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ORIGINAL ARTICLE **OPEN ACCESS**

An Antibacterial Effect of Herbal Fumigation *Kwath* on *Staphylococcus aureus, Pseudomonas aeruginosa* and *Escherichia coli*

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ABSTRACT
Ayurveda is science of the life. Maintenance of health of healthy individual and Treatment of disease is the main principles of Ayurveda management. Acharya Sushruta mainly deals with the surgical conditions and known as father of surgery. He also explained different types of surgeries and documented procedures in sophisticated manner. He also explained Different types of instruments, dressing techniques etc. He clearly knows the importance of asepsis in his words Rakshakarma and different drugs he enlisted for it. Dhoopan is an integral part of rakshakarma. In modern era sterilization and disinfection are the main weapons to deal with the different microbes present in the environment. In hospital setups nosocomial infection is the most common cause for infections thus environment and surfaces should be microbe free. Operation theatre is heart of any surgical hospital and hence its sterilization is most important. Formaldehyde is most widely used chemical for OT complex fumigation but as its carcinogenic, irritable many safer chemicals are emerging but their economical value is great hurdle. Hence an attempt is made to make alternative herbal fumigation formulation for OT fumigation. Before going for actual OT fumigation standardization of formulation and accessing its antibacterial properties is basic requirement. The objective of this study is to assess the anti-bacterial activity of herbal fumigation formulation is discussed.
Keywords: *Herbal, fumigation, formaldehyde, sterilization, OT room*

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INTRODUCTION

Surrounded air is laden by millions of microorganisms. When these microbes invade into host body mechanism leads to variety of infections. Hospital acquired infections are most common in any healthcare setup [1]. Surgical site infections are more dangerous and most common among hospital acquired infections. OT complex is the heart of any surgical hospital [2]. Proper sterilization and disinfection of OT complex and OT equipment can remarkably reduce hospital acquired infections. In Hindu mythology '*Raksha*' and '*Bhuta*' are very vital concepts which can be correlated with prevention from known or unknown causes leading to infections [3].'*Dhupkalpa*' which are composed of several drugs having *krumighna, jantuhara* properties producing fumes with aroma. These fumes are helpful to purify air and such aroma makes environment pleasant. *Acharya Sushruta* known as the father of surgery explained variety of surgical and para-surgical procedures and different types of instruments for performing such surgeries. *Acharya* explained in detail about *rakshakarma.* Dhoopan is an integral part of *rakshakarm*. Dhoopan is explained as preventive as well as therapeutic measures in ayurveda. *Acharya* explained *Dhoopan* for *vranitagar, kumaragar* [4], *sutikagar*. In modern science Formaldehyde is mostly use for OT fumigation. As its carcinogenic [5], irritable many safer chemicals are emerging but economical value is great hurdle. During covid 19 pandemic, Ministry of *AYUSH* advised fumigation with medicated herbs as preventive measure [6]. There is absolute need to develop organic fumigation formulation which is safe for mankind with potent antibacterial properties. It is proven thatmany herbal medicines are having potent antibacterial properties and many studies are still ongoing. In this study 5 *ayurvedic* herbs are selected in combination in *kwath* form for fumigation. Each drug's individual properties explained in table no.1. Fumigation was carried out in the OT room and culture plates of *S. aureus* exposed in OT rooms for 20 mins, incubated for 24 hrs and assessment was done after 24 hrs.

Table 1: Drug's individual properties

Name of Drug	Botanical Name	*Rasa*	*Guna*	*Virya*	*Vipaka*	*Karma*	Parts used	Established activity against microorganism
Sarajarasa	*Shorea Robusta Gaerten.*	*Tikta, Kashaya*	*Ruksha,ushna*	*Sheeta*	*katu*	*Grahanashaka*	seeds	antimicrobial against *staphylococcus aureus, E-coli [9]*
Ushira	*Vetiveria Zizanioides*	*Tikta, Madhura*	*Ruksha,Laghu*	*Sheeta*	*Katu*	*Krimighana*	Root	antimicrobial ability against *staphylococcus aureus, E-coli [10]*
Gour sarshap	*Sinapis alba*	*Katu,tikta*	*laghu,snigdha*	*Ushana*	*Katu*	*Raksho hara, Krimighana*	seeds,seed oil	antibacterial against streptococcus pneumoniaeand antifungal properties [11]
Vidanga	*Embelia ribes*	*Katu, Kashaya*	*Laghu,Ruksha*	*Ushana*	*Katu*	*Krimighana, Jantuhantri*	Fruit, roots	Bacteria *Staphylococcus aureus Escherichia coli [12]*
Guggul	*Commiphora mukul*	*Katu, tikta, kashaya*	*Laghu, ruksha, vishada,sookshma, sara*	*Ushana*	*Katu*	*Krumijayeta*	resin	*Bacillus megaterium, Micrococcus luteus, Enterococcus faecalis, Staphylococcus aureus and fungal strains of Aspergillus niger, A. flavus, Candida albicans, Microsporum fulvum [13]*

MATERIAL AND METHODS

The study was carried out at Parul institute of ayurveda, Parul university, Vadodara. Fumigation was carried out in operation theatre complex and microbiological study was done at Department of microbiology, faculty of applied sciences, Parul University, Vadodara.

Materials: Required herbs for *Dhoopan/*fumigation collected from *ayurvedic drug* vendor and authenticated from *dravyaguna* department, Parul institute of ayurveda. Then coarse powder is made at RSBK dept of Parul institute of ayurveda and research, Parul University. Fresh *kwath* was prepared at GMP certified pharmacy of Parul institute of ayurveda, Parul University as per reference of *Sharangdhar Samhita* [7]. Physiochemical analysis was done at Vasu healthcare, Vadodara explained in Table no. 2

Table 2: Organoleptic & physicochemical analysis

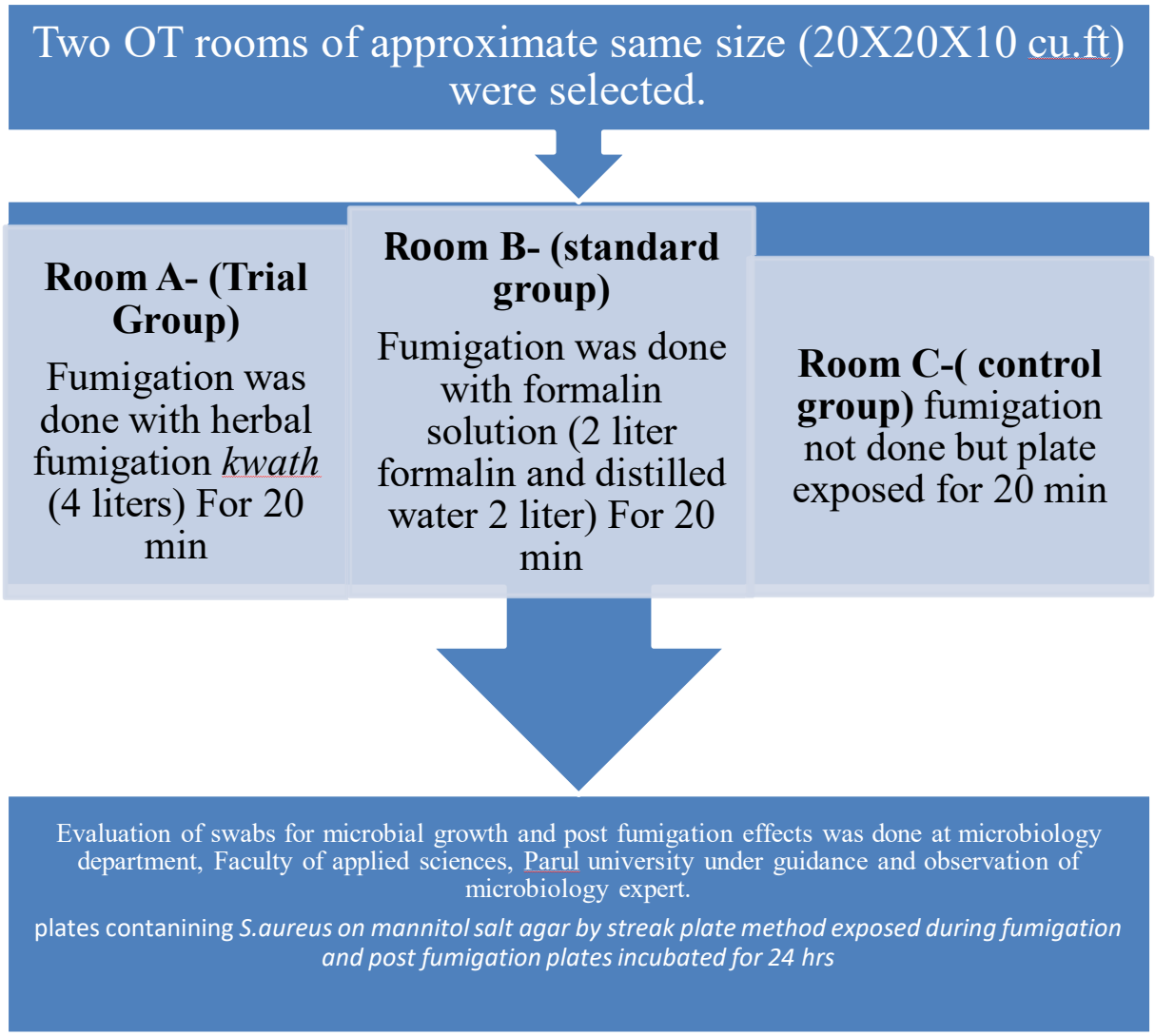
Sr. No.	Parameters	Result
Organoleptic Analysis		
1	Description	Dark Brown Colour Liquid
2	Odour	Characteristic
Physico-chemical Analysis		
1	pH	5.05
2	Specific Gravity	1.007
3	Viscosity	0.079cP
4	Total Solid Content	1.71%

Method of herbal drug fumigation *kwath* preparation and Fumigation:

The raw drugs were cleaned and made in to coarse powdered form (Mesh size 40-60) separately and homogenous mixture was prepared by mixing all the ingredients. Required quantity *kwath* is prepared freshly as per reference *Sharangdhar Samhita*. Culture plates of *S.aureus* prepared with mannitol salt agar

were kept in 3 Theatre rooms A, B and C (figure 1).The fumigation was conducted for 20 min. *Dhoopan*/fumigation area of rooms was 20x20x10cu. ft size was cleaned and door kept closed. AC, fans switched off till the process has been carried out. Theatre A fumigated with herbal drug fumigation *kwath*, Theatre B fumigated with formalin and theatre C no fumigation was carried out. After 20 mins plates closed and safely taken to microbiology lab under all aseptic precautions for further analysis (Table 3).

Table 3: Room A, B & C



Further with help of Agar disc diffusion method study of herbal fumigation *kwath* was carried out at Vasu healthcare, vadodara as strains other than S. aureus were not available at microbiology dept, faculty of applied sciences, Parul University results shown in table no.
Dose calculation: As OT room size is 20x20x10 cu ft formalin used is 2 L in equal quantity of distilled water and same way quantity of herbal fumigation *kwath* is taken as 4 lit as it is aqueous solution. (500 ml formalin with equal quantity of distilled water is required for 10x10x10 cu.ft. OT chamber.)
Duration of fumigation: 20 mins
Incubation period: 24 hrs at 37^0C

RESULT

A Comparison was done between the cultured plates and the following results were obtained, as shown in Table. As per the observation, the *Dhoopana* with herbal fumigation *kwath* for 20 min showed significant result and is near comparable to the formaldehyde fumigation. Remarkable effect was seen in organism *Staphylococcus aureus* (figure no 4 and 5). In OT room C the bacterial growth rate was too high (fig no.6). So herbal fumigation *kwath* has showed significant anti-bacterial property shown in table no. 4.

Table 4: Herbal fumigation

Sr. No.	Fumigation for 20 min	No. of colonies of *Staphylococcus aureus*
1	Formaldehyde	650 colonies
2	Herbal fumigation *kwath*	571 colonies
3	Without fumigation	>more than 1000 colonies

In-vitro study conducted at vasu healthcare also showed significant results against *Staphylococcus aureus, Pseudomonas aeruginosa and Escherichia coli.*

Figure 1 Figure 2 Figure 3

Figure 4 Figure 5 Figure 6

DISCUSSION

Maintenance of health of healthy individual and treatment of disease is the main principles of *ayurveda* management. *Acharya Sushruta*, Father of Surgery explained many surgical and para-surgical procedures. He explained importance of *rakshakarma* and *Dhoopan* is an integral part of *rakshakarma*. Operation theatre complex is heart on any surgical hospital and standard sterilization procedures are mandatory to delt with different types of infections. Formaldehyde is most widely used chemical for OT complex fumigation but as its carcinogenic, irritable many safer chemicals are emerging which are costly. Ayurvedic herbs are potent in antimicrobial properties and fumigation carried out with such herbs is comparatively safe. These herbs are having volatile oils which liberates fragrance on heating makes the environment pleasant. Fumigation with Herbal fumigation *kwath* shows Highly significant results and its soothing fragrance helps in elevating mood of patients.

Probable Mode of action

Herbs belonging to *kushtaghna, krimighna, kandughna* and *vranaropan-shodhan gana* have mostly used for their antimicrobial properties. Different studies shows that individual drugs having virucidal, bactericidal, fungicidal, mycobactericidal properties. *Dhoopana* is an example of drug delivery through the fumes which have very high penetration capacity in various things exposed to fumigation. These fumes can easily reach up to any corner of the room and hence prove very potent against various disease-causing vectors and microorganisms. *Dhoopana dravyas* contain terpenoids which also acts very effectively through inhalation route, having several advantages including ease of drug administration, higher bioavailability and high potential to penetrate the blood brain barrier. Most of *dhoopan dravyas* having *Agni* and *Vayu Mahabhoot Predominance* are used for this procedure. These ingredients having common properties like *Laghu, Ushna, Ruksha* and *Vishada*which help in rapid spread of their fumes.

Burning of *Dhoopa dravyas* causes evaporation of volatile oils, resins and gums present in them. These are active ingredients of *dhoopan dravyas*. Their volatility would be a greatadvantage in lowering microbial contamination in air and difficult to reach surfaces. Furthermore, evidence suggests that the volatile essential oils present in most of herbs possess strong antioxidant activities, which are favorable to combat free radical-mediated organoleptic deterioration*. Sarjarasa, vidanga and ushira* having strong antimicrobial properties especially against *staphylococcus aureus, E-coli. Gaura sarshapa* having antibacterial against *streptococcus pneumonia* and antifungal properties. Many studies have proven that *guggulu* is having very strong antibacterial properties. *Guggulu* having potent action *against Bacillus megaterium, Micrococcus luteus, Enterococcus faecalis, Staphylococcus aureus* and fungal strains of *Aspergillus niger, A. flavus, Candida albicans, Microsporum fulvum [8]*. In physicochemical analysis pH of herbal fumigation *kwath* is 5.05 which is acidic in nature and resembles with pH of formalin which is 3-4 and that of bacillocid is around 5. So acidic nature of fumigation solutions helps in inhibiting bacterial growth.

CONCLUSION

The study shows that fumigation with herbal fumigation *kwath* compared with formalin having much significant results. Herbal fumigation *kwath* is safe, economic and potent solution in sterilization to protect from microbial load as well as nosocomial infections. This is the time to change the chemical based synthetic and toxic agents with *herbal, herbo-mineral* and animal origin safe compounds for sterilization. These *Dhoop dravyas* are having preventive as well as therapeutic properties which aids in early wound healing, less hospitalization stay and limited dose of antibiotics. These herbs having Volatile oils which are very much fragrant help to elevate mood of the patient.

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