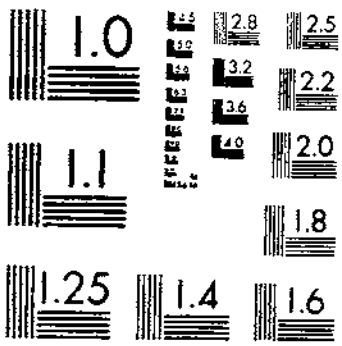
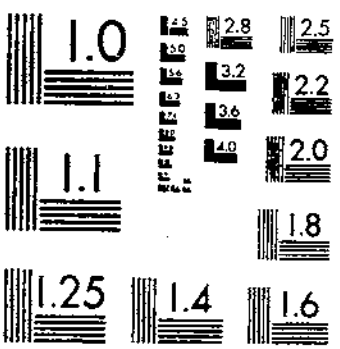
START

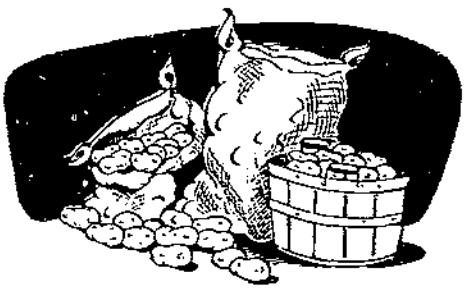


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Cooking Quality and Compositional Factors of Potatoes of Different Varieties from Several Commercial Locations



Technical Bulletin No. 1106
March 1955

UNITED STATES DEPARTMENT OF AGRICULTURE
Washington, D. C.

CONTENTS

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 35 cents

SUMMARY AND CONCLUSIONS

This study was made to determine the relationship between cooking quality and composition of potatoes. For this purpose, different varieties of potatoes each from several locations were obtained and stored under different conditions. The cooking quality for boiling, mashing, and baking was determined and results were correlated with the composition of the raw potatoes.

Potatoes from the most important late-crop producing areas were obtained for this investigation. Twenty-five sample lots representing nine varieties of the 1947 crop were used in a preliminary study. Six of these varieties were obtained from 2 or 3 locations for a more intensive study during the 2 succeeding years. Sample lots studied for 3 years were: Chippewa from Indiana, Maine, and Michigan; Green Mountain I and II from Maine and Green Mountain from New York; Irish Cobbler from Maine, North Dakota, and Wisconsin; Katahdin from Colorado, Maine, and Pennsylvania; Russet Burbank from 2 locations in Idaho and 1 in Washington; and Triumph from 2 locations in North Dakota.

Palatability evaluations were made by a trained panel for the pertinent quality characteristics of color, dryness, mealiness, and flavor in boiled, mashed, and baked potatoes and sloughing in boiled potatoes. Considerable variation was found among the 17 sample lots of potatoes. In many of the varieties, differences in palatability ratings of potatoes representing different locations of any one variety were as great as differences in ratings among varieties. Potatoes of the same as well as different varieties grown in different locations were individual in regard to cooking quality when judged by a basic palatability standard.

Results of palatability tests indicated that in general the method of cooking made little difference in the characteristics of mealiness, dryness, and flavor. A potato that was dry and mealy when boiled was also dry and mealy when mashed or baked; one that was soggy and wet when boiled was also soggy and wet when baked. A similar relationship was true for flavor. In color, however, potatoes cooked by the three methods showed more pronounced differences. A definite trend was shown for boiled potatoes to have poorer color than mashed or baked potatoes, even though in these experiments boiled and mashed products were from the same cooking sample. In some samples ricing and blending were apparently sufficient to improve the color of mashed potatoes over the color of boiled potatoes.

Mealiness generally is considered a desirable criterion for quality in boiled, mashed, and baked potatoes. The sample lots giving the most mealy texture and thus rating best in quality when cooked in these ways were the Green Mountain from New York and Maine II locations in 1948, Irish Cobbler from North Dakota in 1949, and Russet Burbank from Idaho and Washington in both years. Sample lots most lacking in mealiness were Chippewa from Indiana in both years and Katahdin from Pennsylvania in 1949. Potatoes of Triumph variety from both locations in North Dakota were low in mealiness. The fact that mealiness is not a function of variety alone but is influenced also by location is illustrated by results with Katahdin potatoes. Katahdins from Colorado were among the most mealy whereas those from Pennsylvania were in the group of least mealy.

In boiled potatoes, mealiness cannot be used as the sole criterion for cooking quality since some of the most mealy potatoes slough

badly and do not hold their shape well enough to make an attractive boiled potato. For boiled potatoes a cohesive product may be of greater importance than mealiness. In this study, potatoes that held their shape best and did not exhibit sloughing were the Chippewa from Indiana, Maine, and Michigan in both 1948 and 1949, Katahdin from Maine and Pennsylvania in both years, and the Green Mountain from Maine and the Triumph from North Dakota in 1948.

Extreme sloughing occurred in only a few cases—in the Irish Cobbler from North Dakota in 1949 and in the Russet Burbank from Washington in 1948 and 1949. These potatoes were not satisfactory to serve as boiled potatoes. Although sloughing when extreme may cause difficulty in preparation and serving of boiled potatoes it need not necessarily be considered a handicap in the preparation of mashed potatoes.

Length of storage was shown to be an important factor in the palatability of cooked potatoes. Potatoes were less mealy and more soggy the longer they were stored. Sloughing on the other hand occurred to a lesser extent in stored potatoes. As storage progressed, the color of the cooked potatoes frequently became yellow or gray as contrasted with the creamy white color of freshly harvested potatoes. A progressive deterioration in flavor with increased storage time was also noted and found to be associated with increased sugar content of the potatoes.

A wide range in content of many of the constituents of the individual variety lots of potatoes was shown by chemical analyses of the raw samples for dry matter, alcohol insoluble solids, starch, sugars, nitrogen compounds, juice content, and pH values. The data indicate that location and cultural conditions may have as much influence as varietal characteristics on the variation in some of the constituents. Carbohydrates were affected more by storage conditions, particularly at temperatures of 40° F., than any of the other constituents. The volume of juice that could be pressed out of the tissue decreased with storage. Storage conditions had little effect on the nitrogen compounds although a difference, which appeared to be a varietal characteristic, was noted in the ratio of protein to nonprotein nitrogen. A significant relationship of nitrogenous compounds with the other constituents was found only when nitrogen content was expressed on a dry-weight basis. On the other hand, on a fresh-weight basis a high correlation was found between the various constituents, specific gravity, dry matter, alcohol insoluble solids, and starch.

Correlation studies showed that high values for specific gravity, dry matter, alcohol insoluble solids, and starch were closely associated with low ratings for absence of sloughing, high ratings for dryness, and mealiness and to a lesser extent with high ratings for flavor and color. High nitrogen content had a detrimental effect on most of the palatability ratings.

Dry matter, alcohol insoluble solids, starch, or specific gravity were found to be nearly equally good measures for the prediction of cooking quality. When several of these factors were considered simultaneously only slightly more information on the cooking quality was obtained. These measurements provide information that producers and distributors can use in grading and labeling potatoes for designating a particular use that would give the consumer the best quality cooked product. As specific gravity gives information comparable to the other measurements and is the simplest to obtain it is the best practical measure for predicting quality in cooked potatoes.

Cooking Quality and Compositional Factors of Potatoes of Different Varieties From Several Commercial Locations [1]

By Peter H. Heinze, *Physiologist, Biological Sciences Branch, Agricultural Marketing Service;* Mary E. Kirkpatrick, *Food Specialist, and* Elsie F. Dochterman, *Statistician, Human Nutrition Research Branch, Agricultural Research Service* [2]

INTRODUCTION

The potato holds an important place among the leading foods of the world, ranking, in total production, above any other vegetable crop. As a result of its wide distribution and use as a food by many people it has commanded the attention of many writers and research workers. The largest portion of the writings deal with the history, cultural practices, the control of diseases, and the development of varieties but little attention has been given to cooking quality. More than 30 new varieties of potatoes have been introduced for improved yield and resistance to disease and insects during the last 20 years. Slightly over 40 percent of the certified seed produced at present is represented by 6 of these new varieties.

In an attempt to grow more potatoes the producers have frequently minimized the attention on cooking quality and flavor. The producer has shown more immediate interest in such factors as yielding capacity, disease resistance, size and shape of the tubers, and the general adaptability of a particular variety than in the quality of the potato after it is cooked. For purposes of marketing, specifications for U. S. grades are based upon such factors as size, appearance, and freedom from disease or injury but cooking quality is not considered.

This publication reports results of cooperative research conducted to obtain basic information needed for better utilization of potatoes and promotion of quality improvement of potatoes. This research was carried on under the Research and Marketing Act of 1946 (RMA, Title II) and had the encouragement of the United Fresh Fruit and Vegetable Association, the National Restaurant Association, and the National Potato Chip Institute.

---

[1] Submitted for publication April 29, 1954.

[2] Special acknowledgment is made to the late D. F. Fisher of the former Bureau of Plant Industry, Soils, and Agricultural Engineering, and to Esther L. Batchelder, Assistant Chief, Human Nutrition Research Branch, ARS, for valuable suggestions on planning and carrying out these investigations. Acknowledgment is also made to the following colleagues for their assistance and cooperation: R. C. Wright and C. C. Craft, Biological Sciences Branch, AMS, on chemical analyses; Beatrice M. Mountjoy, Linda C. Albright, Shirley Preston, and Carol Howe, staff members of the former Bureau of Human Nutrition and Home Economics, on cooking quality studies; A. B. Parks, Human Nutrition Research Branch, ARS, and D. Mann of the former BHNHE, on statistical analyses of the data, and the field staff of ARS in the various States for assistance in obtaining the potatoes for this study.

Some investigators have made limited studies on the potato from the standpoint of its compositional factors and cooking quality. This study was made to evalutate the relationship of cooking quality to composition in new varieties and old varieties as they are grown under present conditions of production and to determine the suitability of various lots of potatoes for specific purposes. Improved methods for evaluating cooking quality and palatability and for determining specific gravity and composition were used.

Experiments were designed to obtain data on (1) the value of late-crop potatoes of different variety, location, and storage treatment for boiling, mashing, or baking; (2) the relationship between cooking quality and measurements of raw stock for specific gravity, dry matter, alcohol insoluble solids, starch, sugars, nitrogen fractions, juice content, and pH values; and (3) the possibility of any one or combination of these measurements of raw stock serving as a method for predicting the cooking quality of potatoes. It seemed advisable to investigate varieties found adaptable to different growing areas in the United States and those known to be of greatest importance in commercial production.

This research was done in two parts—a preliminary study of the 1947 crop and an intensive study of the 1948 and 1949 crops. Data from the preliminary study furnished the basis for the selection of varieties and methods used in the intensive study.

The Biological Sciences Branch assumed responsibility for obtaining the samples of potatoes, furnishing facilities for maintaining proper storage conditions, and carrying out chemical analyses on raw stock. The Human Nutrition Research Branch had the responsibility for conducting the cooking tests, training and selecting a judging panel to evaluate the culinary quality of cooked samples, and supervising and carrying out the statistical analyses of the data.

REVIEW OF LITERATURE

Many workers have studied the cooking quality of potatoes as affected by various factors, and some have attempted to relate cooking quality to various physical and chemical characteristics of the raw tubers. It is well known that there are differences in cooking quality of potatoes, and that differences exist in the composition of potatoes. No two potatoes of the same variety or even from the same hill (*23*)[3] are identical in their chemical composition. Some of the factors affecting the composition have been variously listed as variety, degree of maturity, method of culture, amount and kind of fertilizers, locality and soil, seasonal variations, temperature during growth and storage period, as well as time in storage. These same factors seem to affect also the cooking quality of potatoes, although workers have disagreed as to their relative importance. A number of investigators (*23, 28, 52, 59, 69*) have reported that composition and cooking quality are less affected by variety than by environmental conditions under which the potatoes grow. However, where a number of varieties produced under the same environmental conditions have been compared, statistically significant differences between varieties were found for specific gravity, total dry matter, sugar content, and vitamin C content (*1, 4, 13, 39, 44, 46*). Differences in

[3] Italic numbers in parentheses refer to Literature cited, p. 57.

cooking quality among varieties have also been found (*60*) with some relatively higher in quality than others when produced over a wide range of environmental conditions (*26, 57*).

A cooperative study (*72*) in the U. S. Department of Agriculture in 1936 showed the influence of storage temperature on cooking quality, palatability, and carbohydrate content of four varieties of potatoes grown at Arlington Farms, Va. At temperatures below 50° F. there was an increase in sugars and a parallel decrease in starch which was accompanied by a diminution in mealiness and an increase in sogginess. At 40° F., appreciable change occurred in the stored potatoes but subsequent storage at 70° F. for several weeks restored many of the potatoes to satisfactory cooking quality. Prolonged storage of potatoes at 32° and 36° F. induced changes that prevented them from being restored to a satisfactory cooking quality.

It was recognized well over one hundred years ago that the amount of dry matter influenced the quality, and that the dry matter content was related to the specific gravity of the potatoes. In 1847, Smee (*53*) in his treatise, *The Potatoe Plant*, lists 160 kinds of potatoes "* * * with the weight of each tuber and the specific gravity, which will roughly indicate the quantity of solid material, and consequently the value of each kind." Von Scheele, Svenson, and Rasmussen (*66*) have reviewed the work of earlier investigators and given the results of numerous tests showing the close relationship between specific gravity and dry matter or starch content. Others (*14, 65*) have closely approximated Von Scheele's earlier work. Later workers (*10, 26, 54*) have also separated potatoes into different specific gravity groups and noted the cooking quality as indicated by the texture or mealiness of the cooked product. In some consumer acceptance studies (*25, 42*) potatoes were separated according to their specific gravity into bakers, boilers, and fryers. Hardenburg (*29*) assigned descriptive terms to potatoes of different specific gravities such as: 1.05 and 1.06, soggy; 1.07 and 1.08, fairly mealy; 1.09, mealy; and 1.10, very mealy. Haddock and Blood (*26*) gave the following quality rating to potatoes of different specific gravities: 1.060–1.070, poor; 1.075–1.080, fair; 1.085–1.090, good; and 1.095–1.105, excellent.

Factors other than specific gravity, dry matter, and starch have been investigated as to their role in the quality of cooked potatoes. Coudon and Bussard (*12*) reported that the content of total nitrogen and protein nitrogen was lower in mealy than in nonmealy potatoes. Cobb (*11*) also showed a negative correlation between nitrogen content and the cooking qualities, mealiness, flavor, and color, but the correlation coefficients were not high. Ashby (*2*) found that potatoes of good quality had a higher dry matter and a lower total nitrogen content than those of inferior quality. Other investigators (*8, 17, 27*) have reported that they found little or no association of nitrogen with quality. Rathsack (*50*) found that taste and flavor become less desirable with increase in nitrogen above a normal of about 0.35 percent on a fresh-weight basis. Gilmore (*21*) noted that potatoes that were yellowish in color and soggy after boiling were usually low in starch and high in protein (nitrogen). He also found that immature potatoes from late-planted crops were "relatively richer in protein and poorer in starch than the normally developed and ripened tubers." The crop from the late-planted tubers was of poor quality

from the consideration of both mealiness in boiling and physical characteristics of the raw potatoes.

Pectins represent another compositional factor that has commanded the attention of a number of people especially in regard to its relationship to the mealiness quality of potatoes. However, Sweetman (*59*), after reviewing the results of a number of investigations, concludes that "there is no acceptable evidence that the content of pectins is a determiner of mealiness." Barmore (*6*) a little later found a similar lack of correlation between pectin content and mealiness in potatoes with equal starch contents. Freeman and Ritchie (*20*) conducted a rather thorough study of the pectic materials and concluded "that the solution or degradation of pectic materials does not determine mealiness in potatoes."

Other constituents that have received some attention but that seem not to be factors of any great importance in quality evaluation are fiber (*18*), organic acids (*52*), and mineral (*50*) content. Solanin has been investigated by a number of workers (*33*, *45*, *59*) but mainly from the standpoint of its imparting a bitter, unpleasant flavor to potatoes.

Methods other than organoleptic tests have been proposed from time to time for measuring quality in the cooked product. Rathsack (*50*) describes two methods of estimating two qualities: one was termed a Disintegration Index Z (Zerkochungsgrad) in which the percentage of whole potatoes, percentage torn, percentage split open and the percentage disintegrated after boiling are all used to calculate the disintegration index. The second measurement was termed a Texture Index S (Schnittfestigkeit) calculated from the time required for a fine wire to cut the cooked potato under standard conditions. He found the disintegration index to be unrelated to the starch or protein content or to the starch-protein ratio. However the texture index was related to the starch content. Freeman (*19*) has described a method for scoring the texture of baked potatoes by observing the color of thinly cut slices of baked potatoes dried on glass plates in an oven at 50° C. Mealy potatoes dried to a white porous mass while the nonmealy potatoes produced a dense, vitreous horny sheet, tan in color. When slightly higher drying temperatures were used greater color contrasts were obtained.

Several investigators have attempted to produce changes in potatoes that would simulate cooking. Personius and Sharp (*49*) used several chemical agents and came to the conclusion that at least two fundamental changes occur when raw potatoes are converted into cooked tissue (1) gelatinization of the starch and (2) a marked decrease in the cell adhesion of the tissue. However, these authors found that neither of these changes alone or in combination offered a satisfactory explanation for the variation in mealiness of different potatoes. Wheeler (*68*) devised a test using cylinders cut from potatoes and then soaked in alcohol for 1 hour. If the cylinders remained white the potatoes would be white and mealy when cooked. If the cylinders became discolored or shrunken in the alcohol those potatoes would produce a dark-colored cooked product.

The above tests for quality in potatoes are, in most instances, laboratory tests and not readily adaptable for use by the potato industry. The evaluation of quality based on specific gravity separation has been proposed by several research workers (*25*, *42*) and war-

rants serious consideration from both a reliable and practical standpoint.

PRELIMINARY STUDY, 1947 CROP

For a preliminary study of cooking quality and chemical composition a number of sample lots of several varieties of potatoes, most important in commercial distribution, were chosen to furnish data upon which to base selections for more intensive research in the 2 years following.

Nine varieties (Chippewa, Green Mountain, Irish Cobbler, Katahdin, Russet Burbank, Russet Rural, Sebago, Triumph, and White Rose) were obtained from 2 or 3 locations each. Location refers to different States except for the Green Mountain variety. Of the 3 Green Mountain samples 2 were grown in different types of soil in Maine and are designated as I and II. A total of 25 sample lots was stored at 40° and 55° F. and prepared by 6 common methods for palatability judging at 3 time periods. Controlled methods for boiling, mashing, hash-browning, baking, french frying, and use in salad were developed to prepare samples for palatability tests. Results of tests made for french frying quality of these potatoes will be included in a later report. The large number of lots of potatoes obtained and the lateness of the season when the work was started prevented replications of cooking and palatability tests.

General Procedures

SELECTION AND STORAGE OF SAMPLES

After potatoes were received at Beltsville and before they were put into storage, cooking samples of suitable size for boiling, baking, and french frying were selected for uniformity and for freedom from defects. Selection for size by means of a suitable caliper was the same as described in a report on early-crop potatoes (*41*). Tubers comprising each sample were packaged in paper bags and stored at 40° and 55° F. for midseason storage tests after approximately 2 to 3 months and at 40° F. for late season tests after approximately 4 to 5 months. It is known that culinary quality, especially for deep-fat frying, is preserved best at about 55° F., but commercially potatoes are usually stored at temperatures near 40° F. in order to prevent withering, decay, and sprouting over a period of several months. For this reason both storage temperatures of 55° and 40° F. were included in this study. The temperature in the rooms was thermostatically controlled and the relative humidity was maintained at 85 to 90 percent.

SPECIFIC GRAVITY AND CHEMICAL TESTS

The specific gravity of each sample lot used in the preliminary study was determined on a randomly selected 50-tuber sample before storage and after storage at 40° F. for approximately 3 months. The specific gravity of the individual tubers was determined by use of salt solutions of different concentrations as described by Clark, Lombard, and Whiteman (*10*). Solutions ranging in specific gravity from 1.055 to 1.115, with intervals of 0.005, were prepared in 5-gallon earthenware jars. All potatoes were washed and dried immediately before determining their specific gravity. The potatoes were placed in the

FIGURE 1.—Separation of potato tubers into specific gravity classes by salt density method.

solutions of lower concentration, the floaters were removed (fig. 1) and placed in baskets beside each jar, and the remainder removed to the next higher concentration in sequence. At the end tubers were washed to remove salt solution and the specific gravity of each tuber was marked on it with indelible pencil. The potatoes were classed as being of the same specific gravity as the solution of the lowest concentration in which they floated. This classification was used for convenience although it is realized that the actual specific gravity of the potatoes was somewhere between that of the solution in which they floated and the next lower concentration in which they sank. The average specific gravity for any one lot was calculated by multiplying the number of tubers removed from each jar by its specific gravity, then summing the various products and dividing by the total number of tubers.

Chemical analyses (as described on pp. 12-13) for reducing sugar, total sugar, starch, dry matter, and alcohol insoluble solids were made before and after storage on samples from the 25 lots. In addition, analyses for pH, total acidity, formol amino nitrogen, and amino

nitrogen were made on 4 representative sample lots (Green Mountain, Sebago, Triumph, and Russet Burbank) each from 3 locations. These latter analyses were made in March after the potatoes had been stored 6 months at 40° F., and after an additional 2 and 4 weeks at 70° F.

COOKING METHODS

Cooking tests of unstored samples were made as soon as possible after sorting and sampling were completed. Tests of stored samples were made approximately 2 and 4 months after the potatoes were received.

Six samples of potatoes were randomly selected from the 25 lots for cooking tests each day. Eight medium tubers, uniform in size and shape, comprised each boiling sample and four tubers somewhat larger than those used for boiling but also uniform made up each baking sample.

Boiling.—Tubers were peeled a minimum time in a mechanical peeler after which they were washed, trimmed, and weighed. The six samples were cooked simultaneously on identical electrical units. Iron-constantan thermocouples attached to a recording potentiometer were used to register the internal temperature of one of the tubers in each cooking sample. As soon as an internal temperature of 96° C. (205° F.) was reached the tubers were drained, weighed, and cut for sampling. The tuber containing the thermocouple was not used for palatability testing. Tubers were divided lengthwise into quarters to furnish four similar samples comprised of a single quarter from each of the seven tubers in the cooking sample for judging the palatability of potatoes when boiled, mashed, hash-browned and prepared as salad. Boiled samples were judged immediately with no further treatment, mashed samples were kept hot, and samples for hash-browning and salad were put aside for later use.

Mashing.—Cut portions for the mashed sample were riced, blended, and judged while still warm. No seasonings were added.

Hash-browning.—The quarters of boiled potatoes reserved for hash-browning were cooled for 3 hours at room temperature then cut into ½-inch cubes. The cut potatoes were then cooked in preheated fry pans in oil in the ratio of ½ tablespoon (6.8 grams) cooking oil for 1 cup cubed potatoes. Potatoes were turned four times with a wide spatula during the 10-minute cooking period. Cooked potatoes were turned out on preheated white china plates and put out in a series for judges to score browning and outside texture. Individual samples were then served on plates for each judge to rate other palatability characteristics.

Salad.—Cubed potatoes for salad (prepared as described for hash-browning) were seasoned with cooked salad dressing. One-fourth cup salad dressing blended with one tablespoon light cream was used with 2 cups cubed potatoes from each sample. Cubed potatoes and salad dressings were tossed 30 strokes with a large blending fork and served on plates for individual judging.

Baking.—Four uniform tubers, one containing the thermocouple, comprised each of the samples baked at one time. Potatoes were washed and dried, then baked in a Despatch electric oven preheated to 218° C. (425° F.). They were baked until the internal temperature

in the tuber containing the thermocouple from each sample reached 98° C. (208° F.). Halves of the tubers were placed on trays, one tray being prepared for each judge.

PALATABILITY EVALUATION

Among those who have made a critical study of quality in potatoes cooked and prepared in various forms, certain attributes of quality in regard to color, texture, and flavor have become generally established. Dunn and Rost (*16*) state that cooked potatoes with a mealy texture, a white color, and a distinctive mild potato flavor are preferred. Mealiness as a standard of quality has been emphasized by many other workers (*11, 23, 70, 72*). Results from an earlier study of consumer preferences for potatoes (*51*) showed that the outstanding quality preferred was that potatoes be dry, mealy, and not soggy. Hotchkiss, Wood, and Findlen (*36*), from a consumer survey in New York State, found that mealiness and whiteness were the cooking qualities considered most desirable by both household and institution buyers. According to Hincks (*34*), Boston consumers in 1940 desired a potato that cooked white, dry, and mealy, and possessed good flavor. Homemakers in cities of 2,500 or over in the United States interviewed in an extensive survey indicated (*68*) that in an all-purpose potato the qualities of "cooking up mealy, cooking evenly, and cooking without breaking to pieces" were of almost equal importance. Although listed as distinct qualities these three characteristics are various aspects of texture and indicate the importance of texture in consumers' evaluation of potatoes.

In this study palatibility refers to those characteristics of cooking quality evaluated by a panel of judges and includes sloughing, mealiness, dryness, color, and flavor. The panel was composed of seven persons experienced in judging food quality. Boiled potatoes were scored by visual evaluation of color and sloughing; dryness, mealiness, and flavor were scored after the judges tasted the samples. Except for the sloughing characteristic, mashed and baked potatoes were judged for the same qualities as boiled potatoes. Salad and hash-browned potatoes were scored for form retention, which included sloughing plus loss of shape when cut pieces were tossed together. Hash-browned potatoes were scored for color of outside crust, interior texture, and flavor.

Palatability judging was done at individual tables in a room separate from that in which the samples were prepared. The room was adequately ventilated and was lighted with artificial-daylight lamps. A 3-point judging scale, with 3 representing the highest score and 1 the lowest, was used. Descriptive terms were listed for each point on the scale (*41*).

Two judging sessions were held each day. Boiled and mashed samples were judged at 11 a. m. and hash-browned and salad samples were judged at 3 p. m. daily. This heavy judging schedule was necessary in order that results from the four methods of preparation of a single boiled sample could be compared.

Results of Preliminary Study

PALATABILITY

Of the palatability characteristics evaluated in the preliminary tests, texture, including mealiness, sloughing, and form retention,

was the most useful in determining cooking quality. Comparison here of suitability of the 25 lots to the 5 cooking methods (table 1), was made on the basis of these aspects of texture.

TABLE 1.—*Specific gravity of 25 sample lots of potatoes and suitability for cooking based on panel ratings* [1] *(Preliminary study)*

Variety and location	Specific gravity	Boiled, hash-browned, salad	Mashed	Baked
Chippewa:				
Maine	1.066	(***)	(*)	(*)
Michigan	1.067	(***)	(*)	(*)
Green Mountain:				
Maine, I	1.080	(**)	(**)	(**)
Maine, II	1.087	(**)	(***)	(**)
New York	1.102	(*)	(***)	(***)
Irish Cobbler:				
Maine	1.082	(***)	(***)	(**)
New York	1.081	(**)	(*)	(*)
Wisconsin	1.081	(*)	(**)	(***)
Katahdin:				
Colorado	1.083	(**)	(**)	(**)
Maine	1.076	(***)	(**)	(*)
Pennsylvania	1.062	(***)	(**)	(*)
Russet Burbank:				
California	1.096	(*)	(***)	(***)
Idaho	1.100	(*)	(***)	(***)
Washington	1.105	(*)	(***)	(***)
Russet Rural:				
Michigan	1.085	(***)	(**)	(**)
Pennsylvania	1.078	(**)	(**)	(**)
Sebago:				
Maine	1.079	(***)	(*)	(*)
Washington	1.095	(**)	(**)	(***)
Wisconsin	1.074	(***)	(**)	(*)
Triumph:				
Colorado	1.077	(**)	(*)	(*)
Nebraska	1.074	(***)	(*)	(*)
North Dakota	1.088	(**)	(**)	(**)
White Rose:				
California	1.082	(*)	(***)	(**)
Idaho	1.102	(**)	(***)	(***)
Washington		(*)	(***)	(**)

[1] Ratings of good***, fair**, poor* for boiled, hash-browned, and salad potatoes based on sloughing and form retention; ratings for mashed and baked potatoes based on mealiness.

Potatoes most desirable for serving boiled were those that showed a minimum of sloughing and disintegration when cooked. Of the 25 lots in the preliminary study, Chippewa from Maine and Michigan, Irish Cobbler from Maine, Katahdin from Maine and Pennsylvania, Russet Rural from Michigan, Sebago from Maine and Wisconsin, and Triumph from Nebraska ranked above the others in this characteristic. Potatoes which held their shape were desirable also for hash-browning and salad making, and the samples considered best for these two uses were the same as previously listed for boiling.

Potatoes ranking highest for mashing were those with a high degree of mealiness. Russet Burbank, White Rose, Green Mountain from Maine II and New York, and Irish Cobbler from Maine gave high quality in mashed potatoes. Sloughing and breaking up during cooking were objectionable from the standpoint of handling but in the family-sized portions used in experimental tests, these changes did not necessarily prevent obtaining a desirable mashed potato. Extreme disintegration, however, was conducive to soaking up water and consequent watery texture in some potatoes. Slight waxiness of texture was not objectionable but extreme pastiness present in some mashed samples always resulted in low scores.

Mealiness appeared to be the outstanding requirement for potatoes suitable for baking. Ranking highest for this quality were Russet Burbank, White Rose from Idaho, Green Mountain from New York, Irish Cobbler from Wisconsin, and Sebago from Washington.

The palatability tests of boiled, mashed, and baked potatoes yielded enough pertinent data to warrant their use in the intensive tests to be made in 1948 and 1949. The hash-browning and salad tests yielded so little additional information it was decided they would not be used in the 1948 and 1949 studies.

Extreme variation in palatability was frequently encountered among tubers making up each cooking sample. This was noticed particularly for the characteristics mealiness and dryness. Although an average specific gravity for the sample lot was obtained from a 50-tuber sample no selection of the individual tubers was made on the basis of specific gravity. As a result considerable variation occurred between the tubers within each cooking sample. In the continuing work, it was considered necessary to select cooking samples of known specific gravity. Also needed were adequate replication of tests, more precise judgments by training of the palatability panel, and evaluation of results by comprehensive statistical analysis in order to properly assess the suitability of various lots of potatoes for cooking in different ways.

SPECIFIC GRAVITY AND COMPOSITION

The average specific gravity for the different variety lots ranged from 1.062 for Katahdin from Pennsylvania to 1.105 for Russet Burbank from Washington. The variations among tubers within the individual variety lots showed the need for rigid selection and limitation of the range in specific gravity of the samples used for chemical analysis as well as for the cooking tests. Samples from a variety lot used for these two purposes should have as nearly as possible identical specific gravity.

Limited analysis of the 25 lots indicated considerable variation in the dry matter, alcohol insoluble solids, starch, and total sugar content. Correlation studies also indicated that some of these constituents were related to the palatability factors, sloughing and mealiness. The differences, particularly in samples of the same variety, in nitrogen content as measured by formol titration pointed toward the need for a more extensive investigation of several of the nitrogen constituents and their relationship to cooking quality.

Indication of relationships between some aspects of cooking quality and certain compositional factors pointed up the need for a more intensive study.

INTENSIVE STUDY, 1948 AND 1949 CROPS

The results of the preliminary study indicated the need for increasing the number of replications. This necessitated reducing the samples to 6 varieties and to 3 methods of cooking—boiling, mashing, and baking. A more rigid selection on the basis of specific gravity was carried out on the individual samples used for the cooking tests and chemical analyses. The analyses for the nitrogenous compounds were changed to include total and soluble or nonprotein nitrogen and amino nitrogen in the soluble fraction. The amount of juice that could be expressed from the chopped raw tissue was also determined. Palatability measurements by a panel of judges were the same as in preliminary work. Some additional information on cooking quality was obtained from data on differences in cooking time, weight changes during cooking, and blackening of the entire cooking sample.

Description and Storage of Samples

Six of the nine varieties of potatoes used in the preliminary study were chosen for further investigation. These six varieties represented more than 75 percent of the certified seed produced in this country in 1948–50. Two of these, Katahdin and Chippewa, are relatively new varieties. The other four, Irish Cobbler, Bliss Triumph, Russet Burbank, and Green Mountain are older varieties. The samples were obtained from States that normally produce more than two-thirds of the total late crop. Each variety, with the exception of one, was obtained from three different locations. The varieties and their locations were: Chippewa from Indiana, Maine, and Michigan; Green Mountain from two locations on different types of soil in Aroostook County, Maine (designated as I and II) and one from New York; Irish Cobbler from Maine, North Dakota, and Wisconsin; Katahdin from Colorado, Maine, and Pennsylvania; Russet Burbank from Washington and from irrigated and nonirrigated land in Idaho; and Triumph from two locations on different types of soil in North Dakota. All were U. S. No. 1 size A potatoes. Nearly all were harvested between late September and early November. Other data on soil types, fertilizers used, and preharvest treatment of vines are given in appendix table 24. After curing for 3 to 4 days to heal the digging injuries, approximately 500 pounds of each lot were shipped by rail express to the Plant Industry Station, Beltsville, Md.

Tubers selected for cooking samples were in general free from serious defects although some greening, scab, rot, cuts, cracks, and wireworm injury were unavoidably present. Feathering, characteristic of immaturity in potatoes, was prevalent in some lots in 1949. This characteristic was associated with the short growing season that year.

As each lot of potatoes was received at Beltsville, three replicated samples for each storage condition were selected for specific gravity determinations, chemical analyses, and cooking tests to be made at periodic intervals during storage. Tests were also made on unstored samples. Two storage temperatures, 40° and 55° F., were used for the various lots. Samples were removed from the lots stored at 40° F. after 3 months and again after 6 months. Samples were taken from the lots stored at 55° F. only after 3 months because of the shorter storage life of the potatoes at this temperature.

Experimental Procedures

PHYSICAL AND CHEMICAL ANALYSES

Specific gravity and sampling procedures.—Specific gravity of the tubers was determined as described in the preliminary study. It is recognized that in determining the average specific gravity by the salt-density method a sufficiently large sample should be measured to give a fair distribution picture of the entire lot. Haddock and Blood (*26*) found 50 to 100 tubers satisfactory for a reasonably accurate rating under uniform conditions. Clark, Lombard, and Whiteman (*10*) in a study relating mealiness to specific gravity measurement reported that 60 tubers yielded the same information as a larger sample of 120 tubers. In the study here reported, the average specific gravity of a 50-tuber sample and the distribution of the tubers in the different specific gravity classes were used as a guide in the selection of the samples.

Ten tubers of the same specific gravity characteristics as those used in the corresponding cooking tests were used in the samples for chemical analyses. The tubers were quartered from stem to bud end and one-fourth of each of the 10 tubers was macerated in a food chopper to form a homogeneous sample. The chopped sample was thoroughly mixed and aliquots were removed for dry matter and for juice determinations. The remainder of the chopped material was blended in a Waring Blendor for approximately 1½ minutes. Aliquots of this material were used for the analysis of total and soluble nitrogen fractions, sugars, alcohol insoluble solids, and starch.

Extracted juice.—The juice was determined by placing a 100-gram sample of the chopped material in a Carver press cylinder and applying a pressure of 2,000 pounds per square inch for 4 minutes. The juice was measured volumetrically and expressed as milliliters per 100 grams of tissue. The pH value of the juice was measured on a Ceneo Titration pH Meter using a glass electrode.

Dry matter.—Dry matter determinations were made by placing duplicate 35 to 40-gram samples in a convection type oven at 70° C. for 24 hours; then the drying was continued in a vacuum oven at the same temperature until a near constant weight was obtained.

Nitrogen.—The total nitrogen was determined on duplicate 5-gram samples of the blended material by the Kjeldahl-Gunning-Arnold Method (*3*). The determination of the nonprotein or soluble nitrogen fraction involved exhaustive extraction of the finely ground fresh pulp with 50 percent ethyl alcohol. The alcohol was evaporated on a steam bath and the aqueous solution was boiled for 1 minute with a few drops of colloidal iron then filtered through an asbestos pad in a small Buchner funnel. The nitrogen in the solution was determined on an aliquot by use of a Micro Kjeldahl apparatus. Amino nitrogen was determined on another aliquot of the same solution by the Van Slyke method (*3*).

Sugars.—Duplicate 20-gram samples of blended material were stored in 80 percent alcohol in Kohlrausch flasks for the sugar determinations. Reducing and total sugars were determined by the Quisumbing and Thomas procedure except in those samples which contained small quantities of sugars. In these samples, a modification (*32*) of the Shaffer-Somogyi method was used. Sucrose was estimated by difference between the reducing and total sugars.

Alcohol insoluble solids and starch.—Alcohol insoluble solids were determined by weighing the dried sugar-free residue from the samples used for sugar determinations. The residue was ground to pass an 80-mesh screen in a Wiley mill and 0.5-gram samples of this material were used for the starch determination. The samples were placed in 100 ml. beakers, 2 ml. of water were added and allowed to thoroughly wet the material, then 4.7 ml. of approximately 42 percent perchloric acid were added slowly with constant stirring. The solubilized starch was determined colorimetrically as described by Nielsen (*47*). Potato starch was used to establish standard curves.

COOKING PROCEDURES

Three methods of cooking potatoes—boiling (with or without skins), baking, and frying—are basic to numerous variations in cooking procedures used in recipes. Based on a survey made in 1936–38 Hotchkiss (*35*) stated that consumers in Rochester, N. Y., and Cleveland, Ohio, used three methods of cooking—mashing, boiling peeled, and baking—to prepare three-fourths of the potatoes bought. More recently results from a study made by the former Bureau of Human Nutrition and Home Economics (*64*) showed that of 261 families in 3 Northern cities who served potatoes at the main meal of the day, the percentage reporting various methods of preparation was as follows: Boiled 44, mashed 23, baked 14, fried 7, other 12. Boiling, mashing, and baking thus account for the use of the largest quantities of potatoes prepared in the home.

In addition to their frequency of use, boiling, mashing, and baking are the three methods which (except for french frying and potato chipping) furnish the most information on the cooking quality of potatoes. The studies of french frying and potato chipping are sufficiently varied and complex as to warrant independent investigations. In this study, therefore, the cooking methods of boiling, mashing, and baking of potatoes were selected for investigation of cooking quality.

Shape, size, and number of tubers in cooking sample.—The cooking samples to be used before and after designated storage intervals were selected promptly after each lot of potatoes was received and before they were put into storage. To provide for uniformity of cooking, tubers of similar size and shape were selected and the smallest diameter was measured with a suitable caliper, as described previously (*41*). Tubers with no more than 0.2 cm. difference in thickness were assembled to make up each cooking test sample. In general, smaller tubers were selected for boiling than for baking. Average measurements for thickness of boiling samples ranged from 4.3 to 5.5 cm. whereas the range in average thickness of baking samples was 5 to 6.5 cm. Varietal differences in size and shape gave corresponding variations in weight of cooking samples from the 17 lots. For example, a representative 6-tuber boiling sample of Triumph variety weighed 545 grams and a Chippewa sample weighed 560 grams before paring. Both varieties averaged 5 tubers to a pound. Representative cooking samples of larger tubers such as Katahdin and Russet Burbank varieties weighed 1,334 and 1,371 grams and approximated 2 tubers per pound.

Tubers to be used for cooking tests following storage were held

without washing until the end of each storage period as potatoes are commonly not washed until taken out of storage for retail sale. To avoid washing of tubers before storage, specific gravity separation was deferred until the end of each storage period just before their use in cooking. To make up each of the storage samples, 15 to 20 tubers of uniform shape, size, and thickness were assembled and put into mesh potato bags. The number 15 to 20, was arbitrarily chosen as large enough to furnish at least 6 tubers of desired average specific gravity at every storage period. Samples were stored to be used for boiling and baking after storage for approximately 3 and 6 months at 40°, and after 3 months at 55° F.

Specific gravity of cooking samples.—Reports in the literature (*26, 38, 41, 55*) have shown that variations exist in specific gravity and also in mealiness among individual tubers of any one lot. Thus, a randomly selected cooking sample might be extremely variable in specific gravity and each tuber comprising it might possess a different degree of mealiness. If such a sample were boiled or baked and sections of individual tubers were submitted to a taste panel for evaluation of quality it is entirely possible that each judge would receive a tuber varying in quality from other tubers making up the test sample. This would result in the judges assigning different scores to the product, indicating an apparent lack of agreement among judges. Such scores would require additional replication for the assessment of an individual judge's performance and the accurate evaluation of the product. It has been reported by Smith and coworkers (*38, 55*) that determining the average specific gravity of the lot, and then selecting experimental samples of potatoes each approximately of the specific gravity of the lot as a whole is necessary for accurate evaluation of texture quality. For the cooking tests on unstored samples, tubers previously selected for uniformity of shape and size were immersed in salt solutions of varying densities until 6 tubers were obtained that had the desired specific gravity. In 1948 the maximum variation between the selected 6-tuber samples from each variety-location lot was ± 0.010 of the average of all 6-tuber samples in the lot; in the 1949 tubers the maximum variation was ± 0.006.

Preparation of cooking samples.—Preliminary to making cooking tests at each storage period, the bags of 15 to 20 tubers, each representing one replicate for a single cooking method were removed from storage and all tubers were washed and separated according to specific gravity. Cooking samples for each test, 6 tubers for boiling or 6 for baking, were selected and returned to storage until 20 hours before cooking. The 6 samples for each day's cooking tests were selected at random out of the 17 lots of potatoes. They were then removed to the laboratory to allow the tubers to warm up to uniform temperature approximating that of the room, 70 to 80° F.

A schedule was set up for the cooking tests covering each storage period to include different cooking methods, storage times, and temperatures, and replications for each test. Palatability samples for the mashed potatoes were subsampled from the boiled sample and both the boiled and mashed samples were scored for palatability at one judging session. Baked samples were prepared and judged on other days.

All tubers were washed, wiped dry, and weighed before cooking. Those to be boiled were pared in a mechanical abrasive peeler (*40*),

hand trimmed, washed, dried, weighed, covered with dampened cheesecloth, and held for the shortest time possible until cooking was started.

Control of heat input.—A battery of electrical units of identical wattage was installed so that the six samples for each day's tests could be cooked simultaneously. Uniformity of heat input was controlled by a voltage regulator. Units were tested periodically with a wattmeter to check their performance and uniformity. Suitable settings for the heat controls were established in preliminary trials, and routinely followed in day-by-day tests.

Cooking equipment—Covered enameledware saucepots of 3½-quart capacity were used for boiling the potatoes and enameledware colanders for draining them when done. Residual cooking liquid was measured in cylinders of 1,000 ml. capacity.

For the baking tests, two small gas range ovens were used instead of the electric Despatch oven used in the preliminary study.

Heat penetration measurement.—In early food research studies one of the controls most sought was standardization of the end point of cooking or the doneness of the product. In cooking of potatoes, for example, piercing cooked tubers with a fork or skewer to determine ease of penetration and thus relative doneness was one of the first methods employed. This method is purely subjective since it depends upon the judgment of the worker. If characteristic texture differences occur among samples the piercing method may not truthfully indicate the same degree of doneness from sample to sample. Or if more than one worker makes the laboratory tests, variation in judgments may occur.

As early as 1917 Langworthy discussed the relationship between internal temperature and doneness of potatoes. He reported (*48*) that doneness was obtained in the interior of potatoes at a temperature of 212° F. when boiled or baked. At that time thermocouples with potentiometers registering in millivolts were used for obtaining internal temperature of food. E. m. f. readings in millivolts were converted to temperatures. The use of this instrument marked a beginning in scientific control of experimental procedure but was laborious and subject to error.

Thermometers have also been used for obtaining internal temperatures in foods. Numerous difficulties have been encountered however, hence their use has been limited. Thermometer readings are also subject to error, because of the difficulty in obtaining the readings.

There are now available automatic time-temperature recording instruments made suitable for any temperature range desired. By means of thermocouples connected to these instruments and inserted into the food, internal temperatures are recorded automatically on a chart from which they may be quickly read. These instruments are valuable aids in removing the subjective element in measuring heat penetration in cooking tests.

In this study, iron-constantan thermocouples attached to an electronic recording potentiometer were employed to obtain and record the internal temperatures of one tuber in each potato sample during boiling and baking. By making a loop of the iron and constantan wires at the thermocouple junction, it was possible to thread an additional thin wire through the loop and also through the eye of a heavy

steel needle especially made for this use. By means of the needle the thermocouple wire and junction were pulled into the center of the tuber (fig. 2). The thin wire was then wound around the circumference of the tuber and secured to the thermocouple wire to hold the junction in place. Potatoes were cooked to a specific internal

FIGURE 2.—A thermocouple is threaded into the center of a potato tuber to measure internal temperature for the end point of cooking.

temperature to indicate the end point of the cooking process. Additional thermocouples recorded water temperatures inside each cooking pot and air temperatures of the laboratory. To record oven temperatures for the baking process thermocouples were also attached to the racks of two identical ovens.

Boiling and baking methods.—Potato tubers for boiling were cooked whole to control uniformity of cooking sample, to allow use of internal temperature measurements in determining doneness, and to obtain data on the sloughing of whole potatoes.

Pared whole tubers were cooked in a sufficient amount of boiling water to prevent cooking dry. The size and shape of tubers, though selected for uniformity within each 6-tuber cooking sample, differed considerably among all the lots. Because of this difference in size some variation was necessary in the amount of water used with different samples. Tubers were grouped according to diameter measurements as shown below and the corresponding amounts of water for cooking were arbitrarily established.

Diameter of tubers	*Volume of water*
cm.	*ml.*
5.0–5.49	800
5.5–5.99	900
6.0 and above	1000

Standardized procedures for boiling tests were routinely followed. All burners were preheated 5 minutes on "high" heat (1,600 watts). Covered saucepots, coded and containing the necessary amounts of water for the samples were then put on burners at "high" heat to bring the water to boiling temperature. When this temperature was reached in each cooking pot as indicated on the potentiometer chart, the appropriate potato sample was put into the saucepot and the lid replaced. "High" heat was continued until the water returned to the boil, again indicated by the potentiometer, then the control was turned to "fast" (800 watts) for the remainder of the boiling time.

Cooking time was counted from the time boiling was resumed after raw potatoes were added to the cooking pot until the end point of 96° C. (205° F.) was reached in the interior of the potato tuber containing the thermocouple. This is the internal temperature reported by Wright, Peacock, Whiteman, and Whiteman (*72*) as that at which boiled or steamed potatoes were considered done.

The boiled potatoes were removed from the heat, drained 1 minute in enameledware colanders lined with dampened cheesecloth, and weighed. The use of cheesecloth speeded up the transfer of potato samples and prevented loss of sloughed-off portions through the colander. For accuracy in weighing, each piece of cheesecloth was tagged with its own wet weight. Drained liquid was measured in milliliters in Pyrex cylinders.

Baking was carried on in two identical ovens preheated to 218° C. (425° F.). The capacity of the 2 ovens was sufficient for baking only 4 lots of 6 tubers each simultaneously. From preliminary tests, approximate baking times were determined for various sizes of each sample lot. Tubers were put into the oven at such a time that end point temperatures in all samples cooked the same day, were reached at approximately the same time. Each sample lot was removed from the oven when an internal temperature of 98° C. (208° F.) was reached within the tuber containing the thermocouple.

Before the cooked potatoes were prepared for the judging panel preliminary evaluations for sloughing and blackening of the entire 6-tuber sample were made in the laboratory. The additional information thus obtained was compared with the judges' scores.

EVALUATION OF PALATABILITY

Preparation of samples for palatability evaluation.—Drained, boiled tubers except the one containing the thermocouple were cut in lengthwise quarters with half of the quarters used for scoring as boiled potato, and half reserved for mashing. Six quarters from each boiled sample were placed in a coded white dish and the six dishes were placed in a specially constructed viewing cabinet equipped with artificial-daylight lamps for visual scoring of sloughing and color (fig. 3) by six judges. The cabinet provided uniform lighting of all samples. After the judges had finished the scoring for color and sloughing each judge selected one quarter at random from each dish for judging the other characteristics. In this and subsequent tests the heated serving dishes were coded to identify the samples.

FIGURE 3. Sloughing and color of boiled potatoes are scored by each judge under daylight lamps.

While the judging of boiled samples was in progress, portions of tubers from each sample reserved for mashing were put through a ricer into a heated bowl, then stirred 30 strokes with a table fork. Six judging samples were measured with a No. 30 scoop into white porcelain dishes. Judges scored mashed samples after boiled samples were completed. Judges stated that they experienced no

difficulty in scoring a total of 12 samples (6 boiled and 6 mashed) at these judging sessions.

Baked tubers to be judged for palatability were cut in half lengthwise and one-half tuber from each sample was given a code number on a tray. Four samples were judged at each judging session.

Quality characteristics rated.—Boiled potatoes were evaluated for the quality characteristics of color, dryness, mealiness, flavor, and absence of sloughing. Except for absence of sloughing, mashed and baked potatoes were scored for these same characteristics. Evaluation was made for color and for sloughing or disintegration or both by visual means; texture by appearance and by feel in mouth, on tongue or palate; and flavor quality by tasting.

Deviations from the creamy white color, established as the standard for cooked potatoes, indicated a decrease in quality and showed up as slightly yellow or gray increasing to intense yellow or gray. As development of both yellow and gray color may occur in the same tubers, and both contribute to off-color, the judges scores reflected a composite of these two factors of color deterioration. No attempt was made to assess the reasons for off-color but the sample lots that were more or less susceptible to discoloration were noted.

Sloughing of the cortical layer and breaking or disintegration of the tubers during boiling have been frequently reported as undesirable characteristics in boiled potatoes (*9, 14, 70*). Sloughing, a component of texture as is mealiness, was rated as an independent characteristic. As scores for increasing amount of sloughing progress in the opposite direction from scores for increasing mealiness, judging these two characteristics independently gives more information than if they are combined as texture. Standards by which potatoes were rated for sloughing are shown in figure 4.

Since potatoes are biological materials subject to continual metabolic changes, no way has been devised to furnish a standard reference sample for use in scoring taste and texture characteristics. For color and sloughing, however, reference samples of whole cooked potatoes which illustrated 3, 2, and 1 scores on sloughing and color rating scales were reproduced in wax by a skilled artist employed for the purpose. The models were available to the judges for frequent use as standard reference samples.

Dryness scores recorded that characteristic of cooked potatoes which varied from dry and powdery to wet and soggy. In some cooked potatoes dryness or wetness was due only to the initial moisture content of the potato and varied according to its composition. In potatoes that absorbed water in cooking, the palatability score for dryness necessarily represented a combination of initial moisture plus that which was absorbed.

Mealiness in potatoes has been described by Sweetman (*59*) as "disintegration into a loose mass of glistening particles when cooked potatoes are riced or mashed." Furthermore, "waxiness is that tendency to form pasty sheets or cohering masses which are translucent but do not glisten." According to Wood (*70*), granularity of texture is also a factor in mealiness. In the evaluation of mealiness, the palatability panel noted the translucency and glistening qualities of cooked potatoes as well as waxiness, pastiness, and granularity of texture.

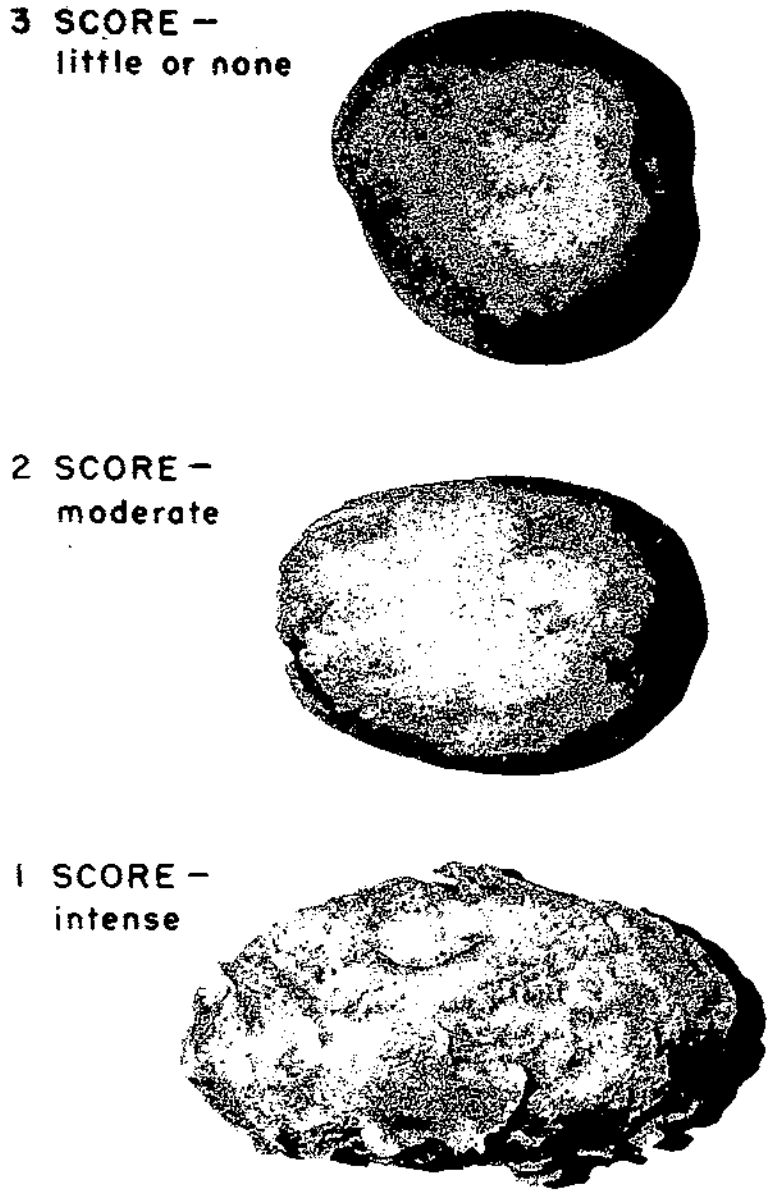


FIGURE 4. Standards for numerical scoring of sloughing in boiled potatoes.

A mild, natural potato flavor was considered evidence of high quality in cooked potatoes. Off-flavors described as earthy, nutty, musty, metallic, bitter, and sweet indicated a decrease in flavor quality and were noted and identified by the judges.

Judging records. Separate judging records were used for each type

of cooked product. A 3-point scale was used and descriptive terms were assigned to each numerical value. Judging records were essentially the same as those used in a study previously reported (*41*).

Training of judges.—Members of the judging panel who scored samples in the preliminary tests during the 1947–48 season learned through experience to detect variations in cooked potatoes. To further refine judging techniques before the palatability testing of the 1948 crop of potatoes, a training period was carried out at the conclusion of the preliminary work.

Potatoes for training samples were of the same varieties and locations as those used in the preliminary study. Quality factors considered in training were sloughing, color, dryness, and mealiness for boiled potatoes, and color, dryness, and mealiness for mashed and baked potatoes. Cooked potato samples representing 3, 2, 1 scores on the rating scale for each quality factor were presented insofar as potatoes to furnish them were available.

Each quality factor was studied independently during the training period. For example, to introduce the scoring for sloughing, standard samples representing scores of 3—no sloughing, 2—moderate sloughing, and 1—intense sloughing, were prepared and shown to the judges. This judging session was for the purpose of acquainting judges with variations in score, range in each score as well as for discussion and interpretation of descriptive terms for each score. On other days the factors color, dryness, mealiness, and flavor were studied in a similar way. Tests were continued 2 additional days for each quality factor, at which time coded samples were presented to the panel and judged with no preliminary discussion.

Tabulations were made of correct scores and errors to show each individual judge's performance throughout the training. To check scores of an individual judge for consistency, duplicate tests were employed on several successive days. Each individual judge's performance was also compared with that of the group. The six best judges were selected as regular members for the panel, others were asked to serve as alternates. Brief discussion periods were held with individual judges to allow each panel member to check his performance and compare his scores with those of the group. This was considered a prime factor in maintaining valid and consistent scoring as well as holding the interest of panel members.

STATISTICAL TREATMENT OF THE DATA

Analysis of variance was applied to the palatability scores obtained from studies made in 1948–49 and 1949–50. The data, consisting of three replicate sets of scores, were treated as in a factorial experiment, specifically, a split-plot design. The nature of the material influenced the method of analysis. Observed variation among scores for the same variety from different locations led to an analysis by variety-location, rather than by variety as distinct from location.

In both years, 17 variety-location lots, replicated 3 times were treated as "whole-plot" effects. The judges' scores and judge interactions with variety-location and replication constituted the "subplot" analysis. The 6 varieties could not be dissociated from the 10 locations in which they were grown. Furthermore, in 2 of

the growth areas soils differed in texture and in another location tubers came from irrigated and nonirrigated land.

The mean scores were differentiated by Tukey's method (*62*) of separating means, which consists of a combination of gap, extreme deviate, and variance tests. By this method, scores were partitioned into distinguishable groups, which varied in number in the different tests but were arbitrarily limited to 3 groups for convenience of discussion.

The 3 cooking methods were analyzed separately each year. Within a cooking method, scores for the 17 variety-location categories were compared with respect to palatability factors by individual storage periods. In addition, all storage periods were combined in one analysis for each palatability factor within a cooking method and differences among the variety-location means as well as among the storage means were investigated.

Relationships between palatability factors and chemical findings were studied by correlation analysis.

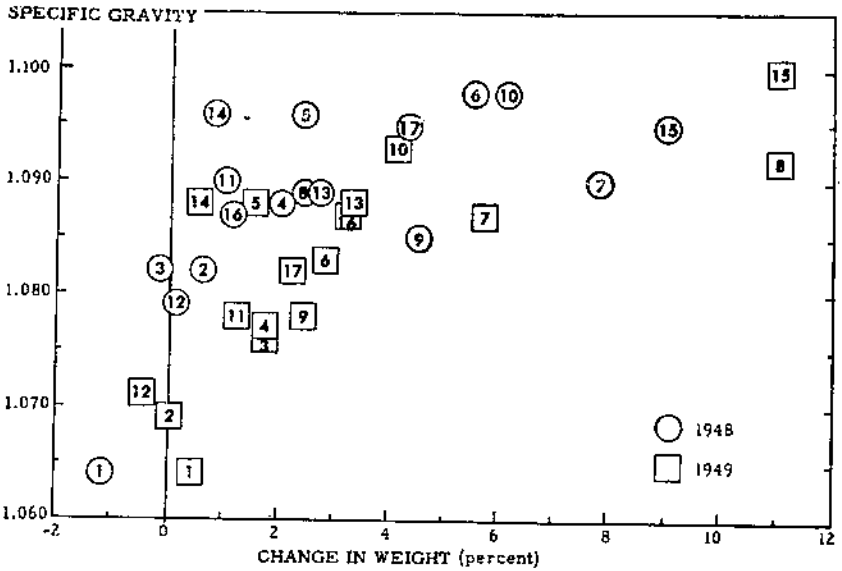
Results and Discussion of Intensive Study

COOKING QUALITY

Cooking time and weight changes.—Cooking time for boiled samples varied from 20 minutes for those composed of small tubers to 35 or 45 minutes for those made up of large tubers. For baked samples the cooking time varied from 40 to 60 minutes.

A significant relationship existed between the boiling times and the weights of raw pared potato samples of 5 varieties of potatoes (Chippewa, Irish Cobbler, Katahdin, Russet Burbank, and Triumph) as indicated by regression coefficients individually calculated. The sixth variety, Green Mountain, did not show a relationship. For this variety, possibly shape or composition of the tubers was more closely related to cooking time than their weight. In previous studies reported by Cobb (*11*), although varieties were not specified, shape was considered more important than weight in determining cooking time. In this study variations in rates of increase in cooking time reflect varietal differences in size and shape as well as weights of the samples. For each 100-gram increase in weight of cooking sample above the average sample weights for each variety, the cooking time increased as follows: 4 minutes for Triumph and Katahdin varieties; 3 minutes for Irish Cobbler; 2 minutes for Chippewa and Russet Burbank varieties.

A general tendency for potato tubers to absorb water during the boiling process was shown by gain in weight of cooked potatoes. In the majority of cases the potatoes gained weight ranging from 0.05 to 11.0 percent although in a few instances loss of weight occurred. Actual loss in weight was shown for Indiana and Michigan Chippewas (1.2 and 0.2 percent, respectively) in 1948 and Pennsylvania Katahdin (0.5 percent) in 1949. Gain or loss of weight during boiling plotted against specific gravity (fig. 5) showed a tendency for the water absorbed in cooking to increase as the specific gravity of the tubers increased. That this is not always true was illustrated by Russet Burbank from Ashton, Idaho, which in both years had high specific gravity yet showed a gain in weight of less than 1 percent.



CHIPPEWA:
1. Indiana.
2. Maine.
3. Michigan.

GREEN MOUNTAIN:
4. Maine I.
5. Maine II.
6. New York.

IRISH COBBLER:
7. Maine.
8. North Dakota.
9. Wisconsin.

KATAHDIN:
10. Colorado.
11. Maine.
12. Pennsylvania.

RUSSET BURBANK:
13. Idaho (Aberdeen).
14. Idaho (Ashton).
15. Washington.

TRIUMPH:
16. North Dakota (Grand Forks).
17. North Dakota (Walhalla).

FIGURE 5.—Gain or loss in weight of potatoes during boiling as related to specific gravity.

Sample lots from the same location but in different years also showed variation in gain in weight during boiling. This is illustrated by North Dakota Irish Cobblers. In both 1948 and 1949 these potatoes had high specific gravity, 1.089 and 1.092, respectively. In 1948 the gain in weight was 2.4 percent compared with 11 percent in 1949. This would indicate that some factor other than specific gravity influences the absorption of water by the tubers during boiling.

Tubers that absorbed largest amounts of water in boiling sloughed badly and in some cases were reported by the judges to be water-soaked. The relationship of percentage gain in weight and scores for sloughing in boiled potatoes was studied in 17 sample lots. Coefficients of correlation were computed from data obtained each year before storage and after 3 and 6 months' storage of the potatoes at 40° F. Highly significant correlations were obtained between percentage gain in weight and scores for absence of sloughing at each storage period: −0.782, −0.760, and −0.843 for 0, 3, and 6 months' storage, respectively. The correlations are negative since sloughing scores decreased as percentage gain in weight increased. The 3 correlation coefficients were not significantly different from each other, which indicates no significant change in relationship during storage.

318987°—55——4

TABLE 2.—*Relative amount of blackening*[1] *occurring in potatoes after boiling, for 6 varieties from different locations, by storage periods, 1948 and 1949*

Variety and location	Harvest, no storage						3 mo. storage 55° F.						3 mo. storage 40° F.						6 mo. storage 40° F.					
	1948 Replication			1949 Replication			1948 Replication			1949 Replication			1948 Replication			1949 Replication			1948 Replication			1949 Replication		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Chippewa:																								
Indiana	----	(*)	----	----	----	----	----	----	----	----	(*)	----	----	----	----	----	----	----	----	----	----	----	----	----
Maine	----	(*)	----	----	----	----	----	----	----	(*)	(*)	----	----	----	----	----	----	----	----	----	----	----	----	----
Michigan	----	----	----	----	----	----	----	----	----	(*)	(**)	(*)	----	----	----	----	(*)	----	----	----	----	(**)	(**)	(*)
Green Mountain:																								
Maine, I	(*)	----	(*)	----	----	----	----	(*)	----	(**)	(*)	(*)	----	----	----	----	(**)	----	(**)	(***)	(***)	----	----	----
Maine, II	(*)	(*)	(*)	----	----	----	----	----	----	(*)	(*)	----	----	----	----	----	----	----	(**)	(**)	(**)	----	(*)	(*)
New York	(**)	(**)	(**)	(*)	----	----	----	(**)	(**)	(*)	(*)	(***)	(**)	(**)	(***)	(**)	(*)	----	(***)	(**)	(***)	(**)	(**)	(**)
Irish Cobbler:																								
Maine	----	----	----	----	----	----	----	----	----	(*)	(*)	(*)	----	----	----	(*)	----	----	----	(**)	----	(*)	(**)	(***)
North Dakota	----	----	----	----	----	(*)	----	----	----	(*)	(*)	(*)	(*)	(*)	----	(**)	----	(*)	----	(**)	(**)	(*)	(*)	(*)
Wisconsin	----	----	----	----	(*)	----	----	----	----	(**)	(**)	(***)	----	----	(*)	(***)	(**)	(***)	----	----	(**)	(**)	(**)	(***)
Katahdin:																								
Colorado	----	----	----	----	----	(*)	(**)	----	(**)	(***)	(***)	(***)	----	(**)	(***)	(*)	(*)	(*)	(***)	(**)	----	(**)	(*)	(***)
Maine	(**)	(**)	(*)	----	(*)	(*)	(***)	(***)	(**)	(*)	(**)	(***)	----	(*)	(**)	(*)	(*)	(*)	(***)	----	(**)	(*)	(*)	(***)
Pennsylvania	(*)	----	----	----	----	----	(***)	(**)	(***)	(**)	(*)	(***)	----	----	(***)	(*)	(*)	----	----	(***)	----	(**)	----	(**)
Russet Burbank:																								
Idaho, Aberdeen	----	(*)	(*)	----	----	(*)	----	(**)	----	(**)	----	(*)	(**)	----	----	(*)	(*)	----	(**)	(**)	(**)	(*)	(*)	(**)
Idaho, Ashton	----	----	----	----	----	----	----	----	----	(*)	(*)	----	----	----	----	----	----	----	----	----	----	----	----	----
Washington	----	----	----	----	----	----	----	----	----	(*)	----	(*)	(*)	----	----	----	(*)	(*)	(*)	----	----	(*)	(**)	(**)
Triumph:																								
North Dakota, Grand Forks	(*)	(*)	(*)	----	----	----	----	(**)	----	(*)	(*)	(*)	----	(*)	----	(*)	----	(**)	(*)	(*)	(*)	----	(*)	(**)
North Dakota, Walhalla	(*)	----	----	----	(*)	----	----	----	----	(*)	(*)	(*)	----	----	----	----	(*)	(*)	----	----	----	----	(*)	(**)

[1] Asterisks indicate samples in which blackening occurred. *Slight blackening, **Moderate blackening. ***Extreme blackening.

Discoloration of boiled tubers.—Upon examination of whole boiled potatoes in the laboratory immediately after cooking, blackening of tubers was found to occur more frequently than any other type of discoloration. Degree of blackening was recorded as slight, moderate, or extreme. No attempt was made to differentiate types of blackening due to different causes. As shown in table 2, blackening occurred more frequently and to a greater degree in Green Mountain, Irish Cobbler, and Katahdin than in the other varieties. In some cases blackening was more intense following the long storage period. Katahdin variety was an exception, showing a higher amount of blackening in tubers cooked after 3 months' storage at 55° F. than those cooked after 6 months' storage at 40° F. In general, in the stored sample blackening was more widespread in the 1949 than in the 1948 crops. Some lots of cooked potatoes were almost entirely free of blackening, showing no more than a slight amount at any cooking period.

The conditions causing blackening are not fully understood. The influence of hydrogen ion concentration has been considered by a number of investigators. Smith, Nash, and Dittman (*56*) and Juul (*37*) have noted an increase in blackening with an increase in pH values, also that higher pH values were usually found in the stem end of the potato where the most blackening occurs. Bandemer, Schaible, and Wheeler (*5*), however, reported the opposite trend, that blackening increased as the pH decreased.

In this study, correlation coefficients were computed for the pH values of the juice of raw potatoes and the blackening scores of the boiled samples. The coefficients for all varieties both years combined for each of the storage periods are as follows: No storage, +0.398, 3 months at 55° F., +0.324, 3 months at 40° F., +0.618, and for 6 months at 40° F. +0.360. Only the lots stored at 40° F. for 3 months showed a statistically significant correlation. However, all coefficients are positive indicating an increase in blackening with an increase in pH values. When the three varieties showing the greatest amount of blackening are considered separately the coefficients of correlation between pH values and blackening are statistically significant for Green Mountain (+0.496) and Irish Cobbler (+0.507) but not for Katahdin (—0.061). These data indicate that pH may have more influence on the blackening reaction in some varieties than in others. Since the coefficients are relatively low it is evident that factors other than hydrogen ion concentration are involved in the blackening reaction.

PALATABILITY OF ALL SAMPLE LOTS

When treated by analysis of variance, judges' mean scores for the palatability factors color, mealiness, and flavor in boiled, mashed, and baked potatoes for each crop year 1948 and 1949 (tables 25, 26, and 27, appendix) showed highly significant differences among the 17 variety-location lots for the different storage conditions of time and temperature. Scores for absence of sloughing in boiled potatoes were significantly different at a lower level. Scores for dryness also showed highly significant differences among the 17 lots each year and for the different storage conditions in 1949. Significant differences in scores for dryness were not found for storage conditions in 1948.

Differences in judges' scores for dryness, mealiness, and absence of

sloughing were highly significant among the 17 variety-location lots each year for each of the storage conditions. Differences for color also were highly significant except for potatoes stored at 55° F. and prepared as boiled and baked products. Differences in flavor were not consistently significant for the various storage conditions.

Potatoes of these 17 sample lots showed considerable variation in palatability. For potatoes of any given lot, however, there was little difference in the quality of the cooked product, whatever the cooking method employed. This was especially true for the taste characteristics of dryness, mealiness, and flavor. A potato which made a dry, mealy baked potato of good flavor, also made high-quality boiled and mashed potatoes. In regard to color, however, greater differences resulted from the methods of cooking. Boiled potatoes consistently had poorer color than mashed or baked. Although some discoloration was noted throughout the flesh of the potato, frequently the discolored areas were greatest on the outside of the boiled potato. This was likely responsible for the lower scores given to the boiled potatoes. Since boiled and mashed samples were from the same cooking sample, the ricing and blending of the mashed potatoes apparently improved their color.

Mean palatability scores for the different variety-location lots (tables 3, 4, 5, 6, and 7) were separated at the 5-percent level of significance by the method of Tukey (*62*). For purpose of discussion, the means were further separated into those that are significantly high, those that are significantly low, and the remaining intermediate group.

Sloughing.– Sloughing, an appearance characteristic, was pertinent only in the judging of boiled potatoes. Since sloughing is considered undesirable, potatoes which sloughed most received lowest scores. These lots frequently scored highest in mealiness. By obtaining separate scores for sloughing and mealiness the data for these two aspects of texture quality were kept independent so that each could be correlated with compositional factors.

Potatoes showing little or no sloughing were scored 3 (high score) on a 3-point scale. In both years boiled potatoes which sloughed least (receiving highest scores) were the samples of Chippewa from all three locations and the Katahdin from Maine and Pennsylvania (table 3). In addition, in 1948 the Triumph potatoes from Grand Forks, N. Dak., and Green Mountain from Maine I, also sloughed very little and thus received high scores for that quality characteristic. In both years most sloughing occurred in Russet Burbank potatoes from Washington. In 1949, intense sloughing in boiled potatoes also occurred in the Irish Cobbler variety from North Dakota as shown by a score of 1.3. Potatoes that received low scores for sloughing were of high specific gravity and in general potatoes with high scores were of lower specific gravity. Russet Burbank potatoes from Ashton, Idaho, were an exception to this relationship. Although in both years, the lots from Ashton were as high or higher in specific gravity as the lots from Aberdeen, sloughing was much less pronounced in the Ashton lots. This result agrees with the statement made by Sweetman (*59*) that it is possible to combine mealiness and high starch content with only a small tendency to slough.

Laboratory records reporting sloughing of the entire 6-tuber samples as observed before the sample was divided for the judges

TABLE 3.—*Sloughing of boiled potatoes: Mean scores for six varieties of known specific gravity from different locations, all storage periods combined, 1948 and 1949*

Variety and location	Specific gravity		Mean scores [1] for absence of sloughing	
	1948	1949	1948	1949
Chippewa:				
Indiana	1.064	1.064	[2] 2.9	[2] 2.8
Maine	1.082	1.069	[2] 2.7	[2] 2.8
Michigan	1.082	1.076	[2] 2.7	[2] 2.4
Green Mountain:				
Maine, I	1.088	1.077	[2] 2.5	2.3
Maine, II	1.096	1.088	2.1	1.9
New York	1.098	1.083	1.7	2.0
Irish Cobbler:				
Maine	1.090	1.087	1.9	1.6
North Dakota	1.089	1.092	2.1	[3] 1.3
Wisconsin	1.085	1.078	1.9	2.1
Katahdin:				
Colorado	1.098	1.093	1.9	1.6
Maine	1.090	1.078	[2] 2.6	[2] 2.7
Pennsylvania	1.079	1.071	[2] 2.6	[2] 2.5
Russet Burbank:				
Idaho, Aberdeen	1.089	1.088	1.8	1.9
Idaho, Ashton	1.096	1.088	2.4	2.2
Washington	1.095	1.100	[3] 1.3	[3] 1.0
Triumph:				
North Dakota, Grand Forks	1.087	1.087	[2] 2.8	1.8
North Dakota, Walhalla	1.095	1.082	2.0	2.1

[1] Mean of 72 values (3 replicates scored by 6 judges, 4 storage conditions); a score of 3 represents the highest score, 1 the lowest.
[2] Significantly higher than other scores at the 5-percent level.
[3] Significantly lower than other scores at the 5-percent level.

compared closely and consistently with the averages for absence of sloughing of all judges' scores.

Color.—In 1948, as shown in table 4, when all storage periods were considered together, the Triumph variety from Grand Forks, N. Dak., most nearly approached creamy white color in boiled potatoes as shown by a score of 2.5, which was significantly higher than the scores for other variety samples. Poorest in color, that year, with significantly lower scores than the others, were the three samples of Green Mountain variety, Irish Cobbler from North Dakota and Maine, the three samples of Katahdin, and Russet Burbank from Ashton, Idaho. In 1949 the color scores for most of the boiled potatoes were considerably lower than those for the preceding year. Chippewa potatoes from Maine and Indiana, Green Mountain from Maine I, and Russet Burbank from Aberdeen, Idaho, had significantly better color than any of the other sample lots although the scores were in the medium of the range at 2.1 and 2.0. Poorest in color in 1949 were the three samples of Irish Cobbler, Russet Burbank from Ashton, Idaho, Katahdin from Colorado, and Green Mountain from New York, which had scores significantly lower than the other sample lots.

TABLE 4.—*Color of cooked potatoes: Mean scores[1] for six varieties from different locations, all storage periods combined, 1948 and 1949*

Variety and location	Boiled		Mashed		Baked	
	1948	1949	1948	1949	1948	1949
Chippewa:						
Indiana	2.4	[2] 2.1	2.1	2.1	[3] 1.8	[3] 1.9
Maine	2.3	[2] 2.1	2.5	2.0	[2] 2.4	2.2
Michigan	2.4	1.9	2.3	2.2	2.2	2.2
Green Mountain:						
Maine, I	[3] 1.7	[2] 2.0	2.1	2.2	2.1	[2] 2.3
Maine, II	[3] 1.7	1.9	2.2	2.1	2.2	2.1
New York	[3] 1.6	[3] 1.5	2.1	[3] 1.8	[3] 1.8	1.7
Irish Cobbler:						
Maine	[3] 1.9	[3] 1.4	2.4	[3] 1.8	2.3	[3] 1.9
North Dakota	[3] 1.7	[3] 1.5	2.1	2.0	2.1	[2] 2.3
Wisconsin	2.0	[3] 1.5	2.4	2.0	2.1	2.1
Katahdin:						
Colorado	[3] 1.9	[3] 1.5	2.3	2.0	2.2	2.0
Maine	[3] 1.7	1.8	2.1	2.1	2.2	2.2
Pennsylvania	1.7	1.7	[3] 1.8	[3] 1.8	2.0	2.1
Russet Burbank:						
Idaho, Aberdeen	2.2	[2] 2.0	[2] 2.8	[2] 2.7	[2] 2.5	[2] 2.4
Idaho, Ashton	[3] 1.8	[3] 1.4	2.3	2.2	2.3	2.2
Washington	2.2	1.8	[2] 2.8	[2] 2.4	[2] 2.6	[2] 2.4
Triumph:						
North Dakota, Grand Forks	[2] 2.5	1.7	2.4	2.0	2.2	2.2
North Dakota, Walhalla	2.2	1.8	2.4	2.0	2.1	2.0

[1] Mean of 72 values (3 replicates scored by 6 judges, 4 storage conditions); a score of 3 represents the highest score, 1 the lowest.
[2] Significantly higher than other scores at the 5-percent level.
[3] Significantly lower than other scores at the 5-percent level.

When the boiled samples were mashed, higher color scores were recorded for many samples than when portions of the same sample were judged as boiled potatoes. The mixing of the discolored areas, which occurred largely on the outside of the tubers, with the white inner portions may have minimized the off-color. Among the mashed samples, Russet Burbank from Aberdeen, Idaho, and from Washington were significantly better in color both years than the other samples. The Katahdin samples from Pennsylvania were significantly poorest in color each year although in 1949, Irish Cobbler from Maine and Green Mountain from New York were also in the group that received significantly lower scores than the remaining mashed samples that year.

Baked potatoes receiving significantly highest scores for color were Russet Burbank from Aberdeen, Idaho, and Washington in both years, Chippewa from Maine in 1948, Green Mountain from Maine I, and Irish Cobbler from North Dakota in 1949. Chippewa from Indiana and Green Mountain from New York each year and the Irish Cobbler sample from Maine in 1949 received significantly lowest scores for baked potatoes.

Dryness.—Russet Burbank potatoes were consistently dry (not moist or soggy) when cooked by all three methods each year. This variety was in the highest scoring group with two exceptions, the sample from Ashton, Idaho, in 1949 when boiled and baked (table 5). Other lots that gave a dry boiled potato and placed in the significantly high group were Irish Cobbler from North Dakota each year, and Green Mountain from Maine II and New York, and Katahdin from Colorado in 1948. Samples of Chippewa from Indiana were wet and soggy when cooked by all three methods and scored significantly lowest for dryness each year. Others in the group receiving significantly lowest scores for dryness were Chippewa from Michigan and Triumph from Grand Forks, N. Dak., of the 1948 lots and Chippewa from Maine and Katahdin from Pennsylvania of the 1949 lots.

TABLE 5.—*Dryness of cooked potatoes: Mean scores*[1] *for six varieties from different locations, all storage periods combined, 1948 and 1949*

Variety and location	Boiled		Mashed		Baked	
	1948	1949	1948	1949	1948	1949
Chippewa:						
Indiana	[3] 1.3	[3] 1.5	[3] 1.1	[3] 1.4	[3] 1.2	[3] 1.2
Maine	2.0	[3] 1.6	1.9	[3] 1.5	1.8	[3] 1.4
Michigan	[3] 1.9	1.8	1.9	1.9	1.8	1.7
Green Mountain:						
Maine, I	2.1	1.9	2.0	[3] 1.6	2.0	1.9
Maine, II	[2] 2.5	2.2	[2] 2.6	2.1	2.4	2.4
New York	[2] 2.5	1.9	[2] 2.8	2.0	[2] 2.6	2.0
Irish Cobbler:						
Maine	2.2	2.2	2.2	2.1	[2] 2.5	2.4
North Dakota	[2] 2.4	[2] 2.4	[2] 2.5	2.1	2.3	[2] 2.7
Wisconsin	2.2	2.2	2.2	2.1	2.1	2.3
Katahdin:						
Colorado	[2] 2.4	2.3	[2] 2.8	[2] 2.7	2.4	2.2
Maine	2.2	2.0	2.4	2.1	2.1	2.0
Pennsylvania	2.0	[3] 1.7	2.2	1.8	1.8	[3] 1.4
Russet Burbank:						
Idaho, Aberdeen	[2] 2.5	[2] 2.5	[2] 2.8	[2] 2.8	[2] 2.6	[2] 2.7
Idaho, Ashton	[2] 2.4	2.3	[2] 2.7	[2] 2.7	[2] 2.6	2.4
Washington	[2] 2.6	[2] 2.8	[2] 2.6	[2] 2.7	[2] 2.8	[2] 2.9
Triumph:						
North Dakota, Grand Forks	[3] 1.9	2.0	1.9	2.0	1.7	1.9
North Dakota, Walhalla	2.3	1.9	[2] 2.6	2.1	2.1	1.8

[1] Mean of 72 values (3 replicates scored by 6 judges, 4 storage conditions); a score of 3 represents the highest score, 1 the lowest.
[2] Significantly higher than other scores at the 5-percent level.
[3] Significantly lower than other scores at the 5-percent level.

In the mashed samples, in addition to all of the Russet Burbank lots the Katahdin from Colorado received significantly highest score for dryness each year. Also in 1948 in the group receiving significantly highest scores were the lots of Green Mountain from Maine II and New York, Irish Cobbler from North Dakota, and Triumph from Walhalla, N. Dak. Mashed potatoes that had significantly lowest scores, in addition to Chippewa from Indiana, were Chippewa

from Maine, and Green Mountain from Maine I from the 1949 lots.

In the baked product, Russet Burbank potatoes from Washington in 1948 were significantly better in the quality of dryness than any other sample lot. In 1949, Russet Burbank from Washington again gave the highest dryness score; the Russet Burbank from Aberdeen, Idaho, and the Irish Cobbler from North Dakota were also in the significantly highest scoring group.

The palatability scores for dryness would be expected to reflect the presence of additional moisture absorbed in cooking. As shown in figure 5, Irish Cobbler potatoes from North Dakota and Russet Burbanks from Washington were two of the 1949 sample lots that had the highest weight gain (11 percent) during boiling. Although these two lots absorbed a rather large quantity of water, they still were in the highest ranking group. Dryness scores for the mashed product from Russet Burbank potatoes also remained in the highest ranking group. Scores for dryness of the Irish Cobbler potatoes from North Dakota, however, were considerably lower. It is not known why the dryness score for the mashed sample of the Irish Cobblers was lower than that for the boiled sample as they were both from the same cooking lot unless moisture differences in mashed samples were more readily distinguished by the judges. There is an additional indication that small differences in the moisture content were more discernible in the mashed than in the boiled samples as shown by the greater range in scores for dryness in the mashed samples. For example, in 1948 scores for dryness in boiled samples ranged from 1.3 to 2.6 whereas in mashed samples the scores ranged from 1.1 to 2.8.

Mealiness.—In both years the three lots of Russet Burbank potatoes were in the group having significantly highest mealiness scores in all three methods of cooking (table 6), as were the Green Mountain from Maine II and New York in 1948 and the Irish Cobbler from North Dakota in 1949. In the mashed samples, Katahdin potatoes from Colorado scored in the significantly highest ranking group for mealiness each year but in the baked samples this was true only in 1949. Irish Cobbler from Maine in 1948 and Green Mountain from Maine II in 1949 were the other baked samples receiving significantly higher mealiness scores than the remaining lots. As was shown in the scores for dryness, each year the Chippewa from Indiana also gave consistently low scores for mealiness in the boiled, mashed and baked samples; in 1949, the Chippewa from Maine and the Katahdin from Pennsylvania in mashed and baked samples were also in the significantly lowest scoring group.

Flavor.—The flavor scores shown in table 7 for each method of cooking each year have a relatively small range from high to low scores for the different sample lots. The averaging of the effects of storage in addition to the frequent occurrence of off-flavors in many cooking samples caused the mean scores to be relatively low and not very different from each other.

Mean scores for flavor of boiled, mashed, and baked potatoes show that the Katahdin sample from Colorado was consistently in the highest scoring group each year except for the mashed samples in 1949. From the potatoes obtained that year, there were no signifi-

cantly high scoring lots in the mashed samples. Other sample lots receiving scores only slightly but significantly above the remaining samples of boiled potatoes were, in 1948, all three lots of Russet Burbank and Triumph from Walhalla, N. Dak.; in 1949, the Russet Burbank from Aberdeen, Idaho, and Washington, and Irish Cobbler from North Dakota. The Russet Burbank from Washington was the only sample of baked potatoes in the high scoring group in addition to the Katadhin from Colorado. The Green Mountain sample from New York was in the lowest scoring group most frequently. Other sample lots having flavor scores occasionally in the significantly lowest group were Irish Cobbler from Maine and Wisconsin, Chippewa from Indiana, and the two Green Mountain samples from Maine.

TABLE 6.—*Mealiness of cooked potatoes: Mean scores*[1] *for six varieties from different locations, all storage periods combined, 1948 and 1949*

Variety and location	Boiled		Mashed		Baked	
	1948	1949	1948	1949	1948	1949
Chippewa:						
Indiana	[3] 1.6	[3] 1.6	[3] 1.5	[3] 1.5	[3] 1.6	[3] 1.6
Maine	2.2	1.8	2.3	[3] 1.6	2.4	[3] 1.7
Michigan	1.9	1.9	2.0	2.1	2.2	2.1
Green Mountain:						
Maine, I	2.4	2.2	2.5	1.9	2.5	2.1
Maine, II	[2] 2.6	2.2	[2] 2.8	2.2	[2] 2.7	[2] 2.6
New York	[2] 2.6	2.1	[2] 2.9	2.1	[2] 2.8	2.2
Irish Cobbler:						
Maine	2.4	2.1	2.5	2.2	[2] 2.7	2.4
North Dakota	2.2	[2] 2.7	2.5	[2] 2.6	2.4	[2] 2.8
Wisconsin	2.4	2.2	2.4	2.2	2.3	2.2
Katahdin:						
Colorado	2.3	2.3	[2] 2.8	[2] 2.8	2.6	[2] 2.6
Maine	2.1	1.8	2.5	2.1	2.5	2.2
Pennsylvania	2.1	[3] 1.6	2.3	[3] 1.6	2.3	[3] 1.6
Russet Burbank:						
Idaho, Aberdeen	[2] 2.8	[2] 2.7	[2] 3.0	[2] 2.9	[2] 2.9	[2] 2.9
Idaho, Ashton	[2] 2.6	[2] 2.5	[2] 2.9	[2] 2.8	[2] 2.9	[2] 2.6
Washington	[2] 2.9	[2] 2.9	[2] 3.0	[2] 2.9	[2] 3.0	[2] 3.0
Triumph:						
North Dakota, Grand Forks	[3] 1.8	2.2	1.9	2.1	[3] 2.0	2.0
North Dakota, Walhalla	2.3	1.9	2.5	2.1	2.4	2.0

[1] Mean of 72 values (3 replicates scored by 6 judges, 4 storage conditions); a score of 3 represents the highest score, 1 the lowest.
[2] Significantly higher than other scores at the 5-percent level.
[3] Significantly lower than other scores at the 5-percent level.

PALATABILITY AS AFFECTED BY STORAGE CONDITIONS

Mean palatability scores showing storage effect of time and temperature were obtained by combining scores for all variety-location sample lots. Significant differences in the mean values that are attributable to storage are shown in table 8.

TABLE 7.—*Flavor of cooked potatoes: Mean scores[1] for six varieties from different locations, all storage periods combined, 1948 and 1949*

Variety and location	Boiled		Mashed		Baked	
	1948	1949	1948	1949	1948	1949
Chippewa:						
Indiana	[3] 2.0	2.1	[3] 1.9	1.9	1.9	2.1
Maine	2.3	1.8	2.4	2.0	2.4	2.0
Michigan	2.2	2.0	2.3	2.1	2.3	2.2
Green Mountain:						
Maine, I	[3] 2.0	1.8	2.2	1.9	1.9	2.0
Maine, II	[3] 2.0	1.9	2.2	2.0	1.9	2.1
New York	2.2	[3] 1.7	[3] 2.1	[3] 1.7	2.1	[3] 1.7
Irish Cobbler:						
Maine	[3] 2.0	2.0	[3] 2.0	2.2	2.1	2.1
North Dakota	2.2	[2] 2.2	2.4	2.1	2.1	2.3
Wisconsin	2.1	2.0	[3] 1.9	2.1	2.0	2.1
Katahdin:						
Colorado	[2] 2.4	[2] 2.2	[2] 2.6	2.1	[2] 2.6	[2] 2.4
Maine	2.2	1.9	2.3	2.0	2.4	2.0
Pennsylvania	2.2	2.0	2.3	1.9	2.2	2.1
Russet Burbank:						
Idaho, Aberdeen	[2] 2.4	[2] 2.2	2.5	2.2	2.4	2.3
Idaho, Ashton	[2] 2.4	2.0	2.4	2.2	2.4	2.2
Washington	[2] 2.4	[2] 2.3	2.5	2.3	2.5	[2] 2.5
Triumph:						
North Dakota, Grand Forks	2.1	2.1	2.2	2.1	2.0	2.1
North Dakota, Walhalla	[2] 2.4	2.0	2.3	2.1	2.3	2.1

[1] Mean of 72 values (3 replicates scored by 6 judges, 4 storage conditions); a score of 3 represents the highest score, 1 the lowest.
[2] Significantly higher than other scores at the 5-percent level.
[3] Significantly lower than other scores at the 5-percent level.

Sloughing.—There was less sloughing (higher scores) in stored potatoes than in those cooked soon after harvesting. This is in agreement with the findings of Whittenberger (*68*) who noted decrease in sloughing of potatoes during storage.

Color.—Color of cooked unstored potatoes was significantly better than that of potatoes cooked after storage. This confirms reports of earlier workers (*72*). There was an increase in yellow and gray color of the tubers (decrease in values for color score) as storage was continued. This was shown in the three methods of cooking during the 2 years. Differences in color scores for boiled, mashed, and baked samples were significant between no storage and 3 months' storage and between 3 and 6 months' storage, except in the case of mashed potatoes from the 1948 crop. Although significant differences in color were not found between potatoes stored at the different temperatures, 55° and 40° F. for 3 months' time, the tendency was for potatoes stored at 55° to be better than those stored at 40° F. Average values showed a trend to lower color scores as storage continued but there was much variation. Some sample lots did not develop appreciable amounts of yellow or gray color on storage, whereas others showed considerable discoloration.

TABLE 8.—*Mean palatability scores [1] for boiled, mashed, and baked potatoes from different storage conditions, 1948 and 1949*

Cooking method and storage time and temperature	Absence of sloughing		Color		Dryness		Mealiness		Flavor	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
Boiled:										
Unstored	[3] 2.1	[3] 1.9	[2] 2.4	[2] 2.1	2.2	2.2	[2] 2.6	[2] 2.4	2.5	[2] 2.5
Stored:										
3 months at 55° F	[3] 2.1	2.2	2.0	1.7	2.2	2.1	2.4	2.1	2.3	2.0
3 months at 40° F	[2] 2.3	2.1	1.9	1.7	2.2	2.2	2.2	2.2	2.3	1.9
6 months at 40° F	[2] 2.3	2.1	[3] 1.7	[3] 1.5	2.2	[3] 1.8	[3] 2.1	[3] 2.0	[3] 1.8	[3] 1.6
Mashed:										
Unstored			[2] 2.6	[2] 2.4	2.4	2.2	[2] 2.8	[2] 2.4	2.5	[2] 2.6
Stored:										
3 months at 55° F			2.3	2.1	2.3	2.2	2.5	2.2	2.4	2.1
3 months at 40° F			2.2	2.0	2.2	2.2	2.4	2.2	2.4	2.0
6 months at 40° F			2.1	[3] 1.8	2.2	[3] 1.9	2.3	2.1	[3] 1.8	[3] 1.6
Baked:										
Unstored			[2] 2.4	[2] 2.5	2.3	2.2	[2] 2.7	2.4	[2] 2.5	[2] 2.6
Stored:										
3 months at 55° F			2.2	2.1	2.2	2.1	2.5	2.3	2.3	2.2
3 months at 40° F			2.1	2.1	2.1	2.2	2.4	2.4	2.2	2.2
6 months at 40° F			[3] 2.0	[3] 1.8	2.1	[3] 1.7	2.3	[3] 1.9	[3] 1.8	[3] 1.5

[1] Mean of 306 values (17 variety-location sample lots x 3 replicates scored by 6 judges).
[2] Significantly higher than other scores at the 5-percent level.
[3] Significantly lower than other scores at the 5-percent level.

Dryness.—Mean scores for dryness in potatoes from the 1948 crop did not differ significantly for the 0, 3, and 6 months' storage periods. Although scores for individual lots of potatoes showed differences in dryness (table 5) when scores for the 17 sample lots were averaged, these differences were not apparent for storage treatments. The 1949 sample lots, however, were scored significantly lower for dryness after 6 months' storage (table 8) than those tested unstored or after 3 months' storage. After 6 months' storage potatoes that received lower scores were less dry and had a tendency to be soggy.

Mealiness.—Mean values for mealiness show that in both years length of storage was a significant factor. Whether boiled, mashed, or baked, potatoes cooked before storage were significantly more mealy than when cooked after 6 months' storage at 40° F. Data from both years show that potatoes boiled after 3 months' storage at 40° or 55° F. were significantly more mealy than those boiled after 6 months' storage and they were significantly less mealy than unstored potatoes.

Flavor.—Deterioration in flavor of potatoes also was progressive as storage time was prolonged. In most cases potatoes cooked before storing were significantly better in flavor than those stored for either 3 or 6 months; also there was significantly less deterioration in flavor of potatoes stored 3 months than those stored for the 6-month period. More significant changes in flavor were shown in baked potatoes from the 1948 crop and in boiled, mashed, and baked potatoes from the

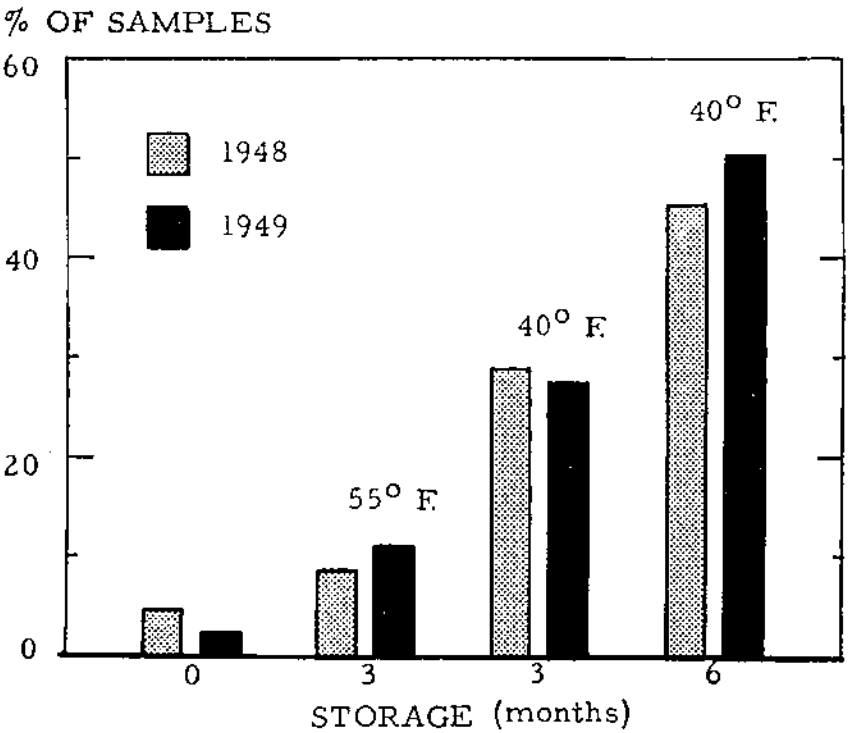


FIGURE 6.—Judges' detection of sweet flavor in cooked potatoes.

1949 crop than in boiled and mashed potatoes from the 1948 crop (table 8).

Off-flavors such as sweet, earthy, bitter, nutty, and stale were listed on the judging record and were checked by each judge if that flavor was detected in any sample. A summary of these results showed that such off-flavors were frequently tasted in cooked potatoes. More of these off-flavors were reported present in cooked potatoes from stored than from unstored samples with the greatest amount present in potatoes stored 6 months at 40° F. In all sample lots there was consistently a greater amount of off-flavor in potatoes from the 1949 crop than from those grown in 1948.

Sweetness when detectable in cooked potatoes is considered an off-flavor. Presence of sweet flavor was detected in approximately 10 percent of the samples stored for 3 months at 55° F. (fig. 6). In those stored at 40° F. sweetness was observed in slightly more than 25 percent after 3 months' storage and in about 50 percent after 6 months' storage.

COMPOSITION OF RAW TUBERS OF ALL SAMPLE LOTS

A sample consisting of 10 tubers from each lot of raw potatoes was analyzed for various chemical constituents at the same time that a comparable sample was used for cooking tests. The primary objective in obtaining these data was to determine the relationship between composition and cooking quality; therefore, the results of the chemical analyses were not subjected to statistical analysis to determine the significance of differences between various sample lots of potatoes. These data are presented to show the variations and similarities in composition of the samples used in this study.

The data in the tables that follow are based on the composition at the time of analysis without any consideration of the shrinkage that occurred during the preceding storage period. Shrinkage in most of these lots ranged, as shown in an earlier publication (*31*) from 2.8 to 7.4 percent for 3 to 6 months of storage.

The composition of the individual variety lots from the various locations is given in table 9. It must be emphasized that a comparison of variety performance should take into account that all of these variety lots were not produced in the same locations. The range in dry matter content from 16.1 percent for the Chippewa lot from Indiana in 1948 to 25.6 percent for the Russet Burbank lot from Washington in 1949 is an example of some of the variation in composition that occurred in these lots. Similar variations are apparent in the alcohol insoluble solids and starch contents. Total nitrogen content of the lots differed considerably but variations within varieties were nearly as great as the entire range. This is shown by the Katahdin lots, which ranged from 0.29 to 0.43 percent. This indicates that location and cultural conditions may have as much influence on total nitrogen content as varietal characteristics. In most instances lots that were high in total nitrogen content were also high in each of the various nitrogen fractions that were analyzed.

TABLE 9.—*Average*[1] *composition for each of 6 varieties of potatoes from several locations, 1948 and 1949*

Variety and location	Dry matter		Alcohol insoluble solids		Starch		Nitrogen								Juice per 100 grams		pH of juice	
							Total		Protein		Nonprotein		Amino					
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Milliliters*	*Milliliters*		
Chippewa:																		
Indiana	16. 1	17. 1	14. 3	15. 2	10. 2	11. 2	0. 30	0. 32	0. 12	0. 13	0. 18	0. 19	0. 09	0. 10	33. 4	33. 8	6. 07	6. 03
Maine	19. 6	17. 2	18. 3	15. 6	14. 1	12. 0	. 33	. 31	. 15	. 14	. 18	. 17	. 09	. 08	33. 3	34. 0	5. 95	6. 08
Michigan	20. 3	19. 2	18. 6	17. 8	13. 7	13. 1	. 37	. 28	. 13	. 13	. 19	. 15	. 10	. 08	25. 1	32. 2	6. 00	6. 13
Average	18. 7	17. 8	17. 1	16. 2	12. 7	12. 1	. 33	. 30	. 15	. 13	. 18	. 17	. 09	. 09	30. 6	33. 3	6. 01	6. 08
Green Mountain:																		
Maine, I	23. 0	21. 6	20. 9	19. 9	16. 4	16. 4	. 34	. 32	. 18	. 16	. 16	. 16	. 08	. 09	28. 1	31. 7	6. 22	6. 17
Maine, II	20. 6	19. 4	19. 0	17. 8	14. 2	14. 5	. 31	. 31	. 17	. 15	. 17	. 18	. 07	. 09	28. 4	34. 2	6. 11	6. 10
New York	23. 2	21. 2	21. 7	18. 8	17. 7	15. 3	. 32	. 33	. 15	. 15	. 14	. 16	. 09	. 10	28. 6	26. 8	6. 22	6. 35
Average	22. 3	20. 7	20. 5	18. 9	16. 1	15. 4	. 32	. 32	. 16	. 15	. 16	. 17	. 08	. 09	28. 4	30. 9	6. 18	6. 21
Irish Cobbler:																		
Maine	21. 9	21. 8	20. 6	19. 8	16. 6	16. 3	. 37	. 38	. 20	. 18	. 17	. 20	. 09	. 11	27. 5	25. 6	5. 98	6. 15
North Dakota	22. 0	23. 4	20. 1	22. 0	15. 8	17. 3	. 34	. 29	. 18	. 16	. 16	. 13	. 08	. 07	24. 2	28. 9	6. 12	6. 15
Wisconsin	20. 3	20. 6	19. 0	18. 7	15. 5	14. 4	. 30	. 34	. 15	. 17	. 15	. 17	. 08	. 09	28. 5	26. 8	5. 93	6. 17
Average	21. 4	21. 9	19. 9	20. 2	16. 0	16. 0	. 34	. 34	. 18	. 17	. 16	. 17	. 08	. 09	26. 7	27. 1	6. 01	6. 16
Katahdin:																		
Colorado	22. 7	24. 1	21. 4	22. 6	17. 6	18. 2	. 29	. 33	. 14	. 15	. 15	. 18	. 08	. 10	29. 4	31. 3	6. 16	6. 22
Maine	21. 5	20. 2	19. 8	18. 4	16. 1	14. 4	. 36	. 34	. 18	. 16	. 18	. 18	. 10	. 09	28. 0	30. 6	5. 97	6. 25
Pennsylvania	20. 1	19. 8	18. 2	17. 9	14. 4	13. 8	. 39	. 43	. 18	. 21	. 21	. 22	. 11	. 12	25. 2	31. 1	6. 13	6. 21
Average	21. 4	21. 4	19. 8	19. 6	16. 0	15. 5	. 35	. 37	. 17	. 17	. 18	. 19	. 10	. 10	27. 5	31. 0	6. 09	6. 23
Russet Burbank:																		
Idaho, Aberdeen	21. 9	22. 6	20. 4	21. 1	16. 4	17. 3	. 30	. 31	. 13	. 13	. 17	. 18	. 09	. 10	32. 5	21. 1	6. 07	6. 09
Idaho, Ashton	23. 6	22. 7	21. 6	20. 8	16. 5	17. 6	. 35	. 28	. 17	. 13	. 18	. 15	. 10	. 08	26. 2	20. 8	6. 05	5. 98
Washington	23. 3	25. 6	21. 9	24. 3	18. 6	21. 2	. 27	. 30	. 14	. 15	. 13	. 15	. 07	. 08	33. 4	24. 2	6. 09	6. 16
Average	22. 9	23. 6	21. 3	22. 1	17. 2	18. 7	. 31	. 30	. 15	. 14	. 16	. 16	. 09	. 09	30. 7	22. 0	6. 07	6. 08
Triumph:																		
North Dakota, Grand Forks	20. 9	22. 2	18. 6	20. 1	13. 5	15. 1	. 36	. 37	. 19	. 19	. 17	. 18	. 09	. 09	25. 2	27. 6	6. 09	6. 22
North Dakota, Walhalla	22. 8	20. 9	21. 2	18. 8	17. 2	14. 2	. 27	. 33	. 14	. 17	. 13	. 16	. 07	. 08	25. 8	24. 7	6. 07	6. 17
Average	21. 8	21. 5	19. 9	19. 4	15. 3	14. 6	. 32	. 35	. 16	. 18	. 15	. 17	. 08	. 08	25. 5	26. 1	6. 08	6. 19

[1] Average of 12 analyses (4 storage conditions x 3 replications) expressed on fresh-weight basis.

The potato tuber is rather unique among plant tissues. It is seldom that the protein and nonprotein nitrogen fractions occur in as nearly equal quantities as they do in potato tubers. It is evident that the ratio of protein to nonprotein nitrogen varies somewhat from variety to variety. Thompson and Steward (*61*) have noted differences in the ratio of these two nitrogen fractions as well as differences in the composition of the soluble fraction of the King Edward, Sebago, and Katahdin varieties. The data in table 9 show that the nonprotein fraction exceeded the protein fraction in both the Chippewa and Katahdin varieties and was slightly higher in the Burbank variety. The two fractions occurred in nearly equal quantities in Green Mountain and Irish Cobbler whereas in Triumph the protein fraction slightly exceeded the nonprotein fraction in all lots.

TABLE 10.—*Total sugar content* [1] *of 6 varieties of potatoes from several locations stored at 40° or 55° F., 1948 and 1949*

Variety and location	1948				1949			
	No storage	3 months at 55° F.	3 months at 40° F.	6 months at 40° F.	No storage	3 months at 55° F.	3 months at 40° F.	6 months at 40° F.
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Chippewa:								
Indiana	0. 40	0. 08	1. 79	1. 68	0. 29	0. 36	0. 82	0. 59
Maine	. 40	. 03	. 85	. 80	. 29	. 22	1. 17	1. 07
Michigan	. 63	. 38	1. 14	1. 34	. 44	. 31	1. 23	1. 32
Green Mountain:								
Maine, I	1. 14	. 59	1. 79	1. 78	. 62	. 42	1. 03	1. 12
Maine, II	. 55	. 63	1. 63	1. 69	. 56	. 42	1. 01	1. 27
New York	. 58	. 60	1. 69	1. 92	1. 00	1. 10	2. 15	2. 01
Irish Cobbler:								
Maine	. 30	. 21	. 73	1. 08	. 40	. 26	. 77	. 92
North Dakota	. 53	. 32	1. 45	1. 77	. 50	. 31	. 98	1. 22
Wisconsin	. 31	. 21	1. 02	1. 37	. 41	. 28	1. 05	1. 34
Katahdin:								
Colorado	. 46	. 41	1. 13	1. 29	. 75	. 28	. 83	1. 02
Maine	. 38	. 36	1. 25	1. 54	. 42	. 30	1. 36	1. 45
Pennsylvania	. 41	. 32	1. 45	1. 59	. 24	. 22	. 87	1. 12
Russet Burbank:								
Idaho, Aberdeen	. 20	. 38	1. 27	1. 23	. 36	. 28	. 91	. 91
Idaho, Ashton	. 52	. 37	1. 11	1. 16	1. 02	. 55	1. 09	1. 19
Washington	. 28	. 37	1. 20	1. 46	. 42	. 25	. 81	. 87
Triumph:								
North Dakota, Grand Forks	. 67	. 74	2. 10	2. 64	1. 00	. 56	1. 54	1. 75
North Dakota, Walhalla	. 70	. 64	1. 80	2. 17	. 81	. 64	1. 70	1. 95

[1] Each figure represents the mean of 3 analyses, all expressed on fresh-weight basis.

COMPOSITION AS AFFECTED BY STORAGE CONDITIONS

It has been shown (*58, 71*) that storage temperature exerts a great influence on the sugar content of potatoes but has relatively little

effect on some of the other major constituents in the tubers. As the greatest changes in composition during storage appear in the carbohydrate fractions, particularly in the sugars, the data for total sugar and reducing sugar content are given in detail, tables 10 and 11, respectively. The changes during storage are given for each variety lot for each of the 2 years. Although there was considerable variation in the same variety from different locations, it is evident that after storage at 40° F. for 3 months or longer some varieties such as Green Mountain and Triumph were consistently high in total sugar content (table 10). This is in agreement with others (*71*, *72*) who have also found that at low storage temperatures these two varieties accumulated greater quantities of sugar than such varieties as Irish Cobbler, Katahdin, and Russet Burbank. The reducing sugar content followed much the same trend as total sugar content. As shown in table 11 Green Mountain and Triumph again had the highest average reducing sugar content.

TABLE 11.—*Reducing sugar content* [1] *of 6 varieties of potatoes from several locations stored at 40° or 55° F., 1948 and 1949*

Variety and location	1948				1949			
	No storage	3 months at 55° F.	3 months at 40° F.	6 months at 40° F.	No storage	3 months at 55° F.	3 months at 40° F.	6 months at 40° F.
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Chippewa:								
Indiana	0.12	0.02	1.00	0.84	0.17	0.25	0.51	0.25
Maine	.07	.02	.42	.36	.20	.12	.84	.71
Michigan	.23	.11	.68	.54	.37	.19	.77	.83
Green Mountain:								
Maine, I	.63	.25	1.11	1.02	.36	.23	.69	.78
Maine, II	.44	.33	1.14	1.00	.36	.26	.73	.94
New York	.19	.20	1.10	1.05	.71	.57	1.46	1.34
Irish Cobbler:								
Maine	.00	.01	.40	.60	.16	.08	.42	.57
North Dakota	.12	.03	.99	1.14	.31	.18	.62	.89
Wisconsin	.01	.01	.75	.93	.25	.15	.72	.93
Katahdin:								
Colorado	.08	.15	.73	.68	.43	.12	.40	.50
Maine	.02	.05	.87	.87	.28	.16	.98	1.01
Pennsylvania	.04	.03	.93	.89	.15	.07	.52	.64
Russet Burbank:								
Idaho, Aberdeen	.06	.12	.89	.85	.25	.16	.60	.62
Idaho, Ashton	.16	.05	.63	.61	.82	.42	.77	.90
Washington	.05	.07	.76	.79	.21	.09	.43	.50
Triumph:								
North Dakota, Grand Forks	.22	.40	1.28	1.40	.71	.38	.99	1.01
North Dakota, Walhalla	.22	.31	1.14	1.17	.67	.47	1.24	1.40

[1] Each figure represents the mean of 3 analyses, all expressed on fresh-weight basis.

TABLE 12.—*Average* [1] *composition of potatoes from different storage conditions, 1948 and 1949*

Storage time, temperature, and year	Dry matter	Alcohol insoluble solids	Starch	Sugar			Nitrogen				Juice per 100 grams
				Total	Sucrose	Reducing	Total	Protein	Non-protein	Amino	
FRESH-WEIGHT BASIS											
Unstored:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Milliliters*
1948	21. 05	19. 80	15. 8	0. 50	0. 34	0. 16	0. 32	0. 14	0. 18	0. 10	33. 9
1949	20. 76	19. 21	15. 4	. 56	. 19	. 37	. 32	. 15	. 17	. 09	38. 5
Stored:											
3 months at 55° F.:											
1948	21. 00	19. 96	15. 7	. 39	. 26	. 13	. 36	. 18	. 18	. 09	26. 6
1949	21. 19	19. 84	15. 7	. 40	. 17	. 23	. 33	. 17	. 16	. 09	27. 8
3 months at 40° F.:											
1948	21. 62	19. 72	15. 3	1. 37	. 50	. 87	. 36	. 18	. 18	. 10	28. 4
1949	20. 89	18. 98	15. 2	1. 21	. 43	. 78	. 33	. 15	. 18	. 09	29. 7
6 months at 40° F.:											
1948	21. 94	19. 52	15. 6	1. 56	. 69	. 87	. 37	. 18	. 18	. 09	24. 8
1949	21. 72	19. 56	15. 3	1. 32	. 47	. 85	. 33	. 15	. 18	. 09	29. 7
DRY-WEIGHT BASIS											
Unstored:											
1948	------	93. 9	74. 6	2. 36	1. 61	. 75	1. 55	. 71	. 84	. 49	163. 0
1949	------	92. 4	74. 0	2. 66	. 84	1. 82	1. 54	. 69	. 85	. 45	170
Stored:											
3 months at 55° F.:											
1948	------	95. 0	74. 3	1. 84	1. 25	. 59	1. 72	. 85	. 87	. 44	128
1949	------	93. 4	73. 9	1. 88	. 79	1. 09	1. 58	. 82	. 76	. 44	133
3 months at 40° F.:											
1948	------	91. 0	70. 4	6. 44	2. 37	4. 07	1. 70	. 84	. 86	. 47	133
1949	------	90. 7	72. 3	5. 52	1. 88	3. 64	1. 58	. 73	. 85	. 44	148
6 months at 40° F.:											
1948	------	88. 8	70. 5	7. 03	3. 06	3. 97	1. 69	. 84	. 85	. 42	114
1949	------	90. 0	70. 3	5. 76	1. 99	3. 77	1. 55	. 73	. 82	. 44	138

[1] Based on 51 analyses: 3 replicates of 6 varieties from 2 or 3 locations.

The average composition for each of the major constituents in the raw tubers for several storage conditions is given in table 12. These data for all varieties and locations combined give only the variations in the constituents that are due to storage conditions and year of production. Alcohol insoluble solids constituted approximately 92 percent of the total dry substance and the starch content was approximately 73 percent. Starch is the most abundant single component among the constituents of potato tubers. As more than 25 percent of the dry matter is material other than starch, there is the possibility for other compounds to have considerable influence on the cooking quality of potatoes. Alcohol insoluble solids and starch contents both showed some changes during storage, especially at the lower temperatures. When considered on a dry-weight basis the loss in starch approximated the gain in total sugar content. The changes in alcohol insoluble solids roughly paralleled those of starch. The other most apparent variation was the volume of juice that could be pressed out of the macerated raw tissues. The quantity of juice decreased with storage at both storage temperatures but more rapidly at 55° F. The total nitrogen content and the various nitrogen fractions showed very little consistent change with storage. This is in agreement with the findings of Stuart and Appleman (*58*) who noted that the nitrogen components of stored potatoes remained remarkably stable until sprouting occurred.

RELATIONSHIP AMONG COMPOSITIONAL FACTORS

The existence of a relation between specific gravity and dry matter and between specific gravity and starch has been known for many years and commercial application has been made of this knowledge. In recent years a number of workers have calculated coefficients of correlation for this relationship. Von Scheele, Svensson, and Rasmusson (*66*) give a coefficient of 0.937 for specific gravity and dry matter. Glynne and Jackson (*22*) working with one variety, King Edward, found values of 0.972 and 0.875, Dunn and Nylund (*15*) 0.869, Le Clerg (*44*) 0.81 to 0.85 for two varieties, and Willaman and West (*69*) a somewhat lower figure of 0.637. The data in table 13 representing 6 varieties of potatoes produced in areas ranging from Maine to Washington gave coefficients for the specific gravity-dry matter relationship more nearly in agreement with the higher values given above. The coefficients for the stored samples were about the same or slighly higher than those for unstored samples, which indicated that storage conditions had little influence on the specific gravity-dry matter relationship. Starch and alcohol insoluble solids show about the same relationship to specific gravity as does dry matter. The correlation between dry matter and starch was slightly higher before storage than after 6 months storage. This may be due to a change of some of the starch to sugar but a similar trend in the alcohol insoluble solids is not apparent. The correlation of dry matter with alcohol insoluble solids gave the highest coefficients of any relationship studied although the correlation between alcohol insoluble solids and starch was almost equally as high.

TABLE 13.—*Coefficients of correlation between various chemical constituents of potato tubers, 1948 and 1949*

FRESH-WEIGHT BASIS

Correlation factors	Potatoes not stored		Potatoes stored 6 months at 40° F.	
	1948	1949	1948	1949
Specific gravity versus:				
Dry matter	+0.859**	+0.953**	+0.937**	+0.962**
Starch	+.841**	+.938**	+.816**	+.946**
Alcohol insol. solids	+.868**	+.948**	+.895**	+.969**
Dry matter versus:				
Starch	+.919**	+.961**	+.885**	+.941**
Alcohol insol. solids	+.965**	+.986**	+.965**	+.981**
Total nitrogen	−.048	−.001	−.253	−.191
Alcohol insol. solids versus:				
Starch	+.980**	+.972**	+.929**	+.974**
Total nitrogen	−.304	−.002		

DRY-WEIGHT BASIS

Dry matter[1] versus:				
Total nitrogen	−.682**	−.707**	−.731**	−.688**
Specific gravity[1] versus:				
Starch	+.615**	+.699**	+.496*	+.782**
Alcohol insol. solids	+.545*	+.425	+.330	+.730**
Alcohol insol. solids versus:				
Starch	+.912**	+.669**	+.702**	+.867**

[1] Dry matter and specific gravity values on fresh-weight basis were used in these correlations.

** Significant at the 1-percent level.

* Significant at the 5-percent level.

Total nitrogen content on a fresh-weight basis did not give a significant relationship with the dry matter content, although a slight trend was noted for nitrogen content to decrease as dry matter increased. On a dry-weight basis the nitrogen content showed a highly significant negative correlation with the percentage of dry matter. The indications are that the nitrogen contents of the variety lots were more similar on a fresh-weight than on a dry-weight basis. When the nitrogen content on a fresh-weight basis is divided by the percentage of dry matter, the resulting percentage of nitrogen on a dry-weight basis varies inversely with the dry matter content on a fresh-weight basis. As nitrogen content is generally found to have a negative and dry matter a positive correlation with mealiness it would seem difficult, if not impossible, to have a potato high in dry matter and high in nitrogen content that would also have a very mealy texture. Based on a number of analyses, East (*17*) concluded that it should be possible to breed a variety with a high proportion of protein to carbohydrate and with desirable quality. He states that "a high percentage of nitrogenous matter is not correlated with a low dry matter content." However, no correlation values were given and

when coefficients are calculated from his data they show highly significant negative values (−0.91 to −0.96) between nitrogen and dry matter content.

Data from the present study show that starch on a dry-weight basis was significantly correlated with specific gravity and with alcohol insoluble solids although the coefficients are not as high as on a fresh-weight basis. This indicates that the increase in alcohol insoluble solids is accompanied by an increase of starch in the alcohol insoluble solids.

RELATIONSHIP OF COMPOSITIONAL FACTORS TO PALATABILITY

Attempts have been made in the past to correlate composition with palatability characteristics. Mealiness has generally received the most attention. In this study the influence of a number of physical and chemical characteristics of the tubers on five palatability characteristics are considered. Four of the compositional factors frequently considered as having a relation to quality are specific gravity, dry matter, starch, and alcohol insoluble solids. Although these four factors are closely related, as shown in table 13, they give a slightly different measure from a compositional standpoint; therefore, it is of interest to compare the relation of each of these to the various palatability factors. The relation of other compositional factors including sugars, nitrogen fractions, and expressed juice to the palatability ratings are also considered.

The coefficients of correlation given in tables 14 to 22 were obtained by using the chemical analyses of uncooked potatoes from comparable lots that received the same handling and storage treatment as those used for evaluating palatability and cooking quality. The coefficients for each storage period and for all storage periods combined involved the use of all of the palatability scores for the various samples and the analyses of the raw tubers expressed on both a fresh- and dry-weight basis. The coefficients in the tables are given in detail for the compositional factors on either the fresh- or dry-weight basis, whichever gave the highest correlation.

Specific gravity.—Numerous proposals (*7, 10, 25, 26, 42*) for the use of specific gravity as a measure of quality in potatoes have been made. Some investigators have found in a few instances a very limited relationship between specific gravity and mealiness. Greenwood, McKendrick, and Hawkins (*24*) working with 6 varieties from 2 farms found the mealiness scores bore little relationship to specific gravity ratings of the potatoes from 1 farm. The specific gravity was relatively low and of a narrow range, 1.0565 to 1.0711. From the other farm the potatoes had a slightly wider range in specific gravity and showed a close relationship between specific gravity and mealiness. Kirkpatrick, Mountjoy, Albright, and Heinze (*41*) who also worked with potatoes of a relatively narrow range in specific gravity (1.06 to 1.08) did not find a statistically significant relationship between specific gravity and mealiness although there was a suggestive trend in the positive coefficients for the boiled, mashed, and baked samples. The potatoes used in that study were of the early Southern-grown crop, which are usually harvested at a very immature stage of development, and consequently are different from the Northern-grown late crop in quality factors and in their use as a cooked product.

TABLE 14.—*Coefficients of correlation between specific gravity of raw potatoes from different storage times and temperatures and palatability characteristics of cooked potatoes, 1948 and 1949*

Cooking method, storage time, and temperature	Specific gravity versus—									
	Absence of sloughing		Color		Dryness		Mealiness		Flavor	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
Boiled:										
Unstored	0. 604*	0. 858**	−0. 185	−0. 535*	+0. 757**	+0. 814**	+0. 569*	+0. 821**	+0. 495*	+0. 320
Stored:										
3 months at 55° F	. 724**	. 815**	. 332	−. 408	+. 924**	+. 864**	+. 707**	+. 814**	+. 366	+. 180
3 months at 40° F	. 647**	. 885**	. 368	−. 408	+. 867**	+. 867**	+. 693**	+. 860**	+. 224	+. 495*
6 months at 40° F	. 480	. 906**	. 403	−. 364	+. 865**	+. 937**	+. 609**	+. 776**	+. 508*	+. 344
All storage conditions	−. 676**	. 904**	. 444	−. 483*	+. 904**	+. 926**	+. 723**	+. 861**	+. 428	+. 470
Mashed:										
Unstored			+. 295	−. 013	+. 757**	+. 517*	+. 666**	+. 704**	−. 032	−. 084
Stored:										
3 months at 55° F			+. 297	+. 291	+. 868**	+. 821**	+. 907**	+. 856**	+. 520*	+. 460
3 months at 40° F			+. 185	+. 320	+. 925**	+. 805**	+. 824**	+. 873**	+. 503*	+. 485*
6 months at 40° F			+. 304	+. 461	+. 841**	+. 802**	+. 743**	+. 886**	+. 463	+. 515*
All storage conditions			+. 268	+. 302	+. 902**	+. 802**	+. 847**	+. 875**	+. 409	+. 531*
Baked:										
Unstored			+. 114	+. 201	+. 796**	+. 825**	+. 613**	+. 715**	+. 155	+. 501*
3 months at 55° F			+. 329	+. 456	+. 780**	+. 869**	+. 745**	+. 865**	+. 253	+. 508*
3 months at 40° F			+. 562*	+. 294	+. 818**	+. 852**	+. 798**	+. 883**	+. 239	+. 460
6 months at 40° F			+. 418	+. 190	+. 800**	+. 855**	+. 760**	+. 868**	+. 550*	+. 526*
All storage conditions			+. 373	+. 351	+. 835**	+. 888**	+. 780**	+. 902**	+. 398	+. 597*

**Significant at the 1-percent level.
*Significant at the 5-percent level.

Investigators (*25*, *42*) have found that potatoes offered to consumers in retail stores for specific purposes such as frying, boiling, and baking must differ appreciably in specific gravity if noticeable differences in cooking quality are to be detected. It is apparent from these cited studies that a considerable range in specific gravity of the samples must be supplied to the judges if a high correlation between specific gravity and mealiness is to be obtained. As specific gravity separation is a practical measurement for determining quality in potatoes it is important that careful consideration be given the relationship between specific gravity and a number of quality characteristics as determined by a judging panel.

The coefficients of correlation for specific gravity and palatability factors are given in table 14. A significant negative relationship was found between specific gravity and scores for absence of sloughing which means that potatoes of high specific gravity sloughed more than those of low specific gravity.

The dryness of the cooked potatoes was very closely associated with the specific gravity as is evidenced by the high coefficients for all three methods of preparation. The coefficients for mealiness are slightly lower than those for dryness but all the coefficients are highly significant and show that mealiness increased as the specific gravity of the samples increased. Although palatability scores for mealiness were lower after storage of the potatoes (table 8) the coefficients of correlation indicated a closer association with specific gravity than at harvesttime. Flavor was much less closely associated than either dryness or mealiness with specific gravity but the trend in all three methods of preparation was toward higher scores for those samples with higher specific gravity. The color of the cooked product was not significantly related to specific gravity although there was a trend toward low color scores for the high specific gravity lots in the boiled potatoes as indicated by the negative coefficients. This trend was reversed in the mashed and baked products.

Dry matter.—As was pointed out, the amount of dry matter varied considerably in these lots of potatoes. In order to note the effect of this variation on quality, the coefficients of correlation for dry matter and the palatability factors are given in table 15. A significant negative relation existed between dry matter content and scores for sloughing, which shows that potatoes with a high dry matter content sloughed more than those with a low dry matter content. The dryness of the cooked product was very closely associated with the dry matter content as is evidenced by the very high coefficients in all three methods of preparation. Mealiness was influenced by dry matter content to a slightly lesser extent than dryness. All of the coefficients for mealiness were highly significant and show that mealiness scores were higher in the samples with higher dry matter content. Flavor was much less closely associated with dry matter but the trend in all three methods of preparation was toward higher scores for those samples with higher dry matter content. The color of the cooked product was not significantly influenced by the dry matter content although there was a definite trend toward lower color scores with increasing dry matter content in the boiled potatoes and higher color scores with increasing dry matter content in the mashed and baked products.

TABLE 15.—*Coefficients of correlation between dry matter content in raw potatoes from different storage conditions and palatability characteristics of cooked potatoes, 1948 and 1949*

Cooking method, storage time, and temperature	Dry matter versus—									
	Absence of sloughing		Color		Dryness		Mealiness		Flavor	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
Boiled:										
Unstored	−0. 579*	−0. 294	−0. 308	−0. 564*	+0. 881**	+0. 810**	+0. 681**	+0. 733**	+0. 701**	+0. 326
Stored:										
3 months at 55° F	−. 742**	−. 788**	−. 286	−. 489*	+. 900**	+. 890**	+. 720**	+. 793**	+. 389	+. 168
3 months at 40° F	−. 671**	−. 916**	−. 311	−. 468	+. 846**	+. 885**	+. 716**	+. 865**	+. 307	+. 638**
6 months at 40° F	−. 530*	−. 893**	−. 465	−. 212	+. 838**	+. 907**	+. 636**	+. 775**	+. 422	+. 394
All storage conditions	−. 671**	−. 892**	−. 406	−. 558*	+. 921**	+. 933**	+. 756**	+. 819**	+. 497*	+. 536*
Mashed:										
Unstored			+. 275	−. 090	+. 873**	+. 529*	+. 773**	+. 683**	+. 099	−. 092
Stored:										
3 months at 55° F			+. 300	+. 238	+. 870**	+. 875**	+. 900**	+. 872**	+. 466	+. 476
3 months at 40° F			+. 217	+. 362	+. 892**	+. 868**	+. 804**	+. 898**	+. 501*	+. 485*
6 months at 40° F			+. 283	+. 329	+. 882**	+. 827**	+. 775**	+. 879**	+. 429	+. 530*
All storage conditions			+. 299	+. 264	+. 918**	+. 858**	+. 863**	+. 885**	+. 473	+. 523*
Baked:										
Unstored			+. 241	+. 165	+. 863**	+. 725**	+. 742**	+. 618**	+. 167	+. 567*
Stored:										
3 months at 55° F			+. 339	+. 421	+. 821**	+. 849**	+. 764**	+. 857**	+. 343	+. 501*
3 months at 40° F			+. 513*	+. 363	+. 825**	+. 829**	+. 810**	+. 848**	+. 192	+. 580*
6 months at 40° F			+. 450	+. 144	+. 850**	+. 863**	+. 794**	+. 859**	+. 545*	+. 529*
All storage conditions			+. 430	+. 332	+. 890**	+. 858**	+. 833**	+. 868**	+. 419	+. 631**

**Significant at the 1-percent level.
*Significant at the 5-percent level.

TABLE 16.—*Coefficients of correlation between alcohol insoluble solids content in raw potatoes from different storage conditions and palatability characteristics of cooked potatoes, 1948 and 1949*

FRESH-WEIGHT BASIS

Cooking method, storage time, and temperature	Alcohol insoluble solids versus—									
	Absence of sloughing		Color		Dryness		Mealiness		Flavor	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
Boiled:										
Unstored	−0.665**	−0.804**			+0.910**	+0.831**	+0.702**	+0.738**	+0.682**	+0.382
Stored:										
3 months at 55° F	−.794**	−.787**			+.890**	+.871**	+.724**	+.786**	+.351	+.229
3 months at 40° F	−.690**	−.905**			+.882**	+.932**	+.747**	+.903**	+.310	+.685**
6 months at 40° F	−.565*	−.886**	0.432	0.402	+.814**	+.943**	+.635**	+.837**	+.487*	+.472*
All storage conditions	−.744**	−.893**	−.402	−.497*	+.941**	+.952**	+.793**	+.862**	+.531*	+.599*
Mashed:										
Unstored					+.921**	+.523**	+.840**	+.691**	+.040	−.028
Stored:										
3 months at 55° F					+.854**	+.876**	+.899**	+.889**	+.458	+.544*
3 months at 40° F					+.892**	+.882**	+.856**	+.920**	+.559*	+.571*
6 months at 40° F			+.339	+.453	+.868**	+.853**	+.811**	+.920**	+.432	+.578*
All storage conditions			+.348	+.328	+.929**	+.858**	+.879**	+.898**	+.468	+.563*
Baked:										
Unstored					+.842**	+.770**	+.707**	+.686**	+.194	+.618**
Stored:										
3 months at 55° F					+.817**	+.850**	+.745**	+.854**	+.299	+.593*
3 months at 40° F					+.875**	+.864**	+.875**	+.900**	+.277	+.652**
6 months at 40° F			+.446	+.263	+.881**	+.910**	+.837**	+.903**	+.605*	+.613**
All storage conditions			+.474	+.420	+.918**	+.876**	+.864**	+.893**	+.472	+.712**
DRY-WEIGHT BASIS										
Boiled, all storage conditions	−.640**	−.656**	−.264	−.080	+.636**	+.890**	+.620**	+.775**	+.479	+.649**
Mashed, all storage conditions			+.401	+.551*	+.629**	+.634**	+.703**	+.731**	+.303	+.613**
Baked, all storage conditions			+.340	+.772**	+.638**	+.763**	+.675**	+.802**	+.519*	+.328**

**Significant at the 1-percent level.

*Significant at the 5-percent level.

A number of investigators have found that high dry matter content was accompanied by a greater degree of mealiness and better quality. Others (*27, 30*) have not found this relationship to exist or have found a very limited relationship. Bewell (*7*) reported that a high dry matter content of 30 percent was associated with good quality and a low dry matter content of 15 percent was associated with poor quality. In a statistical analysis of his data Bewell showed that dry matter was associated with the cooking scores, which included a number of palatability factors. East (*17*) and Gilmore (*21*) have given lower limits of 17 to 18 percent dry matter as the level below which tubers cannot be of good quality and have the desired mealiness. Butler, Morrison, and Boll (*8*) noted that the average water content decreased as the samples increased in mealiness. Pearsall (*48*) reported the use of the following classifications in rating potatoes for baking, boiling, and pressure cooking: 18 to 21 percent dry matter—good; 15 to 18 percent—fair; under 15 percent—poor.

Child and Willaman (*9*) found that higher dry matter tended to be accompanied by better texture (mealiness). Coefficients of correlation calculated for dry matter and texture were 0.541 for boiled and 0.564 for baked samples. Child and Willaman also found positive coefficients for dry matter and flavor. These were 0.179 for boiled and 0.306 for baked potatoes. Although these coefficients are considerably lower than those given in table 15, they also show that dry matter was more closely associated with mealiness and flavor in baked than in boiled potatoes.

Alcohol insoluble solids.—The relationship of alcohol insoluble solids to the quality characteristics was very similar to that given for dry matter and specific gravity. In many instances the alcohol insoluble solids gave slightly higher coefficients than those given by dry matter. Alcohol insoluble solids on a fresh-weight basis were very highly correlated with the dryness, mealiness, and sloughing characteristics and less significantly with color and flavor (table 16). A summary of the correlation of the alcohol insoluble solids on a dry-weight basis with the various palatability factors is given at the bottom of the table. It is evident that the fresh-weight basis gave higher coefficients for all except color and flavor. As color and flavor showed less relationship to alcohol insoluble solids than did the other palatability factors, the difference in the coefficients for these factors on the fresh- and dry-weight basis is of little consequence.

Starch.—Starch was more closely associated with sloughing, dryness, and mealiness than any other compositional factor considered in this study (table 17). The samples containing higher amounts of starch sloughed more, therefore received lower scores for the sloughing characteristic than samples with lower starch contents. The coefficients of correlation for dryness and mealiness with starch were only slightly higher than those with alcohol insoluble solids. The flavor scores were slightly less closely associated with starch than with alcohol insoluble solids in the boiled and mashed potatoes but the relationships were nearly the same for the baked product. The significant positive correlations between starch or alcohol insoluble solids and flavor indicate that higher alcohol insoluble solids and starch contents are conducive to a better flavor. Starch content on a dry-weight basis generally gave lower coefficients of correlation with the quality factors than starch content expressed on a fresh-weight basis.

TABLE 17.—*Coefficients of correlation between starch content in raw potatoes from different storage conditions and palatability characteristics of cooked potatoes, 1948 and 1949*

FRESH-WEIGHT BASIS

Cooking method, storage time, and temperature	Starch versus—									
	Absence of sloughing		Color		Dryness		Mealiness		Flavor	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
Boiled:										
Unstored	−0.732**	−0.763**	−0.221	−0.506*	+0.898**	+0.868**	+0.702**	+0.752**	+0.636**	+0.304
Stored:										
3 months at 55° F.	−.895**	−.749**	−.229	−.127	+.862**	+.884**	+.766**	+.836**	+.382	+.178
3 months at 40° F.	−.808**	−.872**	−.400	−.367	+.896**	+.921**	+.724**	+.920**	+.390	+.636**
6 months at 40° F.	−.707**	−.860**	−.461	−.391	+.840**	+.926**	+.716**	+.826**	+.511*	+.227
All storage conditions	−.840**	−.853**	−.417	−.465	+.939**	+.959**	+.799**	+.880**	+.550*	+.520*
Mashed:										
Unstored			+.304	−.105	+.919**	+.519 *	+.857**	+.716**	−.013	−.016
Stored:										
3 months at 55° F.			−.003	+.308	+.779**	+.856**	+.875**	+.879**	+.465	+.470
3 months at 40° F.			+.227	+.477	+.907**	+.880**	+.829**	+.903**	+.515*	+.525*
6 months at 40° F.			+.365	+.466	+.894**	+.845**	+.886**	+.901**	+.494*	+.576*
All storage conditions			+.364	+.362	+.924**	+.849**	+.903**	+.890**	+.432	+.538*
Baked:										
Unstored			+.229	+.259	+.815**	+.777**	+.673**	+.899**	+.211	+.556*
Stored:										
3 months at 55° F.			+.377	+.474	+.852**	+.859**	+.770**	+.915**	+.392	+.501*
3 months at 40° F.			+.581*	+.409	+.888**	+.889**	+.860**	+.902**	+.357	+.602*
6 months at 40° F.			+.374	+.281	+.900**	+.930**	+.863**	+.689**	+.676**	+.591*
All storage conditions			+.419	+.417	+.911**	+.897**	+.850**	+.915**	+.508*	+.652**
DRY-WEIGHT BASIS										
Boiled, all storage conditions	−.845**	−.642**	−.347	−.279	+.759**	+.846**	+.683**	+.811**	+.477	+.327
Mashed, all storage conditions			+.370	+.440	+.724**	+.698**	+.756**	+.756**	+.279	+.452
Baked, all storage conditions			+.341	+.484*	+.733**	+.834**	+.691**	+.853**	+.503	+.504*

** Significant at the 1-percent level.

* Significant at the 5-percent level.

Sugars.—Total sugar content showed less association with more of the quality characteristics, than the previously considered constituents (table 18). Sugar content on a dry-weight basis gave somewhat higher coefficients than on a fresh-weight basis. This is in contrast to starch and alcohol insoluble solids content which gave considerably higher coefficients on a fresh-weight basis. The influence of storage was more apparent than in any of the correlations previously considered. Although no significant relationship between sloughing and sugar content was found, there was an indication of less sloughing with higher sugar contents especially in those samples stored at 40° F. where sugar accumulation occurred. Only a few significant values for dryness and mealiness were obtained. These coefficients were all negative and were most frequent for the baked product of the potatoes that had been stored at 40° F. for 3 months or more. Likewise there is very little association of sugar content with flavor until the sugar content increased in the tubers considerably above the quantity present at harvest time. Sugar content was not related to the color of the boiled product and had only a slight tendency toward a negative correlation with color in the mashed and baked product.

The coefficients of correlation for reducing sugars and palatability factors are not given in these tables but they were generally lower than those for total sugar content with the exception of flavor where they were approximately of the same magnitude. All of the statistically significant coefficients for either total or reducing sugars are negative, which indicated a detrimental influence of sugar on the quality factors.

Nitrogen.—Although nitrogenous materials occur in potatoes in relatively small amounts, about 0.35 percent on a fresh-weight basis, they exert a considerable influence or are closely associated with several of the quality characteristics (table 19). All lots showed a significant, positive relationship between scores for absence of sloughing and total nitrogen content on a dry-weight basis, indicating that potatoes with a higher nitrogen content exhibited less sloughing. Although they are positive these coefficients are not as high as most of the coefficients obtained for the other compositional factors with sloughing. Dryness and mealiness showed significant negative correlations with total nitrogen content, in contrast to positive coefficients with dry matter, specific gravity, alcohol insoluble solids, and starch. Nitrogen content was also negatively correlated with flavor but the coefficients are not highly significant. Color was not closely associated with nitrogen content but the lots with the higher nitrogen content tended to rate lower in color. This was most apparent in the mashed potatoes.

Nearly all of the coefficients for palatability factors and nitrogen content are considerably lower on a fresh-weight basis that on a dry-weight basis, as is indicated in the data for all storage times at the bottom of the table.

The two fractions of nitrogen content, protein and nonprotein, showed differences in their relationship to some of the palatability factors, tables 20 and 21. Sloughing scores had a closer association with nonprotein nitrogen than with protein nitrogen content. This was especially noticeable in the 1949 data where the coefficients for nonprotein nitrogen and sloughing are higher than for total nitrogen.

TABLE 18.—*Coefficients of correlation between total sugar content of raw potatoes from different storage conditions and palatability characteristics of cooked potatoes, 1948 and 1949*

DRY-WEIGHT BASIS

Cooking method, storage time, and temperature	Total sugar versus—									
	Absence of sloughing		Color		Dryness		Mealiness		Flavor	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
Boiled:										
Unstored	+0. 215	−0. 074	−0. 063	−0. 277	−0. 055	−0. 042	−0. 414	+0. 283	+0. 173	−0. 386
Stored:										
3 months at 55° F	−. 029	+. 089	−. 345	−. 346	+. 299	−. 151	−. 089	−. 061	+. 055	−. 394
3 months at 40° F	+. 451	+. 380	+. 377	. 000	−. 556*	−. 596*	+. 064	−. 484*	−. 375	−. 573*
6 months at 40° F	+. 348	+. 283	+. 155	+. 116	−. 362	−. 360	−. 503*	−. 427	−. 524*	−. 489*
All storage conditions	+. 342	+. 228	+. 115	−. 079	−. 320	−. 354	−. 414	−. 285	−. 399	−. 679**
Mashed:										
Unstored			−. 278	−. 085	−. 168	+. 297	−. 299	+. 301	+. 199	−. 204
Stored:										
3 months at 55° F			−. 045	−. 382	−. 179	−. 111	+. 282	−. 130	+. 253	−. 379
3 months at 40° F			−. 155	−. 386	−. 448	−. 448	−. 568*	−. 427	−. 474	−. 685**
6 months at 40° F			−. 347	−. 356	−. 395	−. 455	−. 501*	−. 438	−. 619**	−. 532*
All storage conditions			−. 328	−. 317	−. 278	−. 224	−. 443	−. 212	−. 298	−. 560*
Baked:										
Unstored			−. 390	−. 232	−. 152	+. 028	−. 285	. 000	−. 200	−. 229
Stored:										
3 months at 55° F			−. 168	−. 604*	+. 105	+. 164	+. 045	−. 144	−. 045	−. 451
3 months at 40° F			−. 470	−. 344	−. 637**	−. 504*	−. 682**	−. 561*	−. 526*	−. 731**
6 months at 40° F			−. 496	−. 335	−. 486*	−. 496*	−. 499*	−. 501*	−. 499*	−. 653**
All storage conditions			−. 532*	−. 437	−. 448	−. 309	−. 530*	−. 340	−. 586*	−. 707**
FRESH-WEIGHT BASIS										
Boiled, all storage conditions	+. 140	+. 010	−. 020	−. 237	−. 032	−. 133	−. 187	−. 063	−. 256	−. 544*
Mashed, all storage conditions			−. 253	−. 263	+. 009	−. 017	−. 182	. 000	−. 155	−. 435
Baked, all storage conditions			−. 414	−. 372	−. 184	+. 103	−. 281	−. 127	−. 470	−. 555*

**Significant at the 1-percent level.

*Significant at the 5-percent level.

TABLE 19.—*Coefficients of correlation between total nitrogen content in raw potatoes from different storage conditions and palatability characteristics of cooked potatoes, 1948 and 1949*

DRY-WEIGHT BASIS

Cooking method, storage time, and temperature	Total nitrogen versus—									
	Absence of sloughing		Color		Dryness		Mealiness		Flavor	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
Boiled:										
Unstored	+0. 511*	+0. 550*			−0. 617**	−0. 700**	−0. 582*	−0. 822**	−0. 551*	−0. 071
Stored:										
3 months at 55° F	+. 734**	+. 639**			−. 591*	−. 681**	−. 596*	−. 765**	−. 259	−. 196
3 months at 40° F	+. 827**	+. 619**			−. 774**	−. 769**	−. 724**	−. 832**	−. 368	−. 580*
6 months at 40° F	+. 762**	+. 626**			−. 752**	−. 752**	−. 732**	−. 781**	−. 448	−. 348
All storage conditions	+. 788**	+. 640**	+0. 085	+0. 206	−. 753**	−. 787**	−. 738**	−. 849**	−. 509*	−. 455
Mashed:										
Unstored			−. 415	−. 204	−. 635**	−. 455	−. 595*	−. 778**	−. 181	+. 080
Stored:										
3 months at 55° F			−. 541*	−. 431	−. 544*	−. 725**	−. 639**	−. 832**	−. 522*	−. 475
3 months at 40° F			−. 421	−. 548*	−. 777**	−. 754**	−. 717**	−. 838**	−. 404	−. 395
6 months at 40° F			−. 587*	−. 657**	−. 718**	−. 604*	−. 756**	−. 792**	−. 216	−. 593*
All storage conditions			−. 581*	−. 562*	−. 719**	−. 710**	−. 733**	−. 862**	−. 352	−. 483*
Baked:										
Unstored					−. 503*	−. 781**	−. 278	−. 782**	−. 110	−. 513*
Stored:										
3 months at 55° F					−. 606**	−. 794**	−. 506*	−. 793**	−. 217	−. 548*
3 months at 40° F					−. 746**	−. 734**	−. 673**	−. 799**	−. 252	−. 578*
6 months at 40° F					−. 758**	−. 728**	−. 791**	−. 773**	−. 594*	−. 410
All storage conditions			−. 377	−. 494*	−. 705**	−. 786**	−. 622**	−. 849**	−. 382	−. 611**

FRESH-WEIGHT BASIS

Boiled, all storage conditions	+. 528*	+. 104	−. 232	−. 254	−. 240	−. 275	−. 374	−. 454	−. 299	−. 186
Mashed, all storage conditions			−. 482*	−. 570*	−. 206	−. 214	−. 274	−. 408	−. 085	−. 202
Baked, all storage conditions			−. 098	−. 416	−. 212	−. 324	−. 166	−. 409	−. 184	−. 319

**Significant at the 1-percent level.

*Significant at the 5-percent level.

Coefficients of correlation for scores for absence of sloughing and amino acid content of the nonprotein fraction as determined by the Van Slyke method were positive, 0.664 for all storage times in 1948 and 0.672 for 1949, both of which are highly significant. Although these coefficients indicate that the amino nitrogen on a dry-weight basis was associated with sloughing, they are lower than those for nonprotein nitrogen. If the amino nitrogen had been largely responsible for the variation in sloughing, higher coefficients should have been obtained. The coefficients for dryness and mealiness are much higher for nonprotein nitrogen than for protein nitrogen and are approximately equal to those for total nitrogen. As indicated by the negative values, the dryness and mealiness scores decreased with an increase in content of either of these groups of nitrogen compounds. Flavor was not associated to any great extent with the protein or nonprotein nitrogen; the coefficients were slightly higher for protein nitrogen. The protein nitrogen appears to have a closer relationship than nonprotein nitrogen to color in the mashed product but all coefficients for color are relatively low.

An increase in any of the nitrogen compounds tended to be associated with a decrease in the amount of sloughing, a very decided decrease in the dryness and mealiness characteristics, and a slight decrease in color and flavor scores. Slightly higher coefficients of correlation between the nitrogen compounds and palatability factors were obtained for the stored than for the unstored samples.

Extracted juice.—Coefficients of correlation were obtained for the relationship between extracted juice and three of the quality factors, sloughing, dryness, and mealiness (table 22). There is an indication that sloughing was related to the amount of extracted juice, especially in the 1949 data where 4 of the 5 coefficients are statistically significant. Since the juice values on a fresh-weight basis showed no significant relationships with palatability factors it is evident that the ratio of juice to dry matter is more important than the actual amount of juice pressed out of the raw tissues. Juice values on a dry-weight basis gave a number of significant coefficients with dryness and mealiness but these were generally lower than coefficients for any of the previously considered compositional factors except sugar and possibly protein nitrogen. Dryness was more closely associated than mealiness with the juice values. Although the amount of juice varied considerably with different storage treatments no pronounced relationship with storage is apparent.

Multiple correlations.—Thus far the variation of only one compositional factor has been considered with the variation of a palatability characteristic. In order to consider the relationship of two compositional factors simultaneously with a palatability characteristic, multiple coefficients of correlation were computed (table 23). Specific gravity and total nitrogen each gave highly significant coefficients of correlation with sloughing, dryness, and mealiness. However, an increase in the value obtained for these two measurements of the tubers had opposite effects on quality ratings. When they were considered simultaneously, only slightly higher multiple correlation coefficients than the highest of the two simple coefficients were obtained for sloughing and dryness. The greatest difference occurred for the mealiness characteristic where the coefficients of determination

TABLE 20.—*Coefficients of correlation between protein nitrogen content in raw potatoes from different storage conditions and palatability characteristics of cooked potatoes, 1948 and 1949*

DRY-WEIGHT BASIS

Cooking method, storage time, and temperature	Protein nitrogen versus—									
	Absence of sloughing		Color		Dryness		Mealiness		Flavor	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
Boiled:										
Unstored	+0. 473	+0. 288	----------	+0. 276	−0. 457	−0. 482*	−0. 466	−0. 702**	−0. 393	+0. 069
Stored:										
3 months at 55° F	+. 572*	+. 516*	----------	−. 090	−. 373	−. 582*	−. 454	−. 712**	−. 380	−. 205
3 months at 40° F	+. 704**	+. 308	----------	−. 152	−. 584*	−. 569*	−. 593*	−. 649**	−. 603*	−. 675**
6 months at 40° F	+. 610**	+. 440	----------	+. 048	−. 540*	−. 552*	−. 641**	−. 633**	−. 529*	−. 475
All storage conditions	+. 669**	+. 420	−0. 055	+. 039	−. 552*	−. 618**	−. 614**	−. 719**	−. 612**	−. 455
Mashed:										
Unstored	----------	----------	−. 379	−. 331	−. 524*	−. 370	−. 483*	−. 722**	−. 115	+. 105
Stored:										
3 months at 55° F	----------	----------	−. 485*	−. 509*	−. 371	−. 648**	−. 448	−. 753**	−. 542*	−. 422
3 months at 40° F	----------	----------	−. 455	−. 674**	−. 584*	−. 637**	−. 551*	−. 624**	−. 395	−. 390
6 months at 40° F	----------	----------	−. 681**	−. 663**	−. 634**	−. 594*	−. 700**	−. 736**	−. 255	−. 465
All storage conditions	----------	----------	−. 574*	−. 658**	−. 569*	−. 632**	−. 612**	−. 760**	−. 336	−. 411
Baked:										
Unstored	----------	----------	----------	−. 407	−. 360	−. 530*	−. 148	−. 652**	−. 098	−. 269
Stored:										
3 months at 55° F	----------	----------	----------	−. 296	−. 452	−. 686**	−. 411	−. 728**	−. 302	−. 487*
3 months at 40° F	----------	----------	----------	−. 572*	−. 562*	−. 499*	−. 488*	−. 633**	−. 406	−. 638**
6 months at 40° F	----------	----------	----------	−. 114	−. 642**	−. 627**	−. 644**	−. 700**	−. 735**	−. 494*
All storage conditions	----------	----------	−. 251	−. 386	−. 534*	−. 616**	−. 505*	−. 731**	−. 493*	−. 544*

FRESH-WEIGHT BASIS

Boiled, all storage conditions	−. 334	−. 157	−. 310	−. 371	−. 045	−. 051	−. 215	−. 239	−. 386	−. 133
Mashed, all storage conditions	----------	----------	−. 447	−. 578*	−. 071	−. 112	−. 149	−. 240	−. 090	−. 082
Baked, all storage conditions	----------	----------	+. 014	−. 222	−. 045	−. 091	−. 055	−. 220	−. 305	−. 180

**Significant at the 1-percent level.

*Significant at the 5-percent level.

TABLE 21.—*Coefficients of correlation between nonprotein nitrogen content in raw potatoes from different storage conditions and palatability characteristics of cooked potatoes, 1948 and 1949*

DRY-WEIGHT BASIS

Cooking method, storage time, and temperature	Nonprotein nitrogen versus—									
	Absence of sloughing		Color		Dryness		Mealiness		Flavor	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
Boiled:										
Unstored	+0.485*	+0.669**			−0.680**	−0.757**	−0.613**	−0.786**		
Stored:										
3 months at 55° F	+.733**	+.681**			−.665**	−.692**	−.603*	−.716**		
3 months at 40° F	+.725**	+.705**			−.735**	−.745**	−.648**	−.783**		
6 months at 40° F	+.739**	+.667**			−.774**	−.728**	−.662**	−.743**		
All storage conditions	+.752**	+.721**	+0.176	+0.310	−.792**	−.806**	−.719**	−.828**	−0.349	−0.389
Mashed:										
Unstored			−.398	−.075	−.656**	−.449	−.617**	−.703**		
Stored:										
3 months at 55° F			−.487*	−.293	−.589*	−.708**	−.680**	−.800**		
3 months at 40° F			−.295	−.341	−.737**	−.675**	−.672**	−.810**		
6 months at 40° F			−.401	−.291	−.646**	−.529*	−.656**	−.691**		
All storage conditions			−.498*	−.404	−.723**	−.669**	−.713**	−.818**	−.310	−.470
Baked:										
Unstored					−.565*	−.771**	−.354	−.762**		
Stored:										
3 months at 55° F					−.621**	−.802**	−.490*	−.752**		
3 months at 40° F					−.709**	−.742**	−.653**	−.744**		
6 months at 40° F					−.707**	−.598*	−.759**	−.704**		
All storage conditions			−.399	−.507*	−.749**	−.806**	−.643**	−.819**	−.232	−.575*

**Significant at the 1-percent level. *Significant at the 5-percent level.

TABLE 22.—*Coefficients of correlation between extracted juice from raw potatoes from different storage conditions and palatability characteristics of cooked potatoes, 1948 and 1949*

DRY-WEIGHT BASIS

Cooking method, storage time, and temperature	Juice versus—					
	Absence of sloughing		Dryness		Mealiness	
	1948	1949	1948	1949	1948	1949
Boiled:						
Unstored	+0.288	+0.660**	−0.735**	−0.595*	−0.405	−0.563*
Stored:						
3 months at 55° F.	+.312	+.468	−.569*	−.551*	−.258	−.399
3 months at 40° F	+.297	+.685**	−.462	−.487*	−.350	−.390
6 months at 40° F	−.010	+.695**	−.381	−.642**	−.089	−.418
All storage conditions	+.257	+.726**	−.610**	−.643**	−.313	−.509*
Mashed:						
Unstored			−.712**	−.508*	−.557*	−.574*
Stored:						
3 months at 55° F			−.703**	−.512*	−.554*	−.466
3 months at 40° F			−.549*	−.487*	−.446	−.492*
6 months at 40° F			−.394	−.457	−.165	−.549*
All storage conditions			−.651**	−.614**	−.465	−.606**
Baked:						
Unstored			−.622**	−.507*	−.534*	−.386
Stored:						
3 months at 55° F			−.390	−.558*	−.311	−.467
3 months at 40° F			−.452	−.570*	−.457	−.452
6 months at 40° F			−.351	−.498*	−.210	−.499*
All storage conditions			−.509*	−.624**	−.439	−.563*

FRESH-WEIGHT BASIS

Boiled, all storage conditions		+.247	+.051	−.040		+.063
Mashed, all storage conditions			+.137	−.050		−.024
Baked, all storage conditions			+.037	−.080		−.026

**Significant at the 1-percent level.

*Significant at the 5-percent level.

TABLE 23.—*Coefficients of correlation for several compositional factors considered separately and jointly with certain palatability characteristics, 1948 and 1949*

Method of preparation, and compositional factors [1] of raw potatoes	Absence of sloughing		Dryness		Mealiness	
	1948	1949	1948	1949	1948	1949
Boiled:						
Total nitrogen and specific gravity	0. 795**	0. 910**	0. 909**	0. 933**	0. 776**	0. 906**
Specific gravity	−. 676**	−. 904**	+. 904**	+. 926**	+. 723**	+. 861**
Total nitrogen	+. 795**	+. 640**	−. 753**	−. 787**	−. 738**	−. 849**
Alcohol insoluble solids	−. 744**	−. 893**	+. 941**	+. 952**	+. 793**	+. 862**
Total nitrogen and alcohol insoluble solids	. 819**	. 927**	. 947**	. 959**	. 820**	. 916**
Mashed:						
Total nitrogen and specific gravity			. 902**	. 814**	. 856**	. 920**
Specific gravity			+. 902**	+. 802**	+. 847**	+. 875**
Total nitrogen			−. 719**	−. 710**	−. 733**	−. 862**
Alcohol insoluble solids			+. 929**	+. 858**	+. 897**	+. 898**
Total nitrogen and alcohol insoluble solids			. 930**	. 864**	. 901**	. 942**
Baked:						
Total nitrogen and specific gravity			. 841**	. 900**	. 781**	. 931**
Specific gravity			+. 835**	+. 888**	+. 780**	+. 902**
Total nitrogen			−. 705**	−. 786**	−. 622**	−. 849**
Alcohol insoluble solids			+. 918**	+. 876**	+. 864**	+. 893**
Total nitrogen and alcohol insoluble solids			. 918**	. 899**	. 866**	. 935**

[1] In determining the coefficients in this table the data for total nitrogen was on a dry-weight basis whereas alcohol insoluble solids and specific gravity were on a fresh-weight basis.

**Significant at the 1-percent level.

for the multiple correlation coefficient showed maximum gains of 5 to 8 percent over the coefficient of determination for the highest of the two simple correlation coefficients.

Multiple coefficients of correlation for total nitrogen and alcohol insoluble solids with sloughing gave more information on the sloughing quality than the multiple coefficients of correlation for total nitrogen and specific gravity. The coefficients of determination of the multiple coefficients of correlation for sloughing showed gains of 5 to 6 percent over the highest of the simple coefficients of correlation. Total nitrogen content gave little or no information additional to that furnished by alcohol insoluble solids on the variation in dryness. When total nitrogen and alcohol insoluble solids were considered simultaneously with the mealiness characteristic the multiple coefficients of correlation were consistently higher than the highest of the simple coefficients.

Results of the correlation studies indicate that a number of compositional factors are good indicators of cooking quality in potatoes and may be used for predetermining quality for boiling, mashing, or baking. Specific gravity, dry matter, alcohol insoluble solids, and starch content all showed highly significant relationships to the palatability characteristics, sloughing, dryness, and mealiness. Nitrogen content also gave a significant relationship to those quality characteristics although not quite as high and in an opposite direction from the above compositional factors. As nitrogen content increased the quality ratings for dryness and mealiness decreased. When several of the compositional factors are considered simultaneously with palatability characteristics, some additional information can be obtained for predicting mealiness, as was shown in these studies by using nitrogen content with either alcohol insoluble solids or specific gravity. However, the additional information obtained through these multiple correlations is rather meager.

As dry matter, alcohol insoluble solids, starch, or specific gravity give almost equally good measures for the prediction of cooking quality, grading or labeling potatoes in terms of any of these measurements would provide useful information. As specific gravity provides information comparable to the other measurements studied and is the simplest to obtain, it is the best practical measure of cooking quality in potatoes.

LITERATURE CITED

(1) Akeley, R. V., and Stevenson, F. J.
1943. Yield, specific gravity, and starch content of tubers in a potato breeding program. Amer. Potato Jour. 20: 203–217.

(2) Ashby, S. F.
1905–6. A contribution to the study of the factors affecting the quality and composition of potatoes. Jour. Agr. Sci. 1: 347–357.

(3) Association of Official Agricultural Chemists.
1945. Official and tentative methods of analysis. Sixth edition.

(4) Baker, L. C., Parkinson, T. L., and Knight, P. M.
1948. Vitamin C content of potatoes grown on reclaimed land. II. Potatoes grown in 1946. Jour. Soc. Chem. Ind. (London) 67: 118–120.

(5) Bandemer, S. L., Schaible, P. J., and Wheeler, E. J.
1947. Discoloration of potatoes after cooking as related to their composition. Amer. Potato Jour. 24: 1–6.

(6) BARMORE, M. A.
1937. POTATO MEALINESS AND CHANGES IN SOFTNESS ON COOKING. Food Research 2: 377–383.
(7) BEWELL, E. R.
1937. THE DETERMINATION OF THE COOKING QUALITY OF POTATOES. Amer. Potato Jour. 14: 235–242.
(8) BUTLER, O., MORRISON, F. B., and BOLL, F. E.
1913. STUDIES ON THE FACTORS AFFECTING THE CULINARY QUALITY OF POTATOES. Jour. Amer. Soc. Agron. 5: 1–33.
(9) CHILD, A. M., and WILLAMAN, J. J.
1949. CULINARY QUALITY IN POTATOES. Amer. Potato Jour. 6: 259–266.
(10) CLARK, C. F., LOMBARD, P. M., and WHITEMAN, E. F.
1940. COOKING QUALITY OF THE POTATO AS MEASURED BY SPECIFIC GRAVITY. Amer. Potato Jour. 17: 38–45.
(11) COBB, J. S.
1935. A STUDY OF CULINARY QUALITY IN WHITE POTATOES. Amer. Potato Jour. 12: 335–346.
(12) COUDON, H., and BUSSARD, L.
1897. RECHERCHES SUR LA POMME DE TERRE ALIMENTAIRE. Ann. Sci. Agron. 2d ser., 1: 250–291.
(13) DENNY, F. E., and THORNTON, N. C.
1941. POTATO VARIETIES: SUGAR FORMING CHARACTERISTICS OF TUBERS IN COLD STORAGE, AND SUITABILITY FOR PRODUCTION OF POTATO CHIPS. Contri. Boyce T. Inst. Plant Res. 12: 217–252.
(14) DUNN, L. E.
1945. EFFECT OF FERTILIZERS ON THE QUALITY OF POTATOES GROWN IN THE RED RIVER VALLEY OF MINNESOTA. Amer. Potato Jour. 22: 173–187.
(15) ——— and NYLUND, R. E.
1945. THE INFLUENCE OF FERTILIZERS ON THE SPECIFIC GRAVITY OF POTATOES GROWN IN MINNESOTA. Amer. Potato Jour. 22: 275–288.
(16) ——— and ROST, C. O.
1948. EFFECT OF FERTILIZERS ON THE COMPOSITION OF POTATOES GROWN IN THE RED RIVER VALLEY OF MINNESOTA. Soil Sci. Soc Amer. Proc. 13: 374–379.
(17) EAST, E. M.
1908. A STUDY OF THE FACTORS INFLUENCING THE IMPROVEMENT OF THE POTATO. Ill. Agr. Expt. Sta. Bul. 127, 83 pp.
(18) FISHER, J. D.
1931. THE RELATION BETWEEN CARBOHYDRATE CONTENT AND THE COOKING QUALITIES OF MICHIGAN POTATOES. Thesis in Michigan State College Library.
(19) FREEMAN, M. E.
1942. MEASUREMENT OF TEXTURE IN BAKED POTATO TISSUE. Food Research 7: 451–458.
(20) ——— and RITCHIE, W. S.
1940. PECTINS AND THE TEXTURE OF COOKED POTATOES. Food Research 5: 167–175.
(21) GILMORE, J. W.
1905. QUALITY IN POTATOES. Cornell University Agr. Expt. Sta. Bul. 230, 22 pp.
(22) GLYNNE, M. D., and JACKSON, V. G.
1919. THE DISTRIBUTION OF DRY MATTER AND NITROGEN IN THE POTATO TUBER. Variety, King Edward. Jour. Agr. Sci. 9: 237–258.
(23) GOLDTHWAITE, N. E.
1925. VARIATIONS IN THE COMPOSITION OF COLORADO POTATOES. Colo. Agr. Expt. Sta. Bul. 296, 77 pp., illus.
(24) GREENWOOD, M. L., MCKENDRICK, M. H., and HAWKINS, A.
1952. THE RELATIONSHIP OF THE SPECIFIC GRAVITY OF SIX VARIETIES OF POTATOES TO THEIR MEALINESS AS ASSESSED BY SENSORY METHODS. Amer. Potato Jour. 29: 192–196.
(25) GREIG, S., and SMITH, O.
1951. GRADING POTATOES FOR MEALINESS AND ITS EFFECT ON RETAIL SALES. Amer. Potato Jour. 28: 499–520.

(26) HADDOCK, J. L., and BLOOD, P. T.
1939. VARIATIONS IN COOKING QUALITY OF POTATOES AS INFLUENCED BY VARIETIES. Amer. Potato Jour. 16: 126–133.
(27) HARCOURT, R.
1907. COMPOSITION AND COOKING QUALITIES OF POTATOES. Farmers' Inst. of Ontario 12th Rept. 1906. 71–77.
(28) HARDENBURG, E. V.
1933. SOME FALSE NOTIONS ABOUT POTATO VARIETIES. Amer. Potato Jour. 10: 201–204.
(29) ———
1949. POTATO PRODUCTION. Comstock Publishing Co., Inc. 270 pp. Ithaca, N. Y.
(30) HEADDEN, W. P.
1927. EFFECTS OF NITRATES ON COMPOSITION OF THE POTATO. Colo. Agr. Expt. Sta. Bul. 325, 96 pp.
(31) HEINZE, P. H., CRAFT, C. C., MOUNTJOY, B. M., and KIRKPATRICK, M. E.
1952. VARIATIONS IN SPECIFIC GRAVITY OF POTATOES. Amer. Potato Jour. 29: 31–37.
(32) ——— and MURNEEK, A. E.
1940. COMPARATIVE ACCURACY AND EFFICIENCY IN DETERMINATION OF CARBOHYDRATES IN PLANT MATERIAL. Mo. Agr. Expt. Sta. Res. Bul. 314, 23 pp.
(33) HILTON, R. J.
1951. FACTORS IN RELATION TO TUBER QUALITY IN POTATOES. II. PRELIMINARY TRIALS ON BITTERNESS IN NETTED GEM POTATOES. Scientific Agr. 31: 61–70.
(34) HINCKS, M. A.
1940. MARKETING MAINE POTATOES. I. A PRELIMINARY REPORT OF CONSUMER PREFERENCE FOR POTATOES IN BOSTON, MARCH 4 TO APRIL 6, 1940. Maine Agr. Expt. Sta. Misc. Pub. 561, 33 pp.
(35) HOTCHKISS, A. S.
1938. CONSUMER PRACTICES IN BUYING POTATOES IN RELATION TO STORE OFFERINGS— A STUDY OF CONSUMER DEMAND. Thesis in Cornell University Library.
(36) ——— WOOD, N., and FINDLEN, P.
1940. COOKING-QUALITY PREFERENCES FOR POTATOES. Amer. Potato Jour. 17: 253–261.
(37) JUUL, FLEMING
1949. STUDIER OVER KARTOFLENS MORKFARVNING EFTER KOGNING. Kobenhavn. (Review translated by Mogen Kunst. Amer. Potato Jour. 27: 32–35.)
(38) KELLY, W. C., and SMITH, O.
1944. SPECIFIC GRAVITY DETERMINATION AS AN AID IN RESEARCH. Amer. Soc. Hort. Sci. Proc. 44: 329–333.
(39) ——— and SOMERS, G. F.
1949. THE EFFECT OF TIME OF HARVEST, VARIETY, AND STORAGE OF THE ASCORBIC ACID CONTENT OF POTATO TUBERS. Amer. Potato Jour. 26: 47–53.
(40) KIRKPATRICK, M. E., MOUNTJOY, B. M., and ALBRIGHT, L. C.
1952. INFLUENCE OF VARIETY ON YIELD OF POTATOES PREPARED FOR COOKING. Jour. Amer. Diet. Assoc. 28: 231–234.
(41) ——— MOUNTJOY, B. M., ALBRIGHT, L. C., and HEINZE, P. H.
1951. COOKING QUALITY, SPECIFIC GRAVITY AND REDUCING SUGAR CONTENT OF EARLY-CROP POTATOES. U. S. Dept. Agr. Circ. 872, 22 pp., illus.
(42) KUNKEL, R., GIFFORD, P. F., EDGAR, A. D., and BINKLEY, A. M.
1952. THE MECHANICAL SEPARATION OF POTATOES INTO SPECIFIC GRAVITY GROUPS. Colo. Agr. Expt. Sta. Bul. 422-A, 38 pp., illus.
(43) LANGWORTHY, C. F.
1917. POTATOES, SWEET POTATOES AND OTHER STARCHY ROOTS AS FOOD. U. S. Dept. Agr. Bul. 468, 28 pp.
(44) LECLERG, E. L.
1947. ASSOCIATION OF SPECIFIC GRAVITY WITH DRY-MATTER CONTENT AND WEIGHT OF IRISH POTATO TUBERS. Amer. Potato Jour. 24: 6–9.

(45) MAYFIELD, H. L., RICHARDSON, J. E., DAVIS, R. J., and ANDES, E. J.
1937. THE EFFECT OF WINTER STORAGE ON THE PALATABILITY AND VITAMIN CONTENT OF POTATOES GROWN IN MONTANA. Mont. Agr. Expt. Sta. Bul. 346, 23 pp., illus.
(46) MURPHY, E. F., DOVE, W. F., and AKELEY, R. V.
1945. OBSERVATIONS ON GENETIC, PHYSIOLOGICAL, AND ENVIRONMENTAL FACTORS AFFECTING THE VITAMIN C CONTENT OF MAINE GROWN POTATOES. Amer. Potato Jour. 22: 62–83.
(47) NIELSEN, J. P.
1943. RAPID DETERMINATION OF STARCH. Ind. and Eng. Chem., Anal. Ed. 15: 176–179.
(48) PEARSALL, L. W.
1952. FACTS ABOUT POTATO QUALITY. Amer. Potato Jour. 29: 182–185.
(49) PERSONIUS, C. J., and SHARP, P. F.
1939. SIMULATION, BY CHEMICAL AGENTS, OF COOKING OF POTATO TISSUE. Food Research 4: 469–473.
(50) RATHSACK, K.
1935. DER SPEISEWERT DER KARTOFFEL. Verlagsgesellschaft für Ackerbau. (Berlin) 139 pp. (As cited by Burton.)
(51) RINEAR, E. H.
1931. CONSUMER PREFERENCES FOR POTATOES. N. H. Agr. Expt. Sta. Cir. 37. 14 pp.
(52) ROBERTSON, I. M., and SMITH, A. M.
1931. A STUDY OF THE HYDROGEN ION CONCENTRATION OF THE POTATO TUBER. Biochem. Jour. 25: 763–769.
(53) SMEE, A.
1847. THE POTATOE PLANT, ITS USES AND PROPERTIES. 157 pp. (London).
(54) SMITH, O.
1950. HOW TO PICK OUT POTATOES—BY SPECIFIC GRAVITY. Pre-Pack-Age 4: 31.
(55) ——— and NASH, L. B.
1940. POTATO QUALITY. I. RELATION OF FERTILIZERS AND ROTATION SYSTEMS TO SPECIFIC GRAVITY AND COOKING QUALITY. Amer. Potato Jour. 17: 163–169.
(56) ——— NASH, L. B., and DITTMAN, A. L.
1942. POTATO QUALITY. VI. RELATION OF TEMPERATURE AND OTHER FACTORS TO BLACKENING OF BOILED POTATOES. Amer. Potato Jour. 19: 229–254.
(57) STEVENSON, F. J., and WHITEMAN, E. F.
1935. COOKING QUALITY OF CERTAIN POTATO VARIETIES AS INFLUENCED BY ENVIRONMENT. Amer. Potato Jour. 12: 41–47.
(58) STUART, N. W., and APPLEMAN, C. O.
1935. NITROGENOUS METABOLISM IN IRISH POTATOES DURING STORAGE. Md. Agr. Expt. Sta. Bul. 372, 23 pp.
(59) SWEETMAN, M. D.
1936. FACTORS AFFECTING THE COOKING QUALITY OF POTATOES. Me. Agr. Expt. Sta. Bul. 383, 90 pp.
(60) THIESSEN, E. J.
1947. THE CULINARY QUALITIES AND NUTRITIVE VALUES OF POTATOES GROWN UPON DRY AND IRRIGATED LAND. Wyo. Agr. Expt. Sta. Bul. 280, 31 pp., illus.
(61) THOMPSON, J. F., and STEWARD, F. C.
1952. THE ANALYSIS OF THE ALCOHOL-INSOLUBLE NITROGEN OF PLANTS BY QUANTITATIVE PROCEDURES BASED ON PAPER CHROMATOGRAPHY. Jour. Exp. Botany 3: 170–187.
(62) TUKEY, J. W.
1949. COMPARING INDIVIDUAL MEANS IN THE ANALYSIS OF VARIANCE. Biometrics 5: 99–144.
(63) UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS.
1948. POTATO PREFERENCES AMONG HOUSEHOLD CONSUMERS. U. S. Dept. Agr. Misc. Pub. 667, 119 pp.
(64) UNITED STATES BUREAU OF HUMAN NUTRITION AND HOME ECONOMICS. UNPUBLISHED DATA FROM 1948 FOOD CONSUMPTION SURVEYS.
(65) VANASSE, N. A., JONES, I. D., and LUCAS, H. L.
1951. SPECIFIC GRAVITY-DRY MATTER RELATIONSHIP IN POTATOES. Amer. Potato Jour. 28: 781–791.

(66) Von Scheele, C., Svensson, G., and Rasmusson, J.
1936–37. Die bestimmung des stärkegehalts und der trockensubstanz der kartoffel mit hilfe des specifischen gewichts. Landw. Versta. 127: 67–96.

(67) Wheeler, E. J.
1939. A quick method of predetermining the culinary quality of potatoes with special reference to color. Mich. Sta. Quarterly Bul. 21: 213–215.

(68) Whittenberger, R. T.
1951. Changes in specific gravity, starch content, and sloughing of potatoes during storage. Amer. Potato Jour. 28: 738–747.

(69) Williaman, J. J., and West, R. M.
1924. A statistical study of the composition of potato tubers. Minn. Studies in Plant Sciences 5: 211–227.

(70) Wood, M. A.
1943. Potatoes in institution food service. Cornell Univ. Agr. Expt. Sta. Bul. 798, 46 pp., illus.

(71) Wright, R. C.
1932. Some physiological studies of potatoes in storage. Jour. Agr. Res. 45: 543–555.

(72) ——— Peacock, W. M., Whiteman, T. M., and Whiteman, E. F.
1936. The cooking quality, palatability and carbohydrate composition of potatoes as influenced by storage temperature. U. S. Dept. Agr. Tech. Bul. 507, 20 pp.

APPENDIX

TABLE 24.—*Information on the factors of production for various lots of potatoes, 1948 and 1949*

Variety, location and year	Soil type	Fertilizer	Vine killer
Chippewa:			
Indiana:			
1948	Muck	1,000 lb. 3-9-18 in row	None.
1949			
Maine:			
1948	Caribou loam (acid)	1,400 lb. 8-16-16 in row	Do.
1949	do	1,400 lb. 8-16-16 in row	Do.
Michigan:			
1948	Montcalm sandy loam	800 lb. 3-12-12	Copper sulfate—1 week before harvest.
1949	Sandy to heavy loam	700 lb. 3-12-12	None—vines dead.
Green Mountain:			
Maine, I:			
1948	Caribou loam (acid)	1,400 lb. 8-16-16 in row	None.
1949	do	1,400 lb. 8-16-16 in row	Do.
Maine, II:			
1948	Chapman		Rotobeater—1 week before harvest.
1949			
New York:			
1948			
1949			
Irish Cobbler:			
Maine:			
1948	Caribou loam (acid)	1,400 lb. 8-16-16 in row	Do.
1949	Caribou A	1,600 lb. 8-16-16 in row	Sodium arsenite.
North Dakota:			
1948	Beardon clay loam	200 lb. 0-20-10	Mechanical.
1949			
Wisconsin:			
1948			
1949	Antigo silt loam	1,500 lb. 3-12-12	Rotobeater.

Katahdin:			
Colorado:			
1948	Sandy loam		
1949	Medium heavy loam	15 tons manure	Rotobeater—1 week before harvest.
Maine:			
1948	Caribou loam (acid)	1,400 lb. 8–16–16 in row	None.
1949	do	1,400 lb. 8–16–16 in row	Do.
Pennsylvania:			
1948	Morrison sandy loam	1,500 lb. 5–10–10 in row	Do.
1949	Sandy loam	1,700 lb. 5–10–10	Mechanical.
Russet Burbank:			
Idaho, Aberdeen:			
1948	Declo loam	Manure	None—verticillium wilt.
1949	do		None.
Idaho, Ashton:			
1948	Loam	None	None—frost.
1949			None.
Washington:			
1948			
1949		400 lb. 16–20–0	Do.
Triumph:			
North Dakota, Grand Forks:			
1948	Beardon clay loam	200 lb. 0–20–10	Mechanical.
1949			Do.
North Dakota, Walhalla:			
1948	Ulen sandy loam		
1949			

TABLE 25.—*Boiled potatoes: Mean palatability scores for 6 varieties from 2 or 3 locations, 1948 and 1949*

Variety and location	Specific gravity		Storage		Mean palatability scores [1]									
					Absence of sloughing		Color		Dryness		Mealiness		Flavor	
	1948	1949	Time	Temp.	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
Chippewa:	*Av.*	*Av.*	*Months*	° *F.*										
Indiana	1.064	1.064	0		2.7	2.5	2.6	2.3	1.3	1.6	1.9	1.9	2.2	2.5
			3	55	2.9	2.7	2.2	2.2	1.4	1.6	1.7	1.6	2.1	2.3
			3	40	2.9	3.0	2.3	1.9	1.2	1.7	1.4	1.6	2.2	1.9
			6	40	2.9	2.8	2.4	1.9	1.2	1.2	1.4	1.6	1.4	1.7
Maine	1.082	1.069	0		2.8	2.6	2.4	2.4	2.1	1.8	2.4	2.0	2.4	2.4
			3	55	2.6	3.0	2.6	2.1	2.0	1.7	2.3	1.7	2.3	1.8
			3	40	2.8	2.8	2.1	2.1	1.9	1.7	2.0	1.7	2.4	1.6
			6	40	2.6	3.0	2.2	1.8	2.1	1.4	2.1	1.7	2.1	1.6
Michigan	1.082	1.076	0		2.4	2.5	2.6	2.1	1.9	1.9	2.7	2.2	2.6	2.3
			3	55	2.9	2.3	2.3	2.1	1.8	1.8	1.7	1.8	2.2	2.0
			3	40	2.9	2.3	2.3	1.9	1.9	2.0	1.7	1.9	2.1	2.2
			6	40	2.8	2.3	2.1	1.5	1.9	1.7	1.7	1.8	2.1	1.7
Green Mountain:														
Maine, I	1.088	1.077	0		2.3	1.9	2.1	2.3	1.9	1.9	2.7	2.6	2.3	2.3
			3	55	2.6	2.4	1.6	1.8	2.1	1.8	2.3	2.1	2.1	1.9
			3	40	2.6	2.4	1.7	2.2	2.2	2.1	2.6	2.2	1.9	1.8
			6	40	2.4	2.3	1.4	1.7	2.1	1.8	2.1	2.1	1.6	1.4
Maine, II	1.096	1.088	0		1.8	1.7	2.2	2.2	2.4	2.6	2.9	2.5	2.6	2.7
			3	55	2.1	2.1	1.6	1.9	2.4	2.2	2.8	2.0	1.7	2.0
			3	40	2.3	2.1	1.9	1.8	2.4	2.0	2.4	2.1	2.1	1.6
			6	40	2.1	2.0	1.3	1.5	2.6	1.9	2.5	2.0	1.6	1.3
New York	1.098	1.083	0		1.1	2.0	1.9	2.0	2.6	2.1	2.9	2.6	2.4	2.5
			3	55	1.7	2.1	1.4	1.4	2.5	2.2	2.7	2.2	2.4	1.5
			3	40	2.0	2.0	1.5	1.4	2.6	1.8	2.6	1.9	2.1	1.6
			6	40	2.2	2.0	1.5	1.3	2.4	1.6	2.2	1.7	1.7	1.2
Irish Cobbler:														
Maine	1.090	1.087	0		1.7	1.3	2.6	2.0	2.2	2.2	2.8	2.4	2.4	2.8
			3	55	1.9	1.9	2.3	1.4	2.3	2.1	2.4	2.1	2.1	2.0
			3	40	1.9	1.7	1.6	1.2	2.1	2.4	2.4	2.2	2.1	1.8
			6	40	2.0	1.5	1.2	1.0	2.1	2.1	1.9	1.9	1.6	1.4
North Dakota	1.089	1.092	0		1.9	1.0	2.2	1.9	2.5	2.3	2.4	2.8	2.6	2.8
			3	55	1.8	1.2	1.9	1.6	2.5	2.4	2.5	2.6	2.3	2.1
			3	40	2.2	1.3	1.6	1.5	2.2	2.7	2.1	2.8	2.2	2.1

Wisconsin	1.085	1.078	6	40	2.5	1.6	1.3	1.1	2.3	2.2	1.9	2.5	1.7	1.7
			0	--------	1.9	1.8	2.6	2.0	2.3	2.4	2.7	2.5	2.4	2.9
			3	55	2.0	2.2	2.1	1.7	1.9	2.2	2.3	2.0	2.1	1.9
			3	40	1.8	2.1	1.9	1.3	2.3	2.2	2.3	2.1	2.1	1.8
			6	40	2.0	2.3	1.4	1.2	2.4	1.8	2.3	2.2	1.7	1.6
Katahdin:														
Colorado	1.098	1.093	0	--------	2.1	1.4	2.2	1.7	2.3	2.4	2.6	2.4	2.6	2.7
			3	55	1.8	1.8	1.8	1.6	2.5	2.4	2.3	2.1	2.6	2.0
			3	40	2.0	1.3	1.9	1.4	2.5	2.6	2.2	2.6	2.6	2.1
			6	40	2.0	1.8	1.7	1.2	2.4	2.0	2.2	2.0	2.1	1.9
Maine	1.090	1.078	0	--------	2.3	2.1	2.2	1.9	2.0	2.4	2.3	2.1	2.4	2.4
			3	55	2.3	2.9	1.6	1.7	2.1	2.1	2.2	1.7	2.3	1.8
			3	40	2.8	3.0	1.7	1.9	2.2	1.9	2.0	1.9	2.2	1.9
			6	40	2.9	2.9	1.4	1.6	2.4	1.6	1.9	1.6	1.9	1.6
Pennsylvania	1.079	1.071	0	--------	2.7	2.6	2.0	2.0	2.2	1.8	2.3	1.7	2.5	2.4
			3	55	2.3	2.5	1.5	1.6	2.2	1.9	2.3	1.6	2.4	2.0
			3	40	2.6	2.3	1.6	1.8	1.9	1.7	1.7	1.7	2.3	1.9
			6	40	2.7	2.6	1.6	1.3	1.8	1.4	2.1	1.4	1.6	1.6
Russet Burbank:														
Idaho, Aberdeen	1.089	1.088	0	--------	1.8	1.9	2.7	2.2	2.3	2.4	2.8	2.6	2.6	2.7
			3	55	1.8	1.9	2.3	2.2	2.7	2.7	2.9	2.7	2.4	2.4
			3	40	1.7	2.0	2.2	1.4	2.7	2.6	2.9	2.9	2.8	2.3
			6	40	1.9	1.8	1.8	1.7	2.5	2.2	2.6	2.6	1.9	1.7
Idaho, Ashton	1.096	1.088	0	--------	2.7	2.2	2.1	1.5	2.2	2.4	2.7	2.6	2.5	2.1
			3	55	2.2	2.6	2.0	1.4	2.6	2.2	2.7	2.5	2.6	2.2
			3	40	2.2	2.3	1.7	1.8	2.4	2.6	2.9	2.7	2.6	2.1
			6	40	2.6	2.3	2.6	1.3	2.4	2.1	2.4	2.3	1.8	1.7
Washington	1.095	1.100	0	--------	1.2	1.0	2.3	2.1	2.4	2.9	3.0	2.8	2.6	2.6
			3	55	1.1	1.0	2.1	1.8	2.6	2.8	2.9	2.9	2.3	2.2
			3	40	1.4	1.0	2.2	1.8	2.7	2.8	2.9	3.0	2.7	2.4
			6	40	1.3	1.0	2.1	1.6	2.7	2.6	2.9	2.8	2.2	1.8
Triumph:														
North Dakota, Grand Forks	1.087	1.087	0	--------	3.0	1.5	2.8	2.1	1.9	1.9	1.9	2.4	2.6	2.3
			3	55	2.7	1.9	2.4	1.6	2.2	2.1	1.8	2.1	2.3	2.4
			3	40	2.8	1.9	2.6	1.6	1.8	2.1	1.8	2.0	2.1	1.8
			6	40	2.8	1.8	2.2	1.6	1.9	2.0	1.7	2.2	1.6	1.8
North Dakota, Walhalla	1.095	1.082	0	--------	2.1	2.1	2.8	2.3	2.4	2.0	2.8	2.2	2.7	2.6
			3	55	1.7	2.1	2.0	1.7	2.3	2.1	2.4	1.9	2.6	2.0
			3	40	2.0	2.1	2.2	1.6	2.1	2.0	2.0	2.1	2.3	1.7
			6	40	2.3	2.3	1.8	1.8	2.2	1.7	2.0	1.6	1.9	1.5

[1] Mean scores of 6 judges on 3 replicates. 3 was highest score; 1 the lowest.

TABLE 26.—*Mashed potatoes: Mean palatability scores for 6 varieties from 2 or 3 locations, 1948 and 1949*

Variety and location	Specific gravity		Storage		Mean palatability scores [1]							
					Color		Dryness		Mealiness		Flavor	
	1948	1949	Time	Temp.	1948	1949	1948	1949	1948	1949	1948	1949
Chippewa:	*Av.*	*Av.*	*Months*	*°F.*								
Indiana	1.064	1.064	0	-------	2.3	2.4	1.3	1.4	2.1	1.7	2.4	2.4
			3	55	1.8	2.1	1.1	1.5	1.4	1.3	2.2	2.1
			3	40	2.2	1.8	1.2	1.6	1.4	1.4	1.8	1.9
			6	40	2.1	1.9	1.0	1.3	1.3	1.5	1.2	1.4
Maine	1.082	1.069	0	-------	2.6	2.2	2.2	1.8	2.7	2.0	2.6	2.8
			3	55	2.8	2.2	1.8	1.3	2.2	1.6	2.3	1.6
			3	40	2.2	1.9	1.7	1.4	2.1	1.6	2.7	1.8
			6	40	2.3	1.8	2.0	1.5	2.3	1.4	2.2	1.6
Michigan	1.082	1.076	0	-------	2.6	2.5	2.0	2.1	2.4	2.3	2.5	2.8
			3	55	2.0	2.2	2.0	2.0	1.9	2.1	2.2	2.2
			3	40	2.4	2.1	1.9	2.1	2.0	2.2	2.4	2.1
			6	40	2.1	1.8	1.8	1.6	1.6	1.9	2.0	1.4
Green Mountain:												
Maine, I	1.088	1.077	0	-------	2.2	2.6	1.9	1.8	2.6	2.1	2.3	2.4
			3	55	2.1	1.9	2.1	1.6	2.4	1.7	2.3	1.9
			3	40	2.1	2.2	2.2	1.8	2.7	1.9	2.5	1.9
			6	40	1.9	1.9	1.8	1.3	2.1	1.8	1.5	1.5
Maine, II	1.096	1.088	0	-------	2.4	2.2	2.8	2.2	2.9	2.4	2.5	2.6
			3	55	1.9	2.1	2.4	2.2	2.7	2.0	2.1	2.0
			3	40	2.6	1.9	2.6	1.9	2.8	2.2	2.4	1.8
			6	40	1.9	2.1	2.8	1.9	2.7	2.0	1.8	1.7
New York	1.098	1.083	0	-------	2.3	2.2	3.0	2.4	3.0	2.8	1.9	2.6
			3	55	2.1	1.8	2.6	2.3	2.9	2.2	2.4	1.6
			3	40	2.1	1.7	2.7	1.8	2.8	1.9	2.3	1.3
			6	40	1.9	1.5	2.8	1.4	2.8	1.7	1.7	1.2
Irish Cobbler:												
Maine	1.090	1.087	0	-------	2.9	2.2	2.3	2.1	2.8	2.2	2.2	2.9
			3	55	2.4	1.9	2.1	2.1	2.4	2.0	2.1	2.1
			3	40	2.2	1.6	2.2	2.2	2.8	2.2	2.1	2.4
			6	40	1.8	1.4	2.1	1.9	2.2	2.3	1.8	1.6
North Dakota	1.089	1.092	0	-------	2.6	2.1	2.8	1.9	2.8	2.5	2.9	2.6

			3	55	2.3	1.9	2.5	2.5	2.8	2.7	2.4	1.9
			3	40	1.8	2.1	2.4	2.3	2.3	2.7	2.4	2.2
			6	40	1.8	2.1	2.3	1.8	2.1	2.4	1.8	1.7
Wisconsin	1.085	1.078	0	-------	2.8	2.6	2.7	2.1	2.9	2.4	1.8	2.5
			3	55	2.2	1.9	2.1	2.3	2.1	2.2	2.2	2.1
			3	40	2.2	1.9	2.1	2.1	2.3	2.2	1.9	1.9
			6	40	2.1	1.4	1.9	1.9	2.2	2.1	1.7	1.7
Katahdin:												
Colorado	1.098	1.093	0	-------	2.4	2.1	2.7	2.7	2.9	2.7	2.7	2.3
			3	55	2.4	2.1	2.7	3.0	2.8	2.9	2.8	2.3
			3	40	2.2	1.9	2.8	2.7	2.7	2.8	2.8	2.1
			6	40	2.3	1.7	3.0	2.3	2.7	2.7	1.9	1.6
Maine	1.090	1.078	0	-------	2.4	2.3	2.4	2.6	2.8	2.6	2.7	2.4
			3	55	2.1	2.2	2.3	2.2	2.5	2.1	2.3	2.2
			3	40	1.9	2.0	2.3	2.1	2.2	2.0	2.4	1.9
			6	40	2.1	1.7	2.4	1.7	2.4	1.8	1.8	1.4
Pennsylvania	1.079	1.071	0	-------	2.0	2.1	2.4	2.0	2.7	1.9	2.6	2.7
			3	55	1.9	1.8	2.3	1.9	2.3	1.6	2.3	1.9
			3	40	1.6	1.9	2.1	1.7	2.1	1.6	2.4	1.8
			6	40	1.6	1.2	2.1	1.7	2.2	1.4	1.9	1.3
Russet Burbank:												
Idaho, Aberdeen	1.089	1.088	0	-------	2.8	2.9	2.8	2.8	2.9	2.9	2.8	2.5
			3	55	2.9	2.8	2.9	2.9	3.0	2.9	2.6	2.4
			3	40	3.0	2.7	2.8	2.8	3.0	2.9	2.5	2.4
			6	40	2.6	2.6	2.7	2.6	2.9	2.8	2.0	1.6
Idaho, Ashton	1.096	1.088	0	-------	2.6	2.4	2.6	2.7	2.9	2.9	2.6	2.5
			3	55	1.9	2.1	2.8	2.7	2.9	2.7	2.6	2.4
			3	40	2.3	2.3	2.6	2.9	2.9	2.9	2.6	2.2
			6	40	2.3	2.0	2.8	2.4	2.9	2.7	1.8	1.8
Washington	1.095	1.100	0	-------	2.9	2.3	2.8	1.9	3.0	2.6	2.4	2.8
			3	55	2.8	2.4	2.2	2.9	2.9	2.9	2.5	2.3
			3	40	2.7	2.4	2.7	2.9	3.0	3.0	2.7	2.2
			6	40	2.9	2.3	2.7	2.8	3.0	3.0	2.2	1.7
Triumph:												
North Dakota, Grand Forks	1.087	1.087	0	-------	2.9	2.4	2.0	1.9	2.1	2.0	2.8	2.4
			3	55	2.6	2.1	2.1	2.1	2.0	2.0	2.5	2.3
			3	40	2.2	1.8	1.8	2.1	1.8	2.2	2.1	2.1
			6	40	2.1	1.8	1.6	2.0	1.6	2.2	1.6	1.6
North Dakota, Walhalla	1.095	1.082	0	-------	2.7	2.3	2.7	2.2	2.8	2.3	2.7	2.9
			3	55	2.6	2.1	2.7	2.2	2.7	2.1	2.4	2.2
			3	40	2.1	1.9	2.4	2.1	2.2	2.3	2.3	1.9
			6	40	2.1	1.8	2.3	1.8	2.3	1.9	1.7	1.4

[1] Mean scores of 6 judges on 3 replicates. 3 was highest score; 1 the lowest.

TABLE 27.—*Baked potatoes: Mean palatability scores for 6 varieties from 2 or 3 locations, 1948 and 1949*

Variety and location	Specific gravity		Storage		Mean palatability scores [1]							
					Color		Dryness		Mealiness		Flavor	
	1948	1949	Time	Temp.	1945	1949	1948	1949	1948	1949	1948	1949
Chippewa:	*Av.*	*Av.*	*Months*	° *F.*								
Indiana	1.066	1.065	0		1.9	2.1	1.3	1.2	2.1	1.5	2.3	2.1
			3	55	1.8	1.8	1.3	1.2	1.8	1.7	2.1	2.3
			3	40	1.7	2.0	1.0	1.6	1.4	1.9	1.9	2.3
			6	40	1.5	1.6	1.1	1.1	1.4	1.4	1.3	1.6
Maine	1.083	1.069	0		2.4	2.6	1.9	1.9	2.6	2.2	2.6	2.6
			3	55	2.5	2.2	1.7	1.2	2.4	1.5	2.2	1.9
			3	40	2.3	2.1	1.9	1.6	2.4	1.8	2.3	1.9
			6	40	2.3	1.8	1.8	1.1	2.2	1.2	2.2	1.5
Michigan	1.082	1.076	0		2.7	2.6	2.2	2.0	2.6	2.7	2.9	2.6
			3	55	2.2	2.0	1.6	1.8	2.2	1.8	2.4	2.2
			3	40	2.1	2.4	1.7	2.9	2.3	2.4	2.5	2.3
			6	40	1.9	1.9	1.6	1.2	1.7	1.6	1.6	1.7
Green Mountain:												
Maine, I	1.088	1.078	0		2.2	2.8	2.1	2.3	2.7	2.6	2.1	2.6
			3	55	2.2	2.1	2.0	1.9	2.3	2.1	2.0	2.1
			3	40	2.1	2.2	2.2	2.1	2.7	2.3	1.9	1.9
			6	40	2.0	2.0	1.9	1.5	2.4	1.3	1.6	1.3
Maine, II	1.095	1.088	0		2.2	2.6	2.6	2.8	2.9	2.7	2.2	2.7
			3	55	2.2	2.0	2.4	2.4	2.7	2.7	1.9	1.9
			3	40	2.3	2.3	2.4	2.4	2.7	2.6	1.9	2.2
			6	40	2.1	1.7	2.3	1.8	2.6	2.2	1.7	1.6
New York	1.097	1.082	0		1.9	2.2	3.0	2.3	3.0	2.6	2.3	2.2
			3	55	1.6	1.7	2.4	2.0	2.6	2.2	2.0	1.7
			3	40	2.1	1.8	2.7	2.1	2.8	2.2	2.0	1.7
			6	40	1.6	1.3	2.4	1.4	2.6	1.7	1.9	1.3
Irish Cobbler:												
Maine	1.090	1.088	0		2.8	2.3	2.7	2.4	2.9	2.4	2.8	2.5
			3	55	2.4	2.2	2.4	2.3	2.6	2.4	2.2	2.2
			3	40	2.1	1.6	2.7	2.8	2.8	2.7	1.9	2.1
			6	40	1.9	1.6	2.3	2.0	2.4	2.2	1.4	1.5

North Dakota	1.090	1.092	0		2.7	2.6	2.5	2.9	2.8	2.8	2.8	2.7
			3	55	2.2	2.5	2.4	2.8	2.4	2.7	2.1	2.4
			3	40	1.8	2.2	2.1	2.9	2.3	2.8	1.9	2.4
			6	40	1.9	1.9	2.1	2.2	2.3	2.7	1.7	1.6
Wisconsin	1.083	1.078	0		2.4	2.3	2.2	2.6	2.6	2.5	2.6	2.7
			3	55	2.2	2.2	2.0	2.4	2.1	2.2	1.8	2.2
			3	40	2.0	2.0	1.9	2.4	2.2	2.3	2.1	2.0
			6	40	1.8	1.7	2.1	1.8	2.3	1.8	1.5	1.4
Katahdin:												
Colorado	1.096	1.093	0		2.3	2.1	2.3	2.3	2.6	2.6	2.7	2.7
			3	55	2.2	1.9	2.5	2.3	2.7	2.8	2.7	2.5
			3	40	2.4	2.3	2.4	2.5	2.7	2.7	2.7	2.4
			6	40	1.8	1.7	2.3	1.9	2.5	2.3	2.2	1.8
Maine	1.088	1.078	0		2.4	2.7	2.2	2.2	2.8	2.7	2.8	2.7
			3	55	2.3	2.2	2.1	2.1	2.3	2.2	2.6	2.0
			3	40	2.2	2.2	2.2	2.2	2.7	2.1	2.3	2.0
			6	40	2.0	1.8	1.9	1.4	2.1	1.6	2.0	1.4
Pennsylvania	1.080	1.070	0		2.1	2.3	1.9	1.4	2.7	1.7	2.3	2.6
			3	55	2.1	2.0	2.1	1.4	2.4	1.6	2.4	2.0
			3	40	2.0	2.1	1.4	1.6	2.1	1.8	2.2	2.1
			6	40	1.9	1.9	1.8	1.2	2.0	1.4	1.8	1.6
Russet Burbank:												
Idaho, Aberdeen	1.089	1.088	0		2.8	2.7	2.6	2.9	3.0	2.9	2.6	2.9
			3	55	2.6	2.5	2.9	2.9	2.9	3.0	2.7	2.3
			3	40	2.4	2.3	2.7	2.6	2.9	2.8	2.3	2.3
			6	40	2.4	2.2	2.4	2.5	2.8	2.7	2.2	1.6
Idaho, Ashton	1.095	1.088	0		2.3	2.4	2.6	2.2	3.0	2.3	2.7	2.6
			3	55	2.5	2.2	2.7	2.6	2.9	2.9	2.6	2.3
			3	40	2.2	2.3	2.6	2.8	2.8	2.9	2.3	2.3
			6	40	2.3	1.8	2.8	2.1	2.9	2.4	2.2	1.5
Washington	1.097	1.099	0		2.6	2.8	2.8	2.9	2.9	3.0	2.2	2.8
			3	55	2.8	2.4	2.9	3.0	2.9	3.0	2.8	2.5
			3	40	2.7	2.5	2.9	2.9	3.0	3.0	2.7	2.6
			6	40	2.4	1.9	2.6	2.8	2.9	2.8	2.3	1.9
Triumph:												
North Dakota, Grand Forks	1.086	1.086	0		2.6	2.4	2.1	2.1	2.3	2.1	2.4	2.5
			3	55	2.3	2.2	1.8	2.1	2.0	2.1	2.3	2.3
			3	40	2.2	2.1	1.4	2.1	1.8	2.3	1.8	1.9
			6	40	1.9	2.0	1.4	1.5	1.7	1.6	1.4	1.6
North Dakota, Walhalla	1.099	1.082	0		2.2	2.4	2.1	1.9	2.4	2.2	2.8	2.7
			3	55	2.2	2.1	2.2	2.0	2.4	2.1	2.2	2.3
			3	40	2.1	2.1	2.1	1.8	2.4	2.0	2.2	2.1
			6	40	1.8	1.6	2.1	1.3	2.2	1.6	2.0	1.3

[1] Mean scores of 6 judges on 3 replicates. 3 was highest score; 1 the lowest.

U. S. GOVERNMENT PRINTING OFFICE 1955

END