Applicability of Textile Industry's Classification of Silk in the Engineering of Silk Protein Material

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Bombyx mori silkworm cocoons can be used to make both silk fabrics and silk protein materials. However, there is only one classification standard for silkworm cocoons so far. This classification stems from the traditional silk textile industry and has been applied in silk fabrics for decades, which classifies cocoons into different grades based on standards focusing on the length of cocoon filament, the cleanliness, and air permeability of cocoons. According to these standards, the cocoons' beauty degree, price and application range show a very high unity. However, whether such classification criteria are suitable for evaluating the properties of silk fibroin materials is still an open question. To explore the potential relevance between the cocoons' grades and mechanical properties of silk fibroin materials, this project evaluates the mechanical properties of cocoon silks and regenerated silk fibroin materials prepared from three grades of cocoons with typically distinctive features. Comparing the mechanical properties, including tensile modulus, fracture strength, and breaking elongation, experiments reveal that the mechanical properties of degummed silk are not necessarily related to the classification of the cocoon. The evaluation of mechanical properties of silk fibroin hydrogels also illustrates that silkworm cocoon evaluation criteria in the textile industry have low applicability to the engineering of silk protein material. Therefore, new standards should be considered for silk protein material in order to recycle waste silk under the present definition and to promote sustainability in development.