CHAPTER V
CONCLUSION AND FUTURE PERSPECTIVES

5.1 CONCLUSION

In the recent investigation, the effects of various commercially available washing agents, along with the traditionally used washing agents, were analyzed for the washing of *Eri*, *Muga,* and *Pat* silk fabrics. The parameters considered were color change, fiber damage, and chemical changes that took place. With the use of ImageJ software, color analysis was carried out easily from where color coordinates were generated. With Delta E, the deviation of color was calculated, which gave a quantitative comparison. SEM indicated the effect of agents on the fibroin filaments that showed the damage. From FTIR reports, the target sites attacked by the respective agents were known. The secondary structure changes due to washing agents were also determined. Considering all these parameters, in the case of *Eri*, COMF (a fabric conditioner) turns out to be a better washing agent. For *Muga*, *KOLAKHAR*, a traditionally used agent, proves to be better. In the case of *Pat* fabric, COMF (fabric conditioner) and EZY (liquid detergent for silk and wool) prove to be better options for washing *Pat* silk fabric.

The study compared the dyeing and functional properties of tannic acid as a mordant in *Eri, Muga*, and *Pat* silk fabrics. An attempt to reveal the correlations between the chemical structures and application characteristics of curcumin and tannic acid applied to the silks was made. The mordant sequence for color-fastness protection has been identified using washfast-ness and lightfastness as indicators. The FTIR reported the bonds related to dyeing and mordanting, as well as the confirmation of curcumin binding. Curcumin, which has two phenolic hydroxyl groups and a diketone moiety, gave silks good yellow colors. Tannic acid used as a mordant not only helped in the retention of curcumin's colour but also proved to be a major factor in antioxidant activity. The DPPH scavenging activity proved that BDM, BM, and BMDM made *Eri, Muga*, and *Pat* fabrics rich in antioxidants. However, *Pat* silk fabric demonstrated that BD and SIM also have good antioxidant properties.

Furthermore, the biocompatibility of the *Eri, Muga*, and *Pat* fabrics was tested, and it was found that *Eri* silk fabric (treated and non-treated) has good biocompatibility. *Muga* silk fabric has its own biocompatibility, which gets disturbed with treatments. The findings contradict previous studies that suggested *Pat* silk fabric to have good biocompatibility. In the present study, unlike *Eri* and *Muga*, untreated *Pat* had poor biocompatibility. However, with mordant (tannic acid) and dye (curcumin) treatments, *Pat* fabric became highly biocompatible.

The degradation results confirmed that the Assam silk fabric of *Eri, Muga*, and *Pat* is biodegradable, which contradicts reports of the US claiming silk to be non-biodegradable. Based on the findings of SEM, weight loss, and FTIR, it can be deduced that *Eri* degrades slower than *Muga* and *Pat* fabrics. The formation of a peak around 466-477 cm-1 in the majority of the degraded samples suggests the peak to be a possible indicator of silk degradation. Untreated *Muga* and *Pat* showed maximum degradation, which can be linked to the presence of remains of sericin in them that acted as an attacking site for microorganisms.

The degradation results also coincide with antibacterial results, as in some cases silk seems to feed for bacterial growth. *Eri* silk, with a significant antibacterial effect on both positive and negative bacteria, showed the least biodegradation, whereas Muga and *Pat* fabric, with a negligible antibacterial effect against gram-positive bacteria, showed good degradation. Antibacterial properties increased with the addition of mordant in the case of gram-positive bacteria by *Pat. Muga* silk fabric showed negligible effect against gram-positive bacteria but had a good antibacterial effect with *Muga*-BD.

Filtration with *Eri, Muga*, and *Pat* fabric proved untreated samples to have better filtration results against E. coli. This proves more than anti-bacterial property; mesh size plays the ruling role, which is assumed to be smaller for untreated compared to treated.

Activated charcoal was shown to be a washing agent exclusively for *Muga*. With the results of SEM, FTIR, colour change, and glossiness, activated charcoal has been confirmed to be a washing powder exclusively for *Muga* fabric.

5.2 Future Prospects

The majority of the time, chromophores are organic molecules with alternating systems of double and single carbon-carbon bonds. We refer to these as conjugated systems. The double bonds' electrons' π-orbitals overlap, resulting in a system of delocalized electrons that cover a significant portion of the molecule. When electron transitions take place in this system, light is absorbed, which results in the color. When this delocalized system is destroyed by breaking or shortening the color is lost. The exact interactions taking place have not been studied, and thus in the case of natural dye, a thorough study will help in understanding the low color-fastness of natural dyes.

During the literature survey it was found that research on the phase transitions of silk fibroin, spinning causes antiparallel β -pleated sheet crystals to form. Interestingly, the mechanism behind the crystallization of β-sheets is not completely understood at this time. With proper analysis of the mechanism, silk can be controlled at the production level for higher or lower levels of β-sheets.

FTIR analysis with dyed and mordanted silk with abundant curcumin and tannic acid and its combination can be carried out for understanding of the bonds and possible interaction sites for fabric-dye-mordant.

As charcoal showed amazing results for *Muga* wash; therefore, experiments may be carried out to make a charcoal-based washing bar or powder specifically for *Muga* silk. Optimization may be carried out by considering the concentration, temperature, etc as different variables for developing the washing formulation.