brown.

EXPERIMENT # 80

Principle: Caratinoids dissolve in fat or oil.

Equipment needed: raw carrots
grater

Procedure: Wash carrots and grate on largest holes of grater. Observe the color of your hands after grating the carrots.

> Explanation: The oil in your skin dissolves some of the caratinoids, so your hands turn orange. Caratinoids contain the substance that forms Vitamin A.

EXPERIMENT # 81

Principle: Acid turns chlorophyll a dark olive green color.

A. Cooked spinach

Equipment needed: fresh or frozen spinach
2 saucepans, one with lid

Procedure: Divide spinach equally into the saucepans. Add a small amount of water to each. Cover one saucepan. Cook both samples over medium heat until spinach is very tender. Observe the color of both samples.

> Explanation: Acid turns chlorophyll a dark olive green color. When green vegetables are cooked uncovered, the plant acids evaporate into the air. When the pan is covered, the plant acids cannot escape. These acids turn the green spinach to brownish spinach.

EXPERIMENT # 82

B. Uncooked beans

Equipment needed: I box frozen green beans
3 small bowls
vinegar
vinegar and oil salad dressing

Procedure: Thaw green beans and divide into the 3 bowls. Keep one bowl for comparison. Add vinegar to one sample; stir so that all beans are coated. Add salad dressing to remaining sample; stir so that all beans are coated. Observe the color changes.

> Explanation: Vinegar, an acid, will turn the chlorophyll of green vegetables to an olive green color. Salad dressing also contains acid, such as vinegar or lemon juice or both.

EXPERIMENT # 83

Principle: Anthocyanins turn blue in alkali and red in acid; the reaction is reversible.

Equipment needed: red fruit juice, such as cranberry, grape, red raspberry (red soft drinks won't work)
vinegar or lemon juice
baking soda
3 custard cups or glasses

Procedure: Pour about 1/4 cup fruit juice in each custard cup or glass. Leave one plain for comparison. To one sample add 1 teaspoon vinegar or lemon juice. To remaining sample add 1/4 teaspoon baking soda dissolved in 1 teaspoon water. Label which is which. Observe color changes. Add 1 - 2 teaspoons lemon juice or vinegar to the baking soda sample. Again observe color change.

Explanation: Alkali in the form of baking soda turns the red pigments bluer or darker. Acid in the form of lemon juice or vinegar keeps red pigments red. Adding acid to the alkali sample brings the red color back. Lemon juice added to a red fruit juice punch will keep the nice red color.

EXPERIMENT # 84

Principle: Alkali turns anthocyanins blue and anthoxanthins yellow.

Equipment needed: red cabbage
saucepan
baking soda

Procedure: Shred red cabbage. Put into saucepan and add water to cover. Add 1 teaspoon baking soda. Cook over medium heat and observe all color changes.

Explanation: Red cabbage contains anthocyanins (red) and anthoxanthins (white). Alkali in the form of baking soda turns the red pigment blue and the white pigment yellow. Blue and yellow make green, so the red cabbage turns greenish.

EXPERIMENT # 85

Principle: Alkali turns anthoxanthins yellow or brown.

Equipment needed: cauliflower or white potatoes
baking soda
cream of tartar or vinegar
2 saucepans

Procedure: Cut potatoes or cauliflower into uniform pieces. Divide evenly into the 2 saucepans. Add water to cover. To one sample add 1 teaspoon baking soda. To the other add 1/4 teaspoon cream of tartar or 1 tablespoon vinegar. Label which is which. Cook samples over medium heat until tender. Observe the color of both samples.

> Explanation: The vegetable cooked with baking soda is more yellow and mushier than the sample cooked with acid. The acid sample is whiter and firmer in texture. A bit of cream of tartar (acid) whipped into mashed potatoes will help keep them white.

EXPERIMENT # 86

Principle: Light colored fresh fruits and vegetables darken when exposed to the air.

Equipment needed:
- sliced raw banana, apple, potato or white turnip
- 5 custard cups
- sugar
- salt
- lemon juice
- water

Procedure: Divide pieces of fruit or vegetable evenly among the 5 custard cups. Sprinkle one with sugar, one with salt, one with lemon juice, one with water, and leave one plain. Label which is which. Let stand at room temperature. Observe the color after 15 minutes, 30 minutes and 1 hour.

> Explanation: Acid keeps light colored fruits and vegetables light. Sugar and water have little effect on stopping the browning. Salt stops the browning for only a short time.

FOOD STORAGE

Proper storage of foods at each stage of the distribution process helps maintain top quality, best flavor and color, and best nutritive value. Home storage conditions can mean the difference between food that is high quality and food that is low quality.

Egg Storage

To maintain the quality of eggs, they should be kept covered in the refrigerator. This keeps moisture loss at a minimum. Frozen eggs maintain their best quality if mixed with a little sugar or salt before freezing. Egg yolks may be frozen successfully with the addition of either sugar or salt. Whites may be frozen without any additions.

EXPERIMENT # 87

Principle: Quality of shell eggs deteriorates with aging and is dependent on storage conditions.

Note: This experiment may be conducted with raw or hard-cooked eggs.

A. Raw eggs

Equipment needed: 9 eggs, same size and age

Procedure: Store 3 eggs at room temperature, 3 eggs uncovered in refrigerator, and 3 eggs covered in refrigerator (in egg carton). After I day, carefully break one of each of the eggs onto a flat surface. Measure how far the egg spreads. Observe the air cell at the large end of the egg. After 3 days, break another of each of the eggs and observe as before. After 7 days, break remaining eggs and again observe.

> Explanation: During storage the amount of thin white increases, so the older eggs spread out more. The yolk increases in size and flattens. Eggs also lose moisture during storage and the air cell at the large end of the egg increases in size. These changes go faster at higher temperatures and go slower when eggs are stored at lower temperatures and are covered. The best way to maintain quality of eggs is to keep them in the refrigerator in the carton they come in.

EXPERIMENT # 88

B. Hard cooked eggs

Equipment needed: 9 eggs, same size and age

Procedure: Store 3 eggs at room temperature, 3 eggs uncovered in refrigerator, and 3 eggs covered in refrigerator (in egg carton). After I day hard cook one of each. Plunge eggs into cold water to stop cooking. Carefully remove shell of each egg. Observe evidence of the air cell by noting the flatness at the large end of the egg. After 3 days, hard cook one of each of the eggs and observe as before. After 7 days hard cook remaining eggs and again observe evidence of air cell.

> Explanation: During storage, eggs lose moisture. The air cell increases and the size of the egg decreases. These changes go faster with time and higher temperatures, and with the absence of covering of eggs. The best way to maintain quality of eggs is to keep them in the refrigerator in the carton they come in.

EXPERIMENT # 89

Principle: The addition of sugar or salt to whole egg and egg yolk maintains quality during freezing.

Equipment needed: 5 fresh eggs
5 small jars with lids
sugar or salt

Procedure: Into 2 of the small jars, break two of the eggs. Stir to blend whites and yolks. Stir 1/4 teaspoon sugar or salt into one. Cover both jars, label, and place in the freezer. Separate one egg, putting the yolk in one jar and the white in another. Separate another egg, putting the yolk in the last jar and the white in with the other one. Stir the yolks; stir the whites. To one yolk, stir in 1/4 teaspoon sugar or salt. Label all the jars, cover and place in the freezer. Place remaining egg in the freezer in the shell. Freeze for at least 1 month. Remove from freezer and defrost in the refrigerator. Observe the thickness and gumminess of all samples. Break open the whole egg and compare with a freshly broken egg.

Explanation: Salt and sugar prevent frozen whole eggs and frozen yolks from becoming thick and gummy. Yolks frozen without sugar or salt are much more gummy than the frozen whole eggs. Egg white maintains quality during freezing without sugar or salt. Eggs in the shell cannot be frozen successfully.

Freezer Wraps

Freezer air is very cold, very dry air. The wrapping around food in freezer storage must prevent the food from drying out in the cold dry air. Improperly wrapped foods in the freezer lose moisture, flavor and quality.

EXPERIMENT # 90

Principle: Moisture-vapor-proof wrapping maintains quality of frozen foods.

Equipment needed: 4 ground beef patties, same size and thickness
freezer foil
saran wrap
waxed paper
butcher paper

Procedure: Wrap one beef patty in each of the wraps, using drugstore wrap as described in a basic cookbook or in U.S.D.A. Home and Garden Bulletin Number 70 (Freezing Poultry in the Home). Freeze for at least 2 months. Defrost in the refrigerator without unwrapping. When defrosted, observe color changes and general appearance of the meat. Broil meat patties in preheated broiler about 3 inches from the heat, about 5 minutes per side. Taste each while warm but not hot. Observe flavor, juiciness and mouth feel.

Explanation: Freezer foil and saran are good freezer wraps because they prevent moisture loss from the food. Waxed paper and butcher paper are not good for freezing because they are not moisture-proof and they cannot be sealed air tight. The food dries out and loses flavor. The beef patties frozen in waxed paper and butcher paper are dry, tasteless, and may be discolored.

FOOD SANITATION

Sanitation is important in every part of the food distribution process. Sanitation means more than keeping food clean. Proper handling, wrapping, storage, preparation and cleanup are all involved in food sanitation.

Good food sanitation practices can mean the difference between wholesome and spoiled food. Food spoilage is caused by bacteria, yeasts and molds... microorganisms which are present everywhere. All microorganisms do not cause food spoilage, however. For instance, we rely on molds to make blue cheese and soy sauce; we use bacteria to make sauerkraut and cheese; we depend on yeasts to make wine and to make bread rise.

Food spoilage, along with off-colors, off-odors and off-flavors, results when some of the objectionable microorganisms multiply faster than others. This happens when food is not properly wrapped, stored, cleaned or prepared.

The following experiments test some of the principles of food sanitation, using techniques of microbiology. The experiments require the use of prepoured agar (AH-gr) plates. The plates are sterile when you get them. Microorganisms transferred to the agar surface will multiply and produce "spots" or colonies. Each colony starts with one or more microorganisms. The molds are fuzzy, and yeasts and bacteria are moist spots, often creamy white but sometimes colored.

Prepoured agar plates are available in boxes of 20. You may wish to use all the plates yourself, or divide them with someone else. Write to:

G. A. Ingram Company
4444 Woodward Avenue
Detroit, Michigan 48201

<u>or</u>

Noble Blackmer, Inc.
801 South Brown Street
Jackson, Michigan 49203

Ask for prices and information on:

BBL 21185 Trypticase Soy Agar

The cost for 20 plates is approximately $7.50.

When working with agar plates, keep the plates covered until contaminated with microorganisms, then cover the plate immediately. Label the lids with a felt pen or tape so you know which is which. Do not touch the agar surface with your fingers unless the experiment says so. Keep unused plates in the refrigerator so they won't dry out.

The agar may not be used a second time. The plates may be used again if you can find some <u>plate count agar</u>, perhaps in a hospital bacteriology lab. Sterilize the plastic plates by boiling them in water for at least 10 minutes. Follow the lab's suggestions on melting and pouring the agar.

Practically all foods have microorganisms present. These experiments are designed to show the contrast between proper and improper sanitation. With these plates, there is no way of distinguishing between pathogenic (disease) and non-pathogenic microorganisms. The "good guys" and the "bad guys" are there together.

Do not keep contaminated plates longer than 5 days because they begin to smell. You may dispose of them as you would any waste material...in the incinerator or the garbage can.

EXPERIMENT # 91

Principle: Microorganisms are present in the air.

Equipment needed: I prepoured agar plate

Procedure: Open plate and let stand at room temperature for 2 hours. Do not touch the agar surface. Cover plate and label it. Invert the plate and let it stand at room temperature for 3 days. Observe plate for evidence of microbial growth.

Explanation: Microorganisms present in the air drop onto the agar surface. These microorganisms grow on the agar and form colonies. Each spot on the agar surface means that one or more microorganisms landed there. This shows how important it is to keep food covered.

EXPERIMENT # 92

Principle: Used dish cloths and dish towels are sources of contamination.

Equipment needed: 2 prepoured agar plates
used dish cloth
used dish towels

Procedure: Use dish cloth and towel to wash and dry dishes. Open one agar plate. Lightly touch center of dish cloth on surface of agar. Cover plate immediately and label it. Open second plate. Lightly touch center of dish towel to agar surface. Cover plate immediately and label it. Invert both plates and let stand at room temperature for 3 days. Observe microbial growth on both plates.

Explanation: More microorganisms may be present on the dish cloth because it is used on dirty dishes and pans. There are some micro-organisms on the towel because the same towel is used to dry many dishes. Microorganisms can be transferred from the dish cloth to other surfaces.

EXPERIMENT # 93

Principle: Proper care of utensils decreases the possibility of microbial contamination.

Equipment needed: 3 prepoured agar plates
2 clean spoons

Procedure: Open one agar plate. Holding one spoon by the handle, lightly move the bowl of the spoon across the agar surface. Cover plate immediately and label it. Drop the spoon on the floor. Open the second agar plate. Pick up the dropped spoon by the handle and lightly move the spoon across the agar surface. Make sure that the part that hit the floor makes contact with the agar. Lick the second spoon. Open the third plate. Move the spoon lightly across the agar surface. Make sure that the part you licked makes contact with the agar. Cover plate immediately and label it. Invert all three plates and let stand at room temperature for 3 days. Observe microbial growth on all plates.

> Explanation: Some microorganisms often remain on clean utensils. The floor probably has a high microbial count, and some of these microorganisms may be picked up by utensils dropped on the floor. Some microorganisms live in your mouth, and are transferred to utensils when they are licked. This shows how important it is to use only clean utensils around food.

EXPERIMENT # 94

Principle: Low temperatures retard microbial growth in cooked foods.

Equipment needed: 1 piece of cooked meat (not ground) cut in half
2 prepoured agar plates

Procedure: Cover one piece of meat after cooking and refrigerate immediately. Cover second portion of meat and let it stand at room temperature about 8 hours. Open one agar plate. Lightly touch the agar surface with the surface of one portion of meat. Cover plate immediately and label it. Open second plate. Lightly touch the agar surface with the second piece of meat. Cover plate immediately and label it. Invert both plates and let stand at room temperature for 3 days. Observe the microbial growth on both plates.

> Explanation: Cooked foods held at room temperature should show evidence of greater microbial growth than foods chilled immediately after cooking and held at refrigerator temperature. This shows how important it is to refrigerate foods as soon as possible after cooking.

EXPERIMENT # 95

Principle: High temperatures destroy many microorganisms.

Equipment needed: 3 spoons...one washed in automatic dishwasher, one washed by hand and air dried, one washed by hand and dried with dish towel
3 prepoured agar plates

Procedure: After dishwasher has completed the washing cycle and dishes are cool, remove one spoon, touching only the handle. Open one agar plate. Lightly move the bowl of the spoon across the agar surface. Cover plate immediately. Pick up the air-dried spoon, touching only the handle. Open second plate. Lightly move the bowl of the spoon across the agar surface. Cover plate immediately and label it. Pick up the towel-dried spoon, touching only the handle. Open the third plate. Lightly move the bowl of the spoon across the agar surface. Cover plate immediately and label it. Invert all three plates and let stand at room temperature for 3 days. observe evidence of microbial growth on all plates.

Explanation: The high water temperatures of automatic dishwashers destroy many of the microorganisms present. Handwashing destroys some but not all of the microorganisms. Microorganisms can be transferred to utensils from the dish towel.

EXPERIMENT # 96

Principle: Washing removes some of the microorganisms present on skin.

Equipment needed: 2 prepoured agar plates

Procedure: Open one agar plate. Run your finger across the agar surface. Cover plate immediately and label it. Wash your hands with soap and water and dry well. Open second plate. Run your washed finger across the agar. Cover plate immediately and label it. Invert both plates and let stand at room temperature for 3 days. Observe microbial growth on both plates.

Explanation: The plate streaked by your unwashed finger will probably show a definite pattern of microbial growth. The other plate should show less growth. This shows the importance of washing your hands before handling food.

EXPERIMENT # 97

Principle: Washing removes some of the microorganisms present in food.

Equipment needed: 1 unwashed apple, peach or pear
2 prepoured agar plates

Procedure: Open one agar plate. Roll fruit over the agar surface, being careful not to tear the agar. Cover plate immediately and label it. Wash fruit carefully in running water. Dry on a clean towel. Open second plate. Again roll fruit over the agar surface. Cover plate immediately and label it. Invert both plates and let stand at room temperature for 3 days. Observe microbial growth on both plates.

> Explanation: Washing removes some but not all of the microorganisms present on food. This shows the importance of washing fruit before eating it.

EXPERIMENT # 98

Principle: Low temperatures retard microbial growth on meat.

Equipment needed: 1 piece of raw meat, cut in half
2 prepoured agar plates

Procedure: Cover both pieces of meat loosely with waxed paper. Refrigerate one piece. Let the other stand at room temperature. After 8 hours, uncover both pieces of meat. Open one agar plate. Lightly touch the agar with the surface of the unrefrigerated meat. Cover plate immediately and label it. Open second agar plate. Lightly touch the agar with the surface of the chilled meat. Cover plate immediately and label it. Invert both plates and let stand at room temperature for 3 days. Observe microbial growth on both plates.

> Explanation: Microorganisms multiply rapidly on meat held at room temperature. This shows the importance of keeping meat chilled until you are ready to use it.

EXPERIMENT # 99

Principle: Defrosting frozen food at low temperatures retards microbial growth.

Equipment needed: 1 piece of meat (not ground) cut in half, wrapped and frozen separately
2 prepoured agar plates

Procedure: Defrost one piece of meat at room temperature and one piece in the refrigerator. Meat should stand at room temperature at least 6-8 hours. When both pieces are completely defrosted, remove wrapping. Open one agar plate. Lightly touch the agar surface with the room temperature meat. Cover plate immediately and label it. Open the second plate. Lightly touch the agar surface with the refrigerated meat. Cover plate immediately and label it. Invert both plates and let stand at room temperature for 3 days. Observe microbial growth on both plates.

> Explanation: Microorganisms are present on both pieces of meat. However, the microorganisms do not multiply as fast on the meat defrosted in the refrigerator as on the meat defrosted at room temperature. This shows the importance of defrosting frozen foods in the refrigerator.

EXPERIMENT # 100

Principle: Raw eggs can be contaminated by their shells.

Equipment needed:
- clean table knife
- clean custard cup
- clean fork
- raw egg
- 2 prepoured agar plates
- clean spoon

Procedure: Crack raw egg with table knife and drop egg into custard cup. Do not allow any of the shell to fall into the egg. Beat egg with a fork. Open one agar plate. With clean spoon place a few drops of egg on the agar. Use the back of the spoon to spread out the egg. Cover plate immediately and label it. Drop half the egg shell into the egg. Carefully pick up the shell. Open second plate. Transfer egg to the agar surface by moving the shell around on the agar. Cover plate immediately and label it. Do not invert plates. Let plates stand at room temperature for 3 days. Observe microbial growth by holding plates up to the light. The opaque spots are colonies of bacteria.

> Explanation: Raw egg has few if any microorganisms present. The shell can be a source of contamination. It is safer to not let pieces of shell fall into the egg.

REFERENCES

These references may help you in completing your experiments. They are available in your county extension office. Ask the Home Economist to loan you a copy.

1. Griswold, Ruth. The Experimental Study of Foods. Houghton, Mifflin Company, Boston. 1962
2. How to Prepare and Serve Vegetables. Extension Publication No. 350.
3. Meat...Let's Cook It Right. Extension Publication No. 520.
4. Home Freezing of Prepared Foods. Extension Publication No. F 270.
5. Prevent Food Poisoning. Extension Publication No. 411.
6. Storing Perishable Foods in the Home. Home and Garden Bulletin No. 78.
7. Home Canning of Fruits and Vegetables. Home and Garden Bulletin No. 8.
8. Home Freezing of Fruits and Vegetables. Home and Garden Bulletin No. 10.
9. Freezing Meat and Fish in the Home. Home and Garden Bulletin No. 93.

Available from Michigan State University:

1. "A Cake Is A System", slide set and narrative.
2. "Food Science For Teen Leaders", slide set and narrative.

APPENDIX I

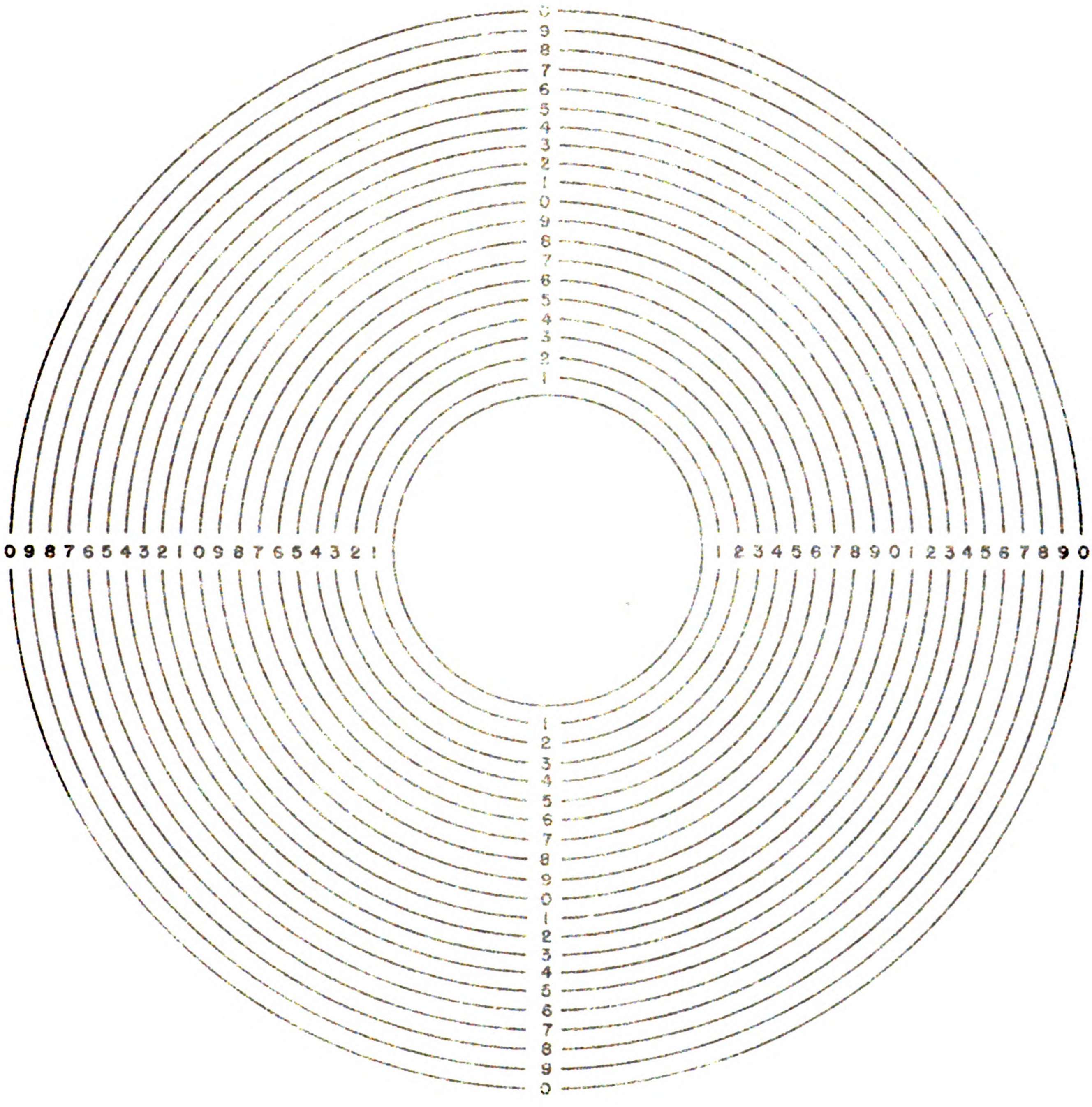
Line Spread Test

The line spread test is for the thickness or thinness of foods. The thinner a food is, the farther it will spread on a flat surface.

The following page has a diagram for the line spread test. To conduct the test:

1. Place a sheet of glass over the diagram. Picture frame glass is fine.
2. Place a hollow cylinder over the center ring. A tomato paste can or frozen juice can with both ends removed is just about right.
3. Put 2 level tablespoons of the food to be tested into the cylinder.
4. Lift up the cylinder and let the food spread on the glass for 2 minutes.
5. Take readings at four widely separated points on the rings at the limit of the spread of the food. Add the numbers on the rings at these points. The total gives the line spread value for that particular food. The higher the number, the thinner the food.

Read the rings carefully. They are numbered in blocks of 10's. The second block is the 'teens.


0 9 8 7 6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0

APPENDIX B

Record Book

4-H BULLETIN 255J

MICHIGAN STATE UNIVERSITY

FOOD SCIENCE AND YOU RECORD BOOK

marilyn mook
food/nutrition specialist

This record book is to help you evaluate and record the food science experiments you have conducted in the Food Science and You learning experience.

The experiments you conduct may come from the Bulletin, FOOD SCIENCE AND YOU, or you may wish to set up some additional experiments on your own.

Your 4-H leader, 4-H Youth Agent, Extension Home Economist, home economics teacher, or science teacher can give you suggestions for resource material for your food science experiments.

In this learning experience you may wish to...
...complete experiments concerned with a particular nutrient such as protein <u>or</u>
...complete experiments involving a particular food group such as breads, <u>or</u>
...complete experiments dealing with food preparation, <u>or</u> food storage, <u>or</u> food sanitation.

Some of the experiments are designed for the novice, and some of the more difficult ones are for the adventurer. Keep this in mind when you make the decision about which experiments you choose.

Whatever your area of interest, select not less than four experiments to complete, and you may do more if you wish.

Share your new-found knowledge with your family, other club members, and other members of your community. You may do this by demonstrations, action exhibits, posters, displays, skits, or any other creative way which presents the information in a way that is interesting and timely to your audience.

This learning experience in Food Science is planned so that you will...

...test the principles of food preparation, food storage, and food sanitation.

...apply what you have learned to your own work with food.

...share your knowledge with others.

...and most of all, have fun with food!

NAME Bill Smith DATE 6-21 TIME TO COMPLETE 1 week

NAME OF EXPERIMENT? Quality of shell eggs deteriorate with aging, and is dependent on storage conditions.

HOW DID YOU SET UP YOUR EXPERIMENT? Store 3 eggs covered in refrigerator, 3 eggs uncovered in refrigerator, and 3 eggs on countertop in kitchen. Break one of each after 1 day, 3 days, and 7 days. Observe air cell and height of thick white.

WHAT RESULTS DID YOU GET? Eggs stored covered in refrigerator showed small air cells and lots of thick white even after 7 days. Uncovered refrigerated eggs showed large air cells. Eggs stored at room temperature showed much larger air cells and smaller amounts of thick white as time increased.

HOW CAN YOU USE AND APPLY WHAT YOU HAVE LEARNED? Be sure shell eggs stored covered in the refrigerator, and avoid letting them sit out for long periods of time.

HOW HAVE YOU SHARED THIS KNOWLEDGE? Told my mother and sisters; did display for County 4-H Action Day; did demonstration for my club; made poster and displayed it in supermarket by egg case.

NAME ____________________ DATE __________ TIME TO COMPLETE __________

NAME OF EXPERIMENT? ______________________________

HOW DID YOU SET UP YOUR EXPERIMENT? ____________________

WHAT RESULTS DID YOU GET? ____________________

HOW CAN YOU USE AND APPLY WHAT YOU HAVE LEARNED? ____________________

HOW HAVE YOU SHARED THIS KNOWLEDGE? ____________________

NAME ______________________ DATE __________ TIME TO COMPLETE __________

NAME OF EXPERIMENT? ______________________________________

____

HOW DID YOU SET UP YOUR EXPERIMENT? ______________________

____

____

____

____

WHAT RESULTS DID YOU GET? ______________________________

____

____

____

____

HOW CAN YOU USE AND APPLY WHAT YOU HAVE LEARNED? __________

____

____

____

____

HOW HAVE YOU SHARED THIS KNOWLEDGE? ______________________

____

____

____

____

NAME ______________________ DATE __________ TIME TO COMPLETE __________

NAME OF EXPERIMENT? ____

____

HOW DID YOU SET UP YOUR EXPERIMENT? ______________________________

____

____

____

____

WHAT RESULTS DID YOU GET? ______________________________________

____

____

____

____

HOW CAN YOU USE AND APPLY WHAT YOU HAVE LEARNED? ________________

____

____

____

____

HOW HAVE YOU SHARED THIS KNOWLEDGE? ______________________________

____

____

____

____

NAME ____________________ DATE __________ TIME TO COMPLETE __________

NAME OF EXPERIMENT?

HOW DID YOU SET UP YOUR EXPERIMENT?

WHAT RESULTS DID YOU GET?

HOW CAN YOU USE AND APPLY WHAT YOU HAVE LEARNED?

HOW HAVE YOU SHARED THIS KNOWLEDGE?

NAME ______________________ DATE __________ TIME TO COMPLETE __________

NAME OF EXPERIMENT? ______________________

HOW DID YOU SET UP YOUR EXPERIMENT? ______________________

WHAT RESULTS DID YOU GET? ______________________

HOW CAN YOU USE AND APPLY WHAT YOU HAVE LEARNED? ______________________

HOW HAVE YOU SHARED THIS KNOWLEDGE? ______________________

NAME ____________________ DATE __________ TIME TO COMPLETE __________

NAME OF EXPERIMENT? ____________________

____

HOW DID YOU SET UP YOUR EXPERIMENT? ____________________

____

____

____

____

WHAT RESULTS DID YOU GET? ____________________

____

____

____

____

HOW CAN YOU USE AND APPLY WHAT YOU HAVE LEARNED? ____________________

____

____

____

____

HOW HAVE YOU SHARED THIS KNOWLEDGE? ____________________

____

____

____

____

NAME ____________________ DATE __________ TIME TO COMPLETE __________

NAME OF EXPERIMENT? ____________________

____

HOW DID YOU SET UP YOUR EXPERIMENT? ____________________

____

____

____

____

WHAT RESULTS DID YOU GET? ____________________

____

____

____

____

HOW CAN YOU USE AND APPLY WHAT YOU HAVE LEARNED? ____________________

____

____

____

____

HOW HAVE YOU SHARED THIS KNOWLEDGE? ____________________

____

____

____

____

APPENDIX C

Slide Narrative

A CAKE IS A SYSTEM

Slide set prepared for 4-H leaders and others working with youth and food.

SLIDE NUMBER	NARRATIVE
1	A cake is a system.
2	Prepared by Marilyn Mook, Food and Nutrition Specialist, Michigan State University.
3	No endorsement of products is intended or implied.
4	What are the parts of a cake system?
5	Flour
6	Sugar
7	Shortening
8	Baking powder
9	Egg
10	Liquid
11	Salt
12	And a recipe for the right proportions.
13	Why flour? Flour forms the framework of the cake. The protein in the flour is called GLUETEN. When this protein is moistened with liquid, the gas given off by the baking powder rises through the gluten strands. And the cake rises.
14	Too much flour? A heavy compact cake, because there is too much flour for the liquid to moisten.
15	Not enough flour? A little cake, because there is not enough gluten to form the proper framework.
16.	Why sugar? Sugar adds flavor and tenderness, and helps the cake to brown.
17.	Too much sugar? A too tender, too sweet cake, with a sticky crust.
18.	Not enough sugar? A tough cake, pale crust, and not sweet.
19.	Why shortening? For tenderness. And flavor and color if you use butter or margarine.

SLIDE NUMBER	NARRATIVE
20	Too much shortening? A greasy, crumbly cake.
21	Not enough shortening? A dry tough cake.
22	Why baking powder? To make the cake rise; to make it light and airy.
23	Too much baking powder? A holey cake, and perhaps low in volume because the gluten strands stretch so much they collaspe.
24	Not enough baking powder? A flat cake.
25	Why egg? Egg adds flavor, color and some protein for structure.
26	Too much egg? A rubbery cake, maybe chewy, maybe low in volume.
27	Not enough egg? The batter may curdle because the egg yolk keeps the fat from separating out.
28	And the cake may be dry and low in volume.
29	Why liquid? To dissolve the sugar and salt. To moisten the flour proteins. To dissolve the baking powder so gas can be formed.
30	Too much liquid? The proteins are moistened too much and can't stretch. And the cake is dry and heavy.
31	Not enough liquid? Not enough moisture for the gluten so it doesn't stretch. And the cake is dry and heavy.
32	Why salt? For flavor. To bring out the characteristic flavor of the cake.
33	Too much salt? A salty taste, and maybe low in volume.
34	Not enough salt? No flavor. It looks pretty good, but tastes pretty flat.
35	All these parts work together in the cake system.
36	When one part is altered, the whole system is out of whack.
37	And that's why a cake is a system.

Marilyn Mook
Food and Nutrition Specialist
Youth Emphasis
Michigan State University

APPENDIX D

Questionnaire

FOOD SCIENCE AND YOU

Return to Marilyn Mook, M.S.U. in the envelope provided.

1. How old are you? ______

2. Where do you live? ______city ______country

*3. What experiments did you do? List the numbers:

*4. Did you enjoy doing these experiments? ____yes ___no ___ so-so

*5. What did you learn?

6. How did you share your new knowledge?

7. Are you a teen leader? ______

*8. Can you use your new knowledge with other members? ______

9. Would you like to do more of these experiments? ______

*10. Were any parts not clear to you? Anything you would change to make this project better for other young people?

*These questions were used on the questionnaire for the adults.