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Review of *Jatwadi Dhoom Agad* as a proposed fumigation product for mosquito repellent and antimicrobial action

Suryajeet H Pawar*[1], Abhijit B Patil[1], Manasi Deshpande[2], Trupti Patil[3], Sharvari Jawale[4]

[1]Department of Agadtantra, Bharati Vidyapeeth Deemed to be University, College of Ayurved, Pune-411043, Maharashtra, India
[2]Department of Dravyaguna, Bharati Vidyapeeth Deemed to be University, College of Ayurved, Pune-411043, Maharashtra, India
[3]Department of Rasashastra & Bhaishajya Kalpana, Bharati Vidyapeeth Deemed to be University, College of Ayurved, Pune-411043, Maharashtra, India
[4]Department of Samhita Siddhant, Late Kedari Redekar Ayurvedic Mahavidyalaya, Gadhinglaj-416502, Maharashtra, India

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Abstract

Ayurveda has given much importance to prevent the diseases by stating various measures. Medicated smoke fumigation (*Dhoopana*) is one of such measures described for disinfection as well as protection from poisonous animals and insects. Herbal, herbo-mineral and animal origin formulations containing volatile oil and having antimicrobial property are used for medicated smoke fumigation. Fumigation with such drugs is safe, natural and cost effective technique. Mosquito borne diseases are major human health problem in all tropical and subtropical countries by affecting millions of people each year. Commercial repellents like Allethrin, DEET have been reported many harmful effects for humans. There is a need for further standardised studies in order to develop new products that offer high repellency as well as good consumer safety. A review is planned to investigate ingredients of *Jatwadi Dhoom Agad* through analyzing published experimental research work. Out of eight ingredients of *Jatwadi Dhoom Agad*, two showed mosquito repellent effect and three have mosquito larvicidal effect. This paper is foot step in the efforts to establish probable mode of action of *Jatwadi Dhoom Agad* as insect repellent. The effect of smoke of these drugs may be repellent for mosquitoes. All drugs have shown antimicrobial activity in vitro. This product has potential to be used as fumigation product in current COVID 19 pandemic.

*Corresponding Author

Name: Suryajeet H Pawar
Phone: +91-9762865005
Email: suryajeetpawar@yahoo.com

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INTRODUCTION

Ayurveda is ancient system of health care deals with the curative as well as preventive aspects of diseases. Ayurveda mentions the treatment modalities as *Bahi-parimarjana Chikitsa* (topical), *Anta-parimarjana Chikitsa* (systemic) and by *Shastrapranidhaana* (surgical intervention) (Brahmananda, 2000). *Dhoopana* (Medicated smoke fumigation) comes under topical (*Bahi-parimarjana*) treatment, has been told as a treatment in all the ayurvedic classics but detail description is present only in *Kashyapsamhita*

'Dhoopakalpa' chapter.

Dhoopana Chikitsa exists since ancient time. It is in practice in India since time of Vedas to sterilize house and environment and is widely used in Ayurveda. *Dhoopana* has also been mentioned for its antimicrobial and growth promoting activities for the healthy production of plants in *Vrikshayurved* (Nene, 2014). Medicinal drug or mixture of medicinal drugs is burnt in a specific way to produce smoke is called as *Dhoopa* (Ayurvedic Pharmacopoeia Committee, 2011). *Dhoopana* creates an aseptic environment by killing microbes and thus, prevents infection. In *Dhoopana* only natural substances are used which is safe for environment as well as human beings. Herbs, minerals, and sometimes animal products (hair, horn) are mixed and the combination is used. Ayurveda mentions *Dhoopana* as a part of raksha vidhi procedure to ensure protection against microbes (Sharma, 2010). Ample references of *Dhoopana* are found in *Brihatrayi* proving their vital role in disinfection and sterilization. It is necessary to undergo detailed study to identify the bioactive chemical compounds of the formulations and establish their safety and efficacy profiles. Standardizing, characterizing and marketing these *Dhoopana* formulations are the need of the hour to bring a natural eco-friendly and cheap solution. Such formulations of Ayurveda are worth investigation in COVID 19 pandemic times, with a potential to disinfect COVID ward, homes, home isolation rooms, cloths and related items. As the herbal combo is stated to be rodent-repellent, it can be used by fumigation method in grain storage units and agricultural units to protect the grains from microbial contamination and rodents. Use of harsh chemicals can be prevented by this method.

Mosquito borne diseases and infectious air borne diseases are major human health problems in all tropical and subtropical countries by affecting millions of people each year. Personal protection measures such as mosquito repellents are an important tool against mosquito nuisance. Commercial repellents like Allethrin, DEET have been reported adverse effects like skin and eye irritation, sneezing, running nose, anxiety, nervousness etc (Veltri *et al.*, 1994).

Mosquitoes (*Mashak*) are included in *Kita varga* by *Sushruta* (Sharma, 2001). *Dhoopana* technique is stated in Ayurveda for protection from *Aagantuj* factors (external agents). This mode has been in use for centuries in India for prevention from mosquitoes. The presently used products for repellent action can be harmful. The allethrins from mosquito coil repellents can cause inflammation of trachea (Abdulaziz *et al.*, 2020). There have been reports of convulsions by local application of insect repellent in kids (Lipscomb *et al.*, 1992; Centers for Disease Control (CDC), 1989).

The *Jatwadi Dhoom Agad* is stated in *Charak Samhita* for protection from snakes, rats, insects and lice (Brahmananda, 1999). The Ayurvedic herbal combination may be used widely for purpose of disinfection and repellent for insects and rodents.

Aim

To review ingredients of *Jatwadi Dhoom Agad* formulation for potential mosquito repellent action.

Objectives

Primary

To detect evidences of antimicrobial and insect repelling activity of ingredients of *Jatwadi Dhoom Agad*.

Secondary

To review physical properties, phytochemicals and pharmacological action of the ingredients of *Jatwadi Dhoom Agad.*

MATERIAL AND METHODOLOGY

This review includes experimental research articles and systematic review articles related to mosquito repellent and Dhoopana Chikitsa area. The electronic bibliographic databases like AYUSH Research Portal, PubMed, Science direct and Google Scholar were searched. Manual search includes postgraduate and doctor of philosophy dissertations in Ayurveda. Physical properties, phytochemicals and pharmacological properties of the ingredients of Jatwadi Dhoom Agad along with their mosquito repellent, mosquito larvicidal and antimicrobial effects have been noted.

The anti-microbial effects through in vitro researches have been included in this review paper. Of course, in vitro action cannot be directly correlated with potential anti bacterial, antiviral or insect repellent action of a medicated fumigation. But these actions are reviewed in the present paper as many of the ingredients of *Jatwadi Dhoom Agad* have been investigated previously for these in vitro actions.

Most of the drugs of this formulation are safe and edible. This product can be used safely for fumigation. Many of the chemical insect repellent are strong harmful chemicals like allethrin, transallethrin etc. These are known to be harmful for humans and entire eco-system (Narendra *et al.*, 2008).

Observations

The *Jatwadi Dhoom Agad* is stated in *Charak Samhita Chikitsasthan* chapter 23 *Visha Chikitsadhyaya* used as fumigation for protection from snakes, rats, insects and lice. It consists of seven plants and one animal originated drug.

Table 1 shows Ayurvedic attributes of ingredients of *Jatwadi Dhoom Agad* (Figure 1).

Table 2 summarizes the information of phytochemicals and pharmacological effects of ingredients. Information of chemical composition and biological effect of these plants would be helpful in exploring its use as mosquito repellent.

Laksha

Solvent wise variations in antimicrobial activity of lac were observed against different test microbes. Acetone extract of lac showed antimicrobial activity against five microbes i.e. *Escherichia coli, Staphylococcus aureus, Bacillus subtilis, Xanthomonas citri* and *Erwinia carotovora*, the highest being against Escherichia coli. It showed moderate activity against *Erwinia carotovora* and *Xanthomonas citri* and lesser antimicrobial activity against *Bacillus subtilis* and *Staphylococcus aureus* (Dinesh and Sirsikar, 2016). This proves the antimicrobial activity of *Laksha.*

Ushir

Vetiveria zizanioides (vetiver) against *Staphylococcus aureus, Streptococcus pyogenes, Escherichia coli* and *Corynebacterium ovis* were evaluated. Against *S.aureus*, vetiver oil was superior to the other two oils in the pure state and diluted with dimethyl sulphoxide 1:10, 1:100, 1:1000 and 1:10000; inhibition by the pure oil was 60-70% that by penicillin or streptomycin (Singh *et al.*, 2013). It was found that VZ3 sample (Bamboofiber: Vetiver root -70:30) was good in all aspects. These forms of natural insect repellent pouches were very safe and eco-friendly and protect us from mosquitoes and other insects (Manokari and Meenu, 2014). The larval mortality of *A. stephensi* after the treatment of methanolic extract of *V. zizanioides* root extract respectively was demonstrated (Aarthi and Murugan, 2010). This validates the mosquito repellent and larvicidal action of *Ushir*.

Tejpatra

In-vitro antimicrobial potential of *Cinnamomum tamala* leaves extracts showed variable degree of inhibition zones against the selected six gram negative, three gram-positive bacterial strains and a fungus. All the extracts showed their best inhibitory activity against *B. atrophaeus*, amongst which the aqueous extract recorded the highest zone of inhibition measuring 38 mm (Hassan and Kazmi, 2016). *Cinnamomum tamala* essential oil and its major constituent, eugenol were evaluated for repellent, insecticidal, feeding inhibitory, oviposition inhibitory and acetylcholinesterase enzyme inhibitory activities in insect known as rice weevil, *Sitophilus oryzae*. In repellency assay, *C. tamala* oil and eugenol repelled *S. oryzae* adults significantly at 0.2% concentration. Essential oil of *C. tamala* and eugenol caused fumigant and contact toxicity in *S. oryzae* adults (Mukesh, 2016). The aqueous extracts of tamalpatra exhibited larvicidal activity against the 4th instar larvae of *C. quinquefasciatus*. Mortalities were reported to be directly proportional with concentration of aqueous extract of the plant (Iqbal *et al.*, 2018). This validates the mosquito repelling and mosquito larvicidal action of *Tamalpatra*.

Guggul

Extract of *Guggul* gum possesses significant antibacterial activity against gram-positive bacteria and moderate activity against gram-negative once. *S. aureus* and *S. aglactiae* were found to be most susceptible organisms whereas *E. coli* was shown resistance and no inhibition reported for the *P.aerugunosa (Kumara et al., 2017)*. This validates the antimicrobial activity of *Guggul*.

Bhallatak

Phytochemicals such as flavonoids, phenolics, saponins, alkaloids and glycosides possess anti microbial activity. Phenolic compounds are thought to be toxic to micro organisms, inhibiting the enzymes which are essential for the growth of microorganism (Bagewadi *et al.*, 2012). This validates the antimicrobial activity of *Bhallatak*.

Arjun

The water and methanol extracts of *T. arjuna* bark produced significant zones of inhibition against twenty-two tested bacteria including eight uropathogens. MIC values against the bacteria were found in the range of 0.16 to 2.56 mg/mL. The polar extracts of *T. arjuna* also demonstrated strong antifungal effect against eight species of Candida, with MIC between 0.16 and 0.64 mg/mL (Debnath *et al.*, 2013). This validates the antifungal activity of *Arjun*.

Sarja

Shorea robusta resin has a stronger and broader spectrum of antimicrobial activity against a number of pathogenic microorganisms. Aqueous extracts of *Shorea robusta* exhibits significant activity against *Bacillus coagulans, Escherichia coli, Bacillus cereus* and moderate inhibition on *Salmonella typhi* and

Table 1: The ingredients of *Jatwadi Dhoom Agad* and their ayurvedic properties

Sr. No	Drug	Botanical Name with family	Part Used	Rasa (Taste)	Guna (Physical properties)	Veerya (Potency)	Vipak (Post digestive effect)	Karma (Pharmacological action)
1	Laksha (Indradev, 2010a)	*Laccifer lacca* Lacciferidae	Resin	*Tikta*, *Kashaya*	*Snigdha*, *Laghu*	*Ushna*	*Katu*	Pacify *Kapha* and *Pitta*, *Vishaghna, Krimighna, Bhutaghna*
2	Ushir (Sharma, 2005a)	*Vetiveria zizanioides* Poaceae	Root	*Tikta*, *Madhura*	*Ruksha*, *Laghu*, *Sugandhi*	*Sheeta*	*Katu*	Pacify *Pitta*, *Vishaghna*
3	Tejpatra (Indradev, 2010b)	*Cinnamomum tamala* Lauraceae	Leaf	*Katu*	*Teekshna*, *Laghu*, *Sugandhi*	*Ushna*	*Katu*	Pacify *Kapha, Vata, Vishaghna*
4	Guggul (Sharma, 2005b)	*Commiphora mukul* Burseraceae	Resin	*Tikta*	*Laghu*, *Ruksha*, *Teekshna*, *Sugandhi*	*Ushna*	*Katu*	Pacify *Kapha, Vata, Krimighna, Bhutaghna*
5	Bhallatak (Sharma, 2005c)	*Semecarpus anacardium* Anacardiaceae	Fruit	*Katu*	*Laghu*, *Teekshna*	*Ushna*	*Madhura*	Pacify *Kapha, Vata*, *Krimighna*
6	Arjun (Sharma, 2005d)	*Terminalia arjuna* Combretaceae	Flower	*Kashaya*	*Laghu*, *Ruksha*	*Sheeta*	*Katu*	Pacify *Kapha, Hrudya*
7	Sarja (Sharma, 2005e)	*Shorea robusta* Dipterocarpaceae	Resin	*Katu*	*Guru*, *Ushna*, *Snigdha*	*Ushna*	*Katu*	Pacify *Kapha, Vata*, *Vishaghna*, *Bhutaghna, Grahaghna*
8	Aparajita (Indradev, 2010c)	*Clitoria Ternatea* Fabaceae	Root	*Katu*, *Tikta*	*Laghu*, *Ruksha*	*Ushna*	*Katu*	Pacify *Kapha, Vata*, *Vishaghna*, *Grahaghna*

(English terminology for Sanskrit terms: Vishaghna– Antitoxic, Krimighna –Anthelmintic, Bhutaghna –Antimicrobial/Antiviral effect, Grahaghna – Anti psychotic effect, Hridya –Cardio tonic, Sheeta – Cold, Ushna –Hot, Madhur –Sweet, Tikta – Bitter, Katu – Pungent, Kashaya –Astringent, Laghu – Lightness, Guru – Heaviness, Ruksha – Dryness, Snigdha– Unctuous, Teekshna – Sharpness)

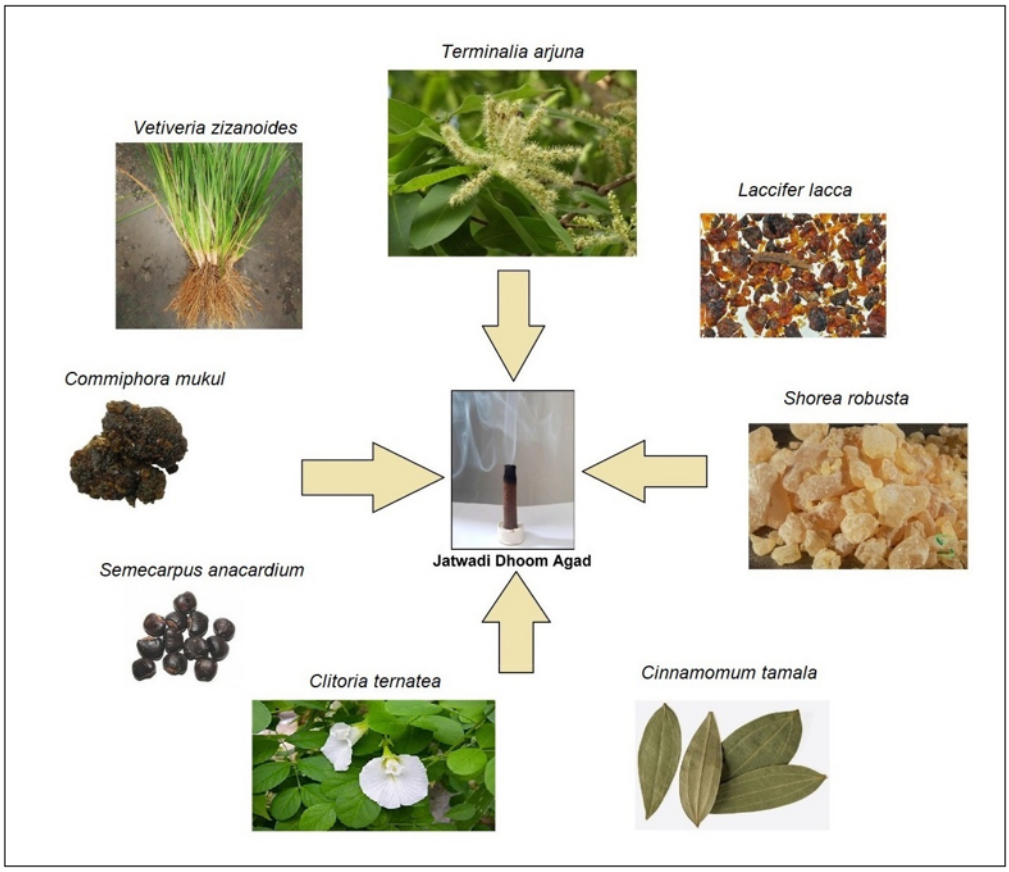

Figure 1: Ingredients of *Jatwadi Dhoom Agad*

Bacillus subtilis and less activity against *Proteus vulgaris* and *Pseudomonas fluorescence*. However, ethanolic extracts also exhibited significant activity against *Staphylococcus aureus, S. epidermidis* and *Escherichia coli*, moderate inhibition on *Candida albicans* and *Bacillus coagulans*. The petroleum ether extract showed activity against *Escherichia coli, Aspergillus flavus* and *Candida albicans* and whereas benzene extracts worked against *Bacillus licheniformis, Bacillus cereus* and *Aspergillus flavus* (Kumar *et al.*, 2014). This proves the antimicrobial activity of *Sarja.*

Aparajita

The antimicrobial activities of methanol extracts using leaf, stems, seed and roots of *C. ternatea* against 12 bacterial species, two yeast species and three filamentous fungi. The tested microorganisms consist of *B. cereus, B. subtilis, Bacillus thuringiensis, S. aureus, Streptococcus faecalis, E. coli, K. pneumoniae, P. aeruginosa, S. typhi, Enterobacter aerogenes, Proteus mirabilis, Herbaspirillum spp., Candida albicans, Saccharomyces cerevisiae, Rhizopus spp., Penicillium spp.,* and *Aspergillus niger*. The antimicrobial activities using disc diffusion assay of leaf and root extracts *C. ternatea* showed the most effective against all of the tested organisms with a zone of inhibition 10 mm to 25 mm (Jamil and Pa'ee, 2018). Among the methanol extracts of *C. ternatea* leaves, roots, flowers, and seeds, the seed extract was effective against the larvae of all the three species with LC50 values 65.2, 154.5, and 54.4 ppm, respectively, for *A.stephensi, A. aegypti,* and *C. quinquefasciatus. C. ternatea* shows the most promising mosquito larvicidal activity (Mathew *et al.*, 2009).

DISCUSSION

Mosquitos are known as *Mashak* in Ayurveda. These are nuisance to human health. They get attracted to humans through sense of warm and humid convection arising from human body and that of concentration of carbon dioxide. According to action, the mosquito repellent agents can be divided into two types viz. acting on olfactory senses and tactile senses. Olfactory mode is known as transpiration repellency in which repellent works by blocking humidity sensing holes of mosquitoes so they cannot locate humans. Tactile mode also known as direct contact repellency affects mosquito's peripheral nervous system which leads them in a confused state and inhibits their behavior at sub-lethal doses, before knockdown. This drives the insects away off the surface before they can suck blood (Lalit *et al.*,

Table 2: Phytochemical constituents of *Jatwadi Dhoom Agad* and there pharmacological properties

Sr. No	Plant Name	Phytochemicals present	Pharmacological properties
1	*Laccifer lacca*	Alkaloids, steroids, tannins, quinine, carbohydrates, saponins, flavonoids, phenol, triterpenoids, carboxylic acid (Shankar and Pradeep, 2017)	Antimicrobial Activity (Dinesh and Sirsikar, 2016)
2	*Vetiveria zizanioides*	Vetiverol, Vetivone, Khusimone, alkaliod, sterols, triterpeniodes, saponins, tannins and flavonoids (Singh *et al.*, 2013)	Antibacterial (Singh *et al.*, 2013), Mosquito Repellent (Manokari and Meenu, 2014), Larvicidal (Aarthi and Murugan, 2010)
3	*Cinnamomum tamala*	Tannins, alkaloids, flavonoids and terpenoids (Hassan and Kazmi, 2016)	Antimicrobial Activity (Hassan and Kazmi, 2016) Insecticidal (Mukesh, 2016), Mosquito Repellent (Mukesh, 2016), Larvicidal (Iqbal *et al.*, 2018)
4	*Commiphora mukul*	Steroids, diterpenoids, aliphatic esters, carbohydrates, amino acids and triglycerides (Jasuja *et al.*, 2012)	Antibacterial (Kumara *et al.*, 2017)
5	*Semecarpus anacardium*	Bioflavonoids, phenolic compounds, bhilawanols, minerals, vitamins and amino acids (Paras *et al.*, 2014)	Antimicrobial (Bagewadi *et al.*, 2012)
6	*Terminalia arjuna*	Flavonoids, tannins, phenols, phytosterols, saponins and alkaloids (Mandal *et al.*, 2013)	Antibacterial and antifungal activity (Debnath *et al.*, 2013)
7	*Shorea robusta*	Carbohydrates, alkaloids, tannins, glycosides, phenols, saponins, terpenoids, flavonoids (Marandi *et al.*, 2016)	Antimicrobial (Kumar *et al.*, 2014)
8	*Clitoria ternatea*	Tannins, Alkaloids, Glycosides, Resins, Steroids, Saponins, Flavonoids and Phenols (Manjula *et al.*, 2013)	Antimicrobial (Jamil and Pa'ee, 2018), Larvicidal (Mathew *et al.*, 2009)

2015). The chemical agents used for this can be harmful to humans also.

The fumigation therapy is practiced all over the world across various cultures and civilizations (Mohagheghzadeh *et al.*, 2006). Fumigation referred as *Dhoopana* in Ayurved classics is prescribed for treatment of various ailments and disinfection of environment and inanimate objects. The effectiveness of fumes which emanate by burning plants products in rituals (yagnas or havan-offering of various material including plants products through fire) to reduce airborne bacteria and as a part of prescribed procedure for treatment of bacterial infections has been reported (Nautiyal *et al.*, 2007). Generally *Dhoopana yoga* contains aromatic plants as well as resins to bind it together. In *Jatwadi Dhoom Agad, Tamalpatra, Guggul, Sarja, Ushir* etc are aromatic while *Laksha, Guggul, Sarja* contains binding resins.

Most of the ingredients of *Jatwadi Dhoom Agad* are having *Katu, Tikta* and *Kashayarasa*, *Teekshna guna* with *Ushna veerya*. They have predominance of *Vayumahabhoot* along with *Agni*, *Aakash* and *Prithvimahabhoot* respectively. *Vayu* and *Akash* are responsible for quicker combustion and rapid spread of smoke. These all are having resins, oleoresins, phenolic compounds, flavonoids, volatile oils and essential oils. After burning the *Dhoom agad*, volatile principles are released in air. Due to predominance of *Vayu, Agni* and *Akash*, the smoke has tendency to move upward and spreads quickly everywhere. Being very subtle, smoke can reach in the minute space and carry all the properties of all its ingredients. Due to hot property of ingredients the temperature of atmosphere increases which is opposite to damp and humid conditions. The formulations consist of drugs that show a synergetic effect and help in propagating the activity of the main repellent drugs. So collectively this is useful to generate smoke (*Dhoom*) which exerts its action.

The ingredient Bhallatak contains fixed oil which is irritant. *Ushir, Tamalpatra and Aparajita* already showed mosquito repellent and larvicidal activity. Hence all these properties synergistically may act for obtaining the mosquito repellent effect of *Jatwadi Dhoom Agad*.

As an effect of combustion of *Jatwadi Dhoom Agad,* aromatic and irritant volatile oil vapors are released this may block the olfactory receptors of mosquitoes stimulating the biochemical changes in the CNS. As mosquitoes sense these irritant vapors faster with the chemoreceptors than tactile so they don't attract towards the humans. Also mosquitoes are kept away as they may not like produced gases due to burning of drug. Due to oil containing drugs the smoke may remain for a longer time in atmosphere so generally we get more protection time.

One of the ingredients *Bhallatak* is reported under *Upavisha Dravya* in classical ayurvedic texts. It is observed that *Shodhana* (purification procedures) of the fruits should be carried out before its internal administration to reduce the irritation (Kashinath, 2012). A systematic study can be planned further to assess activity and safety of smoke of raw and purified *Bhallatak* to humans.

CONCLUSION

Jatwadi Dhoom Agad is *Dhoopana* formulation stated in *Charak samhita* for protection from poisonous animals and insects. This literature review suggested that out of eight ingredients of *Jatwadi Dhoom Agad* all are having antimicrobial activity, two showed mosquito repellent effect and three showed mosquito larvicidal effect. This formulation can be used to get relief from mosquito nuisance and for prevention from vector borne diseases. This also may be effective for sanitizing COVID wards, hospital beddings, curtains, related things. It can be used for fumigation to repel insects and for antiviral action. Further research is necessary for validation and wide use of this formulation as fumigation product.

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Future Challenges

There is need of further experimental studies to determine the effective dose of repellency and average protection time of the *Jatwadi Dhoom Agad*; as such studies were not found during the review. How drug works in reference to change in humidity and temperature, identification of bioactive compounds, human safety evaluation of this drug is also needs to be studied.

Conflict of Interest

The authors declare that they have no conflict of interest.

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