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Case Report
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Forensic Evidence of Fiber in Disputed Textile Material

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Abstract

The different types of fibers like animal fiber, synthetic fiber, vegetable fiber, mineral fiber and also both human and animal hair are encountered during investigation of crime since used in varied house hold materials and available on human/animal body parts. In one case, a textile consignment containing wearing apparel (sari) was seized at state border gate and imposed tax since appearing alike natural silk sari. The trader filed a complaint claiming the wearing apparel (sari) to be spun with synthetic fiber and requested to levy tax accordingly. The matter was not settled as such, one disputed sari was received for forensic examination to ascertain the nature of fiber (natural/synthetic) used to decide the tax on the textile consignment. The fibers used in the disputed sari were collected and compared with genuine silk conducting physical features, microscopic, scanning electron microscopic (SEM) and FTIR studies. The forensic examination ruled out the use of silk fiber in knitting the disputed sari and solved the case. The details have been discussed in this paper.

Keywords: Wearing apparel (sari); Genuine silk fiber; Synthetic fiber; Physical features; Microscopic; SEM; FTIR

Abbreviations: SEM: Scanning Electron Microscope; FTIR: Fourier-Transform Infrared Spectroscopy; TLC: Thin Layer Chromatography

Introduction

The demand of textile products has led to the invention and production of an increasing range of man-made/synthetic fibers. Presently total worldwide production of man-made fibers is on a par with natural fibers [1]. The natural fibers such as silk, sinew, wool, animal hairs, flax, cotton, jute, bamboo etc. and the man-made synthetic fibers such as rayon, acetate, nylon, olefin, acrylic, polyester etc. are very commonly used in different wearing apparels. The fiber used in textile is the smallest single unit forming the basis of the textile yarn and the yarn is composed of numerous fibers which are twisted together to prepare the unit for weaving. This is commonly known as thread. Many times fiber is dyed for knitting. The dye is very much helpful as additional evidence for forensic comparison by TLC [2]. Different types of cases are reported where examination of fiber is involved for forensic evidence [3-6]. They are:

I. Disputed wearing apparel to ascertain the origin of fiber

II. Disputed sock/blanket to ascertain the percentage of wool used

III. As trace evidence at crime scene like murder/rape/accident cases fiber analysis is helpful

IV. Distinguish between fiber and hair

V. Forensic examination of all types of fiber (animal, vegetable, mineral, hair, silk, polymer, rayon etc. are done in disputed cases)

VI. Examination of fiber help to link between victim, accused and scene of crime

VII. In hanging cases, fibers are collected from victim's neck for examination/comparison with hanging material like rope etc.

VIII. Examination of animal fiber at crime scene is of great significance

IX. Two pieces of rope, cloth etc. are compared to establish the common origin to link evidence with suspect – crime scene

X. Examination of ornaments used along with fiber in costly garments may have immense forensic value

Case Report

A trader was transporting textile consignment containing synthetic wearing apparel (sari) and the tax department

imposed tax considering natural silk sari. There was huge financial loss, as such the trader lodged legal complaint against the tax department to levy tax for synthetic fiber product. As per complaint, the disputed sari was sent for forensic examination to ascertain the fiber used for knitting the sari. The forensic examination was done and based on the report tax was collected accordingly and the trader got relief from financial burden in this case.

Materials and Methods

Sample collection and cross section

Figure 1: Natural silk fiber.

Standard sample of natural silk fiber was collected from government department and fiber used in disputed sari was carefully isolated for different studies (Figures 1 & 2). In order to observe both the silk fiber and the fibers used in sari under microscope, a furrow was made on the paraffin block (cube) using a hot scalpel. A few silk fibers and fibers used in sari were taken and placed separately in the furrow. Thereafter, the gap was filled with liquid paraffin and the whole block was allowed to solidify in a refrigerator. The paraffin wax block so formed used to obtain thin sections of fibers manually with the help of a hand razor blade. The cut sections were de-waxed using xylene and were placed on a slide for observation under microscope (Leica DME, Germany) at a suitable magnification (100X-400X) [7].

Figure 2: Disputed multicolor sari.

Physical features of natural silk and fiber used in sari shown in Table 1.

Table 1: Showing the difference between natural silk and fiber used in sari.

Physical features	Natural silk fiber	Fiber used in sari
i. Color	Light yellow (natural color)	Color added for different shades
ii. Elastic recovery	Moderate/not so good	Better
iii. Luster	Bright	Bright due to synthetic dye used
iv. Burning test	Emits smell of burnt hair and produces soft black bead that forms dust on pressing	Emits unusual smell and produces hard smooth blackish bead
v. Effect of heat	No change at 130 ^{0}C	Becomes curly at 130 ^{0}C
vi. Fiber structure	Does not change	Easy to change

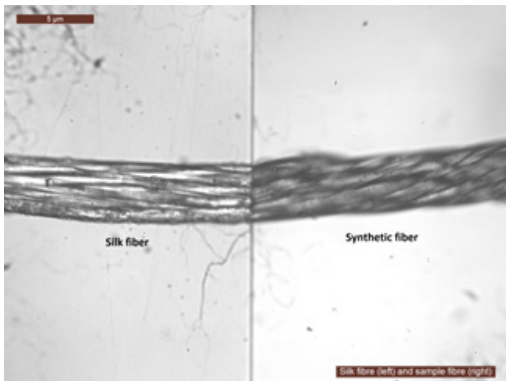

Figure 3: Silk fiber and synthetic fiber under comparison microscopeappear dissimilar.Surface of the filaments of silk fiber is uneven and show many irregularities such as fissures and folds, whereas surface of the filaments of synthetic fiber is comparatively even and smooth.

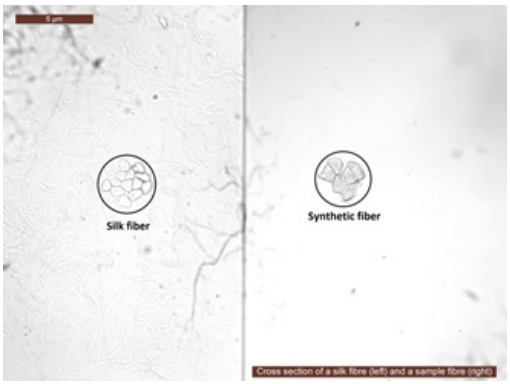

Figure 4: Cross sectional view of silk fiber andsynthetic fiber under comparison microscope also look different; silk fiber is triangular with rounded corners, whereas synthetic fiber is tetragonal/pentagonal in cross section.

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Observation under microscope

The observations made under microscope are shown in Figures 3-6:

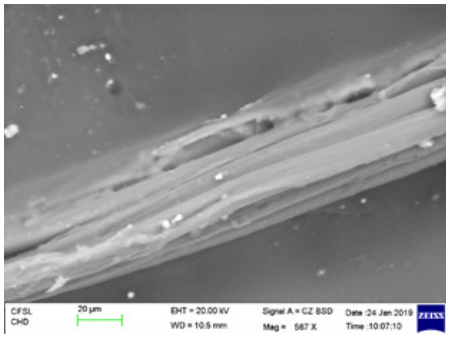

Figure 5: SEM image of natural silk fiber with uneven surface, fissures and folds in the filaments.

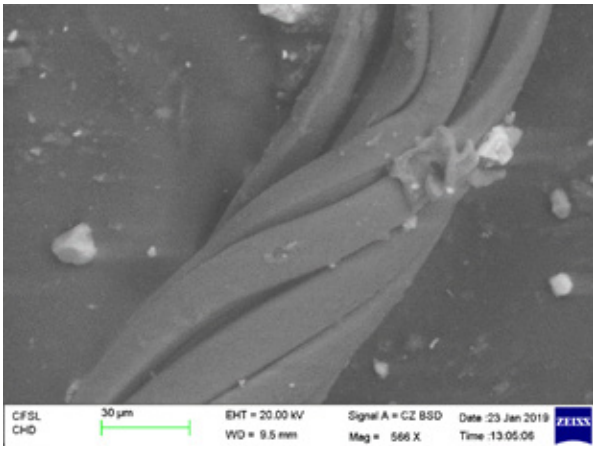

Figure 6: SEM image of the fiber in the sari with even and smooth surface of filaments.

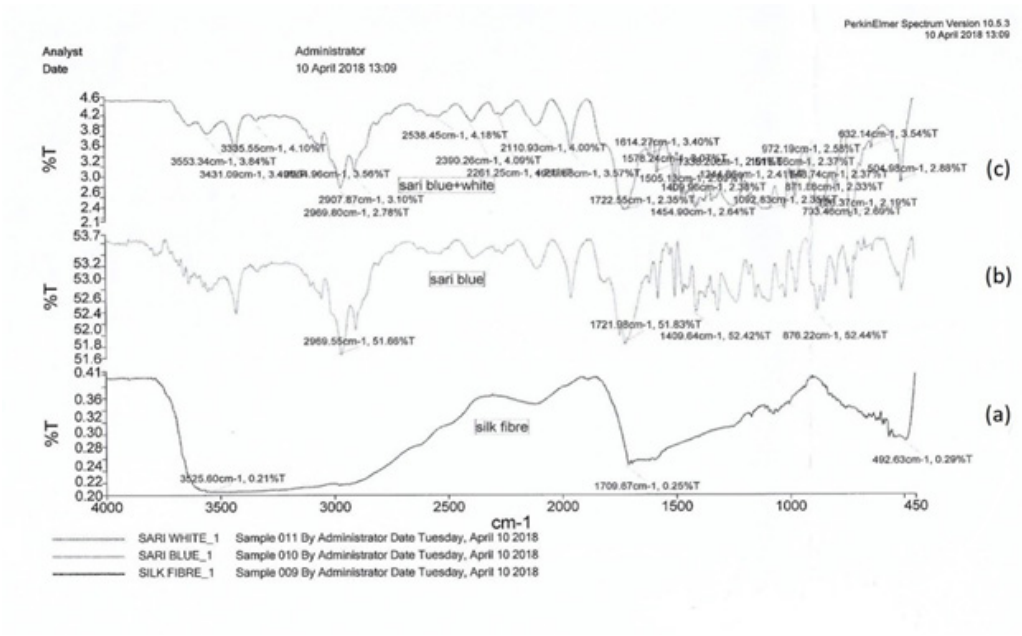

Figure 7: FTIR spectra of fiber collected from genuine silk fiber (a) and disputed sari from two places (b and c).

Discussion

In this case textile consignment (sari) was seized to examine the origin of fiber and levy tax accordingly. The forensic examination/comparison of the fiber of the disputed sari along with genuine silk fiber was conducted and the results found on physical properties, microscopic, SEM and FTIR studies could conclusively prove that the disputed sari was not spun with natural silk fiber. The results of forensic examination could establish the fact and settle the legal dispute in this case.

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