

## FTIR SPECTROSCOPY OF DRAGLINE SILK OF *Eriovixia excelsa* (SIMON, 1889) FROM FAMILY Araneidae

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### Abstract

The spider from family araneidae weave orb web consists of silk polymeric protein. The spider produces silk is used for different purposes like spinning web, catching of flying insect, and for self protection. This attempt was made to investigate the functional groups in the stretched and unstretched dragline silk fiber of spider *Eriovixia excelsa* (Simon, 1889) from the family araneidae. The silk samples were periodically collected from the leaves and branches of herbs, shrubs and plants of residing fences close to the agro-ecosystem in and around Akola district, Maharashtra. In FTIR (Fourier transform infrared) spectroscopy the molecules once interact with the infrared radiations, the incident radiations are absorbed by a molecule in the silk fiber in particular wavelength. The molecules give vibrations that intern produces absorption spectrum. The absorption spectrum provides information of different functional group present in the spider silk fiber.

**Keywords:** Polymeric proteins, Araneidae, FTIR spectroscopy, agro-ecosystem, absorption spectrum

### Introduction

*Eriovixia Archer* (1951), currently contains 34 described species and has wide distribution in the world (World spider catalogue, 2025). Spider webs are beautifully woven by spiders and are made of protein. In the web they create themselves, they sit in the center of the web and use it to catch their prey and eat it. In true sense, the webs they create for survival are very important. The spider silk has an elastic nature and higher tensile strength due to presence of proteins like Spidroin I and Spidroin II. Repetitive sequences of amino acids, such as glycine (40%) and alanine (29%), are found in the proteins Spidroin I and II. The Glycine provides elasticity to the spider silk. The silk that the spider produces is used for a variety of things, including self-defense, web spinning, and capturing flying insects. The kind of species, its diet, and its surroundings all affect the precise composition of these proteins. The spider silk gland is acquired to produces different type of silk that perform different functions like resting, hiding, feeding, protection of egg sacs (Foelix, 2011). The spider spinnerets' silk fibers perform a crucial function by supporting the spider's weight and paralyzing the pray by wrapping them in silk fibers during feeding. In order to catch insects flying in a horizontal direction, spiders have evolved to weave horizontal webs. Silk fibers are very sensitive to movement. The spider must be able to get to the flying insect as soon as it strikes the silk web in order to prevent it from escaping. Because spiders can move more quickly downward than upward, the orb web has a larger area down to the hub and central disc, resulting in top-down asymmetry. The hub is present in the centre of the upper part of the web (Vollrath *et al.*, 1997). In order to keep the

killed prey and feeding on the starving insect, many spider species build ceases in their webs. The killed insect is shielded by the silk used for cease. The protein Spidroins in the silk are composed of polypeptide molecules containing alpha helices and beta sheets, which give them greater extensibility and elasticity than rubber as well as greater tensile strength and strength than steel. The increase in temperature or change in the P<sup>H</sup> can denature the protein folding that intern changes the three-dimensional structure and function of the protein in the silk. Environmental conditions such as reeling speed can affect silk properties (Madsen *et al.*, 1999; Riekel *et al.*, 1999). In Fourier transform infrared (FTIR) spectroscopy, a molecule in the silk fiber absorbs the incident infrared radiation at a specific wavelength after interacting with it. The vibrations produced by the molecules result in an absorption spectrum. The various functional groups that are present in the spider silk fiber are revealed by the absorption spectrum. Humidity is the important factor responsible to alter the mechanical properties of spider silk. Dew and rain will lead spider dragline fibers to shrink significantly (up to 50 % of its initial length) and restrained silk generates stresses in excess of 50 MPa (Work 1981; Bell *et al.* 2002; Pérez-Rigueiro *et al.*, 2003; Boutry and Blackledge 2010). This process is known as super contraction (Work 1977, 1981).

### Materials and Methods

The present study is based on the dragline silk samples collected from the leaves and branches of herbs, shrubs and plants of residing fences close to the agro-ecosystem in and around Akola district, Maharashtra. Using a Carl-Zeiss Stemi 2000c stereo zoom microscope, the spider specimens from

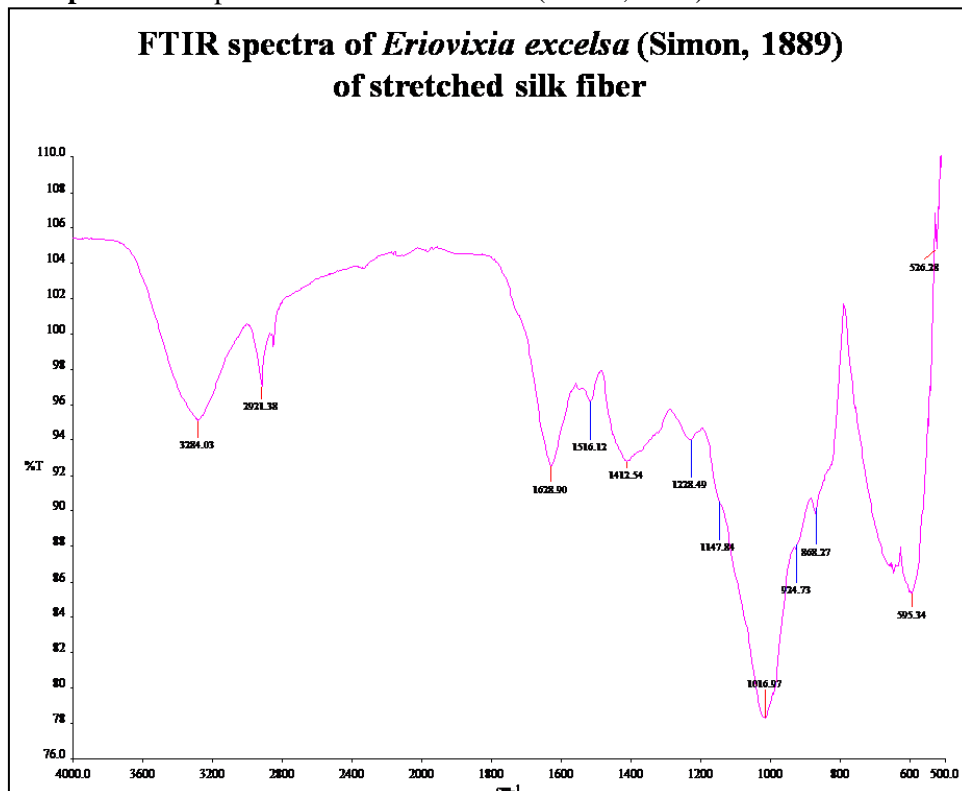
the web were also gathered and identified using the morphological descriptions and illustrations provided by Levi (1997) and Gajbe (2007). The National Chemical Laboratory in Pune, India, performed Fourier transmission infrared spectroscopy (FTIR) of the clean and strong silk

fiber after grouping all the identified spider species according to their type of silk. They have rimmed all the silk samples on ATR attenuate transmittance resonance mode. The FTIR instrument were spectrum GX from Pe Perking Elmer.

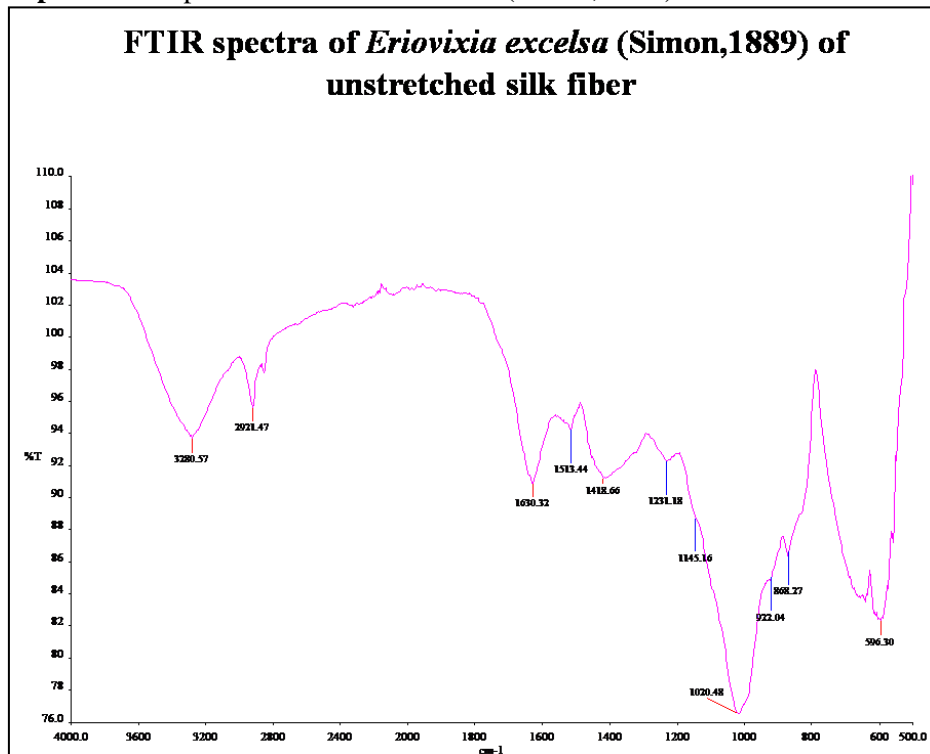
**Table 1** FTIR absorption values for spider silk samples

Peak range cm-1.	Assignments	Spider silk		Remarks
		Stretched	Unstretched	
643-967	-	924	922	Absorption due to vibration of alpha helix structure
1015-1032		1016	1020	Absorption due to bending
1140-1492	N-H amide II	1147	1145	Absorption due to bending vibrations
1500-1600	Protein Amide II	1516	1513	Absorption due to tyrosine ring - OH vibrations
1600-1700	Protein amide I	1628	1630	Frequency peaks or (wave number peak) due to alpha helix structure,
2941-2946	O-H, C-H	2921	2921	O-H bond formation/ salt formation and C-H stretching
3297-3300	O-H, N-H	3284	3280	Hydroxyl group/N-H Stretching

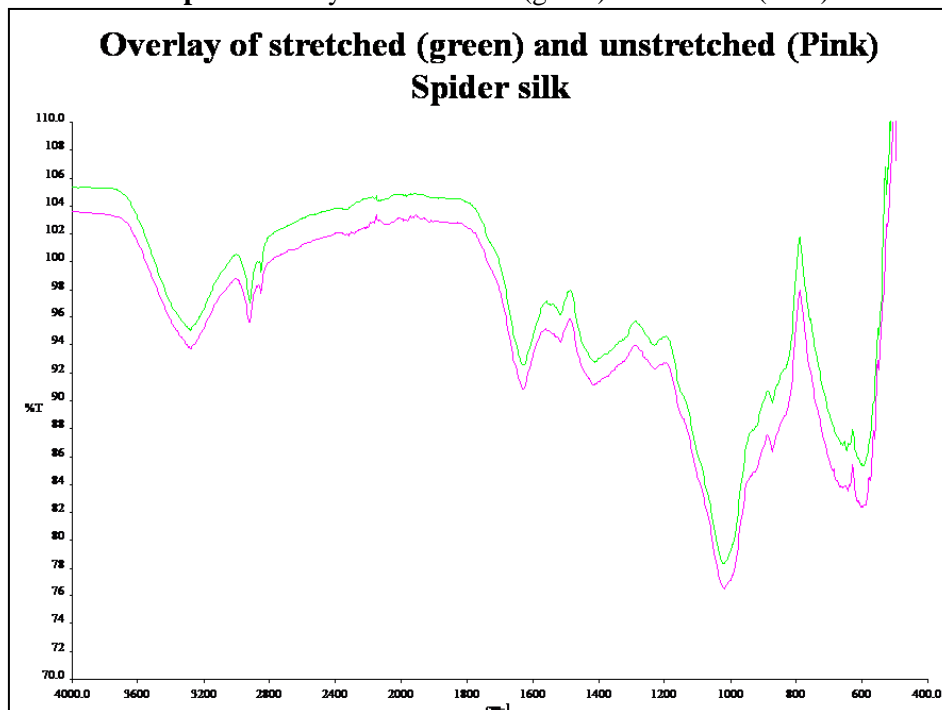
**Graph-1** FTIR spectra of *Eriovixia excelsa* (Simon, 1889) of stretched silk fiber

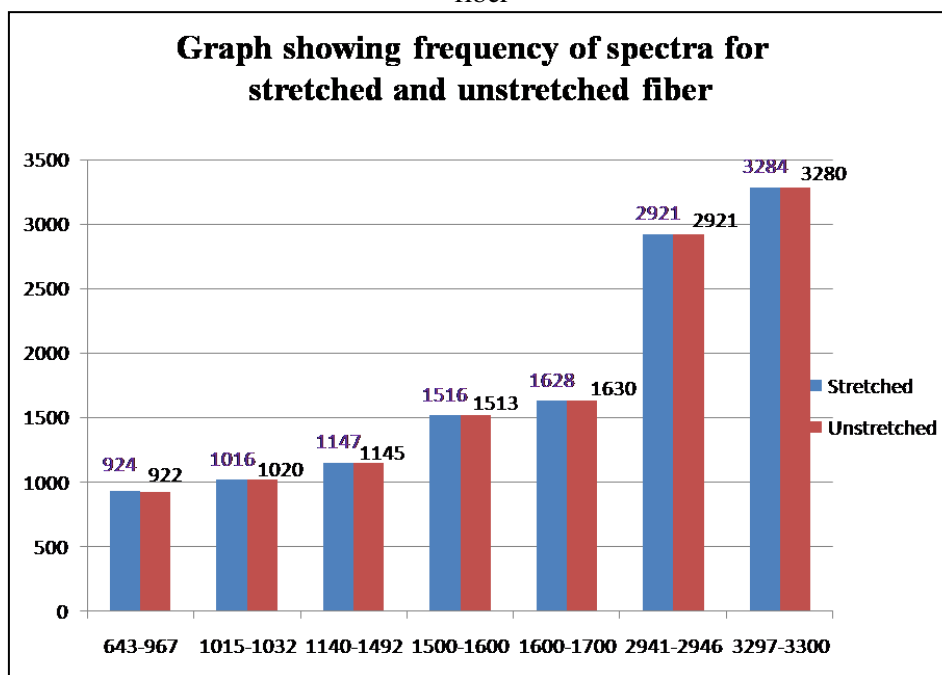


**Graph-2** FTIR spectra of *Eriovixia excelsa* (Simon, 1889) of unstretched silk fiber



**Graph-3** Overlay with stretched (green) unstretched (Pink)



**Graph-4** Graph showing frequency ( $\text{cm}^{-1}$ ) of spectra obtained from stretched and unstretched spider silk fiber

## Results and Discussion

FTIR spectroscopy of Spider *Eriovixia excelsa*, (Simon, 1889) was recorded for stretched and unstretched silk fiber. As detailed in table 1, a number of well-defined peaks are obtained in the range of 600-4000  $\text{cm}^{-1}$ . All the silk types show protein peaks in the Amide I (1600-1700  $\text{cm}^{-1}$ ) and Amide II (1500-1600  $\text{cm}^{-1}$ ) regions. The amide group in protein and polypeptides give specific vibration band in UV spectra. The spider silk in unstretched sample shows a peak at around 1630  $\text{cm}^{-1}$  due to presence beta sheet. The frequency peak (in stretched sample) is at around 1628. This frequency peak in the stretched sample is due to unordered secondary structure of protein. Below 1200  $\text{cm}^{-1}$ , spider silk fiber exhibit frequency peak at 1016  $\text{cm}^{-1}$  (stretched), 1020  $\text{cm}^{-1}$  (unstretched) 1147  $\text{cm}^{-1}$  (stretched) and 1145  $\text{cm}^{-1}$  (unstretched) due to bending vibrations. In addition, spider silk exhibits a frequency peak at 1516  $\text{cm}^{-1}$  due to presence of amide group. The spider silk fiber exhibit frequency peak at 2921.38  $\text{cm}^{-1}$  (stretched) and 2921.46  $\text{cm}^{-1}$  (unstretched) for salt formation and C-H stretching. The spider silk fiber exhibit frequency peak at 3284  $\text{cm}^{-1}$  (stretched) and 3280  $\text{cm}^{-1}$  unstretched for N-H stretching.

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