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Comparative effects of muscardine and flacherie diseases on the free amino acid contents of *Bombyx mori* l. at the pupal stage during seed and commercial rearing seasons

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Abstract
Asparagine, Cysteine, Serine and Valine are traces during the seed crop season due to the effect of Muscardine disease. Asparagine, Cystic acid, Cysteine and Threonine are traces during the commercial crop season due to the effect of Muscardine disease. Glutamine traces in the seed crop season and Glutamic acid, Lysine and Threonine are traces in the commercial crop season due to the effect of Flacherie diseas. Arginine, Glutamic acid, Histidine and Threonine are absent during the seed crop season and Glycine, Methionine-sulphoxide and Valine are absent in the commercial crop season due to the effect of Muscardine disease. Arginine, Asparagine, Histidine, Threonine, Valine are absent in the seed crop season and Cysteine, Methionine-sulphoxide, Threo nine, Valine are absent during Commercial crop season due to the effect of Flacherie disease.
The relative impact of two diseases namely Muscardine and Flacherie has clearly shown that the Flacherie disease of the pupae of *Bombyx mori* L. has a greater Pathological effect on free Amino acids of pupae than the Muscardine disease. The commercial crop season provides relatively better dietary and climatic conditions to pupae than the seed crop season.

Keywords: Pupae (*Bombyx mori* l.), free amino acids, flacherie, muscardine, seasons

Introduction
Silk is a beautiful gift of nature being produced by silk producing insect speciallyMulberry silk under domesticated, semidomesticated and wild conditions. The place of indigenous silks in Agricultrue and industrial development is very important, because, it constitution the main raw material of india's chief cottage industry and provides fruitful source of income to millions (siddappaji *et al*., 2014) [16]. The Amino acids supplementation has good influence on the filament length which is one of the important parameters of silk content and regulate the reeling speed (chattopadhyay *et al*.,2018) [5]. The silk producing insect suffer great loss of crop (20-30%) due to various diseases like virosis, sporozoasis, Muscardine and Flacherie. The Muscardine and Flacherie diseases caused by fungal and bacterial infection are very prominent among the Mulberry silkworm (*Bombyx mori* L.). It retards the growth and development of a silkworm pupae as a result the length and width of the worm get affected (Agrawal & Jolly,1974) [1]. The seasonal changes greatly influence the number of Amino acids in the haemolymph of healthy pupae as they are greater in comparison to diseased pupae (Sinha,1970) [17].

Materials and Methods
Pupae of *Bombyx mori* infected with different diseases were collected from the rearing sights with the help of symptoms, as workout by (Jolly *et al*., 1968) [9]. The infected pupae after proper identification were put for the biochemical analysis in respect of free Amino acids contents during the seed crop and commercial crop season. As per the standard methods suggested a control was also maintained. Further data were collected, compared and analysed and finally presented in the Tables 1 and 2. The entire work during both the seasons were carried out in the P.G. Department of Zoology, Magadh University Bodh Gaya, Bihar, India.

Results
The results obtained in relation to the impact of Muscardine and Flacherie diseases on free Amino acids of pupae of Mulberry silkworm *Bombyx mori* L. have been recorded in tables 1 and 2 during the seed crop and commercial crop seasons.
Table 1 reveals the relative effect of Muscardine and Flacherie diseases on free Amino acid content during the seed crop season. It is evident from the table that the number of free Amino acids in the experimental lot for Muscardine is 15 where as the total no. of free Amino acids in control is 19. The Arginine, Glutamic acid, Histidine, Threonine are absent in experimental lot. Further the Asparagine, Cysteine, Valine have been found in traces under the experimental lot. The Aspartic acid, Beta-alanine, Cystic acid, Glycine, Leucine, Lysine, Methionine-sulphoxide, Proline and Tyrosine are abundant in the haemolymph of the Muscardine infected lot. Likewise, the impact of Muscardine disease in respect of free Amino acids at pupal level during commercial crop season against the control has been presented in table 2. The table reveal the presence of altogether 16 free Amino acids under the infected lot in the comparison to 19 free Amino acids under the control lot. The Glycine, Methionine-sulphoxide, Valine are altogether absent in the experimental lot. Further the Asparagine, Cystic acid, Cysteine, Threonine are in traces in comparison to control. It is further clear that the Alpha-alanine is excess in control. Where as this acid show present in respect of Muscardine. The Asparagine, Cystic acid, Cysteine, Lysine, Threonine are present in control but traces in respect of Muscardine.

The overall observations the effect of Muscardine disease on free Amino acids are avident as it affects the biochemical concentration of the pupae of Mulberry silkworm.

likewise the impact of Flacherie disease of Mulberry silkworm (*Bombyx mori*) caused by bacterial infection has also been evaluated and its relative analysis with Muscardine disease in respect of biochemical contents at pupal stage of *Bombyx mori* has been carried out as per the tables 1 and 2 during seed crop and commercial crop season. According to table no. 1 *Bombyx mori* pupae infected with Flacherie disease have total number of free Amino acid 14 in experimental lot and total no. of free Amino acids in control is 19 during seed crop season. The Arginine, Asparagine, Histidine, Threonine and Valine are altogether absent in the experimental lot. The Alpha-alanine, Aspartic acid Beta-alanine, Cystic acid, Cysteine, Glutamic acid Glycine, Leucine, Lysine, Methionine-sulphoxide, Proline, Serine, Tyrosine are abundant in the haemolymph of the Flacherie infected lot. Likewise the impact of Flacherie disease in respect of free Amino acids at Pupal stage during commercial crop season against the control has been presented in table 2. The table reveal the presence of altogether 15 free Amino acids under the infected lot in the comparison to 19 free Amino acids under the control lot. The Cysteine, Methionine-sulphoxide, Tyrosine, Valine are altogether absent in the experimental lot. Further the Gluamic acid is in traces in comparison to control. It is further clear that the Alpha-alanine is excess in control whereas this acid show that presence in respect of Flacherie. The Leucine, Lysine and Threonine are present in control but traces in respect of Flacherie.

Discussion

The Results regarding the parameter of the project are indicative of the fact that under the influence of Muscardine and Flacherie diseases the free Amino acids at pupal stages of *Bombyx mori* get deteriorated due to the metabolic degradation of biochemical contents taking part in the process of growth (Agrawal & Jolly, 1974; Choudhary,2008; Jolly and Sen, 1972; Ramesh *et al*., 2018; Radjabi,2010; Sinha,1970). [1, 6, 10, 13, 12, 17] The said result becomes very clear when we consider the earlier work carried out by many investigators (Akerele, 2009; Ahsan, 1982; Basti & Ashfaq,1999; Hiratasuka, 1917; Ishimori & Muto, 1951; Sinha *et al*., 1990) [3, 2, 4, 7, 8, 18]. The result obtained is clear when we consider the fact that the commercial crop season provide relatively better dietary and climatic condition to the developing stages of *Bombyx mori* than the seed crop season as reported by number of workers (choudhary,2008; Kanchan, 2003; Sen & Sinha, 1986; Sannapa *et al*., 2002). [6, 11, 15, 14]

Conclusion

Finally when we summed up the discussion it becomes very clear that Muscardine disease caused by fungal infection and Flacherie disease caused by bacterial infection among the Mulberry silkworm (*Bombyx mori* L.) significantly affect the biochemical contents particularly free Amino acids resulting in to poor growth and development of pupal stage of *Bombyx mori* during both the seaons (Ramesh *et al*., 2018; Radjabi, 2010; Sinha, 1970). [13, 12, 17]. The loss of biochemical contents Are relatively greater due to Flacherie infection than the Muscardine infection.

Table 1: Comparative effects of diseases on the free amino acid contents at the pupal stage during seed crop season

S.N.	Free Amino acid	Experimental		Control	C.D. at 0.5% Level
		M	F		
1	Alpha-alanine	+ -	+	+	H.S.
2	Arginine	-	-	+ -	
3	Asparagine	+ -	-	+	
4	Aspartic acid	+	+	+	
5	Beta-alanine	+	+	+	
6	Cystic acid	+	+	+	
7	Cysteine	+ -	+	+ -	
8	Glutamic acid	-	+	+	
9	Glutamine	+ -	+ -	+	
10	Glycine	+	+	+ -	
11	Histidine	-	-	+	
12	Leucine/Isoleucine	+	+	+	
13	Lysine	+	+	+	
14	Methionine-sulphoxide	+	+	+ -	
15	Proline	+	+	+	
16	Serine	+ -	+	+ -	
17	Threonine	-	-	+ -	
18	Tyrosine	+	+	+	
19	Valine	+ -	-	+ -	
		15	14	19	

+ = Present, + + = Excess, + - = Traces, - = Absent, M=Muscardine, F=Flacherie,
H. S=Highly significant

Table 2: Comparative effects of diseases on the free amino acid contents at the pupal stage during commercial crop season

S.N.	Free Amino acid	Experimental		Control	C.D. at 0.5% Level
		M	F		
1	Alpha-alanine	+	+	+ +	
2	Arginine	+	+ +	+	
3	Asparagine	+ -	+	+	

4	Aspartic acid	+	+	+	H.S.
5	Beta-alanine	+	+	+	
6	Cystic acid	+ -	+	+	
7	Cysteine	+ -	-	+	
8	Glutamic acid	+ -	+ -	+ -	
9	Glutamine	+	+	+	
10	Glycine	-	+	+	
11	Histidine	+	+	+	
12	Leucine/Isoleucine	+	+ -	+	
13	Lysine	+ -	+ -	+	
14	Methionine-sulphoxide	-	-	+ -	
15	Proline	+	+	+	
16	Serine	+	+	+	
17	Threonine	+ -	+ -	+	
18	Tyrosine	+	-	+	
19	Valine	-	-	+	
		16	15	19	

+ = Present, + + = Excess, + - = Traces, - = Absent, M=Muscardine, F=Flacherie,
H. S=Highly significant

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