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Study on Comfort Properties of Plasma Treated Handloom Cotton Fabrics

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Abstract: *Many applications are available for the surface modification of textile fabrics. Plasma is the one of techniques available for surface modification. This technique is used for handloom cotton fabrics to modify the surface characteristic so as to improve its comfort properties such as moisture regain, wicking, water absorbency, relative water vapour permeability, air permeability and thermal resistance. The plasma treated handloom cotton fabrics were dyed using natural colourant Curcuma longa (Turmeric) using mordants such as Alum and Myrobolan. The test results shows that a significant variation in moisture regain, water absorbency, air permeability and wicking characters of plasma treated dyed fabric when compare to parent fabric. This study shall provide value addition of handloom cotton products to enhance the socioeconomic conditions of handloom society members.*

Keywords: *Woven fabrics, Plasma treatment, Comfort properties, Natural dyes, Handloom cotton fabrics, characteristic*

1. INTRODUCTION

The plasma is a technique being used in many industries for various applications. In the textile industry this technique is used to modify characteristic of textile fabrics. In this study oxygen and organ were used for the plasma treatment of handloom cotton fabric. The plasma treated handloom cotton fabrics were dyed using natural namely *Curcuma longa* (Turmeric), which has the advantage of eco-friendly, biodegradability and less toxicity. The comfort properties such as moisture regain, wicking, water absorbency, relative water vapour permeability, air permeability and thermal resistance were critically analysed. The test result shows a significant improvement in the above said properties. Through this attempt a value addition, the handloom cotton fabric will enhance the socioeconomic condition of handloom weavers.

2. Materials and Methods

Plasma treatment on handloom cotton fabric is a novel attempt. A commonly available handloom cotton fabric has been selected for this study. The dyeing has been done using natural dye namely *Curcuma longa* (Turmeric) and comfort properties like moisture regain, wicking, water absorbency, relative water vapour permeability, air permeability and thermal resistance were studied.

2.1 Materials

A commonly available handloom cotton plain fabric was selected for this study with the construction details of handloom cotton are given below table 1, which is then plasma treated and dyed with natural dye namely *Curcuma longa* (Turmeric) using mordants such as Alum and Myrobolan.

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Table 1 handloom cotton woven fabric parameters

Sl no	Description	Values
1	Warp count	2/34^{s}Ne
2	Weft count	17^s Ne
3	Ends per cm	18
4	Picks per cm	23
5	Weight per square meter	159 grams
6	Cover Factor	19.90
7	Weave	1/1 plain

2.2 Methods

A low pressure Plasma instrument having frequency of 60 kHz with Aluminum & Electrode has been used. Two types of gases namely Oxygen and Organ gases were used with a Pressure of 5 X 10^{-2}m bar to study the effect of Oxygen and Organ Plasma treatment. The following comfort properties characteristic have been studied by using the following standards:

Table 2 Comfort Properties Testing Standards

Sl no	Properties	Standards	units
1	Moisture Regain	ISO	%
2	Vertical Wicking	AATCC197/198:2001	mm
3	Water Absorbency	AATCC-79:2010	sec
4	Air Permeability	ASTM D 737:2012	$cm^3/s/cm^2$
5	Relative Water Vapour Permeability	ISO 11056 :1984	%
6	Thermal Resistance	ISO 11092	m^2k/W

3. Result & Discussion

The test results of handloom cotton fabrics of plasma untreated and plasma treated and natural dyed using *Curcuma longa* (Turmeric) with double mordants Alum and Myrobolan and comfort properties like moisture regain, wicking, water absorbency, relative water vapour permeability, air permeability and thermal resistance were critically analysed.

3.1 Comfort Characterisation

The following comfort properties moisture regain, vertical wicking, water absorbency, relative water vapour permeability, air permeability and thermal resistance were studied with handloom cotton grey fabric, Plasma treated with oxygen and organ gas, dyed with *Curcuma longa* (Turmeric) with double mordants using Alum and Myrobolan and the results were discussed graphically .

3.2) Moisture Regain Characteristic

The moisture regain characteristic for the handloom cotton grey fabric, Plasma treated grey fabric, Plasma treated natural dyed fabrics have been tested and the results were shown below:

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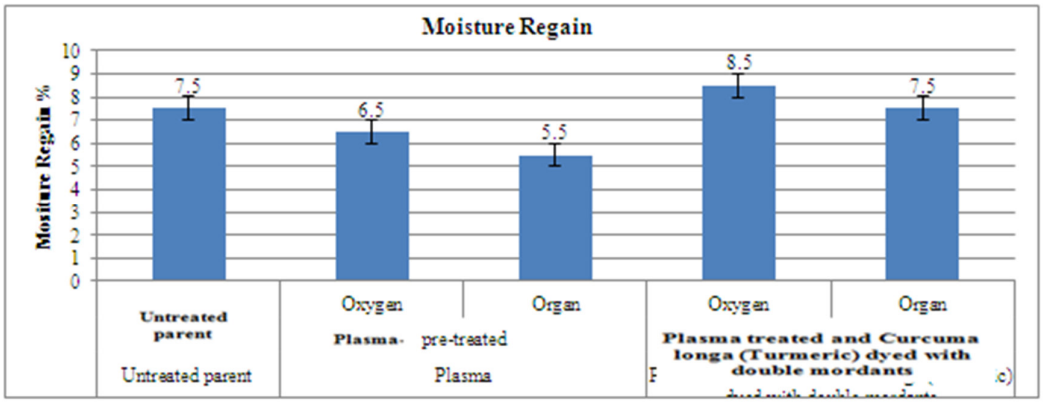

Figure 1 Comparison of moisture regain property of Plasma treated and untreated with natural dye *Curcuma longa* (Turmeric) dyed handloom cotton fabric.

From the figure 1, it is observed that the maximum moisture regain of 8.5% has been noticed in the *Curcuma longa* (Turmeric) natural dye using double mordants with Oxygen gas plasma treated sample when compare to other samples. The moisture regain 7.5% is noticed for untreated grey handloom cotton fabric and it reduced to 5.5 - 6.5% after Organ and Oxygen gas Plasma treated grey fabric sample respectively.

The moisture regain value has been increased to 7.5 – 8.5% after Organ and Oxygen gas plasma treatment and dyed with *Curcuma longa* (Turmeric) using double mordants.

3.3) Wicking Characteristic

The vertical wicking Characteristic for the handloom cotton grey fabric, Plasma treated grey fabric, Plasma treated natural dyed fabrics have been tested and the results were shown below:

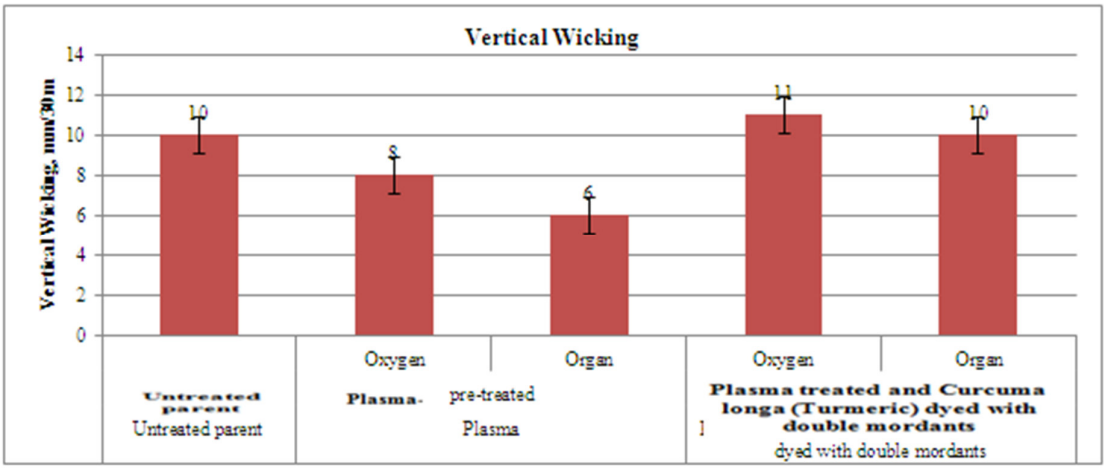

Figure 2 Comparison of vertical wicking property of Plasma treated and untreated with natural dye *Curcuma longa* (Turmeric) dyed handloom cotton fabric.

From the figure 2, it is observed that maximum vertical wicking of 11mm/30m has been noticed in the *Curcuma longa* (Turmeric) natural dye using double mordants with Oxygen gas plasma treated sample when compare to other samples. The wicking 10mm/30m is noticed for untreated grey handloom cotton fabric and it reduced to 6 and 8mm/30m after Organ and Oxygen gas Plasma treated grey fabric sample respectively.

There is no change in value for Organ gas plasma treatment and dyed with *Curcuma longa* (Turmeric) using double mordants .

3.4) Water absorbency Characteristic

The water absorbency characteristic for the handloom cotton grey fabric, Plasma treated grey fabric, Plasma treated natural dyed fabrics have been tested and the results were shown below:

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From the figure 3, it is observed that the maximum drop water absorbency of 17sec has been noticed in the grey fabric. The water absorbency value has been reduced to 10-13sec after Oxygen and Organ gas plasma treatment on handloom fabric respectively. The water absorbency value has been increased to 12-16sec after Oxygen and Organ gas plasma treatment and dyed with *Curcuma longa* (Turmeric) using double mordants.

The water absorbency value are comparatively high for Organ gas plasma treated grey fabric 13sec and Organ gas plasma treated and dyed with *Curcuma longa* (Turmeric) using double mordants 16sec.

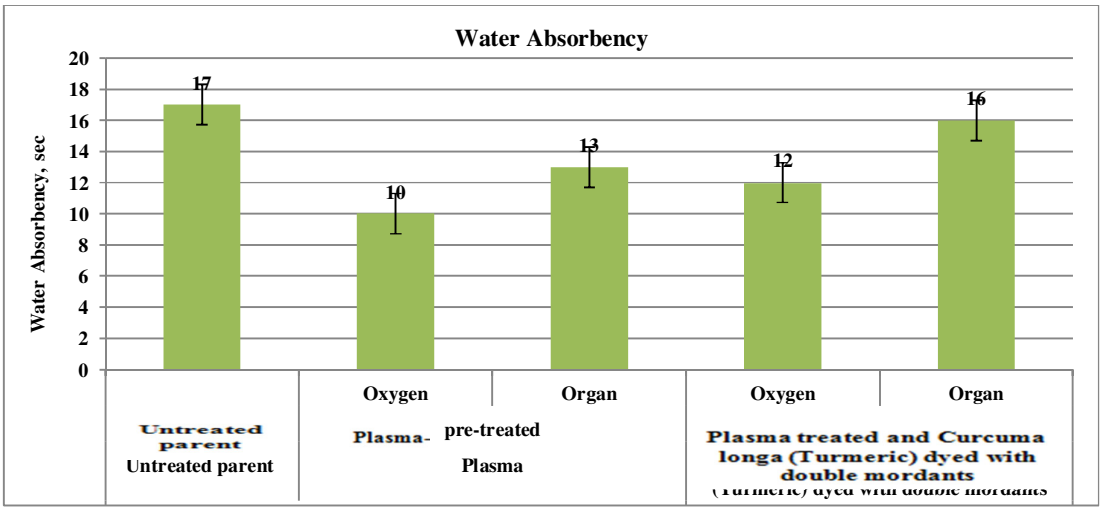

Figure 3 Comparison water absorbency property of Plasma treated and untreated with natural dye *Curcuma longa* (Turmeric) dyed handloom cotton fabric.

3.5) Air Permeability Characteristic

The air permeability characteristic for the handloom cotton grey fabric, Plasma treated grey fabric, Plasma treated natural dyed fabrics have been tested and the results were shown below

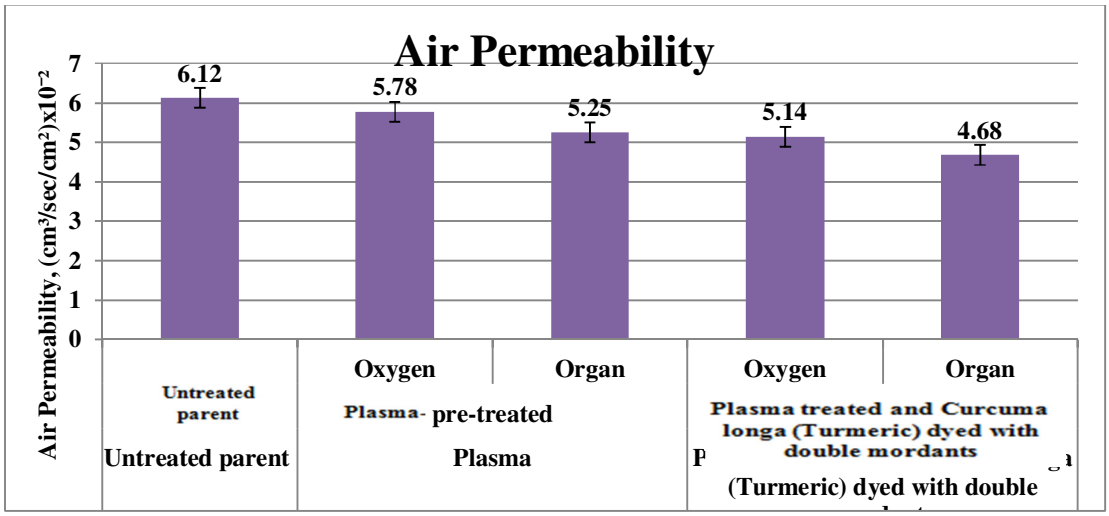

Figure 4 Comparison air permeability property of Plasma treated and untreated with natural dye *Curcuma longa* (Turmeric) dyed handloom cotton fabric.

From the figure 4, it is observed that the maximum air permeability of 6.12 (cm3/sec/cm2) x 10^{-3} has been noticed in the grey fabric. The slightly reduced air permeability value of 5.25 – 5.78 (cm3/sec/cm2) x 10^{-3} was noticed in Organ and Oxygen Plasma treated grey fabric.

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The air permeability value has been further reduced to 4.68 – 5.14 (cm3/sec/cm2) x 10^{-3} after Organ and Oxygen gas plasma treated and dyed with *Curcuma longa* (Turmeric) using double mordants Alum and Myrobolan respectively because of dye particles covered in porous area of cotton fabric.

3.6) Relative Water Vapour permeability Characteristic

The relative water vapour permeability characteristic for the handloom cotton grey fabric, Plasma treated grey fabric, Plasma treated natural dyed fabrics have been tested and the results were critically analysed.

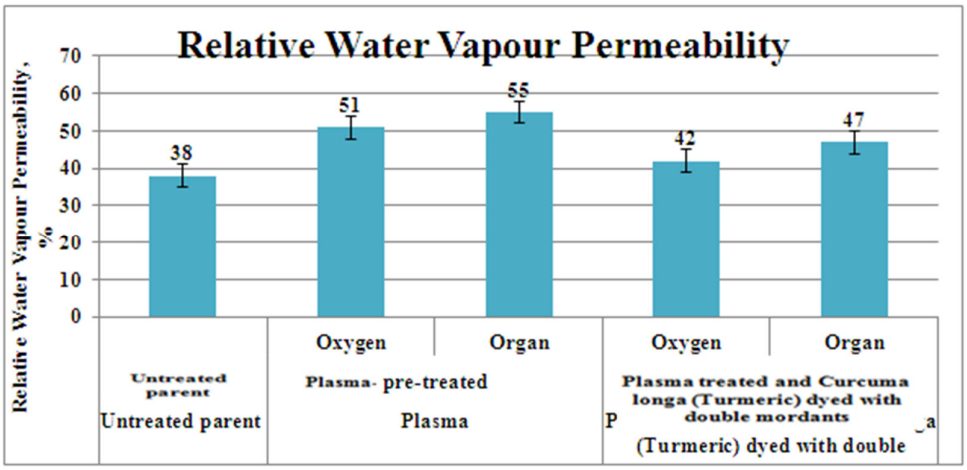

Figure 5 Comparison relative water vapour permeability property of Plasma treated and untreated with natural dye *Curcuma longa* (Turmeric) dyed handloom cotton fabric.

From the figure 5, it is observed that the maximum relative water vapour permeability of 55% has been noticed in Organ gas plasma pre treated the grey fabric. The low relative water vapour permeability value 38% is noticed for grey parent handloom cotton fabric sample. The relative water vapour permeability value has been increased to 51- 55% after Oxygen and Organ gas plasma treated grey fabric respectively.

The relative water vapour permeability value has been further reduced to 42 – 47 % after Oxygen and Organ gas plasma treated and dyed with *Curcuma longa* (Turmeric) using double mordants Alum and Myrobolan respectively because of dye particles covered in porous area of cotton fabric.

3.7) Thermal Resistance Characteristic

The thermal resistance characteristic for the handloom cotton grey fabric, Plasma treated grey fabric, Plasma treated natural dyed fabrics have been tested and the results were shown below:

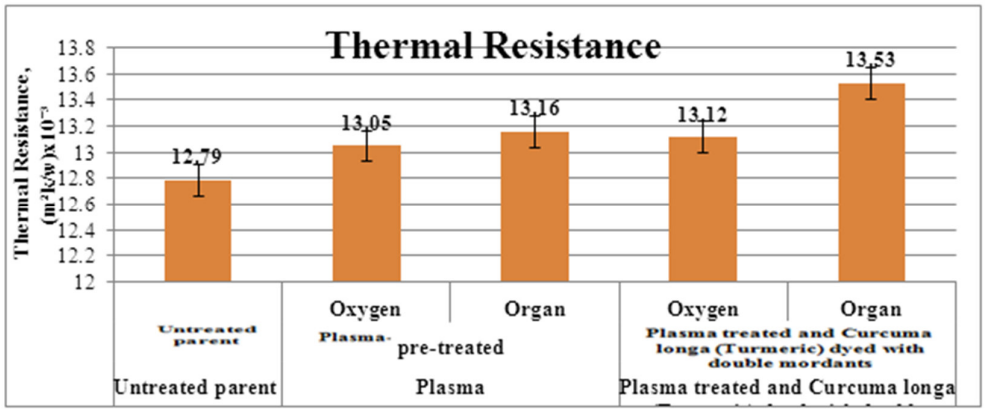

Figure 6 Comparison thermal resistance property of Plasma treated and untreated with natural dye *Curcuma longa* (Turmeric) dyed handloom cotton fabric.

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From the figure 6, it is observed that maximum thermal resistance of 13.53 (m^2k/w) $x10^{-3}$ has been noticed in Oxygen gas plasma treated and dyed with *Curcuma longa* (Turmeric) natural dye using double mordants sample but gery fabric having low value of 12.79(m^2k/w) $x10^{-3}$.

The thermal resistance value has been incresed to 13.05 – 13.16 (m^2k/w) $x10^{-3}$ after Oxygen and Organ gas plasma treated grey fabric. The values are further iincreased to 13.12 – 13.56 (m^2k/w) $x10^{-3}$ after Oxygen and Organ gas plasma treated and dyed with *Curcuma longa* (Turmeric) using double mordants Alum and Myrobolan respectively. Cotton fabric normally have higher thermal resistance value, retains higher moisture and so cotton fabrics are protecting the body temperature.

4. Conclusion

The Oxygen gas plasma treated and natural dyed handloom cotton fabrics have identified the better comfort properties such as moisture regain, vertical wicking, air permeability but Organ gas plasma treated and natural dyed with *Curcuma longa* (Turmeric) using double mordants Alum and Myrobolan have better water absorbency, relative water vapour permeability and thermal resistance The air permeability characteristic of Oxygen plasma treated naturally dyed with double mordant has slightly lower value when compare to plasma treated grey fabric because of dyeing process the porous of cotton fabric was covered with dye particles.

5. References

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