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Introduction and Review of Literature

The comparative composition of hybrid and open-pollinated varieties of corn and their relative feeding values have been the subject of much discussion at feed conferences and meetings, but very little scientific work has been published on this topic. The plan in use for corn variety testing at the Oklahoma station when this project was initiated made it possible to secure replicated samples of corn from the experimental plantings without any undue labor or cost. Consequently, this project was started to find if over-all differences could be found in the two types of corn, and to give some information about the protein content of Oklahoma-grown corn samples.

Fraps (3) analyzed several varieties of corn and found little variation in composition according to varieties. However, the protein content did vary considerably according to the location in which the corn was grown. Doty et al (2) studied the chemical composition of hybrid and open-pollinated varieties of dent corn in relation to soil, season, and degree of maturity of the corn. They concluded that there was no significant difference in the composition of the more than forty commercial hybrids and open-pollinated varieties they studied. Seasonal variations were found in the protein and fat content of the corn grain. The general protein content was also affected by soil type and location. A recent article by Schaible (6) deals with the composition and feeding value, for poultry, of the two types of corn. The hybrids in most instances were slightly lower in protein but were about the same in fat and ash content when compared to open-pollinated varieties. Attention was called, however, to the fact that there are hybrids that contain as much protein as any open-pollinated variety. Poultry feeding tests failed to show significant differences between the two types.

Feeding trials with pigs, comparing the two types of corn, were described by Robinson (5), and in a summary he reported that hybrid corn had a value of 97 percent as compared to 100 percent for the open-pollinated varieties.

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Experimental Conditions and Methods

No attempt will be made to describe the experimental growth conditions inasmuch as the tests were conducted on various sized field plots and on various areas; however, all tests were conducted under standard field plot conditions such that yield data could be accurately determined. The grain samples were graded before using, and larger composited samples were reduced in a Boerner sampler to 50 g samples for use in analyses. Data reported from Stillwater and Perkins are the results secured by averaging the values for each of four replications selected at random from the six field replications of each variety.

Moistures.—Determinations were run on each replication or sample and were secured by drying over night in an oven at 105 degress C., and calculating the loss in weight as moisture.

Protein.—The conventional Kjeldahl-Gunning procedure was used (1) for nitrogen, and protein was calculated using the factor 6.25.

Carotenoids.—The procedure used was a modification of the one described in an article by Randolph and Hand (4). Samples were ground through the 40-mesh screen of a Wiley semi-micro cutting mill and 2.5 g samples were placed in glass stoppered flasks, covered with 50 ml of anhydrous methanol, and allowed to stand for 18 to 20 hours. The flasks were shaken gently two or three times during the first six hours. The extract was filtered off through sintered glass crucibles and the residue was washed several times with absolute methanol. Volumes were made up to 100 ml and the concentrations were determined from readings made in a Cenco photelometer using a pyrex filter No. 554. The instrument was calibrated using commercial carotene samples consisting of approximately 90 percent beta and 10 percent alpha carotene. Repeated extractions of the residue yielded less than 2 percent additional carotenoids.

Results and Experimental Data

The large number of analyses and the emphasis upon overall differences rather than upon varietal variations has made it seem desirable to publish only a summary of the results and not to include detailed figures.

Protein

Table I summarizes the protein results, which were treated statistically by use of the "t" test following the method given by Snedecor (7). Each plot was treated as a variety or hybrid sample, so that the number of samples used was four times the number of varieties or hybrids sampled. The hybrid varieties were deliberately

Table I.—Comparison of Average Protein and Carotene Content in Grain of Corn Varieties and Hybrids By Locations and Years.[1]

Year	Type		Stillwater				Perkins			
			No. Str.[2]	Percent Protein	No. Str.	Carotene mg/g	No. Str.	Percent Protein	No. Str.	Carotene mg/g
1939	Varieties		11	11.05			10	11.12		
	Hybrids		17	10.80			17	10.91		
		difference		0.25				0.21		
1940	Varieties		16	11.29			16	11.49		
	Hybrids		13	10.77			13	11.04		
		difference		0.52**				0.45*		
1941	Varieties		14	10.47	11	.0226	14	8.87	11	.0216
	Hybrids		20	10.07	19	.0199	20	8.49	19	.0188
		difference		0.40**		.0027**		0.38**		.0028**
1942	Varieties		12	10.18	10	.0213	12	9.35	10	.0200
	Hybrids		22	9.72	22	.0197	22	8.83	22	.0177
		difference		0.46**		.0016**		0.38**		.0023**
1943	Varieties		4	9.70	3	.0192	10	9.13	9	.0192
	Hybrids		15	9.70	15	.0178	20	8.73	20	.0170
		difference		0.00		.0014**		0.40**		.0022**
All years	Varieties		57	10.70	24	.0217	62	10.04	30	.0203
	Hybrids		87	10.16	56	.0193	92	9.41	61	.0178
		difference		0.54**		.0024**		0.63**		.0025**

[1] The results of the chemical analyses were treated statistically by the use of the "t" test following the method given by Snedecor (7). Each plot was treated as a variety or hybrid sample so that the number of samples used was 4 times the number of varieties or hybrids sampled.

[2] Number of strains.

* Indicates that a difference is significant at the 5% level

** Indicates that a difference is significant at the 1% level

varied from year to year, keeping the study abreast of the changing development of hybrids. The open-pollinated varieties remained essentially without change during the tests.

The data show a small but consistently higher protein content for the open-pollinated varieties. Some hybrids were as high in protein as the highest open-pollinated varieties, but as a whole the hybrids used in these tests were slightly lower in protein. A general survey of the detailed data (unpublished) indicated that the varietal differences in any one year were only slightly less than the average annual differences.

Carotene

Carotene results are also shown in Table I. As found with the protein, open-pollinated corn varieties were higher in carotene than were the hybrids; the difference here, however, was much greater. Unlike the protein values, a survey of the unpublished, detailed figures showed that varietal differences in any one year were much greater than the average annual differences, and sometimes were as much as 50 percent.

Effect of Location in the State

Eighteen varieties of corn, 9 hybrids and 9 open-pollinated, were grown at seven different locations in the state in 1940. Table II gives average figures for protein and carotene values at each location. These results indicate that a variation of as much as 25 percent may be expected in protein and carotene analyses reported for samples from various parts of the state. A study of the detailed figures (unpublished) showed that there were extreme varietal differences at a given location, of as much as 50 percent of the low value. This is true for both protein and carotene. No good explanation is known for this wide varietal difference, which is at variance with the Stillwater and Perkins results published in Table I and with most published results in other reports.

Table II.—Protein and Carotene Content of Corn Samples from Various Locations in the State; 1940.
(18 Protein Samples, 14 Carotene Samples)

County	Protein %	Carotene mg/g
Garvin	8.46	.0249
Haskell	9.46	.0247
Logan	10.78	.0241
Wagoner	9.53	.0243
Oklahoma	10.93	.0235
Washington	9.39	.0202
Mayes	9.90	.0211

Discussion and Summary

Considered as a whole, hybrid corn varieties in these tests have averaged slightly lower in protein and considerably lower in carotene than open-pollinated varieties. Such differences are consistent and are statistically significant, but at least for protein they are not numerically large. The results point to the possibility of selecting corn varieties that are high in protein and carotene and that meet other desired requirements. Such needs can be met, for there are hybrid varieties that contain as much protein and nearly as much carotene as the open-pollinated varieties. Varietal differences due to seasons and location in the state make it undesirable to use average figures for corn protein and carotene when computing feed mixes.

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