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Impact of biopolymer *Commiphora wightii* (guggul) oleo gum resin fumes on indoor environment

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The present study focuses on the physico-chemical composition of *C. wightii* oleo-gum resin, a biopolymer comprising steroids, diterpenoids, aliphatic esters, carbohydrates, and various inorganic ions. The ash, water-soluble, and alcohol-soluble extractive content of the resin were found to be 4.47±0.78%, 25.76±0.15%, and 10.65±0.25%, respectively. Additionally, the oleo-gum resin contained 0.85±0.21% essential oil. Biologically active chemicals, guggulsterone-E and guggulsterone-Z were estimated 0.05±0.01%, and 0.53±0.07%, respectively. Moreover, this study assessed the inhibitory effect of oleo-gum resin fumes on the indoor microbial environment and the concentration of inorganic pollutants. Exposure to guggul resin fumes for 30 minutes resulted in a significant reduction of 82%-90% in colony-forming units (CFU) of environmental microbes, including bacteria and fungi. Furthermore, the impact of guggul fumes on inorganic pollutants, specifically SO_2 and NO_2 concentrations, was investigated in the study area. Before treatment, SO_2 and NO_2 levels were observed to be 4.6 ppm and 0.021 ppm, respectively. Following fumigation, there was a reduction in SO_2 levels ranging from 8.47% to 26.73%, while NO_2 levels increased by 9.52% to 14.85%. This comprehensive study sheds light on the potential of *C. wightii* oleo-gum resin to influence indoor microbial contamination and inorganic pollutant levels, showcasing its significance in environmental and health-related applications.

Keywords: *Commiphora wightii*, guggulsterones, microbial contamination, bacterial colonies, colony forming units, SO_2, NO_2

INTRODUCTION

Medicinal values of guggul, *Commiphora wightii* oleo gum resin, are reported in Atharva Veda [1]. It is found effective in treatment of several diseases [2-4]. Besides, it is also used in incense, lacquers, varnishes, ointments as a fixative and in perfumes. It has very high demand in national and international herbal industries. National Medicinal Plant Board, Ministry of Ayush, New Delhi has considered it as one of the priority species for research and development [5].

The significance of this gum-resin is due to the presence of a steroid "guggulsterone", in two active isomers, guggulsterone E and Z which are responsible for the hypolipidemic activity [6, 7]. Guggulsterone and guggulipid have been demonstrated to reduce risk of cardiac function in clinical studies [8] and also inhibit platelet aggregation and provide protection from myocardial ischemia in rats [9, 10] due to antioxidant property. The plant extracts of guggul were used as major components in the preparation of 100% natural disinfectants[11]. The potential antioxidant and antimicrobial activities of guggul against different organisms, *viz*., *Klebsiella pneumoniae*, *Bacillus subtilis*, *Staphylococcus aureus, Proteus vulgaris, Escherichia coli*, and *Staphylococcus epidermidis* were also documented [12]. Guggulsterone Z and gugulipid (GL) possess anti-cancer activity [13]. The fresh guggul plant extract was found more effective compared to its distillate. The antibacterial efficacy of guggul gum was assessed against gram-positive and gram-negative bacterial strains [14, 15]. The efficacy of guggul resin fumes was compared with some weeds; maximum reduction was observed in oleo-gum resin fumes. Fumes of weed species were also found effective for reducing bacteria population in the laboratory rooms. The bhils tribes inhale the fumes of gum resin of guggul to cure fever and bronchial diseases [16]. The inhalation of medicinal smoke is a simple way of administering a drug. Since ancient times, fumes of frankincense and myrthwere used for religious purposes, had hygienic functions, also to remove bad smell, and reduce pollutants of air. The bactericidal, germicidal, antiviral, and fungicidal properties of benzoin resin and oil due to the presence of biocidal constituents- benzoic acid, benzaldehyde, and benzyl benzoate were assessed [17, 18]. Similarly, fumes of odoriferous medicinal herbs and wood were used to purify the environment [19]. Keeping these facts in mind, the present study deals with the effect of fumes on air quality and the anti-microbial activities of oleo-gum-resin *C. wightii*.

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MATERIALS AND METHODS

Collection of sample and determination of quality of guggul

Samples of guggul were collected from the forest of Bhuj (Gujarat). Quality of resin, i.e., moisture%, water soluble, ethanol soluble extractive value, total ash and acid insoluble ash value were determined by following methods as per WHO guidelines [20].

Estimation of bioactive chemicals- guggulsterone E & Z

The quantity of biologically important chemicals guggulsterone-E and guggulsterone-Z was estimated with the help of chromatographic technique - high performance thin layer chromatography (HPTLC) [21]. Standard solution of both chemicals was prepared in separate 10 ml volumetric flasks by dissolving 1000 µg in 3 ml of ethyl acetate and final volume was made up with methanol. 50 mg resin was dissolved in 2 ml of ethyl acetate and the volume was made up with methanol in a 10 ml volumetric flask. A standard graph was plotted with different concentrations of the standard (200, 400, 600 and 800 ng/spot).

Development of HPTLC plate and quantity estimation of guggulsterone - E&Z

Standard and 20 µg/spot samples were applied in three replicates using Linomet 5 (CAMAG) on 20 cm × 10 cm, 200 µm silica gel 60 F254 coated aluminum plates. A toluene:acetone (6:1) solution was used as mobile phase to develop plate in a CAMAG derivatization chamber. 100 µm/step data resolution was used to scan developed plates in a wavelength range of 200 to 400 nm. WinCATs Planner Chromatography manager software (CAMAG) Switzerland Excel (Microsoft Office 10) USA was used to quantify guggulsterone E & Z through the calibration curve of standards (Figs. 9a to 9f, 10a to 10c) and their peak area. Following formula was used to calculate guggulsterone E & Z percentage:

$$\mathrm{E-GS\ and\ Z-GS\ (\%)} = \frac{\text{Estimated amount (µg)} \times 100}{\text{Dry amount spotted on the track (µg)}}$$

Testing of microbial activity

Fumigation was carried out by burning 10 g of guggul [22] in the room (8 m × 10 m × 3.5 m). Settle plate method as passive sampling was used to determine the total microorganisms (bacterial and fungal) in the air. The efficacy of fumes was assessed by microbial count, CFU before and after exposure of plates of nutrient agar (NA) and potato dextrose agar (PDA) for 30 min, placed at different distances (1, 1.5, 2, 2.5, 3, 3.5 and 4 feet). After exposure the plates were incubated at 37°C.

Effect of fumes on NO_2 and SO_2 levels

NO_2 in air was collected by scrubbing a known volume of air through an alkaline solution of arsenite. The nitrite ions thus formed reacted with sulfanilamide and N-(1-naphthyl) ethylenediamine (NEDA) in phosphoric acid to form the colored azo dye, which was measured on a spectrophotometer at 540 nm. SO_2 from the air stream was absorbed in a sodium tetra-chloromercurate solution, it forms a stable dichlorosulfomercurate complex, which then behaves effectively as fixed SO_3^{2-} in solution. The amount of SO_2 was then estimated by the color produced when prosaline-hydrochloride and formaldehyde were added to the solution, measured on a spectrophotometer at 560 nm**.**

RESULTS AND DISCUSSION

Guggul, oleo-gum resin physico-chemical properties were assessed. The physical nature of the resin is viscous, moist and granulous. It burns in fire, melts in the sun light, and forms milky emulsion in hot water. The ash, water-soluble and alcohol-soluble parts were 4.47±0.78, 25.76±0.15 and 10.65±0.25%, respectively. The quantity of essential oil in the oleo-gum resin was estimated as 0.85±0.21%. The bioactive constituents, i.e., guggulsterone-E, guggulsterone-Z (Fig. 1) and total guggulsterone were quantified as 1.45±0.30, 0.05±0.010, and 0.53±0.07%, respectively. The results of this study are in accordance with earlier studies on the quality of guggul reported [23, 24]. However, some variation was observed in quantity which might be due to collection of material from different geographical regions.

Efficacy of fumes on air micro flora

The efficacy of oleo-gum-resin on bacterial and fungal population in air is depicted in Table 1 and Fig. 2**.** Colony forming units (CFU) were reduced significantly after burning of resin. The CFU of environmental microbes/bacteria decreased by 82-90% compared to the control. The percent reduction of fungal colonies varied from 88.55 to 91.72% over control. The results of the study show that the bacterial and fungal population decreased after fumigation with guggul resin in the area, the number of CFU before fumigation varied 1 to 13.

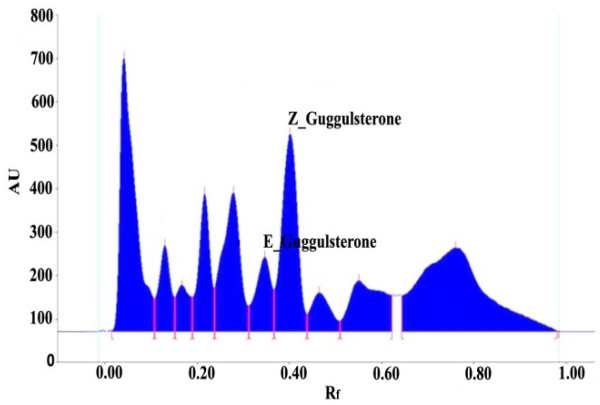

Fig. 1. HPTLC fingerprint profile of oleo-gum resin of *C. wightii* showing guggulsterone-E&Z

The result of this study is in the agreement with the findings of a study, determined potential efficacy of guggul against six gram-positive and four gram-negative bacteria [14]. Several studies have been undertaken to develop ecofriendly fungicides to reduce their harmful effect of synthetic carcinogenic [25]. Benzoin oil showed biological activities due to the presence of benzoic acid, benzaldehyde, and benzyl benzoate, and its smoke worked as a disinfectant [17, 18]. The present study was supported by the study on the effectiveness of guggul to inhibit gram-negative and gram-positive bacteria [16]. Further, the results of our study are in the line of a previous work which studied the effect of different weed fumes on the microbial population and compared with guggul and observed potential reduction of microbial population by oleo-gum resin fumes in comparison to other plants [15]. The result of the study is consistent with the findings of recent studies, reported the ability of the smoke to purify the air. The ability of traditional ayurvedic fumigation practices in environmental disinfection is also reported in several studies [26]. The white benzoin resin fumes inhibit bacterial strains of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Candida albicans* [27]. The fumes lead to purification of air by oxidizing the carbonic compounds and along with that they have antimicrobial properties which benefit the people around. They have disguising effect on various pollutants in the atmosphere including the oxides of sulfur. The present investigation reports the potential of fumes of oleo-gum resin on microflora in the environment. The results clearly disclosed the effect of oleo gum resin on different microbes in air.

Efficacy of C. wightii oleo-gum-resin fumes on SO_2 and NO_2levels in air

In the study area, for investigation of effect of guggul fumes on inorganic pollutants, i.e., SO_2 and NO_2, concentrations had been undertaken. The concentrations of SO_2 and NO_2 before treatment were 4.6 ppm and 0.021 ppm while after fumigation, SO_2 decreased from 1.23 to 0.39 ppm, corresponding to 8.47 to 26.73% decrease in SO_2 level and NO_2 increased from 0.025 to 0.051 ppm (Fig. 3). Our results are in conformity with the study conducted on the effect of fumes onSO_2 and NO_2 levels in ambient air [26]. In the present study, it was assessed that guggul fumes reduce microbial load and SO_2 levels, while a slight increase in NO_2 levels was observed in the air. However, it was below the threshold limit as per the guidelines of National ambient air quality standards (NAAQS) of 0.053 ppm.

Table 1. Effect of fumes of oleo gum resin on reduction of microbes

Treatment number	Distance (ft)	% of bacterial colonies after fumigation (mean)	% of fungal colonies after fumigation (mean)
1	1.0	9.526±1.065	15.86±0.078
2	1.5	11.78±1.725	14.56±0.181
3	2.0	12.51±1.595	18.77±0.295
4	2.5	13.68±2.44	12.10±0.108
5	3.0	14.98±2.77	11.80±0.378
6	3.5	12.78±3.635	17.06±0.178
7	4.0	14.81±0.94	10.41±0.505

Values are mean ± standard deviation (three replicates)

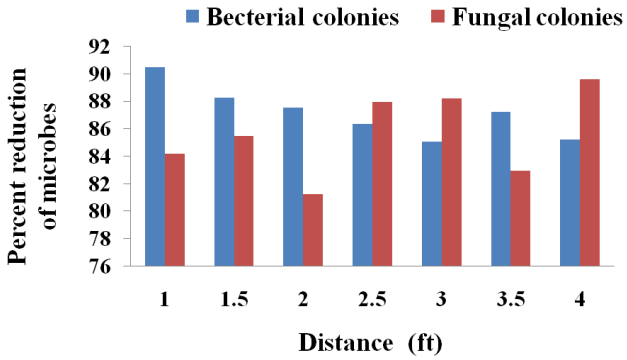

Fig. 2. Effect of fumes of guggul on reduction of microbes (bacteria and fungi)

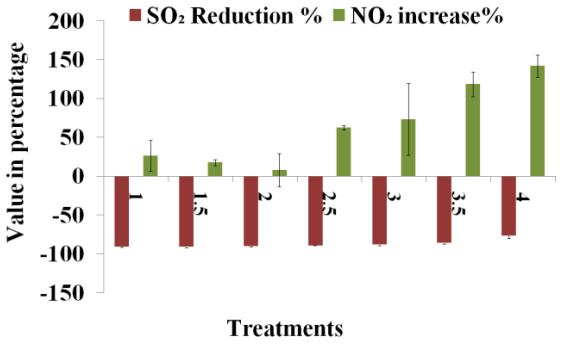

Fig. 3. Effect of fumes on reduction/increase of SO_2 and NO_2 levels

CONCLUSIONS

In the present study, the potential of *C. wightii*, oleo gum resin fumes was observed in environment purification. The phytochemical analysis of guggul revealed the presence of 4.47±0.78% ash, 25.76±0.15% water-soluble ash, 0.65±0.25% alcohol-soluble part and 0.85±0.21% essential oil. The quantity of bio active ingredients in guggulsterones was observed to be 1.45±0.30%. Moreover, this study assessed the inhibitory effect of oleo-gum resin fumes on the indoor microbial environment and concentration of inorganic pollutants. Exposure to guggul resin fumes for 30 minutes resulted in a significant reduction (82%-90%) in colony-forming units (CFU) of environmental microbes. Furthermore, the concentrations of the inorganic pollutants SO_2 and NO_2, were also found changed due to burning of guggul. A reduction in SO_2 levels ranging from 8.47% to 26.73% was observed, while NO_2 levels increased by 9.52% to 14.85%. On the basis of our study it was revealed that fumigation with *Commiphora wightii* oleo-gum resin is effective to improve air quality through minimizing/ reducing microbes and effects on toxic gaseous pollutants have potential. The use of fumes of this medicinal oleo-gum resin can reduce bacterial and fungal growth, as well as toxic gaseous pollutants of atmosphere. Findings of the study may pave the way to develop integrated approach to use bioproducts of *Commiphora wightii* (guggul), an important natural resource, to manage air quality.

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