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STUDIES ON BIOSYNTHESIS OF QUALITY PARAMETERS IN PEARL MILLET

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Studies have revealed significant variation in genotypes with respect to biosynthesis of various quality parameters. Soluble sugars in general decreased while starch, soluble protein and lipid content increased with the advancement of seed development. Different genotypes had different rates of accumulation of quality constituents. A stage, 21 days after anthesis, has been identified as the critical stage, when biosynthesis of all the quality parameters is at peak for exploiting and manipulating the variability for developing good quality genotypes.

Pearl millet is considered to be physiologically highly efficient plant type as it transfers almost all the nutrients from plant tissue to the grain. It has been indicated that there is wide range of variation in this regard (Gupta *et al.*, 1980). This variation was quantitative and seemed to be controlled by additive gene effects. The present investigations were undertaken with a view to have better understanding with regard to variation in the biosynthesis of various quality parameters viz., soluable sugar, starch, soluable proteins, and total lipids contents in the developing grains of pearl millet. In addition to this, an attempt has also been made to study the rate of synthesis of fatty acids during the development of pearl millet grain.

MATERIALS AND METHODS

Samples of developing pearl millet grains were collected at 6, 14, 21, 28 days after flowering and at grain maturity from twelve inbred genetic stocks of pearl millet. The samples were analysed for soluble sugars, starch, soluble protein and total lipids content. The soluble sugars and starch content were estimated by the method of Yemm and Willis (1954), soluble protein by the method of Lowry *et al.*, (1951) whereas total lipid content was estimated by cold extraction method (Folch *et al.*, 1957). In addition to the above constituents, rate of fatty acid synthesis was also studied by incorporating 1-C^{14} sodium acetate into total lipids as described earlier (Stumpf, 1977).

RESULTS AND DISCUSSION

The studies have revealed that soluble sugars decreased while starch, soluble proteins and lipid content increased during seed development in all the genotypes, however, the rate of fatty acid synthesis was more in the earlier stages as compared to the later stages (Fig. 1).

The analysis of variance for different biochemical constituents at different stages of development revealed highly significant genotypic differences for all the traits at all the stages except for starch content at 28 days after anthesis. The estimates of genotypic and phenotypic coefficients of variation and heritability revealed less influence of environment during grain development. Significance of variances due to genotype x stage interaction suggested differential rate of utilization of soluble sugars and accumulation of soluble protein.

The mean values for different biochemical constituents at different stages of development are presented in Table 1. The highest amount of soluble sugars at first stage was observed in L 10 (19.3%) followed by A1 (18.9%) and L24 (18.6%). At maturity, maximum amount of soluble sugars was found in L 20 (8.6%). Starch content at first stage was maximum in L5 (58.6%) closely followed by L6 (58.1%). At maturity, it was maximum in L6 (61.1%) followed by L24 (60.7%). For these two parameters i.e., soluble sugars and starch the genotypes showed greater variability at early stages of development as compared to later stages of development. Singh and Julliano (1977) in rice and Yazdi-Samadi *et al.* (1977) and Adams *et al.* (1980) in soybean have also reported that changes in the soluble sugar content closely follow the changes in the rate of starch accumulation during seed development. With the increase in starch content, there is decrease in the soluble sugars content.

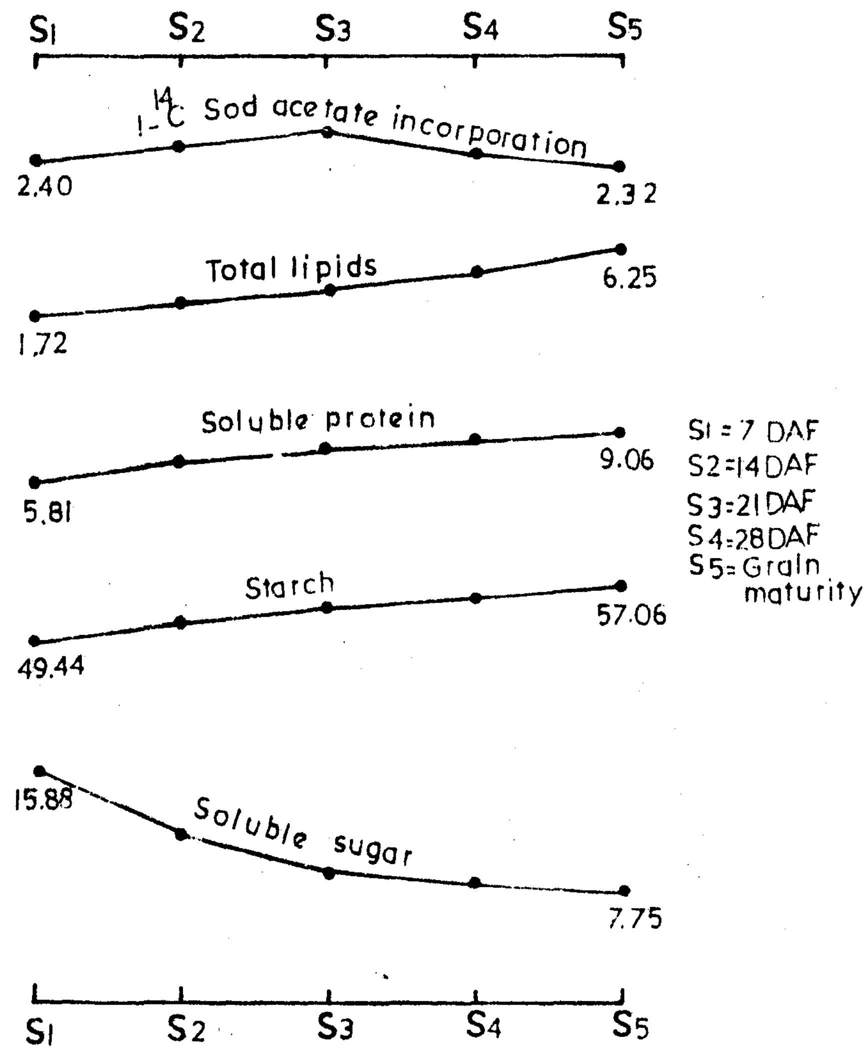

Fig. 1. Trend in biosynthesis of various biochemical constituents in pearl millet grain

Table 1 : **Mean values for soluble sugars content during grain development in pearl millet**

Genotypes	Soluble sugars (%)					Starch (%)					Soluble protein (%)					Total lipids (%)					$1\text{–}^{14}C$ sodium acetate incorporation (mol/g fresh wt)				
stages	S_1	S_2	S_3	S_4	S_5	S_1	S_2	S_3	S_4	S_5	S_1	S_2	S_3	S_4	S_5	S_1	S_2	S_3	S_4	S_5	S_1	S_2	S_3	S_4	S_5
L 5	12.3	9.3	8.3	8.0	7.0	56.8	58.2	59.4	59.6	59.6	6.5	7.1	8.7	9.9	9.9	1.8	2.1	4.3	4.6	5.5	2.2	3.0	3.6	2.9	1.8
L 6	14.9	9.1	8.9	7.9	7.8	56.1	58.4	59.0	60.6	61.1	6.5	7.1	7.3	8.1	8.2	1.8	2.6	3.7	5.2	6.2	3.0	3.5	4.5	3.4	2.8
L 7	17.4	10.1	8.9	8.3	8.3	44.6	51.4	52.6	52.9	53.9	6.5	6.9	7.1	8.5	8.5	1.9	2.9	3.7	4.5	6.5	2.8	3.7	4.7	2.4	1.3
L 10	19.3	14.3	10.3	8.5	7.9	51.1	52.0	53.2	53.4	53.8	6.6	6.9	7.7	7.9	8.3	1.9	2.5	3.3	4.5	6.9	1.8	2.7	4.9	2.7	2.4
L 11	16.7	12.3	8.9	8.3	8.1	51.0	52.4	53.6	55.1	57.8	5.9	6.2	6.7	8.0	8.9	1.8	2.5	3.7	4.3	5.5	2.5	3.9	4.6	3.4	2.8
L 19	15.9	10.4	10.1	8.8	7.4	54.0	55.0	56.5	57.7	57.9	5.7	7.0	7.1	7.5	10.4	1.8	2.8	4.1	4.2	6.2	1.3	2.3	2.6	1.7	1.5
L 20	13.4	11.8	10.8	9.9	8.6	50.7	51.3	56.6	57.4	57.9	5.0	5.5	5.7	6.3	7.4	1.9	2.0	3.6	4.8	5.9	3.6	5.9	7.7	6.8	4.9
L 24	18.6	12.1	9.8	8.8	8.3	50.9	52.3	56.4	56.4	60.7	5.2	6.7	6.7	6.9	9.0	1.3	2.7	2.4	4.5	6.3	2.9	4.8	5.0	2.5	2.0
L 46	12.4	11.4	9.2	8.8	8.3	49.3	52.1	57.0	57.1	55.6	5.5	8.9	9.1	10.1	11.7	1.5	2.5	3.1	4.0	6.0	2.8	3.7	6.0	3.7	2.8
A 1	18.9	13.8	11.6	8.9	8.3	41.1	46.4	49.3	52.6	56.6	5.1	5.7	7.1	7.5	7.9	1.8	2.2	3.4	4.4	6.4	1.9	3.2	3.6	2.5	1.9
A 6	15.6	9.3	6.5	6.4	6.4	40.4	46.4	49.3	51.1	53.2	5.3	8.2	8.3	9.3	9.8	1.3	2.2	3.4	4.2	7.3	2.1	3.8	4.8	2.8	2.0
A 7	13.6	11.0	9.4	8.6	6.6	47.5	49.4	51.7	55.0	56.8	5.7	7.1	7.4	8.3	8.7	1.8	2.4	3.3	3.7	6.3	1.9	2.5	3.1	1.9	1.6
Mean	15.8	11.2	9.4	8.4	7.8	49.4	52.1	54.6	55.7	57.1	5.8	6.9	7.4	8.2	9.1	1.7	2.5	3.5	4.4	6.3	2.4	3.6	4.6	3.1	2.3
S.E.	0.7	0.5	0.4	0.2	0.2	1.5	1.1	1.0	0.8	0.8	0.2	0.3	0.3	0.3	0.3	0.06	0.08	0.14	0.11	0.15	0.19	0.29	0.39	0.38	0.28
Range	12.4 to 19.3	9.1 to 14.3	6.5 to 11.6	6.4 to 9.9	6.4 to 8.3	40.4 to 56.8	46.4 to 58.4	49.3 to 59.4	51.1 to 60.6	53.2 to 61.1	5.0 to 6.6	5.5 to 8.5	5.7 to 9.1	6.3 to 10.1	7.4 to 11.7	1.3 to 1.9	2.0 to 2.9	2.4 to 4.3	3.7 to 5.2	5.5 to 7.3	1.3 to 3.6	2.3 to 5.9	2.6 to 7.7	1.7 to 6.8	1.3 to 4.9

The soluble protein content was maximum in L10 (6.6%) followed by L5, L6 and L7 (6.5%) each at the first stage of seed development. However, at the grain maturity, maximum protein content was observed in L 46 (11.7%). This genotype had low protein content at the first stage but because of the faster rate of protein accumulation, this genotype could accumulate more protein compared to other genotypes. Similar findings have been reported earlier in pearl millet grain (Gupta *et al.*, 1981).

Earlier studies have revealed that pearl millet grain contains 5 to 8 per cent lipids. In the present study, attempt has been made to study the biosynthesis of these lipids. It is observed that at earlier stages of grain development, the lipid accumulation is less while at later stages, it is more. Such trend has also been reported in oil seeds grown under different conditions (Bhatia and Sukhija, 1971; Gurr *et al.*, 1972; Norton and Harris, 1975).

Studies regarding rate of fatty acid syntheses revealed that in all the lines, the acetate incorporation into total lipids was considerably low at the first stage of grain development (i.e. 7 DAF). However, it increased rapidly and reached a maximum level by the time of third stage (i.e. 21 DAF). Thereafter rate of incorporation gradually decreased, as the seed advanced towards maturity.

The low initial uptake of acetate could be attributed partly to the seed being engaged in the biogenesis of various sub cellular organelles and partly to the non-availability of adequate precursors like ATP, NADPH and glycerol which are needed for the synthesis of lipids (Gurr *et al.*, 1972, 1974). Norton and Harris (1995) have also reported low lipid content and high content of soluble sugars and starch in the initial stages of seed development. It can be said that though the amount of soluble sugar was high at the initial stages yet their catabolism to yield ATP, NADPH, glycerol and acetate was probably low. In addition, the lower activity of acetyl Co A-carboxylase, which catalyses the first committed step in long chain fatty acid biosynthesis (Bhatia *et al.*, 1978), could also attribute to lower lipid synthesis at the initial stages.

The maximum 1-14C-sodium acetate incorporation into total lipids at 21 days after anthesis, a stage where the grains display maximum oil filling, has indicated that the tissue was geared up for the optimal synthesis of fatty acids during the brief developmental span. It is, therefore, suggested that the stage of 21 days after flowering may be considered as the critical stage for exploiting and manipulating variability for developing genotypes with better quality.

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