

CHANGES IN THE AMYLASE ACTIVITY AND STARCH CONTENT IN MULBERRY LEAVES AS AFFECTED BY FUNGAL DISEASES

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SUMMARY

Fungal infection alters the amylase activity and the starch content in mulberry leaves. The intensity of variation is not uniform in all the varieties but, depends upon the fungal diseases viz., rust, powdery mildew, spot and mixed infection (rust and powdery mildew). In order to estimate the activity of the amylase and starch level, 12 indigenous and four exotic mulberry varieties suffering from above diseases were considered. The amylase activity as well as the starch level were impaired depending on the pathogen and the host variety.

Key words: Amylase, fungal diseases, mulberry, starch

INTRODUCTION

Mulberry (*Morus* spp.) is a hardy plant found globally in almost all types of agroclimates extending from tropical to temperate regions (Ullal and Narasimhanna 1981). It is the basic food material for silkworm *Bombyx mori* L. and the bulk of silk goods produced in the world are from the mulberry silk. Increased production of raw silk, to large extent, depends on timely supply of quality mulberry leaves to silkworms. The quality of mulberry leaf is influenced by several factors such as variety, agronomic practices, biotic and abiotic components (Krishnaswamy *et al.* 1970). In spite of adopting all these, sometimes, the nutritive values are degraded due to diseases. Mulberry is prone to attack by various pathogens. This alters the morphology, physiology and also the biochemical components of the host (Mehrotra 1980). Three fungal foliar diseases are very destructive and frequently seen in mulberry gardens. They are rust, powdery mildew, and spot caused by *Peridiopsisora mori*, *Phyllactinia corylea* and *Cercospora moricola*, respectively. Many biochemical changes occur in mulberry

leaves in response to infection (Shree and Nataraja 1993). Detailed studies regarding enzymatic changes have not been done. Starch is the principal storage carbohydrate in plant cells. Amylase is starch hydrolyzing enzyme. The enzymes α and β -amylase are involved in hydrolyzing starch. Hydrolysis by α -amylase yields dextrans, short chains of glucose molecules with 6 to 12 glucose residues whereas β -amylase cleaves amylose molecule into disaccharide maltose (Mahadevan and Sridhar 1986, Powar and Chatwal 1999). An attempt was therefore made to study the effect of fungal diseases on the amylase activity and its substrate level *i.e.* starch content in the leaves of some popular indigenous and exotic mulberry varieties.

MATERIALS AND METHODS

The healthy and diseased (rust, powdery mildew, spot and mixed infection [both rust and powdery mildew]) leaves of 12 indigenous (C₆, C₁₀, C₁₄, DD, Kajali, M₅, Mysore local, S₃₀, S₃₆, S₄₁, S₅₄ and TG) and four exotic (EB, Italian, KNG and Kosen) mulberry varieties were

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collected from Germplasm Bank, Jnanabharathi Campus, Bangalore University, Bangalore. The amylase activity (Noetling and Bernfold 1948) and the starch (Mahadevan and Sridhar 1986) content were estimated in the leaves of all the varieties. The results were statistically analysed using Student's t-test.

RESULTS AND DISCUSSION

There was alteration in the amylase activity and starch content of mulberry depending the varieties and the disease. The amylase activity increased in the rust affected leaves of C₆, EB, Kajali, KNG, Kosen, M₅, S₃₀, S₃₆, S₄₁, and S₅₄, but decreased in C₁₀ and C₁₄ varieties. The increase was significant in Kajali, M₅, S₃₀, S₃₆ and S₅₄ varieties (Fig. 1). There was an increase in the

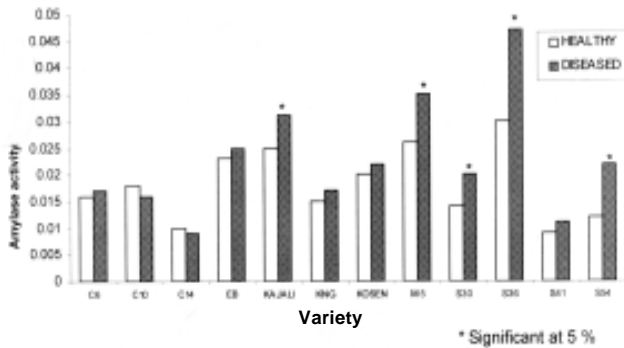


Fig. 1. Amylase activity in the healthy and rust affected mulberry leaves

amylase activity of DD, Kajali, S₃₆, S₄₁ and TG varieties affected by powdery mildew, while it decreased in M₅ and S₅₄. The increase was significant in Kajali, S₃₆, S₄₁ and TG but, it decreased significantly in M₅ and S₅₄ (Fig. 2). The spot affected S₃₀ variety showed significant

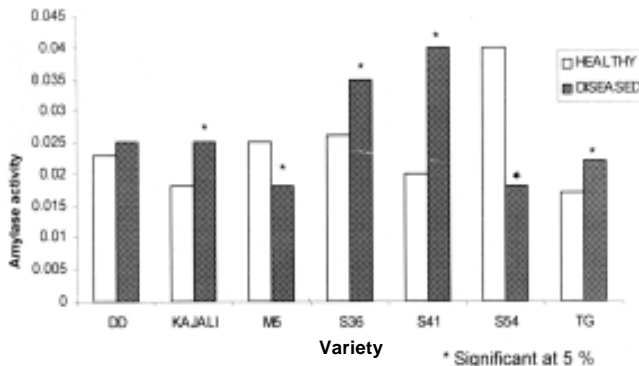


Fig. 2. Amylase activity in the healthy and powdery mildew affected mulberry leaves

increase in the amylase activity whereas there was significant reduction in variety C₆. The Italian and Mysore local varieties also showed reduction in amylase activity but the results were not significant (Fig. 3). In mixed infection affecting DD, Kajali, S₃₆, S₅₄ and TG varieties,

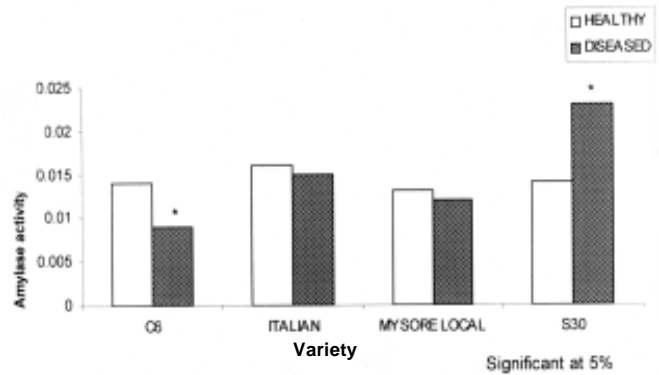


Fig. 3. Amylase activity in the healthy and spot affected mulberry leaves

amylase activity increased as compared to healthy plants whereas it decreased in variety S₄₁. The varieties S₃₆ and S₅₄ showed significant increase in amylase activity as compared to healthy leaves (Fig. 4).

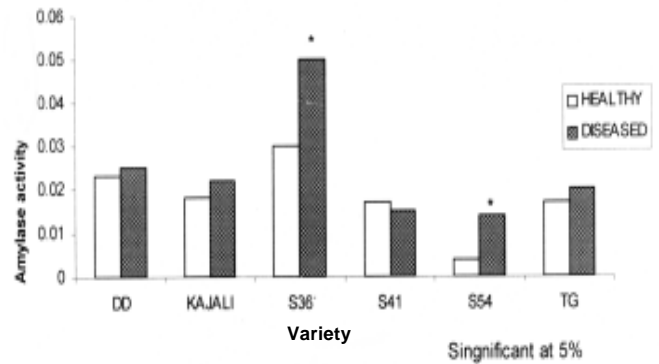


Fig. 4. Amylase activity in the healthy and mixed infection (powdery mildew and rust) affected mulberry leaves

In the present study amylase activity increased in some mulberry varieties affected by fungal pathogens. Prasad *et al.* (1976) while analyzing the biochemical changes in safflower leaves, caused by rust infection, observed higher amylase activity in the diseased tissues. They attributed the increase to facilitate the supply of assimilated nutrient to the pathogen and to meet the requirement of glucose by the infected tissues for rapid respiration. Umesh Kumar (1992) reported increase in the amylase activity of leaf spot affected *Shorea robusta*;

Nagaraj and Thite (1995) conducted enzymatic studies in the leaves of *Strychnos nux-vomica* infected with *Meliola strychnicola* and found increased amylase activity. Shree *et al.* (1997) noticed increase in the amylase activity of powdery mildew (*Phyllactinia corylea*) affected Kanva-2 (M₅), Mysore local and Kajali varieties. Of these, the activity was highly significant in Mysore local compared to others. This was attributed to the release of more reducing sugars in the infected parts, which increases the breakdown of starch into simple sugars due to host-pathogen interaction. Chandrahas and Thite (1993) found decrease in the amylase activity of diseased host-tissue (*Holigarna grahanii*) due to utilization of the substrate for the growth of pathogen (*Meliola holigarne*) and thereby, the enzyme activity becomes low due to non-availability of the substrate.

The starch content increased significantly in rust affected leaves of Kosen, S₃₀ and S₅₄ mulberry varieties, whereas, in C₆, C₁₀, C₁₄, EB, Kajali, KNG, M₅ and S₄₁ varieties, it was decreased significantly. There was no change in starch content in variety S₃₆ (Fig. 5). In the powdery mildew affected Kajali, M₅, S₅₄ and TG the

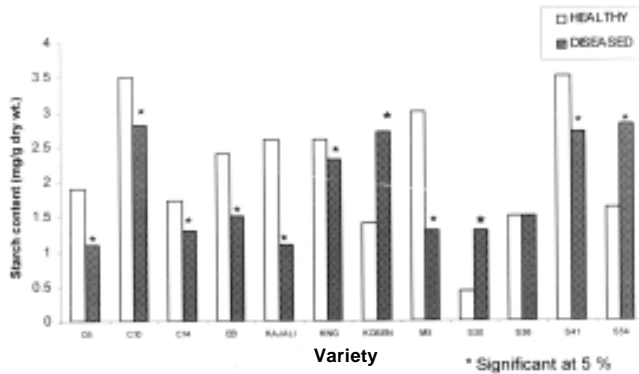


Fig. 5. Starch content in the healthy and rust affected mulberry leaves

starch content increased significantly as compared to healthy plants. On the other hand starch content decreased significantly in DD, S₃₆ and S₄₁ varieties (Fig. 6). In the spot affected S₃₀ mulberry variety, the starch content increased significantly over healthy ones. Whereas, it was found to decrease significantly in C₆, Italian and Mysore local varieties (Fig. 7). The varieties Kajali, S₃₆, S₄₁ and TG affected by mixed infection showed significant increase in starch content. Whereas, in DD and S₅₄, significant reduction was observed (Fig. 8).

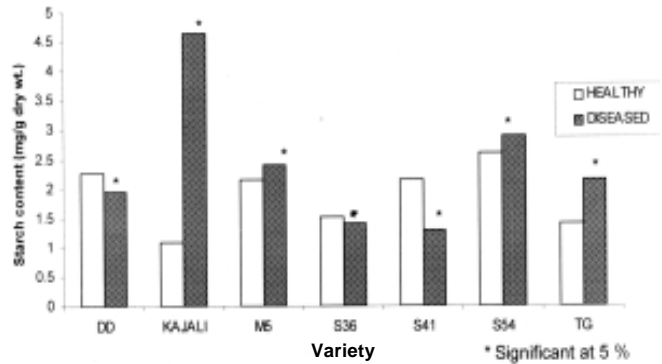


Fig. 6. Starch content in the healthy and powdery mildew affected mulberry leaves

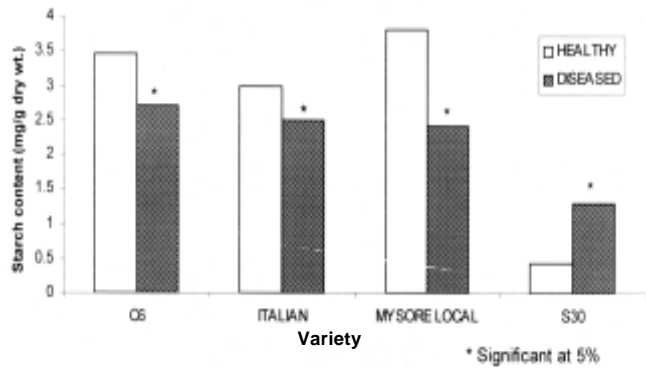


Fig. 7. Starch content in the healthy and spot affected mulberry leaves

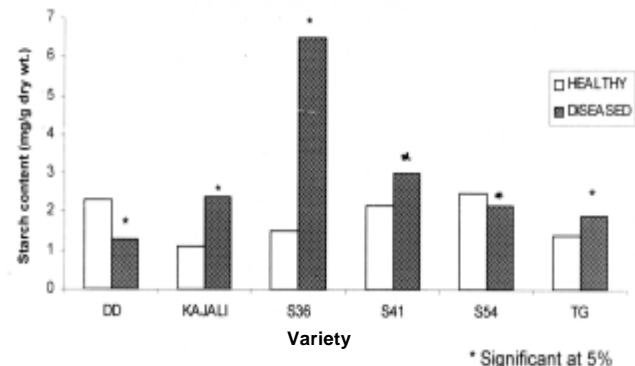


Fig. 8. Starch content in the healthy and mixed infection (powdery mildew and rust) affected mulberry leaves

Nagaraja (1990) reported changes in the starch content of *Phyllanthus emblica* infected by *Ravenelia emblica*. Umesh Kumar and Shree (1990) have also noticed an increase in the starch content of mulberry leaves (M₅) infected by *Myrothecium roridum*. This is due to its production by the fungus or translocation of the

contents towards the site of infection or because of their stability in the infected region. Umesh Kumar (1991) recorded increase in the starch content of powdery mildewed mulberry leaves of Berhampur local, Channapatna local, M₅, *M. cathayan* and *M. multicaulis*; spotted leaves of Mysore local and *M. nigra*; rust affected leaves of M₅, *M. cathayana*, *M. multicaulis* and Mysore local varieties. On the contrary, the author observed decrease in the starch content of mildewed *M. lembang*, *M. nigra*, S₃₆ and S₄₁; spotted Berhampur local, M₅, *M. australis*, *M. macraura*, *M. multicaulis*, S₃₆, S₄₁ and S₅₄; rust affected Berhampur local, *M. lembang*, *M. macraura*. Thind *et al.* (1996) also observed reduction in the starch content of *Cichorium intybus* leaves infected by *Alternaria cichorii*. This was attributed to enzymatic activity of pathogen which was strengthened by increased contents of reducing sugar in the infected parts. Shree *et al.* (1998) have also reported alteration in the starch content of castor leaves under pathogenesis. Earlier workers (Shree and Nataraja 1993, Alam *et al.* 1996) have reported increase in the starch content of diseased plant tissues. Radha (2001) reported variation in starch content of mulberry varieties affected by rust, mildew, spot and mixed infection.

In the present investigation, it was observed that both the enzyme (amylase) activity and the substrate (starch) level increased in rust affected Kosen, S₃₀ and S₅₄; powdery mildewed leaves of Kajali and TG; spot affected S₃₀ and mixed infection affected Kajali, S₃₆ and TG varieties. This was due to the accumulation of substrate in diseased leaves which triggered the enzymatic activity (Rajendra Singh and Saxena 1989, Shree *et al.* 1997, Radha 2001). Decrease in the enzyme activity as well as substrate level was noticed in rust affected C₁₀ and C₁₄; spot affected C₆, Italian and Mysore local varieties. The enzyme activity decreased probably due to non-availability of the substrate. The fungal pathogen might have changed the normal metabolism of leaf tissues, which reduces the photosynthetic activity. In rust affected C₆, EB, Kajali, KNG, M₅ and S₄₁; powdery mildew infected DD, S₃₆ and S₄₁; mixed infection affected DD and S₅₄ varieties, the enzyme activity increased but the substrate level decreased. The actual level of the substrate decreased due to the covering of leaf surface by fungal mycelial mat which reduced the entry of sunlight, thereby inhibiting the

photosynthesis (Shree *et al.*, 1997). In spot affected M₅, S₅₄ and mixed infection affected S₄₁ varieties, the substrate level was high but enzyme activity was low. The increased level of substrate may be due to its production by the fungus, its translocation towards the site of infection or because of its stability in the infected region (Reddy and Rama Gopal 1982, Shree and Nataraj 1993).

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