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Isolation of simple sugar from a hydro colloid: gum arabic

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Abstract
Gum arabic, a natural polysaccharide derived from exudates of Acacia senegal and Acacia seyal trees, is a commonly used food hydrocolloid. The complex chemical structure of the gum has been widely studied revealing a multi fraction material consisting mainly of a highly branched polysaccharide and a protein–polysaccharide complex (GAGP) as a minor component. This work investigates the sugar which is isolated through acid hydrolysis of gum arabic.

Keywords: Gum Arabic; Complex; Sugar; Isolation.

INTRODUCTION

Carbohydrates are among the most abundant compounds in the plant world, and the analysis of sugars and sugar mixtures is of considerable importance to the food and beverage industries[1]. A natural exudates gum includes Gum Arabic, Gum karaya, Gum ghatti and Gum tragacanth. Use of the latter mentioned gums diminished over the years because of uncertain availability and increased cost. At present only gum Arabic still holds its importance in food applications [2].

Gum Arabic (GA), a natural composite highly branched, slightly acidic (pH 4.5 -5.0) arabinogalactan polysaccharides obtained from the stems and branches of two main trees namely Acacia Senegal and Acacia Seyal, where total production ranges about 60,000 -80,000 tons[3,4]. A simple fingerprint of the molecule is the value of the optical rotation which easily demonstrates from which acacia species the gum has been collected. A. Senegal gives laevorotatory of about -30° and A. seyal shows dextrorotatory of about +50° [5,6].

It is widely used as food hydrocolloids, as a very efficient emulsifier and a long time stabilizer in food and cosmetic products containing oil-water interfaces [7]. The exceptional surface-active and rheological properties of the gum made the researchers much fascinated to work over the years to reveal the molecular structure and finally recognized that GA consist of three fractions. (i) the major one is a highly branched polysaccharide(MW = $3X10^5$) consisting of β-(1-3) galactose backbone with linked branches of arabinose and rhamnose, which terminate in glucuronic acid (found in nature as magnesium, potassium & calcium salts). (ii) a smaller fraction (~ 10 Wt % of the total) is a higher molecular weight (~ $1X10^6$ g/mol) arabinogalactan-protein complex (GAGP-GAglycoprotein) in which arabinogalactan chains are covalently linked to a protein chain through serine and hydroxyproline groups. The attached arabinogalactan in the complex contains ~13% (by mole) glucuronic acid. (iii) The smallest fraction (~1% of the total) having the highest protein content (~50 Wt %) is a glycoprotein which differs in its amino acid composition from that of the GAGP complex [8, 9, 10, 11, 12, 13, 14, 15].

The GAGP complex, although being a minor component, it has an important role in both structure and properties of the gum. The structure of the complex has been fully resolved by "wattle-blossom" model which is currently used for description. The "wattle-blossom" model where several arabinogalactan units have molecular weight of ~$2X10^5$ g/mol each are described as being attached to a common protein chain forming a compact spheroidal structure [16, 17]. It has been suggested that GAGP complex composed of polypeptide parts must be on the periphery of the molecule and probably account for GA's true emulsifying capacity and stabilizing properties, even though its specific action and conformation at the interface are not clear[18].

Acacia gums is a natural vegetable product, a non-carcinogenic soluble fibre with prebiotic and hypoglycaemic effects, having a low calorific value used in drinks, meal substitutes, cereal bars, bakery products, dairy products and confections use acacia gum for its health benefits [19,20]. Apart from food uses, it has medicinal applications, sizing fabrics and paper, printing etc [21].

METHOD AND MATERIAL

Selected sample (2g) was soaked in 50mL doubly distilled water for 24 h. 50mL of 0.2N sulphuric acid was added to the gel state gum and kept under hot plate for about 5 h at 65 °C and mixture is cooled to room temperature, left undisturbed overnight. Needle shaped crystal growth was observed from the viscous liquid, which is carefully filtered and dried.

Instrumentation

The crystals were subjected to UV analysis using Agilent 8453 coupled with Diode array detector. HPLC–MS analysis was performed with LCMSD/Trap System (Agilent Technologies, 1200 Series) equipped with an electrospray interface. The MS spectra

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were acquired in positive ion mode. The mobile phase consisted of 0.10% formic acid in hplc grade deionized water (A) (milli-q-water (subjected to IR radiation under 3.5 micron filters) and Methanol (B) taken in the stationary phase of Atlantis dc 18 column (50 x 4.6mm - 5µm). The gradient program was as follows: 10% B to 95% B in 4 min, 95% B to 95% B in 1 min, 95% B to 10% B in 0.5 min followed by 10% B in 1.5 min at a flow rate of 1.2 mL min^{-1}. The column oven temperature was kept at 40°C and the injection volume was 2.0 µL. Product mass spectra were recorded in the range of m/z 150-1000. The instrumental parameters were optimized before the run.

RESULT AND DISCUSSION

Analysis showed that the extracted separated components are UV inactive as in Figure-1. HPLC run gave a single ionized peak at 0.681 and 0.832 shown in Figure-2. The Mass Spectrum was detected at 0.667min. The MS report recorded at the appropriate time as per MSD scanned between the times period 0.461:0.852 min gave m/z values 363.1, 701.2, 717.0 respectively. This gives a conclusion that these masses correspond to tetrasaccharide depicted in Figure-3 [22-30].

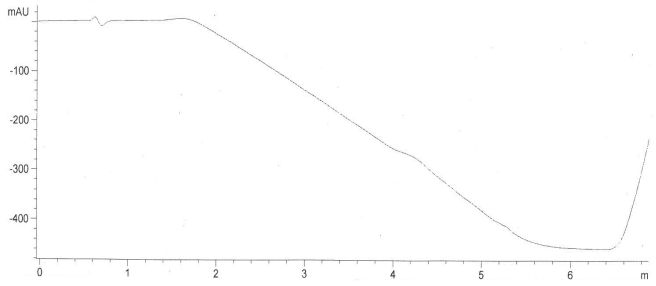

Fig 1. UV spectrum of the acid hydrolysed product

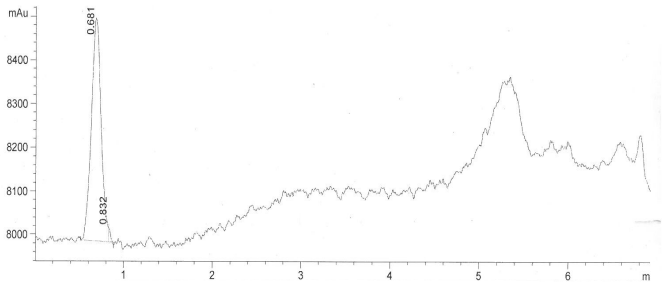

Fig 2. HPLC report of the acid hydrolysed product

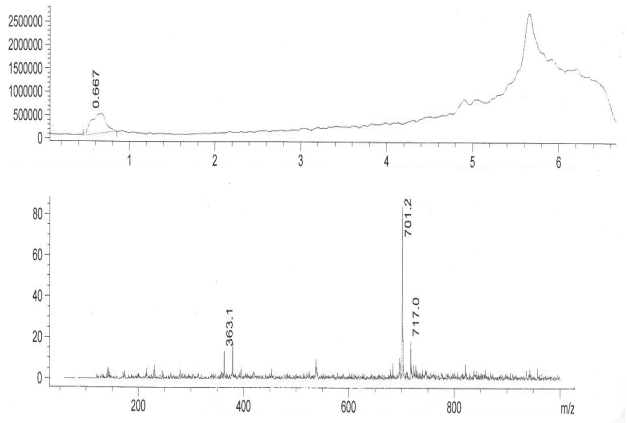

Fig 3. Mass spectrum of the acid hydrolysed product

CONCLUSION

The UV and mass spectroscopy techniques serve as effective tools for the characterization of the isolated simple sugar from gum arabic with intense m/z value 701.2 and UV inactive spectra.

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