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Physicochemical, structural and thermal characterization of natural biopolymers of Indian medicinal trees: Rohina (*Soymida febrifuga*) and Goinja (*Lannea coromandelica*) gum exudates

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Abstract
Rohina (*Soymida febrifuga*) and Goinja (*Lannea coromandelica*) biopolymers (gum exudates) was extracted from naturally growing trees species from forest areas of Chhattisgarh through tapping techniques, using gum enhancers (Ethephon) and collected gum was purified. The purified gum exudates of Rohina and Goinja, was physico-chemically analyzed. The protein, Fiber, pH, Swelling index, moisture content and Tannin content were found to be ranging from 1.15 to 1.29, 87.41 to 82.03, 6.29 to 5.64, 3.53 to 5.33, 9.52 to 9.47 and 1.07 to 0.68 respectively. The SEM analysis of both species, gums revealed a typical trend of particle shape/structure indicated the amorphous nature. Goinja (*L. coromandelica*) gum water absorption capcity higher (swelling index) compared to Rohina gum because of their particle shape. DSC and TGA thermograms were characteristic of each gum. The thermogram showing the exothermic peak at round 130°C in of Goinja (*Lannea coromandelica*) and Rohina (*Soymida febrifuga*) it observed at 33°C. Goinja (*Lannea coromandelica*) gum show more stable as compared to Rohina gum.

Keywords: SEM, thermogram, Rohina, DSC, TGA

1. Introduction

Indian mustard (*Brassica juncea* L.) is an important *Rabi* oilseed crop extensively grown as Natural gums are natural exudates from tree areal parts (trunk or branches or fruit) of trees due to any abiotic or biotic factor (injury) and they are widely used traded non-timber product. They're useful for their chemical characteristics and associated applications, such as the manufacturing of varnishes, adhesives, and food glazing agents. They are used in foods, pharmaceutical and many other industries. Gums are hydrocolloids polysaccharides (Glicksman, 1982; FAO, 1990; Flindt *et al.*, 2005) [6, 24, 21].

These are plant exudates that occur when internal plant tissues disintegrate due to a process known as gummosis. The popularity of herbal medicine is growing day by day because the environment has the potential to cure many diseases (Rekha *et al.*, 2010) [14]. NRGs originated from the plants/insects may be classified in three categories namely natural resins, natural gums and gum resins. About 120 gum and resin producing plant species are known to grow in India, and they occupy in various climates. The forests of central India support the rich diversity of tree species, many of which provide invaluable gums. (Kala, 2011). This is also recognized as an important source of raw materials for the production of organic matter as well as for the composition of incense and perfumes.

Rohina (*Soymida febrifuga* A. Juss.) is an indigenous lofty deciduous medicinal tree endemic to India. The tree found in the tropical area mainly and one of the most popular traditional medicines in India. Gunja (*Lannea coromandelica*) is medium to big deciduous tree with a spreading crown and sturdy limbs that grows up to 24 metres tall and may be found across India and it also called Jhingan gum. The local unscientific and brutal tapping methods are leading to the death of the tapped trees and erratic supply of gum or resin in the market. Therefore, need to find out the appropriate time and method of tapping of trees to achieve high gum production, without change in its characteristics feature via use of various gum enhancers.

2. Material and methods
The naturally grown trees were selected *i.e.* Rohina (*Soymida febrifuga* A. Juss) and Goinja (*Lannea coromandelica*) for the experiment at Sanwatpur, under the Achanakmar Tiger Reserve, Lormi, District-Mungeli (CG) during the year 2018-19 to 2019-20 respectively.

2.1 Materials
Raw gum exudates of Rohina (*Soymida febrifuga*) and Goinja (*Lannea vcoromandelica*) were collected from village Sanwatpur, Lormi under ATR region of Mungeli district, Chhattisgarh, India. All chemicals used were of analytical grade and the solvents used for physicochemical analysis.

2.2 Methods
Naturally grown Rohina and Goinja trees were tapped by traditional method of tapping (single cut with axe) and gum enhancers (ethephon concentration), the raw gum exudates was collected and stored at dry place.

2.2.1 Physicochemical analysis
AOAC standard methods were used to determine moisture, protein, and total fiber (AOAC 2016). Swelling index, 1 g of power gum was placed in a 100 ml stopper measuring cylinder, and added 100 ml of distilled water to create the final capacity 100 ml. The volume of the gum before hydration (V0) was measured. The free water was decanted after 24 hours, and the volume of swollen (hydrated) gum (Vi) was measured (Phani *et al.*, 2011) [10].
One percent gum solution was used to measure pH of gum solution and Solubility of gum was analyzed by using of 2% solution of gum exudates (Eddy *et al*., 2012) [27].
Tannin content was estimated by the method given by Makkar, 1996 [28]. Microstructures at SEM can be analyzed for its elemental composition in more detail using EDX system at NIT Raipur, Chhattisgarh. This is a non-destructive analysis and the elements and their concentration in the sample can be determined reasonably accurately. The operation is free of liquid nitrogen requirement. Low Z elements like Boron, carbon and oxygen can also be routinely detected. EDX analysis: Oxford- Energy Dispersive X-ray system (INCA 250 EDS with X-MAX 20mm Detector) (Yang *et al.* 2013; Cerqueira *et al.* 2011) [8, 12]. DSC (Differential Scanning Colorimetry) and TGA (Thermogravimetric analysis) use for thermal properties of exudates gum from Rohina and Goinja biopolymers (powder gum exudates) analyzed at CIPET, Raipur Chhattisgarh.

3. Result and discussion
3.1 Tapping techniques and gum exudation
Gum enhancers *i.e.* ethephon (2-chloroethyl phosphonic acid) were used in various concentration and combination to obtain potential production of gum in Rohina (*Soymida febrifuga* A. Juss), Goinja (*Lannea coromandelica*), in various season *i.e.* winter and summer. In general summer season (March to June) was found appropriate for tapping. In Rohina, Goinja ethephon @3.9 % applied at triple place and its slightly increased in concentration resulted superior over other tapping techniques. When compared to traditional tapping, the use of gum enhancer was much more successful in these trees. Exudation began within a week, and the flow rate and quantity of gum were determined by environmental parameters such as temperature, relative humidity, tree height (1 DBH), tree diameter, treatment application direction, slope of tree over ground surface, and tree elevation. Summer was the most effective season for tapping, although it may also be tapped in the winter with a little greater ethephon concentration.

3.2 Physicochemical analysis
3.2.1 Proximate analysis
The proximate analysis of Rohina and Goinja gum is listed in Table 1. Proximate composition of gum exudates is an indication of the purity of gum. The protein content 1.15 % and 1.29 % was obtained in Rohina (*Soymida febrifuga*) and Goinja (*Lannea coromandelica*) gum respectively similar result reported by Ghritlahare *et al.*, 2021 [7] the content of protein in gum is mainly responsible for its emulsion capacity. Further, these gums *i.e.* Rohina and Goinja gums also differ in composition in terms of quantity of fiber (Table 1). Total fiber content of Rohina and Goinja gum found to be 87.41 and 82.03 % respectively. Similar result found 87 and 80 % total fiber in kondagogu and Karaya gum respectively (Jananki and Sashidhar 1998).

Table 1: Physicochemical characteristics

Parameters	Rohina gum	Goinja gum
Protein Content (%)	1.15	1.29
Total Fiber	87.41	82.03
pH	6.29	5.64
Swelling index (%)	3.53	5.33
Moisture Content (%)	9.52	9.47
Tannin content (mg/g)	1.07	0.68

The pH value was obtained higher 6.29 in Goinja gum sample as compared to Rohina gum (5.64). The swelling index of Rohina gum (3.53 %) and Goinja (5.33 %) was significantly differed and show that Goinja gum had swelled as a result of ingesting vast amounts of water molecules and entangling them between its chains and branches (Rana *et al.*, 2011). The pH of the medium has been shown to have a significant impact on the swelling index of gums in studies (Ghritlahare *et al.*, 2022; Kamboj *et al.*, 2014) [15].
The moisture content 9.52 % and 9.47 % in gum exudates of Rohina and Goinja respectively. Studies reveled that the moisture content is inversely proportional to shelf life (Bashir and Haripriya, 2016).
The tannins content was analysed for first time of Rohina and Goinja gum exudates (Table 1). The tannin content of gum exudates was found that the higher 1.07 % in Rohina as compare to Goinja gum (0.68 %). Furthermore, the tannin level of gum kondagogu differed by grade, with Grades II and III containing more tannin than Grade I, presumably suggesting gum quality. The tannin concentration may be utilised as one of the biochemical markers to assess the gum kondagogu's quality and distinguish it from gum karaya and other gum exudates reported by Shashidhar and Janaki, 1998.

3.2.2 Element composition analysis using EDX system through microstructure of powder gum sample (Mineral content)
The elemental analysis result shows in Table 2. Rohina gum it was observed that in traditionally tapped gum having Si, Hg, Cu additionally while in gum enhancer tapped gum having Cd, Co, Na, Fe and Ni in gum sample in Rohina (*Soymida febrifuga*). However, remaining Ca, K, Pd, Mg, Cl, Al were

same. Sharma and Lalita (2011) [25] and Kothiyal and Sharma (2012) also reported that the element composition of guar gum. The result on elemental compound s indicated that the Ca, K, and Mg were the major element present in the pithecellobium dulce (Roxb.) benth and *Terminalia tomentosa* gum exudates (Jani *et al.*, 2009; Chaudhari and Annapure, 2020; Ghritlahare *et al.* 2022) [22, 4].

3.2.2 Thermal properties
DSC analysis

The thermal analysis of gum helps in understanding the temperature influence on the process of gum. The DSC analysis results (Fig. 1 and Fig. 2) showed initial broad exothermic

Table 2: Elemental composition of analyzed gum exudates of Rohina and Goinja

Rohina gum		Goinja	
Traditionally tapped	**Gum enhances**	**Traditionally tapped**	**Gum enhances**
Ca	Ca	Ca	Ca
Mg	Mg	Mg	Mg
K	K	K	K
Na	Na	Cu	Cu
Cr	Cr	Ni	Ni
Cl	Cl	Co	Co
Mn	Mn	Cl	Cl
Fe	Fe	Mn	Fe
Cu	Hg	Cd	Al
	Al	Al	
	Pb	As	
		Zn	
		Hg	

peak at 150°C Goinja and respectively. Whereas in Rohina showed endothermic peak at 250°C. Similar results have been obtained by Singh *et al.* 2010 [1] in *mangifera indica* gum, Bothara and Singh (2014) in *Diospyros Melonoxylon* Roxb. Singh *et al.* 2021

3.2.3 TGA analysis
The thermograms of Rohina and Goinja gums are given in (Fig 3 and 4) which shows a weight loss of gums with respect to temperature. All gums losses their weight in three steps, first weight loss was a result of dehydration of gum (30 to 263°C, 30 to 262°C for Goinja, Rohina respectively). Second weight loss of gum was attributed due to dehydration of polysaccharides and observed between 263 to 463°C, 262 to 462°C for Goinja, Rohina respectively. While the third step start at 462 and 463°C and ends at 900°C. The third weight loss might be the result of the conversion of gum into carbon residues similarly reported by Ghritlahare *et al.* 2022 in *Terminalia tomentosa* gum exudates.

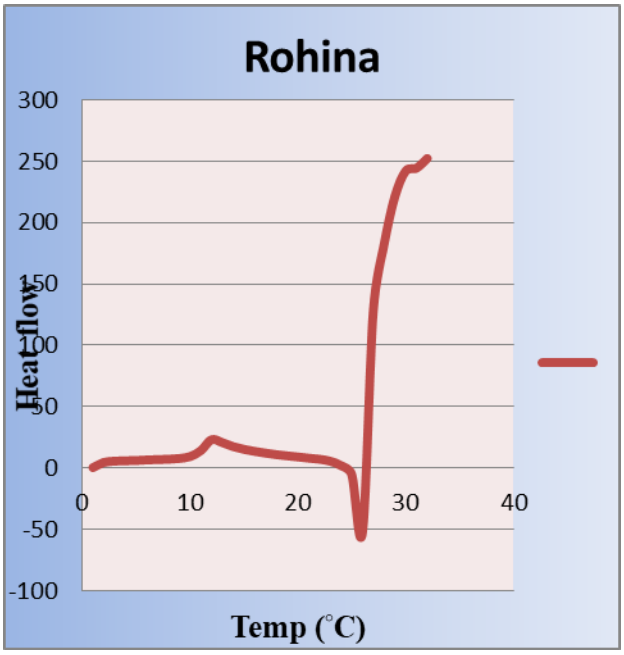

Fig 1: DSC of Rohina (*Soymida febrifuga*) gum

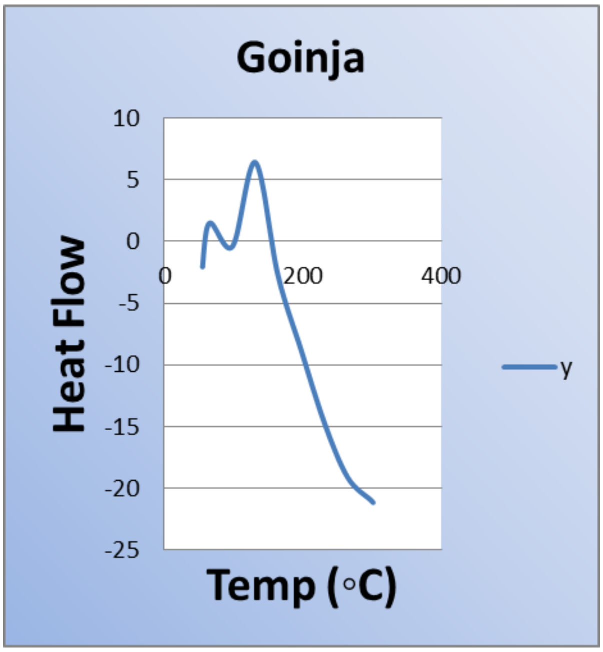

Fig 2: DSC of Goinja (*Lannea coromandelica*) gum

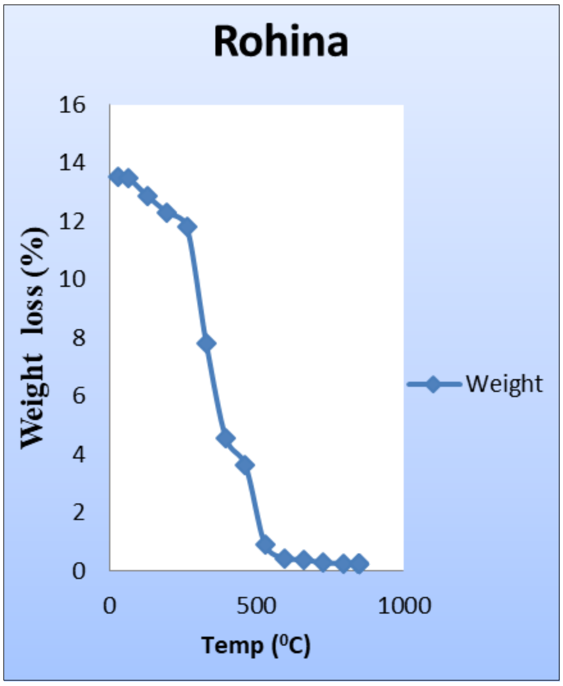

Fig 3: TGA of Rohina (*Soymida febrifuga*) gum

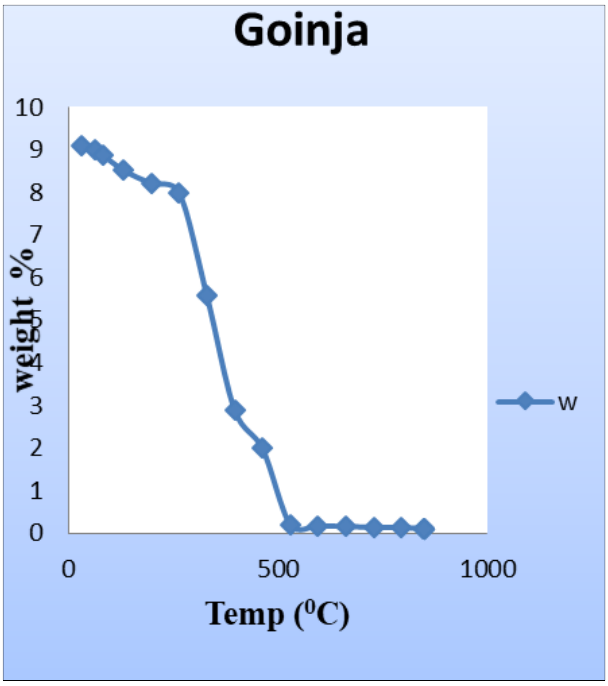

Fig 4: TGA of Goinja (*Lannea coromandelica*) gum

4. Conclusion

Rohina (*Soymida febrifuga*) and *Goinja (Lannea coromandelica*) plant was identified and selected for gum production and its characterization. The use of ethephon helps to inducing gummosis process resulting high yields of exudates gum. Proximate composition of Rohina gum shows corresponded with Goinja gum and achieved. Moreover physicochemical properties of both exudates gum from experimental trees are slightly changed with the increased the level ethephon. The fiber, tannin moisture and was significantly higher in Rohina exudates gum. However, the pH value, swelling index, and protein percent was higher in Goinja gum exudates.

Traditionally tapped gum having Ca, Mg, K, Na, Cr, Cl, Mn, Fe and Cu. apart from these elements gum exudates tapped by gum enhancers having Hg, Al and Pb additionally in Rohina (*Soymida febrifuga*). The thermogram of Goinja (*Lannea coromandelica*) showing the exothermic peak at round 130°C while in Rohina (*Soymida febrifuga*) it observed at 33°C. The thermal stability of Rohina was lower than of Goinja (*Lannea coromandelica*). The TGA analysis indicated that the gum exudates shown the presence of volatile compound presence of polymers, carbon black and at 510°C have ash (Zink oxide silica).

5. Acknowledgement

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