CONCOCTION OF BIO BASED POLYMER AND ITS APPLICATION IN PERSONAL CARE PRODUCTS

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Abstract: Bio-surfactant is a bio-based (mainly plants and animals) derived class of surface active molecules. This manifold class of surface active molecules contains both hydrophobic and hydrophilic moieties in their organized structure which lets them partitioning the liquid/liquid (mainly), gas/liquid or solid/liquid interfaces resulting into lower interfacial tension. This facilitates their emulsification, foaming, solubilization, detergent and dispersing functioning. This nontoxic, biodegradable and eco- friendly bio-molecules are competent to replace/blend with their chemically synthesized counterparts and divulge themselves as a green alternative to be applied in the application field of food, cosmetic, pharmaceutical, petrochemical and others. The high molecular weight bio-surfactants such as Guar gum are also known as bio-emulsifiers. Efforts have been made to discuss the bio-surfactants based polymer and their blending with chemical counterparts along with their advantages, their properties and their application in cosmetic & pharmaceutical industry. Prime objective is to produce bio-surfactants based composition involving bio- based surfactants and its application in personal care formulations such as shampoos.

INTRODUCTION

The term surfactant is derived from the term surface active agent and is defined as a substance which at low concentration has the property of absorbing onto the surfaces or interfaces of a system and altering the surface or interfacial energies of those surfaces (or interfaces).**Chemical Surfactants** are mainly petroleum based and are widely used in cleaning products, detergents and various cosmetics like shampoos, shower gels and bath products. The main disadvantages of using chemical based surfactants are that they contribute to the depletion of non- renewable resource and are highly polluting. If the surfactants enter into the human body, they damage the enzyme activity and thus disrupt the body's normal physiological function. They are slightly biodegradable and they can release toxic chemicals when they decompose. [1]

Bio-based surfactants, a group of surface-active compounds based on plant origin, have emerged as promising alternatives to the chemical surfactants. In the past 10 years, bio-surfactants have received pronounced attention owing to their excellent interfacial activities, low toxicity, high biodegradability, and stability under extreme conditions of temperature, pH and salinity. [2] As a result of these properties, bio-surfactants can be blended with chemical surfactants in many industrial applications. **Bio-surfactants** are diverse groups of surface active molecules/chemical compounds referring to plant origin. These are amphiphilic molecules having both hydrophilic and hydrophobic domains that confer the ability to accumulate between fluid phases, thus reducing surface and interfacial tensions at the surface and interface respectively. [3] The use of chemicals for the treatment of a hydrocarbon polluted site may contaminate the environment with their by-products, whereas biological treatment may efficiently destroy pollutants, while being biodegradable themselves.

Surfactant Type	**Characterization**	**Test duration in days**	**Biodegradability (%)**
AOS	C_{14}-C_{16}	70	0
MES	C_{10}-C_{17}	70	0
Alcohol Sulfonates	C_{18}	70	88
lkyl ether Sulfates	C_{12}	56	0-30

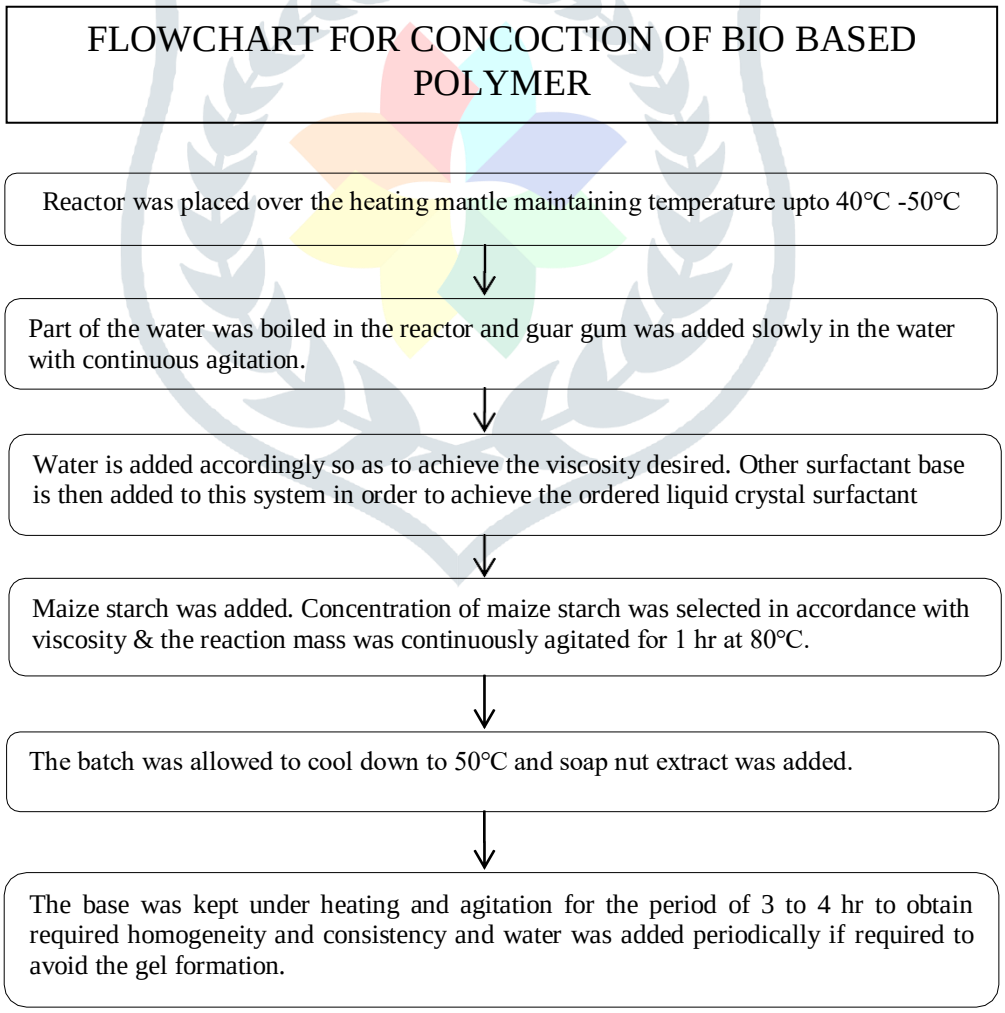
Table 1-Biodegradability of some of the widely employed Chemical (anionic) surfactants [4]

EXPERIMENTATION

The ingredients with their composition are shown in the table below.

INGREDIENTS	LATION I	LATION II
Guar gum	0.5	0.75
Maize starch	9.5	9.5
Soap nut Extract	4.0	6.75
Borax	0.3	0.3
Citric acid	3.7	3.7
Water	82.0	79.0

Table 2- Formulation of BIO based polymer



ANALYSIS OF BIO-BASED POLYMER

Parameters	ılation I	ulation II
pH (100%)	1	1
pH (1.00%)	5	5
Viscosity (1%)	8.68	8.96
% solids	23.6	20.55
m Height (1%)	370	350
AV	55.63	51.24
SV	77	71

Table 3-Properties of polymer DETERMINATION OF BIODEGRADABILITY OF

FORMULATION I:

- COD analysis as per Indian standards: In the reflux flask, 0.4 g of HgSO4, 20 ml of diluted sample

were added and mixed well. Subsequently 10 ml of 0.25 N $K_2Cr_2O_7$ and 30 ml H_2SO_4-Ag_2SO_4 solution were added with constant stirring and the contents were refluxed for 2 hours.[5][6][7] After refluxing, the content was titrated against standard ferrous ammonium sulphate solution using ferroin indicator.[8][9]

- Dissolved oxygen analysis as per Indian standards: 2 ml of manganese sulphate solution followed by 2 ml of alkaline iodide and sodium azide solution were added. The precipitate was allowed to settle at the bottom. [10] After settling 2 ml of concentrated sulphuric acid was added to dissolve the precipitate. Again it is mixed and shacked to dissolve liberated iodine. [11] This solution was taken and titrated immediately against standard sodium thiosulphate.[12]

- BOD analysis as per Indian standards: The required volume of distilled water was aerated in a container by bubbling compressed air for 8 to 12 hours to attained dissolved oxygen saturation level.[13][14]1 ml each of phosphate buffer, magnesium sulphate, calcium chloride and ferric chloride were added for each litre of dilution water.[15] 5 ml of treated sewage per liter of dilution water was added for seeding purpose and the sample was incubated at 20 degrees.[16]

The value of COD of a polymer for a particular dilution remains same and taking the same amount of dilution for BOD we can conduct the BOD/COD biodegradability test. Taking the COD as a base value, the calculation for BOD/COD can be done.

BIODEGRADABILITY OF FORMULATION I

COD of sample of formulation I:
Blank = B = 2.7ml Sample= S= 2.2ml
COD [17] = (B-S)*N*8000/V = (2.7-2.2)*0.833*8000/10 **= 332mg/L**

DO (for day 0)
Initial DO of sample = 5.4mg/L
Initial DO of blank = 5.3mg/L

DO (for day 4)
DO of sample after 4 days = 0.6mg/L
DO of blank after 4 days = 0.7mg/L BOD (for day 4)
[18] = [(initial DO of sample- DO of sample after 4 days) – (initial DO of blank –DO of blank after 4 days)]*p
[(5.4-0.6) – (5.3-0.7)] * 250 / 0.5
=100

(BOD/COD) for 4^{th} day= 100/332 = **0.301**

Hence, the bio-surfactant degraded 30.1% in 4 days of incubation.

MODIFICATIONS IN THE BIO-BASED POLYMER (FORMULATION I)

In order to commensurate the properties of the bio-polymer to the commercial surfactant base; it was blended with small amount of SLES. Three different blends were formed depending upon the amount of the SLES added. These are as follows:

Sr. no.	Polymer %	SLES%
1	90	10
2	80	20
3	70	30

Table 4-Addition of varying % SLES to Polymer

All the three blends were tested for the primitive properties of the polymer, and optimum was selected.

ANALYSIS OF MODIFIED BIO BASED POLYMER

The **formulation I** formed shows bit of less foam height as compared to commercially available synthetic surfactant (700-750 ml). In addition to this, surface tension of the polymer was observed to be high.
The analysis of the modified formulations is:

Parameters	(90-10)%	(80-20)%	(70-30)%
pH (100%)	1	1	1
pH (1%)	6	6	3
Foam height (1%)	440	600	850

Table 5-Properties of Bases modified

INFERENCES:

- Considering the pH, the pH of (70-30) % composition in 1% solution is very acidic, which is not desirable for cosmetic formulation. Thus (70-30) % is discarded.
- Further, considering the foam height, the foam height of (80-20) % composition is well within the range. Hence, (80-20) % composition is found to be most suitable for further formulations.

Thus, Desired & optimum Bio- based surfactant polymer was FORMULATION I, modified with (80-20) % SLES composition. The base formulated is used to prepare personal care formulations.

APPLICATION OF BIO-BASED POLYMER IN PERSONAL CARE FORMULATION

Ingredients	Formulation I	Formulation II
Sorbitol	-	20
Glycerin	20	-
30% SLS	10	-
Bio-based Polymer	50	55
SLES	20	20
AOS	-	5

Table 6-Formulation of Shampoo

PROCEDURE:

- Take the required amount of polymer in the beaker.
- To this add sorbitol, glycerin, SLES, AOS and SLS solution slowly.
- Mix the mass thoroughly till a homogeneous and consistent mixture is obtained.
- Avoid vigorous agitation as it will cause foaming.
- Allow the mixture to stabilize overnight and thus shampoo is formulated.

ANALYSIS OF SHAMPOO:

Parameter	Formulation I	Formulation II
Surface tension (1%)	14.223 dyne/cm	19.663 dyne/cm
Foam height (1%)	780ml	920ml
% solids	67.82%	71.1%
pH (1%)	5	6
Viscosity (1%)	10.95sec	10.99sec

Table No 7-Analysis of Shampoo

INFERENCES:

- The pH of formulation I & II are nearly same.
- Foam height was found to be max in formulation II as compared to the other formulations.[19]
- Surface tension was found to be near about same in all the formulations as determined using stalagmometric method[20][21]
- Viscosity was also found to be same in all the formulation by using Fords cup No.4[22]

COMPARISON OF COMMERCIAL SHAMPOOS WITH SHAMPOO BASED ON BIO-BASED POLYMER

Parameters	Head & shoulders	Dove	Formulation II
pH (1%)	7	7	6
% solids	15.75%	20.2%	71.1%
Surface tension (1%)	15.999 dyne/cm	18.866 dyne/cm	19.663 dyne/cm
Foam height (1%)	830ml	870ml	920ml
Viscosity (1%)	11.01sec	10.96sec	10.99sec

Table No 8-Analysis of commercial Shampoos with formulation II

CONCLUSIONS

- It was observed that sedimentation was seen in formulations II. Gel formation was observed in formulations II which is not desirable in base polymer.
- % solids were observed to be least in formulation I which is inclined to more eco-friendly product which is desirable for formulating personal care compositions.
- Surface tension and viscosity of all formulations were in vicinity of each other. Homogeneity and consistency of formulation I was observed to be better than that for formulations. Thus, formulation I was selected as base polymer for further processing in the preparation personal care formulations.
- During the modification of Bio-based polymer, the pH of 70-30 composition in 1% solution is observed to be acidic, which is not desirable for cosmetic formulation, thus 70-30 composition is discarded.
- The foam height of 80-20 composition is well within the range to concoct personal care products. Hence, 80-20 composition is found to be propitious for further processing. Thus, Desired & optimum Bio- based surfactant polymer was FORMULATION I, modified with (80-20) % SLES composition. The base formulated is used further to prepare personal care products.
- Synthetic surfactants leading to contamination of the environment represents a serious threat to the health of humans and ecosystems. Given the human health effects of synthetic surfactants, effective and cost- competitive remediation technologies are required.
- Bioremediation has shown promise as a potentially effective and low-cost treatment option, but concerns about the slow process rate and bioavailability limitations have hampered more widespread use of this technology.
- Bio-surfactants are one of the most promising compounds in this regard. The success of the commercialization of a biotechnological product mainly depends on the economics of process.
- The future of bio-surfactants is expected to be very bright because of their environment-friendly composition and wide range of applications. Through various experiments performed over the bio- surfactant base, it concludes that the results to the date are promising and in future, these products have potential to replace the current synthetic surfactants products

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