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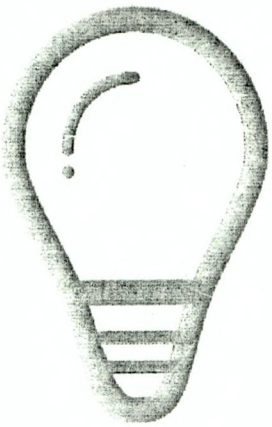

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REMOVAL OF SELECTED REACTIVE DYE FROM AQUEOUS SOLUTION USING WHEATBRAN

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ABSTRACT

Adsorption is a potent method for the treatment of dye-bearing effluents. In this study, different agro-wastes were screened as adsorbent for the removal of selected reactive dyeT blue G from aqueous solution. The effects of various experimental parameters like time, temperature, pH and adsorbent dose on decolorization was investigated and optimal conditions were determined for decolorization in batch mode. Among the different agro-wastes screened, maximum decolorization was achieved with wheat bran. Maximum decolorization capacity was found to be with two per cent of adsorbent concentration and pH7 was found to be favorable for decolorization of T. Blue Greactive dye. An incubation time of 30 h at 50^0C was found to be optimum for dye decolorization. Waste water reuse is a favorable alternative which can reduce pollution and add-on the available water resource. In the present study, the decolorized solution was reused for dyeing cotton fabric. It is found that the physical and color fastness properties of the fabric dyed with decolorized water was comparable with that of the fabric dyed using fresh water. The results indicate that the selected agro-waste wheat bran could be employed as low-cost adsorbent for the removal of reactive dye T.Blue Gfrom dye waste water.

Keywords: Adsorption, Reactive dye, Agro-waste, Optimization, Reuse

Introduction

Worldwide, nearly one million tonnes of synthetic dyes are produced annually, of which India's contribution alone is 60,000 metric tonnes (Singh and

Arora, 2011). Synthetic dyes are widely used in a number of industries such as textile, leather, paper, printing, food, cosmetics, paint, pigment, rubber and plastics (Chowdhury et al., 2011). Inefficiencies in textile dyeing result in a large amount of dyestuff being directly lost in the wastewater, which ultimately finds way into the environment.It is estimated that 10–35 of the dye is lost in the effluent during the dyeing process (Sivakumar et al., 2009).

The presence of unfixed dyes is perceived as one of the major environmental problems. In addition, only 47 per cent of dyestuffs are biodegradable (Allen and Koumanova, 2005). A very small amount of dye in water (10-50mg/l) affects the aesthetic value and transparency of water bodies (Kumar et al. 2009).

The release of coloured effluents into the environment is undesirable, not only because of their colour, but also many dyes and their breakdown products are toxic and mutagenic. Without adequate treatment these dyes are stable and remain in the environment for an extended period of time (Santos et al2007).

Decolourization is a challenge for textile industry as well as waste water treatment systems. Various dye/colour removal methods such as aerobic and anaerobic microbial degradation, coagulation, chemical oxidation, membrane separation, filtration, reverse osmosis have been employed. All these methods are quite effective, but suffered with one or other limitations such as high cost, unfriendly nature or unreliability in operation (Aksu, 2005). The removal of dyes from effluent using adsorption process provides an attractive alternative treatment. It has also received considerable attention, for removal of colour especially if the adsorbent is inexpensive and readily available (Reddy, 2006). The utilization of agro-wastes as adsorbent is currently receiving wide attention because of their availability and low-cost owing to relatively high fixed carbon content and presence of porous structure (Bhatnagar et al. 2009).

Numerous agricultural wastes have been used for decolourization of textile dyes. The present research is carried out to explore the potential use of wheat bran as an adsorbent for the removal of reactive dye from aqueous solution and to reuse the decolorized water for dyeing.

Methodology

Materials

Wheat bran, collected from local market, Coimbatore, Tamil Nadu was washed thoroughly with de-ionized water for removing dirt, dried and powdered. Reactive dye- T Blue G Reactive (C.I. 021) was procured from Ultra chemicals, Tirupur, Tamil Nadu.

Collection of different agro wastes

Agro wastes such as groundnut shell, sugarcane bagasse, wood dust, orange peel, rice husk, corn stalk, wheat bran, water hyacinth stem, sisal fiber, onion peel and garlic peel were selected for the study. The selected agro-wastes were collected from the local market, dried in shade and powdered.

Adsorption studies

Adsorption studies were performed in a batch technique. About two grams of each agro waste was taken individually in a series of 250ml Erlenmeyer flasks containing 0.01per cent of selected reactive dye and kept in shaking condition (120 rpm) for 24 h and filtered. The filtrate obtained was centrifuged at 5000 rpm for 15 minutes. The colour intensity of the supernatant was measured using UV-visible spectrophotometer at 584nm (maximum absorbance wavelength). The per cent decolorization was calculated by the following formula.

$$\% \text{ Decolourization} = \frac{\text{Initial absorbance} - \text{Final absorbance}}{\text{Initial absorbance}} \times 100$$

Optimization of different parameters for decolourization *Adsorbent Concentration*

The optimum quantity of agro waste required to decolourize the selected reactive dye solution, different concentrations of wheat bran such as 1, 2, 3, 4 and 5g was added separately to beakers containing 0.01 per cent of reactive T.Blue G. Absorbance was measured using UV-visible spectrophotometer. The concentration at which the per cent decolourization was maximum was selected as optimum concentration and fixed for subsequent studies.

Time

In order to determine the optimum time, the beakers containing 0.01 per cent of selected reactive dye with optimized agro- waste concentration was incubated at different time intervals (6 - 48 h). The per cent decolourization was determined.

pH

pH of the reactive dye solution was adjusted to 5-11 using 1N HCl and 1N NaOH. The selected agro waste at optimum concentration was added to all the beakers and incubated for optimum time. The per cent decolourization was determined.

Temperature

The optimum temperature needed for decolourization was determined by selecting agro waste in beakers containing 0.01 per cent reactive dye was incu-

bated for 24 hours at varying temperatures ranging between 40°C and 80°C and per cent decolourization was found out.

Reuse of decolourized solution for dyeing selected fabric

Waste water reuse is a promising alternative which can reduce pollution and supplement the available water resource. In the present study, the decolourized dye solution was utilized for dyeing the selected cotton fabric.

Fabric sample

Desized, scoured and bleached cotton fabric of plain weave was purchased from Murugan mills, National Textile Corporation Ltd., Coimbatore, Tamil Nadu. Before being used, the fabric was treated with a solution containing 5g/L non-ionic detergent at 95° C for four hours. The fabric was thoroughly washed with water and air dried at room temperature.

Dyeing of selected fabric with reactive dye using fresh and decolorized water

The selected cotton fabric was dyed with the reactive dye- T Blue G Reactive (C.I. 021) using decolourized and fresh water. Pre-weighed fabric was introduced into the dye bath containing one per cent dye. The dye bath temperature was gradually elevated to boiling and maintained for about 30 min. The water level in the dye bath has been maintained during the dyeing process. The fabric was washed thoroughly and dried in shade.

Evaluation of dyed fabric

Laboratory tests like fabric weight, tensile strength and elongation, fabric thickness, absorbency and colour fastness were carried out for the fabrics dyed using fresh water and decolourised water.

All experiments were carried out in triplicates, and average values are reported.

Results and Discussion

Screening of different agro wastes for decolourization of selected reactive dye

Among the selected agro wastes, wheat bran showed maximum per cent decolorization(93%). Hence wheat bran was selected for the present study as the potent adsorbent for decolourization of reactive dye, T. Blue G. Gupta et al, (2007) used wheat husk for the removal of react fix golden yellow three RFN from aqueous solution. However, Gong et al, (2008) utilized rice straw for the removal of basic dyes from aqueous solution.

Effect of adsorbent concentration

Adsorbent concentration is an important process parameter to determine the capacity of an adsorbent. Per cent dye decolourization increased with increase in adsorbent concentration up to 2.0 per cent (Fig.1). Increase in adsorbent concentration above two per cent did not show significant increase in per cent decolourization. Lowering in percentage removal of dye with increase in concentration may be due to the lack of available surface-active sites on adsorbent as well as the formation of monolayer of dye on the surface of adsorbent and also any further formation of layer is highly hindered at higher concentration (Mondal et al., 2011). Hence optimum concentration of 2.0 per cent was used for subsequent experiments. Similar observation was reported by Gong et al. (2008) who have reported an optimum sorbent dosage of 2.0 g/l for the removal of basic dyes using raw straw.

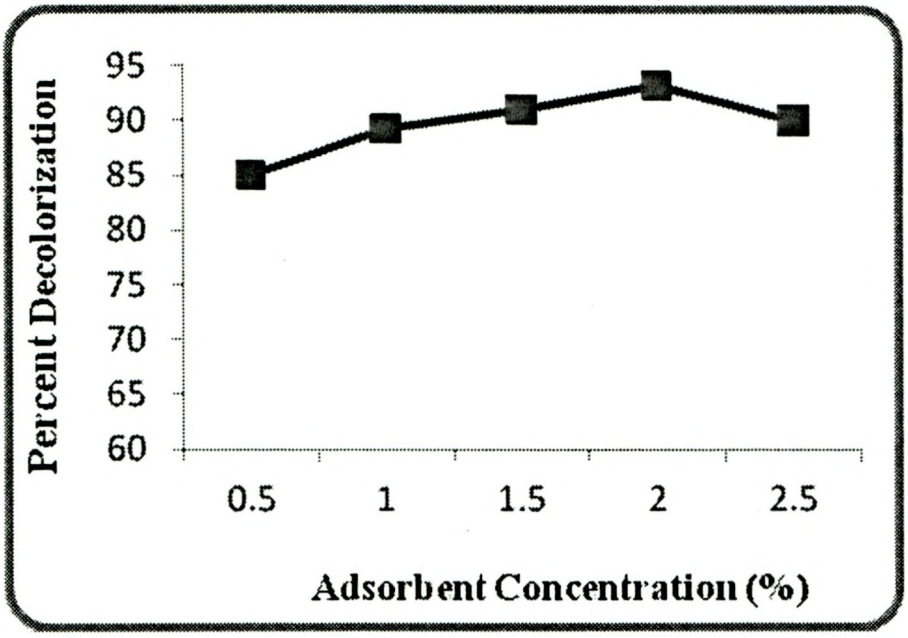

Figure 1 Effect of Adsorbent Concentration

Effect of contact time

The effect of contact time on the rate of removal of reactive dye by selected agro-waste was determined and the results are shown in Fig.2. Maximum rate of decolorization was noticed after 30 hours of incubation (89%). Further increase in contact time decreases per cent decolourization, which might be due to larger surface area available initially on the adsorbent. Hence contact time of 30 hours was fixed for subsequent studies.

Effect of pH

Adsorption is strongly dependent on the pH of the medium since variation in pH leads to the variation in the degree of ionization of the adsorptive molecule

and the surface properties of adsorbent. Therefore the effect of the initial pH was studied by varying the pH of the solution from 5-11 (Fig.3). pH 7 was found to be the optimum pH for decolourization of T. Blue G (95%). A decrease in adsorption with increase in pH may be due to presence of excess OH^- ions competing with the dye anions for the adsorption sites (Reddy, 2006). Gong et al. (2008) have reported an optimum pH of 6 for the removal of basic dyes using raw straw.

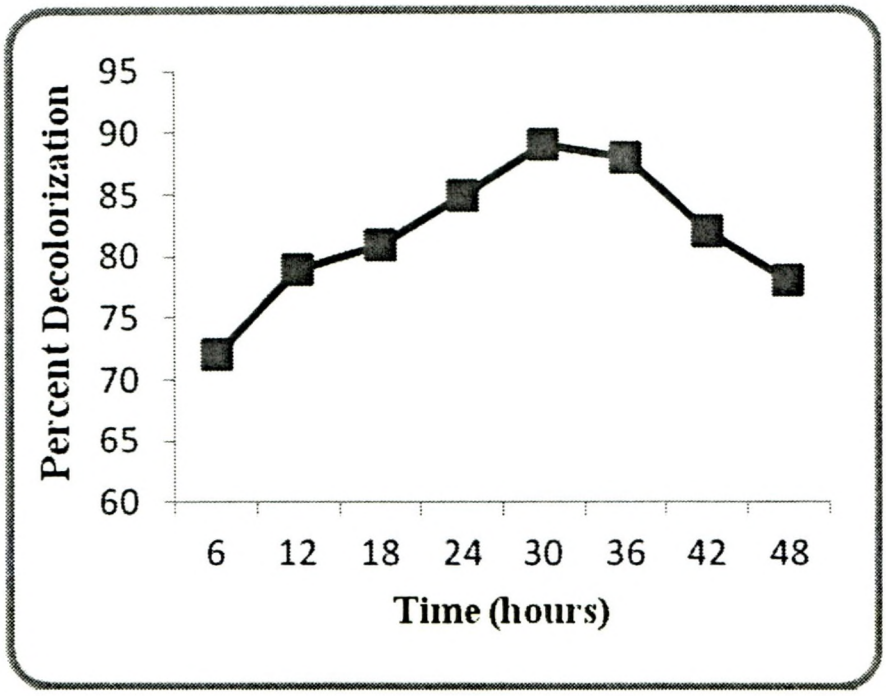

Figure 2 Effect of Contact Time

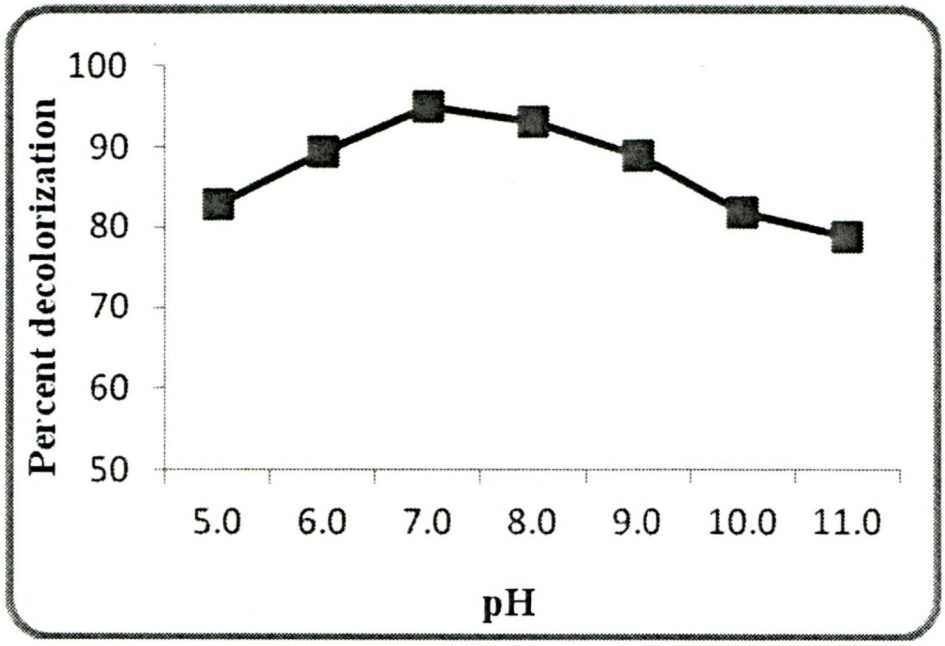

Figure 3 Effect of pH

Effect of temperature

Per cent dye decolourization was found to be maximum at 50°C (Fig. 4). Increase in temperature above 50°C resulted in decrease in per cent decolourization.

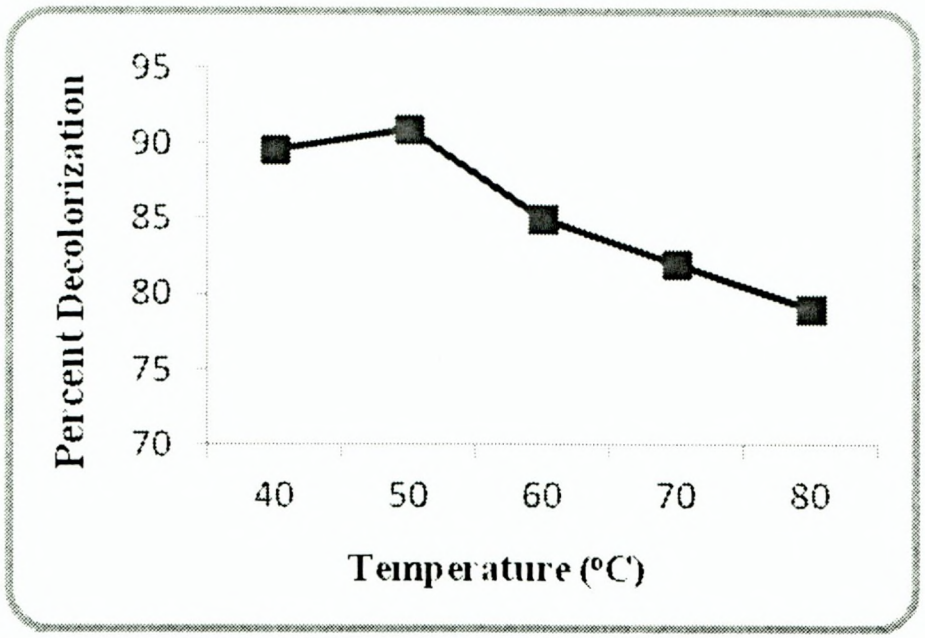

Figure 4 Effect of Temperature

The decrease in adsorption might be due to weakening of adsorptive forces between the active sites of adsorbate and adsorbent.

Fabric analysis

The fabric weight, thickness, strength and elongation was found to be increased in samples dyed with fresh and decolourized water in warp and weft directions when compared to the original fabric. The absorbency of decolourised water dyed fabric sample was on par with fresh water dyed sample. The dyed samples showed good fastness to sunlight, pressing and crocking. All the dyed samples were found to have excellent washing fastness.

Conclusion

In this study, wheat bran was utilized as a low-cost adsorbent for the removal of reactive dye from aqueous solution and the decolourized water was reused for dyeing. The results showed that the adsorption of reactive T.Blue G is highly dependent on temperature, pH, time and adsorbent concentration. The properties of fabric dyed with decolourised solution was comparable with that of fresh water dyed fabric. Hence wheat bran could be fruitfully used as low-cost adsorbent for the removal of reactive dye from textile effluents. Waste water

reuse reduces discharge of pollutants and usage of good quality water from ground and surface aquifers. It also decreases the cost for fresh water.

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HERBAL MOSQUITO REPELLENT FINISH ON COTTON FABRIC

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ABSTRACT

This study shows the importance of herbal finishing on textile material for functional application. Currently the expectations of every customer keep on changing so they prefer a multifunctional textile material rather than a traditional textile. Furthermore the people are very much conscious about their health and environment. Today a lot of diseases occur due to cross infection by air, water and also by mosquitoes. So in this work cotton fabric was given mosquito repellent finish using citronella and eucalyptus oils. Initially nano particles were synthesized using the selected oils with sodium alginate as particle reducer. Then the prepared nano particles were applied on to the cotton fabric by exhaust method with citric acid as binder. The finished fabrics were evaluated for its strength, elongation, thickness, stiffness and mosquito repellency. Among all the finished fabrics citronella oil finished fabric has higher mosquito repellency of 84 per cent.

Keywords: Mosquito repellency, textile finish, plant oil, nano particle, exhaust method, excito chamber test.

Introduction

The recent disaster in Tamilnadu that take place due to heavy rains and floods led to ideal breeding conditions for mosquitoes which result in vector borne diseases namely dengue, malaria, filariasis and chickunguniya (Jaipura et al, 2015). Mosquitoes can carry diseases that may be passed on to people through mosquito bites. Mosquito-borne diseases can make people ill and, in severe cases, can cause death. As per the data given by Tamilnadu Health Organization, In 2015 alone nearly 2,843 dengue and 5,653 malaria cases were reported. According to the World Health Organization (WHO), more than one million people dies every year due to mosquito bites and the majority are due to malaria.

Prolonged use of synthetic based mosquito repellents causes a lot of health issues. Moreover direct application of repellents on the skin last only for few hours due to perspiration and also causes skin problems. Hence there exists a need for mosquito repellent textiles. Whole plants and substances obtained from plants were used to repel or kill mosquitoes (Trongtokit et al, 2005). Citronella and eucalyptus belonged to the family graminaceae and myrtaceae. The botanical name of citronella was Cymbopogon citrates and eucalyptus was Eucalyptus globulus respectively(Yang and Ma,2005). The active compounds namely citronellal, geraniol and p-menthane-diol present in citronella and eucalyptus are responsible for mosquito repellency Williams (2011).

The study has been undertaken with the following objectives to

- develop mosquito repellent textiles with selected herbal oils
- study the effect of different herbal oil on the mosquito repellency of textiles
- evaluate the mosquito repellent activity of finished fabrics by excito chamber method and
- assess the fabric properties namely physical, mechanical and comfort properties

Methodology

Selection of fabric

For this study 100 per cent cotton fabric with plain weave was selected due to its wide utilization. Mosquitoes will be in egg form in winter season and become to hatch in summer season. Hence the need for mosquito repellents will be higher in summer season. By considering the above fact cotton fabrics which has greater demand in summer was selected for finishing.

Selection of mosquito repellent

Two of the oils namely citronella and eucalyptus (Fig.1) were selected to impart mosquito repellency based on the citronella content present in it. These oil were procured from Swastik oil company, Ooty. The oil was extracted by steam distillation method in order to retain its biological active compound.

Binder

Citric acid was used as the binder for this study to enhance the durability of the finish.

Pretreatment

The pretreatment namely desizing was done in order to ensure uniform fabric finishing. The fabric was desized in a bath containing water and detergent and

boiled for one hour in the MLR of 1:10. The fabric was taken and then rinsed thoroughly and dried.

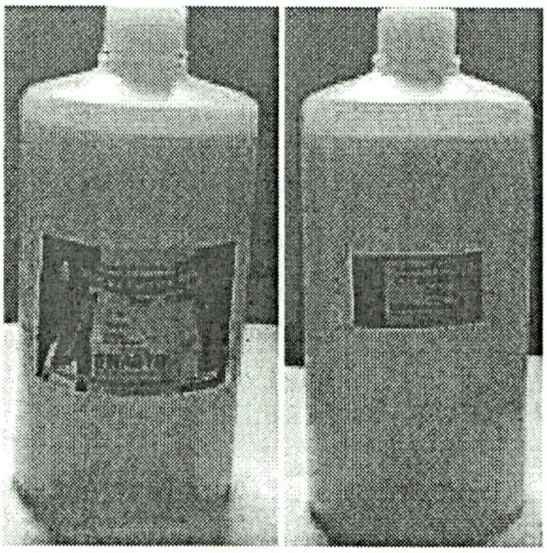

Figure 1 Plant oil

Synthesis of nano particles

Citronella and eucalyptus oil nano particles were synthesized using three per cent sodium alginate solution. The viscous dispersion is then sprayed into calcium chloride solution. Finally the nanocapsules were obtained by decantation and recurring washing with iso propyl alcohol.

Finishing by exhaust method

The pretreated fabrics was finished with the prepared citronella and eucalyptus oil nano encapsules by exhaust method according to the following recipe.

Composition:

Nano capsules	: 700g
Citric acid	: 8%
MLR	: 1:20
Temperature	: 50° C
Time	: 30 minutes

Fabric evaluation

The finished and unfinished fabrics were evaluated for its strength, elongation, thickness and stiffness as per ASTM standards. Mosquito repellency of the fabric was assessed using excito chamber method.

Wash durability test

The finished fabrics were washed and tested for its mosquito repellency after 5 and 10 washes.

Nomenclature

The Nomenclature used in this paper was given in Table.1.

Table 1 Nomenclature

S. No.	Abbrevation	Expansion
1	UF	Unfinished fabric
2	CO	Citronella oil nano particle finished fabric
3	EO	Eucalyptus oil nano particle finished fabric

Results and Discussion

The test results of the fabric properties namely strength, elongation, stiffness, thickness and mosquito repellency are discussed under the following headings.

Tensile strength

The result of tensile strength reveals that the strength of unfinished sample seem to be higher for weft direction when compared to warp direction. After finishing the strength seem to decrease in both warp and weft direction (Fig.2).

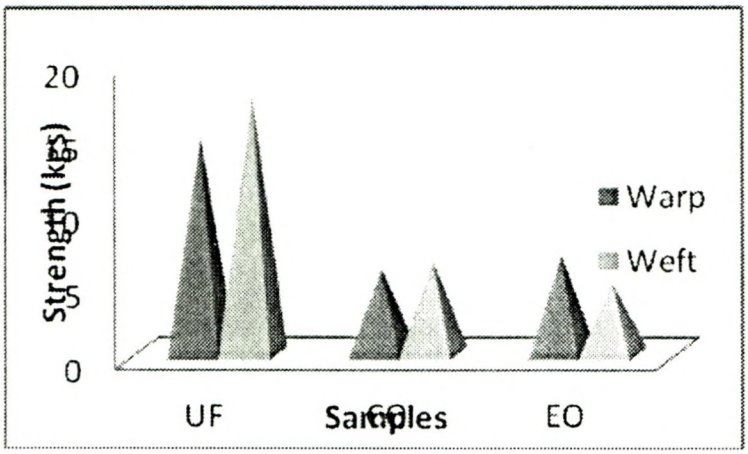

Figure 2 Tensile Strength

Elongation

Over all the elongation was higher in warp direction when compared to weft direction. After finishing the elongation seem to decrease in both the fabric directions (Fig.3).

Stiffness

As far fabric stiffness was considered the finished fabrics had increased in stiffness when compared to unfinished fabrics along both warp and weft direction (Table.2).

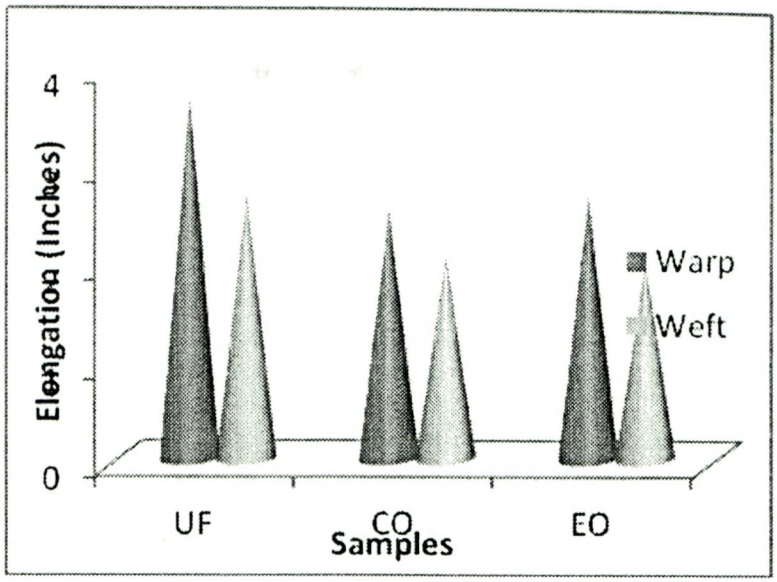

Figure 3 Tensile Elongation

Thickness

The fabric thickness was higher for eucalyptus oil finish (0.35mm) followed by citronella oil finish (0.33mm) when compared to original sample (Table.2). This increase in thickness was due to the application of finish.

Table 2 Fabric Properties

Tests		UF	CO	EO
Stiffness (cm)	Warp	1.8	2.2	2.5
	Weft	1.5	1.9	2.2
Thickness (mm)		0.31	0.33	0.35

Mosquito repellency test

The citronella oil nano particle finished fabrics has a mosquito repellency of 84% which is higher when compared to eucalyptus oil nano particle finished fabrics with a repellency of 80 per cent. This difference in repellency is due to variation in citronella content. Repetitive washing results in reduction of mosquito repellency percentage due to the removal of finish (Table.3).

Conclusion

This study clearly shows that herbal finish can also act as a viable mosquito repellent when compared to synthetic sources. Thus these finishes protect from mosquitoes without creating any side effects on humans like synthetic repellents. Citronella oil finished fabric has higher mosquito repellency of 84 per cent and hence can be effectively used against mosquitoes.