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SOME BIOCHEMICAL CHARACTERISTICS OF MODIFIED PHENOTYPE STRAINS OF OPAQUE-2 (*ZEA MAYS* L.)

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ABSTRACT

Studies with modified strains of opaque-2 maize with vitreous endosperm fractions showed that their endosperm generally contained more protein and less tryptophan compared to chalky-opaque endosperm types. Increase in kernel vitreosity (opaque→100% vitreous) was associated with an increase in the protein and a decrease in lysine and tryptophan in endosperm. The vitreous fraction of the endosperm contained more protein but less tryptophan than the opaque fraction.

NUTRITIONAL quality of protein in normal maize is relatively low since it is deficient in the essential amino acids lysine and tryptophan. The discovery by Mertz, Bates and Nelson[1], that the maize mutant opaque-2 has nearly twice as much lysine and tryptophan as normal maize, opened up new vistas in improving cereal protein quality. Opaque-2 maize varieties have in recent years been developed and recommended for cultivation in several countries[2]. Although the nutritional superiority of opaque-2 maize over ordinary maize has been well established in experiments with rats[3], swine[4], young childern[5,6], and adult humans[7]; yet it has shown limited acceptability among the farmers because of some agronomic and acceptability problems[2]. These problems are associated with soft endosperm and dull chalky appearence of opaque-2 maize kernels. Efforts were made to develop modified strains of opaque-2 maize[8] with vitreous (normal) endosperm fraction. This paper reports some of the biochemical characteristics of such strains.

Modified opaque-2 maize strains were developed from opaque-2 composites Shakti, Rattan and Proteins as described by Singh *et al.*[8]. After harvest, opaque and various categories of modified opaque-2 kernels were separated on the basis of their vitreousness by screening them against light. For comparing opaque and vitreous fractions of modified opaque-2 kernels (½ normal–½ opaque), a sample of modified endosperms from each family was separated into opaque and vitreous fractions. Twenty randomly selected kernels of each type were taken and analysis was made on defatted endosperm samples. Protein was estimated by micro-Kjeldahl procedure[9], tryptophan by colorimetric method[10] using papain enzyme for hydrolysis and lysine by Amino acid Analyser.

Results presented in Table I showed that modified opaque-2 kernels, in general, contained more protein in the endosperm than opaque kernels. For ear Nos. 181 and 464, however, there was small decline in protein. On the other hand, the per cent tryptophan in the endosperm protein in the modified kernels was generally lower than chalky-opaque kernels. However, ear Nos. 353, 409, 464 and 508 were most desirable since there was little change in tryptophan content. These results suggested the possibility of selecting modified opaque-2 kernels having tryptophan in protein comparable to chalky-opaque kernel types.

TABLE I

Protein and tryptophan contents of opaque and modified phenotype opaque–2 kernels selected from different ears*

Ear*	% Protein		% Tryptophan in protein	
	Opaque	Modified	Opaque	Modified
12	6·70	9·24	0·90	0·83
34	6·45	8·09	1·22	0·95
181	6·58	6·47	1·06	0·88
353	9·01	12·01	0·71	0·70
389	6·70	8·78	1·25	0·80
399	6·81	7·16	1·13	0·93
405	10·05	12·47	0·77	0·51
409	10·05	11·09	0·77	0·76
464	9·93	9·47	0·83	0·86
508	8·55	8·78	0·79	0·75
Mean	8·08 ± 0·48	9·36 ± 0·59	0·91 ± 0·06	0·80 ± 0·04

* Analysis is based on defatted endosperm.

Studies with different categories of modified opaque-2 kernels showed that protein and amino acid composition of endosperm were affected by kernel vitreosity (Table II). With the increase in

TABLE II

Protein, lysine and tryptophan contents of different categories of hard endosperm opaque-2 kernels selected from an opaque-2 composite*

	Phenotype	% Protein	% Lysine in protein	% Tryptophan in protein
1	100% opaque	9·44	3·58	0·96
2	25% normal—75% opaque	10·13	3·33	0·88
3	50% normal—50% opaque	10·25	3·13	0·81
4.	75% normal—25% opaque	10·97	2·30	0·57
5.	More or less normal	12·06	1·63	0·43

* Analysis is based on defatted endosperm.

kernel vitreosity (opaque → nearly normal), protein content increased from 9·4% to 12·6% but lysine and tryptophan (in protein) decreased, respectively, from 3·6% to 1·6% and from 0·96% to 0·43%. Although from grain yield and acceptability point of view 100% vitreous kernel type would be more desirable, yet from quality and phenotypic marker view point, this will not be suitable. Therefore, a compromise has to be made. Thus semi-normals (50% opaque—50% vitreous) seem to be more desirable since they combine high levels of protein and tryptophan in hard endosperm background[11].

On comparing opaque and vitreous fractions of the endosperm of modified opaque-2 kernels, it was observed, for the families sampled, that the chalky-fraction had lower protein (per cent) but higher tryptophan (per cent of protein) than the vitreous fraction (Table III). However, the tryptophan values obtained for vitreous-fractions were lower but more reflective of values obtained for whole endosperms. These observations further supported the findings that with the increase in kernel vitreosity protein increased and tryptophan decreased.

TABLE III

Comparison of protein and tryptophan contents of opaque and vitreous portions of modified kernels (½ normal—½ opaque)

Family	Component analysed	% Protein	% Tryptophan in protein
Shakti-181	Opaque portion	7·72	0·93
	Vitreous portion	9·22	0·82
	Whole endosperm	8·94	0·37
Shakti-201	Opaque portion	6·69	1·24
	Vitreous portion	10·22	0·81
	Whole endosperm	9·19	1·02
Shakti-375	Opaque portion	7·75	1·17
	Vitreous portion	14·63	0·69
	Whole endosperm	11·69	0·73
Shakti (SO) H.S. 17	Opaque portion	7·76	1·10
	Vitreous portion	11·82	0·81
	Whole endosperm	11·04	0·92
Raitan-34	Opaque portion	9·25	1·26
	Vitreous portion	12·69	0·65
	Whole endosperm	10·75	0·75

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