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Effect of GA_3 on Total Sugar Content During Fruit Maturation of Trapa bispinosa

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***Abstract* -The changes in the content of total sugar in the kernel of *Trapa* during fruit maturation exhibit fluctuations due to the effect of three different concentrations of GA_3 (viz. 0.001%, 0.005% & 0.01%) after 24 hours treatment.**

Key Words- Kernel, Gibbprellic acid (GA_3),

1.INTRODUCTION

Water chestnut, popularly known as Singhara or Paniphal in India, is a floating, edible, annual and aquatic angiospermic herb usually grown in rainy season in shallow water fields, beels, ditches, ponds, lakes or swampy lands in tropical, sub-tropical and temperate zones of the world. Fruit ripening is the co-ordinated process of biochemical differentiation, metabolic reorganization leading to enhanced ethylene, RNA and protein synthesis and increased respiratory activity in climacteric fruits. However, all fruits do not have the distinctive and well co-ordinated pattern of ripening of the typical climacteric fruits and these non-climacteric fruits show neither a rise in respiration nor an accelerated production of ethylene during the ripening of mature fruits. Immature fruits may shrivel, ripen abnormally or fail to ripen at all, and over-maturity may result in shortened market life, both resulting in poor eating quality. Softening of fruits is brought about by alteration in the activities of specific hydrolytic enzymes on pectins or other carbohydrates (Ahmed & Labavitch, 1980; Singh *et. al.*, 1996).

The regulation of starch degradation is not as well understood as that of starch biosynthesis (Beck & Ziegler, 1989).

The carbohydrates accumulating in seeds are either oligosaccharides or polysaccharides. The major oligosaccharide is the sucrose and the most common storage polysaccharide is the starch (Matheson, 1984; Singh & Bhargava, 1988). Sucrose is usually the principal carbon source for starch synthesis in reserve tissues (Preiss, 1982).

2.METHODOLOGY

During maturation and development, the fruits were treated with three different concentrations of gibberellic acid (0.001%, 0.005% and 0.01%) at each of the three stages (i.e on 30 DAA, 84 DAA and 105 DAA) separately for the period of 24 hours. At all the stages of fruit development and seed germination six apparently identical and healthy experimental samples were selected and weighed. A weighed amount of kernel in six different replicates was homogenized in a pre-chilled glass mortar and pestle separately and was properly diluted with glass distilled water (GDW) or specific buffer solution in a desired ratio. All the chemicals used were of analytical grade. Total sugar content was estimated by phenol sulphuric acid method of Dubois *et. al.* (1956). From the aliquot at obtained during starch estimation 0.5 ml was taken in a test tube and the volume was made 2 ml with glass distilled water (GDW) and mixed. Thereafter, 1 ml of 5% aqueous phenol was added. The tube was then kept at about 10˚C using ice-bath and 5 ml of concentrated sulphuric acid was added slowly. Optical density of the coloured complex (furfural) was recorded at 490 nm against the reagent blank. The amount of total sugar was calculated with the help of standard curve of glucose and expressed in terms of µg glucose/mg tissue on fresh weight basis.

3.RESULT

The changes in total sugar content in the seed tissue (kernel) due to effect of different concentrations of GA_3 (0.001%,0.005% & 0.01%) after 24 hours treatment separately at each of the three stages of fruit development have been presented in Table 1 and Figure 1 along with the changes observed in control fruits.

In control fruits, the amount of total sugar in the kernel of *Trapa* ranged in between 21.37±1.66 and 41.81±1.11 µg/mg tissue on fresh weight basis during the period of fruit development. At immature stage, the content of total sugar in the kernel of control fruits was maximum and it decreased significantly in half mature fruits. Thereafter, it showed a further sharp decline in the content of total sugar in the kernel of fully mature fruits.

In 0.001% GA_3 treated fruits, the amount of total sugar ranged in between 17.64±0.99 and 42.66±5.87µg/mg tissue in the seed tissue of *Trapa* during the development of fruits. In 0.001% GA_3 treated fruits there was a considerable increase in total sugar content from immature to half mature stage and thereafter, it showed a sharp decline at fully mature stage.

In 0.005% GA_3 treated fruits, the amount of total sugar ranged in between 32.76±4.17 and 44.39±3.15 µg/mg tissue in the kernel during the development of fruits. In 0.005% GA_3 treatment, the amount of total sugar was high in the kernel at the immature stage which further increased

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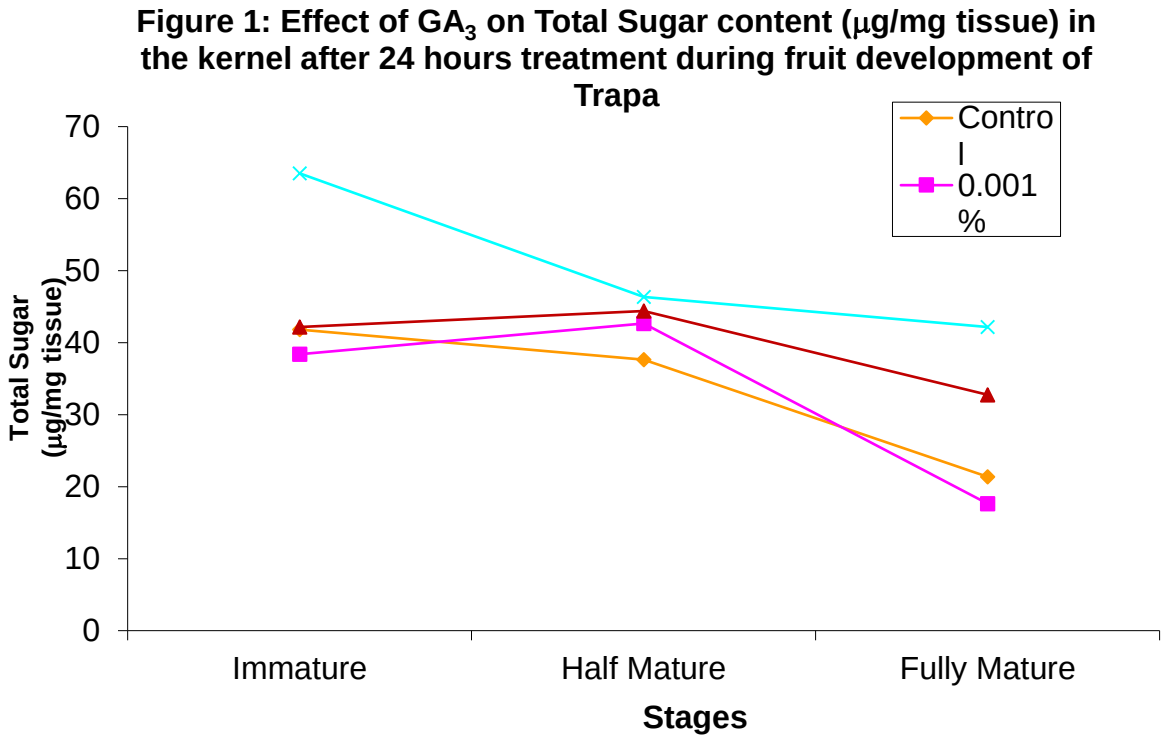
to reach its maximum level at half mature stage, however, it declined considerably at fully mature stage.

In 0.01% GA_3 treated fruits, the amount of total sugar in the kernel ranged in between 42.17±2.54 and 63.51±10.24µg/mg tissue during the development of fruits. In 0.01% GA_3 treatment, the amount of total sugar in the kernel was at the highest level at immature stage which abruptly declined at half mature stage and was then followed by a further decline reaching its lowest level at fully mature stage.

Table 1: Effect of GA_3 on Total Sugar content (µg/mg tissue) in the kernel after 24 hours treatment during fruit development of Trapa.

No. of stages	Stages of fruit development	DAA*	Period of GA_3 treatment (in hours)	Total Sugar content, µg/mg tissue ± S.E.			
				Control/ Untreated	GA_3 treatment		
					0.001%	0.005%	0.01%
I	Immature	30	24h	41.81±1.11	38.39±0.85	42.16±4.69	63.51±10.24
II	Half Mature	84	24h	37.63±0.21	42.66±5.87	44.39±3.15	46.34±4.11
III	Fully Mature	105	24h	21.37±1.66	17.64±0.99	32.76±4.17	42.17±2.54

** Days after Anthesis*



4.DISCUSSION

The fruit growth in *Trapa* during maturation has been observed to follow a pattern of continuous increase in size and weight accompanied with cell enlargement and expansion which is characterized by active cell division.

The changes in the content of total sugar in the kernel of *Trapa* during fruit maturation exhibit fluctuations due to the effect of three different concentrations of GA_3 (viz. 0.001%, 0.005% & 0.01%) after 24 hours treatment.The content of total sugar remains relatively high in the kernel of immature and half mature fruits both under conditions of control and GA_3 treatment after 24 hours. After 24 hours, the percentage decline or loss in total sugar content in the kernel at fully mature stage as compared to immature stage has been 49%, 54%, 22% and 34% respectively under experimental conditions of control, 0.001%, 0.005% and 0.01% GA_3 treatment.

Fruit sweetness is one of the major characteristics of fruit quality and market value, reflecting the concentrations of sucrose, glucose, fructose, and sorbitol in the fruit flesh (Thammawong & Arakawa 2010). In the early stages of maturation, starch accumulated in the fruit is progressively hydrolyzed in order to increase sweetness, thus affecting fruit taste during ripening (Brookfield *et.al.*, 1997; Lau, 1988; Magein & Leurquin, 2000; Warrington *et.al.*, 1999). These changes in starch and sugar content during the

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ripening process can greatly affect the sweetness of the fruit. In addition, once the fruit has been harvested.

In the present study, the relatively high level of total sugar in the kernel of immature and half mature fruits, with some exceptions, may be attributed to the loss of moisture from the fruits, enhanced translocation of photosynthates to fruits, partial hydrolysis of starch and transformation of acids to sugars as well as partial breakdown of pectin, celluloses and other polysaccharides particularly non-reducing sugars (Kalra & Tandon, 1983). However, decrease in total sugar in the kernel of fully mature fruits accompanied with increase in starch content in the present study may be attributed to conversion of sugars into starch which leads to reduction in sweetness in fruits at late stages of maturity. Due to increase in dry matter and starch content at over-maturity the *Trapa* fruits become more suitable for making into flour rather than as fresh fruit whereas the immature and half-mature fruits are more suitable for being eaten as fresh fruit.

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