Poultry Products Research

A GUIDE FOR RESEARCH WORKERS, INCLUDING A LIST OF SOME PROBLEMS IN PROJECT FORM

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ANIMAL HUSBANDRY SECTION

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The trends are clear in poultry science. More study is given to the physical handling of eggs and poultry to deliver what consumers have a right to expect in quality and kind. In the art of poultry raising, more attention is given to the physical surroundings which determine the comfort and health of the birds and to producing the kinds of eggs and poultry wanted in the market.

These are profitable things for science to consider. They are phases of poultry improvement which are susceptible of scientific control. In the main they can be stated in terms of well-known laws of physics and chemistry and are not subject to so many exceptions in individual birds or flocks as is the case in husbandry. This department of poultry science is broadly known as poultry products research and is the grouping under which the projects described in this manual fall.

Poultry products research began many years ago, but it did not enter the poultry departments of state experiment stations or of the U. S. Department of Agriculture until recently. It began, rather, as an interest of consumers to which the government granted some facilities for laboratory and field experimentation, centered in the U. S. Food Research Laboratory. These first attempts to study the better handling of poultry products reached a peak during the first world war and then subsided for want of sufficient appropriations. The laboratory was closed and the staff scattered, but insight into the nature of the problems remained wherever the seed had been sown. Scientific interest in poultry products research revived slowly, beginning about 15 years ago with a more scientific approach to understanding the behavior of market eggs. Many people contributed to the reviving interest and it soon spread to poultry meat and its behavior.

Meanwhile the scientists and the industry held several conferences to promote a better understanding of the importance of research to profitable handling and good merchandising of poultry products. Acquaintance spread in two directions; toward a better understanding of the in-
dustry by those who are directing research; and toward a better understanding, on the part of industry, of the facilities for chemical and physical research in the state institutions. Fraternizing has become usual, and the future of poultry products research looks bright today.

The form in which this manual appears was recommended by the Committee on Research Projects of Poultry Products Revolving Fund at a meeting of the committee, May 26-28, 1940, when the manual was planned and work on it was begun. Seven of the nine members of the committee were present in person: R. E. Buchanan, J. G. Halpin, Benjamin R. Harris, E. H. Harvey, Paul E. Howe, Fred C. Koch, and W. I. Westervelt. V. R. Gardiner was represented by W. L. Mallmann, and Morley A. Jull was unavoidably absent. The committee had as its guests T. L. Swenson and G. F. Stewart. All of the above will be readily recognized as among the foremost authorities in their several fields of scientific work.

It was an able committee. The members worked faithfully for 3 days and the plan for this manual emerged. Shortly following the meeting, Iowa State College undertook the completion and publication of the manual under the editorial direction of Dr. Stewart.

Its publication will, we predict, provide ignition for beginning poultry products research in a number of institutions where the desire exists but the way has not yet been found to undertake it.

Paul Mandeville,
Director, Library Research Conference.
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SCOPE AND PURPOSE

The term "Poultry Products" is comparatively new. Dairy products, corn products, and soybean products are subjects for rather elaborate research and are manufactured for a multitude of uses. Egg products also have many potential uses.

In the case of poultry only about half of the live weight is edible flesh as commonly served at the table. The other parts are of value and some of them may have medicinal and/or food-fortifying value as is the case with the by-products of heavy livestock.

Before progress will be certain in this field of research, as in all worth-while research, there must be a clear understanding of the fundamental problems. There must also be trained people, good physical facilities, labor and money, and a planned advancement, which constitute favorable research or fact finding, interpreting of the results, and putting the discoveries to use.

BROAD PURPOSE

This publication is concerned primarily with scientific research in, and technical control of poultry products, in order that new uses may be created, new standards of dependability realized in the market, and sound facts and practices used in all efforts to expand markets by publicity.

Poultry Products Research does not concern itself with the problems of poultry raising or poultry keeping except as the cost or marketability of the product may be affected.

SPECIFIC PURPOSE

By reducing the important problems in this field to definite, well-planned and organized projects, it is hoped that talented research workers will find problems to challenge them and thus start them working in this field.

The projects have been outlined by persons chosen for their interest in the subject and who know the problems of the industry. The outlines should serve to guide new workers into fields most suited to their interest and qualifications.
OUTLINES FOR POULTRY PRODUCTS RESEARCH

The following pages contain suggestive outlines of research projects. They are thought by a large group of persons interested in Poultry Products to be those most needing study.

Every effort has been made to reduce each problem to a definite and concise project which could be studied by a single research group with the reasonable hope of securing worth-while results within a few years. The outline is general rather than specific because men of research caliber should be able to work out the specific design of their experiments to fit their own facilities and abilities.

At first it was hoped that cost estimates of the work involved in a particular project could be made. It later became apparent that costs varied widely among the various research institutions. Some are willing to initiate research when funds to cover personnel and materials are given, others only when all costs (including overhead) are covered.

Individuals and firms wishing to subsidize some research project listed here may usually do so by making arrangements with their state experiment station, university, or endowed research institutions. Obviously much of the work is done on public money, and the appropriations for research then come from state or federal legislative bodies.

This list of research projects by no means exhausts the possibilities for research in Poultry Products. Solutions to some of the problems will undoubtedly suggest many new ones to be investigated.
I. EGG RESEARCH

USES FOR EGGS

The generous use of eggs in the dietaries of American families of moderate incomes is proof of their value and versatility as a food. This very fact should bestir members of the egg industry to be more concerned about the quality and character of the eggs supplied to consumers.

Besides the eggs directly consumed at the table as cooked, poached and fried, many are used in cookery. Their presence in cooked products is not always apparent, but without them the product would generally be something less desirable or non-existant, as for example in mayonnaise or cooked salad dressings, and angel food cake.

In table eggs the desirable qualities are usually associated with those ordinarily found in the freshly-laid eggs. These factors are primarily concerned with eye appeal and taste. They consist of a white made up principally of a thick, gelatinous mass and a well-centered upstanding yolk of mild “egg” flavor.

The performance of eggs in cookery may or may not be associated with their state of “freshness.” There is increasing evidence to show that for angel food cakes, egg whites perform best when physically altered before beating. On the other hand, eggs for custards seem to work best if they are freshly-laid (according to our present meagre knowledge). It would appear, therefore, that the type of cookery in which eggs are to be used may determine the egg quality desired.

Too little research has been done in this field to advise housewives or commercial food manufacturers as to the most suitable eggs for the different uses. Great opportunities for research and development await talented workers who are gifted and trained in the fundamentals of food technology. The chances for fruitful research are exceedingly great, providing a challenge to the initiative and resourcefulness of anyone who is interested and trained for work in the field.

GRADING EGGS

The protective qualities of the egg shell are appreciated by nearly everyone. Even small cracks greatly increase the chances for spoilage in the handling and storage of eggs. However, the great advantages possessed by the shell are
partially offset by the difficulties presented when we desire to ascertain the interior quality of eggs. After a number of years of rather intensive study it has been learned that quality in eggs is only very roughly measured by candling methods.

The quality factors for table eggs are now quite generally understood and easily measurable. A comprehensive study of methods for the determination of those interior quality factors through the shell is urgent. Such studies conducted by competent physicists and chemists, with practical advice from persons familiar with these egg quality factors, should surely result in improved techniques for estimating the quality while the egg is still in the shell.

If such studies were carried to a successful conclusion, the consumer of eggs would be assured of a more uniform quality of eggs, and what is more important, be assured of receiving no defective eggs (blood spots, etc.). The increased confidence in eggs offered for sale that would follow the practical application of this work, would surely lead to an increased and continuous consumption of shell eggs.

KEEPING QUALITY OF EGGS

The seasonal production of eggs coupled with the distance from production points to consumption centers make the keeping quality of eggs an important research problem.

It is now quite widely accepted that refrigeration is a primary essential for the handling of eggs. At present it is difficult to provide refrigeration at the point of production at a cost which can be justified. By the time the eggs reach the packing plants where refrigeration is economically feasible, much of the original quality has been lost.

Carbon dioxide has been shown to have remarkably beneficial effects on the keeping quality of eggs even at temperatures from 70° to 100° F. Research should be directed toward putting this knowledge to practical use in the handling of eggs on the farm and in transit to the refrigeration plant.

Studies in developing practical ways of using carbon dioxide, temperatures and other quality controls should be made in an effort to provide efficient and economical means of maintaining the quality of eggs all the way through the market channels to the consumers.

FROZEN AND DRIED EGGS

The production of frozen and dried eggs has shown a surprisingly steady growth since 1916. In 1937 there were approximately 196 plants with a combined total production
of 225 million pounds of frozen eggs. In the same year 15 plants were reported producing 2,401,000 pounds of dried eggs (on a liquid egg basis this amounts to approximately 9,210,000 pounds).

This growth of the frozen and dried egg industries is direct evidence of the acceptability of the products to wholesale consumers such as bakers, and salad dressing, candy, and noodle manufacturers. This is the more remarkable in view of the fact that little technical work has been done in the field. Freezing methods, treatment of eggs prior to freezing, and other details have been given but little attention by research workers. The patent literature shows, however, that some commercial firms have been much more active than the industry as a whole. Considerable progress in maintaining and enhancing the quality of frozen and dried eggs in their various uses could be expected by a concerted program of research.

NUTRITIVE VALUE OF EGGS

Outstanding nutritionists like E. V. McCollum and the late Mary Schwartz Rose place eggs in the class of "protective" foods. Eggs supply a good quantity of protein, fats, minerals, and some of the vitamins which are not common in the staple foods of our daily diet.

In recent years eggs have had to compete with many highly advertised vitamin and mineral concentrates. They will probably meet still more competition as our knowledge of these valuable elements grows.

This increased competition has made it necessary for the poultry industry to reinvestigate the nutritive values of eggs. As a result we have found ourselves less sure of their exact value. It is now certain that the vitamins found in both poultry and eggs depend to a considerable degree on the feed the chicken receives.

Today there is a real need for more knowledge concerning the nutritive values of eggs and the effect of feed on the nutrients. Trained biological chemists, properly equipped and financed, are sure to find an intriguing field for research here.
CONTROL OF EGG YOLK COLOR THROUGH FEED INGREDIENT CONTROL—INCREMENT INCREASE WITH COMMON FEEDSTUFFS

SIGNIFICANCE:

There is surprisingly little information available regarding the relationship between the amount of carotenoid pigments deposited in eggs, skin and shanks, and the pigment content of the feed. There are no data available, for example, indicating the pigment content of the feed, beyond which a further increase will not produce a further increment in egg yolk or skin color.

On a given pigment intake there appears to be a wide variability among hens in the amount of pigment deposited in the eggs. The feed ingredients, management, and genetic factors responsible for this variability should be studied, in order that yolks of uniform and proper color can be produced at will. Research should make it possible to satisfy a discriminating consumer as to egg yolk color.

There is increasing evidence that certain feed ingredients and certain combinations of ingredients prevent the ready mobilization of pigment into yolks, skin and shanks. This has been reported to be particularly true of certain fish meals. The stability of carotenoid pigments in certain standard feed combinations should be determined chemically, and the factors affecting the ready mobilization of these pigments into the eggs, skin and shank studied by feeding experiments.

Yolk color influences the depth of the shadow cast when eggs are candled, and thus affects the grade given by present methods.

Further, various off-colored yolks have been thought to be due to weeds, certain seeds, etc. Much more information is needed.

Regardless of yolk color, the nutritional value of the egg and the proper nutritional balance of the hen should be maintained. The economy of egg production demands that the maximum of natural feedstuffs be used in laying rations. A study of feed ingredients, with the view of evaluating the common ingredients, separately and in combination, from the standpoints of economy, egg yolk color, and nutritional value, should lead to a practical solution of the problem.
PERSONNEL AND FACILITIES:

1. Nutritionist.
2. Biological chemist.
3. Laying hens of a uniform strain.
4. Facilities for feeding individually.
5. Equipment necessary for determining egg yolk color and the amount of carotenoid pigments in feedstuffs.

SUGGESTED PROCEDURE:

1. Study causes of variation in yolk color of eggs produced by hens on the same ration.
   a. Effect of breeding
   b. Effect of rate of production
   c. Effect of position of egg in clutch
   d. Effect of rate of feed consumption
   e. Effect of age of laying bird

2. Study availability of pigments in feedstuffs.
   a. Effect of concentration of pigment
   b. Complementary action of pigments
   c. Availability of the same pigments from various natural sources
   d. Measurement of pigments in total ration
   e. Feedstuffs hindering deposition of color

3. Study yolk colors.
   a. Visual methods
   b. Physical methods
   c. Chemical methods
Egg Project 2.

DEVELOPMENT OF AN ACCURATE METHOD FOR THE DETECTION OF QUALITY IN SHELL EGGS

SIGNIFICANCE:

About 37 billion eggs, with a farm value of about 700 million dollars, are produced each year, and about 77 percent of these eggs are marketed. The price of shell eggs as they pass through the marketing channels should bear a close relation to the quality of the eggs. The character of the contents must be determined by some method which does not involve breaking the shell. At the present time this is done by candling which, at best, is a rather uncertain procedure. Millions of dollars and billions of eggs change hands annually on the basis of values determined by the uncertainties of candling. A simple accurate method for the determination of the quality of the eggs’ contents would place buying and selling on a sounder basis. This would be beneficial to the poultryman, the marketman and the consumer.

PERSONNEL AND FACILITIES:

1. Physicist.
2. Mechanical engineer.
3. Electrical engineer.
4. Poultry specialist with knowledge of egg quality.
5. Eggs of known history and quality.

SUGGESTED PROCEDURE:

In the beginning the work would be the development of physical equipment, and the services of an instrument maker to work under the direction of the physicist would be necessary. Later there should be a testing of the devices by one familiar with the measurements of egg quality. Work on this project would be exploratory and must necessarily proceed step by step. The known properties of the eggs suggest several possibilities which are worthy of investigation.

1. Develop an instrument for determining the displacement of the yolk from center when the egg is at rest. Determine the approach of the yolk to the shell with the egg at rest. This should indicate the amount and condition of the thick white which tends to center the yolk.
2. The difference between the horizontal and perpendicular axis of the yolk while at rest in the egg should indicate the degree of mistreatment in handling. Perhaps this could be measured.

3. An instrument might be devised to take advantage of the difference in inertia of the contents, as the yolk expands and as the white becomes watery.

4. Light absorption and reflection particularly by the small mucin particles in the thick white might be utilized to determine the character and position of the thick white.

Egg Project 3.

Dirt as a Factor in the Keeping Quality of Eggs

Significance:

Bacteria-laden dirt on the shells of eggs is an important factor as a cause of shell-egg spoilage. From 20 to 80 percent of eggs are soiled to some extent at the time of gathering. Improvements in management can greatly improve or almost eliminate dirty eggs and this is the sound solution of the dirty egg problem. Since this ideal may never be approached in certain sections of the country, dirty eggs must be dealt with properly. If the shells are soiled, the chance of microbiological contamination of the contents is greatly increased. A study should be made of the extent of the hazard involved when soiled and cleaned eggs are stored under different conditions.

Personnel and Facilities:

1. Poultry husbandryman.
2. Bacteriologist.
4. Eggs of known history.
5. Cooperation with a commercial egg-breaking firm.
6. Proper equipment for making bacteriological examination of eggs; facilities for grading and examining eggs for interior edible quality and their cooking properties.
SUGGESTED PROCEDURE:

1. Determine the amount of quality deterioration which results from the contamination of the egg shell.
   a. Degree and kind of dirt as a factor
   b. Fresh eggs held under conditions similar to those that prevail when eggs are marketed through the regular channels
   c. Eggs stored at different seasons, at different temperatures, and for various periods of time.

2. Determine the types of organisms gaining entrance to the interior of the egg through the shell.

3. Determine the extent, if any, of a health hazard resulting from dirt and bacterial contamination.

4. Determine the points in production and marketing where contamination occurs.

5. Determine the deterioration of quality of soiled eggs, measuring the changes by candling and interior quality tests, bacteriological examination and cooking tests.

6. Compare the numbers of bacteria in the egg white and yolk from eggs which were:
   a. Clean
   b. Dirty
   c. Cleaned
      1) Mechanically
      2) Chemically

7. Determine the effect of such environmental factors as temperature and humidity on the deterioration of egg quality resulting from contamination of egg shell.
Egg Project 4.

The Problem of Meat and Blood Spots in Eggs—A Study of Methods of Control

Significance:

Meat spots occur with great frequency and constitute a considerable loss to commercial egg producers. Blood spots are reported to be of increasing importance, and because eggs containing large ones are classed as inedible, they represent a substantial economic loss.

Extended observations have shown that large meat spots occur in as high as 30 percent of the yearly production from hens in certain breeds, and large blood spots in as high as 4 percent. Many more eggs contain small meat or blood spots. In general, the frequency of occurrence of these abnormal eggs is greater among the American breeds than among Leghorns. There are indications that, within a breed, certain strains tend to produce a significantly larger proportion of eggs with blood spots than do other strains.

It appears desirable to determine the origin and causes of meat and blood spots, and to study the possibility of preventing them, either by suitable management practices or by excluding from the breeding flock all birds which consistently produce eggs with either of these defects.

Personnel and Facilities:

1. Physiologist.
2. Geneticist.
3. Poultry plant facilities.

Suggested Procedure:

1. Determine the origin of blood and meat spots by techniques which will be developed.
2. Determine whether or not blood and meat spots are always of similar origin. (It has been shown that meat spots are composed mainly of degenerated masses of red blood cells, and it may be that meat spots originate from blood spots.)
3. Find the causes of blood and meat spots, and investigate the possibility of removing these causes if they are of an environmental nature.
4. If the causes are found to be hereditary in nature, determine the mode of inheritance and best selection methods for the elimination of carriers.
Egg Project 5.
A COMPREHENSIVE STUDY OF THE SEALING OF THE EGG SHELL TO MAINTAIN QUALITY

SIGNIFICANCE:
Numerous materials have been used to seal the shell of the egg in an effort to preserve the original quality of its contents. The majority of these, if not all of them, have had one or more objectionable features. However, it appears reasonable that there may be other materials and/or methods that would give better results than those that have been investigated. It would be of considerable economic importance if such a material could be found and a satisfactory method devised for using it to seal the egg shell.

PERSONNEL AND FACILITIES:
1. Chemist familiar with egg quality.
2. Bacteriologist.
3. Eggs of known history and quality.

SUGGESTED PROCEDURE:
1. Investigate new materials that could be used in sealing the shell of eggs with emphasis on some of the more recently developed resins and waxes.
2. Further investigate some of the more satisfactory materials and methods that have been proposed.
3. Study the effect of treatment on the egg.
   a. The effect of treatment on the appearance, sound of the shell (when eggs are clicked together) and on the evaporation rate
   b. The effect of sealing of the shell on the keeping quality of the egg contents:
      1) On the appearance of the egg contents
      2) On the odor and flavor of the egg contents
      3) On change in pH of egg contents
      4) On transfer of water from white to yolk
      5) On growth of bacteria during storage
      6) On cooking qualities
4. Cost of sealing eggs.
   a. Cost of material
   b. Cost of equipment
   c. Labor costs
Egg Project 6.

Use of Carbon Dioxide to Partially Replace Refrigeration for the Maintenance of Quality in Shell Eggs

Significance:

There is some information available that carbon dioxide gas may be used as a supplement for low temperatures in maintaining the interior quality of eggs. Other studies show that CO₂ retards the occurrence of mold growth which usually occurs at just above freezing temperature. It has been found also that when a portion of the air of a storage room is replaced with CO₂, eggs may be satisfactorily maintained over a period of time at temperatures of 50° and higher.

This suggests the possibility of using CO₂ to partially replace refrigeration for the maintenance of quality in eggs particularly in places where low temperatures are not readily obtainable.

Personnel and Facilities:

1. Chemist familiar with egg quality.
2. Bacteriologist.
3. Eggs of known history and quality.

Suggested Procedure:

1. Determine the minimum concentration of CO₂ for maintenance of egg quality at different temperatures.
2. Study the possibility of the addition of CO₂ to egg containers.
3. Investigate the use of high humidity and CO₂ in refrigerator cars as an improvement over the present system of low temperature in the shipment of eggs.
4. Effect of various types of materials (for example, paints) in preventing escape of CO₂ from egg storage rooms and containers.
5. Determine economical methods for maintaining requisite quantities of CO₂ in the egg.
6. Methods for sealing eggs shortly after laying to maintain natural CO₂ content.
SIGNIFICANCE:

There is abundant information showing that bacterial counts in frozen eggs are high when compared to those in other products used in food manufacture. It is still debatable whether or not a health hazard results; because of high bacterial counts, eggs are frequently accused of causing food poisoning. Public acceptance, also confidence in the cleanliness of a food is commonly measured by bacterial counts.

Since egg pulp cannot be heated to kill the bacteria present, we must look for other means of control. It appears that a study of improved sanitary practices in the plant would lead to practical suggestions for attaining much lower bacterial counts.

PERSONNEL AND FACILITIES:

1. Sanitarian.
2. Chemical engineer.
3. Access to and cooperation with an egg breaking establishment.

SUGGESTED PROCEDURE:

1. Study sources of contamination.
2. Study the growth of bacteria during breaking, canning and freezing.
3. Study the effect of washing and sterilizing the equipment used in process.
4. Study the possibility of sterilizing eggs in the shell by such means as:
   a. Short heat treatments
   b. Chemical treatments
5. Study the effect of process temperatures on bacterial growth.
   a. Egg temperature
   b. Room temperature
   c. Insulation of equipment to reduce high surface temperatures
   d. Rate of freezing
   e. Storage temperatures
6. Study the defrosting conditions.
   a. Rate
   b. Container size
   c. Gelation effect

EGG PROJECT 8.
HIGHLY CONTAMINATED SHELL EGGS AS A PROBLEM IN EGG BREAKING OPERATIONS

SIGNIFICANCE:
In egg breaking room practice it is now generally agreed that the control measures for producing low count frozen eggs must stress the shell egg. Very often adequate candling, smelling, and visual inspection of the opened egg serve to keep out eggs of high bacterial count, but there are indications that many contaminated shell eggs pass visual and organoleptic tests, and thus make for high-count frozen eggs, especially with whole egg (mixed yolk and white).

There is a seasonal distribution of these very high count, organoleptically sound eggs, and more important still, a geographical distribution of high-count yolks from these “sound” eggs. The bacteria encountered in these eggs that passed ordinary inspection are: Pseudomonas (many species), Coliform group, and gram-positive Diplococci (probably “Enterococci”). The bacilli are gram-negative nonsporing, aerobic rods. In one test using 150 shell eggs it was impossible to detect the high-count eggs in only 7 instances. The bacterial counts ranged from 70,000 per gram to 46 million per gram of whole mixed egg.

Of course, the equipment should be kept scrupulously clean, but increases in counts during the breaking operations must necessarily take these preliminary conditions into account.

Cold shell eggs, when broken into cups, sometimes do not give off any odor. However, a test run on eggs at room temperatures showed that many high-count eggs could be detected.

PERSONNEL AND FACILITIES:
1. Bacteriologist.
2. Eggs of known history.
3. Cooperation with a commercial breaking firm having connections in several parts of the country.
SUGGESTED PROCEDURE:

1. Incidence of contaminated shell eggs.
   a. Seasonal
   b. Geographic distribution
   c. Nesting conditions, etc. on farms
   d. Porous shells
   a. Candling under various conditions such as various kinds of light
   b. Cleanliness of shells
   c. Temperature for breaking eggs so that high-count eggs may be smelled
   d. Appearance of eggs broken into cup
   e. Some chemical or physical method applied to the yolk and/or white which may correlate with non-odorous high-count eggs

EGG PROJECT 9.

THE RELATIONSHIP OF PHYSICAL-QUALITY FACTORS AND PHYSICO-CHEMICAL CHARACTERISTICS OF EGG WHITES AND YOLKS TO THEIR CULINARY QUALITY AND USE

SIGNIFICANCE:

A substantial portion of the eggs used go into the making of egg dishes: cakes, custards, candy, salad dressing, noodles, doughnuts, etc. The housewife is the principal user of eggs for this purpose, though it must be remembered that approximately 250 million pounds of egg pulp are used in the commercial manufacture of food products.

At present there is no agreement as to the relationship between so-called high-quality eggs and high-quality cakes, high-quality candies, etc. For eggs, high quality, generally, means those qualities usually found in freshly-laid eggs—a white, mainly thick and gelatinous; and a yolk, upstanding and well centered in the white, and of excellent flavor. As a matter of fact, many believe that egg whites need some altering before they will make the best cake. Others feel
that only the very best “quality” eggs can make the best
custards, etc.
There is great need for work to show the true relationships, if any, between the various physical indexes of quality and the culinary use to which the eggs are put.
The loss in physical quality, most commonly observed in eggs that are held, may result in a net gain in their culinary qualities. To divert the various qualities of eggs into those channels for which their characteristics best suit them, would be a natural and beneficial goal. Therefore, the establishment of culinary uses for each specific quality found in eggs is essential.

PERSONNEL AND FACILITIES:

1. Chemist familiar with egg-quality problems and measurements, and trained and experienced in baking and other types of cookery.
2. Research assistant.
3. A research laboratory equipped also for baking and cooking studies.
4. Eggs of known history and quality.

SUGGESTED PROCEDURE:

1. Relationship of various physical-quality factors and physico-chemical characteristics of egg whites and yolks to quality and cost per unit volume of the basic types of cakes baked therefrom is to be determined.
2. Correction, if any, to be made for undesirable and uneconomical characteristics of the cheaper and lower quality eggs when used in cake baking.
3. Similar to 1 and 2 for custards.
4. Similar to 1 and 2 for cookies and sweet breads.
5. Similar to 1 and 2 for fillings, meringues and confections.
6. Similar to 1 and 2 for salad dressings.
7. To establish the optimum conditions for the most effective use in baking for eggs in each quality grade and make an economic comparison of the relative value in baking for eggs in each quality grade at different altitudes.
Egg Project 10.

Physico-Chemical Studies of Egg Yolk and Egg-Yolk Fractions as Stabilizers of Oil-Water Emulsions

Significance:

It is well known that egg yolk represents an extremely stable oil-water emulsion. It is also true that the ether-soluble fraction of egg yolk can easily be emulsified in water to form a stable emulsion. It is obvious then that egg yolk contains one or more very powerful emulsion stabilizers. Stable emulsions are very important in cooking and in the manufacture of many industrial, pharmaceutical and food products. If we knew what components of the yolk are effective as emulsion stabilizers, and under what conditions they are most effective, it should be possible to apply egg yolk more satisfactorily to its present uses, and extend its usefulness to entirely new fields.

Personnel and Facilities:

1. Colloid chemist.
2. Freezing and drying facilities.

Suggested Procedure:

1. Methods of evaluating emulsifying property.
2. Chemical composition of egg yolk in relation to its emulsifying properties.
3. Factors affecting the emulsifying power of egg yolk.
   a. The pH
   b. Freezing and frozen storage
   c. Drying
   d. Additions (sugar, salt, glycerin, oil, acid, etc.)
   e. Age
   f. Temperature
   g. Physical treatment of yolk
4. Factors affecting the stability of egg yolk emulsions.
   a. The pH
   b. Temperature
   c. Degree of dispersion
   d. Viscosity
   e. Presence of electrolytes
EGG PROJECT 11.

A STUDY OF THE COAGULATION AND DENATURATION OF EGG PROTEINS UNDER THE INFLUENCE OF PHYSICAL AND CHEMICAL AGENTS

SIGNIFICANCE:
The coagulation of egg protein is involved in nearly every use to which eggs are put. The texture and body of the final product is generally greatly influenced by how this coagulation takes place. Yet our present knowledge of the nature of coagulation and denaturation of egg and the other proteins is limited. Such knowledge is fundamental to the understanding of many normal and pathological biochemical phenomena. Assurance that egg proteins are used effectively in medicine, nutrition, cooking, and industry must await a satisfactory understanding of the nature of these changes. Many practical problems will be answered, no doubt, by these studies.

PERSONNEL AND FACILITIES:
1. Colloid chemist.
2. Research home economist.
3. A chemical laboratory equipped for colloidal as well as culinary studies.
4. Eggs of known history and quality.

SUGGESTED PROCEDURE:
1. Physico-chemical studies of fresh, partially coagulated and/or denatured, and completely coagulated and/or denatured protein isolates from eggs, followed by similar studies of egg-protein mixtures.
2. Determination of coagulation and denaturation rates for egg proteins by different physical and chemical treatments. Studies of the influence of reagents in the protein environment upon these coagulation and denaturation rates, and the character of the final products.
3. Determination of the desirable physical and chemical environments for egg proteins for optimum results when egg white proteins, yolk proteins, or mixtures thereof, are used in the production of basic types of cakes, pastries, custards, meringues, fillings and confections.
4. Determination of the relationship between the rate of gelation of cake batters during baking, the rigidity and elasticity developed in the baked cake, and the egg-coagulation phenomena.
Egg Project 12.

Whipping and Foaming Properties of Whole Egg (Mixed White and Yolk) and Yolk

Significance:

Considerable work has been done on the foaming properties of egg whites, but little or nothing has been done on the foaming properties of the yolk or the yolk and white combined. The white foam exhibits adsorption of the stabilizing agent at the liquid-air interface; the adsorbed film coagulates forming a non-soluble solid film, thereby stiffening and stabilizing the foam.

Egg foams are used extensively in many prepared foods although their production alone and with the addition of other ingredients is but slightly understood. These foams are useful because they are more or less stable; the degree of their stability influences their usefulness and applicability. A better understanding of the changes and processes taking place would make their use more extensive.

Personnel and Facilities:

1. Colloid chemist.
2. Eggs of known history and quality.

Suggested Procedure:

1. Properties and nature of the films formed at the liquid-air interface and their stability.
   a. Nature of the material which concentrates at the interface
   b. Agents affecting its concentration and changes which take place as a result of this concentration
   c. Acids, alkalies, colloids, etc.
2. Effects of elevated temperatures on foam production and stability.
3. Design of more efficient beating equipment. Equipment capable of producing a lighter foam with less reduction in viscosity of egg white and so more stable foams.
4. Effects of the addition of sugar, flour, other foams, etc. used in preparation of foods.
Egg Project 13.

Improving Foaming and Whipping Properties of Egg White—An Investigation of the Process from the Physico-Chemical Point of View

Significance:

Advantage is taken of the foaming properties of egg white in the commercial manufacturing of candies and bakery products as well as in home cooking. Angel food cake and frappé are two important products.

All of the physico-chemical factors responsible for whipping volume and time, foam stability, strength, and drainage have not been clearly determined. These properties vary under certain conditions and are markedly altered by drying the whites before using. From the standpoint of the large commercial users it would be desirable if the factors involved in producing a standard product were known so that in processing, as much as possible of each of the desirable characteristics could be retained.

Personnel and Facilities:

1. Colloid chemist.
2. Eggs of known history and quality.

Suggested Procedure:

1. Determine the mechanics of foam formation and the physical structure of albumen whips.
   a. Foaming stage
   b. Beating stage
2. Determine the relative amounts of surface-altered proteins under various conditions and their effect on the properties of the foam.
3. Determine the effect of environmental factors both of the shell egg and the albumen on foaming and beating characteristics.
   a. Physical effects
      1) Temperature and time
      2) Albumen index
      3) Percent thin white
      4) Physical degradation
   b. Chemical effects
      1) The pH
      2) Alteration of chemical groups
      3) Addition of electrolytes
      4) Addition of non-electrolytes
      5) Mucin as a factor
EGG PROJECT 14.

THE CHEMICAL AND PHYSICAL CHANGES IN FROZEN EGG PRODUCTS AS AFFECTING THEIR UTILIZATION

SIGNIFICANCE:

Approximately 40 percent of all stored eggs are frozen for use by bakers, salad dressing manufacturers, noodle and candy makers, etc. While these products are considered to be quite satisfactory, there are changes, such as the gelation of the yolk, which occur on freezing and holding that are objectionable.

A thoroughgoing study of the changes occurring in the freezing and storage of egg products should yield useful information that could make them more uniform and possibly improve their quality from a culinary standpoint.

PERSONNEL AND FACILITIES:

1. Colloid chemist.
2. Food technologist.
4. Freezing and storage space.
5. A well-equipped chemical and food preparation laboratory.
6. Eggs of known history and quality.

SUGGESTED PROCEDURE:

1. Physico-chemical changes occurring during freezing of egg products (whites, yolks and whole eggs).
   a. Effect of rapid freezing
   b. Effect of slow freezing
   c. Effect of post-freezing storage temperatures
   d. Effect of original quality on above a, b, and c

2. Treatment of products before freezing to prevent undesirable alterations.
   a. Electrolytes
   b. Non-electrolytes
   c. Enzymes
   d. Physical treatment

3. Effects of the chemical and physical changes in frozen whole eggs, whites and yolks on the utilization of these products in cookery.
SIGNIFICANCE OF GELATION FROM THE STAND-POINT OF COMMERCIAL UTILIZATION OF EGG YOLK—A PHYSICO-CHEMICAL STUDY

SIGNIFICANCE:

Egg yolk sets to a firm mass as a result of freezing and thawing. Glycerin, sugar, salt, etc. are sometimes added to liquid yolks before freezing and storing to prevent this change. Studies are needed to determine the real effect of gelation by freezing on the various properties of egg yolk and its subsequent use in food preparation, and to study the reversibility of the process. A study of this kind would lead to a more intelligent control of the physical and chemical properties of frozen yolk and extend its utilization.

PERSONNEL AND FACILITIES:

1. Chemist.
2. Food technologist.
3. Freezing and storage facilities.

SUGGESTED PROCEDURE:

1. As a basis for a more detailed study of the changes involved, determine the time-temperature-coagulation curves on the effect of freezing of egg yolk without, and with a number of the stabilizers. Make measurements of shear and rigidity.
2. Select a few sets of coagulation conditions, produce coagulated yolk and test its effect on the making of mayonnaise, ice cream, etc.
3. Study the factors necessary to redispose the coagulated egg yolk from the standpoint of the physico-chemical factors involved.
4. Determine particle size as influenced by the various procedures. The particle size is probably related to covering power, a property, no doubt, of primary importance in the utilization of egg yolk.
Egg Project 16.
DEVELOPMENT OF FROZEN EGG PRODUCTS
FOR HOME USE

SIGNIFICANCE:
The housewife uses a considerable portion of her eggs in cooking. With the advent of retail distribution of frozen products and of locker plants, frozen yolks and whites could be prepared for home consumption. This might prove to be more economical for the housewife and supply only that portion of the egg needed.

PERSONNEL AND FACILITIES:
1. Food technologist.
2. Research home economist.
3. Refrigeration and food preparation facilities.

SUGGESTED PROCEDURE:
1. The amount of whole egg, yolk and white equivalents by measure and weight.
2. Routine tests to determine comparative value to shell eggs.
3. The best use of frozen egg products.
   a. Thawing and conditioning
   b. Mixing with other ingredients
   c. Times of beating, etc.
4. Possible alterations of eggs for freezing.
   a. Additions
   b. Physical changes
5. Proper packaging for best keeping qualities.

Egg Project 17.
DEVELOPMENT OF METHODS FOR USING DRIED EGG PRODUCTS PACKAGED FOR HOME CONSUMPTION

SIGNIFICANCE:
Since at some seasons of the year there is a great surplus of eggs, at other seasons egg quality is low, and because it is difficult for the homemaker to determine quality of eggs even though they are graded, the use of dried eggs packaged for home use may be desirable.
Before there will be public acceptance of this product, additional work must be done to determine:

1. The quality of products made from dried eggs by various methods.
2. The amounts of dried egg to use to replace fresh.
3. Best methods of combining dried egg products with other ingredients in various typical recipes.
4. How to store such eggs in the home.

The practical findings of such studies should be published in a form suitable for the homemaker's use, if and when dried eggs are available to her.

PERSONNEL AND FACILITIES:

1. Food research home economist.

SUGGESTED PROCEDURE:

1. Amounts of dried whole egg, yolk and white equivalent by measure and weight to fresh eggs.
2. Determine effect of moisture, temperature, and light on reconstituted egg, (white, yolk and whole egg).
3. Compare dried egg with fresh egg in:
   a. Batters and doughs
   b. Custards, soufflés, omelets, and scrambled eggs
   c. Mayonnaise and cooked salad dressings
   d. Desserts, as whips
   e. Meringues
4. Study foaming and leavening properties of dried egg whites in food products — angel food cakes, meringues, whips.
5. Study emulsifying properties of dried egg in food products—mayonnaise—cake batter.
6. Test the use of dried egg by sifting it with the flour in products like: griddle cakes, muffins, breads, rolls and cakes containing fat.
EGG PROJECT 18.
THE DEVELOPMENT OF DRIED EGG YOLK AND WHOLE EGG FOR HOUSEHOLD CONSUMPTION

SIGNIFICANCE:

It is economically sound to reason that good quality dried egg yolk and whole egg should have utility as a household article. Before such products can be suitable for this purpose, they must be of such quality that they can be used interchangeably for fresh eggs. Quality dried egg products should be in demand for household use for the following reasons:

1. Greater uniformity of quality than shell eggs as they will ordinarily be manufactured during the heavy producing season when eggs are of the best quality and cheap.
2. Suitable standards of measurements should eliminate variation in egg size, often the cause of variable results.
4. More convenient to use, eliminating the possibility of waste.
5. Greater economy, since the manufacturer can give the consumer the benefit of his savings in shipping, storing and packaging expenses.

PERSONNEL AND FACILITIES:

1. Food technologist.
2. Research home economist.
3. Laboratory equipment:
   a. Spray-type dryer
   b. Tray—or conveyor-type dryer
   c. Culinary equipment
   d. Apparatus necessary for laboratory tests and analyses

SUGGESTED PROCEDURE:

1. Breaking room practices—effect on the dried products.
2. Quality of breaking stock—effect on the dried products.
3. Preliminary treatment before drying:
   a. Processing
   b. Drying
   c. Storage

4. Development of best drying methods for:
   a. Yolks
   b. Whole eggs

5. Study factors affecting the keeping quality of dried whole eggs and dried yolks.
   a. Method of drying
   b. Drying temperature
   c. Drying time
   d. Treatment before drying

6. Requisites necessary for dried eggs of quality suitable for household consumption.
   a. Clean and wholesome in appearance, flavor, and odor
   b. Quick solubility or mixing with other ingredients
   c. Results equal or better than those obtained using shell eggs

7. Study the use of dried egg products to all household recipes requiring eggs.

8. Packaging dried egg products:
   a. Appearance—consumer appeal
   b. Material
      1) Effect on keeping quality
      2) Flavor
      3) Moisture-proofness
      4) Cost
   c. Size
      1) Convenience
      2) Utility
      3) Shelf life—space
Egg Project 19.

The Development of a Dried Egg-White Equivalent to or Better Than Liquid Egg White

Significance:
A dried egg white having good keeping qualities at all temperatures within the range of normal holding conditions should not only have a very wide commercial application but should also have very definite utility as a household article. If such a product can be developed, it should, as far as use is concerned, be equivalent to liquid egg whites, and it should be superior to liquid egg whites from the standpoint of convenience in use, uniformity and bacteriological condition.

Personnel and Facilities:
1. Chemist.
2. Food technologist.
4. Laboratory equipped with various types of dryers and apparatus for testing the dried product.

Suggested Procedure:
1. Preliminary study of the known methods of drying egg whites.
   a. Pan or tray drying
   b. Spray drying
   c. Other dryers
   d. Concentration before drying
2. Factors affecting the keeping quality of the dried product.
   a. Drying temperature and time
   b. Storing temperature
   c. Type of package
   d. Methods of treating liquid egg whites before drying
      1) Fermentation
      2) The pH adjustments
      3) Chemical treatment
      4) Physical treatment
3. Factors affecting the whipping quality and stability of the foam of the dried product.
4. Factors affecting the culinary properties of dried egg white.
Egg Project 20.

A Comprehensive Study of the Nutritive Values of Chicken Eggs

Significance:

Eggs rate as one of the “musts” in an adequate diet for humans. Their value as a protective food is well recognized by the leading authorities in human nutrition. While there is a good deal of information concerning the qualitative composition of eggs, only a little information is available on the quantitative composition and its variability. It is very desirable that more be learned about the quantitative composition of eggs. This is necessary if eggs are to maintain their present high rating as a protective food.

Personnel and Facilities:

1. Nutritionist.
2. Chemist.
3. Well-equipped analytical and biological assay laboratory.

Suggested Procedure:

Study would be made both of eggs obtained on the open market and of eggs produced under controlled conditions. In this way information would be obtained about variability of composition and about the effect of diet. The study would include:

1. Variability of nutritive constituents.
2. Vitamin assays.
3. Comparisons of diets in which the bulk of the protein and fat, either one or both, is derived from eggs.
4. Comparisons of diets in which the vitamins are derived from eggs as compared with other appropriate sources.
5. Utilization of minerals of eggs.
6. Comparisons of diets in which eggs predominate with other diets.
Egg Project 21.
A STUDY OF THE INFLUENCE OF THE NUTRITION OF THE HEN UPON THE NUTRITIVE VALUE OF EGGS

SIGNIFICANCE:

At the present time eggs are meeting strong competition for a place in the American dietary from cheap, highly-advertised cereal foods which possess a lower nutritive value. To meet this competition successfully, the excellent nutritive value of eggs must be emphasized to a greater extent than is being done at the present time. This should not be done, however, until a thorough knowledge of the nutritive value of eggs is available. This must include a knowledge of the extent of variations in nutritive value as well as the causes of these variations.

It is the purpose of this project, therefore, to determine the effect of variations in diet upon the nutritive value of eggs in order to obtain reliable information upon which to base programs for encouraging the production of eggs of uniformly high nutritive value and for increasing the consumption of eggs.

A considerable body of information concerning the nutritive value of eggs which may be used as a basis for undertaking this study is available. It is known that the amount of vitamin A, thiamin (vitamin B₁), vitamin D, alpha tocopherol (vitamin E), pantothenic acid and riboflavin vary with the amount of these vitamins in the diet of the hens.

It does not appear that the amount of iron and copper in eggs is influenced by the diet but there is some evidence that they are affected by certain, unknown, environmental factors. The amount of iodine in eggs can be increased markedly by increasing the iodine content of the diet of the hens. The amount of calcium, and hence the breaking strength of egg shell, is affected by the amount of vitamin D and calcium in the diet.

The character of the fat of egg yolk is influenced by the character of the dietary fat. There appears to be little or no evidence that the character of the egg protein is affected by the character of the dietary protein. There is also little or no evidence that the total amount of fat or proteins in eggs is affected by the amount or quality of these nutrients in the diet.

The evidence that eggs vary in nutritive value in accordance with variations in the nutritive properties of the diet,
and in certain other conditions, has been obtained for the most part in isolated experiments. It is frequently fragmentary and the experimental work in general has not been carried to the points where the results can be practically applied. As a consequence, it is impossible to use this evidence in an effective manner in encouraging the production of eggs of uniformly high nutritive value and the greater consumption of eggs.

PERSONNEL AND FACILITIES:

1. Nutritionist.
2. Biochemist.
3. Cooperation with a poultry department possessing adequate egg production facilities.

SUGGESTED PROCEDURE:

1. To determine the nutritive value of eggs which can be used as a reference or standard of comparison.

   It is proposed in this study to consider as standard the eggs of hens in their first year of egg production fed a diet considered complete in the light of present knowledge.

   The amount of each of the proteins, the amount and character of the fat, the amount of each of the nutritively important minerals including the trace elements, and the amount of each of the known vitamins will be determined in eggs of the character just described. In making determinations of vitamin content, chemical methods will be used wherever possible.

2. Studies in the same detail on the nutritive value of eggs which have been produced by hens fed a diet that varies in one important respect from that fed the hens which produced the reference eggs.
EGG PROJECT 22.

A STUDY OF THE UTILIZATION OF THE CALCIUM OF EGGS BY CHILDREN

SIGNIFICANCE:

The calcium content of an egg compares favorably with that of an average-sized serving portion of many of the foods which compete with milk as a source of calcium—namely: lettuce, carrots, cabbage, celery, etc. Three eggs a day would contribute almost 100 milligrams of calcium. If egg calcium were 100 percent, or even 80 percent available, a well-nourished pre-school child might be getting enough calcium to satisfy his needs if he consumed daily 2 eggs, 1 glass of milk, 2 vegetables, 2 or 3 fruits, potatoes, meat, cereal, breads, sugar and butter.

PERSONNEL AND FACILITIES:

1. Nutritionist.
2. A well-equipped nutrition laboratory.
3. Access to pre-school children for experimental dietary work.

SUGGESTED PROCEDURE:

1. Subjects—
   Pre-school children, five or six in number.
2. Dietary regimen—
   Period I. Preparation of subjects:
   A generous amount of calcium should be given in order that the skeletal tissues be well calcified.
   Time: 12 to 14 weeks.
   Period II. Low calcium (basal diet, without egg):
   Considerably less calcium than is required for maximum retention should be fed. Two-hundred cubic centimeters of milk should be included in the diet primarily for culinary purposes. Eggs should not be used in the basal dietary.
   Time: 6 to 8 weeks.
   Period III. High calcium (egg added to basal diet):
   Three eggs a day should be fed in addition to the diet used in period II. The calcium intake of the pre-school children would thus be raised 90 to 100 milligrams (egg calcium) per day.
   Time: 4 to 6 weeks.
3. Analyses—
   All food and excreta should be analyzed for calcium.
4. Calculation of percentage utilization—
The difference in amount of calcium retained during
periods II and III divided by the difference in intake
between these 2 periods multiplied by 100 will give
a value for the percentage utilization of calcium
in eggs.

EGG PROJECT 23.

TECHNICAL ALBUMEN—A STUDY OF ITS USES
WITH REGARD TO ESTABLISHING THE
MOST DESIRED PROPERTIES

SIGNIFICANCE:
Dried egg albumen has been used in industry for many
years (as an adhesive, in silk dyeing, leather finishing, and
lithography). There is little technical literature concerning
the desired properties in each use. A careful study needs
to be made of each use with a view to determining the
properties most valued and the possible opportunity to
enhance these properties or eliminate some fault now
possessed.

PERSONNEL AND FACILITIES:
1. Chemist.
2. Chemical engineer.
3. Drying facilities.

SUGGESTED PROCEDURE:
1. Survey the present uses of technical albumen.
2. Determine the properties most valued in albumen.
3. Study possible improvement in albumen.
   a. Enhance properties
   b. Control processing to ensure uniform product
   c. Eliminate undesirable properties
SIGNIFICANCE:

Only the very simplest segregation of eggs into derived products has been commercially made—yolks and whites.

In contrast to this, milk has been converted to a number of such products: cream, skimmilk, butter, buttermilk, condensed skim and whole milk, casein, milk albumen, lactose and whey.

It is quite conceivable that at least as many products could be made from eggs. Without doubt egg oil possesses unique properties which, once determined and evaluated, might be commercially important in food and non-food products. Egg-yolk proteins, free of oil, too, should yield some interesting and valuable products.

Egg whites have several proteins of unusual properties. These might find separate uses when isolated and their properties investigated.

PERSONNEL AND FACILITIES:

1. Colloid chemist.
2. Food technologist.
3. Equipment for protein and lipoid separations and purification.

SUGGESTED PROCEDURE:

1. Thorough review of literature on composition and properties of eggs.
2. Chemical separation of components.
3. Physical separation of components.
4. Denaturation as a problem in separation.
5. Exhaustive studies of properties.
   a. Protein fractions
   b. Fat fractions
6. Culinary properties of fractions.
7. Non-food uses.
8. Medicinal and food-fortifying elements.
II. POULTRY RESEARCH

PRODUCTION FOR MARKET PURPOSE

Poultry meat has too long been considered a by-product of egg production. As a source of meat it has received but little emphasis in our research and breeding programs.

However, interest in the production of quality-meat birds has been awakened by the tremendous increase in commercial broiler, fryer and turkey production in recent years. Production for market purposes is certainly due for its just share of research time and money.

There is much that a coordinated research and breeding program could accomplish in improving meat quality in poultry. Rapid growth and feathering, good body size and conformation, ability to fatten, and freedom from defects such as crooked keels and blister breasts, are all obtainable through studies of breeding, feeding and management of birds.

Rare opportunities for research await the workers trained in genetics, physiology, nutrition and poultry husbandry who have the proper facilities for the work to be undertaken.

POULTRY KEEPING QUALITY

The need for refrigeration in the handling of dressed poultry is generally recognized by packers everywhere. The specific refrigeration requirements of dressed poultry, in its various forms, are not so generally known. Insufficient technical studies have been made to determine the effects of various temperatures, freezing and cooling conditions, packing materials, etc., on the quality of dressed poultry.

Due to the recent and rapidly increasing production of eviscerated and cut-up poultry, new problems have come up giving rise to an increased need for information on refrigeration requirements. Dessication is especially important when the birds are disjointed and cut up. Perhaps, also, the deterioration of the fat has new significance.

Research in this field is urgent. Workers trained in chemistry, physics and engineering will find an untouched field for extensive research.
The ordinary by-products of packing plants (manure, feathers and blood) have not been consistently utilized. Feathers have been a source of revenue from time to time but never a reliable one. The tonnage available is very high, but the uses for these products in their raw states are very limited. There is, as a result, a periodic glutting of the market with them. With the recent growth of eviscerated and cut-up poultry, there is now a very much larger volume of waste to be disposed of (approximately 25 percent of the dressed weight of the bird). This fact has made the whole problem of by-product recovery of immediate concern to the processors of poultry.

In many ways feathers are of unique composition and should yield some interesting possibilities when given study with a properly planned and financed research program. Animal foodstuffs, textile fibers and plastics seem to be possible by-products. Poultry manure also might be utilized if the problem of drying, stabilizing and deodorizing are solved.

The heads, feet and viscera are potential sources of other valuable by-products. Meat scrap and soap oil already are being made from these offals, but this is only one example of what can be salvaged from them. Vitamin concentrates, hormone preparations and gelatins are possibilities to be investigated to determine the exact values, present and recoverable, at a profit.
POULTRY PROJECT 1.

TO DETERMINE SOME BASIC INFORMATION ON THE EFFECT OF ATMOSPHERIC CONDITIONS ON LIVE POULTRY

SIGNIFICANCE:

Poultry raising is rapidly becoming highly intensified. More and more chickens are being raised and hens are being kept under greatly confined conditions—particularly in broiler production. As a result atmospheric problems are becoming extremely important.

Before the problem of satisfactorily housing poultry under confinement is solved, basic information on the behavior of poultry under varying conditions of temperature, relative humidity, air velocity, pressure, etc., is needed.

Among the significant facts needed to formulate the principle of good housing for poultry is the range of tolerance of the birds under changing air conditions. The optimum diurnal and seasonal ranges in temperature for healthy living should be determined, including a study of optimum humidities and rates of air movement at each temperature level. The importance now given to constant conditions should be determined as compared with controlled changing conditions which might prove more desirable for health and productivity.

PERSONNEL AND FACILITIES:

1. Physiologist.
2. Air-conditioning engineer.
3. Poultry husbandman.
4. Facilities for controlling temperature, relative humidity, air velocity, carbon dioxide, possibly atmospheric pressure and the total atmospheric gases.

SUGGESTED PROCEDURE:

1. Study of behavior with variation in a single factor.
2. Study of behavior with variation in two or more factors.
3. Effects of rate of change from one set of conditions to another.
4. Determination of optimum conditions for chicks, growing stock, laying hens and breeding stock.
POULTRY PROJECT 2.

ADEQUATE HOUSING FOR POULTRY: POSSIBILITIES FOR AN ECONOMICAL, COMPLETELY-CONDITIONED POULTRY HOUSE

SIGNIFICANCE:

The North Central States where feed is abundant and the raising of poultry is a major industry, comprise an area where extremes of weather occur, not only wide seasonal changes, but frequent diurnal and cyclical changes of a pronounced kind due to cyclonic air movements natural to the latitude. If poultry raising in this area is to compete successfully with similar kinds of farming in areas having more equable climatic conditions, it must be done by means of better housing.

PERSONNEL AND FACILITIES:

1. Geophysicist.
2. Air-conditioning engineer.
3. Poultry husbandman.
4. Industrial group interested in construction.
5. Experimental house of commercial size, capable of holding at least several hundred birds in batteries or tiers.
6. Control of temperature, relative humidity, air movement, carbon dioxide, dust and odors.
7. Recording instruments for each important factor.

SUGGESTED PROCEDURE:

1. Formulation of conditions desired.
   a. Temperature range
   b. Relative humidity range
   c. Air movement
   d. Carbon dioxide range allowable
   e. Dust allowable
2. Control of conditions.
   a. Using outside conditions
   b. Closed system
   c. Various combinations
   a. Arrangements for birds
   b. Sanitation
   c. Response to condition provided
4. Economy of controls.
POULTRY PROJECT 3.

FATTENING POULTRY AS AN AGE, BREED AND SEX PROBLEM

SIGNIFICANCE:

In commercial fattening of chickens, the type of diet required, the gains in weight, and the quality of the dressed birds may be influenced by the age, breed and sex of the birds which are fed. It would be more profitable to adapt the diet to the type of birds in the batteries at any one time rather than to feed all types on the same diet. It would also be desirable to know how long birds of different types may be fed profitably, and how much of an increase in weight may be expected.

PERSONNEL AND FACILITIES:

1. Nutritionist.
2. Physiologist.
3. Facilities for individual fattening on a large scale.
4. Killing and dressing equipment.

SUGGESTED PROCEDURE:

The birds used in these trials would be fed in fattening batteries with individual compartments so that individual records of feed consumed and gains in weight could be obtained. At the conclusion of the feeding period, they would be slaughtered, dressed and graded. A series of trials would have to be run to determine:

1. The most efficient type of diet, especially with regard to protein content, for birds of different ages, breeds and sex.
2. The gains in weight which may be expected.
3. The length of time that birds of different types may be fed economically.
4. The comparative quality of the dressed carcasses of birds of different age, breed and sex.
POULTRY PROJECT 4.

A STUDY OF FARM FATTENING OF POULTRY—
PRACTICAL AND ECONOMICAL PRACTICES

SIGNIFICANCE:

Mass production of chicks, commercial and intensified methods of poultry production during the past 15 years have given rise to many of the pressing problems with which our modern poultry industry is faced today. One of these problems is the need for standardization and the improvement of market poultry. In this connection, there is a great need for the finish feeding or fattening of market poultry on the poultry farms. This problem was handled by large packing establishments in the main poultry-producing areas 15 to 20 years ago. Diseases (particularly respiratory complications) later made the concentration of poultry in fattening stations for fattening a hazardous undertaking. Other reasons, mostly as affecting costs, were also responsible for this change. The obvious solution would seem to be for the poultry farmer to fatten his poultry at home, and market it as live poultry to a nearby poultry packing plant.

The best solution of the market poultry problem for the poultry industry and the consumers will be the improvement of the quality of poultry, basing its sale on quality. Once suitable standards and requirements are established with proper price differentials for quality poultry, poultry raisers will readily respond to meet the requirements.

PERSONNEL AND FACILITIES:

1. Nutritionist.
2. Physiologist.
3. Pathologist.
4. Poultry production plant.

SUGGESTED PROCEDURE:

1. A study of rations and methods of feeding with respect to:
   a. Rate of gain
   b. Quality of finished product
   c. Economy in cost of:
      1) Feed
      2) Equipment
      3) Labor
2. Development of rations, and methods of feeding which involve a minimum of time and skill in feeding.
3. A comparison of pen versus battery feeding.
5. Designing of inexpensive labor-saving equipment.
6. Cost of fattening poultry on the farm.
7. A study of the age and previous condition of the birds as it affects the fattening process.
8. Investigations dealing with the better utilization of day-old sexed cockerels and older cockerels for market purposes.

Poultry Project 5.

Broken Bones as a Problem in Long-Term Fattening—Mineral Requirements for Fattening

Significance:
The frequent occurrence of broken wing and leg bones in the slaughter of birds that have been fattened for 10 days to 2 weeks makes it desirable to study the cause and discover methods of preventing such a condition. These defects affect the appearance of the dressed bird and are usually responsible for a reduction in the market grade.

Personnel and Facilities:
1. Nutritionist.
2. A laboratory equipped for poultry nutrition research.
3. Supply of uniform stock.

Suggested Procedure:
Groups of birds of different ages should be fed under fattening conditions similar to commercial practices and the effect of supplements, such as minerals and vitamins, should be determined:

1. On the occurrence of broken wings.
2. The breaking strength of the bones.
3. The chemical composition of the bones.
POULTRY PROJECT 6.

A STUDY OF THE INTERACTION BETWEEN HEREDITY AND ENVIRONMENT TO PRODUCE UNIFORMITY DURING GROWTH AND AT MATURITY IN POULTRY

SIGNIFICANCE:

The only permanent improvements which may be made in poultry are accomplished through changes in heredity and the concentration of heritable factors affecting characters of economic importance.

Studies of feeding and fattening will be greatly facilitated by a knowledge of the heritable influence under varying conditions.

The subject titles which are of vital importance to the production of a uniform product are:

1. Body size.
2. Body conformation.
3. Color of skin with emphasis on:
   a. Pigments
   b. Distribution of skin fat
4. Relative proportion of skin, muscular and internal fat.

Information from genetic studies along these lines would greatly aid in developing feeding and fattening methods.

The influence of environment on these characters should then be studied in order to determine the optimum environmental conditions for accentuating desirable or undesirable heritable characters.

PERSONNEL AND FACILITIES:

1. Geneticist.
2. Poultry husbandman.
3. Poultry production facilities.

SUGGESTED PROCEDURE:

1. Development of suitable techniques to measure:
   a. Body size
   b. Body conformation
   c. Skin and fat color
   d. Relative proportions of skin, muscular and intestinal fat
2. Determine the difference between the items listed under no. 1, in several breeds.
3. Determine the influence of selected popular environment on these factors.
4. Modify the environmental factors to determine which contributes the greatest variability to the parts, and the influence of this factor on the characteristic as a whole.

Poultry Project 7.

A Study of Factors Influencing the Quantity and Distribution of Bone, Flesh and Fat in Chickens

Significance:

There has been a marked decline in percentage of flesh and fat on roaster chickens during the past 30 years. Purchasers of poultry constantly remark that there is proportionally more flesh on the breast of a guinea or any of the game birds than on the breasts of chickens and turkeys. These two facts would indicate that much worth-while improvement could be made. An appreciable increase in the edible parts of poultry carcass should greatly benefit the poultry industry.

Personnel and Facilities:

1. Physiologist.
2. Chemist.
4. Poultry husbandman.
5. Poultry production plant.

Suggested Procedure:

1. Set up a standard for the quantity and distribution of bone, flesh and fat on a desirable present-day strain being operated on a closed flock under a common method of rearing. (A preliminary study of the possibility for eliminating gross dissection and analysis by means of indicators would be desirable.)
2. Study the effect of various nutritional factors and management practices on the distribution of edible meat using the strain of birds used in establishing the standard.
3. Study of the interaction of inheritance and environment with the possibility of regulating the environment to suit the inheritance, or vice versa, with respect to the production of a carcass carrying more edible meat.
Poultry Project 8.

Studies on the Efficiency of Various Strains in Fryer and Roaster Production

Significance:

The demand for suitable stock for the production of broilers, fryers and roasters is increasing, and in view of the trend toward the sale of eviscerated poultry, will probably be greater in the near future. The fact that some poultrymen now have difficulty in securing satisfactory stock indicates that the problems involved in breeding this type of bird need to be investigated.

The important factors which have a hereditary basis are growth, rate of feathering, freedom from defects, and uniformity of body type within strains. None of our general-purpose breeds can be said to be entirely satisfactory in these respects. There are, however, some strains which appear to approach in part, at least, the ideal sought.

Since hatching eggs must be available at all seasons of the year, the strains also must be bred to lay. The supply of such can hardly meet the demand. It would seem advisable to determine the suitability of other existing strains or of breed crosses between such strains, particularly in those regions where cheaper grains and adequate plant facilities are available.

Personnel and Facilities:

1. Geneticist.
2. Large brooding and rearing facilities.

Note: A breeding project designated to test existing strains or to produce new strains for efficient fryer production would require a physical plant and facilities such as few institutions possess. It is suggested that cooperative projects carried on by two or three institutions would allow for the testing of more strains and provide the needed information in a shorter time.

Suggested Procedure:

1. Determination of the standards considered necessary.
2. Testing of existing strains.
   a. Provision for standard, environmental brooding conditions
b. Provision for standardized feeding practices
c. Collection of adequate data on:
   1) Rate of growth
   2) Rate of feather growth
   3) Feed efficiency
   4) Uniformity of type
   5) Dressing and boning percentages
   6) Absence of defects

3. Production of cross-bred birds and subsequent testing.
4. Development of new strains and subsequent testing.

POULTRY PROJECT 9.

A CRITICAL STUDY OF THE GROWTH OF CHICKENS IN BATTERIES FOR BROILER-FRYER PRODUCTION

SIGNIFICANCE:
The production of market poultry to the broiler-fryer stage has developed into a major industry. Many of the so-called broilers are produced under conditions of management and sanitation which violate all concepts of good husbandry, sometimes with good results, and frequently with disastrous consequences. As an alternative to the methods in common use, the battery system of broiler-fryer production has been introduced, but with the introduction of this method, many new problems have become apparent. A study of the battery system as a possible practical solution to large-scale production methods and problems is needed.

PERSONNEL AND FACILITIES:

1. Nutritionist.
2. Biochemist.
3. Veterinarian.
4. Air-conditioning engineer.
5. Adequate buildings in which the following could be studied:
   a. Heating and ventilation problems
   b. Varying types and sizes of batteries
   c. Chicks of varying inherent rates of growth
   d. Feathering
   e. Physiologic reactions
SUGGESTED PROCEDURE:

1. To study physical environment.
   a. Type of house construction
      1) Area and cubic allowances per bird
      2) Amount and type of light
   b. Type of battery construction
      1) Supplementary heat during first weeks
      2) Handling droppings
   c. Effect of humidity, temperature, and air movement upon mortality, rate of growth and rate of feather-growth
   d. Control of dust and drafts
   e. Insulation, ventilation, humidity controls

2. To study disease control.
   a. Sanitation
   b. Preventive techniques
   c. Isolation of groups

3. To study rate of growth and feathering.
   a. Levels and types of protein
   b. Other ingredients affecting rate of growth and quality of feathering

4. To study causes of market defects.
   a. Breast blisters
   b. Dented breast bones
   c. Lack of fleshing
   d. Scratched backs

5. To study the effect of raising chickens in batteries on:
   a. Edible meat
   b. Finish
   c. Feed-gain ratios

6. To study the management practices for most economical growth and finish.
POULTRY PROJECT 10.

A STUDY OF METHODS FOR DISINFECTION OF BROILER OR FATTENING PLANTS

SIGNIFICANCE:

The successful operation of broiler plants in which successive lots of chicks are reared in batteries to broiler size is often seriously handicapped by the occurrence of certain types of infectious diseases. Infection, once established, is likely to be recurrent in successive broods of chicks. Relief from such difficulty often requires complete cessation of activities for thorough cleaning and the disinfection of equipment and buildings. This is a costly procedure and not always successful because exact and effective disinfection methods have not been developed.

PERSONNEL AND FACILITIES:

1. Pathologist.
2. Physicist.
3. Chemist.
4. Air-conditioning engineer.
5. Facilities for controlling temperature, humidity, air movement, and heat sterilization of large pieces of equipment.
6. Cooperation of broiler plant operators to enable studies to be made under actual plant conditions.

SUGGESTED PROCEDURE:

1. Study of effectiveness of fumigants with respect to:
   a. Germicidal effect
   b. Relation of atmospheric conditions to their effectiveness
2. Study of tolerance of young chickens to fumigants, with the object of determining if fumigation could be done effectively without completely depopulating a plant.
3. Studies to determine both the most desirable types of liquid disinfectants for use in broiler plants and the best methods of application.
4. Studies on the effectiveness of radiations, such as those produced by the "Sterilamp" in the control of disease in broiler plants.
5. Study of steam sterilization.
A CRITICAL STUDY OF CAPON PRODUCTION

SIGNIFICANCE:

Capon production antedates Pliny's writings, 50 A. D. Capons are referred to by some writers on poultry down through the centuries to the present period. However, even though the prices usually exceed those paid for other classes of poultry, including turkeys, the supply of capons on the market is very erratic. Some years they are plentiful, while at other times they are scarce. No one seems to make a business of producing capons in large numbers and continuously, as is done with broilers and fryers. Too often those without experience attempt to raise capons only to be disappointed, the result usually being too many slips, failure to attain the size advertised, and inability to locate a desirable market for the small number of good capons available.

There are sufficient data on rate of growth, size at maturity, and cost of production to indicate that a good profit can be made under normal conditions. Now that sexed cockerels are available at many hatcheries, it would be possible to produce capons in large numbers without having to provide for the pullets as has been the case when mixed sexes only were available.

Perhaps the major disadvantage to capon production has been the large percentage of slips, frequently caused by operating on too old birds. With the new technic being developed whereby chicks 10 to 14 days of age can be caponized, the percentage of slips may be materially reduced.

PERSONNEL AND FACILITIES:

1. Poultry husbandman.
2. Poultry production plant.

SUGGESTED PROCEDURE:

1. A rather extensive survey should be made to ascertain the major reasons why capons are not grown consistently by poultry farmers.
2. A critical analysis of such a survey to decide upon the main points of attack.
3. The outlining and conducting of experiments with large numbers of birds in an effort to solve the main problems revealed in nos. 1 and 2.
4. Extend the season for capon production over a period of several months.
5. Obtain critical figures on the cost of production and profits for different varieties and crosses hatched at different seasons of the year.

Poultry Project 12.

Composition of Capons as Influenced by Time of Caponizing

Significance:
The capon fattens easily and without special methods, yet the optimum conditions for caponizing are not now known. The basal metabolism of an 8- to 10-week cockerel is known to change remarkably with caponizing, and the fat deposition increases greatly. It has not been shown if this is true in birds caponized very early or much later. This may become an important factor in the economical production of fat, frying and roasting chickens.

Personnel and Facilities:
1. Physiologist.
2. Poultry husbandman familiar with poultry-meat quality.
3. Adequate supplies of cockerels of uniform breeding and at various stages of growth.

Suggested Procedure:
1. Use chicks from known breeding stock.
2. Caponize young males at 1 week, 2 weeks and on up to 16 weeks of age.
3. Use similar stock not caponized as controls.
4. Make careful studies at 3-pound, 5-pound, 6-pound and 8-pound weights of the amount of:
   a. Abdominal fat
   b. Subcutaneous fat
   c. Gizzard fat, etc.
5. Palatability comparisons between capons and cockerels.
POULTRY PROJECT 13.

A STUDY OF THE INFLUENCE OF THE RATION ON FLAVOR AND QUALITY OF POULTRY FLESH

SIGNIFICANCE:

It is extremely important that poultry flesh has desirable flavor and texture. There is some information available to show that under certain conditions fish oils and some other feeds may impart undesirable flavors to the poultry flesh. The ability of certain other feeds to produce desirable flavors in poultry flesh has also been given some study.

Some large broiler farms have used certain "finishing" feeds with the idea of imparting desirable flavors to the poultry flesh. Many operators believe the following influence the amount of off-flavor, and also the amount of liquid in the gall bladder at the time of killings, etc.:

1. The kind and amount of partially digested feed in the tract at the time the bird is killed.
2. The length of time that elapses between killing and eviscerating.
3. The temperatures employed for same.

PERSONNEL AND FACILITIES:

1. Nutritionist.
2. Research home economist.

SUGGESTED PROCEDURE:

1. Grow chickens to 10, 16 or 24 weeks of age on the same ration, then divide them into groups for a final feeding period. Test palatability at the time of killing and after chilling and/or freezing and storing for various lengths of time.
2. Grow chickens on radically different rations from the start to the finish and then test for flavor, etc.
3. From nos. 1 and 2 and similar studies, plan special rations for the final feeding period.
4. Study the digestive processes in poultry with special reference to the influence of feed in the crop upon digestion and assimilation (forced feeding or noodling) and its influence on market quality.
5. Study the factors that influence the production of gall with special references to producing an empty gall bladder at killing time. This will include influence of rations and management (fright, etc.).
6. Study the deteriorative changes that occur after killing with special emphasis on the “make-up” of the ration, temperature at which the dressed bird is held, etc.

POULTRY PROJECT 14.
HISTOLOGY OF POULTRY FLESH AND ITS PREDICTION VALUE FOR TABLE QUALITY

SIGNIFICANCE:

Some non-subjective method of predicting the palatability of poultry flesh is urgently needed. Very little is known regarding the structural differences in poultry flesh and their variability.

Preliminary histological work indicates that breeds differ in the amount of connective tissue between the muscle fibers. One would expect this to mean that there are differences in palatability between breeds.

Practically nothing is known regarding the characteristics of the fat depots and their distribution in poultry flesh, yet it is known that the quantity of fat in the muscle lends juiciness and flavor upon cooking.

Histological difference, if correlated with palatability, should prove to be valuable in studies for the improvement in breeding, management and processing of poultry.

PERSONNEL AND FACILITIES:

1. Histologist.
2. Poultry husbandman interested in meat quality.
3. Source of poultry whose breeding, age, sex, rearing and post-mortem environment are known.

SUGGESTED PROCEDURE:

1. Study of variations in tissue structure and their relation to palatability.
2. Study of variation produced by differences in and interactions between the following:
   a. Age
   b. Rate of growth
   c. Sex
   d. Methods of rearing
   e. Methods of feeding
3. Study of post-mortem environment on tissue characteristics.
POULTRY PROJECT 15.

A CRITICAL STUDY OF BRAINING AS AN AID IN THE REMOVAL OF FEATHERS IN POULTRY DRESSING OPERATIONS

SIGNIFICANCE:

There is ample proof that the piercing of the brain, when properly done, has a direct and beneficial effect upon the removal of the feathers. Improperly applied, however, it has none of the desired influence in loosening the feathers and, in fact, under these circumstances may have the opposite results. The brain center which controls the follicle has been but vaguely defined anatomically, and the physiological processes involved under this control are even less perfectly understood.

A proper knowledge of the anatomy and physiology of the nervous system from the brain center to the feather follicle is a basic requirement to an intelligent application of the "stick" as a means of releasing the feathers. Equally important is a thorough knowledge of what transpires when braining takes place as:

1. When a "stick" is successfully made.
2. When imperfectly made.

Equally important to produce men is the occurrence of visible blemishes on the carcass which develop at the time of dressing the fowl, such as red hips, blood in wing and leg circulation, and a condition vaguely referred to as "bloom," part of which may be influenced by braining or bleeding, or both of these.

The possible influence of braining upon the general removal of blood from the carcass should be investigated. It is said that the quantity removed by commercial methods equals 1 percent of the live weight, and the Kosher method, 4 percent.

PERSONNEL AND FACILITIES:

1. Physiologist.
2. Poultry of various ages and of different sexes.

SUGGESTED PROCEDURE:

The precise procedure would best be left to the institution undertaking the study. A tentative suggestion might be along the following lines:
1. Ascertain the exact feather-follicle control center in the central nervous system.
2. Define the foregoing anatomically.
3. Determine whether or not the brain center has but a single effect upon the feather follicle.
4. Follow the mechanism involved in influencing the feather release when the exact center is mutilated or otherwise immobilized.
5. Conversely, find out what takes place in defective “sticks” causing a tightening of the feather association with the follicle.
6. Locate other nearby brain centers with any possible effects they might have, beneficial or otherwise.
7. Ascertain whether or not there is any relationship between the brain mutilation, either as a perfect or imperfect “stick,” and the percentage of total blood removed under either condition.
8. Determine braining effects, if any, upon carcass blemish such as local blood deposits, or even lack of “bloom.”
9. Develop “non-sticking” techniques to secure release of feathers by effects produced in central nervous system.
Poultry Project 16.

Studies of the Bacterial Flora of the Intestinal Tract of Poultry

Significance:

Bacteria from the intestine of poultry serve as contaminants of the tissues of these animals after they are slaughtered. Consequently they are concerned in spoilage, and certain pathogenic types have been incriminated in outbreaks of food poisoning. Certain of the food-poisoning organisms have been traced to duck eggs which came from ducks carrying these organisms in their intestinal tracts. An accurate knowledge of the flora of the intestinal tract of poultry would be of value, therefore, to the poultry industry in the defense of law suits brought against them by "food-poisoning" victims.

Personnel and Facilities:

1. Intestinal bacteriologist.
2. Active cooperation with a poultry packer and an egg breaking establishment.

Suggested Procedure:

1. Study of the bacterial flora in different parts of the intestinal tract of chickens and turkeys.
2. Study the organisms concerned in food poisoning, (Salmonella Staphylococci and Alpha-type Streptococci), and test for human pathogenicity.
3. Feed chickens, turkeys and ducks, cultures of isolated organisms and observe:
   a. Disease in the animals
   b. Persistence of the introduced organisms in the intestine and other tissues of the birds
   c. Possibility of eggs from chickens and ducks being contaminated with these organisms
4. Influence of time after death on the bacterial flora in the intestinal tract.
5. Permeability of the wall of the intestine for bacteria within its contents.
6. Influence of temperature and time of storage on nos. 3 and 4.
7. Permeability of egg shell to these organisms when they are mixed with fresh poultry manure and applied to egg shell.
POULTRY PROJECT 17.

POULTRY FAT—CHEMICAL AND PHYSICAL PROPERTIES AFFECTING ITS KEEPING QUALITY

SIGNIFICANCE:

There is evidence that at least some of the characteristic odor and flavor of meats are associated with the fats present. It is also well known that changes in the chemical composition of the fat give rise to undesirable flavors when meats are stored.

Complete knowledge of the chemical nature of poultry fat would probably make it much easier to determine how to produce, process and cook poultry to preserve or enhance its fine flavor. Furthermore, it is likely that knowledge of the composition of poultry fat would suggest new uses for it or some of its components.

PERSONNEL AND FACILITIES:

1. Chemist trained in the field of fats.
2. Research home economist.
3. Source of uniformly bred, fed and handled birds.

SUGGESTED PROCEDURE:

1. Investigate the following chemical and physical properties:
   a. Determine the amount and kind of the fatty acids present in various fatty tissues of freshly-dressed poultry
   b. Determine the compounds in which these acids exist in the fresh tissues
   c. Study the odor and flavor of each of the above compounds, as well as their odor and flavor after oxidation and hydrolysis

2. Study in compounds with significant odor and flavor the changes which occur during storage.
3. Study changes in the above compounds during cooking.
4. Study production methods with the aim of producing poultry with a maximum of compounds associated with desirable flavor and odor, and a minimum of compounds rendering the fats unstable.
POULTRY PROJECT 18.
CUT-UP POULTRY—A STUDY OF YIELDS AND QUALITY MAINTENANCE

SIGNIFICANCE:
There is little, if any, available information regarding volume handling of poultry which is cut in pieces. Although the disjointing and cutting of poultry in pieces is an age-old custom among housewives and restaurant operators, it is a comparatively recent innovation with the poultry-packing house operators and the retail butchers.

Quite a little variation can be had in the methods for cutting the pieces from a poultry carcass. The naturally bony parts of the bird can be robbed of practically all the meat by close cutting. Parts like the wings can be made almost valueless, or they can be made tempting pieces. Techniques in cutting up poultry should be developed as to:

1. The most desirable method from the consumer's standpoint.
2. The most desirable method from the merchandising standpoint.

Problems in connection with eviscerating and chilling in the cutting up of dressed poultry, and the freezing and chilling of cut-up poultry need to be solved such as:

1. Eviscerating then cutting up before chilling.
2. Chilling before eviscerating and cutting up.
3. Freezing cut-up poultry without chilling.
4. Freezing after allowing cut-up poultry to cool under chilling temperatures.
5. Chilling periods before freezing.

PERSONNEL AND FACILITIES:
1. Food technologist.
2. Research home economist.
3. Refrigeration facilities.

SUGGESTED PROCEDURE:
1. Study disjointing with the idea of keeping the most meat on the breast and thighs.
2. Study the effect of chilling before eviscerating and disjointing.
   a. Ease of operations
   b. Quality maintenance
3. Study the keeping quality of cut-up poultry.
   a. At temperatures above freezing
   b. At temperatures below freezing
   c. Study effects of freezing and thawing on subsequent holding above freezing before cooking
POULTRY PROJECT 19.  
FREEZING RATES AS INFLUENCING TISSUE CHARACTERISTICS AND PALATABILITY OF EVISCERATED AND CUT-UP POULTRY

SIGNIFICANCE:
The successful handling and merchandising of eviscerated and cut-up poultry depends to a large measure on the use of sub-freezing temperatures. More than 50 percent of poultry consumed in the United States is frozen. A small proportion of this poultry is prepared by commercial quick-frozen methods while the greater portion is sharp frozen. The rates of freezing in other meats have been shown to affect the palatability. Work on poultry meats is needed to establish the optimum rate for quality maintenance and possible improvement.

Research to determine the efficacy of various rates of freezing would help to establish proper processing methods and provide the consumer with superior products.

PERSONNEL AND FACILITIES:
1. Food technologist.
2. Research home economist.
3. Freezing and storage facilities.

SUGGESTED PROCEDURE:
1. Poultry of same sex and weight to be selected from the same flock.
   a. Broilers
   b. Roasters
   c. Fowl

2. Killing and dressing methods to be identical for all specimens. Poultry held for various times at 32° to 35° F. before freezing.

3. Eviscerated poultry, cut pieces and ground tissues to be frozen as follows:
   a. Freezing time, 30 minutes or less
   b. Freezing time, 1 to 3 hours
   c. Freezing time, 10 to 30 hours

4. Poultry examined as follows after storage periods not longer than 7 days at +5° to -20° F.
   a. The pH determinations on defrosted tissues
   b. Determination of drip
   c. Histological examination
   d. Organoleptic tests
   e. Defects—bone and meat discoloration, bloom, etc.
POULTRY PROJECT 20.

STORAGE TEMPERATURES AND PERIODS AS THEY INFLUENCE TISSUE CHARACTERISTICS AND PALATABILITY IN POULTRY

SIGNIFICANCE:

Industry now accepts the fact that the longer the storage period required, the lower the holding temperature should be. Since this is generally true, the greatest difficulties are not found in the storing of products over extended periods. A certain volume of products is held for only short periods, and here higher temperatures might prove adequate and more economical. Information is required for the preparation of charts showing suitable storage conditions for various storage periods up to 2 years duration.

Loss of bloom and freezer burn, caused by desiccation, are two of the most common forms of deterioration in frozen products but chemical changes such as rancidity may also occur. Changes due to drying may be prevented more economically by humidification of the freezer or by proper packaging than by the use of the extremely low temperatures sometimes used commercially. This, and problems concerned with the lowest temperatures necessary to prevent detrimental chemical changes in both the fats and proteins, require investigation.

Although bacterial growth does not occur at the freezer temperatures normally used, there is little available information on the effect of storage time and temperature on the bacterial development.

Whether advantages which may be derived from quickfreezing of poultry are sacrificed by high storage temperatures, is, at present, controversial. The effect of storage temperatures on rancidity development and freezer burn on poultry products is also an unsolved question.

PERSONNEL AND FACILITIES:

1. Food technologist.
2. Research home economist.
3. Freezing and storage facilities.
SUGGESTED PROCEDURE:

1. Poultry of the same approximate weight and sex to be selected from the same flock.
   a. Broilers
   b. Roasters
   c. Fowl

2. Birds to be handled in the same manner prior to freezing.

3. Eviscerated poultry, cut pieces and ground tissue to be frozen as follows:
   a. Frozen fast (30 minutes or less)
   b. Frozen fairly fast (2 to 3 hours)
   c. Frozen slowly (10 to 48 hours)

4. Specimens frozen as above to be stored as follows with and without packaging to protect from freezer burn:
   a. At $-20^\circ$ F. for 3, 6, 9 and 12 months
   b. At $-5^\circ$ F. for 3, 6, 9 and 12 months
   c. At $+5^\circ$ F. for 3, 6, 9 and 12 months

5. Poultry examined after storage as follows:
   a. Weight loss during storage
   b. Organoleptic and chemical determinations on fat
   c. The pH determinations on defrosted tissues
   d. Drip values on defrosted tissues
   e. Histological examination of tissues
   f. Organoleptic tests on paired (half chicken) samples
   g. Weight-loss determinations during cooking
POULTRY PROJECT 21.

A STUDY OF BONING, CURING AND SMOKING POULTRY MEATS

SIGNIFICANCE:

Poultry has a unique as well as a desirable flavor and is usually preferred to other meats. Its sale, however, is often hindered by the merchandising methods commonly employed in the live and dressed poultry trade. The established methods of merchandising, either alive or as New York dressed poultry, are relatively uneconomical and, furthermore, the product lacks eye appeal. Consumer response to eviscerated, and more especially to cut-up poultry, indicates the existence of a good potential demand for poultry meat prepared in more convenient forms.

Through these new programs consumers are gradually learning to purchase poultry on an edible meat basis. This trend offers the possibility of a more profitable sale of poultry meat in more compact economical forms, and put up in new and attractive ways.

PERSONNEL AND FACILITIES:

1. Food technologist or meats specialist.
2. Research home economist.
3. Suitable smoking, pickling and refrigerating facilities.

SUGGESTED PROCEDURE:

1. Study edible meat yields of birds of different grades and compare results with market costs.
2. Study different boning, curing and smoking methods comparing quality of finished product, yields and costs.
3. Study different ways of presenting finished product to consumer, determining, if possible, the most attractive and appealing forms.
4. Study the boning problem, comparing quality of product prepared from meat removed from bone before and after cooking.
5. Study effects of refrigeration on birds before and after being boned, and needs for refrigeration for the finished product.
6. Study value and use of the by-products from boning.
   a. Bones
   b. Necks and backs
   c. Excess fat
   d. Skin
POULTRY PROJECT 22.

A COMPREHENSIVE STUDY OF THE NUTRITIVE VALUES OF CHICKEN MEAT

SIGNIFICANCE:

Chicken flesh may be expected in general to be similar in nutritive value to other meats. By analogy it may be expected to show slight species differences and to be affected, especially in the vitamin and inorganic salts, by the character of the diet or by the extent to which the bird is capable of synthesizing certain vitamins.

Studies have been made of the protein, fat and mineral content of poultry flesh but practically nothing is known of the biological value of these constituents nor of the possible influence of the diet of the bird on some of them. There is reason to believe that some of the biological evaluations of poultry flesh have been complicated by other factors than those under investigation.

Furthermore, the effect of storage conditions and methods of cooking on the nutritive value of chicken flesh have not been studied.

PERSONNEL FACILITIES:

1. Nutritionist.
2. Source of poultry of known history.

SUGGESTED PROCEDURE:

The investigation should be separated into two phases. The first phase should be concerned primarily with chickens as they are produced and handled on the markets. Dressed birds of different grades and classes together with live birds as they are obtained from the producer would be studied. This phase would serve to establish methods of procedure, and the information obtained would be valuable in planning the studies of the second phase. The second phase would be concerned with a study of the effect of storage conditions, dietary factors, and methods of cooking on the nutritive value of poultry flesh.

In both phases of the investigation, the nutritive values of the meat would be determined according to the methods outlined below. All determinations should be related to the dressed weights of the chickens and, if possible, to the live weights as well.

1. Physical analyses to determine the relative proportion of the several edible portions.
2. Chemical analyses to determine the protein, fat, ash and moisture content of the dark and light tissues.
3. Feeding trials with suitable laboratory animals to determine the potency of the dark and light tissues as sources of the vitamins. In cases where satisfactory chemical methods are available, they could be used instead of the biological assays.
4. Feeding trials to determine the biological value of the proteins in dark and light chicken meat.
5. Investigations of the fats to determine the presence of the essential fatty acids.
6. Chemical analyses of the ash of the dark and light tissues to determine the content of the inorganic elements in the ash.
7. Determinations of the energy values of the tissues.

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POULTRY PROJECT 23.

A STUDY OF THE NATURE OF THE VITAMIN B COMPLEX IN POULTRY LIVER

SIGNIFICANCE:

Poultry liver may contain vitamin B factors in addition to those reported in other livers, or the distribution of the known factors of the B complex may be very different. Presumably this would be of scientific interest mainly, and might lead to separating new forms of the B complex. This knowledge might lead to new uses or a better understanding of the nutritive value of livers.

PERSONNEL AND FACILITIES:

1. Nutritionist.
2. Source of livers of known history.

SUGGESTED PROCEDURE:

1. Comparative studies on the extraction and fractionation of poultry, calf, cow, hog and sheep livers by chemical and biological methods.
2. Effect of post-mortem treatment on potency.
POULTRY PROJECT 24.

A STUDY OF THE POTENCY OF THE POULTRY ENDOCRINE ORGANS

SIGNIFICANCE:

Aside from the purely scientific interest in the differences in concentration of hormones in various endocrine organs, it is easily possible that some of these organs may turn out to be of value in the first isolation of the pure substances because some of the organs may be especially rich in hormone content, or they may not be admixed to so great an extent with other activities, and thus the purification would be simplified. It is, however, not too likely that poultry organs will be a good commercial source for the preparation of these therapeutic principles because the labor cost in collecting them will probably be too high to make them of any practical significance even with their possible higher concentration of hormones.

PERSONNEL AND FACILITIES:

1. Biochemist trained in hormone assay.
2. Source of organs of known history.

SUGGESTED PROCEDURE:

Special arrangements would need to be made to collect the fresh material accurately in adequate amounts for the quantitative determination of the hormone content. The assays would need to be made by a laboratory staff specially equipped and trained to make accurate observations. If the assays suggest that methods of purification seem desirable, workmen would need to be trained to collect the material under specified conditions. The fractionation should be undertaken by one especially trained in this particular field.
POULTRY PROJECT 25.

A DETAILED STUDY OF POULTRY LIVER AND KIDNEY FOR ANTI-ANEMIA PRINCIPLE

SIGNIFICANCE:

Either or both of these organs may prove to be good sources of these important principles. It is possible that poultry livers and kidneys might have special sale for medicinal or dietary use.

PERSONNEL AND FACILITIES:

1. Biochemist.
2. Organs from birds of known history.

SUGGESTED PROCEDURE:

Assays would need to be made on crude concentrates presumably on human patients although according to present indications some progress toward perfecting an animal assay method is being made.

POULTRY PROJECT 26.

A STUDY OF POULTRY LIVER AS A SOURCE OF HEPARIN

SIGNIFICANCE:

Poultry liver may be a rich source of heparin, an important anti-coagulant. This may offer commercial possibilities leading to a special use for chicken livers.

PERSONNEL AND FACILITIES:

1. Biochemist with training in extraction, purification and assay of the heparin-biochemical group.
2. Source of livers of known history.

SUGGESTED PROCEDURE:

1. A comparative study of poultry, calf, beef, hog, and sheep livers as to yield of heparin and its purification.
2. Effects of post-mortem conditions on potency.
POULTRY PROJECT 27.
A DETAILED STUDY OF POULTRY LIVER AND KIDNEY AS SOURCES OF OXIDIZING AND DEAMINIZING ENZYMES

SIGNIFICANCE:
Mainly scientific curiosity to begin with, but might later turn out to be of commercial value.

PERSONNEL AND FACILITIES:
1. Enzyme chemist.
2. Source of livers of known history.

SUGGESTED PROCEDURE:
1. A comparative study of poultry, calf, beef, hog and sheep livers as sources of these enzymes.
2. Effects of action in the post-mortem changes known to occur in poultry.

POULTRY PROJECT 28.
A DETAILED STUDY OF THE NON-SAPONIFIABLE FRACTION FROM POULTRY HORNY LEG SKIN

SIGNIFICANCE:
Sufficient work has been done to demonstrate that chicken leg skin contains a complex mixture of a number of sterols. These vary in nature from the lanosterol to the cholesterol type, and one of the latter has considerable pro-vitamin D value. The lanosterol type may prove to be of value also as a substitute for lanolin.

PERSONNEL AND FACILITIES:
1. Biochemist.
2. Source of chicken shanks of known history.

SUGGESTED PROCEDURE:
1. Preparation of large amounts of the concentrate, the fractionation to pure compounds with the hope of identifying the special pro-vitamin D. The value of this vitamin D in preventing avian rickets would be determined.
2. Isolation of other sterols and investigation of their properties.