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The Evaluation of Effectiveness of Addition of Antimicrobial Agents to Acrylic and Silicone Soft Denture Liner to Prevent The Growth of Microorganisms: Systematic Review

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Abstract:
Background*:Soft denture liner (SDL) is a soft material that is most often used in prosthodontics as a soft coatingmaterial whose soft properties remain after polymerization. However, due to its soft nature and rough surface, SDLcannotbe cleaned mechanically. The cleaning method for relined dentures is the chemical method,namely byadding antimicrobialingredients suchas carvacrol,tea treeoil,fluconazole,soluneem,nystatin,miconazole,ltraconazole,clotrimazole, silvernanoparticles(AgNP),zirconiumnanoparticles,andpropolis.intoSDL.*
Purpose *: The purpose of this study was to determine the effectiveness of antimicrobial agents added to acrylic orsiliconSDLtopreventthegrowthofmicroorganisms basedonasystematicreview.*
Materials and Methods*: The objective of this systematic review was to evaluated the effectiveness of addition ofantimicrobial agents to acrylic and silicone soft denture liners to prevent the growth of microorganisms. Twoelectronic databases were searched through 2011-2021. The terms "Soft denture liner" AND addition of carvacrolOR "tea tree oil" OR fluconazole OR soluneem OR nystatin OR "silver nano particle" OR "zirconium nanoparticle" ORpropolis"waschosen. Articlesmeetingthe inclusionand exclusion criteria wereselected.Thedatabase search resulted in a total of 213 potential studies. After screening titles and abstracts and applyinginclusion and exclusion criteria, 34 studies were collected for a full text assessment. Full text assessment resulted in17studiesthatwereeligibleofqualitativesynthesis.*
Results*: The 7 articles showed that the concentration of antimicrobial ingredients added to the softdenture linerwas different for each material used, but it was proven effective in preventing the growth of candida albicans. Thetype of soft denture liner that is most widely used is silicon soft denture liner. Based on the results of research in thelast5years,herbalplantshaveshownquiteeffectiveresultsagainstmicrobialgrowthindentures.*
Conclusion: *There are 5 articles that discuss the effectiveness of adding antimicrobial ingredients such as SilverNano Particles, Propolis, Fluconazole, Soluneem, Tea Tree Oil and Carvacrol to Silicon Soft Denture Liner topreventthegrowthofmicroorganisms(71.43%)and2anarticlethatdiscussestheeffectivenessofaddingantimicrobial materials such as Nystatin and Zirconium Nano Particles into Acrylic Soft Denture Liner to preventthe growth of microorganisms (28.57%). There are 4 articles that use preparations (57.14%), and 3 articles that useherbalingredients(42.86%).*
Key Word*: SiliconeSoft DentureLiner,AcrylicSoftDentureLiner,AntimicrobialAgents*

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I. Introduction

Edentulous is tooth loss which is often accompanied by disturbances in masticatory, speech, aesthetic, andpsychosocial functions. The cause of edentulous is due to a combination of disease factors in the teeth, periodontaltissue,patientbehavior,dentalcare,andtheavailabilityofdentalhealthservices.Theestimatedtoothlosspopulation in the United States is over 36 million. For adults aged 18 years and over, about 10% (9.7%) wereedentulous, with the rate increasing with age. Approximately 26% of the population in the United States between theages of 65 and 74 years, approximately 23 million people, are edentulous and another 12 million are edentulous inone arch. Among the geriatric population over 65 years of age, the ratio of edentulous individuals to individuals withteethis2to1.[1]

A complete denture is a denture that replaces natural teeth and is in direct contact with the maxillary andmandibularteethinpatientswhohavelostteeth.Thepurposeofmakingcompletedenturesistoimprovemasticatoryfu

nction,estheticsandmaintainthehealthofthepatient'soralcavity.Patientswhohavelostteeth,if

they do not use dentures immediately, will cause resorption or atrophy of the residual ridge. Resorption that occurscontinuously at the alveolar ridge can cause the ridge to become flat. Complete dentures in patients with flat ridgescan cause problems, such as non-retentive dentures that are unstable and cause pain and discomfort because thedenturemoveswhenitfunctions.OnewaytoovercomeloosedenturesiswithRelining.[2]

Relining is one of the procedures used to overcome the problem by re-coating the fitting surface of the denturethat is no longer suitable or loose with a new base material, resulting in a new layer that adapts accurately to thesupporting mucosaof the denture. The purpose of relining is to correct dentures, health care on softtissues so thatthe dentures can be used and the patient feels comfortable with the dentures that are worn. Reline materials consistof: (1) Hard reline material, namely reliner with heat cured acrylic resin and self cured acrylic resin, (2) Tissueconditioners and soft denture liner. Soft denture liner (SDL) type consists of plasticized acrylic resin and siliconelastomer. The use of soft denture liners (SDL) is an important adjunct in the management of patients with loosecomplete dentures and removable partial dentures, especially in patients indicated when the denture loses retentionand stability, changes in vertical dimension, decreases speech, and changes in the base. denture. Soft denture linermaterial is used as a cushion (base) for denture adjuncts through absorption and redistribution of compressivestrengthreceivedintheedentulousridgearea.[3]

Softdenture liners thatare oftenusedtoday are softdenture liners,plasticizedacrylicresinandsiliconelastomer. The weakness of SDL material is the discovery of microbial colonization, one of which is Candidaalbicans. It was reported that fungal and bacterial species can enter the porous space in the SDL, the porosity of theSDL also allows the absorption of water and the diffusion of nutrients that can support the growth of Candidaalbicansintheoralcavity.[3-5]

The results of several studies evaluating the effectiveness of adding antimicrobial agents to acrylic and siliconsoft denture liners on preventing the growth of microorganisms, one of which is the Chincholikar et al. study,reported that the use of fluconazole and soluneem materials can prevent the growth of microorganisms. Pachava etal., added tea trre oil (TTO) into a silicon soft denture liner and evaluated its effectiveness against the growth ofcandidaalbicans.TheresultsofhisresearchstatedthatTTOwaseffectiveasatopicalantimicrobial,anti-inflammatoryandantifungal.Therefore,itisnecessarytoevaluatetheresultsofresearchexaminingtheeffectivenessofaddingantimicrobialagentstoacrylicandsiliconSDLmaterialstopreventthegrowthofmicroorganisms.[6,7]

II. Material And Methods

Search Strategy and Data Extraction

An online literature search was conducted using PubMed and ProQuest. The search was done with Booleansystem with the keyword “Soft denture liner” AND addition of carvacrol OR “tea tree oil” OR fluconazole ORsoluneem OR nystatin OR “silver nano particle” OR “zirconium nano particle” OR propolis”. PRISMA (PreferredReporting Items forSystematic Reviews and Meta-Analysis) was used to get the suitable articles foranalysis.PICOS (Population, Intervention, Comparison, Outcome, Study) was used to narrow the scope of the articles search(Table1).

	Inclusion	**Exclusion**
Source	PubMedandProQuest	*Others*
Dates	March2011–May2021	*Others*
Language	*English*	*Others*
Population	*Tooth loss patients treated using dentureswithacrylicandsiliconesoftdentureliners*	*Others*
Intervention	*Denturecleaningmethod*	*Others*
Comparative	*Addition of antimicrobial agents todentureswith softdentureliners*	*Others*
Outcome	*Theeffectivenessofantimicrobial agentstopreventthegrowthofmicroorganisms*	*Others*
Study/studies	*RandomizedControlledTrial*	*Others*
Type ofPublication	*Freeandpaidfulltextjournal*	*Others*

Table1.Inclusionandexclusioncriteria.

Study Selection

The selection process began with filtering identified articles by reading the abstracts. Full texts of therelevant articles were then evaluated. Evaluation was done with inclusion and exclusion criteria based on PICOS(Table1).

Quality Assessment

Quality assessment is carried out using an assessment according to the research design of the journal beingassessed. Randomized controlled trial (RCT). Score 1: Yes/complete is given in the text; score 0 : No/no detailsprovided; NA : Not clearly stated in the text, not reported or not applicable. Articles that have low quality are thendiscardedandwillnotbeincludedinthedataanalysis process(Figure1).

	Question	Articles						
N0		1	2	3	4	5	6	7
1	Does theresearchaddressa clearlyfocused question/problem?	1	1	1	1	1	1	1
2	Is the research method (studydesign)appropriatetoanswertheresearchquestion?	1	1	1	1	1	1	1
3	Is the subject selection method(employee,team,division, organization)clearlyexplained?	1	1	1	1	1	1	1
4	Could it be that the way thesample was obtained(selection)was biased?	0	0	0	0	0	0	0
5	Is a representative sample ofsubjects related to thepopulation that will be thereference?	1	1	1	1	1	1	1
6	Wasthesamplesizebasedonpre-study statistical powerconsiderations?	0	0	0	0	0	0	0
7	Was asatisfactoryresponserateachieved?	1	1	1	1	1	1	1
8	Is the measurement(questionnaire) possible validandreliable?	1	1	1	1	0	1	1
9	Was statistical significanceassessed?	1	1	1	1	1	0	1
10	Was a confidence intervalgivenforthemainoutcome?	1	1	1	1	1	0	1
11	Could there be confoundingfactors that have not beentakenintoaccount?	0	0	0	0	0	1	0
12	Can the results be applied toyourorganization?	1	1	1	1	1	1	1
Total		9	9	9	9	8	8	9

III. Result

Two hundred and thirteen articles were obtained from PubMed and ProQuest databases. The articles werechecked for duplicates which were then deleted, leaving 208 articles. The remaining articles were then checked forthetitlesandabstractsaccordingto theinclusionandexclusioncriteriabasedonPICOS,leaving7articles(Fig.2).

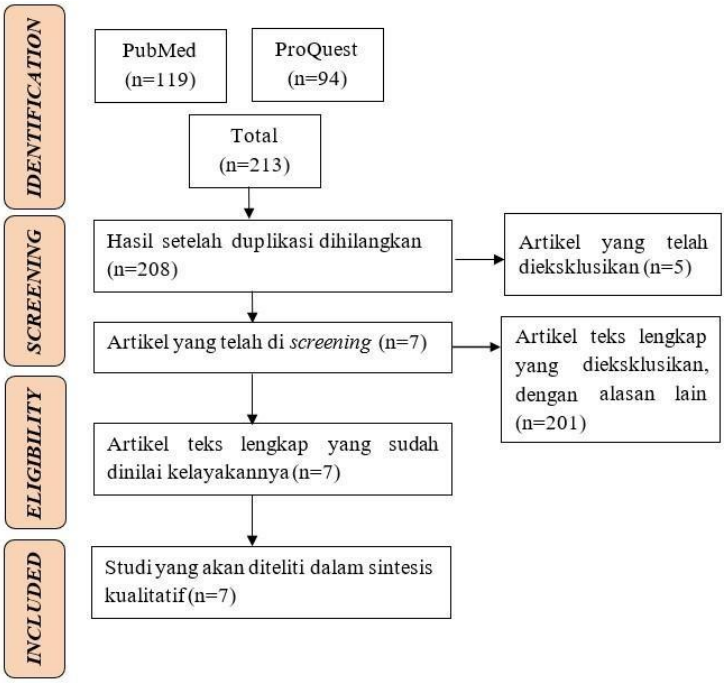

Figure2.Studyworkflowandfinding.

All articles were analyzed and data were extracted. The data needed include the incidence of biological, clinical,technical complication, and the conclusions from the study. Based on data analysis of 7 articles on the effectivenessofaddingantimicrobialmaterialstoacrylicandsiliconsoftdenturelinersonpreventingthegrowthofmicro organisms, 5 articles using silicon soft denture liners were obtained and 2 articles using acrylic soft dentureliners.

In the study of Chladek, et al., the use of silver nanoparticles on silicon soft denture liner with a concentration of200ppm, effectively prevented the growth of Candida Albicans by 16.3% - 52.5%. In the study of Perchyonok et al.,theuseofpropolisonsiliconsoftdenturelinerwithaconcentrationof10%waseffectiveinpreventingthegrowthof Candida Albicans. In the study of Chincholikar, et al., the use of fluconazole and soluneem on silicon soft dentureliner with a concentration of 10%, effectively prevented the growth of Candida Albicans. In the study of Baygar etal.,incorporationofcarvacrolintosiliconsoftdenturelinerwithaconcentrationof10ml,effectivelyreduced(98.03 ± 0.2%) the formation of Candida Albicans biofilm. According to Baygar et al., there was the same inhibition zonewhen using soft liner discs with carvarol, with the highest inhibition zones being Bacilus Subtilis (41.33 ± 1.53mm),Candida Albicans (34.00 ± 1.73mm), Streptococcus Sanguis (32.33 ± 0.58mm).), Streptococcus Mutans (28.67 ±1.15),EscherichiaColi(25.33±0.58),StaphylococcusAureus(24.67±1.53)andPseudomonasAeruginosa(16.67 ± 1.53). In the study of Pachava, et al., the use of tea tree oilon silicon softdenture liner with a concentration of15%effectivelypreventedthegrowthofCandidaAlbicans.[5-9]

In the study of Bueno, et al., the use of Nystatin material on acrylic soft denture liner with a concentration of0.016-0.128 g/ml was also proven to be effective in preventing the growth of Candida Albicans by 90%. In the studyof Yasser et al., the use of zirconium nanoparticles (ZrNPs) on acrylic soft denture liners with concentrations of 1%and1.5%was proventobeeffectiveinpreventingthegrowthofCandidaAlbicans.[10-11]

IV. Discussion

This systematic review aimed to identify published articles about the evaluation of effectiveness of addition ofantimicrobial agents to acrylic and silicone soft denture liner to prevent the growth of microorganisms. A total of 7articles were obtained after going through the identification process to quality assessment and were eligible to beanalyzed in this systematic review. Seven articles with RCT design were published in 2011-2020. In this study, therewere 5 antimicrobial ingredients in dosage form and 2 herbal ingredients to be used. The antimicrobial ingredients inthe dosage form used were silver nanoparticles with a concentration of 200ppm added to the silicon soft dentureliner, propolis with a concentration of 10% was added to the silicon soft denture liner, fluconazole and soluneemwith a concentration of 10% were added to the silicon soft denture liner, nystatin with a concentration of 0.016-0.128g/ml added to acrylic soft denture liner and zirconium nanoparticles with a concentration of 1.1.5% added toacrylicsoftdenture liner.The herbalingredientsusedasantimicrobialsinthisstudywerecarvacrolwithaconcentration of 10 ml was added to the silicon soft denture liner and tea tree oil with a concentration of 15% wasaddedtothesiliconsoftdentureliner. (Tabel2-3)

Inthisstudy,themostwidely usedtypeofsoftdenturelinerissiliconsoftdentureliner.Thistypeofsoftlineris widely used because it has several advantages, namely it has a short working time, has permanent soft propertiesbecause it does not depend on plasticizers, has a lower water absorption rate than auto-polymerized acrylic SDL, hasgood shock absorption properties so that pressure become lighter and more evenly distributed and

biocompatible.Plasticizedacrylicusuallyhasashorterservicetimebecauseitcanhardenandabsorbwater.Plasticizedac rylichasa similar composition to denture base polymers with a high percentage of plasticizers. Plasticizers keep thesematerials soft, but these properties can wear off over time. Acrylic soft denture liners can be used for up to 6 monthswhile silicon soft denture liners can be used for up to 1 year. Silicone material has better stability than acrylicmaterial. With acrylic the cushioning effect may wear off over time. Silicone material remains stable over timebecause it has water absorption properties and low component solubility. The type of microbial candida albicans wasfound in all articles. Candida albicans is a commensal in the oral cavity of 45-65% of healthy individuals with ahigher prevalence found in children and young adults. In denture wearers, the prevalence of Candida increases to 60-100% and can be opportunistic, which can be explained by the fact that dentures can decrease oxygen and salivaryflow to the underlying tissues resulting in a localized acidic and anaerobic microenvironment that favors fungalovergrowth. . In addition, Candida has an affinity for acrylic denture surfaces and non-renewing surfaces such asteeth and fillings. Candida albicans biofilm on mucosal surfaces and intaglio soft denture liner surfaces can causefailure of topical antifungal use with changes in Candida albicans resistance to antifungals. Candida albicans is anoral fungus found in 40% of humans, which facilitates the formation of plaque on dentures, whereas Candidaalbicans is generally isolated as a pathogenic agent. Adhesionof Candida albicans to denture base materials,especiallywhen usedcontinuouslyinconditions oftraumaandpoororalhygiene,willcausedenturestomatitis.[12-14]

Cleaningmaterialsusedaregenerallydividedintonaturalingredientsandartificialingredients.Naturalingredi ents are usually made from a mixture of plant oranimal extracts. WHO (WorldHealthOrganization)recommends the use of natural ingredients derivedfromanimals,plants and natural minerals.Many plants havebeen known and studied to have antimicrobial effects and are biocompatible with living things andcan be obtainedat relatively low prices. Based on the results of research in the last 5 years, herbal plants have shown quite effectiveresults against microbial growth in dentures. Herbal denture cleaners are also a powerful alternative but have few orno side effects. This is the reasonfor many countries to develop herbal denture cleaning materials that canbe usedbythepublicbecausetheyarebiologicallysafewitheffectiveantifungalandantimicrobialproperties.[15]

Table 2. The Results of Data Analysis on the Effectiveness of Addition of Antimicrobial Agents to Acrylic andSilicone Soft Denture Liner Materials on Prevention of Microorganism Growth Based on SDL Type, AntimicrobialMaterial,SDLPreparationFormandTypeofMicroorganisms

Penulis/Tahun	BahanSDL	Bentuk SediaanSDL	BahanAnti-mikroba	JenisMikroorganisme
Chladek, dkk.(2011)	*Silicon Softdentureliner*	UfiGelSC	*Silver NanoParcticle*	*CandidaAlbicans*
Perchyonok,dkk.(2017)	*Silicon Softdentureliner*	GC*RelineExtraSoft*	*Propolis*	*CandidaAlbicans*
Chincholikar, dkk.((2019)	*Silicon Softdentureliner*	UfiGelSC	*Fluconazole,Soluneem*	*CandidaAlbicans*
Baygar, dkk.(2018)	*Silicon Softdentureliner*	UfiGelSC	*Carvacrol*	*Candida Albicans,Bacilus Subtilis, EscherichiaColi,PseudomonasAeruginosa,StaphylococcusAureus, StreptococcusMutans,StreptococcusSanguis*
Pachava, dkk.(2015)	*Silicon Softdentureliner*	GC*RelineExtraSoft*	*Tea TreeOil*	*CandidaAlbicans*
Bueno, dkk.(2015)	*Acrylic Softdentureliner*	*TrusoftResilientDenture*	*Nystatin*	*CandidaAlbicans*
Yasser, dkk.(2017)	*Acrylic Softdentureliner*	Vertex*Soft*	*Zirconium NanoParticles*	*CandidaAlbicans*

Table 3. The Results of Data Analysis on the Effectiveness of Addition of Antimicrobial Agents to Acrylic andSilicone Soft Denture Liner Materials on Prevention of Microorganisms Growth Based on the Concentration ofAntimicrobialMaterialsandTheirEffectiveness AgainstMicroorganisms

Penulis/Tahun	KonsentrasiBahanAntimikroba	Efektivitas terhadapMikroba	Kesimpulan
Chladek, dkk.(2011)	200ppm	16,3% - 52,5%	Efektif
Perchyonok,dkk.(2017)	10%	(p<0,0,1)	Efektif
Chincholikar, dkk.(2019)	10%	*Fluconazole*(>0.05) *Soluneem*(0.04)	Efektif
Baygar, dkk.(2018)	10ml	*Bacillus Subtilis* (43.67±0.58 mm), *StreptococcusMutans* (40.33±0.58 mm), *Candida Albicans*(38.33±1.15mm),*Streptococcus Sanguis*(36.67±1.154), *Escherichia Coli* (29.33±1.15), *Staphylococcus Aureus* (26.67±1.53),*Pseudomonas Aeruginosa*(15.33±0.58)	Efektif
Pachava, dkk.(2015)	15%	(p<0.05)	Efektif
Bueno,dkk.(2015)	0.016-0.128g/ml	90%	Efektif
Yasser, dkk.(2017)	1%-1,5%	P-value(000)	Efektif

V. Conclusion

Based on this systematic study, it can be concluded that there are 5 articles that discuss the effectiveness ofadding antimicrobial ingredients such as Silver Nano Particles, Propolis, Fluconazole, Soluneem, Tea Tree Oil andCarvacrol to Silicon Soft Denture Liner to prevent the growth of microorganisms (71.43%) and 2 an article thatdiscusses the effectiveness of adding antimicrobial materials such as Nystatin and Zirconium Nano Particles intoAcrylic Soft Denture Liner to prevent the growth of microorganisms (28.57%). The 7 articles showed that theconcentration of antimicrobial ingredients added to the soft denture liner was different for each material used, but itwas proven effective in preventing the growth of candida albicans. The type of soft denture liner that is most widelyused is silicon soft denture liner. Silicon soft denture has advantages such as lower surface roughness, less waterabsorption, better tensile bond strength, lower surface hardness, and better color stability over a period of time thanacrylicsoftdentureliner.Thereare4articlesthatusepreparations(57.14%),and3articlesthatuseherbalingredients

(42.86%). Based on the results of research in the last 5 years, herbal plants have shown quite effectiveresultsinfightingmicrobialgrowthindentures.

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