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Liquid laundry detergents based on polymeric surfactants containing sorbitol, starch and sugar syrup

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ABSTRACT

A combination of natural products of vegetable origin viz. sorbitol, starch and sugar syrup have been used along with acids and minor proportions of polyethylene glycol(400) to synthesis a novel polymeric surfactant which can be used to replace acid slurry in powder, liquid and cake detergents. The synthesized polymer has been studied for physicochemical and spectral properties. I.R. and N.M.R. spectra show the presence of ester, ether, free hydroxyl and acid groups in the polymer. The synthesized polymers have been used in liquid laundry detergents to the extent of 10 to 14, %. These polymers containing liquid laundry detergents show excellent viscosity, transparency, foaming properties and capacity to reduce surface tension, soil and stain removing characteristics are satisfactory and comparable to commercial liquid detergents tested simultaneously. These ecofriendly products must be tested and tried for pilot and commercial production.

Keywords: Detergents, polymeric surfactants, HLB ratio, ecofriendly products.

INTRODUCTION

Starch, sorbitol and sugar are globally available commodities of vegetable origin. These materials are produced in huge amount and can be used as key ingredients in detergent compositions. In our earlier efforts we have used malenized oils, rosin, starch and sorbitol to develop novel polymers which can be used in powder, liquid and cake detergents. In third world countries like India and south East Asian countries powder and cake detergents are still popular. In western and developed world powder and cake detergents have already been replaced by liquid laundry detergents. There are practical and commercial difficulties in promoting liquid detergents in third world countries.

In this present piece of research workcheaper vegetable products likesugar [1],starch [2], andsorbitol [2, 3] havebeen used to synthesis polymers which can be used as a replacement of acid slurry of petroleum origin. The liquid laundry detergents available in India are very costly. This is an attempt to develop cost effective ecofriendly and technically superior liquid laundry detergents.

MATERIALS AND METHODS

A) **Synthesis of polymer**: - The synthesis of polymer has been carried out in two liter four neck glass reactor fitted with a stirrer(with speed control), thermometer(control±3^{0}c) and condenser. At first syrup of sugar and starch were

prepared by mixing with desired amount of water and introduced in the reactor sorbitol, polyethylene glycol and acids were added.Finally catalysts were (sodium metabisulphite, sodium bisulphate, con. HCl and acetic acid) added to the reactor. The temperature was raised slowly and steadily. It takes about 70 to 90 minutes to attain temperature of 130^0c. At this temperature the heating was continued for next three hours. At the end of this period when desired acid value and viscosity is attained the reactor was cooled to 80^0c and then the sample was filtered and stored in corkedbrown glass bottles.

Table-1 Composition of sugar sorbitol based polymers(% by weight)

Serial No.	Raw material	Batch-1	Batch-2	Batch-3
1	Starch (70%)	-	50	30
2	Sorbitol (70%)	40	20	40
3	Polyethylene glycol(400)	10	10	10
4	Sugar syrup (60%)	30	10	10
5	Maleic anhydride	7	7	7
6	Citric acid	5	3	3
7	Oxalic acid	5	-	-
8	Phthalic anhydride	3	-	-
Catalyst used	Sodium metabisulphite	1.5	1	1
	Sodium bisulphate	1.5	1	1
	Con. HCl	1	-	1
	Acetic acid	-	1	-

Table-2 Analysis of novel polymers based on sorbitol, starch and sugar

Serial No.	Polymer property	Batch-1	Batch-2	Batch-3
1	Acid value of polymer	155	82	51.69
2	pH of 1% solution	3	3	4
3	% solid	70.8	70.20	73.71
4	Solubility 1.Water 2. Xylene	 Soluble Insoluble	 Soluble Insoluble	 Soluble Insoluble
5	Hydrophilic-lipophilic balance of polymer	18.1	11.17	11.82
6	Flow time in second at 30^0c by Ford cup no. 4	203	160	158
7	Surface tension in dyne/cm by Ostwald's viscometer.	35.57	34.20	29.19
8	Oxiraneoxygen (%)	3.49	2.39	2.70
9	*Foam volume in $cm^3$by cylinder method.	800	900	700

**Foam volume was measured for combination of 90% polymer and 10% linear alkyl benzene sulphonate (LABS) neutralized.*

Table-3 Composition of liquid detergents (% by weight)

Serial No.	Raw material	LB-1	LB-2	LB-3
1	Acid slurry	12	10	08
2	Polymer(batch-3)	10	12	14
3	SLES (40%)	5	5	5
4	SLS (30%)	3	3	3
5	Sodium sulphate	3	3	3
6	Sodium carbonate (50%)	7.5	7.0	7.6
7	Distilled water	59.5	60	59.4

Note*- Sodium hydroxide neutralized polymer acid slurry was used as a solution in water*

Table-4 Analysis of liquid detergents at 1% concentration

Sample	Density in g/cm^3 By density bottle	Surface tension in dyne/cm by stalagmometer	Foam volume in $cm^3$by cylinder method			Viscosity Flow time in sec (at 30^0)
			0 min	5 min	10 min	
LB-1	1.046	36.84	1000	900	840	160
LB-2	1.019	34.01	900	800	720	180
LB-3	1.013	37.50	800	700	630	170
CD-1	1.21	38.31	1000	800	750	210
CD-2	1.21	36.66	1000	800	750	230

Note: *The pH of all samples was 8.5-9 at 1% concentration in distilled water*
CD-1 and CD-2 are commercially available market liquid detergents.

B) **Analysis of polymers**: - The physico- chemical properties of polymers like acid value, pH, % solids, H.L.B. value, surface tension [5]viscosity [6], and % oxirane oxygen were determined by standard laboratory methods as given in literature[1,2,3,4,5]. The foaming characteristics of (90%polymer: 10% acid slurry) were also measured by cylinder method [5, 6]. The I.R., N.M.R and mass spectra have been obtained from research laboratory in Chandigarh, (Brucker Advance 400 NMR Spectrometer, SAIF, Punjab University, and Chandigarh. (Fig.1, Fig.2and Fig.3). This data is essential to confirm the presence of ester, ether, free hydroxyl and free acid groups in the polymer selection and molecular weight.Finally liquid laundry detergents were formulatedsee Table- 3. All ingredients were taken in a glass reactor and homogenized by running the stirrer for about an hour. The solution is cooled in refrigerator at 10^0c for 48 hours. The clear liquid solution was filtered and packed in superior grade air tight plastic containers.The analysis of liquid detergents is given in Table-4 Simultaneously commercial liquid laundry detergents were analyzed so that we can compare our products with performance of commercial products. Density, surface tension, foam height and viscosity are reported in Table -4.Finally cleaning capacity of detergents [7] prepared along with commercial samples is given inTable-5. Standard technique of soiling and stain removing as given in literature is adopted in all these tests[8, 9].

Table-5 Stain removing properties of laundry liquid detergents based on novel polymer-Batch-3

Sample	Soil	Tea	Coffee	Spinach	Cleaning score
LB-1	3	4	3	4	14
LB-2	3	3	3	3	12
LB-3	2	3	3	3	11
CD-1	3	4	4	4	15
CD-2	3	4	4	4	15

Abbreviation- 4*: 90% stain removed,* ***3****: 75% stain removed,* ***2****: 50% stain removed.*
CD-1, CD-2-Commercially available market liquid detergents1and 2.

Fig.1 IR spectra of Batch-1 polymer

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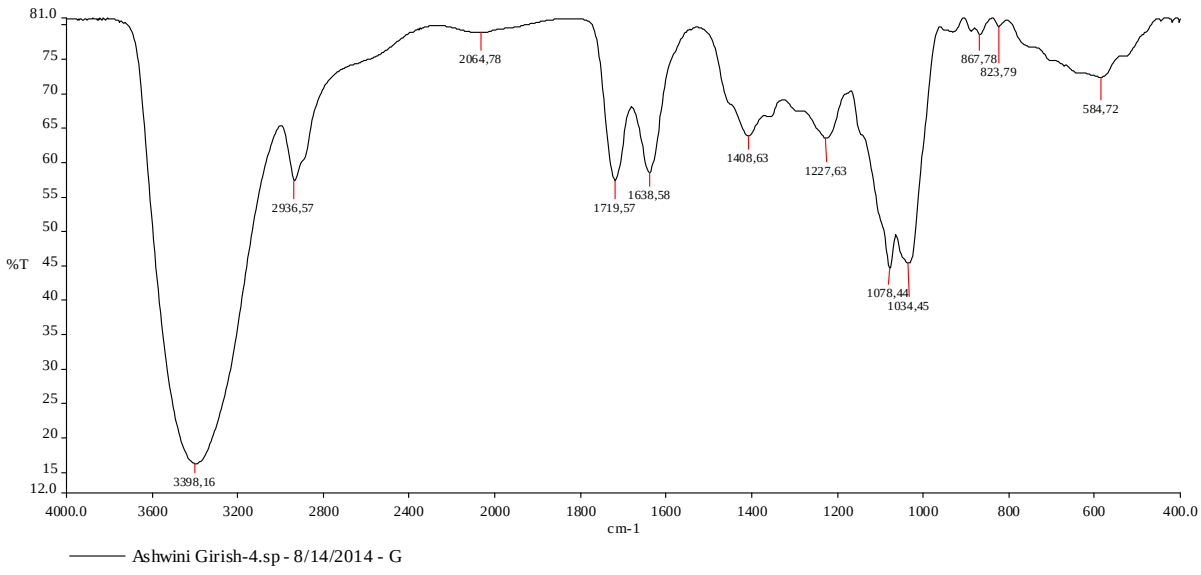


Fig.2 NMR spectra of Batch-1 polymer

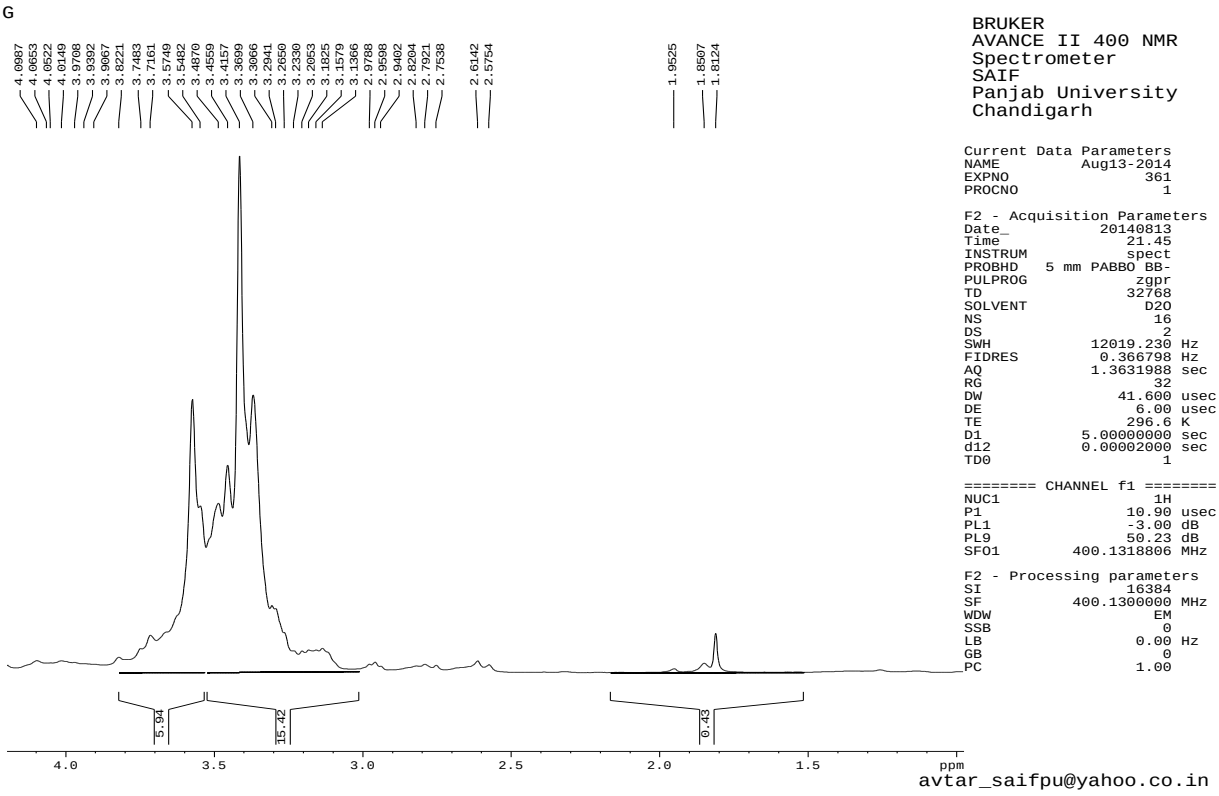
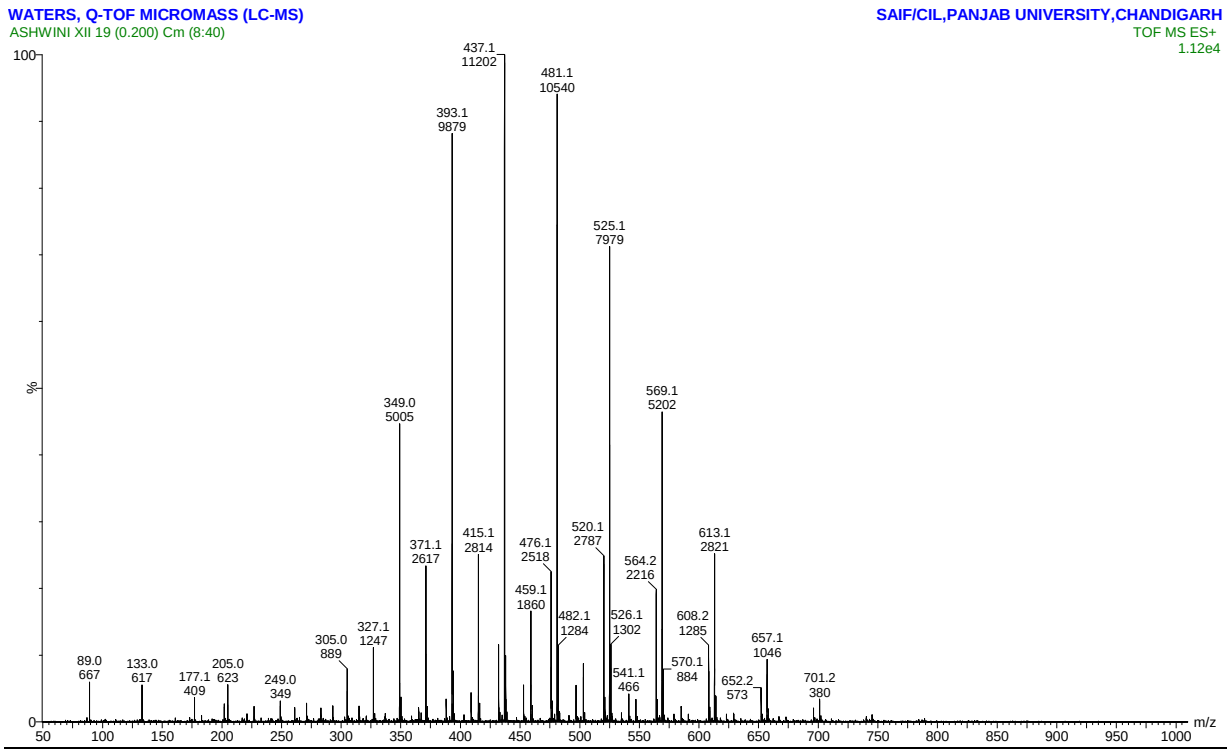


Fig. 3 Mass spectra of Batch -1 polymer



RESULTS AND DISCUSSION

1) The composition of novel polymer is given in table No.1
2) The use of polyethylene glycol has been especially tried as this gives enhanced water solubility cleaning and stain removing capacity to the polymer acid catalysts have beenused as shown in Table-5.
3)The physicochemical analysis of prepared polymer is shown in table No. 2. Depending upon the input and quantity of acids theacid value of samples varies from 51 to 155. The solids for all samples are 70-73%. The sample is soluble in water but insoluble in organic solvents like xylene
4)The polymer 1 which contains higher proportions of acids is having higher viscosity while samples containing 10% acids is slightly lower still all the samples have a reasonable viscosity so they can be handled and used in various detergent formulations. The surface tension reduction is appreciably good in all samples. The % oxirane oxygen show the presence of epoxy groups in the molecule which will enhance water affinity and stain removing capacity of polymer. The foam volume of samples containing 10% acid slurry is appreciably good.
5) The composition of liquid laundry detergents is shown in Table No. 3. Increasing property of novelpolymer (10-14%) has been used and progressively acid slurry is decreased from 12-08 % other ingredients are practically constant in all compositions.
6) The physicochemical analysis of prepared laundry detergents along with commercial samples are shown in Table 4.Reduction in surface tension and foam height is comparable to commercial samples while viscosity is slightly less than commercial samples.
7) The foaming characteristics of polymers with incorporation of 10 % acid slurry gives satisfactory foaming (see Table No.2).
8) In laundry liquid detergent compositions progressively 10 to 14%. Polymer can be incorporated without satisfactory performance characteristics of the polymer. In sample we reduced the proportion of acid slurry to just 8% without satisfactory performance.
9) Smaller quantities of S.L.E.S.(40%) and S.L.S.(30%) have been used to boost the foaming characteristics.
10)A comparative analysis of liquid laundry detergent with commercial samples is given in Table No. 4. Our samples are on par with market liquid detergent compositions in respect of foam, viscosity and surface tension reduction.
11)The stain removing properties of polymer based samples are comparable to commercial samples tested simultaneously.
12)This research work will boost the sales and marketing of liquid laundry detergents in third world countries which is the need of our for third world countries.
13)The stain removing properties as given in table show that our samples have practically the same cleaning score as compared to commercial samples.
14) Powderdetergent pollutes the rivers and lakes with carbonate, dolomite, salt and other fillers used in powder detergents. Our liquid laundry detergents are practically free from these chemicals. This will help in creating ecofriendly environment.
15)Pilot plant and commercial production of these products should be taken up by industries.
16)The average molecular weight of Batch-1 polymer is 3638.(Fig. 3)

CONCLUSION

1. Novel polymers based on 80% vegetable sourced material (sorbitol, sugar and starch) can be successfully prepared by selecting proper mole ratio, temperature and time of heating as show in Table No.1.
2. Use of 10 to 20% organic acids gives desirable properties of viscosity, surface tension reduction and water solubility.
3. Sodium metabisulphite, sodium sulphate and 1% HCl can be used successfully as catalyst.
4. The H.L.B.ratio, viscosity, foaming and surface tension reducing capacity suggest its use in liquid laundry detergents.
5. The presence of oxirane oxygen group as indicated by % oxirane oxygen give water affinity, cleaning and stains removing capacity to polymer.
6. The following chemical reactions are possible in the polymer-

a) Esterification of acid groups and –OH groups in sorbitol, sugar and starch.
b) Etherification in –OH groups of same polyols or other polyols in the molecule.

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REFERENCES

[1] A. D. Deshpande, B. B. Gogte, B. W. Phate, *International Journal Of Chemtech Research*,**2010**,2(4),2009-2014.
[2] B.B. Gogte, A.S. Agrawal, *Detergents & Toiletries Review*, 34, **2003**, 25-28.
[3] B.B. Gogte, A.S .Agrawal, *Soaps, Detergents & Toiletries Review*,34,**2003**,19-22.
[4] S.K. Kharkate, V.Y. Karadbhajne,B.B.Gogte, *Journal Of Scientific And Industrial Research*,64.october **2005**,752-755.
[5] Harries," Detergency evaluation and testing," Wiley- interscience publisher, 92-103, **1954**.
[6] ASTM standard methods, for viscosity by ford cup method, **1982**, 1200-82.
[7] BIS' methods for the test for detergency for household detergent, BIS,**2000**, 4995.
[8] B.B. Gogte, P.V. Patil, *Journal Of Chemical Engg. World* (40), **2000**, 71-75.
[9] B.B. Gogte, J.R. Dontulwar, *Asian Journal Of Chemistry*, **2004**, 16(3), 1385-1390.