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CARBON PROFILE OF COMMERCIALLY IMPORTANT SERICIN PROTEINS OF SILKWORM, *BOMBYX MORI*

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ABSTRACT

Sericin is a hydrophilic protein produced in different length during production of silk by *Bombyx mori*. Carbon content in this glue protein is investigated. The carbon distribution analysis reveals that all sericin proteins contain below the average of 31.45% of carbon. The carbon distribution plot gives the pattern of repeats in these proteins. Based on this carbon distribution pattern a further reduction at appropriate place of sequence is possible to improve the cleaning effect of this glue protein. CARBANA tool can be fully exploited for mutational studies on any functional proteins for improvement in productivity.

Keywords: hydrophilic character, sericin, carbon profile, silkworm, carbana, commercial protein.

INTRODUCTION

Silkworm is being used as biofactory for the production of useful protein using the silk gland, which has promoted the technological development in sericulture. Sericulture in India is essentially a cottage industry [1]. India is second largest producer of silk in the world and capable of producing all 4 silk varieties. But in the post genome era, it is time now to explore the possibilities of gene or protein modification for higher and quality silk production. Insects, spiders and silkworm produce silk. But silk from *Bombyx mori* is a natural conversion of leaves into fiber. The leaves (of mulberry) are local to warm tropical regions of Asia, Africa and Europe, with the majority of the species native to Asia.

Bombyx mori, claimed to have economic insect that emerge as an ideal molecular genetics resource for solving a broad range of biological problems [2]. It produces massive amount of silk proteins at the end of the fifth instar. There are two kinds of silk proteins, such as, fibroin and sericin. Sericin is a natural protein, serving as an adhesive to unite fibroin for making silk cocoons of silkworm. Ultimately, it is washed out on removal of fibroin. This protein contains essential amino acids. Introduction of new gene might produce this glue protein with other useful applications. Proteomics has to be developed for such applications. As it has properties like gelling ability, moisture retention capacity and skin adhesion, one can also think of designer's protein for various applications. Mutational studies leading to increase the solubility of this protein will ease the removal. A wide variety of applications in medical, pharmaceutical and cosmetic industries are already been demonstrated [3]. It is possible to develop a multipurpose sericin protein for wide application as transformation in BmN cells by piggyBac transposon vectors [4] are already tested. Further to aid this changes in sequence, a carbon distribution study in protein is the important step. Many work leading to understand the protein stabilization at atomic level is explained by our group [5-7]. It is here to study and report the carbon distribution in this commercially important protein for further applications.

Materials and Methods

The following sericin protein sequences of silk moth, *Bombyx mori* are collected from UniProtKB (www.uniprot.org/uniprot) are shown in Table 1.

Table 1. Sericin protein and its UniProtKB details

S.No.	Protein Name	Accession No.	No of amino acid
1	Sericin	O96852	38
2	Sericin 1	P07856	1186
3	Sericin 2	D2WL76	1758
4	Sericin 2	D2WL77	900
5	Sericin 3	A8CEQ1	1271
6	Sericin 1B	Q17240	1217

The carbon distribution profiles for all these proteins are obtained from CARBANA program available online. The details on this program on the principle, input, output, interpretations are discussed in reference paper [5]. It does a window analysis of carbon distribution with a principle that proteins prefer to have 31.45% of carbon for its stability. A window size of 500 atoms is used in all calculations. The results on carbon percentage versus amino acid numbers are plotted as shown in figures.

Results and Discussion

The carbon distribution plot on various sericin proteins are given in figures 1-4. Generally, all sericin proteins are hydrophilic in nature. The scale of 31.45% of carbon is used to measure the hydrophobicity along the sequence. A line in each graph is drawn at 31.45% of carbon for comparison. Most of the times the sequences are below the line 31.45%, indicating that these proteins contain less carbon content. This is the reason why this protein has glue character and soluble in water. A further reduction in hydrophobicity can be achieved for better and efficient removal this waste protein on removal of fibroin. There are many repeats found in all sericin proteins based on carbon content. Sometime difference in sequences can have same carbon distribution and repeats. Two different portion of sequence can have similar carbon distribution pattern and are caller repeats.

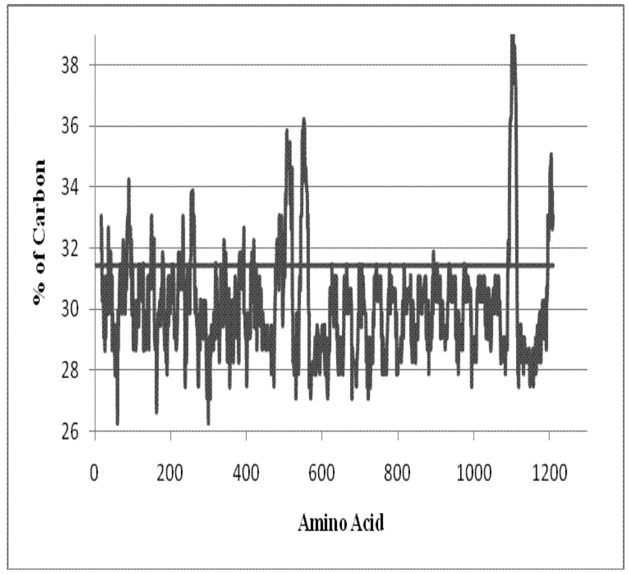

Fig 1: Carbon profile in sericin1 protein.

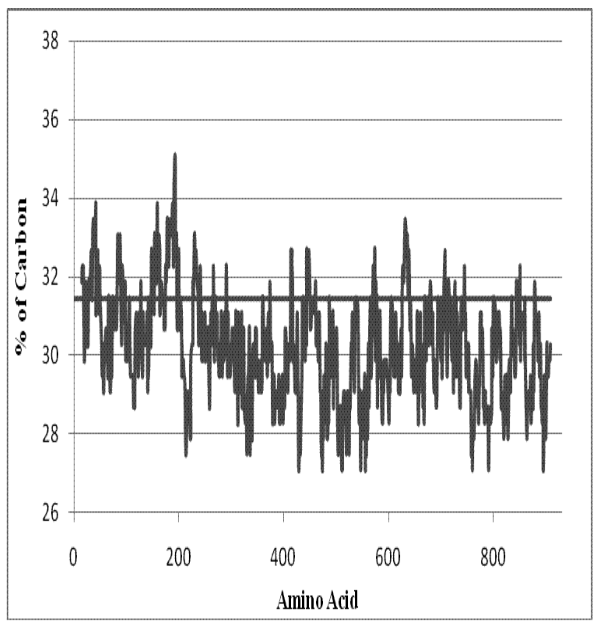

Fig 2: Carbon profile in sericin2 protein.

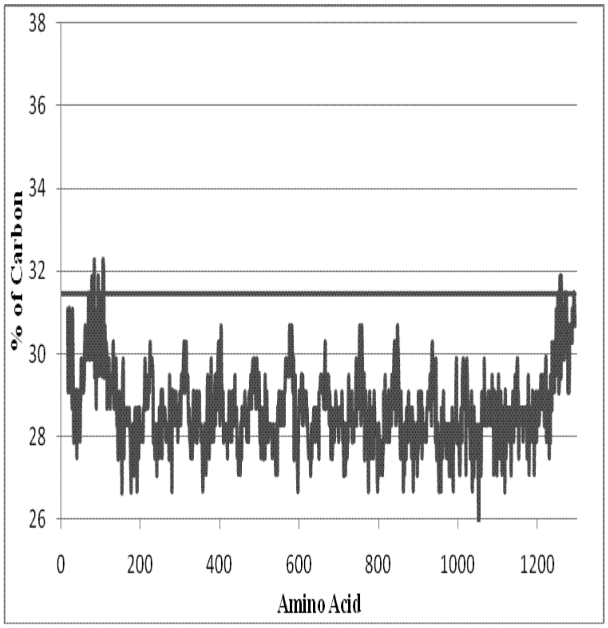

Fig 3: Carbon profile in sericin3 protein.

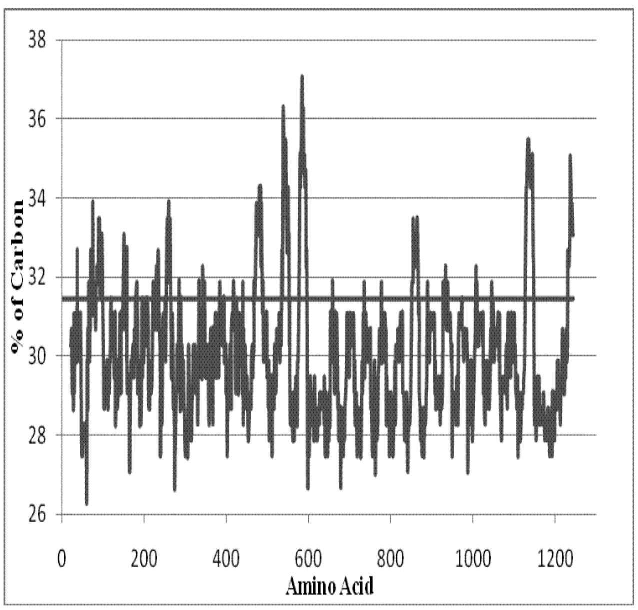

Fig 4: Carbon profile in sericin1B protein.

The 38 amino acid length sericin protein sequence was submitted to CARBANA. Due small number of amino acid and window effect, it is not possible to get distribution plot. However multiple sericin sequence ordered in sequence is tested for carbon distribution. It reveals that the carbon distribution is far below the value of 31.45% of carbon and highly hydrophilic.

Unlike other functional proteins, there is no active sites in sericin proteins. However there is is higher carbon content region between 477 and 566 in sericin1 protein. Ordering more hydrophilic amino acids in these regions might free the packing and easily washable in water. In Sericin2 protein this can be done at 140-200.

Sericin3 has highly hydrophilic sequence which is far below the value of 31.45% of carbon. Only at the terminals a marginal carbon contents are found. This protein may not be stable in biological condition as amino acids from 90 to 1250 contain less carbon content. These regions nowhere near the value of 31.45% carbon. Due to this these portion has strain and cannot fold properly. May be washable easily but stability isn't there. On the other hand the sericin1B has both hydrophilicity and and stability. It has a better carbon distribution for both glue and washable characters. In essence, sericin1B has proper distribution of carbon all along the sequence than other proteins presented here. This can better exploited for commercial purpose.

CONCLUSION

Carbon distribution in sericin proteins is investigated here. The results conclude that the proteins are highly hydrophilic in nature. Based on carbon distribution a further reduction at appropriate place of sequence is possible to improve the cleaning of this waste protein during silk production. From washing and stability point of view, sericin1B has better carbon distribution over the other proteins presented here. This protein can be better exploited for commercial purpose. CARBANA tool can be fully exploited for mutational studies on any functional proteins for improvement in productivity.

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