glutamic acid were added per kilogram of diet. After receiving the diets for 10 weeks, the hens fed the low level produced eggs containing 23 mγ of folic acid per gram of yolk, and those the high level 242 mγ per gram.

No loss of folic acid occurred during the first 3 months of cold storage of shell eggs. During the next 3 months 16.4% of the folic acid was lost, and 26.6% was lost in 12 months of total storage (Table I). The loss was all from the egg yolk. The folic acid content of the white increased slightly (Table II). The 21.6% increase of total folic acid in egg white and the 50% increase in micrograms of folic acid per gram of egg white (Table IV) is not unexpected. A much larger increase more nearly to equalize the concentration of folic acid in the yolk and white would be expected from the work of Evans *et al.* (*11*), who found that the pantothenic acid concentration in egg white more than doubled and that in the yolk decreased so as to approach a more equal distribution of pantothenic acid between white and yolk. Apparently pantothenic acid moves through the vitelline membrane more freely than folic acid.

Total folic acid in the egg yolk decreased by 32.8% and the folic acid concentration by 38.8% during 12 months of storage (Tables III and IV). Part of the folic acid was in some way lost and the rest migrated to the white. The method of folic acid loss is unknown and will not be speculated on at this time. The folic acid concentration in the white and the yolk changed to a greater extent than did the total folic acid content of these parts of the egg. Evans and Davidson (*8*) observed a migration of water from the white to the yolk of stored shell eggs and also an additional loss of water from the whole egg, probably from the white through the shell membrane. The loss of water from the white combined with the transfer of folic acid from the yolk to the white can explain why a 21.6% increase in total folic acid in the white would cause a 50% increase in folic acid concentration. And the transfer of some water from the white to the yolk at the same time that folic acid migrates from the yolk to the white explains why the folic acid concentration of the yolk can decrease by 38.8% when the total folic acid decrease is but 32.8%.

Total folic acid in the whole egg decreased by 26.6%, and the folic acid concentration decreased by 21.3% during 12 months of cold storage. The reason for the smaller percentage decrease in the folic acid concentration than in the total folic acid of whole stored eggs is that the loss in folic acid is accompanied by a loss of water that tends to increase the folic acid concentration and partially counteract the folic acid loss.

Summary

Eggs from ten White Leghorn hens kept in laying cages and fed a diet of constant composition were used in an experiment to study changes in the folic acid content of fresh and stored shell eggs. The eggs were studied on an individual hen basis. Whites and yolks of fresh eggs and of eggs stored for 3, 6, or 12 months at 0° C. were assayed for folic acid with *S. faecalis* R. Fresh eggs contained on the average 4.59γ (94 mγ per gram) of folic acid with 0.51γ (16 mγ per gram) in the white and 4.09γ (232 mγ per gram) in the yolk. There was a loss of folic acid from the egg yolk and some transfer of folic acid from the yolk to the white during 12 months of cold storage. Twelve-month-old eggs contained 3.37γ (74 mγ per gram) of folic acid with 0.62γ (24 mγ per gram) in the white and 2.75γ (142 mγ per gram) in the yolk.

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NUTRIENT COMPOSITION

Corn in the United States

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THE COMMITTEE ON FEED COMPOSITION of the National Research Council, Agricultural Board, Division of Biology and Agriculture, was formed in August 1946 at the suggestion of the Committee on Animal Nutrition to compile complete and accurate tables on the composition of all feeding stuffs (*3–5*).

Because corn is used in livestock feeding to a greater extent than any other single grain, a survey of the 1946 crop was undertaken for the purpose of evaluating the effect of hybrid corn varieties on the composition, particularly the protein content. The survey also had for its purpose the evaluation of all the readily measurable nutritive constituents in this important feed crop on a nation-wide basis that would be representative of that crop as marketed and fed to animals.

The success of the first year's survey encouraged the committee to repeat it in 1947, in order to obtain the benefit of two seasons. By chance, the two years were markedly different in character, 1946 being a normal year and 1947 a "soft corn" year.

Plan of the Surveys

The extent of the surveys was limited

The 1946 and 1947 corn crops in the United States were sampled for the purpose of evaluating trends in nutrient composition, especially with regard to the protein content. Statistical results, including analysis of variance and correlation of nutrients on 169 samples from the 1946 crop and on 197 samples from the 1947 crop taken from 30 states in 10 climatic regions, are reported. The nutrients determined included proximate nutrients, vitamins, and minerals. Regional differences did not appear to indicate practical importance. Significant regional differences in fat content were somewhat confounded with varietal and color differences. The mean protein content was found to be 8.66 ± 0.91% in 1946, and 9.08 ± 0.87% in 1947, with 95% confidence limits of 8.52 to 8.80% in 1946 and 8.96 to 9.20 in 1947. The results indicate the desirability of periodic national surveys to determine effects of soil and climatic factors on the variation in nutrient values of crops.

by facilities for chemical analysis. It appeared that about 200 samples could be processed each year by enlisting the cooperation of various laboratories. It was estimated that this number of samples would yield national averages having coefficients of variation of about 1% for the proximate nutrients and certain macronutrient elements, and of about 3% for most of the micronutrient elements and vitamins. These accuracies were deemed sufficiently good to warrant proceeding with the surveys, even though their scope would be limited.

Climate, plant species or variety, soil type, and management practices, including fertilization, were recognized as factors which might influence the nutrient composition of crops. The smallness of the surveys limited greatly the amount of control that could be placed on these factors. Numerous varieties of corn may be grown in a single state, and there are similar wide variations in soil type and management. As a result these were ignored in allocating the samples, but some notes regarding them were made at the time of sampling. It was possible to obtain a degree of control on climatic variations by dividing the nation into ten regions on the basis of rainfall and temperature, assuring fairly uniform growing conditions within each region.

The samples were so distributed that the number in a region was proportional to the total corn production of that region, and that the number of samples in a given state was proportional to the production of that state. Within a state the counties were stratified according to production; the number of strata was equal to the number of samples to be taken in the state and the total production in all strata was equal. One county was then selected at random from each stratum. The farms to be sampled within the counties were located by the geographical "point" method, principally because better methods did not appear feasible.

Two hundred counties were designated to be sampled in each year, and one farm was sampled in each county in 1946. In 1947, however, an extra farm was designated in each of 50 counties, distributed among states and regions at a rate proportional to production.

The states sampled are listed by region in Table I.

Table I. States Sampled, Grouped by Regions

Region I	New York, Pennsylvania, New Jersey, West Virginia, Michigan
Region II	Ohio, Indiana
Region III	Maryland, Virginia, North Carolina, Kentucky, Tennessee
Region IV	South Carolina, Georgia, Alabama, Mississippi
Region V	Minnesota, Wisconsin, Iowa, Missouri, Illinois
Region VI	Arkansas
Region VII	North Dakota, Nebraska, Kansas, Colorado
Region VIII	Texas, Oklahoma
Region IX	Oregon
Region X	Arizona

Between 5 and 10 pounds of shelled corn or an equivalent amount of ear corn was taken for each sample. If yet unharvested, the sample was selected from 15 to 20 well distributed points in the field. If harvested, it was taken from cribs or from loads destined for elevators.

The only restrictions placed on sampling were: that the sample be unground corn, and that it be of corn harvested as grain for feeding purposes.

Treatment of Samples and Methods of Chemical Analysis

County agents and extension personnel in the various states were enlisted to procure the samples, which were then shipped to the National Research Council offices in Washington, D. C., where they were dried and subsampled. These subsamples were then shipped to the cooperating laboratories for vitamin, mineral, and proximate analyses.

Standard, accepted methods of chemical analysis were used, and sufficient duplicate samples were sent out to different laboratories to assess the uniformity of results. The data for the proximate nutrients and for calcium and phosphorus were found, on the basis of the duplicate samples, to be very reliable. For all practical purposes, and with only one possible exception, the other mineral and vitamin analyses were satisfactory, although in some instances the methods appeared to be less sensitive than is desirable.

Results

Of the 200 samples requested in 1946, 169 were received and analyses obtained, and of the 251 requested in 1947, 197 were received and analyses obtained. The original allocation distribution was not greatly disturbed because of missing samples. Analyses were obtained for the proximate nutrients on almost all the samples received and for calcium and phosphorus on the majority of the samples. The number of samples on which it was possible to determine the other minerals and vitamins varied considerably and was limited in many cases. In so far as was possible, the regional allocation proportions were maintained in selecting the limited samples for analysis.

Table II. Average Nutrient Composition and Variability in Composition of Shelled Corn in United States

(15% moisture basis)

Constituent	Mean		Confidence Limits[a]		Standard Deviation		Coefficient of Variation, %		No. of Samples		Significance of Difference between Years[b]
	1946	1947	1946	1947	1946	1947	1946	1947	1946	1947	
Gross energy, cal./g.	3864	...	3848–3880	...	100	...	3	...	160	...	
Crude protein, %	8.66	9.08	8.52 – 8.80	8.96 – 9.20	0.91	0.87	10	10	169	189	s
Crude fat, %	3.89	3.86	3.82 – 3.96	3.80 – 3.92	0.45	0.45	11	12	169	189	0
Crude fiber, %	1.99	2.07	1.95 – 2.03	2.02 – 2.12	0.25	0.37	12	18	169	189	s
N-free extract, %	69.22	68.71	69.06 –69.38	68.54 –68.88	1.08	1.18	2	2	169	189	s
Ash, %	1.22	1.27	1.19 – 1.25	1.24 – 1.30	0.21	0.18	17	15	169	189	s
P, %	0.273	0.262	0.260– 0.286	0.250– 0.274	0.082	0.072	30	28	153	149	0
Ca, %	0.019	0.024	0.016– 0.022	0.021– 0.027	0.016	0.019	82	80	169	146	s
K, %	0.285	0.282	0.224– 0.346	0.246– 0.318	0.170	0.078	59	28	31	21	0
Mg, %	0.102	0.111	0.097– 0.107	0.107– 0.115	0.014	0.008	14	8	37	21	s
Na, %	0.010	0.009	0.006– 0.014	0.009– 0.009	0.009	0.000	90	0	26	12	0
Cl, %	0.041	0.045	0.035– 0.047	0.039– 0.051	0.015	0.014	38	32	26	22	0
Fe, mg./lb.	10.25	8.38	9.66 –10.84	8.34 – 8.42	2.44	2.44	24	29	66	197	s
Cu, mg./lb.	1.82	0.73	1.37 – 2.27	0.71 – 0.75	1.44	0.174	80	24	42	197	s
Co, mg./lb.	0.011	0.008	0.008– 0.014	0.007– 0.009	0.007	0.006	67	73	24	197	0
Mn, mg./lb.	2.43	2.19	2.17 – 2.69	2.12 – 2.26	1.20	0.50	49	23	87	197	0
F, mg./lb.	2.3	2.6	0.09 – 3.7	1.3 – 3.9	3.6	3.3	155	128	27	26	0
Carotene, mg./lb.[c]	1.33	1.34	1.11 – 1.55	1.08 – 1.60	0.81	0.78	61	58	52	36	0
Thiamine, mg./lb.	1.72	1.63	1.65 – 1.79	1.50 – 1.76	0.28	0.35	16	21	61	28	0
Niacin, mg./lb.	9.75	9.92	9.30 –10.20	9.46 –10.38	1.76	1.16	18	12	60	27	0
Riboflavin, mg./lb.	0.514	0.570	0.484– 0.544	0.531– 0.609	0.137	0.122	27	21	83	40	s
Pantothenic acid, mg./lb.	2.44	3.08	2.30 – 2.58	2.68 – 3.48	0.56	0.98	23	32	61	26	s
Folic acid, mg./lb.	0.034	0.047	0.026– 0.042	0.033– 0.061	0.007	0.011	19	23	5	5	0

[a] 95% confidence limits for mean.

[b] 0 Difference not statistically significant.

s Difference statistically significant ($P \leqslant 0.05$).

[c] Only yellow corn included in carotene data.

In the sampling no restriction was made on grade or color of corn. For the two years combined, only 20 samples were of white corn, and in 1946, at least, very few samples graded other than U. S. No. 2.

Nutrient Composition And Variability

The national means for the content of various nutrients in corn are shown in Table II along with their 95% confidence limits. The data for the two years are presented separately. The variabilities in nutrient content are expressed both as standard deviations and as coefficients of variation. The number of samples analyzed is indicated for each nutrient.

The standard errors of the means are not given but may be easily computed, either on the absolute basis or as coefficients of variation, by dividing the standard deviations or the coefficients of variation, respectively, by the square roots of the numbers of samples.

In general, the data for the two years are in good agreement as regards both the means and the standard deviations. The only exception is with copper, where both the mean and the standard deviation are relatively larger in 1946 than in 1947, but only 42 samples were analyzed in 1946 as compared with 197 in 1947.

In several other instances the differences between means for the two years are statistically significant. The nitrogen-free extract content was significantly lower in 1947 than in 1946, and the contents of protein, fiber, ash, and some of the minerals and vitamins were significantly higher in 1947 than in 1946. Most of these differences may be too small to be of practical importance, but they seem to be satisfactorily explained by the fact that much of the corn in 1947 was soft or immature. The 1946 data are no doubt better to use as representative of commercial corn, at least in normal years.

Notable are the small coefficients of variation for gross energy and the proximate nutrients. The low coefficient of variation for magnesium is striking as compared with those for most of the minerals, while that of fluorine appears to be much larger than the others. The coefficients of variability for thiamine, niacin, riboflavin, and pantothenic and folic acids are not very large as compared with that for carotene.

Geographical Variations In Composition

The relative importances of region and state-within-region variations in composition were studied by means of analysis of variance. Because of insufficient data this analysis was not made for folic acid. The results are summarized in Table III.

Some statistically significant regional and state-within-region effects were found. For most nutrients, however, these effects accounted for only a small portion of the total variance and are thus of questionable practical importance. Even where the regional and state variations were moderate or large, they may be of little practical nutritional importance. Thus copper, niacin, potassium, chlorine, and iron show moderate or large regional and state variations, but corn is not an important source of supply for these nutrients. Calories, nitrogen-free extract, and fat show moderate regional and state variation and are supplied in important amounts by corn. Here, however, the total variability over the nation is so small (see Table II) that the variance attributable to region or state would seem to be of little concern.

Although of doubtful importance from the point of view of the practical nutritive value of corn, the magnitude and pattern of regional and state differences are of interest from the standpoint of nutrient composition of feeds in general. Although the size of the surveys was too limited to obtain a clear picture of the locational variations in nutritive value, certain findings seem worthy of brief mention.

Protein content was lower than average in a region approximately defined by the states of Illinois, Indiana, Ohio, Kentucky, West Virginia, and Tennessee. With the exception of West Virginia, these states were sampled relatively heavily. This low-protein region appeared to extend southward and southwestward to include Texas, Arkansas, Louisiana, Mississippi, Alabama, and Georgia. With the exception of Texas, however, the sampling rates in these states were relatively low. Corn of about average protein content was obtained from two regions. The first of these was defined roughly by Minnesota, Iowa, and Missouri, where the sampling rate was heavy. New York and Pennsylvania formed the second region, but these two states were not sampled heavily. Corn of above average protein content was obtained in three regions: (1) North and South Dakota, Nebraska, Kansas, and Oklahoma; (2) Wisconsin and Michigan; and (3) Atlantic seaboard states from New Jersey to South Carolina, inclusive. With the exception of Nebraska and Wisconsin, the sampling rates in these states were relatively light. In general, regions of similar composition did not necessarily correspond to climatic regions.

The lowest fat content was observed in Indiana, Ohio, Kentucky, and West Virginia. This is roughly the lowest protein region, except that Illinois and Tennessee are not included. The southern states, which appeared to be in the low-protein group, did not fall in the low-fat group. Instead, it appeared that the southern states in general, including Texas and Oklahoma but excluding Virginia, Tennessee, and Kentucky, produce corn of higher than average fat content. The remainder of the states in the East and Midwest which produced corn of average or high protein content in general showed average fat content, although a few showed higher than average fat values. Location and variety (including color) were partially confounded in this study; hence the regional differences in fat content are possibly due to variety and color.

Table III. Per Cent of Total Variance Accounted for Jointly by Region and State-within-Region Variation, Average of Both Years

(Statistically significant effects indicated in parentheses)[a]

Nutrients for Which State and Region Effects Accounted for		
<10% of variance	*15 to 30% of variance*	*50–65% of variance*
Protein (r,s)	Calories (r,s)	Potassium (r,s)
Fiber (r)	Fat (R,s)	Chlorine (r)
Ash (r)	N-free extract (R,s)	Iron (r,S)
Phosphorus (O)	Copper (S)	
Calcium (r)	Niacin (O)	
Magnesium (s)		
Sodium (O)		
Cobalt (s)		
Manganese (s)		
Fluorine (O)		
Carotene (O)		
Thiamine (r)		
Riboflavin (O)		
Pantothenic acid (O)		

[a] r. Significant regional effects in one year.
R. Significant regional effects in both years.
s. Significant state-within-region effects in one year.
S. Significant state-within-region effects in both years.
O. No significant effects in either year.

With respect to the other nutrients studied, there were often rather marked differences between states, but in general, no region having characteristic values could be discovered. One exception was the iron content. The southern states in general showed low iron values and the midwestern, northern, and eastern states showed generally high values. Exceptions were present, however. For most of the nutrients, the number of analyses was too few to warrant attempts to define regions as was done for protein.

Effects of Soil Type On Proximate and Mineral Composition

The results of the locational analyses suggested that perhaps soil type was a factor affecting the composition of corn. To supplement the locational analysis, therefore, the samples were classified by Great Soil Groups and by soil associations. Analyses of variance were then conducted on the proximate nutrients and the minerals, it being considered that these would show greater effects from soil than would the vitamins. The results are summarized in Table IV.

Table IV. Per Cent of Total Variance in Proximate and Mineral Composition Accounted for Jointly by Great Soil Groups and by Soil Associations, Average of Both Years

(Statistically significant effects indicated in parentheses)

Nutrients for Which Soil Type Accounted for		
< 10% of variance	*15 to 30% variance*	*> 50% of variance*
Calories (O)	Protein (m)	Fat (M, S)
Fiber (m)	Potassium (O)	
N-free extract (m,s)	Iron (s)	
Ash (s)		
Calcium (O)		
Phosphorus (O)		
Manganese (m,s)		
Copper (m,s)		
Cobalt (m,s)		

m. Significant Great Soil Group effects in one year.
M. Significant Great Soil Group effects in both years.
s. Significant soil association effects in one year.
S. Significant soil association effects in both years.
O. No significant effects in either year.

As was true with location, soil classes

Table V. Per Cent of Total Variance Accounted for by Varieties[a], Average of Both Years

(Occurrence of statistically significant varietal differences indicated in parentheses)

Nutrients for Which Varietal Effects Accounted for		
< 10% of variance	*10–20% of variance*	*30–40% of variance*
Calories (o)	Calcium (v)	Fat (V)
Protein (o)	Magnesium (o)	Niacin (o)
Fiber (o)	Manganese (v)	
N-free extract (o)	Carotene (o)	
Ash (o)		
Phosphorus (o)		
Potassium (o)		
Iron (v)		
Copper (o)		
Cobalt (o)		
Thiamine (o)		
Riboflavin (o)		
Pantothenic acid (o)		

[a] Yellow varieties only.
v. Significant varietal effects in one year.
V. Significant varietal effects in both years.
o. Significant varietal effects in neither year.

were in general only slightly associated with variations in the composition of corn. Fat content was the only factor that appeared to be associated with differences in soil groups or soil associations in any marked way, but there was a suggestion that protein, potassium, and iron may bear a relation to the Great Soil Group classification. The minerals, which might be expected to vary considerably with soil classes, were in general for the two years associated only slightly with them, although soil classifications were significant in one of the years in several instances.

Differences between White and Yellow Corn Analyses of variance were conducted to acertain whether white and yellow corn differed in nutrient composition in any way other than carotene content. All the samples of white corn were open-pollinated, but the yellow samples included both hybrid and open-pollinated varieties. The data were insufficient to make comparisons on cobalt and folic acid in 1946 and on calories, potassium, magnesium, sodium, chlorine, fluorine, thiamine, niacin, pantothenic acid, and folic acid in 1947.

For none of the nutrients was there a significant difference between white and yellow corn in 1946. In 1947 significant differences existed for only fat and iron. In both years the fat content of white corn was higher and the iron content lower than in yellow corn. In general, however, it appeared that the only practical nutrient difference between white and yellow corn is carotene.

Varietal Differences In Composition Because all varieties of white corn were designated simply as open-pollinated, varietal variation was studied only on yellow corn. Analyses of variance were conducted for each year separately, and only those varieties were included for which there were data on two or more samples, nearly all of which were hybrids, in the year being analyzed. Because of insufficient data, determinations of sodium, chlorine, fluorine, and folic acid were not made in either year, of calcium in 1946, or of calories in 1947. Location effects were disregarded in making these analyses because of the computational difficulties involved in adjusting for them.

The results are summarized in Table V. In few instances were varietal effects statistically significant in either year and only in the case of fat were they significant in both years. In general, varietal differences accounted for a small portion of the total variation in nutrient composition. It appears that, with the possible exception of fat, differences in nutrient composition among varieties

Table VI. Simple Correlation Coefficients between Nutrients Which on Average for Two Years Equaled or Exceeded 0.30

(Statistical significance indicated in parentheses)

	N-Free Extract	*K*	*Mg*	*Cl*	*Fe*	*F*	*Carotene*	*Thiamine*	*Calories*
Protein	−0.88 (S)	0.33 (s)	0.38 (s)						
Fat	−0.46 (S)								
Ash	−0.32 (S)								
Ca				0.36 (0)					
P			0.34 (s)						
K	−0.30 (s)								
Mg	−0.38 (s)								
Na		−0.33 (0)				0.80 (s)	0.42 (s)		
Cl							0.36 (0)		
Mn	−0.30 (S)				0.32 (s)	0.60 (s)	0.43 (s)		
Cu						0.39 (s)			
Co		−0.56 (s)			0.36 (s)	0.52 (0)			−0.41 (0)
F		−0.41 (0)	−0.61 (s)	0.35 (0)	0.42 (s)		0.75 (s)		
Thiamine							0.60 (s)		0.50 (s)
Niacin					−0.30 (s)	−0.32 (0)	0.42 (s)	0.38 (s)	0.51 (s)
Riboflavin					0.37 (s)	0.30 (s)			−0.48 (s)
Pantothenic acid		0.37 (s)		−0.47 (0)			−0.42 (s)		

S. Significant correlation in both years.
s. Significant correlation in one year.
0. Significant correlation in neither year.

grown in practice are not of practical nutritional importance. It is not intended to imply that nutritionally improved varieties cannot be developed by proper breeding and selection, but only that the more important commercial varieties appear to be genetically rather uniform with respect to factors determining nutritive value.

Correlations Between Nutrients Simple correlation coefficients were computed for all pairs of nutrients for which there were sufficient data. Data were insufficient to compute correlations of folic acid with all other nutrients in both years, calories with all other factors in 1947, and fluorine with potassium, magnesium, sodium, and chlorine in 1947. Something over 200 correlation coefficients were computed for each of the two years. An appreciable number were significant in each year, but the values were small for the most part and often did not agree in sign—i.e., positive or negative—for the two years.

Only the more significant correlation results which, after being averaged for the two years, equaled or exceeded 0.30, are presented in Table VI. This figure was selected because correlations of this size or less mean that 9% or less of the variance in one factor is associated with variance in the other factor.

The negative correlations of nitrogen-free extract with protein, fat, and ash would be expected because the former is determined by subtracting these three nutrients and fiber from the total dry matter. No attempt is made to explain the other correlations shown. The relatively large number of nutrients with which fluorine and carotene are appreciably correlated should be noted.

Discussion

The observation of the feed industry that the protein content of corn had declined appreciably in the years prior to 1946 seems to have been verified by this study. Morrison (*2*) gives the mean protein content of No. 2 corn as 9.4%. In contrast, a value of 8.7% was obtained in the 1946 survey, and 9.1% in the 1947 survey.

Earley and De Turk (*1*) concluded that "the decline in protein reported by the feed industry is not due to inherently low protein hybrids," and that "the decrease in corn protein is believed to be caused by both a decreased soil nitrogen at regular rates of planting and by an increased rate of planting on soils relatively low in nitrogen." These views were not contradicted by the results of the present work. At least, the heavier corn-producing areas tended to yield corn of low protein content, and varietal differences in protein content accounted for a very small portion of the variance. Nothing conclusive on these points is offered by the present studies, because their design did not permit drawing such conclusions.

Regional, state, and varietal differences were appreciable and statistically significant for some nutrients. For most of the nutrients, however, it appears that these factors per se have little to do with the nutrient content of commercial corn. To account for the major variability in nutrient composition of corn, one must look to other factors. Soil type and localized climatic effects are indicated, with attention directed particularly to some of the things, such as the micronutrient element content, which might vary within a given soil type. Other factors of possible importance are those associated with cultural practices such as fertilization. These factors seem especially worth consideration for minerals and vitamins which have high coefficients of variation. In surveys designed to inquire into the causes of locational variations in composition, it appears that special emphasis would have to be placed on the above local factors in allocating samples, and intense sampling rates would have to be employed. Controlled experiments would possibly be helpful.

The change in protein content of corn through the years indicated the desirability of periodic checks on nutritive composition of feeds. New varieties of crops and greater use of fertilizers, particularly the micronutrient elements, permit the production of many crops under new and different ecological conditions. Thus, different soil and climatic factors combined with the new varieties may change materially the composition of the normal plant. Relatively small nation-wide surveys, such as those reported here, appear to be adequate for such periodic checks.

It was hoped that the correlation study would show sufficiently significant relationships between the contents of various nutrients to be of practical use. A possible use envisaged was the estimation of the content of difficult-to-determine nutrients from the content of easily determined nutrients for samples on which complete analysis was not feasible. It appears, however, that the correlations are in general too low to be of value in this respect.

Summary

In 1946, 169 samples, and in 1947, 197 samples of corn were collected at harvest time from 30 states in 10 climatic regions in the United States. Chemical determinations were made of proximate nutrients, vitamins, and minerals. These data were used to calculate means, coefficients of variation, and other statistical results.

The variation between regions was significant (19 to 1) for fat in both years, and for a number of nutrients in one year but not the other. The large within-state variation for most nutrients casts doubt on the practical importance of regional differences. Regional variations in fat are possibly confounded with varietal and color differences.

Color of the corn could not be significantly related to any constituent except carotene and fat. Between varieties of yellow corn no significant differences were found except for fat.

No sufficiently high correlation was found between any nutrients to indicate a possible relationship useful in estimating the amount of nutrients that are difficult to determine.

The mean protein content of No. 2 corn as found in this study is lower than that reported by Morrison in 1936. No direct explanation for these lower values was found as a result of this study.

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