J. Indian bot. Soc. Vol. 92 (3&4) 2013 : 169-172

STARCH METABOLISM DURING PETAL SENESCENCE IN *Tagetes erecta* L. CUT FLOWERS

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Estimation of starch content, amylase activity and a- amylase activity was studied from first stage to senescent stage of *Tagetes* erecta L. flowers in cut conditions.The amount of starch had a decreasing trend with progressing stages. The amylolytic activities had an increasing trend initially but at senescent stage decrease in activity was observed. The increase in the activities of amylase suggests more breakdown of starch. The products of this starch breakdown could have been used up by the flower petals or might have been transported out of the ray florets.

Key words: *:Tagetes erecta* L., Starch, Cut flower petals

Tagetes erecta L. (African marigold) of Asteraceae is one of the most important commercial flower crops from all over the world and India accounting for more than half of total flower production. Marigold is an annual herb with large, solitary bright yellow, showy flowers for a considerably long period and excellent as cut flower as the blooms are long lasting and bloom profusely. The flowers are raised commercially for religious and social ceremonies, since they have a long shelf life. Hence, there is need to study the changes taking place during petal senescence in cut flowers of *Tagetes erecta* L.

Flowers provide an excellent system for the study of senescence. Different flower parts senesce at different rates. In the commercial use of cut flowers, it is usually the life span of the petals, an ornamental part of the flower which determines its effective life. Therefore, the study of petal senescence should provide insight into the methods to improve the post harvest longevity of cut flowers and insight into the mechanisms involved in the control of plant senescence. The senescence of flower petals is associated with a series of physiological and biochemical changes. These include an increase in hydrolytic enzymes, degradation of macromolecules, increased respiratory activity and loss of cellular compartmentalization. A degradation of macromolecules during petal senescence in the carnation flowers was observed by Bovy *et al*. 1995. Endogenous carbohydrate status of cut flowers is an important factor which regulates the longevity of flower (Coorts 1973, Rao *et al*. 1986, Bhattacharjee, 1994). Petalsenescence generally accompanied loss of dry matter, apparently due to hydrolysis of macromolecules like starch, protein and nucleic acids and there distribution of carbon and nitrogen compounds to other parts of the flower(Bovy *et al*. 1995). Mayak and Halevy (1979) reported that the hydrolysis of cell components viz. macromolecular components such as starch and cell wall polysaccharides was a major metabolic event occurring in the senescing petals. The present study focuses on the estimation of starch metabolism during senescence of *Tagetes* petals in cut condition.

MATERIALS AND METHODS

The plants were grown in experimental plots of the department. It was observed that the time taken by flower to open was 6-8 days in *Tagetes erecta* L.which was considered as stage 1.For cut conditions, the fresh flowers of stage 1 were harvested and placed in test tubes with Distilled

Received on October 11, 2013 Accepted on October 15, 2013

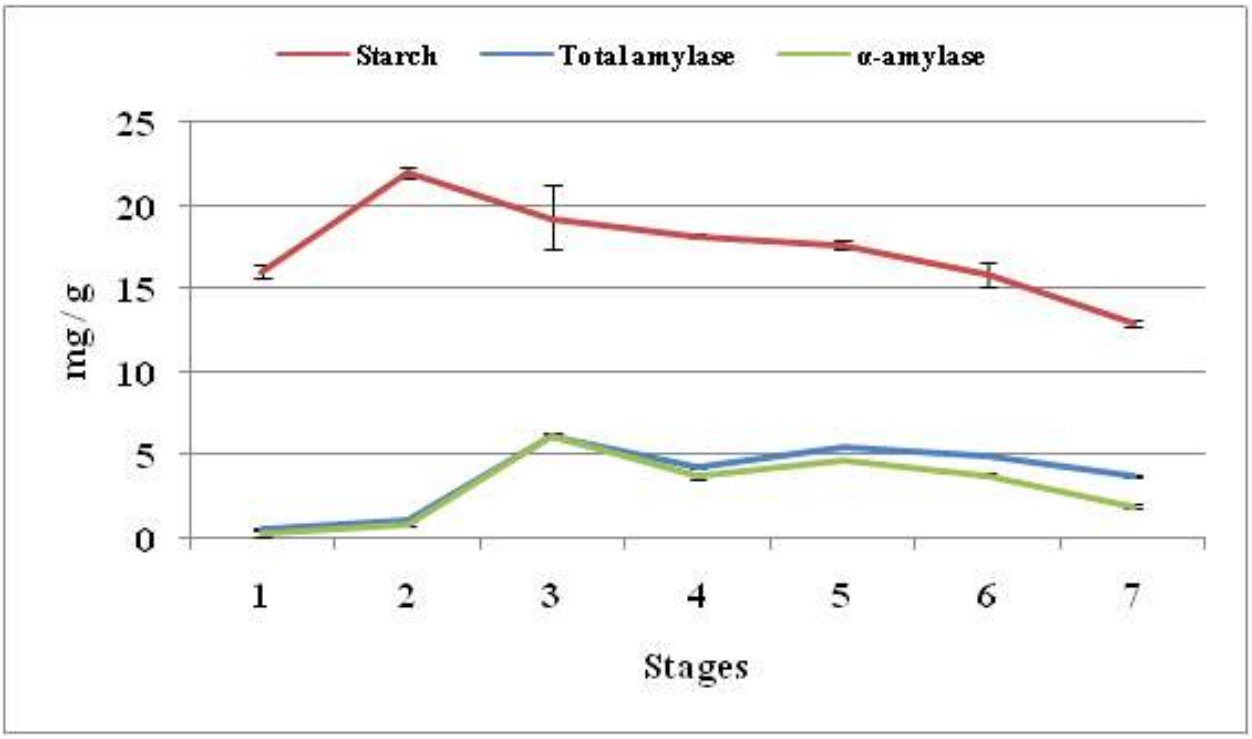

Figure-1 Starch (mg/g dry petals), amylase activity and a- amylase activity (starch reduced in mg/g fresh petals) in cut flower petals.

Water (DW). After 48 hours they were considered as stage 2 flowers. Data was recorded at the interval of 2 days till the end of their life. In case of cut flowers of *Tagetes erecta* L. a shelf life of 18 days was observed. The flower was completely unacceptable after stage 7 with the petals completely wilted and dried. Hence, 7 stages were defined as follows:

Stage 1: Flowers that had opened completely (Day 6)

Stage 2: Day 8

Stage 3: Day 10

Stage 4: Day 12

Stage 5: Day 14

Stage 6: Day 16

Stage 7 (Senescent stage): Day 18

In order to carry out the estimation of starch from dry material, the petals were collected according to stages mentioned and were collected and packed separately with proper labels. Then they were placed in oven at 80^0 C for drying for 24 hours till constant dry weight is achieved. For the estimation from the fresh material, the flowers of appropriate stage were freshly collected in the morning from the field.

In order to study the changes in the starch metabolism, the biochemical estimations of starch was done from 100 mg dry petals of all stages of *Tagetes* whereas the estimation for the activity of amylase enzyme was done from the 100 mg fresh material of all the stages of *Tagetes*. Starch was estimated by Chinoy's methods (1939). The results are expressed as mg starch per g petals. Total amylase activity and a - amylase activity were estimated by the methods of Sumner and Howell (1963) and the results were expressed as mg starch reduced per gram petals.

Statistical Analysis: The data obtained were analyzed statistically by the means of ten replicates for each stage and the standard error was computed. It was also statistically

Table-1 Starch (mg/g dry petals), Total Amylase activity and a -Amylase activity (starch hydrolysed in mg/g fresh petals) in cut flower petals.

Stages	Days	Starch (mg/g)	Amylase activity (mg/g)	a -Amylase activity (mg/g)
1	6	.....	0.57 + 0.063	0.33 + 0.017
2	8	22.00 ± 0.33	1.16 ± 0.063	0.90 ± 0.148
3	10	9.29 ± 1.93	6.21 ± 0.103	6.16 ± 0.126
4	12	8.19 ± 0.17	4.36 ± 0.095	3.71 ± 0.085
5	14	7.67 + 0.29	5.52 + 0.063	4.64 + 0.082
6	16	5.91 + 0.74	4.95 + 0.103	3.83 + 0.082
7	18	3.00 + 0.19	3.76 + 0.041	1.97 + 0.082

Amylase:

The amylolytic activities had an increasing trend initially but at senescent stage decrease in activity was observed (Table-1). The increase in the activities of amylase suggests more breakdown of starch. This is also reflected in the decreasing amount of starch. This breakdown is probably to maintain the size of respirable substrate pool which is composed mainly of sugars. Ho and Nichols (1977) and Nichols (1976) have also reported that the size of respirable substrate pool is affected by the rate of hydrolysis of starch and other polysaccharides. After stage 5 when the senescent changes must have started taking place reduction in the amylolytic activity was observed though the activity at the senescent stage was found to be more as compared to the activity at the stage 1(Table -2b).

a -**Amylase:**

The a - amylase is known to cleave the unbranched chains of starch. It was found that the a - amylase activity had an increasing trend which later declined (Table -1). Hammond (1982) and Tirosh and Mayak (1988) have reported that the activity of a - amylase plays an important role in the mechanism of petal opening. In the present case also during the developing stage of flowers the activity of a - amylase was found to be increasing. The a - amylase activity was also found to be significantly different at various stages (Table -2c).

Table- 2(a) ANOVA Summary Table for Starch in cut flower petals.

Source of Variation	Sum of Squares (SS)	Degree of Freedom (DF)	Mean Squares (MS)	F ratio	Table value of F
Between groups	146.472	6	24.412	11.270	2.9*
Within groups	30.327	14	2.166		
Total	176.799	20			

Table-2(b) ANOVA Summary Table of Amylase activity (starch reduced in mg/g fresh petals) in cut flower petals.
* at 0.05 level of significance.

Source of Variation	Sum of Squares (SS)	Degree of Freedom (DF)	Mean Squares (MS)	F ratio	Table value of F
Between groups	0.16	6	0.003	733.136	2.8*
Within groups	0.000	14	0.000		
Total	0.309	20	0.000		

Table-2(c) ANOVA Summary Table of a - Amylase activity (starch reduced in mg/g fresh petals) in cut flower petals.

Source of Variation	Sum of Squares (SS)	Degree of Freedom (DF)	Mean Squares (MS)	F Ratio	Table value of F
Between groups	79.302	6	13.217	323.817	2.8*
Within groups	0.571	11	0.41		
Total	79.874	20	0.000		

examined by the one way Analysis of Variance (ANOVA) at 0.05 level of significance.

RESULTS AND DISCUSSION

Starch:

It was observed that starch content increased slightly on the 2nd stage (Table-1). Koch (1996) reported that sugar accumulation favours expression of enzymes associated with the biosynthesis, utilization and storage of starch. This justifies the rise in the starch content on the 2nd stage. It was found that the starch content shows decreasing trend in the values with a slight increase at the senescent or wilting stage. This decreasing trend in the amounts can be related with the breakdown of starch. The products of this starch breakdown could have been used up by the flower petals or might have been transported out of the ray florets. Ho and Nichols (1977) also reported that during the course of petal senescence, a decrease in the level of macromolecular components such as starch was noted. At stage 6 (pre-senescent stage) a steep decrease in the amount was observed. This suggests that with the onset of the senescence, probably the demand of carbohydrates increased very much and to suffice this demand the starch was broken down.

The starch content was also found to be significantly different in all the stages. (Table-2a). Also, the mean starch content at various stages was statistically different.

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