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Viscosity, Swelling Index and Moisture Content in Gum Karaya

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Abstract: ***The present paper deals with viscosity, swelling index and Moisture content studies on Gum Karaya. We analysed ten Gum Karaya samples stored for about two years showed high viscosity of maximum about 1835 cps and swelling index 66ml/min. Gum Karaya samples of all the three grades I, II, and III showed almost the same viscosity pattern. Since viscosity is a very important factor in determining the quality of the product. Studies were extended to various biological activities .Gum Karaya can be used as a good candidate for oral floating drug delivery. Also, because of its favorable biological properties such as non-toxicity, biocompatibility, and biodegradability, Gum Karaya is a promising candidate for the enhancement of absorption of drugs through floatation using floating drug delivery system. As a result of the physical, chemical, and biological properties, Gum Karaya can is used in different formulations for drug delivery.***

Keywords: Gum Karaya, Viscosity, swelling index, Moisture content, Drug delivery

1. Introduction

Plant gums are organic substances obtained as an exudation from fruit, trunk or branches of trees, spontaneously or after mechanical injury, of the plant by incision of the bark, or by the removal of a branch, or after invasion by bacteria or fungi. The exudate becomes hard nodules or ribbons on dehydration to form a protective sheath against micro-organisms. They form clear glassy masses which are usually coloured from dark brown to pale yellow. These gums are classes of high molecular weight polymeric compounds, composed mainly of C, H, 0 and N are capable of possessing colloidal properties in an appropriate solvent, or swelling agent at low dry weight. They occur naturally as salts (especially of calcium and magnesium) and in some cases proportions of the hydroxyl group are esterified, most frequently as acetates. In practical terms gums are either hydrophobic or hydrophilic. Hydrophobic gums are insoluble in water and include resins, rubber, etc. where as hydrophilic gums are soluble in water and can be subdivided into natural, semi-synthetic and synthetic gums. Numerous theories for the process by which the tree exudes gums have been proposed. It has been suggested that gums exudates may be a product of normal plant metabolism (Hirst and Jones, 1958; Smith and Montgomery, 1959), that they may arise from a pathological condition of the tree, or they may arise from microbiological infection of fungal (Vassal, 1972), or bacterial (Blunt, 1926 Mantell,1954) origin. Another theory proposed is that starch may undergo transformation into gum .This seems unlikely according to Anderson and Dea (1968) as the enzyme systems necessary to transform starch into a highly branched arabinogalactan with galactose. arabinose, rhamnose, glucuronic acid and its 4-0 methyl ether are complex. Further Anderson and Dea(1968)found that starch was not represent in the tissues of excised branches and therefore proposed that the gums have a he micellulose -type highly branched arabinogalactan precursor to which is added rhnmnose glucuronic acid and 4-0 methyl glucuronic acid terminated side chains in the final stages of gum production. Miskiel (1990) suggests that gum exudates are more likely to be formed by enzymatic glycosylation reactions rather than direct conversion of other plant polysaccharides. Gum Karaya is defined as the dried exudate obtained from Sterculia Uren Ro.xcl. Gum Karaya consists mainly of high molecular weight acetylated polysaccharides which on hydrolysis yields galactose, rhamnose and arabinose to gather with a small amount of glucuronic acid (Anderson et.al, 1982). Karaya Gum in the dry state is not soluble in water but only forms viscous suspensions. The gum enormously swells in water and forms thick suspensions. Viscosity and swelling factor play a key role in the utilization of gum for various purposes. At the processor level the raw dried gum is further dried to about 16 to 20% moisture. Then it is quickly processed by removing impurities and broken into pieces of different sizes and grades according to the buyers' requirement of end use. Karaya gum finds major application in bulk laxatives, denture adhesives, colostomy appliances and in appetite suppressants. Viscosity and swelling ability of the gum decides the quality of gum in industrial applications. There are applications of importance other than those mentioned above like food additives and ice cream stabilisers. A substantial quantity of the gum is exported from India while only a small percentage is indigenously used. Sterculia or Karaya or Thapsi tree is a native of dry deciduous forests of dry rocky hills lands having tropical climate. Gum Karaya is an exudate of gum obtained from the trees of Sterculia Urens one of the most important forest products of our country. In India, the species of sterculia are found in tropical Himalayas, west and central India, throughout eastern and western ghats. In Andhra Pradesh, Gum Karaya trees are found in Adilabad, Khammam, Warangal, Karimnagar, Mahabubnagar, Kurnool, Vishakhapatnam, East/West Godavari and Chittoor districts. Gum Karaya trees are also found in Australia, Pakistan, Panama, Phillippines, Indonesia, Senegal, Sudan and Vietnam.

2. Methods

1. Viscosity of Gum Karaya:

With the help of a grinder the sample of Gum Karaya is crushed gently avoiding excess heat. The sample is sieved and the material between 8 and 30 mesh is taken for viscosity. 7 grams of sample is accurately weighed on an electrical single pan balance. 693 ml water (distilled water) is stirred under a mechanical stirrer with an approximate speed of 1200 R.P.M.

The sample is slowly added to the water under agitation in a span of about 2 minutes. The stirring is continued at 2000-2200 R.P.M for a period of 7 minutes. The material is taken out from the stirrer and kept aside for 24 hours. After 24 hours the material is stirred at about 2000-2200 R.P.M for 7 minutes. The bubbles are allowed to surface out in about 5-8 minutes.

The temperature is adjusted to 25±2° C by cooling in a refrigerator. The viscosity is checked using Brookfield viscometer model RVT at 20 RPM using spindle No.3. The reading is multiplied with the factor to get viscosity in centipoises (cps). Where needed the spindle, speed combinations are changed according to the viscosity. Viscosity measurements are done on "as is" basis without moisture correction.

2. Determination of Bark and Other Foreign Organic Matter (BFOM)

Weigh accurately about 5 g of the material and transfer to a 250ml conical flask. Add 25 ml of dilute hydrochloric acid (4N) and 25 ml of water. Cover the flask with a small watch-glass and boil gently until the mixture loses its viscosity. Shake the flask occasionally. After heating for 10 minutes, break the lumps with a glass rod. Wash the glass rod with 5 ml of water. Heat the flask for another 20 minutes with occasional shaking to ensure complete dispersal of the lumps. Filter through a tared filtering crucible and wash the residue with water until the washings are free from chloride ions. Remove the crucible to an air-oven maintained at 105 ^{0}C, cool in a desiccators and weigh, Then dry to constant mass in an air-oven.

Calculation

Bark and other foreign organic matter, percent by mass (on dry basis) = $\frac{10\,000\ M}{(100-\!-M,)\ Ms}$

where
M = mass, in g, of the residue;
MI - percent volatile matter in the material (loss on drying)
M2 = mass, in g, of the material taken for the test

Determination of Loss on Drying

Weigh accurately about 5 g of the material in a tared weighing bottle, place the bottle containing the sample (uncovered) in an oven maintained at 110 f 1°C for 4 hours. Remove the bottle from the oven, close it and allow it to come to room temperature in a desiccator and weigh. Calculate the loss on drying as percent by mass.

Determination of Moisture Content

Moisture content was determined using the Karl Fischer auto titrator M/s. MetRohm. The sample was dispersed in methanol, stirred to extract water, and then titrated with standardized Karl Fischer reagent until the end point is reached. Moisture content was determined using the following formula:

$$\text{Moisture content } (\%) = \frac{V_1 \times W_e}{S_w} \times 100 \quad (3)$$

where V_1 is the volume of the Karl Fisher reagent, W_e is the water equivalent, and S_w is the sample weight in milligrams. Fifteen milliliters of the reagent is equivalent to 75 mg of water, and the water equivalent is 5.2.

Determination of the pH Value of Gum Karaya

The pH of 1% *w/v* aqueous mucilage of gum Karaya was determined using a pH meter (Systronics, Model 361).

Determination of the Swelling Index

Swelling and water retention capacity of gum karaya were determined using the modified method which was reported by Gauthami and Bhat[13]. One gram of BG powder was accurately weighed and transferred to a 100-mL stoppered measuring cylinder. The initial volume occupied by the powder was noted and the volume was made up to 100 mL with distilled water. The cylinder was stoppered, shaken gently, and set aside for 24 h. The volume occupied by the gum sediment was noted after 24 h.

Swelling index (SI) is expressed in percentage and was calculated by the following equation:

$$\text{SI } (\%) = \left[\frac{V_t - V_0}{V_0}\right] \times 100 \quad (4)$$

where V_0 is the initial volume of the powder in a graduated cylinder and V_t denotes the volume occupied by the swollen gum after 24 h.
The contents of the measuring cylinder from this test were filtered through a muslin cloth and water was allowed to drain completely into a dry 100-mL graduated cylinder. The volume of water collected was noted, and the difference between the original volume of the mucilage and the volume drained was taken as the water retention capacity or water absorption capacity.

Gum Karaya in the raw form is commercially available in three grades Grade I, II and III. The essential difference between these grades is the appearance and percentage of Bark and Foreign Organic Matter (B.F.O.M). The Bureau of Indian Standards laid down the following specifications as presented in table 1 (IS:5025-1969) on gum grading [11].

Table 1

Grades of Gum Karaya	Colour	BFOM
Grade I	White to amber	o.5
GradeII	Reddish to Tan	1.5
GradeIII	Brown to black	3.0

3. Results and Discussion

Table 2: Physical analysis Gum Karaya samples

Sample No	Colour	p^H	Viscosity (cps,min)	Moisture (%max.)	Swelling Index (ml/min)	BFOM (% max.)
1.	Dark Brown	7.0	1780	25.73	32.33	4.02
2.	Dark Brown	7.2	1810	18.23	65.66	2.41
3.	Dark Brown	7.2	1830	9.38	25.66	3.02
4.	White to light Brown	7.3	1790	8.88	22.33	1.007
5.	Light Brown	7.1	1825	11.35	59.00	0.80
6.	Dark Brown	7.0	1795	10.4	45.66	2.61
7.	White to light Brown	7.0	1835	16.85	69.00	1.0
8.	Dark Brown	6.8	1830	19.2	65.66	3.01
9.	Dark Brown	6.8	1795	22.3	62.33	3.01
10.	Dark Brown	6.7	1830	20.4	63.66	2.61

The swelling index characterizes the rate at which a tablet will dissolute and is also an indicative of the mechanism. The present study focuses on studying the effect of Viscosity swelling Index and Moisture content in Gum Karaya. The ten gum samples stored for about two years showed maximum Viscosity (1830 cps/min) and swelling index 66ml/min. Swelling capacity of Acyclovir Sustained release tablets such that for all formulations it increases as increase the concentration of gum in each formulation. The swelling index of all formulation increases as increase the concentration of gum in each formulation. Swelling of matrix tablets increases with respect to time because weight gain by tablets was increased proportionally with rate hydration up to 4hrs and matrix appeared swollen almost from the beginning and a viscous gel mass was created after contact with water later on swelling were decreases due to dissolution of outermost gelled layer of tablets. It has observed that drug release decreases with increasing concentration of gum and swelling index. The reason attributed to this fact is formation of thick gel layer by matrices around tablets that delays diffusion and release drug. It has observed that swelling index of matrix tablets containing only one natural polymer was less this may attributed to the lower water uptake and less hydrophilicity [9]. pH Measurements The hydrogen ion concentration plays great importance in the chemistry and industry of the gums. The change in the concentration of hydrogen ion may determine the solubility of gum and the precipitation of protein, therefore functional properties of a gum may be affected by change in pH for example viscosity and emulsifying power. viscosity is a very important factor in determining the quality of the product, studies were extended to various samples of different periods of storage .The viscosity was found to be as much as 1800 cps for freshly procured and dried gum to about 25 cps for the gum on prolonged storage. It is observed that the viscosity drops down substantially with aging of Gum Karaya making it unusable for desired applications. Since viscosity is an essential factor for products like denture adhesives and colostomy appliances it is desirable that the Gum Karaya should be as fresh as possible for these applications [10].

Gum Karaya is an abundant natural polymer, obtained from sterculia gum, is the dried exudate of Sterculia Urens, a tree native to India. The physical and chemical properties of Gum Karaya, such as inter-and intramolecular hydrogen bonding and the cationic charge in acidic medium, makes this polymer attractive for the development of floating drug delivery system. Being a natural polymer and having all desired properties, Gum Karaya can be used as a good candidate for oral floating drug delivery. Also, because of its favorable biological properties such as non-toxicity, biocompatibility, and biodegradability, Gum Karaya is a promising candidate for the enhancement of absorption of drugs through floatation using floating drug delivery system. As a result of the physical, chemical, and biological properties, Gum Karaya can is used in different formulations for drug delivery in the GI tract[11]

The pH-sensitive PAAm-g-GK copolymer was productively prepared through free radical polymerization in an inert atmosphere and characterized satisfactorily. The pH-sensitive spray dried microspheres were formulated using hydrolyzed PAAm-g-GK for colonic delivery of capecitabine. The PAAm-g-GK copolymer showed considerable response to changing pH. The *in vitro* drug release suggested that the microspheres formulated using native GK were not suitable for retarding release of drug within 5 h in environment of stomach and small intestine. While, the microspheres formulated using pH-sensitive PAAm-g-GK copolymer having cross-linked with GA are most appropriate carriers as release of drug from these was lower within 5 h and targeted maximal drug content to colon in a controlled trend. There was unusual acceleration in drug release in rat caecal contents medium because of colonic bacteria's action on PAAm-g-GK copolymer[12].

4. Conclusion

The use of natural gums for pharmaceutical applications is attractive because they are economical, readily available, nontoxic, capable of chemical modifications, potentially biodegradable, and with few exceptions, also biocompatible. Majority of investigations on natural polymers in drug delivery systems centre on polysaccharides. Natural gums can also be modified to have tailor-made products for drug delivery systems and thus can compete with the synthetic excipients available in the market.

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