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ORGANIC LIQUID DETERGENT FORMULATION AND ITS BIODEGRADABILITY POTENTIAL – AN EVALUATION

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ABSTRACT

Huge quantities of water are wasted due to poor management of the water system by humans. Water is used in two different ways, consumptive use and non-consumptive use. Depletion of energy reserves, ecosystem health, water security and other sustainability challenges are undermined behind wasting the water. Hence there is a threat to the freshwater resources all over the world in both developed and developing countries. It is also recorded that numerous strategies have been adopted to reduce, recycle and reuse the freshwater so as a conserved sustainable utility (Stanley *et al.,* 2012). It is also recorded that an estimated 1 billion lack access to drinking water and 2.7 billion people lack access to sanitation (Varosmarthy*et al.,* 2011). Both in developed and developing countries overlapping challenges are felt with reference to the freshwater management biodiversity (WHO 2008). The study involving the formulation of an organic liquid detergent was carried out in accordance with the standard protocol. Realising the need for effective conservation, the paper aims at encouraging people to adopt a cost-effective product that will be eco-friendly and inert the water conservation for future and present generations.

Keywords: Detergent Formulation-Soap Nut Plant - Biodegradability -Water Conservation-Sustainability

Introduction:

Water, soil and other facets of our environment were affected due to the chemical based cleaning products. If these synthetic cleaning products or the surfactants are substituted with naturally derived products then the water quality can be conserved thereby preventing many other types of pollution. The water quality of recycled water from the domestic usage can be enhanced by using natural surfactants extracted and formulated from plants. As these surfactants are plant derived they are called as Bio-surfactant. Natural surfactants possess several advantages over the chemically synthesized ones, and they have low environmental risk due to their natural origin (Song *et al.,* 2008). Some of the advantages of such compounds over the synthetic ones are their biodegradability, low toxicity, biocompatibility, low cost and specificity. They are available in large quantities and are also very effective in extreme conditions like temperature, pH and salinity (Kosaric, 2001; Rahman &Gakpe, 2008; Chhetri*et al.,* 2009). People use many types of laundry detergents, dish wash powder, sprays, acid based solutions to clean lavatory and other house hold things. All this products are chemical based and causes severe damage to the environment. These products are despite causing pollution to all units environment because they are non-bio-degradable. The synthetic products used for the purpose of cleaning clothes and dishes usually were found to produce very high amount of lather and thus people tend to use more water in order to remove the traces of these synthetic detergents there by very large amount of water were consumed in the process of cleaning. Quality of water was to found to get damaged due to these synthetically formulated cleaning products. In most of the multistoried buildings, the houses were built with water recycling set-up where the people are supplied only recycled water for all their house hold purpose except for drinking. In such cases the quality of recycled water could be made better if we promote and adopt using organic products in the processes of cloth washing, washing dishes and bathing (Muntaha&Khan, 2015). The present study involves in designing the formulation from *Sapindus*plant in combination with lemon skin and other natural dirt removing compound and develop an organic product, a liquid detergent which will be completely devoid of harmful products. The developed product is also tested for various physical and Physcio-chemical properties and the product formulation is tested for its biodegradability potential.

MATERIALS AND METHODS

Formulation of biosurfactant enriched liquid detergent:

Preparation of aqueous extract of soapnut fruits:

Aqueous extract of dried soapnut fruits (50 g) were extracted with 250 mL of distilled water using a soxhlet apparatus by hot percolation method. The cyclic extraction process was continued until no coloured pigments were found in the condensate. The obtained extract was concentrated under reduced pressure using a rotary evaporator. A wavelength scan was done for the obtained extract by using a UV-Vis spectrophotometer in the range 280 to 700 nm (10 mg/mL concentration) and peak absorption was observed at 465 nm.

Preparation of biosurfactant enriched liquid detergent:

Each 100 mL of biosurfactant enriched liquid detergent was prepared by adding 30% Sodium LaurethSulphate, 5M Urea, 50% Soapnut aqueous extract, 1 mL Lemongrass oil dissolved in 5 mL of ethanol. (U.S. Patent No. 3,812,041,1974) with few modification.

Evaluation of Biodegradability:

Biodegradability of Surfactants includes primary and secondary degradation, In primary degradation the surfactant loses its surface-active properties, In Secondary or ultimate degradation the surfactant is completely biodegraded into CO2, water, minerals and biomass (during biodegradation of e.g. laundry detergents the number of microorganisms feeding on the laundry detergent increases). Secondary degradation involves aerobic degradation (corresponds to degradation in sewage works) and anaerobic degradation (corresponds to direct degradation in soil).(OECD,1981; EC,1984).

RESULTS AND DISCUSSION

1.Organoleptic evaluation

The organoleptic evaluation was done for both the selected samples viz., sample (A)-Sapindusmukorossigaertn (Soap Nut Plant) and sample (B) –citrus lemon. Sample A was found to be yellowish to maroon in colour and sample B was found to be yellowish to white in colour, both the samples tastes bitter whereas they vary in texture. Sample A was fibrous and brittle and sample B was amorphous granular. **(Table 1)**

Table - 1: Organoleptic evaluation of selected samples

Characteristics	A	B
Colour	Intermittently yellowish and meroon	Intermittently yellowish and white
Odour	Soapnut	Mild mint odour
Taste	Bitter	Bitter
Texture	Fibrous and brittle	Amorphous granular powder

2. General powder characteristics

Particle size of the selected samples were determined using standard ip sieves. Both the samples was measured separately for their size and they were also mixed in a proportion to measure the size in the formulations. Sample A showed maximum size of 10mm and minimum of 0.05mm whereas sample B showed maximum size of 4mm and minimum size of 0.08mm in the preferred formulation (0.1 of A and 0.9 of B) showed the maximum and minimum size of 10 mm and 0.05mm respectively. **(Table 2)**

Table - 2 : Particle size of the selected samples

Particle size	A (mm)	B (mm)	Preferred formulation 0.1 A + 0.9 B (mm)
Minimum	0.05	0.08	0.05
Maximum	10	4	10

3. Angle of repose

The angle of repose was measured using the funnel method for the preferred formulations and their results were tabulated. The height of the heap, radius of the base was used to calculate the angle of repose in the preferred formulations the angle of repose was found to be 35.27. **(Table 3)**

Table - 3: Angle of repose of the samples in separate and for the formulations

	A	B	Preferred formulation 0.1 A + 0.9 B
H	0.031	0.022	0.029
R	0.039	0.0425	0.041
Angle of repose (θ=tan-1(h/r))	38.48	27.37	35.27

4.pH

The pH of the samples were determined for various combinations of sample A and sample B and the results were tabulated. Neutral ph (7) was observed when the concentration of sample A was

maximum and sample B was minimum and minimum ph of 6.1 was observed when the sample B is found in maximum concentration and sample A was in minimum concentration. **(Table 4)**

Table - 4: pH of the sample solution

Percentage of A in solution	Percentage of B in solution	pH of the solution
10	0	7
0	10	6.1
1	9	6.4
2	8	6.4
3	7	6.5
4	6	6.5
5	5	6.5
6	4	6.7
7	3	6.8
8	2	6.9
9	1	6.9

5.Washability

In the washability test sample a was found to have more foam forming capabilities than sample B when measured manually, hence sample A posses more surfactant property than sample B.

6.Solubility

The preferred formulations of sample A and sample B was checked for their solubility percentage .along with this the residual weight and dried weight was also calculated and tabulated. The solubility percentage was found maximum (69 %) when both the sample concentration was in equal proportions. The minimum solubility percentage (16%) was recorded for maximum concentration of sample B and minimum concentration of sample A. **(Table 5)**

Table - 5: Percentage of Solubility of the samples

Amount of sample A (g)	Amount of sample B (g)	Residual weight	Dried weight	Solubility Percentage
1	0	0.66	0.34	66
0	1	0.94	0.58	42
0.1	0.9	33.08	0.84	16
0.2	0.8	27.37	0.61	39
0.3	0.7	27.13	0.53	47
0.4	0.6	22.78	0.39	61
0.5	0.5	21.83	0.31	69

7. Loss of drying

Loss of drying of the preferred formulations of sample A and sample B was calculated and denoted in percentage. The loss of drying of sample A and B for the formulations were 8, 0.3 and5.6 respectively. **(Table 6)**

Table - 6: Percentage Loss of drying of the samples

Percentage loss in drying (%)		
A	**B**	**A:B (1:9)**
8	0.3	5.6

8. Extractive values

The extractive values were calculated for both the samples in two samples namely water and ethanol and their percentage was recorded, in ethanol the extractive values were 15.3, 8.13 and 10.67 for sample A and B and formulation respectively. The extractive values of water were found to be 67, 38 and 46 for sample A and B and formulations respectively. **(Table 7)**

Table - 7: Percentage solubility of the samples in ethanol and in water

	A	**B**	**A:B (1:9)**
Percentage solubility in ethanol (%)	15.3	8.13	10.67
Percentage solubility in water (%)	67	38	46

9. Ash content

The total ash content and acid insoluble ash content percentage was calculated and represented in percentage in the preferred formulation (A:B) (1:9), the acid insoluble ash content was found to be lesser (2.7 %) than the total ash content (3.8%). **(Table 8)**

Table - 8 : Total ash content and acid insoluble ash content

	A	**B**	**A:B (1:9)**
Total ash content (%)	5.1	3.4	3.8
Total acid insoluble ash content (%)	4.8	1.2	2.7

Biodegradation of detergents:

Soil sample were serially diluted using distilled water and 100 µL of 10-6 dilution was inoculated in nutrient broth and kept for incubation at 37° C for 24 hrs. The lambda max of Urea, Sodium LaurethSulphate and soapnut aqueous extract were determined to be 315, 247 and 465 nm respectively. To study the biodegradation, 2.5 mL of the broth was added to 250 mL of liquid

detergent, soapnut extract and soapnut extract enriched liquid detergent. OD values were noted for 8 consecutive days and graphs were plotted with OD against days.

The biodegradability of soapnut aqueous extract, chemical detergent and soapnut extract enriched detergent was recorded the results showed that the chemical detergent did not show any degradability after eight days. The soapnut aqueous extract showed degradation significantly from day one to eighth day. The degradability was 1.2842(OD) on the first day whereas on the eighth day the OD was recorded to be 0.4331, similarly the soapnut extract enriched detergent showed significant degradation from the day one to eight 1.5646 to 0.3229 respectively. The degradation was more when compared with the soapnut aqueous extract and chemical detergent.The biodegradability of urea present in the soapnut aqueous extract, chemical detergent and soapnut extract enriched detergent was evaluated. The soapnut aqueous extract did not show any change in the degradability potential whereas chemical detergent showed significant decrease in the degradability from 0.98 to 0.34, the soapnut extract enriched detergent showed enhanced degradability of urea than the other two samples from 0.94 to 0.28.**(Table 9)**

Table - 9: OD at 465 nm and OD at 315 nm for the samples:

	OD at 465 nm (Biodegradation of soapnut extract)			**OD at 315 nm (Biodegradation of Urea)**		
Day	**Soapnut aqueous extract**	**Chemical detergent**	**Soapnut extract enriched detergent**	**Soapnut aqueous extract**	**Chemical detergent**	**Soapnut extract enriched detergent**
1	1.2842	0.1356	1.5646	0.0452	0.9825	0.9458
2	1.1648	0.1247	1.2421	0.0546	0.9148	0.7834
3	1.0601	0.1243	1.1684	0.0537	0.8932	0.6935
4	0.8704	0.1346	1.0758	0.0538	0.7583	0.6985
5	0.7794	0.1323	0.9437	0.0483	0.7036	0.6823
6	0.5715	0.1395	0.6594	0.0457	0.5673	0.4532
7	0.5448	0.1432	0.4358	0.0437	0.5328	0.4356
8	0.4331	0.1375	0.3229	0.0485	0.3485	0.2858

The sodium laurethsulphate is the main component of any detergent formulation the degradability of the soapnut aqueous extract, chemical detergent and soapnut extract enriched detergent was tabulated (Table 11 figure 3). The soapnut aqueous extract is devoid of sodium

laurethsulphate so there is no decline in the degradability potential whereas the chemical detergent showed degradability significantly from day one to eight (0.98 to 0.34) but soapnut extract enriched detergent showed more degradability potential than the chemical detergent (0.94 to 0.31). The microbial growth in the Soapnut aqueous extract, Chemical detergent and Soapnut extract enhenced detergent was calculated and the response was tabulated. It was found that in the chemical detergent the microbial growth was very minimal and was found to decrease from day one to eight (0.45 to 0.15) soapnut extract enhanced detergent showa enhanced microbial growth which was observed in increased OD whereas soapnut aqueous extract also showed increased microbial growth than the other two samples of our study .The enhanced microbial growth was also found to be significant. **(Table 10)**

Table - 10: OD at 247 nm and OD at 600 nm for the samples

	OD at 247 nm (Biodegradation of Sodium LaurethSulphate component)			**OD at 600 nm (effect on microbial growth)**		
Day	**Soapnut aqueous extract**	**Chemical detergent**	**Soapnut extract enriched detergent**	**Soapnut aqueous extract**	**Chemical detergent**	**Soapnut extract enriched detergent**
1	0.0452	0.9825	0.9458	0.4256	0.4563	0.4643
2	0.0546	0.9148	0.8938	0.5187	0.4345	0.4867
3	0.0537	0.8932	0.8924	0.5467	0.3464	0.4865
4	0.0538	0.7583	0.7458	0.5758	0.3857	0.5139
5	0.0483	0.7036	0.6837	0.6241	0.2948	0.5783
6	0.0457	0.5673	0.5258	0.7834	0.2485	0.6845
7	0.0437	0.5328	0.4834	0.9587	0.1938	0.7358
8	0.0485	0.3485	0.3198	1.2434	0.1564	0.8336

Conclusion:

The study involving the forrmulation of an organic liquid detergent was carried out in accordance with the standard protocol and the timeline of the work was adhered properly .The organic detergent formulation was made using the sapindus extract, the physio-chemical properties of the extract was evaluated .The biodegradability of the soapnut aqueous extract, chemical detergent and the soapnut extract enriched detergent was also examined by standard methods . It was found that in all our study our organic formulation enriched with soapnut extract showed more biodegradability potential than the chemical detergent the main constituent

of the detergent formulation such as urea and sodium laurethsulphate showed increased degradability in the organic detergent formulation than in the chemical detergent ,the microbial growth was also found to be more in soapnut aqueous extract than in soapnut extract enriched detergent whereas the chemical detergent did not show any significant microbial growth . Hence in our study all the objectives proposed in the project proposal was completed successfully.

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