

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(7): 181-185
www.biochemjournal.com
Received: 18-04-2026
Accepted: 21-05-2026

Nutan Yadav D
M.Sc. Scholar, Department of
Sericulture, College of
Temperate Sericulture,
Mirgund, SKUAST-K,
Kashmir, Jammu and
Kashmir, India

Tejaswini AS
M.Sc. Scholar, Department of
Sericulture, College of
Agriculture, UAS, Bangalore,
Karnataka, India

Nisarga K
M.Sc. Scholar, Department of
Sericulture, College of
Agriculture, UAS, Bangalore,
Karnataka, India

Prashant Natikar
Scientist-C, Silkworm Seed
Production Centre, NSSO,
CSB, Bangalore, Karnataka,
India

S Manthira Moorthy
Director, Central Silk Board,
SSPC, NSSO, Bangalore,
Karnataka, India

Corresponding Author:
Nutan Yadav D
M.Sc. Scholar, Department of
Sericulture, College of
Temperate Sericulture,
Mirgund, SKUAST-K,
Kashmir, Jammu and
Kashmir, India

Health hazards in silkworm seed production centres (SSPCs): Occupational risks, health effects and preventive measures: A review

Nutan Yadav D, Tejaswini AS, Nisarga K, Prashant Natikar and S Manthira Moorthy

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i7c.8963>

Abstract

Silkworm Seed Production Centres (SSPCs), commonly known as grainages, are essential components of the sericulture industry, responsible for the production of disease-free layings (DFLs) required for commercial silkworm rearing. The quality of seed produced in these centres directly influences cocoon productivity and silk yield. However, workers involved in grainage operations are exposed to various occupational hazards that may adversely affect their health. The major biological hazards include exposure to silkworm moth scales, pupal proteins, microbial contaminants, and airborne allergens, which are associated with respiratory disorders such as allergic rhinitis, allergic bronchitis, asthma and other hypersensitivity reactions. Chemical hazards arise from the use of disinfectants, including formalin, bleaching powder, formaldehyde and hydrochloric acid during disinfection and acid-treatment procedures. Exposure to these chemicals may result in skin irritation, eye inflammation, headaches, and respiratory discomfort. In addition, repetitive tasks, manual handling and prolonged standing or sitting in awkward postures contribute to musculoskeletal disorders, particularly lower back pain and fatigue. This review summarizes the major occupational health hazards encountered in SSPCs, the mechanisms underlying allergen-induced diseases, associated health effects and available preventive measures. The adoption of personal protective equipment, improved workplace ventilation, safe chemical handling practices, regular health surveillance and worker training programs can significantly reduce occupational risks. Ensuring a safe and healthy working environment is essential for protecting worker welfare, improving productivity and promoting the sustainable growth of the sericulture sector.

Keywords: Grainage, SSPC, health hazards, allergic disorders, respiratory diseases

1. Introduction

Sericulture is agro based industry which produces silk. It includes various activities from production of host plants to post reeling activities. The industry is labour intensive industry where most of the work is depending on the human resource. This creates rural employment. Moreover, rural women are depended and earning through sericulture industry. The labour activities include cultivation of host plants, grainage activities, rearing of silkworms, reeling and post reeling activities like doubling, twisting and weaving. Sericulture industry is employing around 97.3 lakh people in India. About 35104 MT raw silk is produced in India annually, which generates an economic value and Rs. 3578.76 crore worth silk is exported (CSB, 2024-26). Around 60 lakh individuals in India work in sericulture throughout the year as silk farmers, silk rearers, reelers, twistors and weavers (Sharma and Kapoor, 2020) ^[14]. Although the sericulture sector is vital to rural economies, there are many occupational health risks for those who raise silkworms. Injuries, musculoskeletal disorders, allergies, eye irritation and respiratory ailments are just a few of the health issues that rearers in the silk industry are susceptible to due to their varied responsibilities and exposure to physical, chemical and biological contaminants. Numerous ergonomic, pulmonary, dermatological and musculoskeletal problems that affect worker well-being have been highlighted in recent studies. While exposure to chemicals, dust and silkworm waste causes respiratory and skin-related health issues, prolonged standing, repetitive work and poor posture all contribute to musculoskeletal diseases.

Further aggravating health hazards are physical labour-related weariness and injury.

1.1 Silkworm Seed Production Centres (SSPCS): An overview

Overall development of the sericulture mainly dependent on the quality seed production, so seed organisations are started to maintain the quality and vigour of the silkworm breeds. Silkworm Seed Production Centres (SSPC), known as grainages are responsible for producing Disease Free Laying's (DFLs) and are made available to farmers for commercial silkworm rearing throughout the year. The success of sericulture is largely dependent on the careful operation of these grainages. As a result, the grainage process is the first and most important part of sericultural activities, requiring particular knowledge and care. However, people who work in grainage operations frequently suffer from occupational health conditions such as asthma, allergic bronchitis and allergic rhinitis. Improving working conditions and putting safety measures in place are essential due to these health risks. (Rajitha, K., & Sowmya, P. (2025) ^[15]

In particular, many grainage workers suffer from allergic reactions when they come into contact with cocoons, pupae and moths and they will get serious problems like allergic rhinitis, allergic bronchitis and asthma. Insect allergens have been found to be the main cause of these illnesses in earlier research, including studies by Venkatappa *et al.* (2004 and 2005) ^[27, 26], Yamashita *et al.* (1989) ^[29]. Light on the health-related difficulties encountered by employees in the silkworm seed manufacturing industry. In the study of immune response of sericulture grainage industrial workers exposed to silk moth allergens Venkatappa *et al.* 2012 ^[28] discovered that the peripheral blood eosinophil count and pulmonary inflammation, along with influx of eosinophils into the lung, increased with increase in duration of exposure in workers exposed to silk moth allergens.

In countries like India, Japan and China farmers raise silkworms. However, silkworm's pupae are an important source of allergens farmers can induce severe allergies that manifest as asthma, dermatitis and allergic rhinitis with symptoms such as urticaria, headache, nausea, vertigo, twitching of limbs and even allergic shock (Wang *et al.*, 2014) ^[21] (Araujo *et al.* 2014) ^[1].

Asthma is a long-term immunological condition that typically manifests as wheezing, coughing and shortness of breath especially at night or during physical activity. (Wiparat, 2014) ^[23] (Sircar, 2014) ^[19]. This lung disorder of lung is characterized by airway inflammation, obstruction and increased hyperresponsiveness in reaction to allergenic stimuli. The worldwide incidence rate of asthma, which is much more common among children (Sircar, 2014) ^[19], is as high as 4/1000 per year and has increased dramatically to 330 million over the past 30 years (Yazdanbakhsh, 2002) ^[25] (Finn, 2009) ^[5]. Therefore, asthma is indisputably a major health worldwide problem that affects the quality of life of individuals and causes a financial burden for their families and society (Wiparat, 2014) ^[23] (Sircar, 2014) ^[19]. Silkworm pupae are a source of allergens can induce allergic asthma. However, the immunological mechanisms are not fully understood. Another important study was reported by Mandadi *et al.* (2019) ^[10], that the majority of the workers in the present study suffered from cough (35.5%), chest tightness in 20.1%, and dyspnea in 18% of the study

population. This was similar to Jaiswal study where respiratory problems were observed in 36.8% of the study population (Jaiswal *et al.* 2011) ^[22].

2. Occupational health hazards in SSPC'S

2.1 Biological Hazards

i. Silkworm Moth Scales

Silkworm moth contains scales on wings and abdomen which contain the allergens in it when they inhaled, they will cause allergies in human body which in severe may cause severe inflammations in lungs and in humans it will lead to red eye, itch, sore throat, sneezing and nasal obstruction breathing issues in seed production industry workers. Proteinaceous allergens of silk moth scales contain T and B cell epitopes and promote the possibility of establishing immunotherapy regimens employing specific synthetic peptide epitopes that down-regulate allergen-induced inflammatory reactions in the human beings. The elevated allergen load in the lungs may cause the symptoms to worsen and further impair the workers general immune systems in the sericulture grainage industry. (B Venkatappa, 2012) ^[28]

ii. Silkworm Pupae

Silkworm pupa protein can cause severe IgE-mediated allergic disease. However, mechanism remains unclear. It causes obstruction and increased hyperresponsiveness in reaction to allergenic stimuli. Bom m 9, is involved in the pathogenesis of asthma.

iii. Bacterial/Fungal Spores

More over Ramaswamy *et al.*, (2020) ^[16] also reported that the sericulture workers are also exposed to various biological risks. Inside the cocoon it may found a source of bacteria, fungi and viruses, which can lead to respiratory diseases like asthma, chronic obstructive pulmonary disease (COPD), and other lung infections Silkworms themselves are known to carry certain pathogens, and the exposure to these can increase the risk of zoonotic diseases. Furthermore, prolonged exposure and improper storage of cocoon lot may lead to high humidity and the accumulation of mold and fungal spores in the sericulture environment have been linked to fungal infections and allergies (Thakur *et al.*, 2021) ^[20].

2.2 Chemical Hazards

i. Disinfection

In order to ensure success full grainage operation, the grainage hall and the equipment's should be disinfected properly. The Disinfectants used are formalin, bleaching powder, slaked lime and 2% formaldehyde solution which helps in destroy the disease-causing microorganisms and protect the silkworm eggs. However, these compounds create respiratory issues and are carcinogenic to humans, as indicated by dermatitis, skin lesions, back aches, bronchial asthma, coughs, gastrointestinal pains, ulcers, throat infections, thinning nails, dry skin and hand and eye burning. (CSB, SST).

ii. Acid Treatment

Bivoltine moths lay hibernating and non-hibernating eggs, depending on the environment conditions. However, these hibernating eggs, left undisturbed, undergo diapause. This is due to the secretion of hibernating substance in the egg

during its formation. Hence various techniques have been evolved to break diapause and hatch bivoltine eggs in 10-12 days from oviposition. Treating silkworm eggs with hydrochloric acid is one of the common methods adopted for this purpose. And this acid will release the fumigants/gases which are inhaled causes damage in the respiratory canal and skin allergies if it comes in contact and eyes will become itch and red lashes will appear on the eye. (Narasimhanna, 1988) ^[11].

2.3 Ergonomic Hazards

Workers had body pain especially lower back pain due to working for hours continuously in a same posture.

4. Health Effects among SSPC Workers

4.1 Respiratory Disorders

1. Asthma

Asthma is a common long-term inflammatory disease of the airways characterized by symptoms such as wheezing, coughing, chest tightness and shortness of breath. It occurs when the airways narrow and swell, often producing extra mucus, making breathing difficult. Asthma can be triggered by allergens, exercise, cold air and respiratory infections.

2. Allergic Bronchitis

Allergic bronchitis, is a chronic respiratory condition caused by inflammation of the bronchial tubes due to allergens, leading to persistent coughing, wheezing and breathing difficulties. Rajitha, K., & Sowmya, P. (2025) ^[15].

3. Breathing Problems

Inhalation of gases and scales will cause shortness in breath and allergies in the respiratory tract of humans.

4.2 Allergic Conditions

1. Allergic Rhinitis

Allergic rhinitis is an irritating and persistent allergy that severely affects the quality of life in the sericulture grainage industrial workers. This lung disease accounts for about 35% of the sericulture grainage workers presently seeking treatment for allergic problems in the Andhra Pradesh and Karnataka states of India. A large number of airborne spores are identified in highly humidified sericulture grainage industries and on the surface of silk moth.

Allergies

The silkworm wing and abdomen scales have allergens present in them which cause rashes and itching on skin, the silkworm pupae will have certain protein which cause allergies on human body.

4.3 Eye and skin problems

1. Red lashes on eyes

Ghonmode (2020) Lacrimation can lead to red appearance of the eye, known as red eye. This condition can be caused by various factors, including infections, allergies, inflammation from the adult silkworm scales and pupae protein.

4.4 Musculoskeletal Disorders

Lower back pain

Body fatigue and discomfort

4.5 Other Occupational Symptoms

Inhalation of harmful gases while acid treatment, disinfection and scales after inhalation causes severe

migraine and severe headache, throat irritation and General weakness

5. Mechanisms of allergen exposure and disease development

5.1 Role of moth scales and pupal proteins

Adult silkworm moths shed large quantities of microscopic scales during emergence, mating and egg-laying activities. These scales easily become airborne and may remain suspended in the working environment for extended periods. When inhaled, the scales can deposit along the respiratory tract and act as allergens, stimulating immune responses in susceptible individuals. Repeated exposure may lead to sensitization, resulting in symptoms such as sneezing, nasal congestion, coughing, wheezing, breathlessness and allergic rhinitis. In some cases, prolonged exposure has been associated with occupational asthma and reduced pulmonary function among sericulture workers (Rajaiah and Venkatesh, 1988; Singh and Mathur, 2012) ^[13, 18].

In addition to moth scales, silkworm pupae contain several proteins and bioactive compounds capable of inducing allergic reactions. During pupal handling, sorting, storage and waste disposal, protein-rich dust particles may be released into the air and subsequently inhaled by workers. Direct skin contact with pupal materials can also trigger allergic responses. Studies have shown that these proteins can act as active allergens, causing skin irritation, dermatitis, itching and respiratory discomfort in sensitized individuals (Arora *et al.*, 2006) ^[3]. The process of disease development generally begins with initial exposure to allergenic materials, followed by immune sensitization. During sensitization, the immune system recognizes allergenic proteins as foreign substances and develops specific immune responses (Singh and Mathur, 2012) ^[18].

5.2 Immune and inflammatory responses

The development of allergic diseases among workers exposed to silkworm moth scales and pupal proteins is primarily mediated through immune and inflammatory mechanisms. Continuous occupational exposure to these biological materials can lead to immune sensitization, resulting in a range of respiratory, dermatological and ocular manifestations. The severity of these responses depends on the concentration of allergens, duration of exposure and individual susceptibility (Arora *et al.*, 2006) ^[3].

When allergenic proteins present in moth scales or pupal dust enter the respiratory tract, they are recognized by antigen-presenting cells such as dendritic cells and macrophages. These cells process the allergens and present them to T-helper (Th2) lymphocytes, which stimulate the production of allergen-specific Immunoglobulin E (IgE) antibodies by B lymphocytes (Jeebhay and Cartier, 2010) ^[8]. During the sensitization phase, these IgE antibodies attach to mast cells and basophils, preparing the immune system for subsequent exposures. Upon repeated exposure, allergenic proteins bind to IgE molecules on the surface of mast cells, triggering their activation and degranulation. This process results in the release of inflammatory mediators including histamine, leukotrienes, prostaglandins and cytokines. These substances are responsible for common allergic symptoms such as sneezing, nasal congestion, itching, coughing, wheezing, breathlessness and excessive mucus production (Singh and Mathur, 2012) ^[18].

Therefore, controlling allergen exposure through workplace hygiene, ventilation systems, personal protective equipment and regular medical surveillance is essential to reduce immune-mediated health risks in silkworm seed production centres.

6. Prevention and cure

The prevention of occupational health problems in silkworm seed production centres (SSPCs) requires a comprehensive approach that combines workplace safety measures, personal protection, health monitoring and worker education. Since exposure to moth scales, pupal dust, disinfectants and other biological and chemical agents is common during seed production activities, reducing contact with these hazards is essential for safeguarding worker health (Kumar *et al.*, 2018) ^[9].

One of the most effective preventive measures is maintaining a clean and well-ventilated work environment. Proper ventilation systems help reduce the concentration of airborne allergens such as moth scales and pupal proteins, thereby minimizing respiratory exposure. Regular cleaning of grainages, rearing rooms and processing areas can prevent the accumulation of dust and biological debris that may act as sources of allergens and pathogens (Jeebhay and Cartier, 2010) ^[8]. The use of personal protective equipment (PPE) is equally important. Workers should be encouraged to wear face masks, gloves, protective clothing and safety goggles while handling moths, pupae, disinfectants and other potentially hazardous materials. Appropriate PPE acts as a barrier against inhalation of allergenic particles and direct skin contact, reducing the risk of respiratory and dermatological disorders (Burge, 2002) ^[4].

Periodic medical examinations and health surveillance programs are essential for the early detection of occupational diseases. Regular assessment of respiratory function, skin health, and allergy-related symptoms can help identify affected workers at an early stage, enabling timely medical intervention and preventing the progression of disease. Workers with a history of allergies or asthma should receive special attention, as they may be more susceptible to occupational allergens (Singh and Mathur, 2012) ^[18]. Worker education and training also play a critical role in prevention. Training programs should focus on hazard identification, safe handling practices, proper use of protective equipment, personal hygiene and emergency response procedures. Increased awareness among workers can significantly reduce unsafe practices and improve compliance with occupational health guidelines (Kumar *et al.*, 2018) ^[9]. For workers experiencing allergic reactions or other health problems, prompt medical care is necessary. Mild symptoms such as skin irritation, rhinitis or conjunctivitis can often be managed through avoidance of exposure and appropriate medications. More severe conditions, including occupational asthma, may require specialized medical treatment and in some cases, reassignment to tasks with lower allergen exposure. Continuous follow-up and monitoring are important to prevent recurrence and maintain long-term health (Jeebhay and Cartier, 2010) ^[8].

7. Research gaps and future perspective

Information on the prevalence and distribution of occupational diseases among workers in silkworm seed production centres (SSPCs) remains inadequate. Existing

studies have primarily focused on isolated cases of respiratory allergies, occupational asthma and skin disorders associated with exposure to silkworm moths, pupae and rearing dust (Armentia *et al.*, 2004; Jeebhay and Cartier, 2010) ^[2, 8]. Comprehensive epidemiological data regarding the incidence, prevalence, severity and long-term consequences of occupational illnesses in sericulture workers are still lacking.

Establishing systematic occupational health monitoring programs should therefore become a priority for the sericulture sector. Regular medical examinations, pulmonary function testing, allergy screening, dermatological assessments and ergonomic evaluations can facilitate early diagnosis and treatment of work-related disorders (Jeebhay and Cartier, 2010; ILO, 2022) ^[8, 7].

Future research should focus on designing safer grainage technologies that reduce direct worker exposure to biological and chemical hazards. Mechanized moth collection systems, automated egg handling units, enclosed disinfection chambers, dust-extraction devices and improved ventilation systems could substantially minimize occupational risks. Emerging technologies such as sensor-based environmental monitoring, artificial intelligence-assisted workplace management and automated biosecurity systems offer additional opportunities for enhancing occupational safety in grainages (FAO, 2021; ILO, 2022) ^[6, 7].

8. Conclusion

Silkworm Seed Production Centres (SSPCs) play a vital role in ensuring the availability of quality silkworm eggs and supporting the sustainability of the sericulture industry. However, workers involved in various grainage operations are exposed to a range of hazards that can adversely affect their health and well-being. These hazards include biological agents such as moth scales, pupal dust, microorganisms and allergenic proteins, chemical agents including disinfectants and fumigants, physical hazards such as poor ventilation, dust accumulation and unfavourable workplace conditions and manual handling activities (Kumar *et al.*, 2018; Jeebhay and Cartier, 2010) ^[9, 8].

Among these hazards, exposure to silkworm moth scales and pupal proteins has been frequently associated with allergic rhinitis, dermatitis, conjunctivitis and occupational asthma. Continuous exposure to dust, biological aerosols and chemical substances may further contribute to chronic respiratory disorders and reduced workplace productivity (Arora *et al.*, 2006; Singh and Mathur, 2012) ^[3, 18]. Despite the significance of these occupational risks, worker health in SSPCs has received comparatively limited research attention and systematic health surveillance programs remain inadequate in many sericulture-producing regions.

To achieve sustainable SSPC management, several measures are recommended. These include the implementation of regular health monitoring programs, provision of appropriate personal protective equipment, improvement of workplace ventilation and sanitation, adoption of safe handling and waste management practices and organization of periodic worker training and awareness programs. Additionally, greater emphasis should be placed on the development of worker-friendly and mechanized grainage technologies that reduce direct exposure to biological and chemical hazards. Future research should focus on epidemiological investigations, exposure

assessment studies and the evaluation of innovative technologies aimed at improving workplace safety (WHO, 2010; FAO, 2021) [24, 6]. In conclusion, ensuring occupational health and safety in Silkworm Seed Production Centres is fundamental to the sustainable development of sericulture. A multidisciplinary approach involving researchers, health professionals, sericulture departments, policymakers and industry stakeholders is required to create safer working environments, enhance worker welfare and support the continued growth of the sericulture industry.

9. References

1. Araujo LM, Rosario Filho NA, Riedi CA. Respiratory allergy to moth: the importance of sensitization to *Bombyx mori* in children with asthma and rhinitis. *J Pediatr* (Rio J). 2014;90(2):176-181.
2. Armentia A, Lombardero M, Callejo A, Barber D, Martin-Santos JM, Gil FJ, *et al.* Occupational asthma caused by silkworm (*Bombyx mori*). *Allergy*. 2004;59(1):100-101.
3. Arora N, Gaur SN, Singh BP, Pasha S. Identification and characterization of allergens from silkworm (*Bombyx mori*). *Int Arch Allergy Immunol*. 2006;139(1):42-48.
4. Burge PS. Occupational asthma due to biological agents. *Occup Environ Med*. 2002;59:67-71.
5. Finn PW, Bigby TD. Innate immunity and asthma. *Proc Am Thorac Soc*. 2009;6:260-265.
6. Food and Agriculture Organization. Occupational Safety and Health in Agriculture. Rome: FAO; 2021.
7. International Labour Organization. World Employment and Social Outlook: Trends 2022. Geneva: ILO; 2022.
8. Jeebhay MF, Cartier A. Occupational asthma and allergens from insects. *Curr Opin Allergy Clin Immunol*. 2010;10(2):146-152.
9. Kumar P, Kumar N, Sharma SD. Occupational health hazards in sericulture and preventive measures. *J Entomol Zool Stud*. 2018;6(4):1200-1205.
10. Mandadi J, Mandadi A, Likhithapudi VRN. Study on health problems faced by workers of sericulture industry: A cross sectional study in the North Coastal Andhra Pradesh. *Indian J Community Med*. 2019;44(2).
11. Narasimhanna MN. Manual on Silkworm Egg Production. Bangalore: Central Silk Board; 1988.
12. Pandey RK. Occupational health problems in silk production: a review. *The Silkworm*. 2014 Nov 15.
13. Rajaiah G, Venkatesh D. Respiratory disorders among workers exposed to silkworm allergens. *Indian J Chest Dis Allied Sci*. 1988;30(3):171-176.
14. Sharma K, Kapoor B. Sericulture as a profit-based industry—A review. *Indian J Pure Appl Biosci*. 2020;8(4):550-562.
15. Rajitha K, Sowmya P. A case study on allergy problems encountered at silkworm seed production center (grainage). *J Exp Zool India*. 2025;28(1).
16. Ramaswamy V, Shukla R, Singh D. Biological hazards in sericulture and their impact on workers' health. *Int J Environ Health*. 2020;28(3):115-122.
17. Sharma K, Kapoor B. Sericulture as a profit-based industry—A review. *Indian J Pure Appl Biosci*. 2020;8(4):550-562.
18. Singh AB, Mathur C. An aerobiological perspective in occupational allergy associated with insect-derived allergens. *Indian J Med Res*. 2012;136(3):427-444.
19. Sircar G, Saha B, Bhattacharya SG, Saha S. Allergic asthma biomarkers using systems approaches. *Front Genet*. 2014;4:1-10.
20. Thakur M, Patel H, Joshi S. Psychosocial hazards and mental health among sericulture workers. *J Rural Health*. 2021;37(5):639-646.
21. Wang SH, You ZY, Ye LP, Che J, Qian Q, Nanjo Y, *et al.* Quantitative proteomic and transcriptomic analyses of molecular mechanisms associated with low silk production in silkworm *Bombyx mori*. *J Proteome Res*. 2014;13:735-751.
22. Wani KA, Jaiswal YK. Health hazards of rearing silk worms and environmental impact assessment of rearing households of Kashmir, India. *Nat Environ Pollut Technol*. 2011;10(1):85-90.
23. Wiparat M. Airway remodelling in asthma: role for mechanical forces. *Asia Pac Allergy*. 2014;4:19-24.
24. World Health Organization. Healthy Workplaces: A Model for Action. Geneva: WHO; 2010.
25. Yazdanbakhsh M, Kremsner PG, van Ree R. Allergy, parasites, and the hygiene hypothesis. *Science*. 2002;296:490-494.
26. Venkatappa B, Chandrakala AN, Anuradha P, Chatrappa P. Evaluation of silk moth (*Bombyx mori*) allergens in sericulture grainage industries pollutants. *J Sci Ind Res*. 2005;64:287-292.
27. Venkatappa B, Chandrakala AN, Anuradha P, Chatrappa B. Immunopathologic responses of silk moth (*Bombyx mori* L.) allergen in mice. *J Immunol Immunopathol*. 2004;5:1-2.
28. Venkatappa B, Chandrakala AN, Reddy AH, Nageswari G, Chatrappa B. Immune responses of mice and sericulture grainage industrial workers exposed to silk moth allergens. *J Immunol Immunopathol*. 2012;14(2):96-104. doi:10.5958/j.0973-9149.14.2.015.
29. Yamashita N, Ito K, Miyamoto T, Mano K, Shibuya T, Kamei K, *et al.* Allergenicity of Chironomidae in asthmatic patients. *Ann Allergy*. 1989;63:423-426.