

Sustainable Tapping of *Commiphora wightii* (Arnott) Bhandari

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ABSTRACT

Background: *Commiphora wightii* exudes a yellowish Oleo-gum-resin known as “Guggul” of Commerce. Guggul is used for several disease conditions in Ayurveda like inflammation, gout, rheumatism, obesity, and disorders of lipid metabolism. The traditional guggul tapping methods are unproductive, destructive, and the plant generally dies after tapping for 3 years. *Commiphora wightii* is listed as threatened plants of India. **Objective:** To develop a sustainable tapping technique to enhance production of guggul and ensure the survival of the tapped trees. **Material and Method:** For sustainable tapping of guggul, *Michie gollege* or *Gebung* types of knife is used. Ethephon is used as a stimulator for enhancing production of guggul. **Result and discussion:** Average production of guggul per plant in control and distilled water treated control was 1.7 and 1.3 grams respectively. Average production of guggul per plant tapped after treating with 5.98 per cent ethephon is 25.57 grams. Average production of guggul per plant tapping after treating with 20 per cent of guggul solution is 199.13 grams. These plants treated with guggul solution were died in the second year. The tapping injury from all taped plants healed completely within a month. **Conclusion:** Sustainable guggul tapping method is proposed using *Michie gollege* or *Gebung* types of knife and treatment with appropriate concentration of ethephon. A protocol is suggested. Tapping of guggul

plant using ethephon is economically viable model for commercial production of guggul. This method also ensures the survival of the tapped plants. February to April is the ideal time for tapping the guggul.

INTRODUCTION

Commiphora wightii (Family – Burseraceae) is a small arid zone tree which has several oleo-gum-resin ducts located throughout its bark [1- 4]. A yellowish fragrant oleo-gum-resin called guggul is exuded from the bark on injury or incision. Guggul has a mixture of phytoconstituents like volatile oil which contains terpenoidal constituents such as monoterpenoids, sesquiterpenoids, diterpenoids, triterpenoids, steroids, flavonoids, guggultetrols, lignans, sugars and amino acids. [5 - 14]. It has been used in the Ayurveda for the treatment of variety of disorders such as inflammation, gout, rheumatoid arthritis, and peptic ulcer, arthritis, obesity, microbial infection, wound, pain, fractures, tumor, disorders of lipids metabolism and gastrointestinal diseases [15-28].

Guggulsterone (two isomers E and Z) is an effective *anti-hyperlipidemic* agent obtained from the oleo-gum-resin of *C. wightii* [8, 15, 29- 31, 32 -39]. Guggulu contain myrecene, dimyrecene and ploymyrecene, guggulosterones like Z-guggulsterone, Eguggulsterone, guggulsterone-I, guggulsterone-II, guggulsterone-III and guggulsterone-IV with high therapeutic values for diseases like rheumatism, arthritis, hyperlipidemia, obesity, inflammation, atherosclerosis, wrinkle, acne and also in combating bacterial, viral and fungal diseases [12, 40-43]. Ayurveda preparation such as *Gokshuradi Guggulu*, *Mahayograj Guggulu*, *Kanchanar Guggulu*, *Yograj Guggulu* and *Kaishore Guggul* are prepared using guggul. Guggul products are exported from India to 42 countries like European Union Belgium, France, Germany, Hungary, Italy, the Netherlands, and United Kingdom [44].

It estimated that the annual demand of guggul is 1000 tones while the annual consumption is about 2300 tones. India is importing 500-1000 tones Guggul from Pakistan annually. The wild occurrence of this species is restricted mainly to the dry regions of Rajasthan and Gujarat states of India and the bordering regions of Pakistan. As the increase in the annual demand of guggul, there are reports of various new tapping techniques to increase production of Guggul. *C. wightii* has been overharvested, and has become rare in Gujarat and Rajasthan. Besides, the traditional guggul tapping methods are unproductive and destructive and therefore the wild population of *C. wightii* declined over the last few decades. Consequently *C. wightii* is assessed as critically endangered and enlisted in the IUCN red list of threatened species [11, 45-47].

Commiphora is 100% apomixis i.e. replacement of the normal sexual reproduction by asexual formation of a seed from the maternal tissues of the ovule, avoiding the processes of meiosis and fertilization, leading to embryo development [48].

C. wightii population exist in three forms i.e. male, female and andromonocious (male and hermaphrodite flowers are on the same plant). *C. wightii* has oleo-gum resin ducts naturally present in the secondary phloem of the bark of the stem. The discontinuous ducts are oriented parallel to the longitudinal axis of the stem and anastomose tangentially. Guggul is synthesized in epithelial cells and collected in the duct lumen [49 - 53].

Traditional Tapping of the Guggul Plants

The traditional tapping methods used for obtaining guggul, the oleo-resin from *C. wightii*, are unproductive and destructive. Local tappers make incisions in the bark of *C. wightii* trunk using various implements ranging from simple knife to even axe. People apply a paste around the stem containing wild ass or horse urine, buttermilk, hydrochloric acid, ammonium chloride, sulfuric acid, copper sulfate, sample of “guggul” itself or incubate the stem bark with natural gum suspension containing *Xanthomonas axonopodis p commiphorae* (Xac) [54-57]. In certain cases, the tapping knife (Fig. 1a) is heated well and then dipped in to the camel urine. The knife is then dipped in the guggul solution and insert in to the trunk of the guggul plants in several places (Fig. 1b, c). The tapping is done in November. The guggul is secreted continuously. The secreted guggul is collected when it is dried on the trunk. The collection is made throughout the year. The incision generally goes beyond the bark to the heart wood. The oleo-gum resin will continuously be secreted for a year or two and then the plant will die.

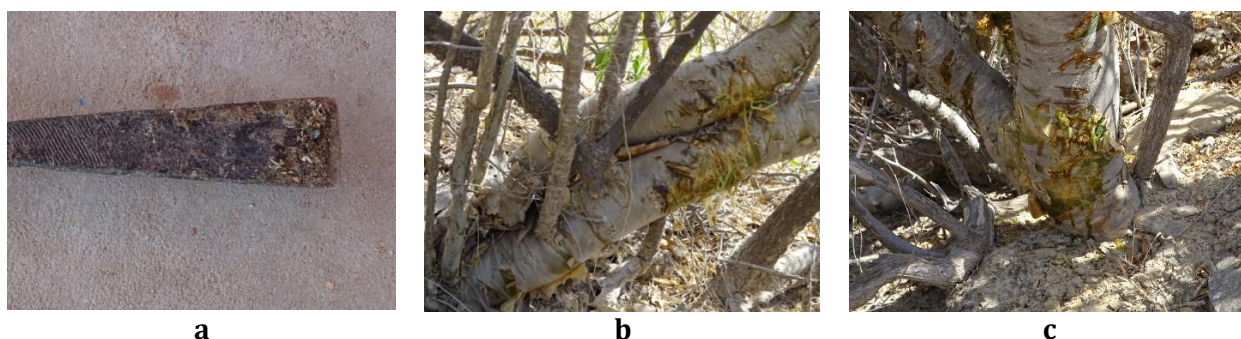


Fig. 1: Traditional tapping (a) traditional tapping knife (b and c) traditionally tapped trees

Therefore, it is urgent to develop a sustainable tapping method in which the production must be increased to meet the demand and ensure the safety of the tapped plants for future. There are studies of enhancement and non-destructive harvesting of oleo-gum resin in *Commiphora wightii* [58, 59]. An improved tapping technique, using 'Mitchie Golledge' knife, coupled with ethephon application enhanced the guggul production about 22times over that of the traditional practices [58]. April and May are the peak months of presence of guggul in the ducts as established by localization of resin in the sectioned material using bright field and epifluorescence microscopy [58]. The objectives of the present study were a).Increase the production of the guggul and ensure the survival of the tapped trees, b). Find out the optimum concentration of the stimulant and its application in the field, c). Identify the best period of tapping, d). Evaluate the quality of the tapped guggul samples and e). Develop a sustainable guggul tapping Protocol.

METHODOLOGY

One hundred and fifty trees of *Commiphora wightii* (Burseraceae) with the average girth of 46.37 cm were selected for the experiment at *Vandhay or Vandhai village in Bhuj Taluka and fifty trees from Faradi village* located in *Mandvi taluka of Kachchh* district in Gujarat, India. They were made into 10 groups and tapped as shown in table 1. One group of control is without any treatment and the other is tapping the plant after 3 days of spraying distilled water on the stem. In seven groups ethephon was sprayed on the stem in various concentrations and tapped after 3 days (Table 1). The *C. wightii* have gum-resin ducts in the

bark oriented longitudinally with tangential connections (Bark is the tissue outside the cambium). The various concentrations of ethephon is sprayed on the stem of the plants and are tapped after 3 days. The plants are tapped in February and March (table 1). The secreted guggul was collected in March and April (Table 1). Tapping is done using 'Mitchie Golledge (Fig. 2a), Gibon or Jabon Knife' (Fig.2b) with least injury to the cambium. Care is taken that the injury to the cambium is minimum during the tapping. The incisions are generally made as 'V' cuts or "fish bone" cut without girdling the stem (Fig.2c) so that several ducts are cuts. The exuded gum-resin is channeled into one place.

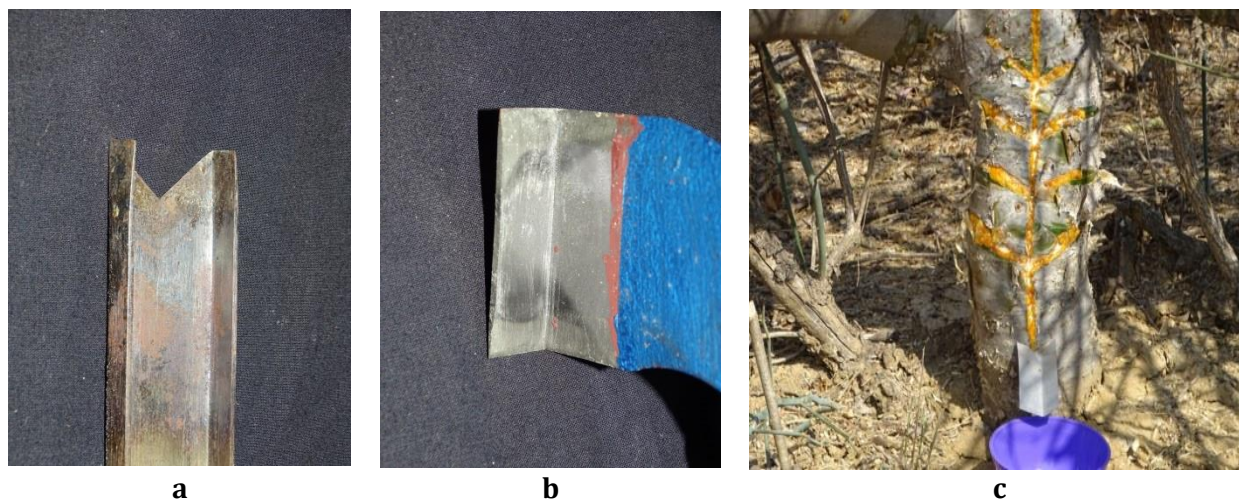


Fig 2: (a) Mitchie Golledge, (b), Gibon or Jabon Knife' (c) "fish bone" cut

Table1: The scheme of tapping of the guggul plants

No	Number of plants tapped	Treatment	Date of tapping	Date of collection
1	15	No treatment -control	20/01/2017	23/3/2017
2	15	Distill water sprayed on the stem 3 days before tapping	23/01/2017	23/3/2017
3	15	3.9% ethephon sprayed on the stem	23/01/2017	23/3/2017
4	15	4.68 % ethephon sprayed on the stem	28/01/2017	30/3/2017
5	15	4.88% ethephon sprayed on the stem	24/02/2018 28/03/2018	27/03/2018 24/04/2018
6	15	5.98% ethephon sprayed on the stem	24/02/2018 28/03/2018	27/03/2018 24/04/2018
7	15	6.8% ethephon sprayed on the stem	24/02/2018 28/03/2018	27/03/2018 24/04/2018
8	15	9.8% ethephon sprayed on the stem	24/02/2018 28/03/2018	27/03/2018 24/04/2018
9	15	11.7% ethephon sprayed on the stem	24/02/2018 28/03/2018	27/03/2018 24/04/2018
10	5	The knife dipped in 20% guggul solution	24/02/2018 28/03/2018	27/03/2018 24/04/2018

The tapping was repeated from 2019 to 2021 on 72 trees after spraying the stem with 5.98 % ethephon. The plants were tapped only in February due to the lock down because of COVID-19.

RESULT

The average yield of the control without any treatment is 1.7 grams and the distilled water control is 1.3 grams (Fig. 3). The average production of guggul treated with various concentration of ethephon is shown in the Fig.3. The production increased with the treatment of the ethephon and 5.98 % of was the optimum concentration which stimulated average production of 25.57 grams per plants (Fig. 3). The concentration of ethephon above 5.98%, the production of guggul was substantially less (fig. 3, fig.3a, b).

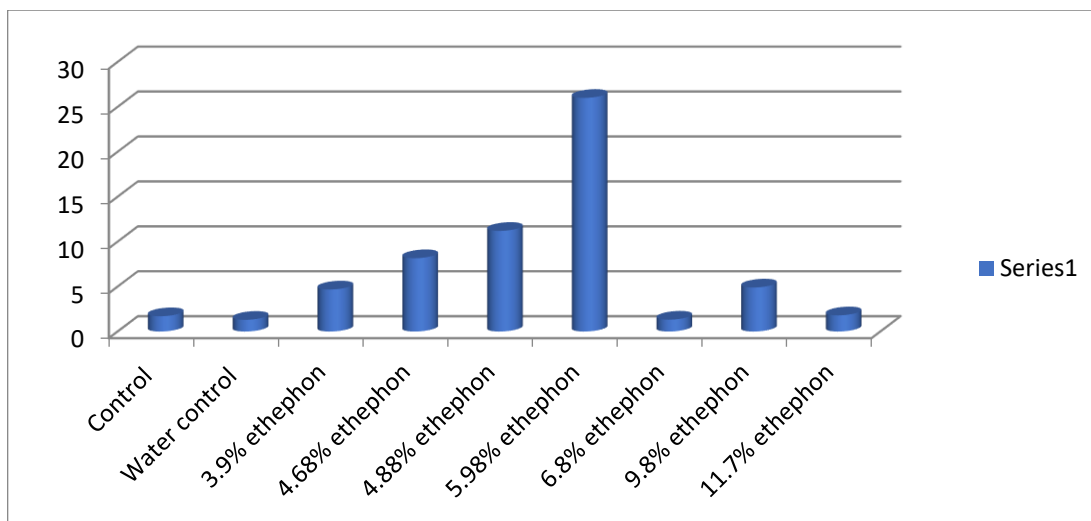


Figure 3: Shows average production of guggul in control and tapping after treatment of various concentration of Ethephon.

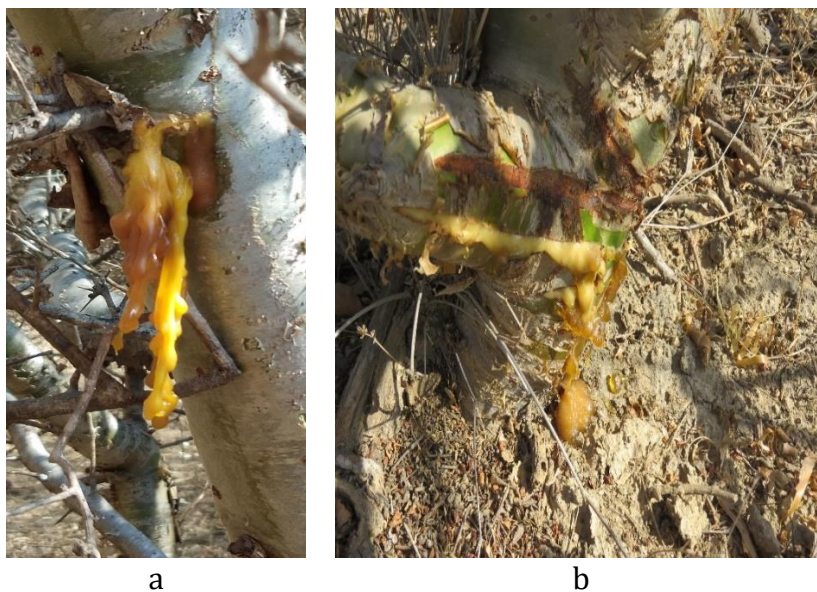


Fig 3

Phytochemical Analysis

HPLC analysis of Guggulu collected from tapping of 5.98% ethephon treated plants was done at Dabur Research and Development center of Dabur India Limited. Below are the observations of HPLC profiling-

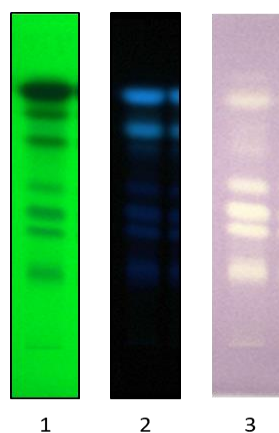


Fig 4a: HPTLC fingerprinting analysis of oleo-gum resin samples
 1. @254nm 2. @366 nm 3. Methanolic DPPH solution

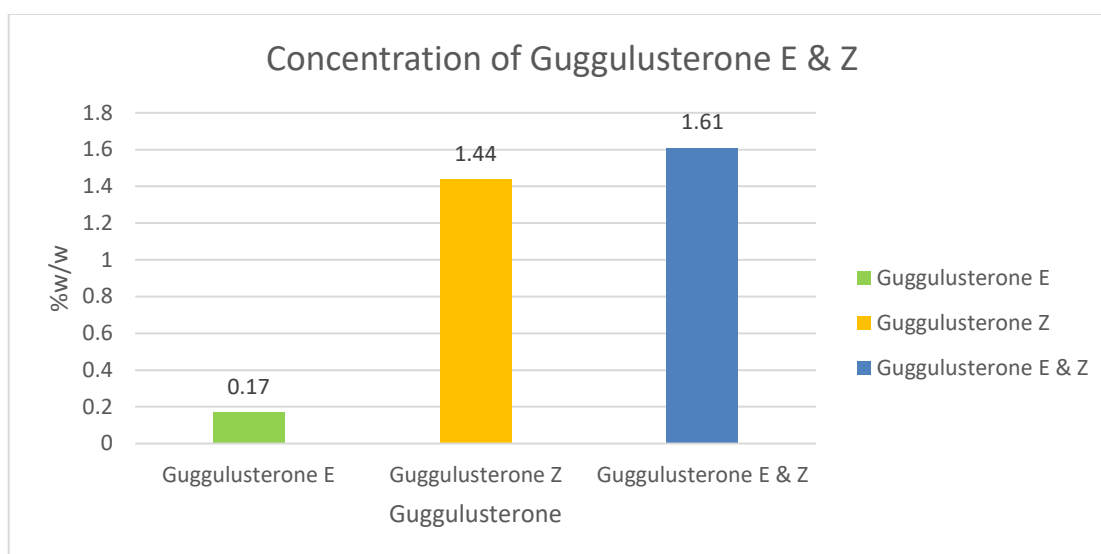


Fig 4b: Concentration of total Guggulusterone E and Z found in Kutch samples is 1.61%, w/w.

The tapped wounds in all the plants were healed within a month and the bark has regenerated and covered the wounds (fig. 5 a-d). No visible negative impact is observed in the tapped plants. The tapped plants look healthy and no sign of wilting or die back. The regeneration is faster with minimum injury to the bark and cambium. The plants tapped after dipping the knife in 20% guggul solution showed profuse secretion of guggul (Fig. 5 e, f) and produced an average of 199.13 grams per plants. However, these plants were secreting the guggul continuously and died in the second year. The 72 plants tapped from 2019 to 2021 on after spraying the stem with 5.98 % ethephon the average production was 25.57 grams per plants.

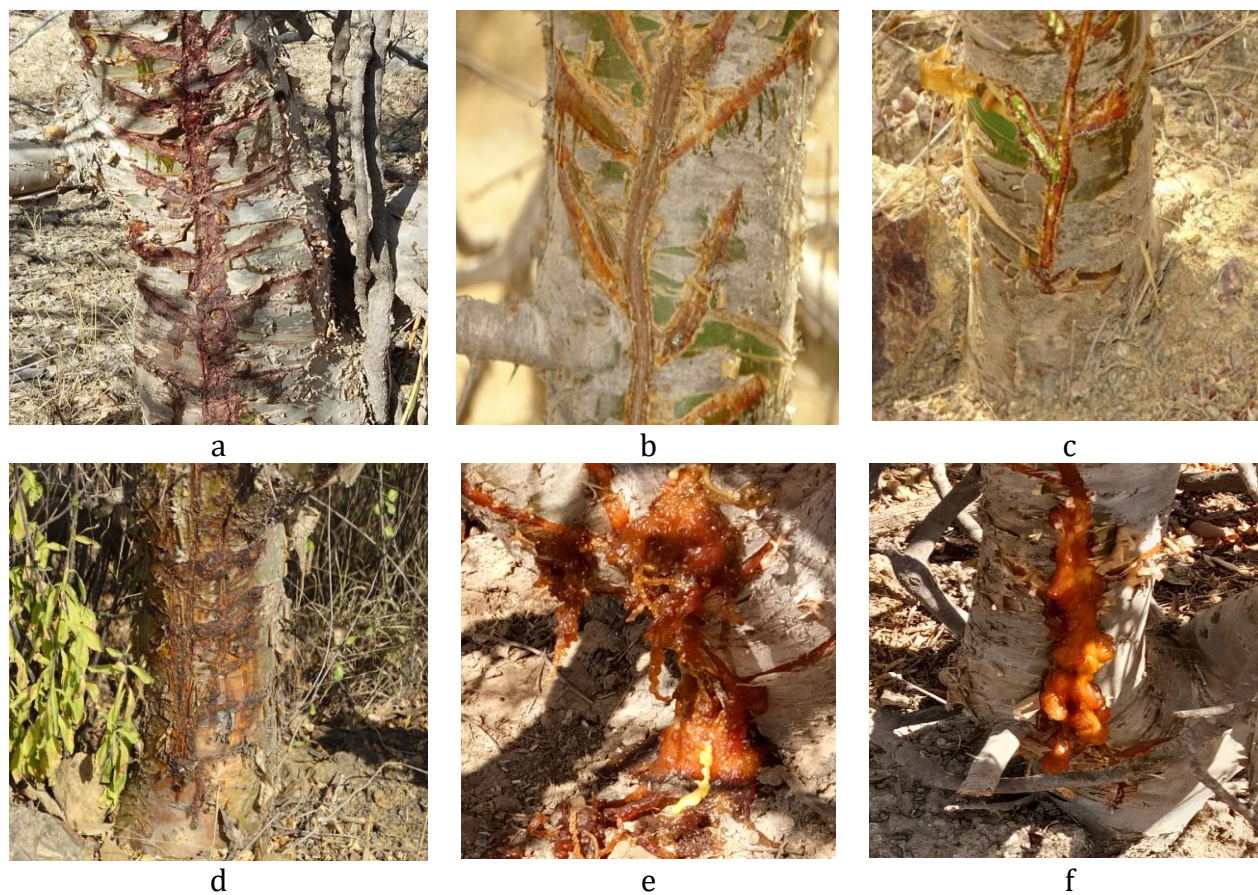


Fig 5 (a - d): Healed tapped injury of the bark (e and f) profuse secretion of guggul when tapped after treating with 20% guggul solution

DISCUSSION

The traditional tapping of the guggul is harmful for the *C. wightii* because the method cause injury to the wood and get infected with microorganisms and finally the plants die after exuding the oleo-gum resin continuously for over a year [59-61]. The present study indicates that the ideal time for tapping the guggul is during the summer namely from February to late April during which the highest amount of secretion occurs as reported earlier [58]. Even though higher guggul yield ($175 \pm 9.0 \text{ g plant}^{-1}$) was reported after treatment *Xanthomonas axonopodis* pv. *Commiphorae* all bacteria treated plant died gradually after the gum exudation [55, 56]. Sustainable production of guggul is very important because of its immense use in the medical use. Even though there are various traditional and improved tapping of the guggul is available, they are harmful for the *C. wightii* as they are unscientific. Therefore, the plants die within a short span of life and [55-61] consequently *C. wightii* is listed as threatened species [11, 45- 47].

The present study indicates that the ideal time for tapping the guggul is during the summer namely from February to April during which the highest amount of secretion occurs as reported earlier [58]. Even though higher guggul yield ($175 \pm 9.0 \text{ g plant}^{-1}$) was reported after treatment *Xanthomonas axonopodis* pv. *Commiphorae* all bacteria treated plant died gradually after the gum exudation [54 - 57]. *C. wightii* has oleo-gum resin ducts naturally present in the

Bark and the oleo-gum resin is synthesized and secreted in to the duct by epithelial cells. It is demonstrated that injury enhances production and secretion of resin in to the duct within 45 minutes because any stress in the bark will produce ethylene which enhances gum and resin production. Histo-chemical and fluoresces study indicate that the duct contains resins during March-April only [58]. Therefore, the statement "Gummosis is mainly a disease of stems and branches of guggul" plant [62] is false because the oleo-gum resin ducts in *C. wightii* are developed naturally in the secondary phloem. Guggul is synthesized in epithelial cells and collected in the duct lumen [49-53] which is exuded when injured. The observation of *Pseudomonas syringe* induced gummosis of guggul plants is due to the stress created by the infection of the bacteria, generating higher amount of ethylene and produce copious amount of oleo-gum resin to sequestrate the injured region to prevent infection. However, if the injury is large the plant will die.

Application of ethephon increases the production of guggul. The optimum concentration of the stimulant is 5.98 % which has shown highest production. Spraying the ethephon on the stem and tapping the plants after 3 days found to be the convenient method for tapping guggul. Ethephon (2chloroethyle phosphate) is a safe, cheap, indigenously manufactured and easily available plant growth regulator [58]. It is used in agriculture and horticulture.

Care should be taken not to injure the cambium and least areas of the bark during the tapping. All the injury to the bark is regenerated within a month. The distance between the two cut ends of the bark and the depth of the cut are the crucial criteria for healing. The plants are left for the rest of the period for regeneration. Tapping of guggul plant using ethephon is appeared to be an economically viable model to commercial production in guggul.

HPLC analysis of Guggulu collected from tapping of 5.98% ethephon treated plants was done at Dabur Research and Development center of Dabur India Limited. Concentration of total Guggulsterone E and Z found in Kutch samples is 1.61%, w/w. It is reported that the quantity of E-GS, Z-GS and both in the samples ranged from 0.230 ± 0.0040 – $0.926 \pm 0.0168\%$ to 0.537 ± 0.0026 – $0.723 \pm 0.0177\%$, respectively [63]

Sustainable Tapping Protocol

1. Select plant which are having minimum 40 cm circumference.
2. Clean the stem removing the dead flakes of the outer bark surface
3. Spray 5.98% of ethephon on the stem (make sure that the concentration is correct)
4. Tap the plants in the third week of February after 3 days of spraying using a Mitchie Golledge knife' (Figure 1) or Gibon/Jabon knife (Figure 2) in such a way that the guggul will flow to a single spot (generally 'V' cuts "fish bone" cut).
5. Care must be taken that the injury to the cambium is minimum
6. Collect the guggul after 20 to 30 days when it is dried
7. Tap the tree for a second time in the March and the collection of guggul is done after a month.
8. Leave the plant to regenerate for the rest of the year
9. Repeat the tapping only next year February

CONCLUSION

Sustainable guggul tapping method is proposed using *Michie gollege* or *Gebung* types of knife and treatment with appropriate concentration of ethephon. A protocol for sustainable tapping of guggul is suggested.

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