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**Original Research Article**

# Understanding the Effect of Different Storage Techniques on Antifungal Activities of Oleo-Gum-Resin of *Commiphora wightii* (Guggul)

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## A B S T R A C T

*Commiphora wightii* is a flowering plant of the family Burseraceae, which produces a fragrant resin called guggul, which mainly finds application in ayurvedic medicine practice and incense industry. It is in the CR (critically endangered) status of the IUCN list of endangered species. The present study emphasizes on the effect that different storage techniques have on the antifungal activities of the oleo-gum-resin obtained from the *Commiphora wightii* plant. The dried samples of oleo-gum-resin were stored in different containers viz, glass bottle, plastic bottle, jute bag, and poly bag in light and dark conditions at room (dark and light) and different temperatures viz., 4, 10 and 20$^0$C.The efficacy of different concentrations of methanol, ethyl-acetate and aqueous extracts of Guggul on the radial growth of four species of fungi- *F.oxysporum*, *A. niger*, *A. flavus*, and *C. albicans* were screened. Different storage treatments had varied effects, the common one being the decrease in activity with increase in storage period. The data revealed that post harvest practices of drying and storage affect the quality of oleo-gum-resin of *C.wightii* during two years of storage period. These findings might be used as an indicator for post after management of Guggul to avoid deterioration of quality of this medicinally important produce. Although, glass bottle was found best to store the collected samples, but in view of non-feasibility of this storage in field conditions, study suggests to store six days shade drying oleo-gum-resin after harvest atleast in high density polethylene (HDPE) made poly bags at dry and cold place in room to retain its quality and quantity for longer period instead of storing in jute bags where in maximum deterioration was noticed. Deterioration in quality and quantity of oleo-gum-resin of *C. wightti* can further be checked if stored at low temperature of 4$^0$C in poly bags.

**K e y w o r d s**

Oleo-gum-resin, *Commiphorawightii*, Antifungal Properties, Guggul, Storage techniques

## Introduction

*Commiphora wightii* (Guggul) is an important medicinal plant. The oleo-gum-resin has high demand in national and international herbal industries due to its potential medicinal properties. The resin of *Commiphora wightii* is a good source of the traditional medicines in various parts of the world and used in treatment of

inflammation, obesity, tumor, arthritis, wound, microbial infection, pain, fractures and gastrointestinal diseases due to the presence of bioactive chemicals. It has pharmacological importance in curing various ailments since ancient period (2000 B.C.). The available literature suggests medicinal use of Guggul from 5000 years back. The Atharva Veda mentioned medicinal and therapeutic properties of Guggul in its references. The Indian ayurvedic medicinal experts like Charaka, Sushruta and Vagbhata have given detailed description of importance of Guggul as a drug (Kumar & Shankar, 1982; Satyawati, 1988).

*Commiphora wightii* is found across three continents, Africa (in 31 countries), Asia (in 5 countries) and North America (in USA) (Shrivastava *et al.,* 2011). In India, it is distributed in the arid rocky tracts of Rajasthan, Gujarat, Madhya Pradesh, Hyderabad and Karnataka states (Thomas *et al.,* 2012; Gupta *et al.,*1996; Khan, I958). Rajasthan, Gujarat and Western Madhya Pradesh are the main commercial sources of Guggul in India (Atal *et al.,* 1975).The post-harvest activities of gums and resins include handling, storage, packaging, transportation and marketing. The efficiency of a product is reliant upon the use of appropriate technology with adequate infrastructure, proper storage, processing, marketing and transportation network. After collection, the natural gums and resins are transported to temporary storage houses and, finally to ware houses for processing or pharmaceutical industries. This product shows fast depletion, therefore, there is a need of urgent processing for retaining its properties. Quality of *C. wightii* oleo-gum-resin is an important issue, which has complex ingredients, Guggulsteron-E and Z. Appropriate storage conditions and good types of packaging containers are important aspects for extending the storage life of oleo-gum resin. Therefore, post-harvest handling is an important task for maintaining the concentration of bioactive compounds. In actual practice, most of the collected medicinal produce are commonly stored in jute bags before processing stage. The selection of proper storage conditions including packaging may be of great importance. Type of containers stored in optimum temperature and relative humidity can directly influence the quality by protecting the product from both oxygen and light (Kader *et al.,* 1989; Razak *et al.,* 2017). The post-harvest process of medicinal plants has great importance to improve quality and quantity of the active constituents of the product. Despite the enormous socioeconomic importance of *C.wightii*, population of plant is declining at an alarming rate due to the destructive harvesting practices. Post-harvest handling is an important operation for maintaining the concentration of bioactive compounds in medicinally important plant produce. Freshly harvested oleo-gum-resin are dried in sunlight and stored in jute bags after collection from field. All chemical constituents of Guggul degrade to varying levels. They are known to be affected by light, temperature, humidity and storage type. Decrease in active constituent of any medicinal product commonly reduces its efficacy. Therefore the present study was undertaken to explicitly understand the effect of storage on the antimicrobial activities of this plant.

## Materials and Methods

### Sample collection and storage

Oleo-gum-resin of *C. wightii* was collected from the naturally growing plants in forest of Bhuj (Gujarat) during October 2015 to February 2016. The oleo-gum-resin resides in

the ducts located in the soft bark of the trees. It is obtained through the process of tapping. The resin ducts occur in the bark potion near cambial layer. Plants above 7.5 cm diameter were considered for the study.1.5cm deep incisions were made on the main stem and a pale yellow aromatic fluid ozzing out of it solidified soon into a golden brown or reddish brown agglomerate of tears or stalactite pieces. It was handpicked from the tree and sometimes collected using a knife. It has been observed that quality of oleo-gum resin deteriorates very fast after harvesting. The quality of gum resin is also affected ifdried in direct sun light and not stored properly in a suitable container. Therefore, samples were dried only up to six days after harvest. Traditional method was adopted for drying of samples under sunlight and shade for 1, 2, 4, and 6 days at room temperature and outside temperature. Dried samples were stored in different containers i.e. glass bottles, air tight plastic containers, plastic bags, and jute bags in two conditions – dark and light at room temperature and at different temperature i.e. $4^{o}$C, $10^{o}$C and $20^{o}$C. Samples of each treatment/methods were analyzed bimonthly for quality test.

## Assessment of antifungal activities

Poisoned food technique (Nene and Thapliyal, 1979) was employed to assess antifungal activity of Guggul extractives at different dilutions against test fungi- *Fusarium oxysporum*, *Aspergillus niger*, *Aspergillus flavus* and *Candida albicans.*

Antifungal activity of Guggul extracts of different dilutions was tested against fungi: *Fusarium oxysporum, Aspergillus niger, Aspergillus flavus, Candida albicans.* This technique involves the poisoning of the fungal growth medium using antifungal agent and then measuring the reduction of growth of the organism on the medium. The decrease in mycelial growth indicates the inhibition of fungal growth by the antifungal substance. Experiment was conducted in three replications. Different quantities of oleo-gum-resin samples (1, 2, 3, 4 and 5g) were dissolved in 10 ml solvents such as distilled water, ethyl-acetate, methanol and ethanol. These solutions were kept at room temperature overnight to prepare the crude extract. The crude extracts were filtered using Whatman filter paper and volume was made upto 10 ml using the particular solvent. Media was prepared by adding 39 gm of Potato Dextrose Agar media was weighed and dissolved in 1000 ml of distilled water. 1ml of the crude extract was added to this 1000ml media. The media was sterilized in an autoclave at 15 lbs pressure for 20 minutes. Finally the warm media was poured into the Petri dishes and allowed to set overnight. The inoculation room was sterilized by using ozoniser and fumigation. The culture area was cleaned by gently washing all walls and floors with detergent soap. This was followed by carefully wiping with 2% sodium hypo chloride solution or 95% ethyl alcohol. The inoculation of fungi (*Fusrarium oxysporum*, *Aspergillus niger*, *Aspergillus flavus* and *Candida albicans*) were carried out in Laminar Air Flow Cabinet under strict aseptic conditions. The laminar air flow cabinet was first swabbed with 70% alcohol and all required paraphernalia were kept inside.

Later the laminar cabinet was UV sterilized for duration of 45 min. Aseptic manipulations was initiated after 10 mins of switching off the UV light. The paraphernalia were then flame sterilized. The mouth of the Petri dishes was sterilized to kill all microorganisms around the dish. The Petri dishes were kept in incubator at 28 ± 2°C under controlled set of environmental conditions for further observation.

## Calculation of radial growth

The radial growth was calculated every day for the first 7 days. The radial growth was measured in centimeter and percent reduction of mycelial growth over control was calculated using the following formula:

Percent decrease over control.=.×100

Where,

Dc = Average diameter of fungal growth in control

Dt = Average diameter of fungal growth in treatment

## Results and Discussion

Assessment of different concentrations of methanol, ethyl-acetate and aqueous extracts of Guggul (100, 200, 300, 400 and 500 mg/ml) on the growth of fungal species- *Fusarium oxysporum*, *Aspergillus niger*, *Aspergillus flavus*, and *Candida albicans* were conducted by poisoned food technique. The results of antifungal activity of different extractives of fresh and stored (at room temperature- light and dark conditions and at 4, 10 and $20^0$C under controlled conditions) samples against *F. oxysporum*, *A.niger*, *A. flavus*, and *C. albicans* was recorded and fungal inhibition was calculated over control. The antifungal activity against *F. oxysporum*, *A. niger*, *A. flavus*, and *C. albicans* are presented in Table 1.

The results showed that the fungal inhibition was found to increases with the increase in concentrations of extractives (recorded after 7 days). It was observed that methanolic extract of Guggul has highest antifungal potential in inhibiting fungal growth in comparison to ethyl-acetate and aqueous extractives.

Significant variation was observed in antifungal activity of extracts of fresh oleo-gum-resin. The aqueous extract showed least activity when compared to that of methanol and ethyl-acetate extracts. Methanol extracts showed potential antifungal activity followed by ethyl-acetate and aqueous extract.

The antifungal activities of methanol extractives against *F.oxysporum*, *A.niger*, *A.flavus*, and *C. albicans* varied 68.17 to 90.45%, 70.31 to 88.58%, 68.11 to 91.20 and 65.99 to 89.60%, respectively. However, ethyl extract also showed more than 50% fungal inhibition of all tested species while it was 34.83 to 64% by aqueous extract. Methanol extracts 500 mg/ml of resin exhibited maximum inhibition of *A. flavus* (0.57 cm) fungal growth while in control, 6.5 cm fungal diameter was observed. The results of antifungal activity showed significant variation at all tested dilutions of different extractives against all tested fungi.

The antifungal activity was found to be decreased significantly after 20 months. Maximum deterioration in antifungal activity was observed in jute bags under room temperature, 4, 10 and 20ºC. In glass bottles, decrease of antimicrobial activity was less as compared to plastic bottles, poly bags and jute bags. Methanol extract of oleo-gum-resin (500 mg/ml) stored in glass bottles showed maximum fungal inhibition at highest tested dilution at 4ºC corresponds to radial growth of *F. oxysporum*, *A. niger*, *A. flavus*, and *C. albicans*, which varied, 0.72 to 1.88 cm, 0.79 to 2.02, 0.98 to 2.08cm and 0.92 to 2.14 cm at $4^0$C temperature, respectively.

Minimum deterioration was observed at $4^0$C followed by $10^0$C at room temperature (dark), $20^0$C (room temperature) under light condition, respectively. No significant variation was observed in plastic bottles and plastic bags. Maximum deterioration of

antifungal activities was observed in jute bags stored at $20^0$C and room temperature over control. The aqueous extract of stored oleo-gum-resin after six months was characterized by least activity when compared to methanol and ethyl-acetate extract tested against four fungus species.

## Effect of storage on antifungal activities of oleo-gum-resin after six months

The antifungal activity was found to be decreased significantly after six months. Maximum deterioration was observed in jute bags at room temperature followed by 20, 10 and 4ºC. Whereas minimum deterioration was observed in glass bottles at $4^0$C followed by, 10, 20 ºC and room temperature. Decrease of antimicrobial activity was leastin glass bottles as compared to plastic bottles, poly bags and jute bags.

Methanol extract of oleo-gum-resin stored in glass bottles at 4ºC showed maximum fungal inhibition at highest tested dilution. Radial growth varied, 0.72 to 1.88 cm, 0.79 to 2.02, 0.98 to 2.08cm and 0.92 to 2.14 cm at $4^0$C temperature in *F. oxysporum*, *A. niger*, *A. flavus*, and *C. albicans*, respectively. Minimum deterioration was observed at $4^0$C followed by $10^0$C, room temperature (dark), $20^0$C and at room temperature under light condition, respectively. No significant variation was observed in plastic bottles and plastic bags. Maximum deterioration of antifungal activities was observed in jute bags stored at $20^0$C and room temperature over control.

The aqueous extract of stored oleo-gum-resin after six months was characterized by least activity compared to methanol and ethyl-acetate extract against four fungus species. No antifungal activity was observed in lower dilution of aqueous extract.

## Effect of storage on antifungal activities of oleo-gum-resin after 12 month

The efficacy of methanol, ethyl-acetate and aqueous extractives of oleo-gum-resin of *C.wightii* after12 months against test fungi, *F. oxysporum*, *A. niger*, *A. flavus*, and *C. albicans* was recorded at 7 days of inoculation.

Storage of oleo-gum-resin at 4,10,$20^0$Cand room temperature after 12 months caused severe decrease in antifungal activities against *F. oxysporum*, *A. niger*, *A. flavus*, and *C. albicans.* In all treatments, decreasing trends were observed in comparison to fresh and six months stored samples. Methanol extract possessed significant inhibitory effect on growth of the test fungi, tested at 100 to 500 mg/ml dilutions.

Minimum fungal growth was observed in aqueous extractive 500mg/ml of oleo-gum-resin in glass bottle, plastic bottle, jute bag and poly bag at $4^o$C, which varied 1.15 to 2.63, 1.47 to 2.80, 1.56 to 2.87 and 1.50 to 2.73 cm growth of tested fungi- *F. oxysporum*, *A. niger*, *A. flavus*, and *C. albicans*, respectively. Minimum deterioration was observed in samples stored in glass bottles.

Maximum fungal growth was observed in aqueous extractive 100mg/ml of oleo-gum-resin in glass bottle, plastic bottle, jute bag and poly bag at room temperature (light condition), which varied 5.66 to 7.93, 6.26 to 7.18, 5.73 to 7.64 and 5.93 to 8.10 cm growth of tested fungi- *F. oxysporum*, *A. niger*, *A. flavus*, and *C. albicans*, respectively. Maximum deterioration was observed in samples stored in glass bottles. While mean growth varied 6-10 cm in control.

Poor activity was detected in aqueous extract after the storage period of twelve months.

Minimum deterioration was observed in samples stored in glass bottles at 4$^{o}$C, while maximum deterioration was observed in samples stored in jute bags at room temperature (light condition), where fungal inhibition ranged 0.0 to 47.18, 5.54 to 49.05,25.77to 70.13 and 0.0 to 60.51% against *F. oxysporum, A. niger, A. flavus,* and *C. albicans* respectively.

## Effect of storage on antifungal activities of oleo-gum-resin after 18 months

The efficacy of methanol, ethyl-acetate and aqueous extractives of oleo-gum-resin of *C.wightii* after 18 months against test fungi, *F. oxysporum, A. niger*, *A. flavus*, and *C. albicans* was recorded at 7 days of inoculation. All extractives prepared from stored oleo-gum-resin in different temperature and containers after 18 months showed drastically reduced antifungal activity against *F. oxysporum, A. nige*, *A. flavus*, and *C. albicans*.

In all treatments, decreasing trends were observed in comparison to fresh and six months and 12 months stored samples. Methanol extract possessed significant (P=0.05) inhibitory effect on growth of the test fungi, tested at 100 to 500 mg/ml dilutions followed by ethyl-acetate and aqueous extracts.

Maximum fungal growth was observed in aqueous extractive 100mg/ml of oleo-gum-resin stored in different containers i.e. glass bottle, plastic bottle, jute bag and poly bag at room temperature (light condition) where fungal growth, varied 6.23 to 8.75, 8.35 to 9.0, 8.94 to 9.84 and 9.29 to 10.0cm growth in tested fungi- *F. oxysporum, A. niger*, *A. flavus*, and *C. albicans,* respectively.

Minimum fungal growth was observed in methanol extractive 500mg/ml of oleo-gum-resin stored in different containers i.e. glass bottle, plastic bottle, jute bag and poly bag at 4$^{0}$C, where fungal growth, varied 1.68 to 2.98, 1.77 to 3.00, 1.52 to 2.93 and 1.77 to 2.93 cm growth in tested fungi- *F. oxysporum, A. niger, A. flavus*, and *C. albicans*, respectively. While, mean growth varied 7.30 to 10.00 cm in control. Poor activity detected in water extract after the storage period of eighteen months.

Maximum deterioration was observed in samples stored in jute bags at room temperature (light condition), where in fungal inhibition ranged 20.43 to 60.63, 5.40 to 60.32, 21.07 to 67.33 and 23.29 to 68.99% against *F. oxysporum, A. niger, A. flavus*, and *C. albicans,* respectively. It was noticed that the activity of some extractives was found to increase in comparison to extractives of 12 months old samples.

## Effect of storage on antifungal activities of oleo-gum-resin after 24 months

The efficacy of methanol, ethyl-acetate and aqueous extractives of oleo-gum-resin of *C.wightii* after 24 months against test fungi, *F. oxysporum, A. niger*, *A. flavus*, and *C. albicans* were recorded after 7 days of inoculation. In all treatments, activity decreased after 24 months.

All extractives prepared from stored oleo-gum-resin in different temperature and containers after 24 months showed reduced antifungal activity against *F. oxysporum, A. niger, A. flavus*, and *C. albicans.*

Methanol extract possessed significant (P=0.05) inhibitory effect on growth of the test fungiat 100 to 500 mg/ml dilutions followed by ethyl-acetate extracts. Less than 25% fungal inhibition activity was observed by aqueous extracts prepared from stored samples in different containers and conditions after 24 months.

**Table.1** Antifungal efficacy of oleo-gum-resin (fresh) against *Fusarium oxysporum, Aspergillus niger, Aspergillus flavus* and *Candida albicans*

| Different solvent extractives | Concentration mg/ml | Fungal growth(cm) | | | |
|---|---|---|---|---|---|
| | | ***F. oxysporum*** | ***A. niger*** | ***A. flavus*** | ***C. albicans*** |
| | | Glass Bottle | | | |
| Methanol | 100 | 1.79±0.51 | 1.84±0.45 | 2.07±0.50 | 2.01±0.22 |
| | 200 | 1.21±0.20 | 1.34±0.33 | 1.64±0.29 | 1.54±0.17 |
| | 300 | 1.02±0.51 | 1.07±0.33 | 1.54±0.30 | 1.21±0.23 |
| | 400 | 0.74±0.24 | 0.87±0.29 | 0.94±0.21 | 1.01±0.18 |
| | 500 | 0.55±0.24 | 0.71±0.20 | 0.57±0.22 | 0.61±0.18 |
| Ethyl-acetate | 100 | 1.55±0.61 | 1.95±0.52 | 1.68±0.13 | 2.81±0.19 |
| | 200 | 1.05±0.53 | 1.41±0.21 | 1.25±0.26 | 1.65±0.07 |
| | 300 | 1.01±0.20 | 1.18±0.18 | 0.95±0.15 | 1.11±0.05 |
| | 400 | 0.81±0.19 | 0.71±0.22 | 0.59±0.10 | 0.98±0.29 |
| | 500 | 1.52±0.26 | 0.48±0.20 | 0.51±0.19 | 0.72±0.11 |
| Water | 100 | 1.78±0.20 | 1.75±0.23 | 1.58±0.16 | 1.71±0.04 |
| | 200 | 1.35±0.19 | 1.18±0.10 | 1.31±0.20 | 1.31±0.05 |
| | 300 | 0.98±0.33 | 1.08±0.16 | 0.81±0.20 | 1.25±0.25 |
| | 400 | 0.68±0.28 | 0.79±0.21 | 0.45±0.15 | 0.88±0.11 |
| | 500 | 0.51±0.11 | 0.71±0.19 | 0.34±0.14 | 0.68±0.10 |
| Control | | 2.80 | 3.20 | 4.50 | 3.90 |
| SEM± | | 0.110 | 0.116 | 0.139 | 0.112 |
| CV(%) | | 0.412 | 0.394 | 0.498 | 0.353 |
| CD(0.05) | | 0.430 | 0.467 | 0.413 | 0.443 |

Values are the mean of three replications± Standard deviation
GB=Glass bottle; PB=Plastic bottle;PoB=Poly bag and JB=Jute bag

Minimum fungal growth was observed in methanol extractive 500mg/ml of oleo-gum-resin samples stored in glass bottle, plastic bottle, jute bag and poly bag at 4$^{o}$C, which varied 1.95 to 3.22, 2.02 to 3.25, 1.98 to 3.18 and 2.02 to 3.18 cm growth of tested fungi- *F. oxysporum, A. niger*, *A. flavus*, and *C. albicans*, respectively.

Maximum fungal growth was observed in aqueous extractive 100mg/ml of oleo-gum-resin samples stored in glass bottle, plastic bottle, jute bag and poly bagat room temperature (light condition), which varied 1.95 to 4.45, 2.12 to 4.42, 2.02 to 4.67 and 2.02 to 4.35 cm growth of tested fungi- *F. oxysporum, A. niger*, *A. flavus*, and *C. albicans*, respectively while 7.67 cm mean growth was observed in control.

Poor activity was detected in all extractives after the storage period of 24 months. Maximum deterioration was observed in samples stored in jute bags at room temperature (light condition), where fungal inhibition ranged 20.43 to 60.63, 5.40 to 60.32, 21.07 to 67.33 and 23.29 to 68.99% against *F. oxysporum, A. niger*, *A. flavus*, and *C. albicans*, respectively. It was noticed that activity of some extractives was found to increase in comparison to extractives of 12 months old samples. Some of the results recorded greater antimicrobial activity in stored material with ethanol extracts. It could

be possible that antimicrobial compound may remain stable in dry conditions. This phenomenon can be due to evaporation, oxidation and other unwanted changes in essential oil components during storage period (Baritaux *et al.,* 1992; Mockute *et al.,* 2005) due to lower boiling compounds, markedly decreased in refrigerator and particularly at room temperature conditions. In our study *C.wightti* oleo-gum-resin exhibited maximum growth suppression of *A. niger* than *A. flavus*. Al-Sabri *et al.,* (2014) advocated the use of ecofriendly product as alternative to chemical fungicides to reduce their harmful effect as environmental pollutants. They found gum resins of related species *C. myrrha* as an important natural product to combat harmful fungus. In our studies, extractives prepared from stored oleo-gum-resin in different temperature and containers after 24 months showed reduced antifungal activity against *F. oxysporum, A. niger, A. flavus*, and *C. albicans.* These findings are in consistence with the study conducted by McGaw (2001) on antibacterial activity of another medicinal plant *Scotia brachypetala* leaf extracts, which was found unaffected by storage for 18 months. They observed that fatty acids were stable when dried powdered plant material was stored in dark at constant temperature (temperature not given), and also leaf extracts when stored at -15°C.

Result of our study reveal maximum deterioration in quantity and quality of *C. wightti*, when stored in jute bag at room temperature in light conditions. Minimum deterioration in quality and quantity of *C. wightti* was observed in samples stored in glass bottle followed by poly bag and plastic bottle made up with high density polyethelene (HDPE) at 4, 10 and $20^0$C (room temperature). In our study, we found non- significant deterioration in quality and quantity of oleo-gum-resin of *C. wightti* in stored samples of glass bottle, plastic bottle and poly bags made up of high density polyethene (HDPE) material while significant deterioration was recorded in samples stored in jute bags. This clearly indicated that we should not store the dried oleo-gum-resin in jute bags, which is the common practice in the forest departments. Our study suggests that we should use poly bags made up of HDPE material to store bulk quantity of gum for maintaining its quality and quantity for longer use. Least deterioration in quality and quantity of *C. wightti* was recorded when stored at $4^0$C followed by 10 and $20^0$C (room temperature). Therefore, where ever it is possible, we should store the material at $4^0$C, however, if not possible to store at $4^0$C or $10^0$C, atleast we should store the material at dry and cold places in room temperature. Storage of bulk quantity is not practical in glass bottle or jars in forest field conditions due to fragile conditions of packing material.

All chemical constituents of Guggul degrade to varying levels. They are known to be affected by light, temperature, humidity and storage type. Decrease in active constituent of any medicinal product commonly reduces its efficacy. In traditional practices, oleo-gum-resin is stored in jute bags at room conditions in daylight or in field. It is evidenced from the present study that storage in jute bags affect quality of resin severely. Therefore, storage in jute bags should be avoided to reduce quality loss of Guggul. The best container was found to be air tight glass bottles/jars kept in dark conditions. In this condition, oleo-gum resins of *C. wightii* can be kept for around six months without much loss in its active ingredients. Only optimum loss of Guggulsterone-E and Z was observed. The study clearly showed that drying method, storage containers and conditions significantly affect different parameters of oleo-gum-resin of *C. wightii* like moisture %, essential oil content, total guggulstrone,

guggulstrone E&Z% contents and biological activities. Significant deterioration in oleo-gum-resin was observed in sun dried samples stored at room temperature in jute bags under both light and dark conditions. Glass bottles followed by plastic bottles and poly bags, kept at dark conditions in controlled temperature i.e.$4^0$Cor $10^0$C was found best storage container and condition to avoid severe deterioration of biologically active constituents as well as bioactivities of Guggul.

This study suggests excluding the traditional practice of storing oleo-gum-resin of *C. wightti* in jute bags because of severe loss of active constituents. Our study recommends to use poly bags made up of high density polyethelene (HDPE) and keeping in low temperature of $4^0$C for storing the oleo-gum resin to retain its quality and quantity for longer duration. In case, it is not possible to store at $4^0$C or 10 $^0$C temperature, oleo-gum-resin should be stored in dry and cold places at room temperature. This assessment of influence of packing and storage condition on quality of resin will be useful for collectors and users to avoid deterioration of medicinally important produce. The findings will be helpful to develop strategies for sustainable post-harvest practices and to pave the way for tribals and forest departments to develop safe practice for storage of oleo-gum-resin of *C.wightii* to check the deterioration in quality and quantity of its biological active constituents.

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