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Enhancing social welfare: evaluating the influence of motor vehicle emissions on mulberry leaves, food sustainability, and conservation efficacy for mulberry silkworm, *Bombyx mori* Linn

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Abstract
This current study is conducted to determine potential impact of feeding motor vehicle-related major pollutants, such as Sulphur dioxide, Nitrogen oxides, Carbon monoxide, Volatile organic compounds, & green gases polluted mulberry leaves, to silkworms, *Bombyx mori* L. The study used silkworm hybrids, CSR2 × CSR4, SH6 × NB4D2, DUN22 × DUN6 & CSR double hybrid, with relation road pollutants from National Highways throughout India. Numerous pollutants from the roads are produced, and these pollutants end up on the leaves of mulberries. The silkworm is a monophagous bug that only consumes leaves from mulberries. By raising silkworm larvae on air-contaminated mulberry leaves, in addition to quantity, the impact on silkworm nutritional indices, food digestion processes & conversion efficiency were evaluated. By feeding silkworm larvae on air-contaminated mulberry leaves, impact on nutritional indices of the silkworms, food digestion processes, and the effectiveness of conversion were evaluated. In addition, the quantity of pollutant sediments on the mulberry leaves was quantified. When fed extremely polluted mulberry leaves, as opposed to different stages of larvae fed lowly contaminated mulberry leaves, the silkworm larvae's assimilation, food consumption & conversion efficiency significantly decreased in both IVth & Vth instar larvae. However, because larvae use the upper limited amount of feed in Vth instar, effect was more enunciate. Because of decreased conversion efficiency, silkworm larvae's average larval weight & average larval weight gain were both lower, as was cocoon production rate. When given extremely polluted mulberry leaves, all of the CSR2 × CSR4, SH6 × NB4D2, DUN22 × DUN6 & CSR double hybrids showed a noticeable effect; nevertheless, the CSR double hybrid was the least pretentious and the CSR2 × CSR4 hybrid was the most pompous.

Keywords: larvae, nutritional indices, fume pollutants, hybrid, mulberry, silkworm

Introduction

India has the distinction of being the world's second-largest silk producer, after China. The primary sources of air pollution include noise, various forms of ionizing radiation, gases, and suspended particulates. The gases include nitrogen (NO, NO_2, N_2O_4, NH^{4+}, NH_3, O_3, SO_2, C_6H_6 vapours, volatile phenols, Hg, Cl_2, and polycyclic aromatic hydrocarbons) and carbon in both reduced and oxidized forms (CO_2, CO, CH_4). The harmful effects of PAHs and heavy metals including Pb, Ni, Cd, and as have an adverse influence on mulberry trees. They may have harmful consequences directly or indirectly by altering the pH of the soil and causing hazardous metal salts, such as aluminium, to dissolve. The mechanical effect of the particulate materials is negative. They enclose leaf blade, decreasing light penetration & obstructing stomata opening. These obstacles have a significant impact on photosynthesis, which experiences a substantial drop in rate. For thousands of years, people have been producing silk through the science and art of sericulture [1]. An agro based sector that has enormous employment potential in both rural and urban areas is sericulture. There are further commercial silkworm species, but *Bombyx mori* is mostly used, extensively researched, trained & has most advanced raising methods [2]. Since it has been tamed for such a long time, the Bombycidae silkworm insect, which belongs to the phylum Arthropoda, is the sole extant species in its family [3]. *Bombyx mori L*., mulberry silkworm, is a single-chambered silkworm which primarily consumes leaves of mulberries (Morus spp.) for its larvae's growth & development. Weight, pupation, silk production & reproductive properties of silkworm larvae & pupae are directly influenced by the features and quantity of mullbery leaves. The organization of converting ingesta and digesta into the body, cocoon, and shell of the cocoon varies depending on the variety of silkworm, influenced by factors such as the environment, mulberry breeds, and seasons [4]. The percentage of food that silkworms eat, assimilate, and are able to digest depends critically on the nutritional qualities of mulberry leaves [5]. The proper growth and silk production in silkworms depend on the quality and quantity of ingesta and digesta they consume [6]. Qualities & quantity of mulberry leaves are becoming more and more limited by environmental contamination, and feeding contaminated mulberry leaves affects development of silkworms as well as their ability to cocoon & produce silk [7]. Mulberry trees primarily found in an erratic shape along road edges, river bunds, farm/garden boundaries, canals, fences, etc. support sericulture at Dewari Kachan, Myur block DC Sonbhadra, India. Sonbhadra's soils are primarily semi-arid to humid, making them vulnerable to erosion by air pollutants during clear, sunny, windy days when a lot of pollutants are produced. The issue of excessive air pollution created by automobiles moving constantly along the highways in the Sonbhadra district is exacerbated by this. State highway SH5A, which links Ranchi, state's summer capital, with rest of India, is congested with millions of cars each year & growing each year from residents & tourists of Sonbhadra. These cars include heavy and light commercial vehicles, as well as patrolling & convoy wagons of Indian army & Central Reserve Police Force. Mulberry leaves are a popular choice for measuring atmospheric air pollution, particularly particle matter in metropolitan areas, due to their well-known ability to draw in air pollutants and granular debris [8]. Kashmir has been noted for its healthy climate, which is ideal for growing silkworms. In addition to the several damaging elements of both biotic and abiotic dawn, one additional issue restricting the characteristics of Sonbhadra's mulberry leaf production is the dust produced by vehicles on the valley's highways. In sericulture, it is a given that the air-polluted leaves will be fed to silkworms, particularly in India where silkworm farmers harvest leaves from mulberry trees, which are primarily found next to roadways. When *B. mori* eventually eats these air-polluted mulberry leaves, it would face challenging conditions for growth and development, which could affect its productivity and leave it susceptible to a number of diseases. Mulberry leaves that have been contaminated by road air may also have an impact on the food that the silkworms consume, which could have a major impact on larval silkworms' development & growth. While numerous educational research have been conducted regarding impact of vehicle air pollution on horticultural & agricultural crops, there are relatively few studies pertaining to silkworms & mulberries [9]. In this context, an effort was undertaken to assess the influence of air pollutants from mulberry leaf roads on the growth, metabolic conversion, and digestive processes of the *Bombyx mori* species of silkworms.

Materials and methods

The Sericulture Silk raising station, located at SH5A Sonbhadra Robertsganj, India, is where the current inquiry was conducted. Based on their proximity to the SH5A, two schemes of small mulberry farms with Goshoerami variety were chosen for purpose of measuring air pollutants and providing food for the silkworms. These sites were designated as site "A," which is located within 30 meters & site "B," which is located beyond 150 meters. In this study, the quantity of air pollutants accumulated on mulberry leaves was assessed by measuring the dust deposition on ten randomly selected mature leaves. The air-polluted dust was subsequently washed off, and the freshly deposited dust was measured every 24 hours for seven consecutive days. Following standard rearing procedures, Bombyx Silkworm hybrids including CSR2 × CSR4, SH6 × NB4D2, DUN22 × DUN6 & CSR double hybrids, were raised on mulberry leaves contaminated with air pollutants; to understand how road air pollution affects the silkworm's digestive system & organization during conversion. Two disease-free laying (DFL) larvae from each breed were placed in rearing trays. One set of trays contained neonates from each breed & provided them with mulberry leaves with highest level of dust contamination, while another set of trays contained neonates from each breed & offered them mulberry leaves with lowest level of air contamination. This setup allowed for preparation of up to eight rearing trays. After the third molt, the larvae in each tray were divided into three replicates, with one hundred larvae remaining in each tray. This process enabled preparation of up to twenty-four rearing trays, while remaining larvae were kept as prepared stock. 12 trays were divided into two clusters, one with twelve trays fed with mulberry leaves that were extremely dust-infected and the other with twelve trays fed with leaves that were only slightly polluted. The first three instars of the larvae were raised at 26±1 °C & 80±5% relative humidity, whereas the fourth and fifth in stars of the larvae were kept at 26±1 °C & 80±5% RH. The feed application trials were conducted during the fourth and fifth instars, as this is when silkworm larvae exhibit the highest food consumption rates. The experimental batches were fed the carefully weighed freshly obtained mulberry leaves three times a day. A few representative mulberry leaves from each meal were used as dummies to establish the dry weight of the food that was consumed. Every day in every replication of every treatment, the larvae in a healthy state were counted. When discovered, the uneven, sick, and dead larvae had been eliminated and replaced with fresh batches kept apart. After drying in the oven at a consistent temperature of 80^{o} C, weight of leftover soil & leaves was monitored daily on a dry weight premise; weight increase of larvae was instead recorded on a fresh weigh premise [12]. Using the gravimetric technique, each individual's nutritional framework—which includes ingested as well as digested food, growth rate, reference ratio, conversion efficiency, consumption index (CI), estimated digestibility (ED) & coefficient of metabolism (COM) was listed [13]. To assess the influence of contaminated mulberry leaves on the growth and development of the silkworm larvae, the average larval weight and average larval weight gain were also recorded. Numerous nitrogenic frameworks were enumerated using the following calculation [13].

Ingested food (g)

Dry weight of total intake (g) of mulberry leaves by larvae of silkworm during fourth & fifth Instars up to stage of spinning & ripening.

Ingested food (IF) = given leaves dry weight –leftover leaves Dry weight

Digested food (g)

Total digested dry food from intake of dry weight of mulberry leaves by larva of silkworm during fourth & fifth stage until they are ready for spinning & ripening.

Food digested = Dry weight of food ingested – Dry weight of faces

Consumption index

The rate of food intake was calculated as the mean weight of larvae during the feeding period.

$$\text{Consumption index (CI)} = \frac{\text{Ingested food}}{\text{Mean fresh larval weight in the 4}^{th}\text{ or 5}^{th}\text{ instar} \times \text{larval duration (Days)}}$$

Reference ratio (g)

An indirect expression of absorption and assimilation of food. Denotes the ingesta required per unit excreta produced.

$$\text{Reference ratio (RR)} = \frac{\text{Dry weight of food ingested}}{\text{Dry weight of excreta}}$$

Growth rate

Growth rate mention to larval gain biomass & specify organization of conversion of nutrition into biomass of Larvae.

$$\text{Growth rate (GR)} = \frac{\text{Fresh weight gained by worms}}{\text{Duration of feeding (days)} \times \text{Mean dry weight of the worms during feeding period}}$$

Approximate digestibility (%)

This demonstrates the direct effectiveness of mulberry leaf assimilation and relies on the speed at which food moves through the silkworm's intestine.

$$\text{A. D.} = \frac{\text{Weight of food ingested} - \text{weight of faces}}{\text{Weight of food ingested}} \times 100$$

Ingested food conversion efficiency (%)

Related to percentage that represents the effectiveness of converting food into biomass or body matter at various phases.

$$\text{IFCE} = \frac{\text{Fresh weight which larvae gained}}{\text{Ingested food's Dry Weight}} \times 100$$

Coefficient of metabolism (COM)

A metric of overall metabolic activity related to the silkworm larvae's productivity in converting food into larval biomass.

$$\text{COM} = \frac{\text{Digested food's weight digested - Increase in larva weight}}{\text{Digested food's weight digested}}$$

$$\text{Average larval weight (ALWt)} = \frac{\text{Total larval weight}}{\text{Total number of larvae}}$$

$$\text{Average larval weight gain (ALWtG)} = \frac{\text{[Total larval weight in Previous instar]- [Total larval weight in present instar]}}{\text{Total number of larvae}}$$

The data were statistically analyzed using software such as MSTAT or the Disc operating system.

Results

Observations related to road dust particles being thrown onto mulberry leaves reveal that there is a variation in the amount of dust thrown onto the leaves in relation to distance from national highway SH-5A (Table 1). As distance from the road increases, the amount of dust particles that are thrown onto the mulberry leaves decreases accordingly. The amount of air-contaminated road dust particles that were found at Site A, which is 30 meters away from the highway, was found to be much higher than at Site B. With increasing duration of exposure, the concentration of dust particles on leaves from both sites increases; however, the deposition of dust particles on leaves from site A is significantly greater than that of site B. Leaves from site A were labelled as severe dust-contaminated leaves (EDP) for the subsequent study, whereas leaves from site B were identified as low dust-contaminated leaves (LDP).

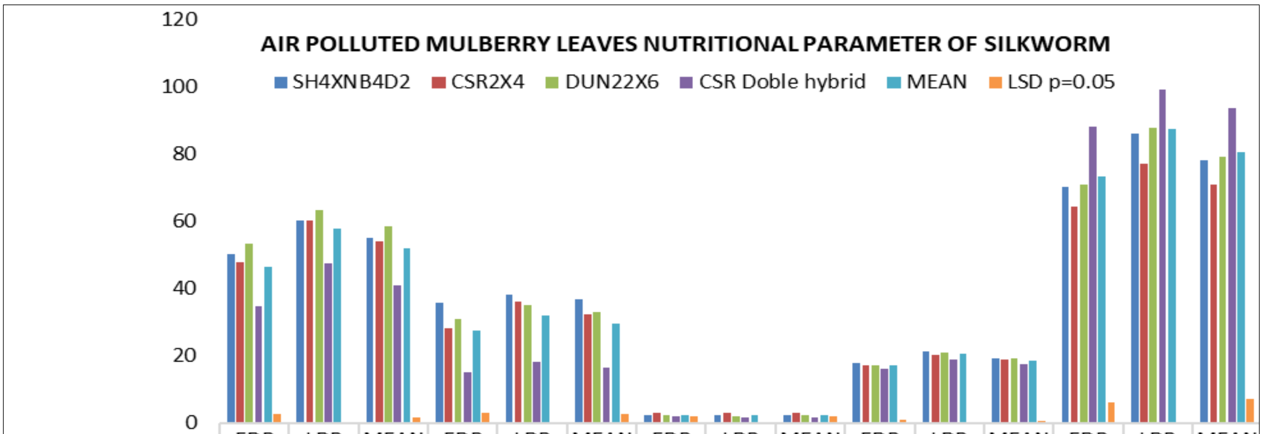
Table 1: Air pollutant deposition on Mulberry leaves at two test sites in CSR & TI

Sites	Amount of air pollutant deposited on mulberry leaves							
	Duration (in day)							
	1	2	3	4	5	6	7	Average ± S.D
Site A	1.66	2.04	2.40	2.55	2.90	3.20	3.50	2.60 ±0.66
Site B	0.80	0.99	1.08	1.30	1.40	1.61	1.72	1.17 ±0.35

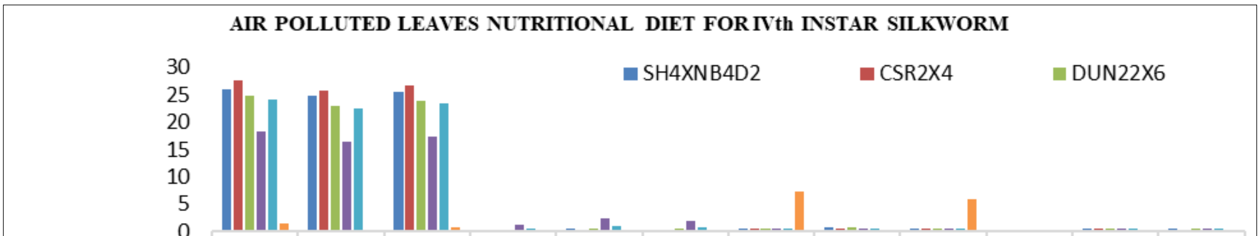
Figure 1 and 2 illustrate how the mulberry leaves contaminated by road dust particles affect silkworm, *Bombyx mori L.*, in terms of food intake, digestion & conversion organization throughout both the fourth and fifth instars. The way the silkworm larvae consumed their food was significantly impacted by the mulberry leaves polluted with dust. When compared to the larvae fed LDP mulberry leaves, those fed EDP leaves during both their fourth and fifth instars exhibited the lowest levels of meal digestion. Specifically, in the fifth instar, CSR double hybrid larvae fed EDP leaves had the lowest amount of digested food in the fourth instar, while SH6×NB4D2 larvae fed LDP leaves showed the highest amount. Regarding the amount of digested food in the fifth instar, CSR2 × 4 larvae fed EDP leaves had the least, while CSR double hybrid larvae fed LDP leaves had the most. The notable uniqueness observed in the food after digestion could potentially stem from the silkworm's lack of interest in the less nutritious mulberry leaves tainted with dust. The decreased amount of food that has been digested makes room for additional nutritional components that are impacted by the mulberry leaves' high dust content.

The food that is consumed is directly influenced by the food that the silkworm larvae have absorbed. When it comes to the assimilation of food, the larvae fed EDP mulberry leaves in their fourth instar range in weight from 14.67 to 30.67 g, whereas those fed LDP leaves range in weight from 17.87 to 35.57 g. The larvae from crosses SH6 × NB4D2 and CSR2 × 4, when fed with low-dust (LDP) mulberry leaves, exhibited the highest food absorption levels during the fourth instar, whereas those from the CSR double hybrid, when fed with extra-dust pollution (EDP) leaves, showed the lowest. In the fifth instar, larvae fed EDP mulberry leaves ranged in digested weight from 89.58 to 137.42 g, while those fed LDP leaves ranged from 116.55 to 173.38 g. Notably, during this stage, SH6 × NB4D2 larvae fed with LDP leaves displayed the highest food assimilation levels, whereas CSR double hybrid larvae fed with EDP leaves exhibited the lowest assimilation. Furthermore, when larvae were provided with maximum amounts of mulberry leaves contaminated with dust, their food assimilation decreased. Comparing larvae fed LDP and EDP mulberry leaves, a consistently higher growth rate was observed in the latter group during both the fourth and fifth instars.

In the fourth instar, larvae of DUN 22 × 6 showed the highest reference percentage value (2.38 g) when fed with EDP leaves, while those of CSR double hybrid displayed the lowest (1.54 g) when fed with LDP leaves. Similarly, in the fifth instar, larvae of CSR2 × 4 exhibited the highest reference proportion value (2.45 g) when fed with EDP leaves, whereas CSR double hybrid larvae displayed the lowest (1.47 g) when fed with LDP leaves. Notably, comparing larval groups fed LDP and EDP mulberry leaves, the latter exhibited faster growth rates. For instance, SH6×NB4D2 larvae (20.38) showed a significantly higher growth rate in the fourth instar when fed LDP leaves, whereas CSR double hybrid larvae (15.16) exhibited the lowest growth rate when fed EDP leaves. Conversely, in the fifth instar, DUN 22 × 6 larvae (13.87) displayed the highest growth rate when fed LDP leaves, while CSR double hybrid larvae (10.04) showed the lowest growth rate when fed EDP leaves.

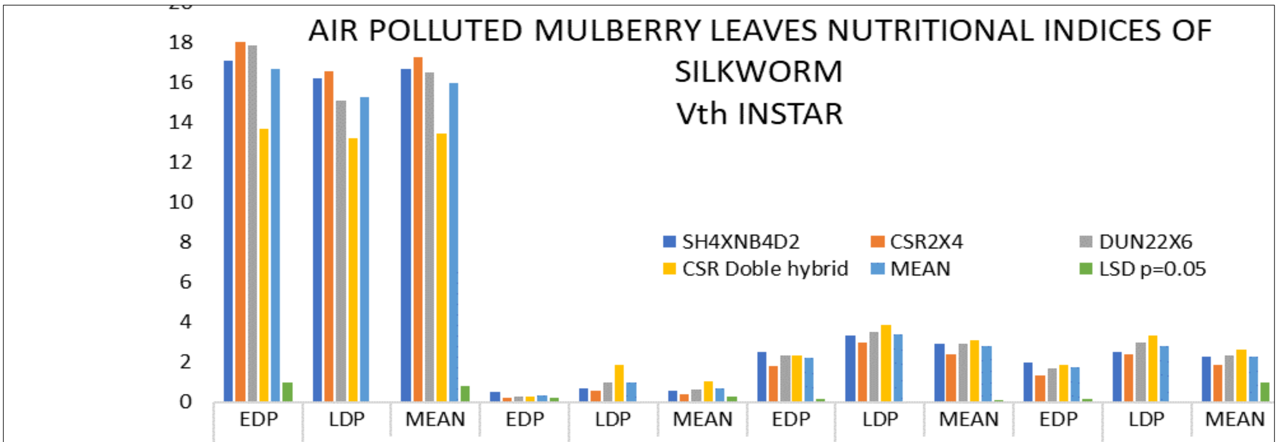


	IF			DF			RR			GR			IFCE		
	EDP	LDP	MEAN	EDP	LDP	MEAN	EDP	LDP	MEAN	EDP	LDP	MEAN	EDP	LDP	MEAN
SH4XNB4D2	50.11	60.12	55.11	35.77	38.11	36.94	2.44	2.34	2.39	17.88	21.33	19.06	70.11	86.11	78.11
CSR2X4	47.77	60.11	53.94	28.23	36.11	32.17	2.99	3.1	3.05	17.23	20.33	18.78	64.33	77.22	70.78
DUN22X6	53.44	63.21	58.33	31.11	35.12	33.12	2.22	2.14	2.18	17.13	21.11	19.12	70.88	87.66	79.27
CSR Doble hybrid	34.66	47.33	40.99	15.12	18.11	16.62	1.98	1.66	1.82	16.11	18.99	17.55	88.11	98.99	93.55
MEAN	46.49	57.69	52.09	27.56	31.86	29.71	2.41	2.31	2.36	17.08	20.44	18.63	73.36	87.49	80.43
LSD p=0.05	2.55		1.81	2.88		2.82	2.11		1.99	0.88		0.622	5.98		7.33

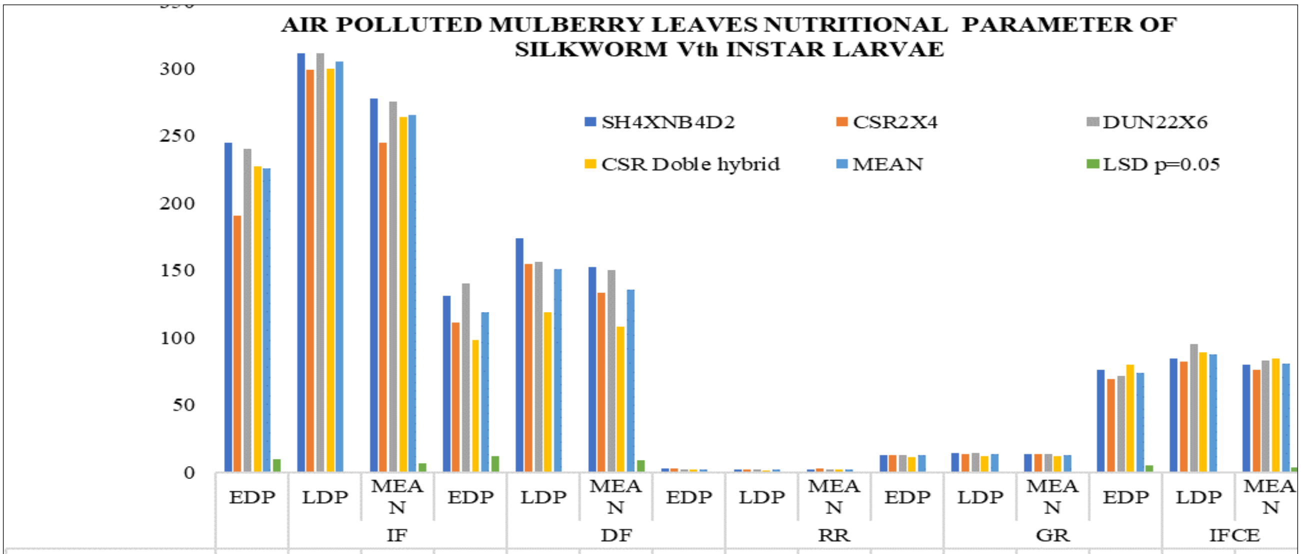


	CI			COM			ALWt.			ALWtG		
	EDP	LDP	MEAN	EDP	LDP	MEAN	EDP	LDP	MEAN	EDP	LDP	MEAN
SH4XNB4D2	25.99	24.88	25.44	0.19	0.55	0.37	0.5	0.67	0.58	0.38	0.55	0.46
CSR2X4	27.55	25.66	26.61	0.16	0.4	0.28	0.48	0.63	0.55	0.32	0.48	0.4
DUN22X6	24.88	22.99	23.94	0.33	0.6	0.46	0.55	0.7	0.63	0.41	0.57	0.49
CSR Doble hybrid	18.33	16.44	17.39	1.33	2.33	1.83	0.51	0.61	0.56	0.33	0.59	0.46
MEAN	24.19	22.49	23.34	0.5	0.97	0.74	0.51	0.65	0.58	0.36	0.55	0.45
LSD p=0.05	1.44		0.85	0.299		0.24	7.4		5.89	0.018		0.014

Fig 1: Effect of air Polluted Mulberry Leaves on the Nutritional Parameters of Silkworm Larvae in the IVth instar stage



	CI			COM			ALWt.			ALWtG		
	EDP	LDP	MEAN	EDP	LDP	MEAN	EDP	LDP	MEAN	EDP	LDP	MEAN
SH4XNB4D2	17.11	16.22	16.66	0.51	0.67	0.59	2.51	3.33	2.92	1.99	2.53	2.26
CSR2X4	18.01	16.55	17.28	0.21	0.59	0.4	1.81	2.99	2.4	1.32	2.41	1.86
DUN22X6	17.88	15.11	16.49	0.31	0.98	0.65	2.32	3.51	2.91	1.72	3.01	2.36
CSR Doble hybrid	13.66	13.22	13.44	0.26	1.87	1.06	2.34	3.87	3.1	1.9	3.33	2.61
MEAN	16.66	15.27	15.96	0.32	1.02	0.67	2.24	3.42	2.83	1.73	2.82	2.27
LSD p=0.05	1.01		0.8	0.23		0.28	0.144		0.09	0.166		0.99



	IF			DF			RR			GR			IFCE		
	EDP	LDP	MEAN	EDP	LDP	MEAN	EDP	LDP	MEAN	EDP	LDP	MEAN	EDP	LDP	MEAN
SH4XNB4D2	244.55	311.55	278.05	131.11	174	152.55	2.44	2.22	2.33	13.01	13.99	13.5	76.11	84.11	80.11
CSR2X4	190.33	299.22	244.77	111	155	133	2.59	2.19	2.39	12.99	13.77	13.38	69.22	82.22	75.72
DUN22X6	240.33	311.12	275.72	140	156	150	2.29	1.99	2.14	12.66	14.02	13.34	71.22	95.11	83.16
CSR Doble hybrid	227.66	299.66	263.66	98	119	108.5	1.88	1.52	1.7	11.09	12.02	11.55	80.11	88.77	84.44
MEAN	225.71	305.38	265.55	119.02	151	136.01	2.3	1.98	2.14	12.43	13.45	12.94	74.16	87.55	80.85
LSD p=0.05	10.01		6.66	12.01		8.55	0.155		0.12	0.433		0.32	4.88		3.44

Fig 2: Effect of air Polluted Mulberry Leaves on the Nutritional Parameters of Silkworm Larvae in the 5th Instar

One key physiological foundation that illustrates how the leaf transforms into the silkworm's body is the ability to digest food. The maximal ingested food change ability (IFCE) was seen in the silkworm groups fed low-dust mulberry leaves, as opposed to the larvae groups fed high-dust-contaminated mulberry leaves. This framework aligns with the previous one. In the fourth instar, CSR double hybrid larvae (116.53 g) fed with LDP leaves exhibited the highest instantaneous growth rate efficiency (IFCE), whereas DUN 22 × 6 larvae (63.37 g) fed with EDP leaves displayed the lowest IFCE. Larvae of DUN 22 × 6 (94.40) were found to have the largest IFCE in the fifth instar when they fed on LDP leaves, while the larvae of CSR2 × 4 (68.21) showed the lowest IFCE when they fed on EDP leaves. The rate of food ingested and the larvae's mean weight growth throughout the feeding phase are related by the expended index. When compared to the larvae that were fed mulberry leaves with minimal dust contamination, Observed Expended Index was higher in silkworm groups that were fed highest amount of dust-contaminated leaves. In the fourth instar, CSR2 × 4 larvae (26.70) fed with EDP leaves demonstrated the highest Consumption Index, whereas CSR Double Hybrid larvae (15.76) fed with LDP leaves exhibited the lowest Consumption Index. CSR2 × 4 larvae (17.66) had highest Consumption Index in fifth instar when they fed on EDP leaves, while CSR Double Hybrid larvae (12.30) had lowest Consumption Index when they fed on LDP leaves. The coefficient of intake reflects the metabolic activity associated with the conversion of mulberry leaves into larval biomass. When fed low levels of dust-infected mulberry leaves, silkworm larvae showed an increased coefficient of metabolism; when fed significantly contaminated mulberry leaves, silkworm larvae showed the lowest coefficient of ingestion. During the fourth and fifth instars, the CSR Double Hybrid larvae (2.03 and 1.76) showed the highest coefficient of ingestion while feeding on LDP leaves, whereas the CSR2 × 4 larvae (0.12 and 0.15) showed the lowest coefficient of ingestion when feeding on EDP leaves.

The CSR Double Hybrid larvae displayed notably higher average larval weights. In both the fourth and fifth instars, DUN 22 × 6, SH6×NB4D2, and CSR2 × 4 were provided with mulberry leaves contaminated with moderate levels of dust. Among these, CSR2 × 4 larvae exhibited the lowest average larval weight during the fourth instar. Conversely, when fed with mulberry leaves severely polluted with dust, CSR Double Hybrid, SH6×NB4D2, and DUN 22 × 6 larvae displayed the lowest average larval weight in the fifth instar.

Furthermore, in the fifth instar, CSR Double Hybrid larvae exhibited the most significant average weight gain when fed with mulberry leaves contaminated with low levels of dust, followed by DUN 22 × 6, SH6×NB4D2, and CSR2 × 4. Conversely, CSR2 × 4 and CSR Double Hybrid larvae showed the least average weight gain, while SH6 ×NB4D2 and DUN 22 × 6 larvae consumed the highest amounts of dust-contaminated mulberry leaves during the fourth instar. During the fifth instar, CSR2 × 4 larvae displayed poor average weight gain, followed by DUN 22 × 6, CSR Double Hybrid, and SH6×NB4D2 larvae that consumed the largest amounts of dust-contaminated mulberry leaves.

Discussions

The volume of mulberry leaves (38.2%) influenced by climate (37.0%) is one of key elements that goes into producing silk and cocoons of superior quality [14]. Therefore, for the sericulture to produce high-quality silk, the mulberry trees used for rearing must be raised in a healthy environment. Dust is defined as solid matter that is made up of dirt, naturally occurring organic compounds, and man-made metallic components [15–16]. On both sides of the road, cars bring in a variety of pollutants and dust particles [17]. Particles of road dust act as a natural sink for both organic and inorganic substances, such as heavy metals and hydrocarbon-containing hazardous pollutants [18]. Along with heavy metals such as lead, chromium, cadmium, copper, nickel & zinc, road dust particles also include a variety of hazardous metals [16]. Concentrations of heavy metals in plants by sides of roadways have significantly increased due to a reckless rush of cars [19]. It has been skilfully produced that, because the host plants have a higher lead content than the authority 20, a variety of insect species that feed on roadside plants have accumulated an exceptionally high amount of lead. In Kashmir, there is a chance that mulberry leaves tainted by road dust will come from both late-age rearing carried out at farmer's level & commercially rearing centres run by government. The results of a recent study clearly show that mulberry plantations near heavily travelled National Highway 1A are subject to significant air pollution from things like vehicle exhaust, particulate matter, and dust from the road.

Research on education shows that feeding mulberry leaves polluted with dust has a significant impact on the silkworm's nutritional structure. The silkworms' lack of interest in the dust-contaminated mulberry leaves may be the cause of the decrease in the amount of food that the larvae digested in both the fourth and the fifth instars. Reduced inclination of silkworm larvae towards contaminated mulberry leaves prepares other food sources for contamination by mulberry leaves polluted with dust. Amount of food that was assimilated reduced as a result of less food being consumed.

The reference proportion in the silkworm groups that were fed the largest amount of dust-contaminated mulberry leaves was discovered to be particularly large, indicating the silkworm larvae's declining capacity for absorption and digesting. The reference percentage indicates that the larvae consume more mulberry leaves in order to receive the nutrients that would be available from less mulberry leaves in the event that the leaves were dust-free. In addition, it was discovered that the mulberry leaves polluted the silkworm's digestive system, reducing its capacity to absorb more nutrients from leaf debris. Effect of polluted mulberry leaves on silkworm larvae's expended index serves as additional evidence of the mulberry leaves' nutritional deficiency. Because the larvae require a considerable amount of contaminated leaves to reduce larval biomass, more leaves must be provided for the larvae to eat, raising the cost of culture and lowering the amount that can be profitably produced. These findings are in line with existing research indicating that nutritional traits and quantity play a significant role in various biological processes, including rates of biochemical and physiological processes [21–22]. Ultimately, these traits can also impact larval characteristics or the quantity of cocoon crops in silkworms. This may reveal the effects of mulberry leaf contamination with road dust on the nutritional structure and biochemistry of the leaves, which provide vital nourishment for silkworms. The contamination of mulberry leaves had a consequential impact on these nutritional activities, causing a decline in the organization of silkworm larvae, thereby resulting in reduced average weight and weight gain. Given its influence on the functioning, development, and growth of silkworm larvae, which subsequently affects silk production, the effect of contaminated mulberry leaves on the organization of silkworms is paramount. Research indicates that tfinal indices to appraise the nutritional composition of a hybrid or variety of silkworm and to gauge quantity of feed utilized are the organization of change of ingesta and digesta [23–27].

The analysis of how road dust affects mulberry leaf properties raises serious questions about the leaf's suitability for silkworm rearing. The silkworms' diet of heavily dust-contaminated mulberry leaves has a markedly negative impact on their growth, digestion, and conversion organization. The mulberry leaves' decreased appealing qualities and the challenging conditions the larvae encountered when eating could be the cause of the decrease in food digestion and the alteration in the silkworm's organizational structure. Given that the silkworm eats on the greatest amount of food during its fifth instar, the effects of the extremely dust-contaminated mulberry leaves were first observed in the fifth instar. This fifth instar, which culminates in the silkworms' productivity of the cocoons & determines success or failure of crop, might negatively affect silkworm's productivity due to its reduced growth & altered organization. These results support a study that found that dust-contaminated mulberry leaves induce silkworm mortality, raise the vulnerability of the worm to microbial diseases, and pollute the worm's larval, silk, and cocoon quality [28].

The digestive process, organizational changes, and diminished larval growth observed when feeding silkworms EDP leaves illustrate the adverse impacts of dust particles, which are directly linked to the quantity of dust inhaled by the larvae along with the leaf material. The decreased growth of larvae consuming mulberry leaves contaminated with dust could indeed have repercussions on crop productivity and the profitability of the resulting products.

The same findings were acknowledged in a study of mulberry plants near NH-34 in West Bengal [9]. According to the study, there are mulberry varieties that are good for growing in contaminated areas and that can help with the challenges of raising silkworms in these harsh situations. Although some information exists about the harmful effects of air pollution components, such as polynuclear aromatic hydrocarbons [29], fluorides [7, 30-33], and sulfur [30], little is known about the impact of road dust and its toxic constituents, such as lead, cadmium, etc., on mulberry and silkworms. Therefore, it is crucial to cultivate mulberry plantations away from roadways to better understand leaf characteristics. In regions like Kashmir, where mulberry cultivation often occurs alongside roads and serves as a primary source of leaves for sericulture, the automobile and tourism sectors are rapidly expanding. Consequently, mitigating the hazardous effects of dust pollution on mulberry and silkworm rearing is essential to rejuvenating the state's struggling sericulture industry over recent decades.

Conclusion

A recent study conducted at CSR & TI, Pampore, Kashmir, India, in the spring of 2013 aimed to assess the impact of road dust-contaminated mulberry leaves on various nutritional indices of silkworm hybrids including SH6 × NB4D2, CSR2 × CSR4, DUN22 × DUN6, and CSR double hybrid. The findings revealed that dust-contaminated mulberry leaves led to a decline in the digestive process, alterations in larval organization, and reduced growth of silkworm larvae during both the fourth and fifth instars, with more significant effects observed in the latter stage. Furthermore, it resulted in mature larvae experiencing weight loss, potentially impacting silk production. Given that sericulture units heavily rely on mulberry cultivation alongside roads, the adverse effects of road dust-contaminated mulberry leaves on the nutritional intake and growth of silkworm larvae pose significant concerns. Consequently, addressing the potential hazards posed by tainted mulberry leaves on silkworm rearing is imperative. Developing a range of treatment and management techniques is necessary to mitigate these adverse effects and foster the growth of this vital industry. Only then can the sericulture sector realize its true potential.

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