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A comparative Studies of Physio Chemical Properties of Linen Yarn Dyed Fabric Dyed with Reactive & Vat Dye

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Abstract:- This paper investigates the physio-chemical properties of yarn dyed linen fabric dyed with reactive & vat dye. The mechanical & chemical properties such as tear strength, tensile strength, seam strength, pilling, colour fastness to washing, perspiration and rubbing of those fabrics were investigated and compared with each other after making reactive & vat yarn dyed linen fabric keeping same shade%, yarn count, epi, ppi& gsm. It is claimed to bring many advantages of linen fabric quality for future. When the results were studied, it was observed that the mechanical properties like tear strength, tensile strength was found higher in yarn dyed vat linen fabric than yarn dyed reactive linen fabric& in case of colour fastness to wash & perspiration, yarn dyed vat linen fabric shows good colour fastness than yarn dyed reactive linen fabric &yarn dyed reactive linen fabric gives better rubbing fastness than yarn dyed vat linen fabric.

Keywords:- *tear strength; tensile strength; seam strength; pilling; colour fastness to wash; colour fastness to perspiration; colour fastness to rubbing.*

I. INTRODUCTION

Cellulose is the main source of vegetable origin for natural textile fibres. All plants contain cellulose. The cellulosic fibres are common to textile industry, such as cotton, linen, jute etc.Flax fibre is a cellulosic polymer& it is more crystalline in nature, crisper, hard to handle &it wrinkled easily.The main components of a flax fibre contain cellulose, hemicellulose, wax, pectin & lignin.There are several types of dyes which can apply on cellulose fibre, like reactive, vat, direct, naphthol dyes etc.

The main structural features of reactive dye are the chromophore system, reactive group, sulphonate groups for water solubility&the bridging group that attaches i.e., reactive group either directly to the chromophore or to some other part of dye molecule. All of these structural features can impact the dyeing & fastness properties. Maximum commercial ranges of reactive dyes have a complete range of colours, many of which are especially vibrant colour.[1]

Vat dyes are the oldest colorants used in textiles, dating back over 2000 years. Since vat dyes are water insoluble, they cannot be applied directly onto textile fibres and fabrics. Dyeing with vat dyes is based on the principle of converting the vat dye from its waterinsoluble form into a water-soluble form (leuco dye) by means of reduction, which allows the dye to enter into the fibre where it is then reconverted by oxidation into the original insoluble form [2].The dyes consist of at least two conjugated carbonyl groups which, during their common application to cellulosic fibres. And then it is converted by reduction process under alkaline medium to the corresponding, water soluble, 'alkali leuco' form which is applied to the material. [3-5].

In the present research, an effort has been made to assess the physio-chemical properties such as tearing strength, tensile strength, pilling, seam strength, colour fastness to wash, perspiration, rubbing of yarn dyed linen fabric dyed with reactive& vat colour. This study will be very useful to execute testing standards &method to improve the quality of textiles materials.

II. MATERIALS AND METHOD

A. Materials

At first 6o lea flax yarn was collected from spinning department of Jayashree textile, Rishra.Then two sets of yarnwere dyed in Fong's package dyeing machine in both reactive & vat colour keeping same shade% 5.45. Reactive dyes such as drimarene navy cl-r(0.12%), drimarene red cl-5b (4.33%), drimarene navy yellow cl-2r (1%) & vat dyes such as novatic grey 3b (1%), novatic blue rcl (3.15%), novatic d black ac (1.3%), coravat olive green(0.03%) were used in yarn dyeing. Cbtreat gd (cationization agent),ladipur dki (levelling agent),caustic lye,hydrose,sodium sulphate,hydrogen peroxide,soda ash, eriopon os (Soaping agent) and invatex ac (alkali neutralizer) were used in vat yarn dyeing.Humectol c (levelling & sequestering agent), sirrix usb liq (Scouring agent),soda ash,acetic acid, ladipur rsa (Soaping agent) were used in reactive dyeing.

B. Method

The one group of flax yarns were dyed separately with reactive dye drimarene navy cl-r (0.12%), drimarene red cl-5b(4.33%), drimarene navy yellow cl-2r(1%) containing humectol c (0.25 gpl), sirrix usb liq(1.5gpl) (pretreatment at 70℃/15 min) & dyeing at 60℃ for 40 min with soda ash(25 gpl).acetic acid(0.5 gpl), maintaining the pH at 11 &material to liquor ratio at 1:10. Then soaping at 60℃ for 10 min using ladipur rsa.

And another group of flax yarns were dyed separately with vat dye novatic grey 3b (1%), novatic blue rcl (3.15%), novatic d black ac (1.3%), coravat olive green (0.03%) containing cbtreat gd (pretreatment at 50℃/30 min),run with dyes at 45℃/5 min, ladipur dki (0.5 gpl),caustic lye(24gpl)& then inject hydrose(9.5 gpl at 45℃/10 min),inject sodium sulphate(5 gpl at 45℃/30 min),hydrogen

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peroxide(oxidation at 60℃/20 min),soda ash&eriopon os (soaping at 95℃/15min)maintainingthe pHat 11& material to liquer ratio at 1:10.Then it was cold wash at room temperature for 20 min using invatex ac 0.75 gpl.

Thereafter two greige yarn dyed fabric(reactive yarn dyed & vat yarn dyed) was made from same 6o lea yarn count of flax yarn & then processed in same rapier loom of same epi 57, ppi 52&gsm 128 g/m^2. Then this fabric were singed,washed & finished for lab testing.

C. Physico-chemical tests

a) Tear strength
The maximum force that is required to continue a tear in a fabric under specified conditions is called tear strength of fabric (gf). [6]This tear test was done in james heal's elmendorf tear tester[ASTM D1424:09(2013)]. Take a specimen of 100 ×63 mm & template is placed on the specimen and cut according to the template. Three specimens were tested for each direction(warp & weft).

b) Tensile strength
A fabric specimens of 150 mm length and 100 mm width (strip) were prepared along warp & weft direction. Then the two end of fabric were placed into two jaws of tinius olsen tensile strength tester(ASTM D5034.2008) [7]. Upper jaw size is 25x25mm & lower jaw size is 25x50mm.Thereafter, switch on the machine &machine is started to stretch the fabric. Then the result shown on screen.

c) Pilling
A fabric specimen of 140 mm diameter and 110 mm diameter is cut from the tested fabric. Then the fabric specimensare mounted in Martindale pilling tester(ISO 12945-4). After mounting the specimens, 1000 turns are set in the electronic counter meter. Finally, the electric supply of the machine is switched on. The machine starts and gets stopped after reaching a pre-set number of turns. Now, the specimens are taken out from the machine. Next, the specimen is compared with the visual standard for evaluation of the degree of pilling.The rating of the test specimen is given by using an arbitrary rating scale (1 to 5).

d) Seam strength
A fabric specimen of 350 mm length and 100 mm width (strip) was prepared (warp & weft). Then fold the specimens in 10 mm & sew a lockstitch and cut the specimen along the fold after sewing. Thereafter, the specimen is mounted at the centre between the upper & lower jaws. The sample is stretched by jaws at a constant rate until the rupture started to happen in the specimen.This test is carried out in Tinius Olsen tester machine(ASTM D434:1995).

e) Colour fastness test
Colour fastness to perspiration (acid&alkali), washing, rubbing of both yarndyed fabric was evaluated using grey scale.

a. Colour fastness to perspiration
At first, 10x4cm specimens' size were cut.Then the multi-fibre fabric of the size equal to the test specimens was joined by sewing operation. Perspiration test was done by ISO 105 E04 method.

For acid perspiration test, the solution was prepared by following chemicals: 2.2 gpl sodium dihydrogen orthophosphate, 0.5 gpl 1-histidine mono-hydrochloride mono-hydrate, 5 gplsodium chloride maintaining pH 5.5 with 0.1N sodium hydroxide.

For alkali perspiration test, the solution was prepared by following chemicals: 2.5 gpl disodium hydrogen orthophosphate, 0.5 gpl 1-histidine mono-hydrochloride mono-hydrate, 5 gpl sodium chloride maintaining pH 8 with 0.1N sodium hydroxide.

The test specimens were wetted in the above-mentionedacid & alkali perspiration test solution at room temperature for 30 min& maintain the material to liquor ratio at 1:50. Then excess solution was poured off. And this test specimenswere placed between two glass plates under a pressure of 5 kg & then humidified in an oven for 4 hours at 37℃. After removing from oven,the specimens were dried in hot air dryer. The difference between untreated & treated samples were compared with grey scale for colour staining on a multi-fibre fabric.

b. Colour fastness to wash
The specimen size of 10x4 cm was stitched along all four edges with the same size of cotton cloth. Then the specimen was washed in a washing machine at 60℃ for 30 min using detergent solution(5 gpl)with 8 steel ball, maintaining the material to liquor ratio at 1:50.The change in colour & staining of colour on a multi-fibre fabric with grey scale.[9]

c. Colour fastness to rubbing
The specimen size of 50x130mm was cut along the lengthwise of the tested fabric & cut the specimen size of 50x50mm in white cotton cloth. Then the specimen & rubbing white cotton cloth were humidified for 4 hours at a standard condition of 21±1℃& 65±2% relative humidity. Place test specimen on base of crock meter with its long dimension along rubbing direction. Check rubbing by Dry and Wet methods. Then switch on the crock meter that complete 10 turns. According to AATCC-08 test method, wet the cotton cloth for wet rubbing test& give rating by comparing the grey scale for colour staining of two tested cotton cloth.

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III. RESULTS & DISCUSSION

A. *Results*

a) Tear strength

Sl no	Sample	Tear strength(warpwise)in gf	Tear strength(weftwise)in gf
1	Yarn dyed vat linen fabric	5539.5	5624
		5567	5649
		5568.7	5665
2	Yarn dyed reactive linen fabric	5126	5312.5
		5214	5407
		5100	5366

Table 1: Tear strength

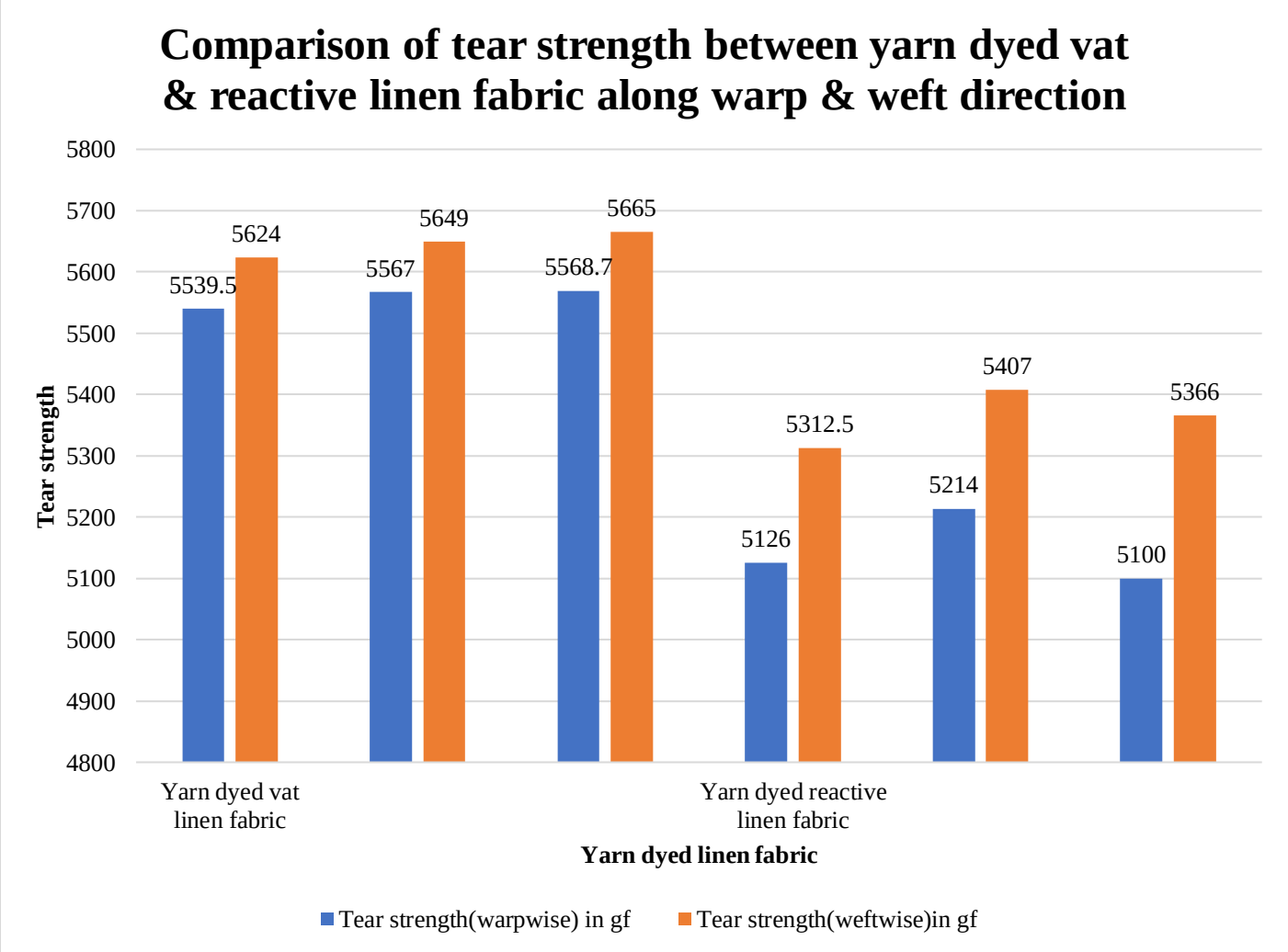

Fig. 1: Comparison of tear strength between yarn dyed vat&reactive linen fabric along warp & weft direction

b) Tensile strength

Sample	Breaking strength(kgf)				Extension%			
	Warp	Warp	Weft	Weft	Warp	Warp	Weft	Weft
Yarn dyed vat linen fabric	24.04	20.55	26.3	26.7	10.28	9.91	9.1	9.13
Yarn dyed reactive linen fabric	27.41	24.6	21.8	22.2	11.87	11.75	9.1	7.97

Table 2: Breaking strength & Extension

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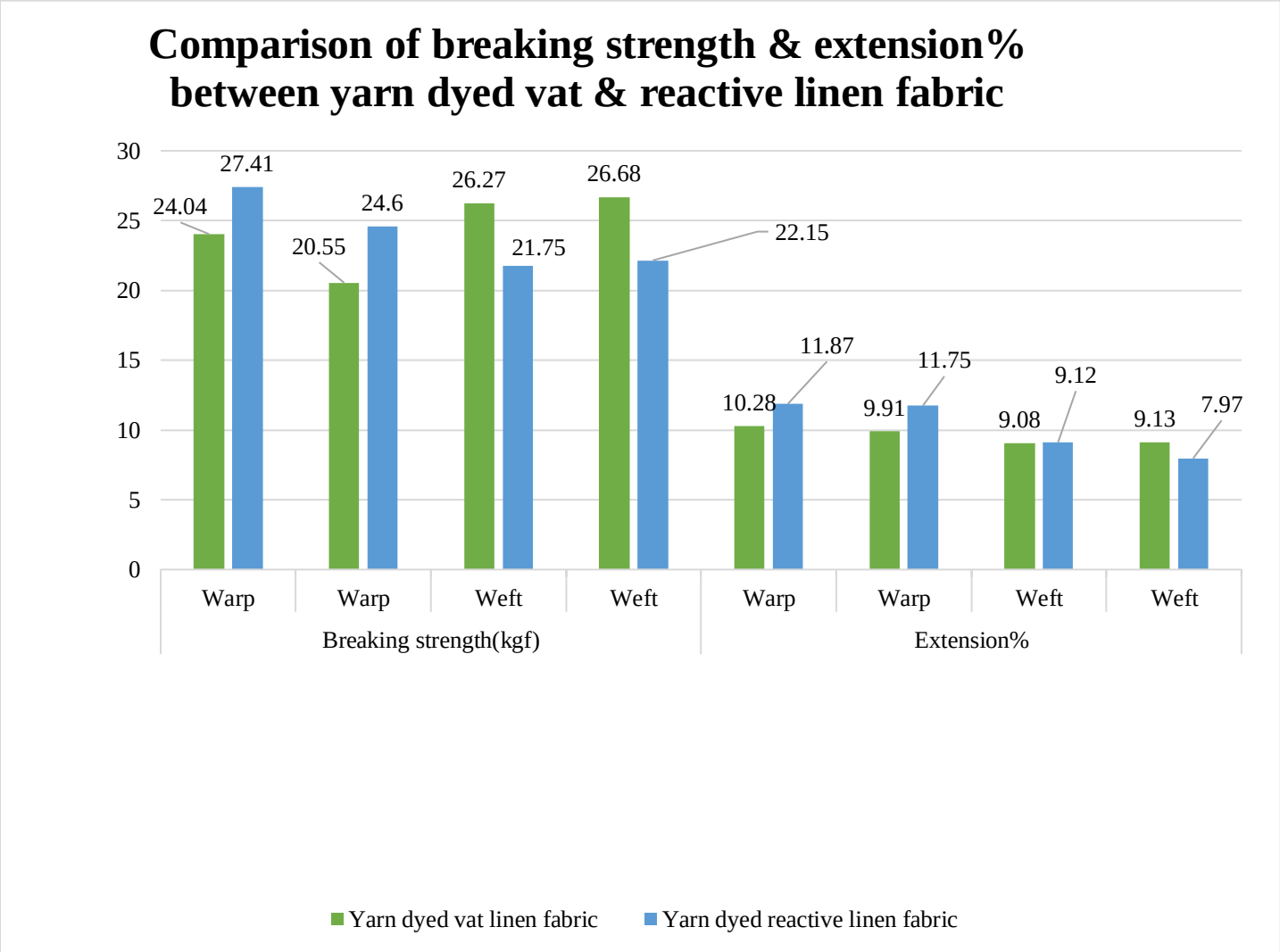

Fig. 2: Comparison of breaking strength & extension%between yarn dyed vat & reactive linen fabric

- **Tensile strength calculation**

For yarn dyed vat linen fabric

Tensile strength = Maximum load in warp + Maximum load in weft [7]

Cross-sectional area

Tensile strength = $\frac{(24.04 + 26.68)\ kgf}{150\ cm^2}$

= 0.338 kgf/cm^2

= 33.15 kPa

For yarn dyed reactive linen fabric

$$\textbf{\textit{Tensile strength}} = \frac{(27.41 + 22.15)\ kgf}{150\ cm^2}$$

= 0.3304 kgf/cm^2

= 32.4 kPa

Sample	Tensile strength(kPa)
Yarn dyed vat linen fabric	33.15 kPa
Yarn dyed reactive linen fabric	32.4 kPa

Table 3: Tensile strength

c) Pilling

Rating	Description	Points to be taken into consideration
5	No change	No visual change
4	Slight change	Slight surface fuzzing
3	Moderate change	The specimen may exhibit one or both of the following: (a) moderate fuzzing (b) isolated fully formed pills
2	Significant change	Distinct fuzzing and/or pilling
1	Severe change	Dense fuzzing and/or pilling which covers the specimen.

Sl no	Sample	Rating (1-5)
1	Yarn dyed vat linen fabric	3/4
2	Yarn dyed reactive linen fabric	3

Table 4: Effect of pilling

d) Seam strength

Sl no	Sample	Seam strength in kgf		Slippage resistance (6.4 mm) in kgf	
		Warp	Weft	Warp	Weft
1	Yarn dyed vat linen fabric	18.62	16.39	11.24	15.24
2	Yarn dyed reactive linen fabric	19.66	17.67	10.89	N/F

Table 5: Seam strength & slippage resistance

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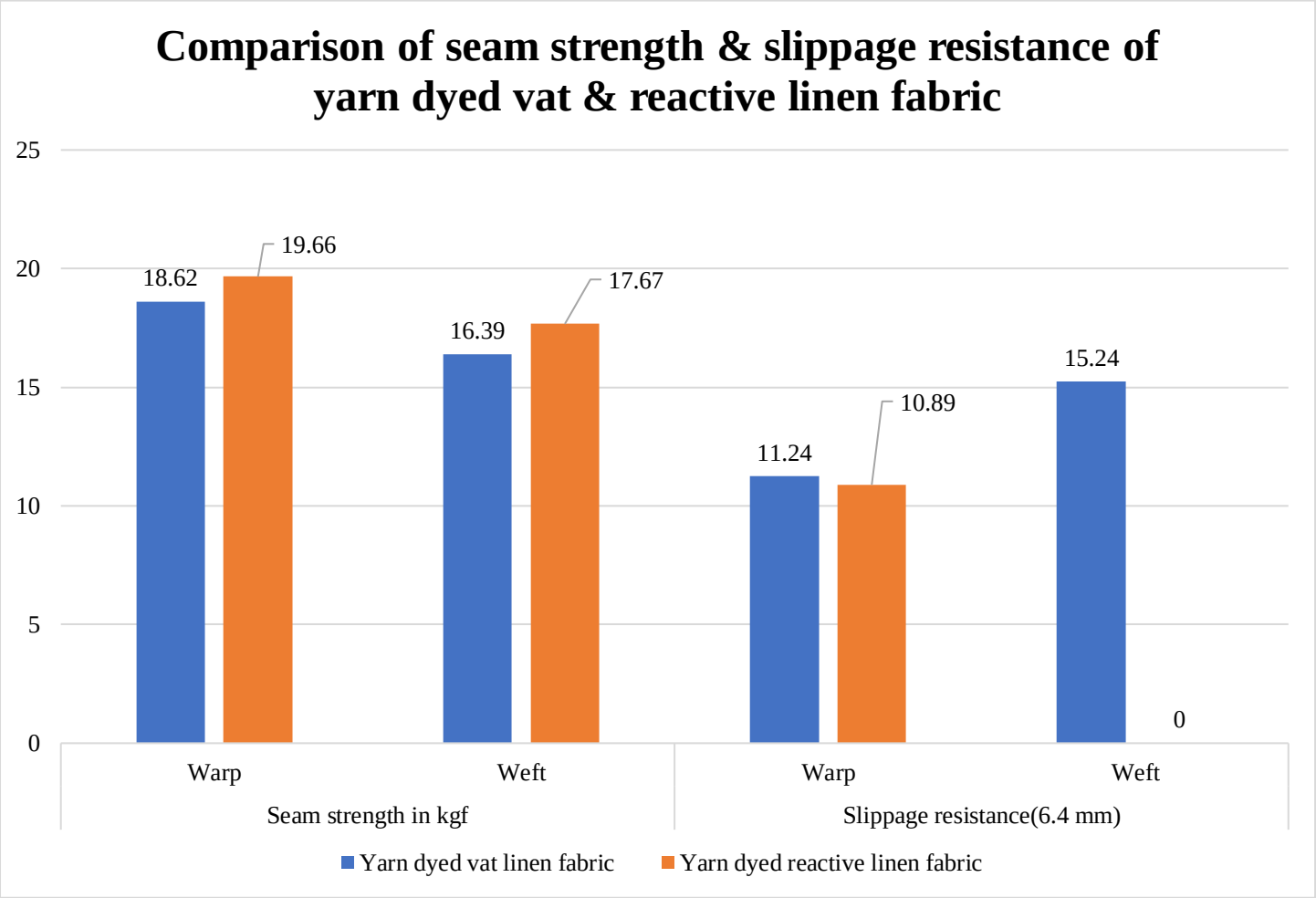

Fig. 3: Comparison of seam strength & slippage resistanceofyarn dyed vat & reactive linen fabric

e) Colour fastness test

- **Colour fastness to perspiration**

Sl no	Sample		Wool	Acrylic	Polyester	Nylon	Cotton	Acetate
1	Yarn dyed vat linen fabric	Acid	4/5	4/5	4	5	5	5
		Alkaline	4/5	4/5	4/5	4/5	5	4/5
2	Yarn dyed reactive linen fabric	Acid	4/5	4/5	5	4	3/4	4/5
		Alkaline	4/5	3/4	4/5	4	3/4	4/5

- **Colour fastness to wash**

Sl no	Sample	Colour change scale	Colour staining scale
1	Yarn dyed vat linen fabric	3/4	3/4
2	Yarn dyed reactive linen fabric	3	3

Table 7: Colour fastness to wash (cotton)

- **Colour fastness to rubbing**

Sl no	**Sample**	**Dry**	**Wet**
1	Yarn dyed vat linen fabric	3	2/3
2	Yarn dyed reactive linen fabric	4/5	3

Table 8: Colour fastness to rubbing (staining)

B. Discussion:

- From table 1 & figure 1 shows the tear strength of yarn dyed vat linen fabric, along warp & weft direction, is much higher than yarn dyed reactive linen fabric.
- From table 2 the breaking force & extension% of yarn dyed reactive linen fabric is higher than yarn dyed vat linen fabric along warp direction. But in case of weft direction, the breaking force of yarn dyed reactive linen fabric is less than yarn dyed vat linen fabric. And extension% shows inconclusive data along weft direction in both yarn dyed reactive & vat linen fabric.
- From table 3 shows the tensile strength of yarn dyed vat linen fabric is slightly higher than yarn dyed reactive linen fabric.
- From table 4 displays the yarn dyed vat linen fabric is slightly better in pilling resistance than yarn dyed reactive linen fabric.
- From table 5 & figure 3 shows the seam strength of yarn dyed reactive linen fabric, along warp & weft direction, is much higher than yarn dyed vat linen fabric. And slippage resistance found higher in yarn dyed vat linen fabric along warp direction. But any slippage resistance is not found in yarn dyed reactive linen fabric along weft direction.
- From the table 6, the colour fastness to perspiration in acid for yarn dyed vat linen fabric showsexcellent in nylon cotton & acetate, good to excellent in wool & acrylic and good in polyester. But whereas the colour fastness to perspiration in acid for yarn dyed reactive linen fabric displays excellent in polyester, good to excellent in wool, acrylic & acetate, good in nylon and fair to good in cotton. And the colour fastness to perspiration in alkaline for bothyarn dyed reactive& vat linen fabric shows good to excellent in wool, polyester & acetate. Yarn dyed vat linen fabric shows excellent in cotton but in case of yarn dyed reactive linen fabric it shows fair to good.
- From table 7 the yarn dyed vat linen fabricshows fair to good result in colour fastness to washing test in cotton & yarn dyed reactive linen fabric shows fair result colour fastness to wash test in cotton in both colour change & staining scale.
- From table 8 shows good to excellent & fair results are found in dry & wetconditions in yarn dyed reactive linen fabric and comparatively fair & poor to fair resultsare found indry & wet conditions inyarn dyed vat linen fabric in colour fastness to rubbing test. So, yarn dyed vat linen fabric is poor colour fastness to rubbing in both dry &wet conditionthan yarn dyed reactive linen fabric.

IV. CONCLUSION

The aim of this research was to determine the physio-chemical properties of yarn dyed vat & reactive linen fabric keeping same yarn count, gsm, EPI, PPI& shade%. From above discussion we can conclude that the mechanical properties like tear strength, tensile strength was found higher in yarn dyed vat linen fabric than yarn dyed reactive linen fabric. Yarn dyed reactive linen fabric gives better seam strength than yarn dyed vat linen fabric. But in case colour fastness to washing & perspiration, yarn dyed vat linen fabric shows good colour fastness than yarn dyed reactive linen fabric. And yarn dyed reactive linen fabric gives better rubbing fastness than yarn dyed vat linen fabric.

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