

Fabrication of Binding, Coating, and Doping Material Via Neem and Arabic Gum

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Abstract

In this research, neem gum of both types, white and brown, and gum Arabic were used as a coating material for apple fruits and to preserve them for the extended possible period. Two samples were prepared for each of the aforementioned types of gum at a concentration of (1:4 and 1:6), where 4 and 6 are the ratios of distilled water. On the other hand, neem gum was also used as an additive in concrete. The research seeks to know the effect of neem gum on some properties of cement and concrete in their soft and hard states. The study of cement and concrete includes the setting and shrinkage times of cement, workability, compressive strength, and durability of concrete in acidic media. The amount of neem gum added as a mixture of cement and concrete was 0.5% of the weight of cement. Neem gum was prepared and tested to ensure shrinkage. The concrete mixture was (1:2:4) (cement: sand: gravel) with different proportions of water (cement + neem gum). The optimal proportions of water used in the actual mixtures were determined for workability. Samples were prepared. Gum in different ratios (1:4 and 1:6) (distilled water: gum). Among the results, it was found that neem gum can be used as an additive to concrete, as it increases the shrinkage of cement, helps with the workability of concrete, and reduces its water requirements, pressure, and strength.

Key words-*Neem gum, Binding, Coating, Doping*

I. INTRODUCTION

Gums are either hydro-phobic or hydrophilic or polysaccharides, of a large molecular weight, generally with colloidal characteristics, that in a suitable solvent yield gel, exceedingly glutinous holdup, or solutions at semi-dry, ingredient content, or most commonly, the phrase "gum" is technically concerned by an industry states the poly-saccharides or their derivatives that are breakup in either cold or hot water to provide gluey solutions. Practically, gums, or all polysaccharides or their byproducts, are dissolved in water and have dry constituents that swell to bring forth gels, highly viscous dispersions, or solutions [1]. The neem tree is considered a member of the mahogany family, known as *margosa* (Indian lilac), and is one of the prosperous sources of secondary breakdown products in nature. It has extended the time for the recognition of its properties, which are equally against improving human health and insects. The neem tree is a striking, deciduous, long-lived tree that can grow tall, with expanding branches ranging to some ten meters. It originates in the mild forests of the southern part of West Africa. The leaf, bark, or seed is ground, and extracted with hot water, and left to cool. This same oily material is also employed as a cosmetic by women for the treatment of their skin and hair in the Ivory Coast as the traditional medicine [2]. The old-style medicine strategy targets of the World Health Organization (WHO) from 2014-2023 encouraged member states in utilize the potential involvement of traditional and supplementary medicine in health, wellness, and people-centered health; benefit its safe and operative usage across the guidelines, assessment, and integration of traditional, complementary products, practices, and health schemes, [3]. Neem is one of those plants that are used in traditional medicine because it contains, in different parts of its plant, compounds like antiseptic, antipyretic, antivirus-tested, antiulcer, anti-fiery, and antifungal properties.

It has great prospects in the fields of best controlling, environmental preservation, and medicine [4]. The flowing naturally air-hardened exudates are well-defined as the gums, which are gotten by scratching the stem and branches of *Acacia* and other species of tree [5]. Gum Arabic is a dried exudation obtained from the stems and branches of *Acacia* and closely related species. This definition has been developed by the FAO / WHO joint expert committee for food additives (JECFA); it is a compound poly-saccharide of large molecular weight, and its magnesium, potassium, and calcium salts, which on hydrolyzing produce Arab Inose, galactose, rhamnase, and glucuronic acid. The item of commerce may be additionally specified as to viscosity [6]. the species *Acacia* is the second major within the *Leguminosae* family and contains at least hundreds of species with their widespread root systems, the trees of the *Acacia* can be found in semiarid parts of Australia, America, India, and mostly, in the Sahelian section of Africa. They are resourceful trees, and in addition to producing gum, they also prevent desert encroachment, return soil fertility, and provide fuel and feedstuff. Almost all profitable gum derives from the zones called gum belts. A vast area that spreads over Senegal, Burkina Faso, Mauritania, Mali, Benin, Niger, Nigeria, Chad, Sudan, Eritrea, Ethiopia, Somalia, Uganda, and Kenya [7]. Marketable gum Arabic is collected from a number of *Acacia* species, of which a Senegal, a Seyal, and a. *polyacantha* are the most extensive in the gum belt, and other gums yield species with a more limited supply [8]. In Sudan, the gums from a. Senegal and a. Seyal are mentioned as Hashab and Talha, correspondingly, the former is considered of better quality than the later [9]. Gum Arabic dissolves in water in concentrations raised around 50% because of the dense, divided structure and a little viscosity, permitting the practice of the high gum concentration in countless applications and uses [10]. Small hydrodynamic volume gum Arabic solutions

exhibit Newtonian behavior at different concentrations. The pH of the solution is ordinarily about 5.5, but greatest viscosity is initiated at pH 6.0. The other major useful attribute of gum Arabic is its aptitude to perform as an emulsifier for indispensable oils and flavors. The Gum Arabic has exceptional emulsifying features. For example, the hydrophobic polypeptide backbone vigorously adsorbs the oil-water terrace, whereas the attached carbohydrate units stabilize the emulsion by steric and electrostatic pulsion. Fractionation experiments show that the emulsifying properties improved by increasing molecular weight and protein content, and the best results are obtained with mixtures of different fractions [11]. Parentally, the erogenous nature of the gum makes it an extraordinary emulsifier [12]. The emulsifying and stabilizing properties are used in the food industry as in confectionery, flavors, bakery, and beverages, which is the most vital application of gum Arabic. It is also applied in medicinal and pharmaceutical fields besides inks and other industries [13]. Gum Arabic and neem are a gluey transude from the branches and stems of Acacia and neem trees when they are exposed to stress [14] [15] [16]. These gums are gathered as a white to pale amber-colored granular solid, or brown in some cases of neem gum. These natural gums, especially Arabic gum was employed millennia ago in different parts of the world for their adhesive properties in tool manufacturing [17]. Early on, gums were used as adhesives to cover mummified bodies and as dye binders for mineral paints. Later, it was used as a binder in the preparation of metallographic ink. Arabic gum has played a vital role in the colonization of Africa by European countries. At present, gum Arabic is still being used for numerous industrial purposes. It is used for illustration, as a flocculating mediator in ceramics, as an adhesive in the cosmetic industry, and as an additive for microencapsulating processes. For its emulsifying properties in litho-print or nutrition products. Currently, gum Arabic has also been used in the fixation of carbon nanotubes [18] [19]. Although, the neem tree is listed as a weed plant, but its uses may lead to reclassification of this important plant. The weed and trade status of gum are affected by significant applications, which represented in medical uses, stock feed, timber and fuel sources, veterinary (animal feed additives), contraceptive oil sources, soil improvement agents, soap and shade, and street tree [20] [21][22][23][24][25] [26]. Several studies on the neem attracted our attention to open the way for using neem gum as binding, coating, and doping material in different applications.

II. MATERIALS AND METHOD

A. Raw materials for neem gum

The raw materials used in the preparation of neem gum: neem gum, distilled water, water, sand, cobbles, and cement

B. Gum collection

Gums are gathered by falling tapping, which contains the part of getting rid of pieces of the bark. Tapping starts when the trees are just preliminary, and they tend to shed their leaves around the termination between October and the beginning of November. In order to reach this step, trees have to be

cultivated for a period of 4 or more years, contingent on the manner of formation. Moreover, there are two tapping seasons in the Sudan, an earlier one before the onset of the colder weather, which is between the months of December and March. Afterward tapping, exudation arises progressively, creating a solid but somewhat elastic nodule. As more gum exudes, the external skin expands or crashes and the nodules grow. When the outside casing becomes so stiff that the liquid cannot drive it to expand any further, the nodule is, ultimately, ready for taking. The time taken to reach this stage is several weeks, from 3 weeks to 6 weeks, and once the nodules are picked, the new ones jump to form, and within a few days, another picking is probable. Numerous branches are preserved in this way at one tapping. In the following years, other branches or the reverse side of the same preserved branches are tapped. A normal of four pickings is accomplished. The nodules are picked by hand and placed in a carrier, and arranged according to color and size.

C. Preparation of samples

Gum nodules were dried at room temperature, then hand cleaned to insure that the sand, dust and bark impurities are out of the gum sample, then powdered using a mortar and pestle, then, kept in container for analysis.

D. Using Neem and Arabic gum as coating material

Subsequently, the samples of neem gum (white and brown) and gum Arabic, which have been prepared in a previous step, were added to the distilled water in ratios of 2:1, 1:3, and 1:6 so the ratio of 1:2 was used, and it was found that the amount of distilled water added was insufficient to dissolve the amount of gum. At the ratio of 1:3, there is also partial dissolution of the gum in the distilled water. Then, the ratio of 1:6 was used in order to use it as a covering material for the fresh apple fruit. The apple fruit was wiped with the mixture from the outside and left at room temperature and pressure. Then, after a week of experimentation, it was found that the gum Arabic sample did not change, as there was a slight change in the white neem gum sample, while a relative change occurred in the brown neem gum sample. After two weeks of the experiment, nothing changed in the samples. In the third week, it was found that the gum Arabic sample began to change colour and it contracted more than what happened in Neem gum samples. From these experiments,

E. Using Neem and Arabic gum as doping material

The strength of concrete is affected by several effects, including those related to the components of the concrete, as well as the age of ripening, the growth of strength, and the method and degree of treatment. There are also features associated to the making of concrete, such as compaction, mistakes in the weight of materials, or mixing time. Therefore, all the above-mentioned factors were fixed, and the additives of (neem gum) used as a percentage were frequently changed. In this research, a number of concrete mixtures were designed by adding (brown and white neem gum) and a compressive

strength test was conducted on hardened concrete at the age of (28 days). This was for mixtures in which a mixture of white and brown neem gum was added with water in a ratio of 1:4 and 1:6, and then 6 cubes were poured on it. For each mixture. As it cleared in the figure(1) below:



Fig. 1: Molded mixture cubes

Also, the tables below (I),(II), and (III) show the weights of brown and white neem gum samples that have been taken in the concert test for each sample the cube weigh taken as wet and dry; consequently this is a benefit for later concrete tests.

TABLE I: Weights of brown neem gum samples

NO	Wet weigh (kg)	Dry weigh (kg)
1	2.4257	2.3471
2	2.3919	2.2835
3	2.3478	2.3126
4	2.4691	2.4142
5	2.4854	2.4269
6	2.4545	2.3815

TABLE II: Weights of white neem gum samples

NO	Wet weigh (kg)	Dry weigh (kg)
1	2.4543	2.4507
2	2.4505	2.4466
3	2.4300	2.4237
4	2.3895	2.4763
5	2.3819	2.3944
6	2.3989	2.3864

III. RESULTS AND DISCUSSION

A. Results of using neem gum as Coating

The effect of gum coatings attracted numerous studies, especially the effect on the imperative features (dehydrated matter, pH, total soluble and water activity) and anti-oxidant fillings of blanched and dried tomato slices. However, throughout the packing of blanched and dehydrated vegetables[23] [24]. In our research, the three glue samples were prepared at room temperature and at two concentrations of 1:4 and 1:6 in order to be used as a covering material for the apple fruit. Later, the changes that occurred in the apples were observed during 3 weeks. It was noted after a week of the experiment that the apple fruit that was covered with gum Arabic had a slight change. In its external appearance, while the neem gum samples maintained their shape, after two weeks of the

experiment, a slight change occurred in the shape of the apple fruit, while the apple fruit that was covered with white neem gum remained in its shape. In the third week, there was a clear change in the shape of the apple fruit, such as shrinkage and rotting in the outer surface of the apple. It was found that neem gum is more effective than gum Arabic for use as a covering material for apple fruits. See the pictures below figures (2, 3, 4), which demonstrate the coating procedure: see the pictures of the apples and the diagram in figure (5).



Fig. 2: Arabic gum coating



Fig. 3: White neem gum coating



Fig. 4: Brown neem gum coating

It was observed from the chart that the as-prepared samples of white neem gum were better than the both brown neem gum and gum Arabic due to the high moisture content in brown

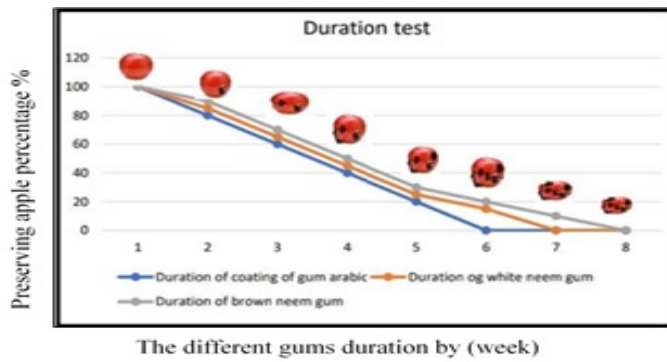


Fig. 5: Duration of gums

neem gum and gum Arabic, which may reach 13.1% due to the nature of its growth in tropical regions, which increases the percentage of water in the soil and also the high humidity in gum Arabic, where it reaches to 14.2%

B. Results of using Neem gum as a concrete Doping

Doping processes using gum (Arabic Gum) applied in polymeric materials to become a good semiconductor material. In preceding works selecting gum Arabic poultice polymeric and adding iodine, the value of energy gap in semiconductors is reduced by using such processes[23][24]. After preparing two samples of brown and white neem gum at two concentrations (1:4 and 1:6) and using them as an additive to concrete to improve its mechanical properties, namely workability, slump, and pressure resistance, experiments proved that white neem gum is better than brown. See the data received from the experimental work in the following tables. The remarkable result of this research is that a ratio higher than 0.025, which is 0.30, was used, and then adding it to the concrete led to a noticeable increase in the flow or viscosity. When the samples were poured, dried, and placed in water to perform the breaking process, after 28 days from the first week, the cement was completely dissolved in the water, and it became clear that high moisture content in the concrete mix. It was found that adding neem gum increased the compressive strength of concrete when it was added by 0.025%. Look to the tables(III) and(IV), also figure(6), which explain the doping process and molded mixture cubes in cement block making.

TABLE III: Results of Brown Neem gum Samples

Cube No	Date of Crushing	Days of drying	Weight (Kg)	Failure load (KN)	Compressive strength (N/mm2)	Average (N/mm2)
1	31/1/2023	28	2.3471	294.7	29.47	31.13
2	31/13/2023	28	2.283	319.0	31.90	
3	31/13/2023	28	2.3126	320.3	32.03	
4	31/13/2023	28	2.4142	313.6	31.36	32.38
5	31/13/2023	28	2.4269	331.9	33.19	
6	31/13/2023	28	2.3815	325.9	32.59	

From the experiments and through the above diagrams in figures(6 and 7), which illustrate white and brown neem gum samples concert tests, respectively. From the results obtained, it's clear that the white neem sample withstands an average stress of 42.47 N/mm2 for the sample with a concentration

TABLE IV: Results of white neem gum samples

Cube No	Date of Crushing	Days of drying	Weight (Kg)	Failure load (KN)	Compressive strength (N/mm2)	Average (N/mm2)
1	31/1/2023	28	2.4507	371.1	37.11	42.45
2	31/13/2023	28	2.4466	449.3	44.93	
3	31/13/2023	28	2.4237	453.2	45.32	
4	31/13/2023	28	2.3763	447.7	44.77	45
5	31/13/2023	28	2.3944	411.1	41.11	
6	31/13/2023	28	2.3864	491.2	49.12	

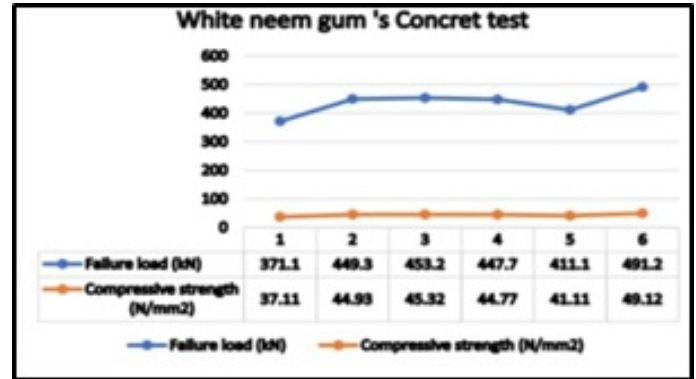


Fig. 6: White Neem gums Concert test

of 1:4. An average stress of 45 N/mm2 for the sample with a concentration of 1:6. As for the brown neem gum sample, consequently, the sample withstands a lower stress force because it contains a high moisture content. When added to concrete, this leads to cracks in the mixture when it dries.

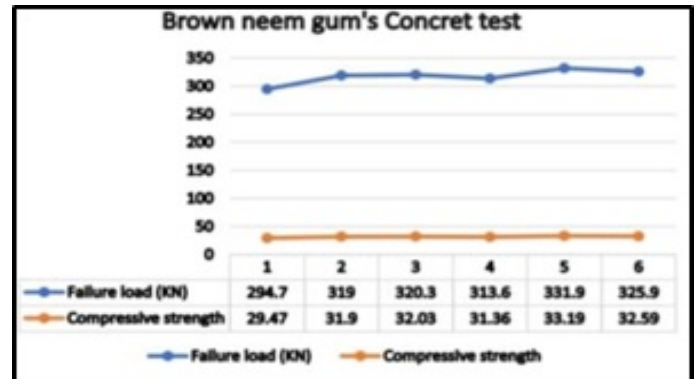


Fig. 7: Brown Neem gums concert test

C. Moisture content

The importance of moisture content plays a noteworthy role in the concert viscosity, adhesive, and strength properties, which represent the indicator of concrete durability, see figures(8 and 9). So, the moisture is determined according to the old-style method. Exactly weighed, one gram of the crushed gum was subjected to heat in an oven at 100°C to a constant weight. After that, the moisture content was determined as the ratio of the lost weight to the total weight as follows: moisture content (%) = $(W1 - W2/W1) * 100$ [13]. W1 = original weight of sample (g). W2 = weight of sample after drying (g). The figures(8) and(9) show the moisture content in the block of the concert.

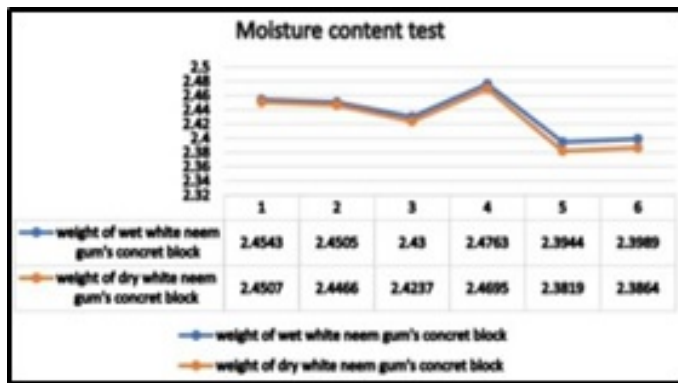


Fig. 8: Moisture content of white neem gum

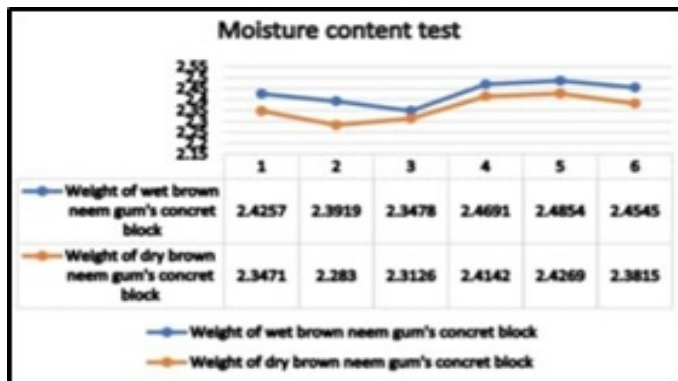


Fig. 9: Moisture content of brown neem gum

D. using neem gum; as a binding agent

Gum is a specimen of hydrophilic materials applied in medicinal dose formulations principally as binders and compressible excipients[25][26]. According to early studies, the use of neem gum for binding was used with sawdust due to its resistance to insects, especially the white bug, as it contains a substance that leads to sterility in insects. Therefore, insects are repulsed by neem tree wood or sawdust mixed with neem gum. It also increases the hardness of wood made of neem gum. These testes play a significant role in furniture fabrication processes, especially in protecting the wood formed from the white bug. See the approximate figure that denotes the action of the gums.

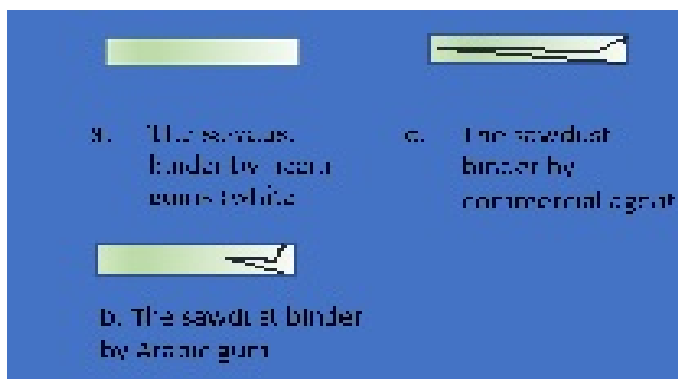


Fig. 10: The usage of gums as binder

IV. CONCLUSION

In this research, neem gum of both types, white and brown, and gum Arabic (1:4, 1:6) used as a coating material for apple fruits and to preserve them for the longest possible period. Neem gum also used as an additive in concrete. The research seeks to know the influences of neem gum on some of cement and concrete characteristics in their soft and hard states. It concluded that using neem gum, especially white neem gum, is more efficient than gum Arabic and brown neem gum as a covering material for apple fruit because it contains a lower percentage of moisture, as high humidity helps to quickly rot and deform the surface of apple fruit. Using both brown and white neem gum is better than gum Arabic in using it as a bonding material with concrete, as it gives higher working strength to the concrete, but white neem gum is also better than brown because it contains a lower percentage of moisture, because high humidity leads to cracks in the concrete after drying. By means of using the glue as a binding material with sawdust and in relation to the specifications of neem gum in combating pests, and that it adds higher hardness specifications than gum Arabic.

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