International Journal of Bioresource Science
Citation: IJBS: 5(2): 117-121, December 2018
**DOI:** 10.30954/2347-9655.02.2018.6


# Thermal Behaviour of *Buchanania lanzan* Gums Collected from Different Places

Arnab R. Chowdhury*, Mahtab Z. Siddiqui and Niranjan Prasad

Processing and Product Development Division, ICAR-Indian Institute of Natural Resins & Gums, Namkum, Ranchi – 834 010 (Jharkhand), India

*Corresponding author: arnabiari@gmail.com

**ABSTRACT**

*Buchanania lanzan* Spreng., a natural plant polysaccharide, commonly known as *char, achar, piyar, chirongi* and pre-dominantly the trees are available in the States of Chhattisgarh, Jharkhand, Madhya Pradesh and in Varanasi and Mirzapur districts of Uttar Pradesh. During last two decades plant polysaccharides/natural polymeric materials have evoked tremendous interest due to their diverse pharmaceutical applications such as diluents, binders, disintegrants, bio-adhesives, thickeners, emulsifiers, stabilizers, gelling agents as also in cosmetics, textiles, paints and paper-making etc. Many natural polysaccharides have been successfully used in sustained drug release because of their well-known non-toxicity, biodegradability, biocompatibility, biosafety, sustainability and unique physico-chemical properties, often at very low costs, as compared to their synthetic counterparts. Further, water-soluble polysaccharides certainly have enormously large and broad applications in both food and non-food industries. The present paper reports the thermal behaviour of *Buchanania lanzan* gum exudates, collected from different places, using various parameters *i.e.* Differential Scanning Calorimetry (DSC), Differential Thermal Analysis (DTA), Thermo-gravimetric Analysis (TGA), Fourier Transform-Infra Red (FTIR) and Particle Size Analysis, as thermal analysis gives information about changes in material properties as function of temperature. The TG thermograms for all the gum samples showed three-stage decomposition. The DSC thermograms of gums showed glass transitions ranging from 80.93 to 91.96 $^{o}$C. The FTIR spectrum of *Buchanania lanzan* gum exudates, collected from different places exhibited the typical bands and peak characteristic for the gums. The particle size analysis of gum samples exhibited $d_{50}$ values ranging from 56.50 to 254.2 μm.

**Keywords:** *Piyar*, *Chirongi*, Thermo-gravimetric analysis, Differential thermal analysis, Differential scanning calorimetry

During last two decades plant polysaccharides/natural polymeric materials have evoked tremendous interest due to their diverse pharmaceutical applications such as diluents, binders, disintegrants, bio-adhesives, thickeners, emulsifiers, stabilizers, gelling agents as also in cosmetics, textiles, paints and paper-making etc. Many natural polysaccharides have been successfully used in sustained drug release because of their well-known non-toxicity, eco-friendliness, biodegradability, biocompatibility, biosafety sustainability, relatively widespread availability and unique physico-chemical properties, often at very low costs, as compared to their synthetic counterparts[1-13].

*Buchanania lanzan* Spreng., a natural plant polysaccharide, commonly known as *char, achar, piyar, chirongi* and pre-dominantly the trees are available in the States of Chhattisgarh, Jharkhand, Madhya Pradesh and in Varanasi and Mirzapur districts of Uttar Pradesh. This species has high socio-economic value providing livelihood to tribal population of the area and has high potential as commercial horticulture species. It is a common associate of sal (*Shorea robusta*), teak (*Tectona grandis*), dhok/kaldhi (*Anogeissus pendula*) and salai (*Boswellia serrata*). About seven species of *Buchanania* have been reported in India, out of which *Buchanania lanzan* and *Buchanania axillaries* (Syn. *Angustifolia*) produce edible fruits. *Buchanania lanceolata,* an endangered species, is found in the evergreen forests of Kerala while *Buchanania platyneura* is found in Andaman. Other species of the genus are *Buchanania lucida*, *Buchanania glabra* and *Buchanania accuminata*. Traditional indigenous knowledge reveals the immense value of almost all parts of the plant like roots, leaves, fruits, seeds and gum for various medicinal uses. It bears fruits, each containing a single seed known as 'chironji' and is quite popular as an edible nut[14].

Structural and functional group differences in natural polysaccharide gums influencing the thermal behavior and affecting the transition temperature is generally studied by TGA / DTA and DSC [15-18].

The significant qualitative and quantitative intra-specific variations in terms of their phytochemicals, physico-chemical properties and antioxidant activity of *Buchanania lanzan* (*B. lanzan*) gum exudates, collected from different places, have been reported by Siddiqui *et al*. in 2015[19]. The present paper reports the thermal characterization of *Buchanania lanzan* (*B. lanzan*) gum exudates, collected from different places, using thermogravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC), Fourier transform-infra red (FTIR) and particle size analysis.

## MATERIALS AND METHODS

Seven samples of gum exudates of *B. lanzan* Spreng. were collected from Bilaspur (Chhattisgarh); Simdega and ICAR-IINRG Farm, Ranchi (Jharkhand); Dindori and Umaria districts of Madhya Pradesh and Mirzapur district of Uttar Pradesh, major *B. lanzan* gum producing districts/States, for studying variations in their thermal properties (Table 1). All the gum samples after manual cleaning and sorting were converted into fine powder and passed through 0.4 mm mesh sieve and packed in air tight containers for further analysis.

### Thermal studies

Thermal properties of *B. lanzan* gum samples were characterized by using a Q20-TA DSC. Nitrogen at the rate of 50 ml/min was used as purge gas. Five milligram of powdered gum sample was sealed in an aluminium pan and heated up to 300 ˚C @10 ˚C/min followed by cooling cycle at the same rate. TGA / DTA study was done by Shimadzu, Japan, DTG-60. The FTIR spectra of gum samples were recorded on IR-Prestige 21, Shimadzu (Japan) in the range of 500-4000 cm$^{-1}$. Particle size of gum samples was determined in isopropanol as dispersion medium using Beckman-Coulter Particle size Analyzer using Laser Diffraction Methods.

**Table 1:** Details of *B. lanzan* gum gum samples

| Gum samples | Place of collection of *B. lanzan* gum samples |
|---|---|
| 1 | Gum exudates collected from Bilaspur (Chhattisgarh) |
| 2 | Gum exudates collected from Simdega (Jharkhand) |
| 3 | Gum exudates collected from ICAR-IINRG farm, Ranchi (Jharkhand) |
| 4 | Gum exudates collected from Dindori (Madhya Pradesh) |
| 5 | Gum exudates (black) collected from Umaria (Madhya Pradesh) |
| 6 | Gum exudates (white) collected from Umaria (Madhya Pradesh) |
| 7 | Gum exudates collected from Mirzapur (Uttar Pradesh) |

## RESULTS AND DISCUSSION

*B. lanzan* gum samples, collected from different places, were thermally characterized using TGA, DTA and DSC under nitrogen atmosphere. Major thermal transitions as well as activation energies of the major decomposition stages were determined. TGA is inherently quantitative, simple and accurate method and, therefore, an extremely powerful thermal technique for studying the decomposition pattern and the thermal stability of polymers. Thermogram is graph of % mass (weight change) *versus* temperature, help to elucidate decomposition mechanisms. TGA is the function of time and temperature involving mass changes on heating. In a desired temperature range, if a species is thermally stable, there will be no observed mass change. The TG spectrum of one of gum samples collected from Bilaspur (Chhattisgarh) exhibited three-stage decomposition (Fig. 1).

DTA is a thermoanalytic technique that is similar to differential scanning calorimetry. In DTA, the material under study and an inert reference are made to undergo identical thermal cycles *i.e.* same cooling or heating programme while recording any temperature difference between the sample and reference. A DTA curve provides data on the transformations that have occurred, such as glass transitions, crystallization, melting and sublimation. The area under a DTA peak is the enthalpy change and is not affected by the heat capacity of the sample. DTA can be used only as a finger print for identification purposes DTA is widely used in the pharmaceutical and food industries as also in cement chemistry, mineralogical research and in environmental studies. The DTA spectrum of one of gum samples collected from Bilaspur (Chhattisgarh) is given as Fig. 2.

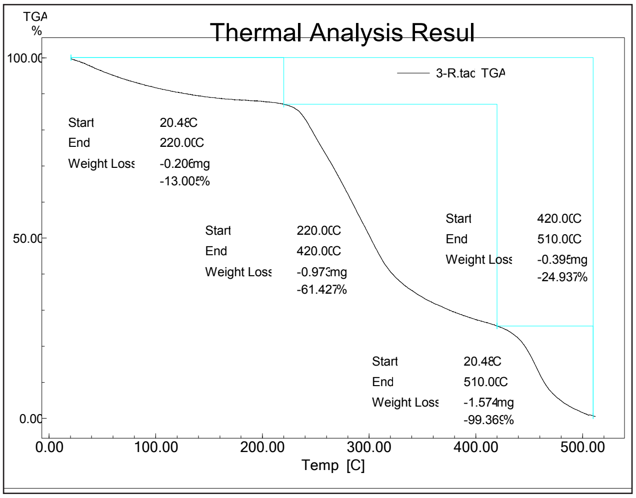


**Fig. 1:** TGA spectrum of gum sample

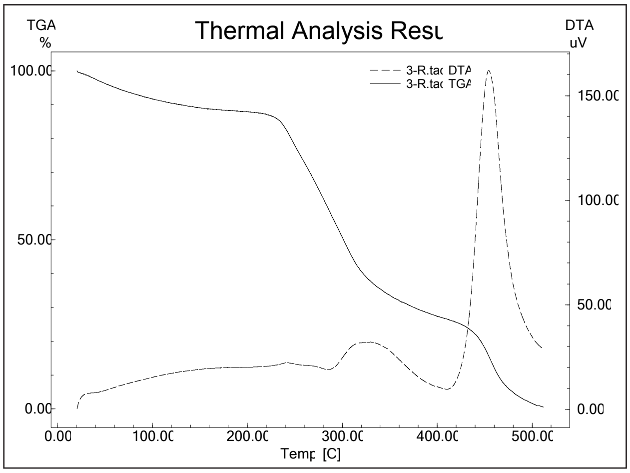


**Fig. 2:** DTA spectrum of gum sample

During the thermal processing, generally dehydration, depolymerization and pyrolitic decomposition are involved in these high temperature stages resulting in the formation of $H_2O$, $CO_2$ and $CH_4$. However, due to differences in the structures and the functional groups, either the degradation routes or the resulting fragments will be different. Most of the polysaccharides comprise carboxylate or carboxylic acid functional groups. Therefore, the thermal scission of the carboxylate groups and the evolution of $CO_2$ from the corresponding carbohydrate backbone may be a probable mechanism for the thermal transitions [20-23]. TGA / DTA thermogram of gum samples revealed that the gum is relatively stable up to 220 ˚C, beyond which degradation starts.

DSC is used to measure the occurrence of exothermal and endothermal changes with increased temperature. Because of its sensitivity and accuracy, it is being extensively used for studying the phase transition of polymers. DSC is used widely for examining polymeric materials to determine their thermal transitions. It is also used in purity analysis, safety screening and pharmaceutical industries for studying curing processes. The DSC thermograms of gums showed glass transitions ranging from 80.93 to 91.96 °C and DSC thermogram of one of gum samples collected from Bilaspur (Chhattisgarh) is given as Fig. 3.

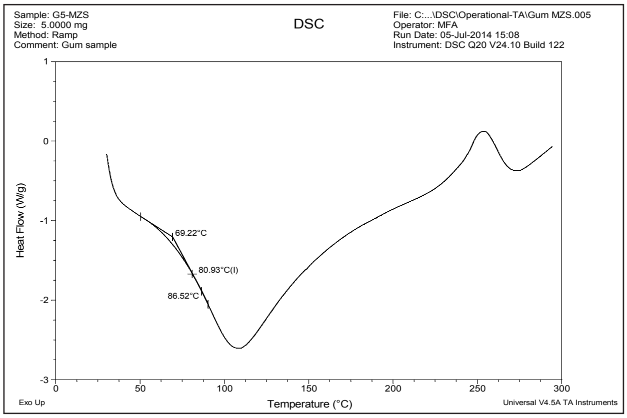


**Fig. 3:** DSC thermogram of gum sample

Particle size analysis of *B. lanzan* gum samples determined by Beckman-Coulter Particle size Analyzer using Laser Diffraction Methods exhibited $d_{50}$ values ranging from 56.50 to 254.2 μm.

FTIR spectroscopy has been extensively used for the characterization of molecular and material structures of polymeric substances. Characterization using FTIR spectroscopy often results in the identification of functional groups and the modes of their attachment to polymer backbone. The FTIR spectrum of *B. lanzan* gum samples, collected from different places, exhibited the typical bands and peak characteristic for the gums [24-26]. A representative FTIR spectrum of gum sample collected from Bilaspur (Chhattisgarh) is given as Fig. 4.

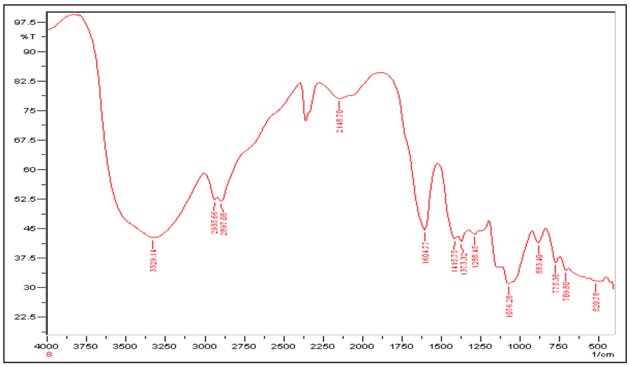


**Fig. 4:** FTIR spectrum of gum sample

## CONCLUSION

TGA / DTA thermo-gravimetric and DSC analyses of *B. lanzan* gum samples revealed that the gum is relatively stable and can be used in food and pharmaceutical sector. The different thermal decomposition pattern exhibited by the *B. lanzan* gum samples may be due to the structural and functional group differences in their phytochemicals, geographical locations and climatic conditions around the resource gum tree, its age and nature of soil etc.

## ACKNOWLEDGEMENTS

The authors are grateful to Dr. KK Sharma, Director, ICAR Indian Institute of Natural Resins & Gums, Ranchi (Jharkhand) for providing necessary facilities for conducting the study. They also acknowledge the financial support from the Network Project on 'Harvesting, Processing and Value Addition of Natural Resins and Gums', ICAR, New Delhi.

## REFERENCES

1. Kapoor, V.P., Farooqi, M.I.H., Travel, F.R. and Joseleau, J.P. 1991. Studies on *Acacia nilotica* gum exudates. Structural variation due to different habitats. *Carbohydrate Research*, **222**: 289-293.
2. Yaseen, E.I., Herald, T.J., Aramouni, F.M. and Alavi, S. 2005. Rheological properties of selected gum solutions. *Food Research International*, **38**: 111-119.
3. Abu Baker, A., Tahir, A. and Sabah, E.M.K. 2007. Effect of tree and nodule age on some physico-chemical properties of gum from *Acacia senegal* (L.) Willd., Sudan. Research *Journal of Agriculture and Biological Sciences*, **3**(6): 866-870.
4. Emeje, M., Nwabunike, P., Isimi, C., Fortunak, J., Mitchell, J.W., Byrn, S., Kunle, O. and Ofoefule. 2009. Isolation, characterization and formulation properties of a new plant gum obtained from *Cissus refescence*. *International Journal of Green Pharmacy*, pp. 16-23.
5. Nep, E.I. and Conway, B.R. 2010. Characterization of *Grewia* gum, a potential pharmaceutical excipient. *Journal of Excipients and Food Chemistry*, **1**(1): 30-40.
6. Singh, A.K., Selvam, R.P. and Sivakumar, T. 2010. Isolation, characterization and formulation properties of a new plant gum obtained from *Magnifera indica*. *International Journal of Pharmaceutical and Biomedical Research*, **1**(2): 35-41.
7. Ogaji, I. and Okafor, I.S. 2011. Potential of *Grewia* gum as film coating agent: some physico-chemical properties of coated praziquantel tablets. *International Journal of Pharmaceutical Research*, **3**: 16-19.
8. Siddiqui, M.Z. 2014. Natural gums---An insight into their pharmaceutical potentials. *World Journal of Pharmaceutical Sciences*, **2**(9): 890-891.
9. Siddiqui, M.Z. 2015. Post-harvest processing & value addition of natural gums and resins. *World Journal of Pharmaceutical Sciences*, **3**(8): 1471-1472.
10. Thombare, N., Jha, U., Mishra, S. and Siddiqui, M.Z. 2016. *Guar* gum as a promising starting material for diverse applications: A review. *International Journal of Biological Macromolecules*, **88**: 361-372.
11. Daoub, R.M.A., Elmubarak, A.H., Misran, M., Hassan, E.A. and Osman, M.E. 2016. Characterization and functional properties of some natural *acacia* gums. *Journal of Saudi Society of Agricultural Sciences*, pp. 1-9.
12. Siddiqui, M.Z., Prasad, N. and Tewari, J.C. 2017. Physico-chemical properties and toxicity test of *Prosopis juliflora* and *Balanites aegyptiaca* gum exudates from Rajasthan. *Indian Journal of Experimental Biology*, **55**: 782-788.
13. Gayathri, R. and Ganapathy, R.S. 2018. Extraction and characterization of the gum isolated from *Araucaria heterophylla*. *International Journal of Pharmaceutical Sciences and Research*, **9**(3): 1062-1067.
14. Siddiqui, M.Z., Chowdhury, A.R., Prasad, N. and Thomas, M. 2014. *Buchanania lanzan*: A species of enormous potentials. *World Journal of Pharmaceutical Sciences*, **2**(4): 374-379.
15. Krueger, B.R., Knutson, C.A., Inglett, G.E. and Walker, C.E. 1987. A differential scanning calorimetry study on the effect of annealing on gelatinization behavior of corn starch. *Journal of Food Science*, **52**(3): 715-718.
16. Giron, D. 2002. Thermal analysis of drugs and drug products. In: J. Swarbrick and JC Boylan (Ed.) Encyclopedia of Pharmaceutical Technology. Marcel Dekker Inc., New York, pp. 2766-2793.
17. Bothara, S.B. and Singh, S. 2012. Thermal studies on natural polysaccharide. *Asian Pacific Journal of Tropical Biomedicine*, S1031-S1035.

18. Vendruscolo, C.W., Ferrero, C., Pineda, E.A.G., Silveira, J.L.M., Freitas, R.A., Jimenez-Castellanos, R. *et al*. 2009. Physico-chemical and mechanical characterization of galactomannan from *Mimosa scabrella*: Effect of drying method. *Carbohydrate Polymers*, **76**: 86.

19. Siddiqui, M.Z., Chowdhury, A.R. and Prasad, N. 2015. Evaluation of phytochemicals, physico-chemical properties and antioxidant activity in gum exudates of *Buchanania lanzan*. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences (DOI: 10.1007/s40011-015-0539-4).

20. Mothe, C.G. and Rao, M.A. 2000. Thermal behavior of gum *arabic* in comparison with cashew gum. *Thermochimica Acta*, 357-358: 9-13.

21. Munir, H., Shahid, M., Anjum, F. and Mudgil, D. 2016. Structural, thermal and rheological characterization of modified *Dalbergia sissoo* gum---A medicinal gum. *International Journal of Biological Macromolecules*, **84**: 236-245.

22. Singh, S. and Bothara, S.B. 2012. Morphological, physico-chemical and structural characterization of mucilage isolated from the seeds of *Buchanania lanzan* Spreng. *International Journal of Health & Allied Sciences*, **3**(1): 33-39.

23. Jamaludin, J., Adam, F., Rasid, R.A. and Hassan, Z. 2017. Thermal studies on *Arabic* gum---carrageenan polysaccharides film. *Chemical Engineering Research Bulletin*, **19**: 80-86.

24. Wang, Q., Ellis, P.R. and Ross-Murphy, S.B. 2003. Dissolution kinetics of guar gum powders 2: Effects of concentration and molecular weight. *Carbohydrate Polymers*, **53**: 75.

25. Kemp, W. 1991. Organic Spectroscopy, 3rd Edition, New York, Palgrave Publisher.

26. Kalsi, P.S. 2004. Spectroscopy of Organic Compounds, 6th Edition, New Delhi, New Age international Publishers.