

## Antimoth finishing treatment for woollens using tannin containing natural dyes

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Attempts have been made to develop natural dye based antimoth finishing process using natural dyes as an alternative of chemical based process. Natural dyes obtained from different sources are used to dye the woollen fabric and then screened for antimoth efficacy. Woollen fabrics dyed with extract of silver oak leaves, wall nut husk and pomegranate rind have shown highest resistance to moth attack. The screened sources carrying antimoth property are then subjected to phytochemical analysis along with non-carrying natural dyes for analyzing their chemical constituents. The result reveals that the chemical constituent of natural dyes plays a crucial role in determining antimoth efficacy. The amount of tannin content present in the natural dyes can be taken as an indicator to determine the antimoth efficacy.

**Keywords:** Antimoth efficacy, Chemical constitution, Natural dye, Phytochemical analysis, Tannin, Wool

Wool and specialty hair fibres are widely used for producing carpet, blanket, namdha (felted carpet), shawl and knit wears in textile industries. These products have unique properties like warmth, softness and flame retardancy. India exports approximately Rs. 6000 crore worth of woollen carpet and handicraft items to other countries. Woollen materials are prone to attack of moth due to its protein content. Moth is an insect and its larvae eat the protein present in wool. The life cycle of moth has four stages, namely egg, larva, pupa and adult. The larva of a moth is the voracious eater of wool. The favorable conditions for moth attack on wool are dark and humid atmosphere with moderate temperature (25 -35°C). The common moths attacking the wool materials are common

cloths moth (*Tineola bisselliella*) and carpet beetle (*Anthrenus verbasci*) distributed in all the areas. There are lot of differences between cloths moth and carpet beetle in terms of their appearance, life cycle and cocoon forming tendency. The common cloths moth constructs cocoons, whereas the carpet beetle does not construct cocoons. The life cycle of common cloths moth is shorter (3-5 months) as compared to carpet beetle (6-9 months). The cloths moth produces more number of larvae than carpet beetle in a given period of time<sup>1</sup>.

The bulk materials like carpet, durries, etc need to be treated with antimoth chemicals during their manufacturing process itself to control the moth attack. Some of the chemicals used as antimoth finishing agent are DDT, permethrin, permethrin/hexahydro pyrimidine derivative, cyhalothrin, etc. Among the different chemicals, the DDT based agents are banned due to their toxicity and environmental problems. Permethrin and pifenthrin based chemicals are widely used at present as a moth proofing agent. Permethrin is chlorine based chemical compound having chemical formula  $C_{21}H_{20}Cl_2O_3$  and the pifenthrin is fluorine based. The challenges associated with the above moth repellent chemicals are development resistance due to mutations in insects, less effectiveness on beetle larvae and eco-toxic properties of permethrin and other synthetic pyrethroids<sup>2</sup>. The ideal antimoth finishing chemical should comply both environmental regulations and should be effective through the lifetime of the wool textile or carpet. Based on the above fact, an attempt has been made in the present study to use natural dyes instead of chemicals for giving single stage dyeing and antimoth finishing process to woollen fabric. Natural dyes are obtained from renewable sources like plants, trees, insect, minerals, sea animals, etc. Chemically, these dyes are mainly classified into tannins, flavonoids, anthocyanins, quinones, carotenoids. The use of natural dyes is considered as ecofriendly and can impart antimoth efficacy. However, there is no detailed study in the literature about the use of natural dyes for antimoth finishing. The chemical composition of natural dyes plays major role in determining the dyeing and antimoth characteristics. There is not much information available in the literature about the

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chemical constitution and antimoth characteristic of the natural dyes. Based on the above facts, an attempt has been made to identify suitable natural dyes for imparting antimoth efficacy for wool as well as to analyze the selected natural dyes chemical composition through phytochemical techniques.

## Experimental

### Screening of Natural Dyes

The aqueous extracts of saffron flower waste, onion skin, henna, myroblan, silver oak leaf, madder, wall nut, dholkanali and yellow root were used as natural dye sources. The grey woollen fabrics were mild scoured with a 0.5 gpL nonionic detergent. The scoured fabrics were then dyed with 5% colorant (owm) at 90°C with 1:40 material- to -liquor ratio at pH 5-6 in presence of 0.5 gpL acetic acid solution for one hour in a water bath. The dyed fabrics were then rinsed with water and dried at ambient condition.

### Testing of Antimoth Properties

The dyed woollen fabrics along with control un-dyed fabrics were kept in petri dishes by adding ten alive adult carpet beetle moths as per standard method described elsewhere<sup>3</sup>. The petri dishes were kept in incubator for 15 days at the temperature range 30-35°C and RH 50-60%. After that, the antimoth properties were characterized based on weight loss in the fabric due to moth attack, visual examination of fabric for damage and number of moths alive after the test. A synthetic antimoth chemical Eulon treated wool fabric was also used for comparative purposes.

### Phytochemical Tests

All seven dyes were analyzed using phytochemical test for chemical constitution. For this purpose 100g of dye powder was soaked in distilled water for 12 h followed by boiling at 100°C for 1 h. The extract was

then filtered, dried under vacuum and weighed. The dried powder was then extracted with different solvents like petroleum ether, chloroform, diethyl ether, diethyl acetate, acetone methanol etc through separating funnel. The extract obtained from each solvent was then subjected to different phytochemical tests to know about the chemical constituents like glycoside, tannin, phenol, coumarin, flavones, quinine, etc. using standard procedure described elsewhere. Finally, the extracts were dried by evaporation and the yield was recorded. The classes of compounds found in various subfractions were identified by photochemical tests<sup>4-10</sup> (Table 1).

## Results and Discussion

All the natural dyes have been applied on woollen materials satisfactorily in different colours with good fastness properties. The antimoth efficacy test results based on initial screening are shown in Table 2. It is inferred that all the natural dyes do not show antimoth properties. Woollen fabrics dyed with extract of silver oak leaves, wall nut husk and pomegranate rind have shown highest resistance to moth attack. The fabrics dyed with henna and madder also exhibit significant resistance to moth attack. However, woollen fabrics dyed with saffron and onion are found prone to attack by moths.

In order to identify cause for antimoth efficacy, all seven dyes are screened for chemical constitution using phytochemical test. The results of phytochemical analysis of different dyes are summarized in Table 3. It is observed that the presence of tannin positively influences the antimoth properties of selected natural dyes. The amount of tannin present in the selected natural dyes is found in the order: silver oak leaves > pomegranate rind > walnut husk > madder > henna > saffron > onion. It is observed that the percentage tannin plays a crucial

Table 1—Experimental details for phytochemical analysis of various sub-fractions

Target compound	Reagent applied/Experimental procedure	Colour response	Ref.
Glycosides	Anthrone + one drop of conc. H <sub>2</sub> SO <sub>4</sub> + warm on water bath	Dark green	7
Coumarins	NaOH (10%)	Yellow colour	8-10
Flavanones	NaOH (10%)	Orange	8
Tannins	FeCl <sub>3</sub> (10%)	Dark blue or greenish black	8-10
Quinones	Conc. H <sub>2</sub> SO <sub>4</sub> (1 mL / mL of extract) NaOH (1 mL, 10%)	Red Bluish green or red	8-10
Carbohydrates	Benedict's reagent (5 mL) + boil for 2 min	Red precipitate	7
Steroids	Glacial CH <sub>3</sub> COOH (1mL) + acetic anhydride (1mL/ mL of extract) + 2 drops of conc H <sub>2</sub> SO <sub>4</sub>	Red → blue →bluish green	7

Table 2—Antimoth properties of different sources

Code	Particulars	Weight loss, %	Moths alive, %	Visual examination
SL	Silver oak leaves			
	Control	3.30	Nil	Attacked
	Treated	0.5		Not damaged
MR	Madder Root			
	Control	4.0	50%	Attacked
	Treated	2.0		Least attacked
OS	Onion skin			
	Control	4.66	75%	Attacked
	Treated	3.77		Attacked
SF	Saffron flower			
	Control	4.5	75%	Attacked
	Treated	7.7		Attacked
HL	Henna leaves			
	Control	4.5	25%	Attacked
	Treated	2.5		Least attacked
WH	Walnut husk			
	Control	5	Nil	Attacked
	Treated	1.0		Not damaged
PR	Pomegranate rind			
	Control	3.5	Nil	Attacked
	Treated	0.25		Not damaged
CAC	Commercial antimoth chemical			
	(Eulon)	4.1	Nil	Attacked
	Control	0.2		Not damaged
	Treated			

Table 3—Phytochemical analysis of sources in different solvents

Chemical group, %	SL	MR	OS	SF	HL	WH	PR
Glycoside	5.46	-	15.26	16.67	8.51	5.46	10.00
Coumarin	1.29	-	2.31	9.21	6.45	2.13	4.28
Flavones	5.27	14.3	15.23	16.67	12.89	2.56	4.50
Tannin	47.87	33.33	11.53	12.93	30.29	44.31	45.23
Quinone	9.64	10.51	20.23	9.25	8.01	13.57	5.02
Carbohydrate	20.13	25.00	22.56	15.74	21.76	18.51	20.00
Steroid	5.59	12.50	-	11.11	8.79	9.56	9.52

role in determining antimoth properties. Silver oak leaves, pomegranate rind and walnut husk with 47.87, 45.23 and 44.31% tannin content impart good

antimoth efficacy on treated wool fabrics. Henna leaves and madder root show moderate antimoth efficacy having tannin content between 20% and 30%. However, saffron and onion with 12.93% and 11.53% tannin content result in poor antimoth efficacy. It indicates that high tannin containing natural dyes could be the better alternative for synthetic antimoth chemicals. Hence, while selecting natural dyes for antimoth finishing, the amount of tannin content can be taken as a parameter to decide the antimoth efficacy.

The natural dyes can be used to impart antimoth properties to wool, depending on the amount of tannin in their chemical composition. The natural dyes having more than 40% tannin show better antimoth efficacy compared to low tannin containing natural dyes. The use of natural dyes is sustainable and ecofriendly as well as adds more value to woollen materials.

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