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

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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...
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/](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.

| Boolean search string "liquid smoke OR wood vinegar OR pyroligneous acid AND antimicrobial OR antibacterial" |
| Database searched : PubMed/Medline, ScienceDirect, and Google Scholar |
| Publication identified based on keywords = 125 in PubMed/MedLine (n = 18), ScienceDirect (n=32), Google Scholar (n = 75) |
| Screening based on Title and Abstract (n = 115) |
| Screening based on duplication (n = 65) |
| Screening based on oral microbial research subject (n =11) |
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

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Microbe</th>
<th>MIC</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>El-shamy, F.M.M et al.</td>
<td>2016</td>
<td>S. mutan, S. aureus, L. salivarius, C. albicans, E. faecalis</td>
<td>liquid smoke 5% performs better than chlorhexidine gluconate</td>
<td></td>
</tr>
<tr>
<td>Hutahuruk, M.A.C, et al.</td>
<td>2016</td>
<td>S. mutan</td>
<td>6.25%</td>
<td>eliminate S. mutans on 12.5% concentration</td>
</tr>
<tr>
<td>Wibowo, A. et al.</td>
<td>2016</td>
<td>P. gingivalis</td>
<td>6.25%</td>
<td>eliminate P. gingivalis on 12.5% concentration</td>
</tr>
<tr>
<td>Kondo, S.A. et al.</td>
<td>2017</td>
<td>S. sanguis</td>
<td>6.25</td>
<td>eliminate S. sanguis on 12% concentration</td>
</tr>
<tr>
<td>Imaniar, A.C. et al.</td>
<td>2017</td>
<td>E. faecalis</td>
<td>25%</td>
<td>eliminate E. faecalis on 100% concentration</td>
</tr>
<tr>
<td>Faisal, M. et al.</td>
<td>2017</td>
<td>S. mutans</td>
<td>14.2%</td>
<td>prohibit S. mutans growth rate on 14.2% concentration</td>
</tr>
<tr>
<td>Susanti, l. et. al.</td>
<td>2018</td>
<td>Streptococcus Sp.</td>
<td>1.5%</td>
<td>prohibit Streptococcus sp. on 1.5% concentration</td>
</tr>
<tr>
<td>Adhiasari, R. et al.</td>
<td>2019</td>
<td>S. aureus</td>
<td>25%</td>
<td>kill S. aureus on 50% concentration</td>
</tr>
<tr>
<td>Darojah, P. et al.</td>
<td>2019</td>
<td>S. epidermidis</td>
<td>25%</td>
<td>kill S. epidermidis on 50% concentration</td>
</tr>
<tr>
<td>Irwandhi, D. et al.</td>
<td>2020</td>
<td>S. aureus</td>
<td>25%</td>
<td>prohibit S. aureus growth on 25% concentration</td>
</tr>
<tr>
<td>Nosartika, I. et al.</td>
<td>2021</td>
<td>C. albicans, L. acidophilus</td>
<td>10% &amp; 50%</td>
<td>prohibit C. albicans growth on 10% concentration and L. acidophilus on 50% concentration</td>
</tr>
</tbody>
</table>

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. aeurus*, *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
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.
REFERENCES


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