the Food and Nutrition Board of the National Research Council in their Reprint and Circular Series, No. 118, released in August 1943, where it is stated:

(1) Margarine fortified with vitamin A in accordance with Food and Drug regulations supplies an important amount of this nutrient as well as of much needed fat. A previous recommendation of the Food and Nutrition Board that all margarine be fortified is reaffirmed. Because of the high proportion of margarine now fortified, mandatory requirement of fortification for all margarine for table use seems unnecessary at present, though it may become desirable if the situation changes in such a manner as to reduce importantly the proportion now fortified.

(2) The present available scientific evidence indicates that when fortified margarine is used in place of butter as a source of fat in a mixed diet, no nutritional differences can be observed. Although important differences can be demonstrated between different fats in special experimental diets, these differences are unimportant when a customary mixed diet is used. The above statement can only be made in respect to fortified margarine and it should be emphasized that all margarine should be fortified.

(3) It is obvious that the present excise and license taxes imposed by both Federal and State governments on margarine interfere with the distribution and utilization of certain of our fat resources, but the implications of these taxes are so extensive and complex that no recommendation with respect to them can be made in this report.

Finally, it should be stated that the nutritional value of milk is not confined to the fat; it possesses proteins of excellent quality and it is an excellent source of certain inorganic salts needed in the diet, such as calcium and phosphorus. Milk is an especially adequate source of riboflavin. We can scarcely view with concern the increasing use of margarine in the diet if that means that larger amounts of whole milk become available at a reasonable cost for human consumption.

Developing Food Acceptance Research[1]

W. Franklin Dove, *Chief*

Food Acceptance Research Branch, Subsistence Research and Development Laboratory, Quartermaster Depot, Chicago

At the present time there appears to be in process of development a science which treats of foods and the consumer of foods as a *relationship* in which the producer or processor of foods (for industrial survival) and the consumer of foods (for human survival) share an equal interest.

During World War II, now just ended, each item of the ration had been carefully produced and prepared according to quality specifications, and each item had been tested to contain and retain through long periods of storage its quota of vitamins, minerals, protein, and calories. But when the soldier-consumer refused to accept some of these ration items, and when these items began to accumulate in the storage dumps in various theaters of the war, a new problem in supply, theretofore unrecognized, was raised to a major issue. To determine the causes of nonacceptance followed as an official directive.

Parallel with the refusals by the soldier-consumer, populations under economic stress, or belabored with a poor soil, or lost in the forest fringe or in marginal environments, or seduced into overspecialization, reveal similar conflicts over acceptance and nonacceptance of foods.

The reasons for this parallel will appear with further development of the subject. Needless to say, both the Army population under stress and the civilian population isolated from the normal balance of supplies—even though it may be living in the midst of a prosperous society—have much in common.

But why had not the subject of food acceptance become an issue before? In order to answer this question and in order to uncover causes, as a step toward instituting prevention, let us go back a few decades.

Not long ago, even in the time of our grandfathers, there was little need for concern over the nonacceptability of the harvest. Each family was largely self-sufficient. Out of the family garden the *seed* for the coming year—and only the best—was selected. That *best* of the harvest was judged at the family table by means of a sizable panel of children and parents, aunts and grandparents, a panel representing all ages and both sexes.

Locally adaptable varieties of sweet corn, apples, squash, peas, beans, bred on the spot for acceptability, were also prepared and cooked in home style. Home cooking meant recipes devised out of the ingredients at hand, upon which the family panel had also placed its stamp of approval. These home recipes had sometimes passed through the judgment of generations of

[1] Research in food acceptance was formally introduced into the Army's food supply program when, in November 1944, a Food Acceptance Research Branch was set up in the Subsistence Research and Development Laboratory, under Col. Rohland A. Isker, Commanding Officer. Food acceptance research has since been included as a section of the food research program of the Military Planning Division, OQMG.

This paper was presented at the Conference on Food Acceptance Research held on 6–7 December 1945 in Chicago, under the sponsorship of the Committee on Food Research, Military Planning Division, OQMG.

families: As the seeds from the best-flavored or the finest-textured foods were saved, so too were the favored methods of preparation and cooking passed down from mother to daughter or from mother to daughter-in-law.

Accordingly, then, the family taste panel passed judgments three times daily, from a breakfast *for work* to a supper *after work,* every day of the week from Monday's labors to Sunday's rest and throughout the seasons, from rain to heat to snow. Though subject to the influences of *imitation,* as when a child imitates one of his parents in food choice; of *domination,* as when a parent punishes a child by depriving him of dessert; of *urging,* as when a mother who, in concern for the well-being of the sickly child, urges him to drink milk; or of *resistance,* as a form of a child's self-assertion in refusing any or all foods presented, nevertheless, the vocal judgments of the family taste panel varied from unanimous vote against the food to unanimous acclaim for the food. The family taste panel passed judgment upon many characteristics conceded important in today's scientific panels: (1) odor, appearance, flavor, texture, and temperature; (2) frequency, monotony, or amount served; (3) the variety grown and even, indirectly, the nature and fertility of the garden soil; (4) methods and temperature of storage as these conditions affected keeping quality; and (5) keeping quality of the raw food, or as cooked (processed) and sealed within the jug, barrel, or jar. All of these judgments, combined into a family chorus, came to expression in the food habits of the consumers and came finally to shape the pattern of the agriculture of every region.

During these earlier times in our history, there were segments of the population isolated from the soil and consequently subjected to limited diets; but for none of these did concern over taste, flavor, and acceptability rise to the level of social, economic, or scientific importance until recent times.

We may conjecture that this gradual rise to awareness of the problem of food acceptability is the result of the gradual change, taking place during the past century, toward *commercial* agriculture with *quantity production* as the chief goal, together with the widespread production by the great food industries of processed and canned foods for the market, while the original strings of taste authority of the family, as producer and processor and consumer, were severed one by one.

By slow but certain strokes the family's seed stock was replaced by the nursery seed stock, by the stock of the large commercial seed house, by the stock of the State and Federal government experimental seed plots —seed stocks which were developed for resistance to diseases and for high yields. By the same slowly changing pattern of life the family's home-canned foods have been displaced by the standardized, colorfully-labeled, commercial product. The advantages to these changes are greater than appear on the surface.

While the civilian consumer's food-getting habits have changed, so too have the methods of feeding armies. Mechanized warfare of World War II required combat and assault rations which possessed operational characteristics for ease of handling, compactness, and keeping qualities, together with nutritional adequacy and acceptability. Such requirements increased the need for *quantity* production and for *commercially* processed, dehydrated, cooked and canned foods in order to keep up with the rapid surge of huge armies. Such armies, as in the Normandy campaign, must travel fast; or, as in the Pacific Island theater, they may be separated for weeks, or even months, from the normal supplies of fresh perishable foods. For the first time in history large groups of men lived for long periods of time solely on commercially produced and processed foods.

Limited and imposed diets, consumed often under stress, tested severely the nutritional adequacy of rations and, even more, their acceptability. For no matter how adequate these foods and rations were nutritionally, only in so far as they were accepted were they a dependable conveyor of nutriment to the body.

With acceptability of foods in this salient position, and with our continued interest in mass feeding, the need has arisen for a careful screening of all scientific researches and methods which might contribute to the evaluation of foods for acceptability. Neither the food producer nor the food processor nor the food consumer (soldier or civilian) can afford to allow food acceptability to remain in its past-present unorganized form. All indications lead one to believe that postwar developments in foods and in feeding, as well as in other approaches to the biological aspects of man's adjustment to his environment, will make extensive use of the scientific advances that may be made in these directions.

The science of genetics has taken the guesswork out of seed selection for disease resistance; food technology and experimental cookery have taken the guesswork out of food processing and food preparation; the science of nutrition has taken the guesswork out of the "plus" factors in foods; while physiology has devised accurate measures of physical and nutritional status of the consumer. But by this modern, efficient, centralized production and processing of foods on the one hand, and by the recognition and supply of the major and minor nutrients required for abundant health on the other, we have left out the relationship—we have left out the *connecting link* between the living

subject (the consumer) and the stuff of life (food) he lives upon: *that link is acceptability.*

Now is the time for the *essence* of the family taste panel, now lost, to be returned—not as it was, but in a modern scientific form, to follow the food from its seed, through development and processing, to the finished, or even assimilated, product. Such a science, if properly developed, is destined to contribute to both consumer and producer alike.

Who will develop the science of food acceptance? Since food acceptance, as someone has aptly remarked, is an in-between study, its proper development will depend upon the combined interest of numerous special approaches. It should include:

(1) Those who have attempted to grade foods for *quality* for government or army specifications, since an application of the blind panel of judges selected on proven ability to test the food or item according to a reliable statistical design provides unbiased decisions and scientific quality control;

(2) Those interested in psychometrics in order to standardize the quality-control methods used for liquors, tea, and coffee, and apply them to milk, eggs, beverages, and finally to all classes and kinds of foods;

(3) Those in food technology and home economics who have used organoleptic methods to determine chemical or physical changes in foods treated or stored in numerous ways;

(4) The biological sciences concerned with self-regulation, or with the embryology, anatomy, or physiology of the sensitivities related to food-getting and to appetite and hunger;

(5) Those interested in social psychology and anthropology, to indicate the background of forces in which food-getting has been reared.

There is need for economists who are aware of the physiological demand as well as market demand; nutritionists who consider food *selection* from the psychological standpoint; and psychologists who know that *food* selection is a matter of nutritional importance.

The question will also continue to tantalize the chemist, who will always try—and may some day succeed—in detecting differences and tracing dilutions with an accuracy equal to that of all the gustatory sensitivities.

Finally, it should interest those who are administrators of research, since food acceptance techniques provide *direction* from the consumer. In other words, food acceptance tests are on more than a mere service-level, since in addition to this they may be used not only *to develop* a product from a correct combination of parts, but also to indicate *what foods to develop* and *in what direction.* As such, they serve the administrator and should therefore be free of any compartmentalization which would disturb their functional nature.

In order, then, to develop the subject of food acceptance as a unit of research, we of the Food Acceptance Research Branch of the Subsistence Laboratory have included in the physical plant the facilities for as many of these approaches as seemed feasible and have relied on various research laboratories of the country, both university and industrial, to carry on correlated research where the best talent, ability, and equipment exist.

Thus, the Food Acceptance Research Laboratory includes in actual concrete structure the facilities for a large number of the potential functions of such research: the statistics of sampling, of design, and of results; the physiology of sensitivities and the psychology of attitudes; the physicochemical tests of quality of the foods; experimental cookery as related to preference; psychometrics and organoleptics. Each of the divisions of interest may be likened to a part of a car: Organoleptics or psychometrics may be the wheels, consumer likes and dislikes (physiological psychology or anthropology), the car body; while experimental cookery may be likened to the snubbers and upholstery. No single part can assume the prerogative of the whole.

During the last six months 215 tests for acceptability have been run on 708 items of foods. The foods tested include every food class, from soup to meats, potatoes, cereals, fruits, beverages, vegetables, desserts, confections, and nuts. Entire rations have also been tested. All of the items intended for rations are now tested for acceptability *before* they enter the rations. The same techniques are used to determine by taste test panels the best methods, from the standpoint of acceptability, for packaging and storing, and the optimum keeping time or shelf-life.

New research methods have had to be devised for nearly every food class or type of food. Each food presented for test presents a special problem which must be analyzed through careful discussion with commodity specialists and with others interested in the development of the food.

The results of the tests are presented as memoranda for administrative action, for further development, or for use by the procurement officers to serve as one of their guides in purchasing supplies. The purchase of the winter's supply of breakfast cereal, for instance, may be influenced by the panel judgments as to brand, composition, method of toasting, etc.

The results of these tests are also being prepared for publication as research papers, since methodology is at present at the crux of testing: Without reliable methods the tester and his results are at the mercy

of personal opinion. Several points which characterize these new methods include the following:

(1) A panel of judges is selected for ability to detect the differences expected to arise.

(2) The test is blind, without comparison of notes by the judges.

(3) A record of differences is secured, together with word records to express the differences.

(4) A record is kept of both positive and negative attitudes toward the differences.

(5) There is a statistical design in the experiment set up in order to measure all variables separately and together and establish significance of results.

When the tests are carried out according to these and other precautions, the results may then be considered reliable. Further tests in camps or in the field must be made to evaluate the relative preference for these foods by the group as a whole. The results show, however, that many totally unacceptable foods can now be eliminated before they enter the ration; that many foods are preferred only by *part* of the population and must therefore be accompanied by substitutes; that some items are so well liked and, fortunately, so stable in the storage method indicated that procurement can proceed with confidence. For example, the best variety of peas as tested by the blind panel turned out to be the variety requested most on the grocery store shelf. Such results indicate actual use-value of the methods.

As we have previously indicated, however, our laboratory approach is not sufficient in itself. Preference for, or prejudice against, a food is a population problem. Attitudes toward foods relate particularly to food habits built up over the years from birth to maturity. Furthermore, food habits are related to the soil, the climate, the food crops, and the socio-economic and even religious characteristics of each region. The final effect of food habits upon the civilian and soldier-consumer from each region should be measurable in terms of physical stamina and success in adjustment in times of stress.

The acceptance rates of foods is a part of the general topic of food habits which has been studied in this laboratory. The Committee on Food Composition of the National Research Council has compiled tables on the nutritive value of American foods. The nutritionist, however, needs additional information in order to devise rations or to evaluate foods correctly. The nutritional value of each food is measured not alone by its nutrient content per 100 grams, but rather by the nutrients in the total amount of each food accepted and, of that, the amount assimilated and utilized. The issue is direct; the arithmetic simple. *Each food must be evaluated not by what it possesses but by what it gives to the consumer*; and it gives to the consumer in gross value its per cent value per unit weight times the weight of food accepted. Acceptance rate in turn depends upon a chain of events and influences, any one of which may negate the chemically high nutrient quality of any food. Thus, acceptance rate waits upon the degree of preference, depends upon form and method of preparation, is hindered or facilitated by differences in flavor of the different genetic varieties, and is influenced by its physiological effect upon, and assimilation by, the individual. In the end, food habits, through acceptance rates, mold the physical status of the consumer, soldier and civilian.

Edgar T. Wherry points out in this issue of Science (page 206) that there really cannot be a Soviet science because science is wholly without national identification. It is interesting to note that every nationality does have its own concept of its importance in the development of science and technology. The following extract is taken from *VOKS Bulletin*, a publication of USSR Society for Cultural Relations with Foreign Countries:

For two centuries Russian scholars, inventors, engineers, and talented, self-taught scientists created the bases for modern electrification. Their work, which was of world-wide importance, is one of the greatest prides of our people.

As far back as 1752 lightning rods were invented by M. V. Lomonosov, the father of Russian science.

The searchlight is the child of Russia twice over: the light of its voltaic arc was the discovery of V. V. Petrov, the first Russian electrical engineer (1802), while the construction and focussing of its optics was the work of the electrical engineer V. N. Chikolev (1890).

The first electric mine was invented during the Crimean War by B. S. Jacoby, member of the Russian Academy of Sciences (1854).

The electric lamp is fruit of the work of A. N. Lodygin (1874).

The explosion-proof electric lamp was invented by the Russian electrical engineer V. N. Chikolev (1880).

The transformer was the invention of I. F. Usagin (1882).

The generator was improved by P. N. Yablochkov, A. I. Poleshko and others; the electric motor was invented by M. O. Dolivo-Dobrovolsky (1890). The electric welding instrument was the invention of N. G. Slavyanov (1885).

The radio and radio broadcasting are the inspired invention of the Russian scientists and electrical engineers A. S. Popov (1895) and M. A. Bonch-Bruevich (1920).