

Characterization on Specific Characteristics of Sericin Silkworm, and Physiological Genetics Analysis

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How to cite this paper: Li, B., Ye, C.J. and Chen, F.S. (2017) Characterization on Specific Characteristics of Sericin Silkworm, and Physiological Genetics Analysis. *Journal of Biosciences and Medicines*, 5, 1-5. <https://doi.org/10.4236/jbm.2017.511001>

Received: August 31, 2017

Accepted: November 14, 2017

Published: November 17, 2017

Abstract

Sericin silkworm is a kind of gene mutant silkworm that can only synthesis and secrete sericin protein instead of fibroin protein. In this study, according to the knowledge of physiology and heredity, the reasons of this special phenomenon for the sericin silkworm were analyzed in order to explore the utilization clues in the production of natural sericin and product development.

Keywords

Sericin Silkworm, Special Characters

1. Introduction

The silkworm is an important economic insect, while silk gland is crucial tissue for the synthesis of silk protein [1]. The wide type of silkworm has whole anterior, middle and posterior silk gland for the synthesis and secreted of sericin and fibroin protein. However, sericin silkworm has a depauperate silk gland (**Figure 1(b)**), leading to produce sericin protein rather than fibroin protein. Using sericin silkworm as materials, it has great significance of application to analyze the physiological of silkworm, production of natural product and research, and the expression of transgenic silkworm. In current study, we listed the special phenotype of sericin silkworm, and discussed by using anatomy, physiology, genetics and molecular biology.

2. The Characteristics of Sericin Silkworm

Because of depauperation of the posterior silk gland (**Figure 1(b)**), sericin silkworm only can secrete sericin protein instead of fibroin protein. Therefore, it

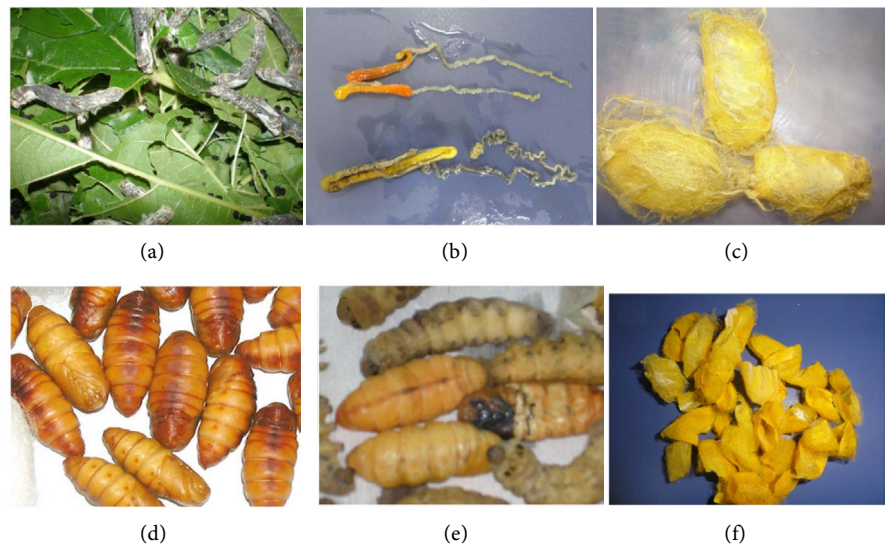


Figure 1. Characterization of sericin silkworm.

exhibited some special characters compared with normal silkworm, such as the short larval stage, the hysteretic of spin, hypertrophic pupa (**Figure 1(d)**), the incomplete pupation of larvae and the thin cocoon (**Figure 1(e)** and **Figure 1(f)**).

3. The Discussion of the Mechanism for Sericin Silkworm Synthesis and Secrete Sericin

Sericin silkworm and normal silkworm belong to two different types in variety and resources. The silk gland cells of silkworm divide more than ten times and form the anterior, middle and posterior silk gland cells only in embryo stage, while the silk gland cells no longer divide in larval stage. The secreted of fibroin is regulated by genes, which can control the divided of posterior silk gland. The middle, posterior silk gland can synthesis and secrete sericin protein and fibroin protein, respectively. In embryo division stage, the DNA replication of posterior is regulated by genes involving in growth and development [2]. These genes can't divide, leading to the depauperation of the posterior silk gland. In previous research, in sericin silkworm, the deletion of 5'-terminal DNA sequence for silk gland gene are about 2 - 4 kb. It will induce the deletion of genes that can regulate the synthesis and secrete of silk gland, and the depauperation of the posterior silk gland. How the deletion of DNA sequence can control the function of the synthesis and secrete of silk gland and the depauperation of the posterior silk gland [3] [4]. We need to further research from molecular level. The fibroin protein is a natural moisturizing factor, which can protect skin from dry, eha-gades and maturing and inhibit the production of melanin. At the same time, it has the function of antioxidant, and resists the erosion of ultraviolet ray, sunshine, microwave, chemical substance and air pollution. The sericin powder has been widely used in top grade cosmetic, food additives and food antioxidant. What's more, it has become a new textile that can efficient prevent the imme-

diate contraction between chemical fiber and skin.

4. The Discussion of Hypertrophic Pupa

Sericin silkworm is about ten percent heavier than normal silkworm. The reasons are that silk gland cell can't divide in its larval stage. Once it is in feeding stage, the sericin silkworm is rapidly growth and development depend on nutrition from the mulberry, but is not benefit for the synthesis of fibroin protein. Therefore, sericin silkworm is increasing in protein synthesis, more nutrients are used for the growth and development of silkworm [5]. However, the distribution and proportion of nutrients from the mulberry need to further research. The silkworm pupa contains 18 kinds of amino acids, among which eight essential amino acids for human had a high content. In silkworm pupa, the content for eight kinds of essential amino acids is about twice for pork, fourfold for egg, tenfold for milk, and has balanced nutrition and suitable proportions. At the same time, it as high quality insect protein possesses high nutritional value, and abundant crude protein, crude fat, vitamin A, vitamin B2, vitamin D and ergosterol. The protein content in pupa is more than 50% and exceeds ordinary food. What's more, a variety of essential amino acids in protein is complete, and the fresh untreated pupa has considerable utility value.

5. The Discussion of Short Larval Stage

Even through the time of cocooning for sericin silkworm is 1 d and 16 h later than normal silkworm, yet the formation time of cocoon is the same to normal silkworm. Xiao *et al.* performed comparative experiments to research the change of the fifth larval body weight and silk gland dry matters, and the organization data of total nitrogen for the Nd silkworm. It indicated that Nd silkworm of the fifth instar larvae have smaller amount of food ingestion and digestion. Moreover, it has higher urate excretion, and has smaller absorptive total nitrogen. During the fifth later period, these changes will be transferred from larvae to pupa quickly, leading to short larval stage [6]. Due to the depauperate of silk gland for sericin silkworm, it can be regarded as an abnormal silkworm in organ development. At the same time, whether the depauperate of silk gland have relationship with metamorphosis from larvae to pupa need to further research.

6. The Discussion of Hysteretic Cocooning

The spinning of sericin silkworm is behind the normal silkworm during the feeding stage. For the matured silkworm of mount cocooning frame at the same time, sericin silkworm will start to spin after 1 - 2 days. In the process of spinning, the autoradiographic technology proved that radioactive isotope was detected in the posterior silk gland, and then was detected in the middle silk gland. Twenty-four hours later, the radioactive isotope was detected in central lumens. However, the radioactive isotope can't be detected after 72 hours. Because the sericin silkworm only synthesis sericin protein instead of the fibroin protein,

suggesting the time of sericin protein lagging behind fibroin protein. However, the secretion mechanism of sericin silkworm need to further study. On the other hand, the amino acid component and structure of sericin protein and fibroin protein have major difference. Therefore, we have to consider the composition of serine, amorphous structure and the influence of sericin silkworm spinning lag. In production, technical guidance should be presented for silkworm raiser in order to avoid panic.

7. The Discussion of Many Incomplete Pupation Silkworm

The incomplete pupation of silkworm can form the pupa, but it doesn't develop into the moth, and majority of silkworm can develop into incomplete pupation or to die. The incomplete pupation of silkworm will appear after ten days of co-cooning. The color of the pupa will become brown. Because depauperation of the posterior silk gland and different of amino acid composition, and the types and content of amino acid. Partial amino acids that do not involve in convert moth will be accumulated in pupa not through secrete silk discharge. It will induce amino acid poisoning and product more incomplete pupation of silkworm. Some people considered that adding a fair dose of antioxidants could prevent a large number of incomplete pupation of silkworm [7]. On the one hand, we need further research the types of antioxidants and amino acids, and the content of amino acids. On the other hand, we should breed high pupation rate sericin varieties

8. The Discussion of Thin and Fragile Cocoon for Sericin Silkworm

The silkworm cocoon shell is composed of silk proteins. The absorptivity and digestibility of nitrogen are low. The reasons of thin cocoon shell are that only secrete sericin protein rather than fibroin protein [8]. The fibroin protein is a kind of protein that has a tight crystalline. However, partial non-polar side chains of sericin protein have a certain ordered arrangement and spread conformation. The total molecular conformation is mainly random coil, incompact and unordered space structure. It contains a β structure, while it has not α helical crystalline structure. At the same time, sericin protein has large number of side chains in serine and aspartic acid with hydrophilic group. The sericin protein with characteristics of diffluent, and strong moisture absorption and desorption [9]. Therefore, the thin and fragile of cocoon shell for sericin silkworm is an intuitive identification of silkworm cocoon and its purity.

Acknowledgements

This work was supported by the China Agricultural System (CARS-22-Syz09); Outstanding Youth Foundation of Anhui Academy of Agricultural Sciences (15B0605); Subject Construction Foundation of Anhui Academy of Agricultural Sciences (17A0617); the Natural Science Foundation of Anhui Province (1608085MC75).

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