

## Efficiency of surfactants on stain removal

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**Abstract:** In the present study an attempt has been made to know the effect of surfactants on stain removal. On the basis of survey results, three popularly sellable surfactants in the local market and four common stains experienced by the working men and women were selected. White organic cotton fabric was stained with curry, grease, pickle and mud stains and aged for a period of 7 days to make them artificially old. Each stain was washed with selected three surfactants viz., Pure White with greenish granules (WG), Pure White (PW) and Pure White with blue and orange granules (WBO) totaling to 3 washes with a gap of 24 hours. The change in the shade of the stain was assessed after every wash through spectrophotometer and it was found that off the three selected surfactants, PW was focused to be effective in removing the grease stain where as WBO in removing mud, pickle and grease stains compared to 'WG' surfactant.

**Key words:** Fabric, Stains, Surfactants, White cotton

### Introduction

Surfactant is a blend of surface active agents. These are the compounds that lower the surface tension between two liquids or between a liquid and a solid. Surfactants may act as detergents, wetting agents, emulsifier, foaming agent and dispersant.

Clothing is an expression of a person, his personality and way of living. Clean clothes in good repair are necessary for a person to present neatly groomed and in well organized appearance. Clothes that receive the right kind of care look better and increase the wearability of materials.

Stains in practice are plenty, may be grouped as oily, greasy and mineral in composition. These foreign materials set a very hard and remarkable stain on both cotton and other synthetic fabrics, as some of these stains contain dye pigments. Hence, a great deal of care has to be taken to remove these stains from the clothes. The efficiency of stain removal depends on solvent type and cleansing agents and the cleansing agents commonly grouped as soap and detergents or surfactants. The detergent chemically is a surfactant contains alkyl benzene sulfonates, a family of compounds that are more soluble in hard water. Detergents are amphiphilic chemical substances which partly acts as hydrophilic i.e., polar and partly hydrophobic i.e., non-polar (Kharkwal *et al.*, 2015). The detergent (including soaps) contains active agents that wets the fabric, emulsifies oily matter, solubilises stain and holds the soil in suspension. The active agent molecule is composed of two groups, an oil loving part and a tail with an affinity for water. These two combine together to help in the cleansing process by solubilizing the dirt in water.

The cotton fabric, dyed or undyed attracts dirt, dust and soil from both dry and wet sources/mechanism because of its inherent hydrophilic characteristics. Hence, it is necessary to select a suitable surfactant for effective cleansing without harming its major textile related properties (Samanta *et al.*, 2004).

Presently the young generation is very busy in their career and has little time to clean their daily wear cloths; especially those who work in kitchens have hard time to wash their garments. Similarly military people have to survive in such drastic conditions where hardly get time to cleanse their outfits. Nanotechnology provides a new concept of self cleaning textiles which gives self-cleaning as well as fresh cloths every day, which not only technically benefited but techno economically advantageous (Subhranshu Sekhar Samal *et al.* 2010).

Self-cleaning surface having a water contact angle greater than 150 degree and a very low roll off angle. Water through these surfaces easily rolls off and completely cleans the surface in the process. Self cleaning fabrics not only resist coffee and red wine (vegetable) stains but are also repellant to water, dirt, odour and are antibacterial as well. In other words self cleansing fabrics are beneficial as stain guard or stain-resistant fabric, yet to enter in the domestic markets.

### Material and methods

The present investigation entitled efficiency of surfactants on stain removal was carried out during the year 2015-16 at College of Rural Home Science, Dharwad. This study consisted of two parts – survey and experimental procedure. In total, two surveys were conducted, of which the first self structured interview schedule was administrated on 50 local grocery shop owners to elicit the information on type of surfactants available in the local market; whereas in the second 30 each working men and women were interviewed through schedule to gather information related to the common stains experienced by them.

The second part of the methodology consisted of experimental procedure, where three selected common stains were applied on the white organic cotton fabric. The stained samples were kept for a week to make them artificially old since "Old" stains are more difficult to remove than "fresh" ones, and some staining agents are so strong that they will

not react to any efforts to remove them (<http://www.human.cornell.edu/fsad/outreach/upload/removingstains.pdf>) and were washed with three selected detergents up to three washes. Each stain on each test sample was treated separately with each surfactant, washed, rinsed and shade dried. This procedure is repeated for another two times with a gap of 24 hours. Colour strength of stains on white sample was evaluated before and after washing by using spectrophotometer.

The selected three surfactants were in powder form and coded to avoid discrepancy among the brands. All these three surfactants though basically are of white colour, one of the three surfactants exhibited an admixture of blue and orange granules whereas the second showed greenish blue granules and the last one was pure white. Keeping these physical colour combinations and their pH values were coded as below:

Pure White	- PW (09.50 pH)
Pure white with greenish granules	- WG (10.60 pH)
Pure white with blue and orange granules	- WBO (09.70 pH)

## Results and discussion

The results are presented in three sub headings viz., colour strength and colour co-ordinate values of stains subjected to multiple washes with WG, PW and WBO.

### Colour strength and colour co-ordinate values of stains on white cotton samples subjected to multiple washes with 'WG' surfactant

Table 1 and records the colour strength and colour co-ordinate values of discoloured stains after every wash.

It is apparent from this Table that the highest K/S value was observed with mud (88.52) followed by curry (46.30), pickle (43.68) and least was grease (25.04), at control. However, on washing the colour strength of all four stains decreased. Meanwhile, the colour strength (K/S) of all the four stains expressed in percentage after first wash indicated a great deal of reduction in the tint of the stain. It is observed that after every first wash there is reduction in K/S value. A remarkable reduction was observed with mud (45.56 % and 50.51 %), curry (41.84 % and 49.91%), grease (34.45 % and 43.58 %) and pickle (32.83 % and 42.03 %) after first and second wash, respectively.

On washing with surfactant 'WG' the colour of the stain gradually reduced and curry stain was found to be the highest (54.53 %) after 3<sup>rd</sup> wash compare to pickle (42.43 %) which clearly indicates that 'WG' surfactant is very effective in removing the curry stain than mud, grease and pickle. It may also be stated that the surfactant with 10.6 pH acts on the ingredients of curry viz., dal, turmeric, masala powder, sour components reasonably than oily items. These results are supported by colour co-ordinate values L\*, a\* and b\* when the L\* (17.15 %), a\* (-08.61 %) and b\* (-51.12 %).

The L\* (lightness and darkness) value was found to be higher with grease (64.17) followed by curry (63.59), pickle (62.16) and mud (40.93), at control. However, there is increase in lightness and darkness (L\*) value of all the four stains on subsequent washes which indicates that the stains have become lighter in colour. Meanwhile, the increase in lightness and darkness (L\*) expressed in percentage after subsequent washes indicated reduction in darkness of the stain. A descending order of reduction in lightness is observed with curry (11.82 %), mud (11.10 %), pickle (07.84 %) and grease (06.26 %) stains after first wash and a similar trend is noticed after 2<sup>nd</sup> and 3<sup>rd</sup> washes. Most fats and grease spots can be removed using washing up liquid or warm soapy water before being washed. It is advisable to see liquid detergent which contains more surfactants than powder, making it more effective at removing fat (<http://www.newway.com.au/files/f/1037/Stain%20Removal.pdf>).

The redness and greenness (a\*) value of control was found to be highest in pickle stain (18.56) followed by mud (15.24), curry (09.02) and grease (04.20). A trend of decrease was observed after each wash which indicated that the stains have turned to be greener (-a\*) in colour, which reveals that there is reduction in the redness (+a\*) of the stains. A great reduction in redness is observed among curry (-03.42 %), pickle (-03.50 %), mud (-03.89 %) and grease (-08.59 %) stains after first wash i.e., the standard colour of 'curry' was remarkably reduced after first wash.

The yellowness and blueness (b\*) of control sample was found to be higher in curry (49.52) followed by pickle (46.39), grease (30.19) and mud (21.19). However, there is decrease in b\* value of all the four stains on subsequent washes which indicated that the stains have become bluer in colour than yellower. On the contrary, a reduction was observed with pickle (-31.69 % and -40.23 %), grease (-32.76 % and -40.26 %), curry (-39.99 % and -47.08 %) and mud (-44.02 % and -47.50 %) stains after first and second washes respectively. Higher the negative value (-b\*) bluer the sample i.e., lighter the stain is.

Meanwhile, the colour strength (K/S), L\* a\* b\* values of all the four stains were found to be significant at 5 per cent level of significance.

The increase in L\* value expresses stain becoming lighter in shade i.e., higher the L\* lighter the shade is. In other words L\* value and shade of the stain are directly proportional. In support of L\* value, the colour co-ordinate a\* expresses either greener (-a\* value) or redder (+a\* value) on repeated washes. Greater the minus a\* value, greener the shade which is lighter than redder shade. Similarly, the colour co-ordinate b\* expressed either blueness (-b\* value) or yellowness (+b\* value) on subsequent washes. Greater the minus b\* value, bluer the shade which is lighter than yellowness where the later is warmer and brighter shade. Hence, after the third wash the curry stain exhibited lighter L\*, -a\* and -b\* values which clearly indicate that the stain has become lighter in shade compared to grease, mud and pickle.

Table 1. Colour strength (K/S) and colour co-ordinate values of stains on white cotton fabric subjected to multiple washes with 'WG' surfactant

Surfactant	Stains	Control			1 <sup>st</sup> Wash			2 <sup>nd</sup> Wash			3 <sup>rd</sup> Wash		
		K/S	L*	a*	K/S	L*	a*	K/S	L*	a*	K/S	L*	a*
WG	Grease	25.04	64.17	04.20	30.91	69.85*	0.43*	11.26*	69.85*	0.43*	16.75*	76.90*	-0.88*
						(34.45)	(06.26)	(-08.59)	(32.76)	(43.58)	(13.31)	(-10.09)	(-40.26)
Pickle		43.68	62.16	18.56	46.39	09.93*	71.44*	17.82*	05.52*	05.43*	76.34*	09.77*	05.21*
						(32.83)	(07.84)	(-03.50)	(-31.69)	(42.03)	(12.47)	(-04.37)	(-40.23)
Mud		88.52	40.93	15.24	21.19	05.55*	74.70*	05.13*	05.50*	03.53*	78.27*	02.01*	03.51*
						(45.56)	(11.10)	(-03.89)	(-44.02)	(50.15)	(14.67)	(-05.34)	(-47.50)
Curry		46.30	63.59	09.02	49.52	05.66*	75.42*	05.60*	09.53*	03.97*	77.89*	02.43*	02.70*
						(41.84)	(11.82)	(-3.42)	(-39.99)	(49.91)	(14.29)	(-8.35)	(-47.08)

Figures in parenthesis indicate percentage \* - Significant at 5% level of significance

(K/S) Colour strength (±L\*) Lightness and Darkness (±a\*) Redness and Greenness (±b\*) Yellowness and Blueness

Table 2. Colour strength (K/S) and colour co-ordinate values of stains on white cotton fabric subjected to multiple washes with 'PW' surfactant

Surfactant	Stains	Control			1 <sup>st</sup> Wash			2 <sup>nd</sup> Wash			3 <sup>rd</sup> Wash		
		K/S	L*	a*	b*	K/S	L*	a*	b*	K/S	L*	a*	b*
PW	Grease	25.04	64.17	4.20	30.91	10.67*	71.30*	00.48*	18.55*	06.24*	75.75*	-0.58*	11.76*
						(33.03)	(07.70)	(-08.54)	(-30.96)	(40.82)	(12.18)	(-09.61)	(-37.75)
Pickle		43.68	62.16	18.56	46.39	09.93*	72.44*	04.64*	21.11*	06.41*	76.26*	04.41*	16.51*
						(30.07)	(08.84)	(-04.38)	(-28.40)	(35.65)	(12.67)	(-04.61)	(-33.01)
Mud		88.52	40.93	15.24	21.19	04.85*	77.23*	05.49*	06.92*	04.54*	78.33*	05.52*	06.09*
						(45.38)	(13.63)	(-03.53)	(-42.59)	(46.86)	(14.72)	(-03.72)	(-43.42)
Curry		46.30	63.59	09.02	49.52	05.88*	75.63*	06.58*	12.03*	02.66*	81.02*	00.65*	-01.45*
						(39.44)	(12.03)	(-02.44)	(-37.48)	(54.55)	(17.42)	(-08.59)	(-50.97)

Figures in parenthesis indicate percentage \* - Significant at 5% level of significance

(K/S) Colour strength (±L\*) Lightness and Darkness (±a\*) Redness and Greenness (±b\*) Yellowness and Blueness

Table 3. Colour strength (K/S) and colour co-ordinate values of stains on white cotton fabric subjected to multiple washes with 'WBO' surfactant

Surfactant	Stains	Control			1 <sup>st</sup> Wash			2 <sup>nd</sup> Wash			3 <sup>rd</sup> Wash		
		K/S	L*	a*	b*	K/S	L*	a*	b*	K/S	L*	a*	b*
Surf Excel	Grease	25.04	64.17	4.20	30.91	09.55*	71.09*	00.01*	15.61*	05.38*	76.78*	-00.27*	09.21*
						(36.00)	(08.10)	(-09.01)	(-33.90)	(43.59)	(13.18)	(-10.10)	(-40.30)
Pickle		43.68	62.16	18.56	46.39	10.26*	71.62*	05.93*	19.33*	06.43*	74.37*	05.51*	10.84*
						(31.39)	(08.02)	(-03.09)	(-30.18)	(40.30)	(10.77)	(-03.51)	(-38.67)
Mud		88.52	40.93	15.24	21.19	06.22*	74.07*	06.29*	08.35*	03.17*	79.30*	03.76*	-00.02*
						(42.56)	(10.47)	(-02.73)	(-41.16)	(52.24)	(15.71)	(-05.26)	(-49.54)
Curry		46.30	63.59	09.02	49.52	05.28*	76.10*	04.00*	08.99*	02.48*	81.08*	01.13*	00.99*
						(42.70)	(12.50)	(-05.02)	(-40.52)	(52.58)	(17.48)	(-08.19)	(-48.53)

Figures in parenthesis indicate percentage \* - Significant at 5% level of significance

(K/S) Colour strength (±L\*) Lightness and Darkness (±a\*) Redness and Greenness (±b\*) Yellowness and Blueness

### Colour strength and colour co-ordinate values of stains on white cotton samples subjected to multiple washes with 'PW' surfactant

Table 2 and highlights the colour strength (K/S) and colour co-ordinate values of stained samples subjected to multiple washes with 'PW' surfactant.

The results revealed from this Table that the highest colour strength value was observed with mud (88.52) followed by curry (46.30), pickle (43.68) and grease (25.04), at control, similar to the values of Table 1, i.e., there is decrease in colour strength (K/S) values of all the four stains on subsequent washes. It is observed that after first and second wash, there is decrease in colour strength (K/S) value of mud (45.38 % and 46.86 %), curry (39.44 % and 54.55 %), grease (33.03 % and 40.82 %) and pickle (30.07 % and 35.65 %) stains, respectively. From the observation it may be inferred that among the two surfactants the most effective surfactant found to be is WG than PW.

Similarly the lightness and darkness ( $L^*$ ), redness and greenness ( $a^*$ ) and yellowness and blueness ( $b^*$ ) value of control sample was found to be higher with grease (64.17), pickle (18.56) and curry (49.52). On subsequent washes there is decrease in the shade of all four stains.

However, maximum lightness ( $L^*$ ) is observed with curry (84.37) followed by pickle (80.43), grease (81.27) and mud (80.09), that of greenness was with curry (-02.44 %), mud (-03.53 %), pickle (-04.38 %) and grease (-08.54 %), finally blueness was found to be with curry (-52.57 %), mud (-50.21 %), grease (-43.56 %) and pickle (-42.04 %) after 3<sup>rd</sup> wash.

A similar trend of colour co-ordinates and colour difference values of stains were observed when cleansed with 'PW' surfactant, having pH 9.50. The curry stain, which was quite strong in colour strength next to mud, was brilliantly reduced in the 3<sup>rd</sup> wash (1.68 K/S value); in fact the results are much better than when washed with 'WG' surfactant. The main ingredient in curry is turmeric which leaves behind a nasty yellow stain which doesn't leave. Curry stains cannot be removed with simple detergents, but ingredients that have a bleaching effect are the only solution for curry stains (<http://www.removeallstains.com/2013/11/how-to-remove-curry-stains-from-clothes.html>). Further, the mud and grease stains were also appeared much lighter after washing with 'PW' cleanser. However, the pickle stain was found to be slightly harder to remove among the four stains.

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### Colour strength and colour co-ordinate values of stains on white cotton samples subjected to multiple washes with 'WBO' surfactant

Change in the colour co-ordinate and colour strength (K/S) values of different stains on white cotton fabrics when subjected to multiple washes with 'WBO' surfactant.

From the results was presents in the Table 3 that the stains have become lighter in colour when cleansed with 'WBO' surfactant and the results are supported with "E values of spectrophotometer. After each cleanse there is reduction in the shade of the stains but the intensity or level of decrease varied when compared with WG and PW surfactants.

It may be stated that WBO is effective on oily (grease, curry and pickle) and mineral (mud) stains because the  $L^*$  value is maximum with grease (08.10 %) and pickle (08.02 %);  $a^*$  values with grease (-09.01 %) and curry (-05.02 %) indicating higher greenness; and blueness ( $b^*$ ) among mud (-41.16 %) and curry (-40.52 %) compared to 'WG' and 'PW' after 1<sup>st</sup> wash. However, it is found that of the three selected surfactants, the most effective one in removing the grease stain is PW; mud, pickle and grease is WBO which has reduced the tint of the respective stains compared to 'WG' surfactant. Samanta *et al.* (2004) also stated that there are progressive increases in per cent soil removal as the number wash cycles increases.

### Conclusion

None of the old stains could be washed off in single cleansing, needs 2 – 3 washes where the surfactant acts on the stain each time and tries to reduce the shade of the stain. A reduction in colour strength was observed with all stains after 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> washes. The colour strength (K/S) value of curry stain was found to be lighter after 3<sup>rd</sup> wash which clearly indicates that PW surfactant having pH 09.50 is effective in removing the curry stain than mud, grease and pickle stains. The curry stain exhibited lighter  $L^*$  value (84.37) and greenness ( $-a^*$ , 0.43) value after 3<sup>rd</sup> wash when cleansed with 'PW' surfactant. Considering the values of colour strength and colour co-ordinates, it may be stated that 'WBO' is effective in discolouration of mud, grease and pickle stains. Irrespective of the surfactants and its pH, it is easy and simple to remove old curry stain but difficult to remove pickle stain. However, the K/S value did not change much with pickle stain which clearly indicated that this stain is hard to remove and may be classified as 'hard stain' or 'strong stain' or 'difficult to remove'.

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