Feasibility Studies on Contact Dermatitis Buffering Textile Finish Using CertainPlant Natural Products

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Abstract

Contact Dermatitis (CD) is a skin disease which can make humans fearful of wearing certain fabrications. Formaldehyde and its compounds are the main causative agents and Nickel and Chromium also work as allergens for CD. Chemicals used in finishing processes are also identified as causative agents and Fiber types can have an effect on the disease. Symptoms of the disease were reviewed using books and previous researches in this study. Reddish blisters, itching and reddish skin are common symptoms of CD. As there is no evidence about CD in Ayurveda, Western medicine and Ayurweda were linked by matching symptoms to find the connectivity of the skin diseases. Ayurweda described about "Kshudra Kushta" which has similar symptoms to those of CD. Herbs such aswild snakegourd, white sandalwood, red sandal wood and Heart leaved Moonseed are used in Ayurveda to cure "Kshudra kushta". Mixtures of herbs with fixing agents were applied to cotton and polyester fabrications through a natural dyeing method to find a fabric finishing method for CD. Two types of fixing agents; Copper Sulphate and Aluminum Sulphate were applied separately with different amounts to identify best recipe. The herbal mixture has a reddish colour. The mixture was tested with colour fastness to wash test ISO – 165-CO1:1987 and pH value of the solutions was also checked to study the feasibility. Cotton fabrications showed acceptable durability up to three (3) washes and polyester had poor durability. Wash durability is also dependent on the amount of fixing agents. There were slight colour changes after Copper sulphate treatment; Aluminum sulphate did not showed any colour change. It has neutral pH range. Fourteen (14) different garments which cause symptoms of CD were treated with the herbal mixture and wear trials were carried out. All garments showed positive results up to 3 domestic washes.

1. Introduction[1]

Contact dermatitis (CD) is caused by a hypersensitivity reaction of the skin. Common allergens like nickel, chromate, dyes and synthetic rubber are some causes of this hypersensitivity reaction. Many compounds which cause contact allergic dermatitis are low molecular weight haptens which require combining with an epidermal protein to become immunogenic[1]. Sri Lankans and many people from all over the world are suffering from this disease. Millions of Americans suffer from constant recurring mysterious skin rashes. These irritating flares may indicate that humans are allergic to formaldehyde which is used to treat fabric finishes on a large portion of the clothing we wear each day[2]. The neck area, waist area, inner and posterior thighs, popliteal fosse, axils, abdomen and buttocks are the main places where this disease can often be seen, because garments are highly contacting these areas. Itching, irruptions [blisters], papules and reddish skin are the common virtual symptoms of the disease[3].

The allergens most likely to cause CD are dyes used to colour fabrics and resins used in finishing processes. Especially, resins like Ethilenurea and Melamine Formaldehyde which are used to get wrinkle free and shrink free effects are the causes for the disease[4]. Polyester and spandex may be a sensitizer because of Mercaptobenzothiazole which is used in these fabrics. Especially Formaldehyde and its resins which are used in the fabric preparation process could be a high sensitizer. Garment types such as diapers, socks, girdles, brassieres and most undergarments and tight garments with above fabrications may lead to this disease[5]. "Further, Disperse blue 106 and 124 can be other sensitizers. These chemicals are used in the 100% polyester blue, black, green and violet linear of women's clothing. There is a possibility in flame retardant fabrics to generate this disease. 2.3- Dibromoproryl phosphate and 2.3-Dibromocresylglycidyl ether has been reported as a causative agent. Basic red 46 dyes are also reported as causative agent of CD"[6].

In eastern medicine "Kushta" is related to skin diseases. There are 18 types of "Kushta" including seven "Mahakushta" and eleven "Kshudra kushta".

In Western medicine "Mahakushta" is known as Leprosy and "Kshudra Kushta" as Skin diseases. Eastern medicine also describes reasons and symptoms of each "Kshudra Kushta". "Alasakaya", "Dhdrawaya" and "Charmadalakushtaya" [three of eleven "kshudra kushta"] have the same symptoms as contact Dermatitis described below.

"Alasakaya" – itching, little reddish blisters on skin

"Dhdrawaya" – little itching, reddish blisters on skin

"Charmadala kushtaya"– reddish skin with itching and blisters[7]

"Charma Roga Nidhana Chikithasa Sangrhaya" explains in depth about skin diseases and "Kushta"[8].

Herbs;Trichosanthescucumerina L.(wild snake gourd), *Santalum album* (white sandalwood), PtercarpussantalinusL.f. (red sandalwood), Tinosporocordifolia (Heart leaved Moonseed)cures "Kushta" and itiching[9].

Heart wood of white sandalwood (*Santalum album*) includes 10% essential oil, 90% sequiterpene alcohols, santalols, (Z)-α-santalol (45-47%), (Z)-β-santalol(20-30%),Sesquiterpene alcohols, epi-β-santalol, (E) β-santalol,spiro-santalol, Cis-nuciferols, cis-lanceol[10].

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Heart wood of red sandalwood includes Isoflavone, liquiritigenin, isoliquiritigenin, savinin, calocedrin, santalinsA, santalinsB, santalinsC, santarubin, santalic acid(16%),7-hydoxy-6-methoxy-courmarin-7O-{β-D-apiofuranosyl(16)}-β-D-glucopyranoside,7-hydroxy-6-methoxy-coumarin-7-O-{α-L-arabinopyranosyl(13)-β-D-glactopyranosyl(16)}-β-D-glactopyranoside, 5-hydroxy-7-O-(3-methyl-β-2-enylcoumarin[11].

Bark of Heart leaved Moonseed includes Daucane-type sesquiterpeneglucoside, Tinocordifolioside. Furanoidditerpeneglucosides,palmatosides C, F.Diterpenes, alkaloids, Diterpenes, norditerpene-furan-glycosides, cordifolisideA-E, clerodane-diterpenes,tinospo-none, tinosporaside, tinocordioside, clerodane-furano-diterpenes,cordioside(glycoside),furano-diterpenes,colombin,epimer of 6-hydroxy arcangelisin. Alkaloids, Magnofiorine, Tembetarine, (aporphine type alkaloids) Jatrorrhizine (protoberberine type alkaloid).Phenolic component syringing, Glucosidealkaloidal, (berberine) crystalline substances 3 bitter principles, neutral fatty alcohol, bitter glucoside-gilon,non-glucoside bitter substance-giloinin,gili-sterol, alkaloid, neturalbodies 3, essential oil, fatty acids. Bitter principles, Columbin, chasmanthin, palmarin. Bitter compounds 3,tinosporon,tinosporic acid, tinosporol and wood of Heart leaved Moonseed include 18-norclerodendrane diterpene O-glucosidetinosporaside, furanoidditerpene. Bitter furanoid, tinsporine, tinosporide, tinosporaside, corkifolie, cordifol, heptacosanol, clerodanefuranoditerpene, ***diterpenoidfuranolactonetinosporidine,columbin, β-sitosterol.*** Tinosporon, Tinosporicacid, Tinosporol, Cordifol, octacosanol, β-sitosterol[12].

There have been many researches about herbal related fabrication developments. Research on diabetes controlling herbal garments has opened up a new avenue in the herbal treated apparels area of research[13]. Apart from that the natural dyeing project of Sri Lanka is using a natural dyeing method which can be successfully used as herbal dyeing method.

This study aims at developing an eco-friendly Contact Dermatitis buffering finish from herbal extracts for textile application. Certain selective CD buffering herbals were identified under guidance of Ayurweda doctors. Wild snake gourd, white sandalwood, red sandalwood, Heart leaved Moonseed were selected to find the best fixing agent for fabric treatment in this study. Cotton and polyester are used as fabrications and two different cross link agents; Copper Sulphate and Aluminum Sulphate are used to herbal dye particles on the fabrics. Since this herbal mixture is not used in the fabric dyeing process, different amount of fixing agents are applied to identify the best recipe. As garments are subjected to washing, a new application was tested with colour fastness to wash test ISO – 165-CO1:1987 and also pH value of the solutions was checked to study feasibility. An extensive study was conducted to assess the contact Dermatitis buffering properties of new application. Fourteen garments which cause CD were selected and those garments treated with new application and wear trials done to find the effects treatment for human skin.

2. Methodology

Books and online resources were referred to get a basic and theoretical idea about CD. Three interviews were conducted with western doctors to find symptoms and reasons for the disease. Industrial processes were analyzed to get a clear idea about causative agents of CD. Visits to a knitting factory; two washing plants, two dyeing plants and a printing plant helped to understand real industrial processes and materials and chemicals which are used throughout the processes. Other than factory visits, books and internet resources were referred to. Further, interviews with Ayurweda doctors and review of knowledge, principles and theories of Ayurweda written in Sinhala and Sanskrit were done to find the solutions for CD. Fabrics were treated with prepared herbal solutions using different plant parts and fixing agents.

2.1 Materials Used for the Finishing Process of Fabrics

100% Cotton and 100% polyester fabrics were used to develop CD buffering fabric finish. Dried roots and leaves of wild snake gourd, heartwood of white sandalwood, heartwood of red sandalwood, creepers and leaves of Heart leaved Moonseed were collected and powdered separately. Thereafter, powdered herbs were mixed well to make one mixture in 1:1:1:1 ratio. Copper Sulphate ($CuSO_4$) and Aluminum Sulphate ($Al_2(SO_4)_3$) were used as the fixing agents.

2.2 Method of Applying Herbals

Fabrics were washed and cleaned prior to the treatment. Ratio of 200 grams per one liter herbal mixture was mixed with water as per ratio of 1 liter per 100 grams of fabrics. Mixture was boiled up to 100°C for Cotton and 120°C for polyester fabrics. Prepared fabrics were kept for 10 minutes in the boiling mixture. Thereafter, fabrics were soaked in the fixing agent for five minutes and kept in air for 50 minutes. Finally, treated fabrics were washed using normal water to remove unfixed herbal particles.
Table 01 shows the composition of the mixture used in the treatment.

Table 1: Composition of the mixture

Water	1*l* per 100g of fabric				
Herbs	200g per liter				
Fixing Agent	3g/*l*	6g/*l*	9g/l	12g/l	15g/l

2.3 Identification of the Best Recipe

Herbal treated cotton and polyester swatches were tested with colour fastness to wash test ISO – 165-CO1:1987. The 10cm×10cm size 100% cotton and 100% polyester fabric swatches were treated with the above recipe with different amount of fixing agents. Mixture with added $CuSO_4$ was categorized as category A and mixture with added $Al_2(SO_4)_3$ was categorized as category B.

Table 2: Recipe of category A

Amount of Water	1l per 100g of fabric				
Amount of Herbs	200g per liter				
Fixing Agent $CuSO_4$	A1 3*g/l*	A2 6*g/l*	A3 9*g/l*	A4 12*g/l*	A5 15*g/l*

Table 3: Recipe of category B

Amount of Water	1l per 100g of fabric				
Amount of Herbs	200g per liter				
Fixing Agent $Al_2(SO_4)_3$	B1 3*g/l*	B2 6*g/l*	B3 9*g/l*	B4 12*g/l*	B5 15*g/l*

2.4 Measurement of the pH Value of Herbal Mixture

pH value of each herbal mixture was measured using a digital pH meter.

2.5 Testing With Humans to Find the Effectiveness with Skin

Seven patients who are suffering from Contact Dermatitis were tested with the 14 identical garments which caused them to contract CD. All garments were cleaned and treated with recipe in Table 4.

Table 4: Recipe used to treat garments

Water amount	1*l* per 100g of fabric
Herbs amount	200*g* per liter
Al_3SO_4	15*g/l*

Wear trials were then done with the patients with their relevant garments. Effects of the herbal treatment were observed by collecting feedbacks after 12 hours of wearing treated garments in their day to day activities. Wear test was replicated three times with three normal domestic wash cycles.

3. Results and Discussion

3.1 Colour Fatness to Wash Test

After discussions with Ayurveda doctors was decided to take "Alasakaya", "Dhdrawaya", and "Charmadala kushtaya" as having the same symptoms as CD. Ayurweda doctors confirmed that wild snake gourd, white sandalwood, red sandalwood, Heart leaved Moonseed are used to cure the above skin diseases. The results of colour fastness to wash test; ISO – 165-CO1:1987, for each fabrication with different amounts of fixing agents are given below.

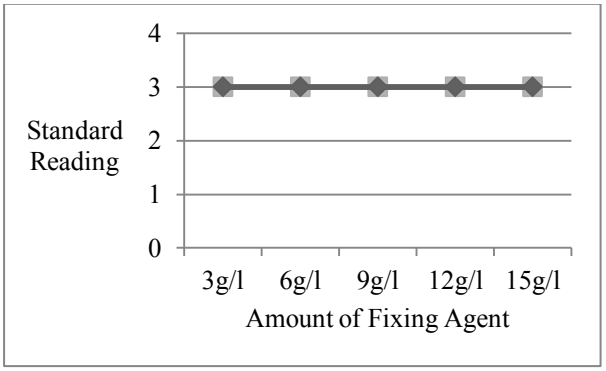

Figure 1: Colour fastness wash results of $CuSO_4$ with cotton fabrications

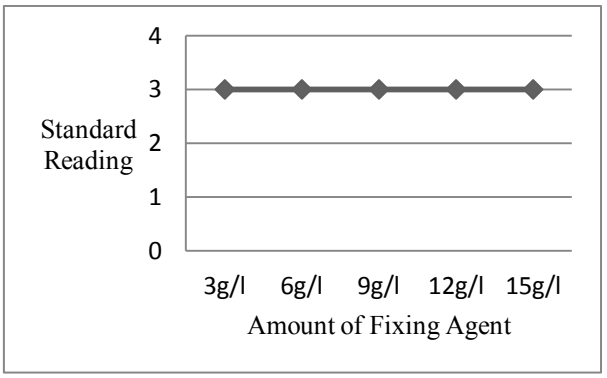

Figure 2: Colour fastness wash results of $Al_2(SO_4)_3$ with cotton fabrications

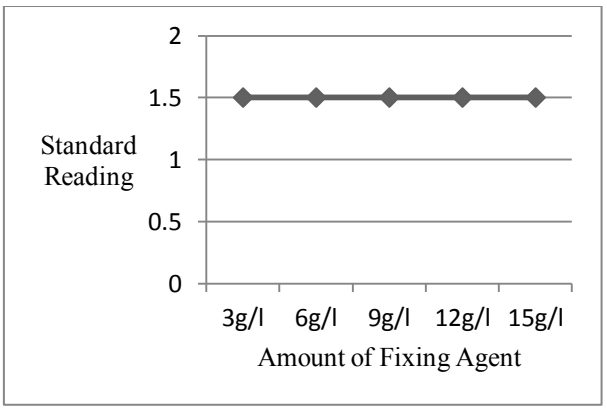

Figure3: Colour fastness wash results of $CuSO_4$ with polyester fabrication

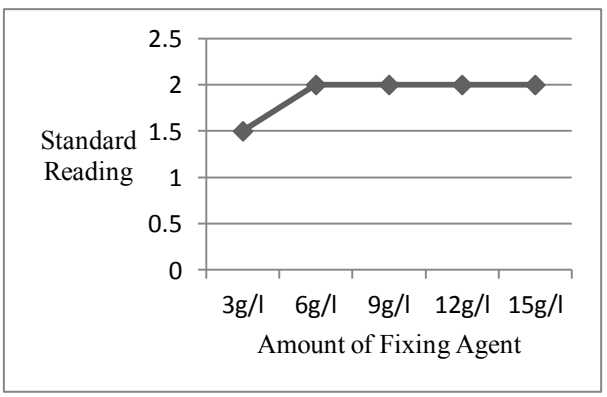

Figure 4: Colour fastness wash results of $Al_2(SO_4)_3$ with polyester fabrication

Both $CuSO_4$and $Al_2(SO_4)_3$ fixing agents shows acceptable results with cotton fabrications. $CuSO_4$ helps to keep the same standard reading in a positive value with cotton fabrications while keeping colour stability at a poor value with polyester fabrications. Standard reading with $Al_2(SO_4)_3$ and cotton fabrication showed an positive increment of colour stability while keeping a slight increment and stability with polyester fabrication. Both $CuSO_4$and $Al_2(SO_4)_3$ fixing agents have poor results with polyester fabrications when compared to cotton fabrications. The best value for the fixing agent for each herbal solution is $\geq 6g/l$ for cotton fabrications.

3.2 Effect With the pH Value of the Herbal Solution With Fabrics

pH value of each solution used in the research has 7.2 which is in the neutral range. Therefore the herbal solution (new application) would not affect the composition of cotton or polyester fabrications.

3.3 Effect of the Treated Clothing for the Skin

According to the feedback of all 7 patients, 14 items of clothing which caused them to contract CD did not create any skin problem after treatment of the clothing with the new herbal mixture. Further more, none of the patient report any negative feed backs after three normal domestic washing cycles.

3.3 Conclusion

This study was conducted to find the best herbal fabric finishing method for the people suffering from Contact dermatitis. Formaldehydes, Disperse dyes, various fiber types, construction methods and chemicals normally used in textile finishing processes were identified as the main causative agents. In Ayurweda, skin problems such as "Kshudra Kushta" which is similar to CD are treated with herbs such as wild snake gourd, white sandalwood, red sandalwood, Heart leaved Moonseed.

Researchers identified a herbal mixture with different plant parts of wild snake gourd, white sandalwood, red sandalwood, Heart leaved Moonseed and different amounts of $CuSO_4$ and $Al_2(SO_4)_3$ as fixing agents.

Cotton and polyester fabrications treated with herbal mixture have shown positive reactions against CD after three domestic washes. Herbal treatment of polyester fabrications resulted in poor colour stability with both fixing agents while herbal treatment of cotton fabrications resulted in better performances with both fixing agents. The use of $\geq$6g/l fixing agents for each herbal solution resulted in strong colour feasibility for cotton fabrications.

This study opens new research avenues for western and Ayurweda doctors, chemists, scientists, textile engineers, fashion brands and apparel retailers.

- To find chemical ingredients and values of Wild Snake gourd, white sandalwood, red sandalwood, Heart leaved Moonseed to introduce new garments those who prefer healthy apparel.
- To develop applications of herbal solutions for foot wear, medical textiles, outerwear, off road garments, and embellishments industry.
- For further research on herbs with textile printing and Nano technology.

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