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Liquid Smoke (Wood Vinegar) Potential As An Antiseptics Agent In Dentistry: A Systematic Review

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ABSTRACT
Aseptic quality is a crucial aspect of successful dental care attainment. Various oral microbes can increase the chance of failure in dental treatment. Multiple efforts have been made to improve the aseptic quality. It is known that the antiseptics used were costly and has numerous side effects. Natural antiseptics such as liquid smoke may be a potential substitute. This research aimed to explore the potential of liquid smoke as an antiseptic in dentistry. A systematic literature search was conducted in the electronic database of PubMed/Medline, ScienceDirect, and Google Scholar using PRISMA guideline. A structured search using the Boolean string "liquid smoke AND antimicrobial AND antibacterial" was performed. Initially, 115 potential articles were discovered. After removal of duplicates and checking the availability of full-text read, eleven studies were included. Liquid smoke with 1.5-50% concentration can eliminate S. mutant, S. sanguis, S. aureus, S. epidermidis, L. acidophilus, L. salivarius, E. faecalis, P. gingivalis and C. albicans. It was also reported that it has a particular effectiveness for the disinfectant and wound healing. Liquid smoke can eliminate both oral bacterial and fungi. Further research should explore the safety aspects of utilizing liquid smoke in dental clinics.
***Keywords**: liquid smoke; antiseptics; dental clinics*

ABSTRAK
Kualitas aseptik merupakan unsur penting dalam keberhasilan perawatan di klinik gigi. Berbagai mikroba rongga mulut berpotensi meningkatkan risiko kegagalan dalam perawatan. Berbagai upaya diupayakan untuk meningkatkan kualitas aseptik. Selama ini bahan antiseptik digunakan dalam prosedur asepsis, relatif mahal dan menimbulkan efek samping. Asap cair, suatu bahan alam berpotensi digunakan sebagai antiseptik pengganti. Penelitian ini bertujuan mengungkap potensi asap cair untuk digunakan sebagai antiseptik di klinik gigi. Penelusuran dilakukan secara elektronik melalui PubMed/Medline, ScienceDirect, dan Google Scholar menggunakan panduan PRISMA. Penelusuran awal menggunakan struktur Boolean string "liquid smoke AND antimicrobial AND antibacterial", diperoleh 115 artikel.

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Dari 115 terpilih 11 artikel, setelah dilakukan eliminasi berdasar artikel duplikasi dam ketersediaan artikel "*fulltext*". Asap cair dengan konsentrasi 1,5-50% mampu membunuh *S. mutant, S. sanguis, S. aureus, S. epidermidis, L. acidophilus, L. salivarius, E. faecalis, P. gingivalis dan C. albicans.* Asap cair juga efektif digunakan sebagai desinfektan alat dan pengobatan luka. Asap cair mampu membunuh berbakai jenis bakteri dan jamur dari rongga mulut. Penelitian lebih lanjut diperlukan untuk mengetahui keamanan penggunaan asap cair di klinik gigi.
Kata Kunci: asap cair; antiseptik; klinik gigi

INTRODUCTION

Aseptic condition is a crucial part of dental treatment. The risk of infection will increase — for both operator and patient — if oral microbial aspects are neglected. This risk may increase from various events, such as patient operator contact through the dental instrument and other typical high bioaerosols dental treatment, such as dental scaling and cavity preparation (Amtha, 2019). Negligence in controlling the risk of infection may cause a failure in dental treatment, and this can be avoided by following a proper aseptic procedure, such as mandatory oral gargle, cavity treatment, and dental instruments disinfection (Kemenkes RI, 2013). Mandatory oral gargles were done with an antiseptic oral gargle before the intraoral examination. This approach can effectively reduce the microbes count in saliva, therefore reducing the potential of microbial spread through bioaerosol. In severe cavity treatment, the aseptic procedure can be applied with pulp involvement through mechanical and chemical measures (Malmberg, Hägg and Björkner, 2019). Hence, dental instruments need to be sterilized thoroughly, utilizing decontamination, pre-sterilization wash, and autoclave for stainless steel instruments or chemical for non-stainless instruments (Kemenkes, 2017).

Liquid smoke, also known as wood vinegar, is an organic chemical substance with pyroligneous acid components obtained through a pyrolytic process of wood cellulose. This process involves heating wood without directly exposing it to fire, hence creating smoke. Furthermore, the residual smoke will be condensed into the liquid smoke, containing carbonyl-phenol, ketone, acetate, aldehyde, methanol, and other minor substances. Although the usage of carbonyl-phenol was reported to be useful as an antimicrobial substance (El-shamy *et al.*, 2016), to the best of our knowledge, there was no overall review yet in the oral health-related microbes as a systematic review is needed to summarize the overall

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potential of the liquid smoke itself. Therefore, this research aimed to explore the potential of liquid smoke as a part of the aseptic procedure in dentistry through a systematic review from various research.

METHOD

A systematic literature search was conducted in the electronic database of PubMed/Medline, ScienceDirect, and Google Scholar using PRISMA guideline (http://www.prisma-statement.org/) in both Indonesian and English language. MeSH appropriate combination terms for the Boolean search string were “liquid smoke OR wood vinegar OR pyroligneous acid AND antimicrobial OR antibacterial”. Publication with the inclusion criteria with a random sampling model, published from 2016 – 2021, in vitro or ex vivo, and presenting oral microbial were included for final analysis if other pertinent data was presented. The need of ethical clearance was waived by the authors’ institution.

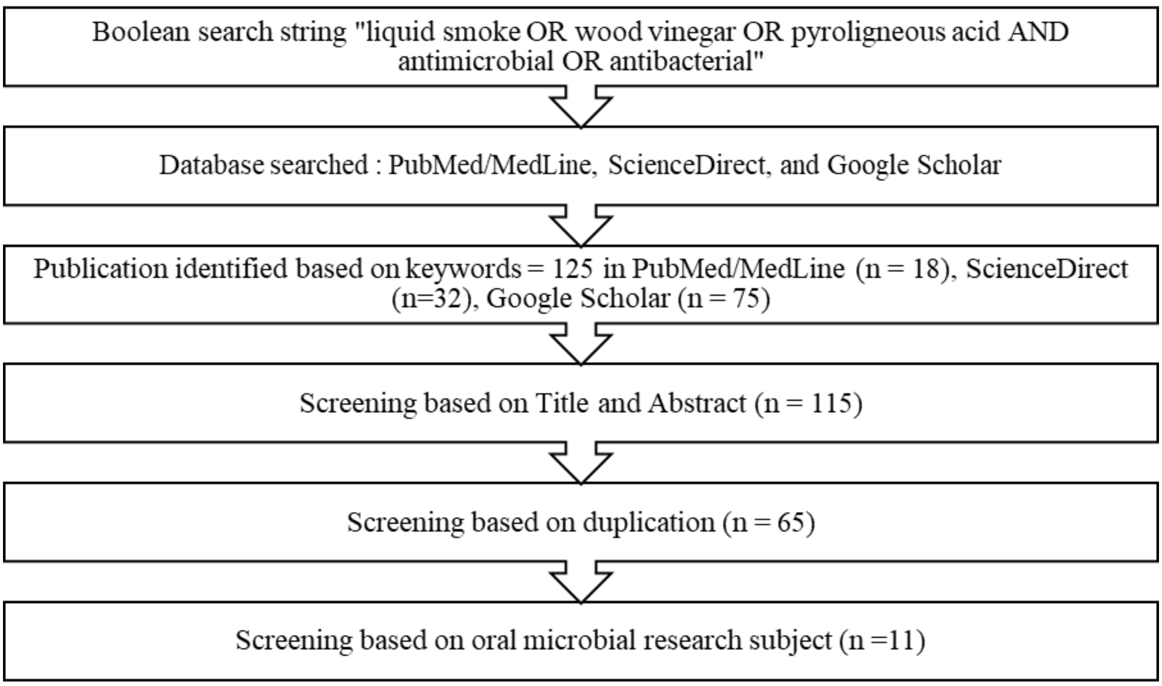

Figure 1. Literature search and selection based on PRISMA systematic review guidelines.

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RESULTS AND DISCUSSION

An electronic search resulted in an initial list of 125 articles. Examination based on title and abstract led to a preliminary list of 115 articles. Furthermore, detailed screening based on article duplication reduced the number of manuscripts further to 65. After full-text examination, 54 articles were excluded due to the research experiment design using fish, meat, food, and the microbial type (Figure 1). All studies were published in both English and Indonesian.

Tabel 1. Studies included in the review. MIC = Minimal Inhibitory Concentration

Author	Year	Microbe	MIC	Result
El-shamy, F.M.M *et al*.	2016	*S. mutan*, *S. aureus*, *L. salivarius*, *C. albicans*, *E. faecalis*		liquid smoke 5% performs better than chlorhexidine gluconate
Hutahuruk, M.A.C, *et al*.	2016	*S. mutan*	6,25%	eliminate *S. mutans* on 12,5% concentration
Wibowo, A. *et al*.	2016	*P. gingivalis*	6,25%	eliminate *P. gingivalis* on 12,5% concentration
Kondo, S.A. *et al*.	2017	*S. sanguis*	6,25	eliminate *S. sanguis* on 12% concentration
Imaniar, A.C. *et al*.	2017	*E. faecalis*	25%	eliminate *E. faecalis* on 100% concentration
Faisal, M. *et al*.	2017	*S. mutans*	14,2%	prohibit *S. mutans* growth rate on 14,2% concentration
Susanti, l. *et. al*.	2018	*Streptococcus* Sp.	1,5%	prohibit *Streptococcus* sp. on 1,5% concentration
Adhiasari, R. *et al*.	2019	*S. aureus*	25%	kill *S. aureus* on 50% concentration
Darojah, P. *et al*.	2019	*S. epidermidis*	25%	kill *S. epidermidis* on 50% concentration
Irwandi, D. *et al*.	2020	*S. aureus*	25%	prohibit *S. aureus* growth on 25% concentration
Nosartika, I. *et al*.	2021	*C. albicans*, *L. acidophilus*	10% & 50%	prohibit *C. albicans* growth on 10% concentration and *L. acidophilus* on 50% concentration

The systematic review results indicate that liquid smoke can hamper or kill various oral microbial with various dosage, from 1.5% to 50%, with an elimination rate of 5 to 100%. These variations were derived from the wood source and composition of the used liquid smoke. Based on the results in Table 1, liquid smoke effectively works

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against *S. auerus, S. mutans, S. epidermidis, S. sanguis, P. gingivalis, C. albicans, L. salivarius, E. faecalis* and *L. acidophilus* (Narayanan and Vaishnavi, 2010), (Wibowo, Vidyahayati and Ciptaningtyas, 2016). These microbes were normal oral flora, although they still can grow at a pathogenic rate and create a various infection.

S. mutans is a plaque bacterium involves in the process of caries and pulp infection. Other known bacteria involved in pulp infection are *P. gingivalis, F. nucleatum, S. sanguis* and *E. faecalis* (Singh Ahirwar *et al.*, 2019). Liquid smoke with minimal inhibitory concentration (MIC) of 5-14.5% could eliminate *S. mutans* (Wibowo, Vidyahayati and Ciptaningtyas, 2016; Kondo, Wibisono and Ciptaningtyas, 2017). In caries, *L. acidophilus* was also involved with *S. mutans*, and liquid smoke with 50% MIC was reported to be able to stop it (Narayanan and Vaishnavi, 2010). Further research should explore liquid smoke's ability in other cares bacterium, such as *Lactobacillus*, which is known to be a dominant bacterium in early caries lesion (Xiao *et al.*, 2020).

P. gingivalis is a bacterium known to be implicated in periodontal infections. Liquid smoke with MIC of 12.5% was able to kill *P. gingivalis* (Kondo, Wibisono and Ciptaningtyas, 2017). Although the effect on other periodontal infection bacteria, such as *T. denticola* and *Actinomycetecomitans*, were unknown (Tong *et al.*, 2015). *S. aureus, S. epidermidis* and *S. sanguis* were known for their significant implication in periapical, mucosal, and skin infection (Liquid smoke with 25-50% MIC were able to eliminate *S. aureus* (Darojah, Santoso and Ciptaningtyas, 2019; Nosartika, Hardini and Prihatiningsih, 2021) and *S. epidermidis* (Irwandi and Sukmawati, 2020).

Fungal infection is a significant case in oral infection, with *C. albicans* as the most common cause. Candida infection was expected in as patient with low immunity or as a result of prolonged antibiotic. Liquid smoke can prevent this infection, like liquid smoke with 50% MIC could kill *C. albicans* (Narayanan and Vaishnavi, 2010; Kurniatuhadi, 2018).

Based on our review, there was no evidence that liquid smoke performs as an anti-viral agent in an oral environment. However, it was reported that the phenol substance in liquid smoke from bamboo was able to cause an inactivation for *Picornavirus* and *Encephalomyocarditis* viruses. Further research on other viruses

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needs to be researched (Khameneh *et al.*, 2019).

The ability of liquid smoke to control the oral microbial infection was caused by its various antibacterial substance, such as carbonyl-phenol and acetate. These substances could alternate the structure and cell wall characteristic in different microbes, although their mechanisms are others in each reported bacterium (El-shamy *et al.*, 2016). Phenol was known to eliminate bacterium with other mechanisms by alternating its cytoplasmic membrane or create a leakage on intracellular bacterial fluid. Carbonyl in aldehyde and ketone act through penetrating cell wall and enzyme inactivation, resulting in hampering the targeted bacteria's growth (Nazzaro *et al.*, 2013). Other research reported that 12.5% MIC of liquid smoke could eliminate microbes in dental instruments, which can also be achieved through 70% alcohol (Erlytasari, Wibisono and Hapsari, 2019).

Further extension of liquid smoke capability in achieving an aseptic environment was also demonstrated in wound healing. Recent research reported that 6% MIC of liquid smoke accelerated oral ulceration healing; macroscopic evaluation proves that this substance was par with povidone-iodine (Permatasari, Purnawati and Wijayahadi, 2019). Liquid smokes were also useful in trauma wound, acting through accelerating the fibroblast synthesis in the wound area (Surboyo *et al.*, 2019; Ayuningtyas *et al.*, 2020).

This substance's capability was promising, although the standard safety usage was not known yet due to reports was still in vitro and in vivo research stage on mice. Further reports indicate that in vitro mice may cause a potential toxic kidney cell through acetate and low pH in liquid smoke (Arundina, Diyatri and Surboyo, 2021). Multiple types of research concerned with the safety of the liquid smoke were conducted mainly in foods, and its performance was promising and proven safe for the food processing industry (Lingbeck *et al.*, 2014; Prasetyo *et al.*, 2020).

CONCLUSION

Liquid smoke can eliminate both oral bacterial and fungi, although further clinical research was needed. Various capabilities show that it demonstrates its usefulness as a disinfectant and wound healing. Further research should explore its capability as an anti-viral and the safety aspects of utilizing liquid smoke in dental clinics.

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