Indian Journal of Fibre & Textile Research
Vol. 24, December 1999, pp. 264-268

# Studies on milkweed fibres

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*Received 3 April 1998; revised received and accepted 17 December 1998*

The physical and mechanical properties and the dyeing behaviour of milkweed fibres have been studied and compared with those of cotton, wool and rabbit hair fibres. Milkweed fibre has 14-19 g/tex tenacity and 32-36% elongation. It has more normalized *K/S* value than cotton fibre for all the dye concentrations, the difference being higher at low dye concentration.

**Keywords**: Cotton fibre, Dye uptake, Fibre properties, Milkweed fibre, Rabbit hair, Whiteness index, Wool fibre

## 1 Introduction

Milkweed (*Asclepias syriaca* L) belongs to the genus *Asclepias* of the family *Asclepiadaceae* and is also known as stubborn weed. In India, it is found as a wild plant in the states of Rajasthan, Karnataka and Tamil Nadu. Its use as a milkweed fibre was found in Europe during 18th century. Milkweed fibre is also used in paper industries. In recent years, the work mainly concentrated on new textile uses of milkweed fibre such as knitted fabric and milkweed comforter. In addition, it is also used as an insulative filling material[1-3]. As per its chemical constitution, the milkweed fibre contains approximately 60% cellulose and 0.33-0.4% extractable oil and waxes[4].

In the present investigation, an attempt has been made to study the physical and mechanical properties and the dyeing behaviour of milkweed fibres and compare these with those of cotton fibre. The physical and mechanical properties have also been compared with those of short-staple wool and rabbit hair fibres.

## 2 Materials and Methods

### 2.1 Materials

Milkweed fibres were collected from the nearby areas of district Tonk (Rajasthan). The fibres were categorized into three groups according to their pod shape and size, viz. small, medium and long, as shown in Fig. 1.

J-34 cotton was collected from CIRCOT, Mumbai, for comparing the physical and mechanical properties. Avivastra wool and rabbit hair fibres were taken from CSWRI, Avikanagar.

### 2.2 Methods

#### 2.2.1 Determination of Fibre Properties

Fibre diameter was determined with the help of an overhead microscope as per the ASTM D 2130-90. Staple length was determined manually with the help of a valvet pad and forceps as per the ASTM D 519. The tenacity and elongation were determined on stelometer as per the ASTM D 1445, keeping the gauge length at zero.

#### 2.2.2 Scouring

The scouring of milkweed and cotton fibres was carried out using 0.5% non-ionic detergent as per the standard procedure.

#### 2.2.3 Dyeing

The dyeing of milkweed and cotton fibres was carried out with Procian Reactive Red M (C I Reactive Red 11) in an open bath (cold dyeing process) at low temperature (20-30°C) in two stages, viz. exhaustion and fixation of colour. For exhaustion of dye bath, the glauber salt (20-30 g/l) was taken in dye bath and the time and temperature were maintained at 20-30 min and 20-30°C respectively. For dye fixation, the dyed samples were passed through the solution of sodium carbonate (15 g/l) for 90 min at room temperature (20-30°C), maintaining the *p*H at 10.5. Dyeing of these fibres was carried out for five different dye concentrations, viz. 0.5%, 1.0%, 1.5%, 2.0% and 2.5%. The dyed samples were washed with non-ionic detergent to remove dye molecules from the surface of the fibres.

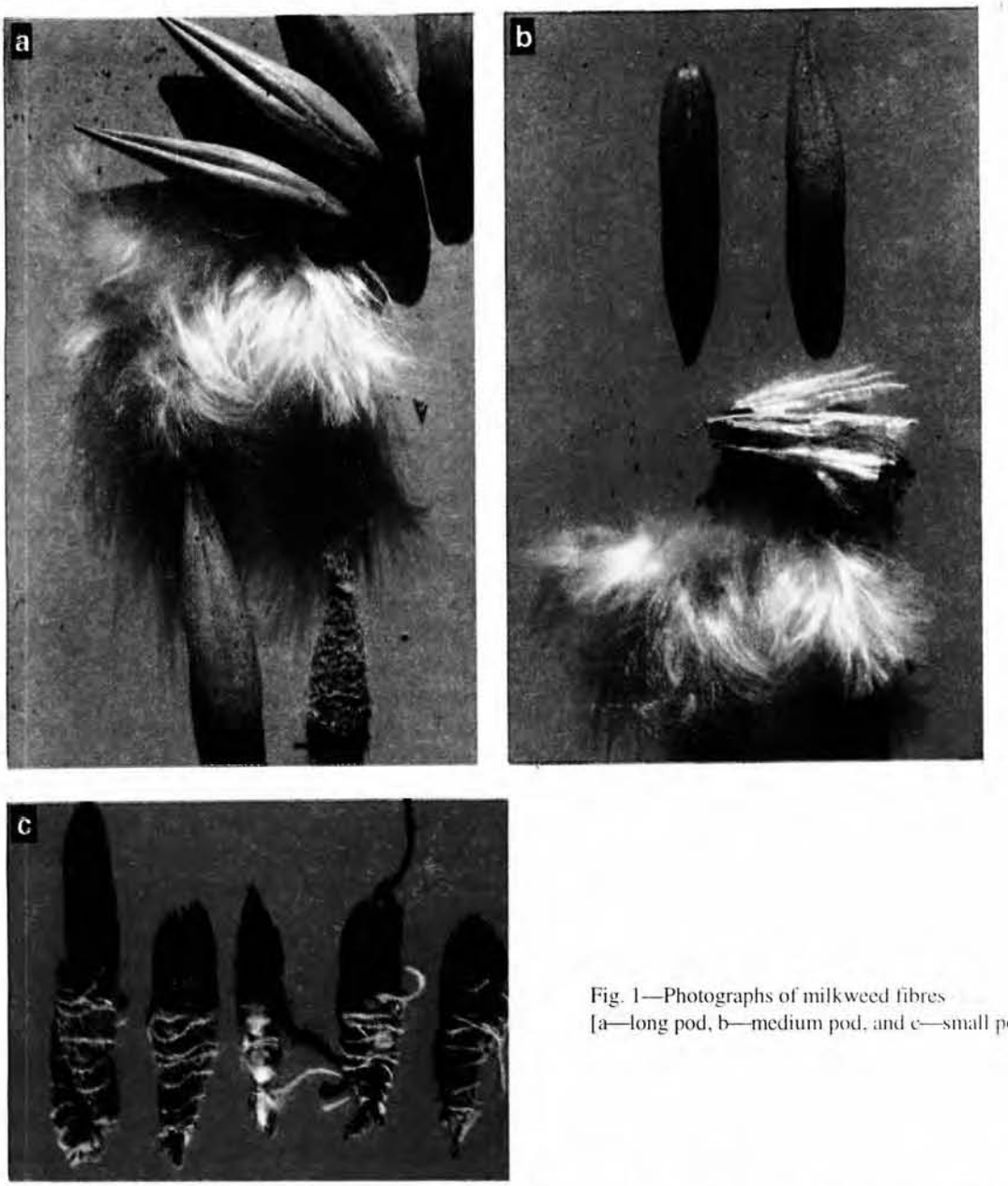


Fig. 1—Photographs of milkweed fibres
[a—long pod, b—medium pod, and c—small pod]

#### 2.2.4 Whiteness Index

The whiteness index (Hunter), *K/S* value and tristimulus values were determined on JAYPAK computer colour matching system. The normalized *K/S* values of dyed samples were worked out using the following formula[5]:

$$\text{Normalized } K/S \text{ value} = \frac{K/S \text{ of dyed substrate} - K/S \text{ of blank substrate}}{\% \text{ Dye concentration}}$$

#### 2.2.5 Dye Uptake and Exhaustion

The dye uptake and dye bath exhaustion (%) were determined on UV spectrophotometer (Spectrocolorimeter 103, Systronics) by measuring the optical density of dye bath before and after dyeing of fibres.

## 3 Results and Discussion

### 3.1 Physical Properties

Fig. 2 shows the fibre diameters of milkweed (small, medium and long pod), cotton, wool and rabbit hair fibres. The average fibre diameters of small, medium and long pod milkweed fibres are 23.95, 27.23 and 21.16 μm respectively. Similar fineness was observed by Drean[2]. The long pod fibres

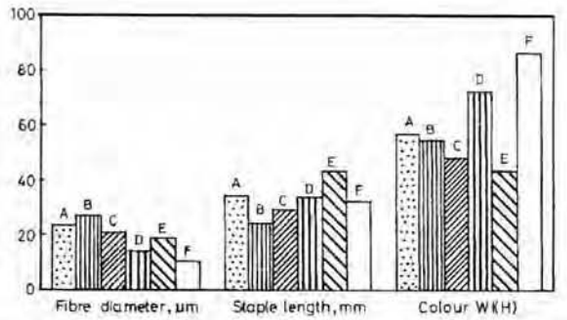


Fig. 2—Physical properties of fibres [A – milkweed small pod, B – milkweed medium pod, C – milkweed long pod, D – cotton, E – wool, and F – rabbit hair]

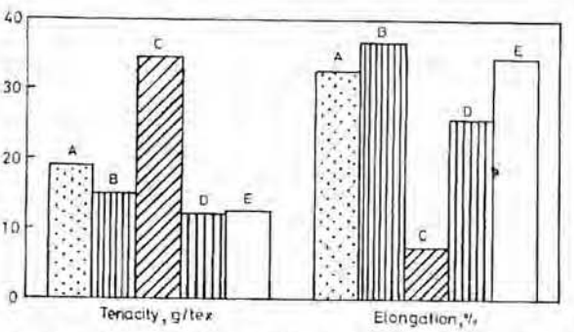


Fig.3—Mechanical properties of fibres [A – milkweed small pod, B – milkweed medium pod, C – cotton, D – wool, and E – rabbit hair]

are finer than small and medium pod fibres. According to fibre fineness, the average fibre diameter of milkweed fibre is quite similar to that of wool fibres. The staple lengths of small, medium and long pod fibres are 34.25, 24.40 and 29.30 mm respectively. According to staple length, the milkweed fibres are compatible with J-34 cotton and rabbit hair fibres having 34 mm and 32.4 mm length respectively.

Whiteness index (Hunter) values of different fibres (Fig. 2) indicate that the milkweed fibres are yellower than cotton and rabbit hair fibres but whiter than wool fibres. It is also observed that small pod milkweed fibre is more whiter than long and medium pod milkweed fibres, which further indicates that the small pod milkweed fibres are more suitable for blending with cotton on the basis of colour whereas the long and medium pod fibres could be blended with wool fibres.

### 3.2 Mechanical Properties

The mechanical properties of milkweed, cotton, wool and rabbit hair fibres are shown in Fig. 3. The tenacity and elongation values of long and small pod milkweed fibres are 14.9 and 19.2 g/tex and 36.7 and 32.7% respectively. The tenacity of the milkweed fibres is moderate, which is higher than those of wool and rabbit hair fibres but lower than that of cotton fibre. The elongation at break of milkweed fibres is higher than those of cotton and wool while it is similar to that of rabbit hairs.

Table 1—Absorbency values of dyed fibres

| Dye conc. % | Absorbency, % | | |
|---|---|---|---|
| | Cotton | Milkweed | |
| | | Long pod | Medium pod |
| 0.5 | 73.91 | 51.67 | 54.84 |
| 1.0 | 68.18 | 52.38 | 57.14 |
| 1.5 | 64.52 | 56.67 | 54.10 |
| 2.0 | 61.33 | 55.26 | 53.33 |
| 2.5 | 58.89 | 55.42 | 52.94 |

### 3.3 Dyeing Behaviour

#### 3.3.1 Absorbency Value

Absorbency values of various dyed fibres are shown in the Table 1. It is observed that cotton fibre shows higher absorbency than long and medium pod milkweed fibres at all dye concentrations. The absorbency value for cotton fibre decreases with the increase in dye concentration whereas for milkweed the trend is not regular and the value first increases then decreases at very high dye concentration.

#### 3.3.2 Tristimulus Value

Table 2 shows that the tristimulus value $Y$, which represents brightness[6], is lower for all milkweed dyed fibres compared to cotton for all the dye concentrations studied, indicating that milkweed fibre has low brightness than cotton. The yellowness ($Y$-$Z$ value)[6] is lower for cotton compared to milkweed fibre (Table 3). The difference between the tristimulus values of cotton and dyed milkweed fibres is highest at low dye concentration but it decreases with the increase in dye concentration and is lowest at 2.5% dye concentration.

#### 3.3.3 *K/S* Value

The *K/S* values of medium and long pod milkweed fibres and cotton fibres are shown in Table 4. It is observed that the *K/S* values of different fibres increase with the increase in dye concentration, the increase being more for medium pod milkweed fibre and less for cotton fibre. As a result, the difference in dye uptake at high dye concentration is minimum.

#### 3.3.4 Normalized *K/S* Value

Normalized *K/S* value[5] is a function of reflectance

Table 2—CIE tristimulus values of dyed fibres

| Dye conc. % | CIE tristimulus value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cotton | | | Milkweed | | | | | |
| | | | | Long pod | | | Medium pod | | |
| | *X* | *Y* | *Z* | *X* | *Y* | *Z* | *X* | *Y* | *Z* |
| 0.5 | 42.9 | 32.4 | 41.4 | 34.8 | 27.7 | 27.5 | 36.0 | 28.7 | 28.6 |
| 1.0 | 37.4 | 25.8 | 35.5 | 32.1 | 24.1 | 25.2 | 32.6 | 24.2 | 25.1 |
| 1.5 | 35.4 | 23.5 | 29.9 | 29.4 | 20.9 | 22.2 | 29.1 | 20.4 | 21.9 |
| 2.0 | 32.9 | 20.9 | 26.3 | 25.8 | 17.3 | 18.8 | 27.2 | 18.1 | 19.7 |
| 2.5 | 30.7 | 19.1 | 23.7 | 25.0 | 16.6 | 18.1 | 26.3 | 17.4 | 18.8 |

Table 3—Yellowness (*Y-Z*) values of dyed fibres

| Dye conc. % | Yellowness value | | |
|---|---|---|---|
| | Cotton | Milkweed | |
| | | Long pod | Medium pod |
| 0.5 | –9.01 | 0.15 | 0.16 |
| 1.0 | –0.97 | –0.40 | –0.88 |
| 1.5 | –6.44 | –1.31 | –1.51 |
| 2.0 | –5.37 | –1.46 | –1.65 |
| 2.5 | –4.59 | –1.51 | –1.37 |

Table 4—Actual *K/S* values of dyed fibres

| Dye conc. % | *K/S* value | | |
|---|---|---|---|
| | Cotton | Milkweed | |
| | | Long pod | Medium pod |
| Substrate | 0.128 | 0.949 | 0.617 |
| 0.5 | 0.463 | 1.830 | 1.866 |
| 1.0 | 0.684 | 2.099 | 2.238 |
| 1.5 | 0.863 | 2.125 | 2.174 |
| 2.0 | 1.121 | 2.638 | 2.478 |
| 2.5 | 1.162 | 2.696 | 2.658 |

due to dye absorption per unit concentration of dye bath. Fig. 4 shows that the normalized *K/S* value is higher at low dye concentration for all fibres. It is inferred that the medium pod milkweed fibre absorbs maximum dye from the dye bath while cotton absorbs minimum. It is further observed that during washing/scouring of dyed fibres, more bleeding of colour takes place in cotton as compared to milkweed fibres.

### 3.3.5 Dye Uptake

The dye uptake of milkweed and cotton fibres is shown in Fig. 5. It is observed that the dye uptake at 0.5% dye conc. is 0.3969, 0.258 and 0.2742 g/100g of material for cotton, medium pod and long pod fibres respectively and that it increases to 1.472, 1.3835 and 1.3235 g/100g of material respectively at 2.5% dye concentration. Although the dye uptake of milkweed fibre is lower than that of cotton fibre at low dye

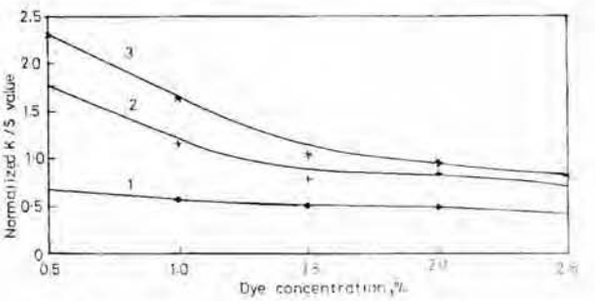


Fig.4 —*K/S* value *vs* dye concentration [(1) cotton, (2) milkweed long pod, and (3) milkweed medium pod]

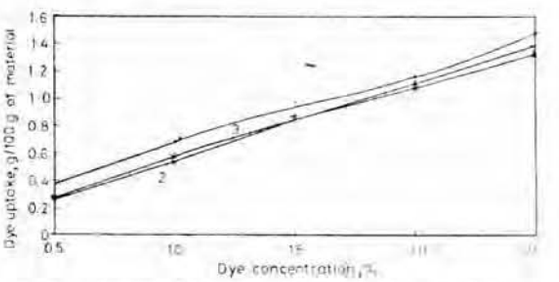


Fig.5 —Dye uptake *vs* dye concentration [(1) cotton, (2) milkweed long pod, and (3) milkweed medium pod]

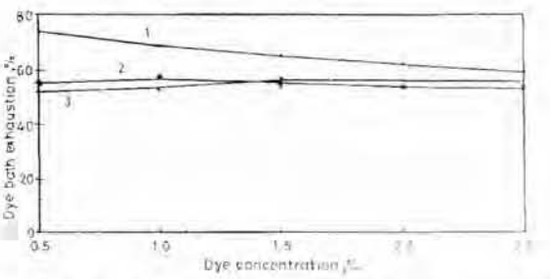


Fig.6 —Dye bath exhaustion *vs* dye concentration [(1) cotton, (2) milkweed long pod, and (3) milkweed medium pod]

concentration (0.5%), it is quite similar at high dye concentration (2.5%). Further, the dye uptake from dye bath is higher in case of cotton while the normalized *K/S* value is low in case of cotton as compared to milkweed fibres. This may be due to more loss of colour bleeding after scouring. It may be

inferred that cotton and milkweed fibres have similar dyeing properties and could be processed as blended product mix.

#### 3.3.6 Dye Bath Exhaustion

Dye bath exhaustion for milkweed and cotton fibres is shown in Fig. 6. It is observed that milkweed fibres absorb less dye from dye bath as compared to cotton fibre at low dye concentration and that the absorption of dye gradually decreases with the increase in dye concentration in case of milkweed fibres.

## 4 Conclusions

**4.1** Milkweed fibre is quite comparable with Avivastra wool and rabbit hair fibres in terms of fibre diameter and staple length.

**4.2** The tenacity and colour of milkweed fibre are moderate and fall between wool and cotton fibres.

**4.3** The dyeing behaviour of milkweed fibre is quite similar to that of cotton fibre.

**4.4** Milkweed fibre has higher normalized *K/S* value than cotton fibre.

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