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Improving the film forming ability of gum arabic

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ABSTRACT

The utility of gum Arabic (Acacia Species) as film former (binder) in formulations was investigated. Some property such as blistering and scratch adhesion of the solutions of crude gum Arabic as a sole binder in formulations were investigated and compared to those of solutions of modified gum Arabic. From the work carried out, it was discovered that the quality of the film resulting from the solution of crude gum Arabic was poor. In order to improve the film forming ability of gum arabic, some additives such as plasticizers and cross-linking agents were incorporated. It was found that the solution of gum Arabic with plasticizer and cross-linking agents incorporated gave a high quality film than that of the crude gum Arabic. It was recommended that additives should be incorporated into gum Arabic solution in order to achieve high quality films.

Key words: Gum Arabic, film, plasticizers, cross linking agents.

INTRODUCTION

Origin/production of gum Arabic:
Gum arabic (Acacia species) is a dried exudates from species of the acacia tree found in the various tropical and semitropical areas of the world. Most of the commercially available gum comes from a single species called ***Acacia Senegal*.**

The acacia tree produce gum arabic under adverse conditions such as lack of moisture, poor nutrition and hot temperature.Moreover, [1] found that gum arabic is produce by bacteria on wounded surface of acacia trees. The wound are generally produce deliberately in cultivated trees by stripping barks during the dry season. The gum is collected by hand over a period of several weeks with average yield of 250g per tree per year.

Gum Arabic (***Acacia Senegal***) is a complex mixture of calcium, magnesium and potassium salts of Arabic acid; a complex branched polysaccharide that contains D- galactose, L-rhamnose, D-glucuromic acid and L-arabinose residues,[2]. [3] discovered that the constituent sugars of gum Arabic are the same but composition and molecular weight of the gum varies from species to species. Reported molecular weights are in the range of 260,000 to 1,160,000; suggesting a broad molecular weight distribution.

Uses of gum Arabic:
According to [4], he revealed that gum Arabic has a wide range of industrial usage. The various industries where gum arabic has been used extensively as binder (film former) inlude; food industry, pharmaceutical industry, medicine, cosmetic industry, paint industry and several other manufacturing industries.

In paints and similar formulation flocculation, gum Arabic is used as binder where it prevents hard setting of pigments. Such controlled flocculation has frequently been achieved by means of additives which presumably affects the coherence of particles in immiscible liquids [5].

Gum Arabic is a non-toxic, tasteless, colorless, odorless, water-soluble plant exudates used mainly as a stabilizer and thickener in food. Gum Arabic when used in food does not alter the flavors. It is used mainly as an adhesive in bakery icings and crystallization inhibitor in sugar

syrups and as a foam stabilizer in beer, [2]. Still in the food industry, gum Arabic has been used as a stabilizer for frozen products such as ice creams because of its water absorbing properties, [5]. Foam stabilizing ability of gum Arabic is utilized in the manufacture of beer and soft drinks [6]. In the soft drink industry, gum Arabic can be used as an emulsifier in the preparation of many flavor emulsion concentrates such as lime, cola or orange. It improves the quality of the soft drink and also separates the globules of flavor oil, thus preventing the formation of ring round the bottle.

In lithography gum Arabic is used widely in plating and etching because of its high solubility.

Here it is used as sensitizer for lithographic plates element in the light, sensitive composition and ingredient for the fountain solution which is used to moisten the plate during printing.

Gum Arabic is used extensively in the textile industry as sizing and finishing agent and in printing formulation for imparting designs or decoration to fabrics. It finds limited use in finished silk and rayon it gives body to the fabric without interfering with its transparency, [2].

In pharmaceutical industry, Gum Aarabic is extensively used because of it's emulsifying and stabilizing properties [6]. It is therefore used in emulsion stabilization and formation of tablets and pills. Gum Arabic syrup which contains sodium benzoate, vanillin tincture and sucrose is recommended for use as a flavored vehicle because of its demulcent effect on the mucous membranes. This demulcent is often effective in masking the bitter or acid taste of medicament by its protective colloid action.

Gum Arabic is widely used in cosmetic production because of its non-toxicity and its comparative freedom from dermatological effect. Gum Arabic is used in lotions and protective creams, where it stabilizes the emulsion, increases the viscosity, assists in imparting spreading properties and from a protective coating.

Gum Arabic finds usage particularly in the manufacture of adhesive for postage stamps envelops, labels, etc, because of their good affinity for water or saliva.

Film/ Film Formation
A film is a flat section of thermoplastic resin or a regenerated cellulosic material which is very thin in relation to its length and breath and which has normally thickness or gage not greater than 0.010 inch. It is any thin sheet of material used for covering, coating or wrapping, or any thin layer that enters into the structure, usually on the surface of substance or object. The term film also denotes the monomolecular layer which is formed on the surface of solution or at an interface between two immiscible liquids.

Films are formed spontaneously by the action of intermolecular and chemical forces at an interface existing between two immiscible bulk phases. There are two ways of attaining thin layers. One can be by mechanical or chemical means in which the thickness of a bulk phase of material is reduced and the second is by deposition of the material on a substance. The various ways by which films can be formed include; film formation by evaporation, sputtering, vapour deposition, electro-deposition, etc. The table below shows the various stages in film formation.

Table1: Stages in Film Formation

	STAGES	CHANGES THAT OCCUR
1.	Induction period	Small changes in consistency natural inhibitors removed by oxidation
2.	Set to touch	Marked changes in consistency from liquid to film gel
3.	Hardening	Small changes in consistency, to gel hardening
4.	Ageing	Changes will vary depending on environment

MATERIALS AND METHODS

Sample Collection
The crude gum Arabic sample used for this work was purchased from central market in Gusau town, Zamfara State of Nigeria. The glycerol, diethyl glycol and ethylene glycol used were obtained from the Agabus chemical Laboratory in central market, Kaduna.

Apparatus:
500ml flat bottomed flask, 100 ml measuring cylinder, Buchner funnel and flask, stirring rod, thin layer chromatographic plates, Mortar and pestle, Spatula and weighing balance.

Sample preparation:
The crude gum Arabic sample obtained from central market in Gusau town was subjected to sorting in order to remove particles that are not required for the work.250g was weighed and transferred to the mortar and was crushed into fine particles.

Solution preparation
Procedure:
25.0g of the crushed gum arabic grains were accurately weighed and was transferred into the 500ml bottomed flask. 100 ml of water was measured using the measuring cylinder. The water was step-wisely emptied into the flask containing the gum arabic sample with continuous stirring. This gives a solution labelled "A".

The above procedure was repeated to obtain three more solution of crude gum arabic labeled as "B" "C"and "D" respectively. To solution "B" "C"and "D of crude gume arabic, 10ml of pure glycerol, 10ml of diethyl glycol and 10ml of ethylene glycol were added respectively and mixtures stirred properly for homogeneous mixing and kept.

Film casting:
Thin layers of solution "A" was carefully and uniformly deposited on properly cleaned thin layer chromatographic plate. This was kept in a safe place in the laboratory and allowed to dry at the laboratory temperature of approximately 27^0C.

The above procedure was repeated for solution "B" "C"and "D respectively.

Physical Analysis

i. **Blistering**:
The fully dried coated surface of the thin layer chromatographic plates was carefully observed visually to determine the extent of blistering.

ii. Scratch Adhesion
The surface of the thin layer chromatographic plates coated with the various solution were scratched using different mineral sample of different Mohr scale hardness. The Mohr scale of the mineral sample that scratched the coated surface was noted. This gives the range of the extent to which the various gum arabic solution were adhered to the surface.

RESULTS AND DISCUSSION

Table 1:Extent of Blistering

samples	Degree of Blistering
solution "A" (solution of crude gum arabic)	High
solution **"**B" (solution of crude gum arabic +glycerol)	Very slight
solution "C" (solution of crude gum arabic +diethyl glycol)	Very slight
solution "D" (solution of crude gum arabic+ ethylene glycol)	Very slight

Table 2:Scratch Adhesion

samples	scratching minerals (Mohr)
solution "A" (solution of crude gum arabic)	Gypsum (2)
solution **"**B" (solution of crude gum arabic +glycerol)	Calcite (3)
solution "C" (solution of crude gum arabic +diethyl glycol)	Calcite (3)
solution "D" (solution of crude gum arabic+ ethylene glycol)	Calcite (3)

The extent of blistering of the coated surface was observed to be higher in the solution "A" compared to the extent of blistering in solution "B," "C", and "D". It was observed that the films produced from solution "A", "B" and "C" is smoother softer and more flexible. This a parameter that has a direct relationship with the quality of the film produced. Although, visual observation has shown that the film produced from solution "A", is smooth, is of lower flexibility and more brittle compare to the film produced from solution "B" "C" and D respectively. The high blistering nature of the dried film of solution "A is attributed to the absence of plasticizers. On the other hand, the low level of blistering and high level of smoothness, softness and flexibility of the films produced from solution that have plasticizers incorporated into them indicate that the quality of film produced from gum arabic can greatly improved by additives such as glycerol, ethylene glycol, diethyl glycol and other cross linking agents.

The scratch adhesion which gives the extent to which the film from the gum arabic solution is attached to the surface of the substrate was determined using minerals of different Mohr strength. It was observed from the analysis that the film formed solution "A" was softer than the films from the rest that have plasticizers incorporated into them. The analysis revealed that the film from solution "A" was scratched by gypsum whose Mohr scale of hardness was 2, while the film produced from solution "B," "C" and "D" were scratched by calcite whose Mohr scale of hardness is 3. It follows therefore that the plasticized gum arabic will produced film of better quality in formulation than the non-plasticized gum arabic.

CONCLUSION

From this study, investigation had revealed that the poor quality of film produced from gum arabic when used in different formulation is as result of absence of certain additives such as plasticizers and cross-linking agents. It was also discovered that when about 10% of the plasticizers is incorporated into the composition, a high quality film will be obtained from the resulting gum arabic solution.

Recommendation:
It is recommended that in a all formulation where gum arabic is be used as binder or emulsifier, about 10% of any of the following plasticizer or an appropriate mixture of two or more of them be incorporated for this purpose.

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