International Journal of Advanced Research in Engineering and Applied Sciences
ISSN: 2278-6252

PREPARATION OF ECO-FRIENDLY BODY WIPES

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Abstract: *In the present scenario of environmental consciousness the new quality requirements not only emphasise on intrinsic functionality and service life of product but also the production process that is environmental friendly. Taking this point into consideration an attempt is made to design eco friendly wet body wipes by using spunlace nonwoven fabrics of 100% Viscose and Viscose/Polyester blends in order to check the suitability of perfection. These fabrics were been finished with four herbal oils like clove, eucalyptus, neem, tulsi oils and combination of the same at 10%, 25% and 50% levels of concentration. These developed wipes have been tested for antimicrobial assessment and other physical tests. The results revealed that 100% viscose fabrics treated with 25% concentration of the oils were most suitable enough to serve the purpose.Also a survey was conducted with these developed wipes among people of different age groups and found to be that they were skin friendly.*

Keywords: *Wipes, Viscose, Nonwovens, Eco-friendly, herbal oils, cow urine.*

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1. INTRODUCTION

An important and growing part of the textile industry is the medical and related healthcare and hygiene sector. The extent of the growth is due to constant improvements and innovations in both textiles and medical procedure [1]. Cleansing the skin is a personal hygiene problem for which wipes are well suited. Wipes are made from tissue paper or nonwoven bonded fabrics, which Wipes are of two types viz.., dry wipes and wet wipes Dry wipes are the most commonly used as cleansing products they are usually referred to as "toilet tissue" or "toilet paper" [2]. Wet wipes are of various types such as facial wipes, baby wipes, body wipes, cleansing wipes, feminine hygiene wipes and antibacterial wipes [3]. Wiping material of this type is pre-packaged in a moist environment and is commonly used by consumers for cleansing or wiping parts of the body, particularly when wash water is not readily available or cannot be conveniently used. These wipes have been used for applying or removing makeup or in cleansing other parts of the body [4].

Basic composition of a wet wipe comprises of:

- An **emollient** which improve the glide of the wipe on the skin and to hydrate the residues thus reduce in dryness and irritation.
- A **surfactant** and / or an emulsifier are employed to emulsify the emollient or any other non water soluble oils present in the composition.
- A **rheology modifier** which is used to increase the viscosity of the composition at lower temperature as well as at process temperature.
- **Preservative** in order to reduce the growth of microorganisms and to enable a longer shelf life.
- **Soothing agent** to reduce the irritation or stinging/burning/itching effect of chemicals [5].

Commercially, hydroentangled fabrics or spunlaced fabrics are used for wipes have been produced for a long time. The soft, strong, flexible and in most cases, absorbent characteristics of the fabrics combined with increasingly attractive economics and a textile like handle have brought hydro entanglement to the fore in this sector [6]. The World Health Organisation (WHO) estimates that 4 billion people, 80% of the world population, presently use herbal medicine for some aspect of primary healthcare. Herbal medicine is a major component in all indigenous people's traditional medicine and a common element in

ayurvedic, homeopathic, naturopathic, traditional, oriental, and Native American Indian medicine. WHO notes that of 119 plants derived pharmaceutical medicines, about 74% are used in modern medicine in ways that co- relate directly with their traditional uses as plants remain the basis for a large proportion of the commercial medications used today. Therefore research on environment friendly antimicrobial agents based on natural products for textile application is gaining worldwide interest. [7]

Phytochemicals are derived from plants and some of them are very useful antibacterial agents. Neem (Azadirachta indica) oil has many antiseptic, antibacterial, antiviral and antifungal qualities. Nimbidin is component of Neem oil which is antibacterial, anti ulcer, analgesic, and anti-fungal properties. Eucalyptus species produces numerous volatile compounds in a large amount as isoprenoids. The major bio active components for microbial inhibition are 1-8-cineole and ά-terpineol.

Dry clove (Syzygium aromaticum) bud contains about 15 to 20 % essential oil. Eugenol is a medicinal component of clove oil and their presence is about 70 to 90 %. Eugenol has been used for analgesic, local antiseptic, anti-inflammatory and

antibacterial effect. Tulsi oil(Ocimum sanctum) phyto chemicals are ursolic acid flavonoids such as apigenin, polyphenols, anthocyanins and luteolin, eugenol, thymol or sesquiterpene alcohols whose properties are Anti-inflammatory, antiarthritic, anti-stress and antipyretic and anti microbial [8-12].

In present days, Viscose/Polyester non-woven fabrics of different blend ratios are most preferred for making wipes due to their combined properties of comfort and strength [13].In the present research work an attempt is made to design the eco-friendly wet body wipes from 100% viscose non-woven and compare them with wipes made from polyester/viscose blended fabrics of two different blend ratios, with the use of naturally available herbal oils and cow urine. The functions of the body wipes is to cleanse the body contours and to absorb sweat mainly for bed ridden patients These wipe adds freshness to the skin by leaving a pleasant fragrance. They can also be used to dab exudates from wounds or cuts, treat burns and insect bites.

2. MATERIALS AND METHODS

2.1 Materials:

Spun-lace (hydro-entanglement) nonwovens of 100% Viscose and blends of Viscose/Polyester of 50GSM were used.

Sample 1: 100 % Viscose

Sample 2: 70/30 Viscose/Polyester blend

Sample 3: 10/90 Viscose/Polyester blend

Chemicals used:

- **Herbal Oils**:
  - Clove (Syzygium aromaticum) oil
  - Eucalyptus oil
  - Neem (Azadirachta indica) oil
  - Tulsi (Ocimum sanctum) oil
    - at 10%, 25% and 50% concentrations.
- **Cow urine** at 10%, 25% and 50% concentration
- **Emulsifier:** Nonyl Phenol Ethoxylate (HLB 9.5)
- **Skin softner**: Gylcerine (0.02 – 0.5%)
- **Fragrance**: (1-2 %),
- **Preservative:** Sodium Benzoate (1- 4%)
- **pH to maintain**: Citric acid(0.1- 0.5%).

2.2. Method:

Five natural products (4 herbal oils and cow urine) in 100 % pure form were selected and considered for the experimental study. Each product is individually taken and mixed continuously with all the other ingredients mentioned above at room temperature, the mixture is stirred well until all components are dissolved completely. The samples were prepared with these natural products for soaking the nonwoven substrates for 5 minutes and then padding the same at 0.5 to 1 kg/cm² pressure. The treated samples were stored in air tight packets in order to maintain them in wet condition.

Note: Generally, wet wipes can contain from about 100 to about 600 weight percent and desirably from about 250 to about 450 weight percent liquid based on the dry weight of the wipe for improved wiping. If the amount of liquid is less than the above-identified ranges, the wet wipe may be too dry and may not adequately perform. If the amount of liquid is greater than the above-identified ranges, the wet wipe may be oversaturated and soggy and

the liquid may pool in the bottom of the container [14]. Therefore the pressure of the padding mangle was maintained in the range of 0.5 to 1kg/cm^2 for all the samples.

3. TEST METHODS:

The experimental work was focused on the measurement of fabric parameters (area weight and thickness) as well as mechanical (tensile and abrasion) and liquid absorption properties. The untreated and treated samples were tested for the below mentioned tests.

- Air Permeability : ASTM 738-04
- Bursting Strength: ASTM D3786/D3786M-13
- Tensile Strength: ASTM D2256 (INSTRON)
- Abrasion Resistance: ASTM D3884-80
- Wicking Height: DIN 53924
- Drop Absorbency: AATCC TS-018
- Absorbent Capacity: IEST-RP-CC004.3
- Antimicrobial Testing AATCC 147

4. RESULTS AND DISCUSSION

The tables shown below time lined to their respective test methods, shows the results of all untreated (UT) and treated (T) samples at three different concentrations. The results show that there exists a significant difference between the treated and untreated samples. However there was no much difference between samples treated with different herbal oils at three different concentrations. Therefore to represent graphically, untreated and treated samples were considered as two different lots, the graphs show the effect of finishing treatment on the particular property of the fabric.

4.1 Effect of physical properties on untreated and treated samples

The arrangement of fibers in the non-woven fabric is very important to determine its physical properties. The arrangement of fibers in the non-woven fabric is very important to determine its physical properties.

4.1.1 Effect of finishing on air-permeability of the sample

When all the three samples are finished with herbal oils and cow urine, presence of viscose shows more affinity towards the chemicals. The finishing chemicals form a thin layer of film

over the fibres once it is padded, this film partially cover up the pores reducing the air permeability as shown in the figure no 4.1.1 and increasing the fabric weight.

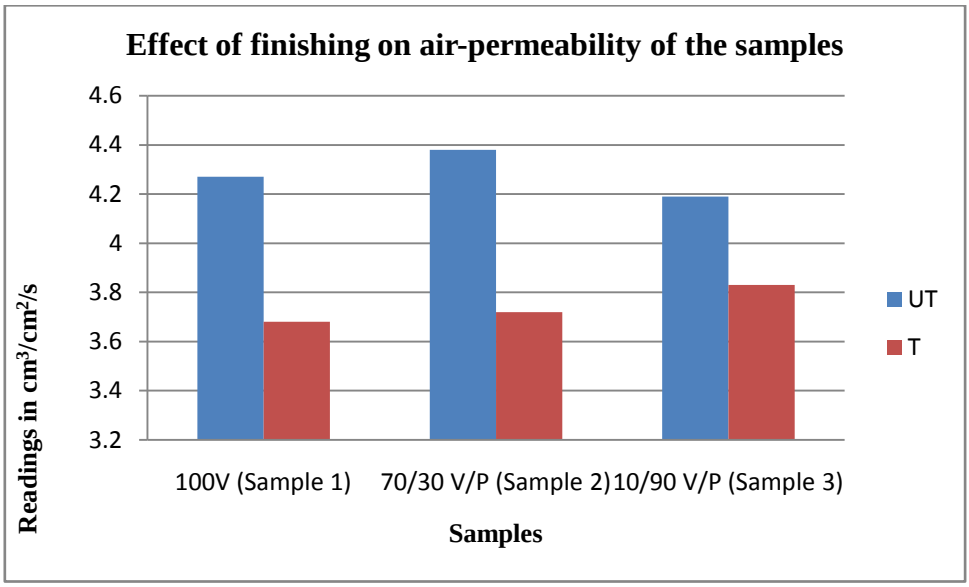


Figure: 4.1.1 Effect of finishing on air-permeability of the samples

4.1.2 Effect of finishing on the tensile properties of the samples

Table: 4.1.2 Effect of finishing on the tensile properties of the samples

Tensile Strength													
Herbal oils	Conc.	Sample 1				Sample 2				Sample 3			
		M/C	C/W	M/C	C/W	M/C	C/W	M/C	C/W	M/C	C/W	M/C	C/W
		Max load (KgF)		Tensile Strain (%)		Max load (KgF)		Tensile Strain (%)		Max load (KgF)		Tensile Strain (%)	
Clove oil	10%	3.79	1.18	33.4	67	4.43	1.35	39.1	89.2	20.8	3.69	69.8	133
	25%	3.24	1.08	31.7	56.2	3.92	1.27	37.7	51.7	19.7	3.35	67	129
	50%	2.82	0.92	30.1	49.2	3.45	1.13	34.2	48.9	17.8	2.97	65.6	112
Eucalyptus oil	10%	3.61	1.17	32.1	66.8	4.23	1.35	38.3	61.2	21.1	3.78	66	131
	25%	3.16	1.11	30.6	58.6	3.67	1.24	33.1	50.3	19.8	3.38	65.4	127
	50%	2.93	1.01	29.8	49	3.19	1.16	31.9	48.7	18.2	3.02	62.3	125
Neem oil	10%	3.87	1.18	35.9	56.7	4.56	1.40	34.4	65.6	19.3	3.56	75.6	127
	25%	3.14	1.15	33.1	55.8	3.58	1.25	32.1	54.2	17.2	3.20	73.4	131
	50%	2.83	0.93	31.5	54.6	3.19	1.12	29.9	50.6	15.9	2.9	68.9	119
Tulsi oil	10%	4.87	1.18	36.7	68.7	5.12	1.35	37.8	62.3	20.8	3.55	78	132
	25%	3.42	1.06	34.2	55	3.88	1.29	38	56.4	18.1	3.22	75.5	130
	50%	3.12	0.97	30.8	54.3	3.14	1.15	35.8	50.2	16.9	3.02	71.1	123

Combination	**10%**	4.01	1.19	33.7	60	4.98	1.33	35	60.9	19.9	2.68	75.5	141
	25%	3.18	1.12	32.4	58.2	3.64	1.23	34.1	55.2	17.1	3.21	72.1	133
	50%	2.87	1	31.1	55.5	3.31	1.12	32.2	51.5	16.3	2.82	70.1	124
Cow Urine	**10%**	4.12	1.17	35.6	54.6	5.63	1.39	35.4	36.2	20.8	3.83	60.8	128
	25%	3.86	1.05	33.2	50.8	4.54	1.21	31.9	34.1	19.7	3.43	57.6	112
	50%	3.32	0.99	30.5	46.8	3.98	1.09	29.8	31.9	18.5	3.11	55.7	107
Untreated		**6.96**	**1.20**	**20**	**115**	**8.26**	**1.43**	**23.2**	**124**	**22.7**	**3.97**	**28.2**	**132**

The tenacity of polyester is higher than viscose, hence it can be seen from the table 4.1.2 that the sample with higher percentage of viscose (sample 1) shows the minimum breaking load, whereas sample 3 with 90% of polyester shows the maximum. However it can be seen that the load taking capacity of the fabric after finishing is reduced considerably this is because, the finishing chemicals adhering to the fibre reduces inter-fibre friction and load distribution capacity, making the fibre/fabric to break earlier than the untreated sample exhibiting higher elongation percentage.

4.1.3 Effect of finishing on bursting strength of the samples:

Table: 4.1.3 Effect of finishing on the bursting strength of the sample

Bursting Strength							
Chemicals	**Conc.**	**Sample 1**		**Sample 2**		**Sample 3**	
		Pressure in bars	**Time in secs**	**Pressure in bars**	**Time in secs**	**Pressure in bars**	**Time in secs**
Clove oil	**10%**	1.67	6	1.78	5	4.77	6
	25%	1.55	5	1.65	6	4.52	6
	50%	1.43	5	1.52	5	4.31	6
Eucalyptus oil	**10%**	1.65	6	1.79	5	4.75	6
	25%	1.54	5	1.64	6	4.52	5
	50%	1.45	5	1.50	5	4.37	6
Neem oil	**10%**	1.67	6	1.75	5	4.67	6
	25%	1.56	3	1.62	3	4.46	4
	50%	1.44	5	1.51	5	4.39	6
Tulsi oil	**10%**	1.71	6	1.76	7	4.79	6
	25%	1.63	8	1.63	7	4.59	4
	50%	1.52	5	1.51	6	4.38	4
Combination	**10%**	1.69	6	1.76	6	4.65	4
	25%	1.57	5	1.64	5	4.43	6
	50%	1.45	5	1.53	5	4.16	6
Cow Urine	**10%**	1.60	4	1.60	4	4.71	6
	25%	1.49	5	1.47	4	4.58	6

	50%	1.30	5	1.32	4	4.24	6
Untreated		**2.23**	**6**	**2.41**	**6**	**5.16**	**6**

The same trend of tensile properties was followed by the samples even in case of bursting strength. Polyester sample with better tensile properties than viscose can resist higher bursting force. Due to the low density of the polyester than viscose the number of polyester fibers available per unit area will be more than that of viscose fabric, due to which more number of fibers are available to resist the bursting force. This is the reason for polyester sample to show better performance towards bursting strength. 100% viscose fabric resisted the bursting force of upto 2.5bars. Hence it can be seen from the table and figure 4.1.3 that the bursting strength of the treated samples is been considerably reduced after finishing with the herbal oils and cow urine

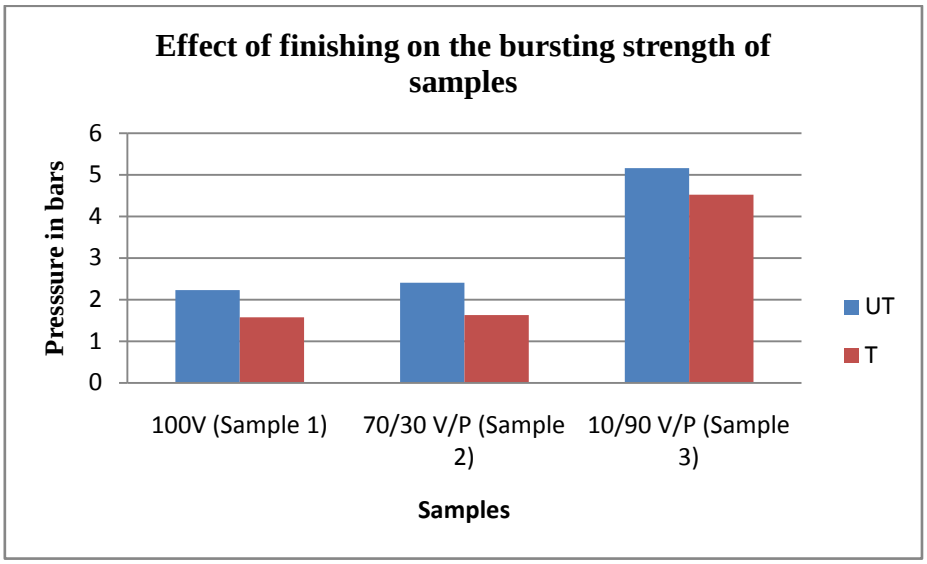


Figure: 4.1.3 Effect of finishing on the bursting strength of samples

4.1.4 Effect of finishing on abrasion resistance of the samples

Table: 4.1.4 Effect of finishing on abrasion resistance of the samples

Abrasion Resistance							
Chemicals	**Conc.**	**Sample 1**		**Sample 2**		**Sample 3**	
		Weight loss %	**No. of cycle**	**Weight loss %**	**No. of cycle**	**Weight loss %**	**No. of cycle**
Clove oil	**10%**	9.89	60	6.71	60	4.03	90
	25%	9.16	60	5.87	55	3.12	70
	50%	8.26	50	5.23	55	2.55	70
Eucalyptus oil	**10%**	9.15	55	8.29	70	5.57	100
	25%	8.20	55	7.34	70	4.61	90
	50%	7.67	45	6.77	60	3.46	80

Neem oil	**10%**	10.23	60	6.56	60	5.22	115
	25%	9.45	60	5.89	60	4.31	85
	50%	8.66	55	5.01	55	3.77	70
Tulsi oil	**10%**	8.53	55	6.22	55	4.59	110
	25%	7.67	50	5.34	55	3.72	75
	50%	7.08	50	4.39	55	2.82	70
Combination	**10%**	10.55	60	6.67	60	6.50	100
	25%	9.63	60	5.72	55	5.69	100
	50%	8.29	55	4.92	50	5.09	90
Cow Urine	**10%**	8.35	60	8.24	60	8.02	80
	25%	7.63	55	7.45	60	7.26	70
	50%	6.34	55	6.22	55	6.36	70
Untreated		**3.9**	**60**	**2.93**	**70**	**1.65**	**120**

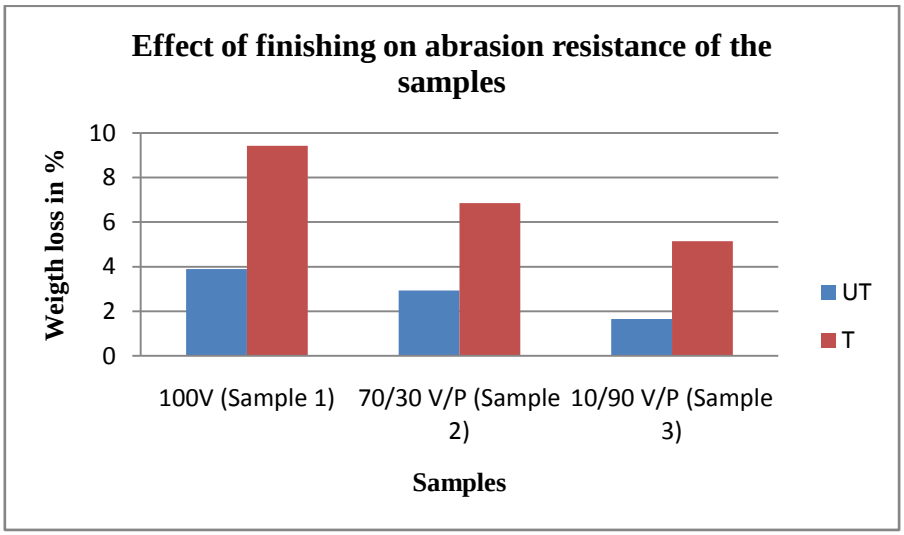


Figure: 4.1.4 Effect of finishing on abrasion resistance of the samples

From the table 4.1.4 the Sample 3 with 90% polyester show better resistance towards the cycles of abrasion where as 100% viscose sample can resist the abrasion up to 60 cycles. The reduced inter fibre friction due to the formation of film makes it easy for the fabric to lose the fibre (and hence the weight loss) during the abrading motion.

It can be seen from the test results that the polyester show better physical performance than viscose which is not desirable for wet wipes. However to move towards eco-friendly, 100% viscose samples were selected to develop the wet wipes as their performance shown is much enough for a single end use product.

4.2 Wicking and absorbency behaviour of the treated and untreated samples

Moisture regain of viscose is 11-13% and polyester is 0.4%.Hence viscose can show better absorbent properties than that of polyester.

4.2.1 Wicking behaviour of the samples

The table and figures 4.2.1 shows the wicking of all samples. The treated samples show lesser wicking height, since they are partially saturated with finishing chemicals and moreover, the finished film of oil creates an oil-water interface which is repulsive in nature. Also polyester being hydrophobic has good wicking properties. Presence of viscose in the same absorbs the finishing chemicals and makes the particular sample partially saturated, which later shows less wicking as its absorbing capacity is reduced. But in case of polyester being hydrophobic, the chemicals just adhere to the surface of the fibre reducing the surface energy and increasing the roughness due to which the sample 3 with more amount of polyester shows better wicking height than all the other two samples. However polyester samples fail to retain the functional chemicals within them since the drying time of polyester is very less as compared to viscose. The latter can efficiently hold the chemicals. The wetness required to give the necessary freshness can be easily maintained in case of wipes containing more amount of viscose.

Table: 4.2.1 Wicking height of the treated and untreated samples

Wicking Height in cm							
Chemicals	**Conc**	**Sample 1**		**Sample 2**		**Sample 3**	
		M/C	Cross	M/C	Cross	M/C	Cross
Clove oil	**10%**	8.6	6.6	8.3	6.6	10.8	8
	25%	8	6.4	7.5	6.1	10	7
	50%	7.5	6.3	7.2	5.8	8.7	6.8
Eucalyptus oil	**10%**	8	6.4	7.6	6	10.5	7.5
	25%	7.4	6.1	7.2	6.2	9.8	6.8
	50%	7.2	6	7	5.9	8	6.1
Neem oil	**10%**	7.6	6	7.7	6.7	10.2	7.3
	25%	7.3	6.4	7.3	6.4	9.8	6.8
	50%	7.1	5.9	6.9	6	8.8	5.9
Tulsi oil	**10%**	8.5	6.5	8	6.5	10.7	8.1
	25%	7.8	6.3	7.6	6.3	10.2	7.2
	50%	7.5	6	7.3	6.1	7.9	6.1
Combination	**10%**	8.3	6.2	7.4	6.4	10.3	7.3
	25%	7.5	5.9	7.1	6	9.8	6.4
	50%	7.2	5.6	6.6	5.7	8	5.8
Cow Urine	**10%**	8.1	5.8	7.9	6.3	7.8	7.4
	25%	7.6	5.3	7.4	5.9	7.5	6.6
	50%	7.3	5.1	7.1	5.5	7.2	6
Untreated		**10.2**	**6.9**	**11.7**	**7.4**	**4.2**	**2.8**

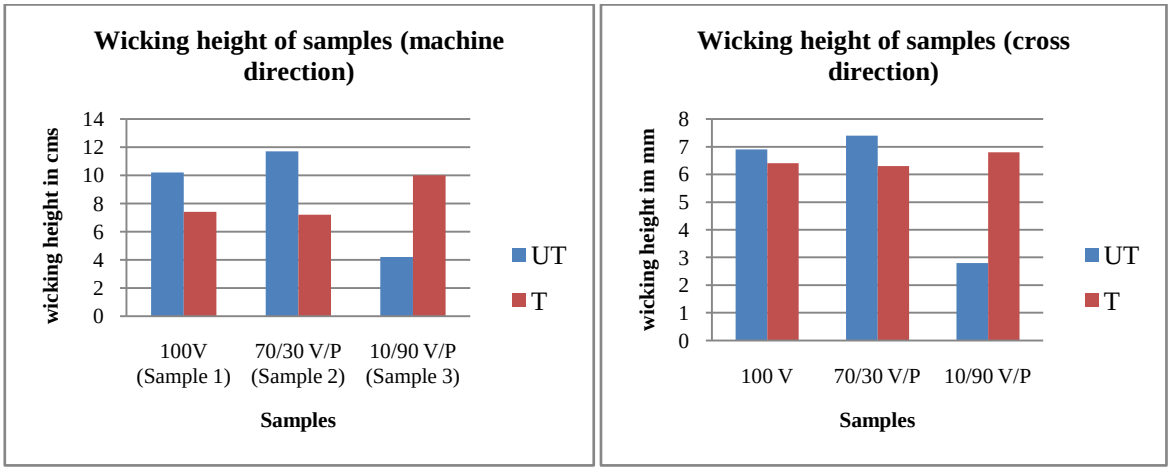


Figure: 4.2.1 Wicking height of treated and untreated samples

4.2.2. Absorbent capacity of the samples

The table 4.2.2 shows absorbent capacity of all three samples, the samples containing viscose in higher percentage shows better absorbent capacity than that of the sample containing higher percentage of polyester. Viscose fibers absorb water and swells increasing its weight. This intrinsic property of viscose to absorb the water and hold in it, is the reason for increasing wet weight of the sample while carrying out the test. Also the samples were tested for absorbent capacity with their respective solution prepared. This solution contained herbal oils and auxillary chemicals which makes the solution denser (i.e more than that of water). These samples tested with herbal oil solution showed higher wet weight, which is because of the use of high density liquid. However samples tested with water showed the standard absorbent capacity and it can be seen that 100% viscose sample had better absorbent capacity than polyester/viscose blends (sample 2 and 3).

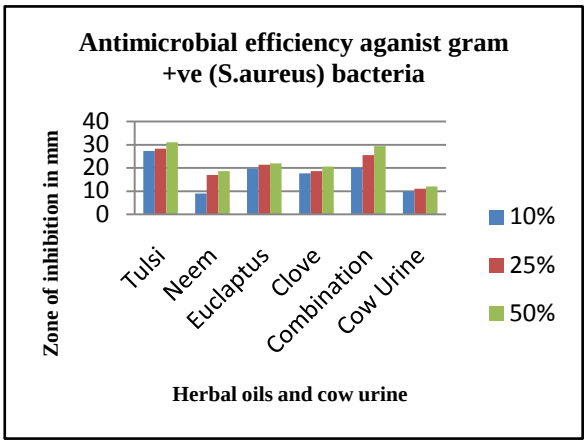
Table no: 4.2.2 Absorbent capacity of samples with water and herbal solution

Absorbent capacity (in percentage to original weight)				
Herbal oils	**Concentration**	**Sample 1**	**Sample 2**	**Sample 3**
Clove oil	**10%**	1029	840	561
	25%	1109	925	644
	50%	1249	1066	786
Eucalyptus oil	**10%**	1237	980	589
	25%	1322	1060	672
	50%	1465	1203	813
Neem oil	**10%**	990	592	534
	25%	1073	674	616
	50%	1220	815	759

Tulsi oil	**10%**	1351	857	580
	25%	1432	940	662
	50%	1574	1083	804
Combination	**10%**	1039	786	574
	25%	1122	867	665
	50%	1265	1008	798
Untreated (with water)		**1044**	**879**	**553**

4.3 Antimicrobial assessment of samples

The antimicrobial property of samples treated with tulsi, neem, eucalyptus, clove oils, combination of all these four oils and cow urine was evidenced in Staphylococcus aureus and Proteus vulgaris in three different levels of concentrations each (at 10%, 25%, and 50%) for all the three samples. From the above figures it can be seen that the antimicrobial efficiency of the samples increases with the increase in concentration of the herbal oils and cow urine. Tulsi treated samples showed a higher zone of inhibition against S.aureus (Fig: 4.3.4(a)) and samples treated with combination of all four oils showed good results against P. Vulgaris (Fig:4.3.4(b)) whereas samples treated with cow urine showed minimum antibacterial activity in all the cases(Fig:4.3.4(c)). It can also be seen that 100% viscose sample shows higher zone of inhibition than the other two samples (Figures 4.3.1, 4.3.2 and 4.3.3). Viscose being hydrophilic in nature can absorb the herbal oils much easier than the polyester and also hold it for a longer duration of time. Presence of polyester in the fabric samples reduces its absorbent capacity due to which they can hold lesser amount of chemicals to fight against the bacteria. Therefore, sample 3 with 90% polyester showed less efficiency towards bacteria compared to other two samples. It can also be seen that the difference in the anti-bacterial efficiency of 10% and 25% concentration treated samples is much higher than the the difference between the samples treated with 25% and 50% concentration respectively.



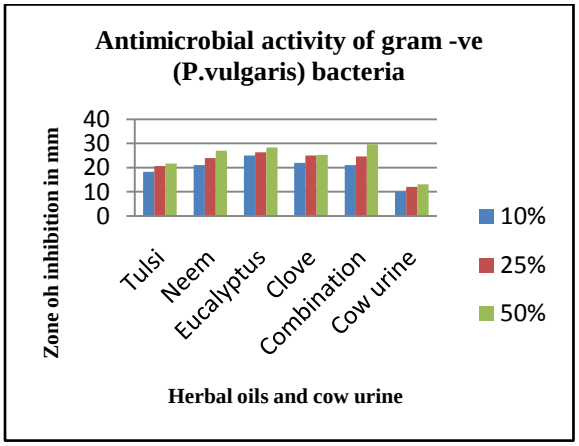
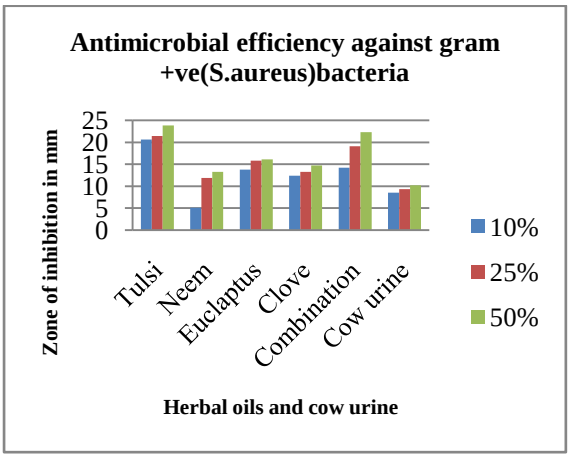


Figure: 4.3.1 Assessment of antimicrobial efficiency of treated 100% Viscose (Sample 1)



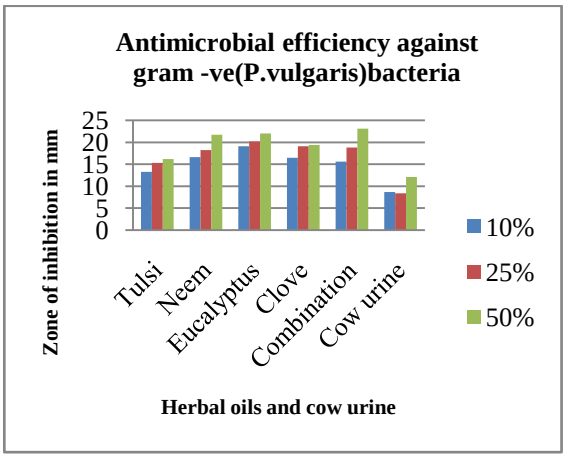
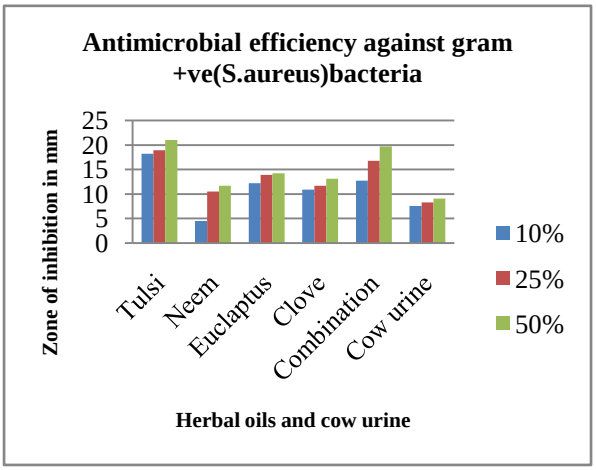


Figure: 4.3.2 Assessment of antimicrobial efficiency of treated 70/30 V/P (Sample 2)



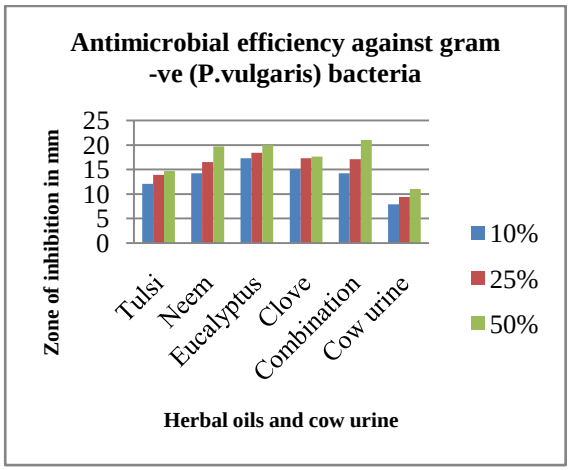


Figure: 4.3.3 Assessment of antimicrobial efficiency of treated 10/90 V/P (Sample 3)

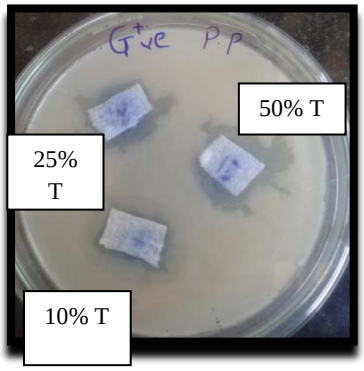


Fig 4.3.4(a) Zone of inhibition of Tulsi treated samples against gram +ve bacteria.

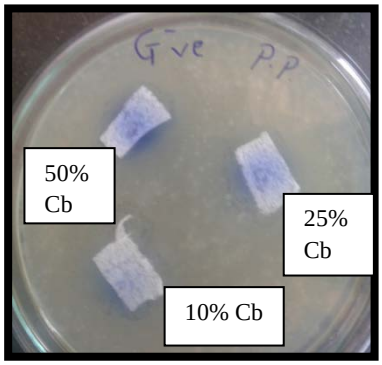


Fig 4.3.4(b) Zone of inhibition of samples treated with combination of all oils against gram-ve bacteria

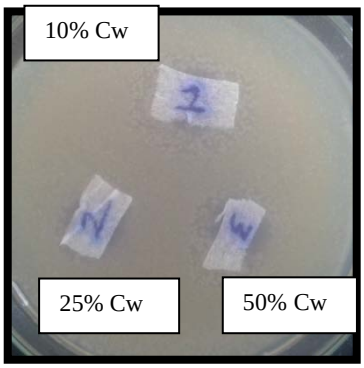


Fig 4.3.4(c) Zone of inhibition of cow urine treated samples against gram +ve bacteria.

Though the sample treated with 50% concentration showed higher efficiency, that much is not desirable as per the end use purpose. Therefore 25% concentration of herbal oils can be made optimum for finishing with respect to performance and economic point of view. As cow urine treated samples showed minimum antimicrobial activity against both gram negative and gram positive bacteria and also because of its not so pleasant odour cow urine treated samples were not considered to prepare the wipes.

5. CONCLUSION

The interest was to eradicate the use of polyester and to develop an eco-friendly wipe with 100% viscose fabric as it is biodegradable. As per the results, the samples containing polyester showed better tensile properties. This contribution of polyester towards the strength is not much desirable/essential as it is a single use wipe, where viscose alone can serve the purpose giving excellent comfort, feel and sufficient strength required. Also viscose have showed better absorbent capacity of herbal oils and hence were able to show better anti-microbial efficiency against the bacteria than that of polyester. Tulsi treated samples showed better zone of inhibition against gram +ve bacteria and samples treated with combination of all oils showed better zone of inhibition against gram –ve bacteria in all three concentrations. Though the three samples treated with 50% concentration showed higher efficiency in antimicrobial property, which is that not desirable as per the end use requirement. Hence eco-friendly wipes were developed with 100% viscose non-woven fabrics finished with 25% concentration of herbal oils.

A survey was also conducted with these wipes treated with 25% concentration of herbal oils among people of different age groups and gender, to whom the wipes were given for use to check for the feel, freshness, fragrance and skin irritation. The trials revealed that the wet wipes prepared were skin friendly without irritation and tulsi treated samples were more preferred by the people due to its pleasant fragrance and also from the antimicrobial assessment tulsi has comparatively showed higher zone of inhibition. Thus 100% viscose fabric, treated with 25% concentration of tulsi oil can considered the most suitable as per the study.

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