

Literatur

Braunwarth H, Böttrich JG, Brill H, Dissemmond J, Münter K-C, Schümmelfeder F, Steinmann J, Wilken P: Antimikrobielle Wirkung von Silber-Wundverbänden gegen Pilze und Viren: Ergebnisse einer systematischen Literaturübersicht. *WUNDmanagement* 2020; 14(5):247-255.

1. **Aazam ES, Zaheer Z:** Growth of Ag-nanoparticles in an aqueous solution and their antimicrobial activities against Gram positive, Gram negative bacterial strains and *Candida* fungus. *Bioprocess Biosyst Eng.* 2016; 39(4): 575–584.
2. **Abad FX, Pintó RM, Diez JM, Bosch A:** Disinfection of human enteric viruses in water by copper and silver in combination with low levels of chlorine. *Appl Environ Microbiol.* 1994; 60(7): 2377–2383.
3. **Agarwal A, Pranami G, Nelson TB et al:** Microfilm wound contact dressing with metallic silver that conforms to wound-bed, prevents wound infection, and allows normal healing. *Wound Repair Regen* 2016; 24(2) (A1).
4. **Ahmed AA, Hamzah H, Maarooif M:** Analyzing formation of silver nanoparticles from the filamentous fungus *Fusarium oxysporum* and their antimicrobial activity. *Turk J Biol.* 2018; 42(1): 54–62.
5. **Akbarzadeh A, Kafshdooz L, Razban Z et al.:** An overview application of silver nanoparticles in inhibition of herpes simplex virus. *Artif Cells Nanomed Biotechnol.* 2018; 46(2): 263–267.
6. **Anasane N, Golińska P, Wypij M, Rathod D, Dahm H, Rai M:** Acidophilic actinobacteria synthesised silver nanoparticles showed remarkable activity against fungi-causing superficial mycoses in humans. *Mycoses* 2016; 59(3): 157-166
7. **Baram-Pinto D, Shukla S, Perkas N, Gedanken A, Sarid R:** Inhibition of herpes simplex virus type 1 infection by silver nanoparticles capped with mercaptoethane sulfonate. *Bioconjug Chem.* 2009; 20(8): 1497–1502.
8. **Borrego B, Lorenzo G, Mota-Morales JD et al.:** Potential application of silver nanoparticles to control the infectivity of Rift Valley fever virus in vitro and in vivo. *Nanomedicine.* 2016; 12(5): 1185–1192.
9. **Bowler PG, Duerden BI, Armstrong DG:** Wound microbiology and associated approaches to wound management. *Clin Microbiol Rev* 2001; 14(2): 244–269.
10. **Bradford C, Freeman R, Percival SL:** In vitro study of sustained antimicrobial activity of a new silver alginate dressing. *J Am Col Certif Wound Spec* 2009; 1: 117–120.
11. **Choi YM, Campbell K, Levek C, Recicar J, Moulton S:** Antibiotic ointment versus a silver-based dressing for children with extremity burns: A randomized controlled study. *J Pediatr Surg.* 2019; 54(7): 1391–1396.
12. **Costa M, Oliveira A, Scota S et al:** Buschke-lowenstein tumor resection and topical care. *Sex. Transm. Infect.* 2014; 41: Suppl. 1 (S5).
13. **Dakal TC, Kumar A, Majumdar RS, Yadav V:** Mechanistic Basis of Antimicrobial Actions of Silver Nanoparticles. *Front Microbiol.* 2016; 16(7):1831. eCollection 2016.
14. **Devi LS, Joshi SR:** Evaluation of the antimicrobial potency of silver nanoparticles biosynthesized by using an endophytic fungus, *Cryptosporiopsis ericae* PS4. *J Microbiol.* 2014; 52(8): 667–74.
15. **Dissemmond J, Böttrich JG, Braunwarth H, Hilt J, Wilken P, Münter K-C:** Evidenz von Silber in der Wundbehandlung - Metaanalyse der klinischen Studien von 2000-2015. *J Dtsch Dermatol Ges* 2017; 15(5): 524–536.
16. **Dissemmond J, Steinmann J, Münter K-C et al:** Risk and clinical impact of bacterial resistance/ susceptibility to silver-based wound dressings: a systematic review. *J Wound Care* 2020; 29(4): 221–234.
17. **Dowd SE, Delton Hanson J, Rees E et al:** Survey of fungi and yeast in polymicrobial infections in chronic wounds. *J Wound Care* 2011; 20(1): 40–7.
18. **Dowsett C:** The use of silver-based dressings in wound care. *Nurs Stand.* 2004; 19(7): 56–60.
19. **Elbeshehy EK, Elazzazy AM, Aggelis G:** Silver nanoparticles synthesis mediated by new isolates of *Bacillus* spp., nanoparticle characterization and their activity against Bean Yellow Mosaic Virus and human pathogens. *Front Microbiol.* 2015; 6: 453.
20. **European Wound Management Association (EWMA) Position Document:** Hard-to-heal-wounds: a holistic approach. London MEP Ltd, 2008.
21. **Fernandez-Flores A, Saeb-Lima M, Arenas-Guzman R:** Morphological findings of deep cutaneous fungal infections. *American Journal of Dermatopathology* 2014; 36(7): 531–556.
22. **Gaikwad S, Ingle A, Gade A et al:** Antiviral activity of mycosynthesized silver nanoparticles against herpes simplex virus and human parainfluenza virus type 3. *Int J Nanomedicine.* 2013; 8: 4303–14.
23. **Gajbhiye M, Kesharwani J, Ingle A, Gade A, Rai M:** Fungus-mediated synthesis of silver nanoparticles and their activity against pathogenic fungi in combination with fluconazole. *Nanomedicine.* 2009; 5(4): 382–6.
24. **Gherman AMR, Dina NE, Chiş V, Wieser A, Haisch C:** Yeast cell wall - Silver nanoparticles interaction: A synergistic approach between surface-enhanced Raman scattering and computational spectroscopy tools. *Spectrochim Acta A Mol Biomol Spectrosc.* 2019; 222: 117–223.
25. **Gottrup F, Apelqvist J, Bjansholt T et al.:** EWMA Document: Antimicrobials and Non-healing Wounds-Evidence, Controversies and Suggestions. *J Wound Care* 2013; 22 (5 Suppl.): S1–S92.
26. **Govindarajan M, Vijayan P, Kadaikunnan S, Alharbi NS, Benelli G:** One-pot biogenic fabrication of silver nanocrystals using *Quisqualis indica*: Effectiveness on malaria and Zika virus mosquito vectors, and impact on non-target aquatic organisms. *J Photochem Photobiol B.* 2016; 162: 646–655.
27. **Govindarajan M, Kadaikunnan S, Alharbi NS, Benelli G:** Single-step biological fabrication of colloidal silver nanoparticles using *Hugonia mystax*: larvicidal potential against Zika virus, dengue, and malaria vector mosquitoes. *Artif Cells Nanomed Biotechnol.* 2017; 45(7): 1317–1325.
28. **Gupta A, Bonde SR, Gaikwad S, Ingle A, Gade AK, Rai M:** Lawsonia inermis-mediated synthesis of silver nanoparticles: activity against human pathogenic fungi and bacteria with special reference to formulation of an antimicrobial nanogel. *IET Nanobiotechnol.* 2014; 8(3): 172–8.
29. **Hipler U, Wiegand C:** Silver-containing crèmes inhibit the growth of *Candida albicans* and *Malassezia* spp. *Exp. Dermatol.* 2010; 19(2): 218.
30. **Hodek J, Zajícová V, Lovětinská-Šlamborová I, Stibor I, Müllerová J, Weber J:** Protective hybrid coating containing silver, copper and zinc cations effective against human immunodeficiency virus and other enveloped viruses. *BMC Microbiol.* 2016; 16 (Suppl 1): 56.
31. **Hu RL, Li SR, Kong FJ, Hou RJ, Guan XL, Guo F:** Inhibition effect of silver nanoparticles on herpes simplex virus 2. *Genet Mol Res.* 2014; 13(3): 7022-8

32. **Hooks KB, O'Malley MA:** Contrasting Strategies: Human Eukaryotic Versus Bacterial Microbiome Research. *Journal of Eukaryotic Microbiology* 2019; 67: 279–295.
33. **Hooper SJ, Williams D, Percival SL:** Antimicrobial efficacy of a silver-containing alginate wound dressing. *Wound Repair Regen* 2011; 19:2 (A26).
34. **Ishida K, Cipriano TF, Rocha GM, et al.:** Silver nanoparticle production by the fungus *Fusarium oxysporum*: nanoparticle characterisation and analysis of antifungal activity against pathogenic yeasts. *Mem Inst Oswaldo Cruz* 2014; 109(2): 220–228.
35. **Ivanova VT, Ivanova MV, Sapurina IY et al.:** Comparative study of carbon nanotubes and polymer composites with silver as sorbents of the influenza A and B viruses. *Vopr Virusol.* 2015; 60(3): 25–30.
36. **Jalal M, Ansari MA, Alzohairy MA et al.:** Biosynthesis of Silver Nanoparticles from Oropharyngeal *Candida glabrata* Isolates and their antimicrobial activity against clinical strains of bacteria and fungi. *Nanomaterials (Basel).* 2018; 8(8).
37. **Jung WK, Koo HC, Kim KW, Shin S, Kim SH, Park YH:** Antibacterial Activity and Mechanism of Action of the Silver Ion in *Staphylococcus aureus* and *Escherichia coli*. *Applied and Environmental Microbiology* 2008; 75(7): 2171–2178
38. **Kalan L, Loesche M, Hodgkinson BP et al.:** Redefining the chronic-wound microbiome: fungal communities are prevalent, dynamic, and associated with delayed healing. *mBio* 2016; 7(5): e01058–16.
39. **Kalan L, Grice EA:** Fungi in the wound microbiome. *Adv Wound Care (New Rochelle)* 2018; 7(7): 247-55
40. **Kampf G:** Antiseptic stewardship Biocide Resistance and Clinical Implications. Springer Verlag; 2018; ISBN 978-3-319-98784-2 ISBN 978-3-319-98785-9 (eBook).
41. **Karinja SJ, Spector JA:** Treatment of infected wounds in the age of antimicrobial resistance: Contemporary alternative therapeutic options. *Plast Reconstr Surg* 2018; 142(4): 1082–1092.
42. **Karnik T, Jerram M, Nagarajan A et al.:** Antimicrobial functionalization of ovine forestomach matrix with ionic silver. *Wound Repair Regen* 2018; 26: 5 (A1).
43. **Karnik T, Jerram M, Nagarajan A:** Ionic silver functionalized ovine forestomach matrix - a non-cytotoxic antimicrobial biomaterial for tissue regeneration applications. *Biomater Res* 2019; 23: 6.
44. **Kierans M, Staines AM, Bennett H, Gadd GM:** Silver tolerance and accumulation in yeasts. *Biol Met.* 1991; 4(2):100–6.
45. **Kumar D Banerjee T, Chakravarty J, Singh SK, Dwivedi A, Tilak R:** Identification, antifungal resistance profile, in vitro biofilm formation and ultrastructural characteristics of *Candida* species isolated from diabetic foot patients in Northern India. *Indian J Med Microbiol.* 2016; 34(3): 308–14.
46. **Li G, He D, Qian Y et al.:** Fungus-mediated green synthesis of silver nanoparticles using *Aspergillus terreus*. *Int J Mol Sci.* 2012; 13(1): 466–76.
47. **Li Y, Lin Z, Zhao M et al.:** Silver Nanoparticle Based Codelivery of Oseltamivir to Inhibit the Activity of the H1N1 Influenza Virus through ROS-Mediated Signaling Pathways. *ACS Appl Mater Interf.* 2016; 8(37): 24385–93.
48. **Luchsinger BP, Meyer TR, Kelsey M:** In vitro evaluation of viable microorganisms on the surface of a luer access device treated with two antimicrobial agents. *Am J Infect Control* 2009; 37(5): E47.
49. **Lv X, Wang P, Bai R et al.:** Inhibitory effect of silver nanomaterials on transmissible virus-induced host cell infections. *Biomaterials.* 2014 Apr; 35(13): 4195–203.
50. **Maghima M, Alharbi AS:** Green synthesis of silver nanoparticles from *Curcuma longa* L and coating on the cotton fabrics for antimicrobial applications and wound healing activity. *J Photochem Photobiol B* 2020; 204: 111806.
51. **Mahadik K, Yadav P, Bhatt B, Shah RA, Balaji KN:** Deregulated AUF1 Assists BMP-EZH2-mediated delayed wound healing during *Candida albicans* Infection. *J Immunol.* 2018; 201(12): 3617–3629.
52. **Mahnel H, Schmidt M:** Effect of silver compounds on viruses in water. *Zentralbl Bakteriol Mikrobiol Hyg B.* 1986; 182(4): 381–92.
53. **Martin C:** Recent Developments in Wound Management: Intelligent biomaterials to novel antimicrobials 24 september 2009, London, UK. *IDrugs* 2009; 12(11): 695–698.
54. **Minoshima M, Lu Y, Kimura T et al.:** Comparison of the antiviral effect of solid-state copper and silver compounds. *J Hazard Mater.* 2016; 312: 1–7.
55. **Moher D, Liberati A, Tetzlaff J, Altman DG:** The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *PLoS Med* 2009; 6 (6): e100009.
56. **Montes LF, Muchinik G, Fox CL Jr:** Response of varicella zoster virus and herpes zoster to silver sulfadiazine. *Cutis.* 1986; 38(6): 363–365
57. **Mori Y, Ono T, Miyahira Y, Nguyen VQ, Matsui T, Ishihara M:** Antiviral activity of silver nanoparticle/chitosan composites against H1N1 influenza A virus. *Nanoscale Res Lett.* 2013; 8(1): 93.
58. **Musarrat J, Dwivedi S, Singh BR et al.:** Production of antimicrobial silver nanoparticles in water extracts of the fungus *Amylomyces rouxii* strain KSU-09. *Bioresour Technol.* 2010; 101(22): 8772–6.
59. **Oka H, Tomioka T, Tomita K, Nishino A, Ueda S:** Inactivation of enveloped viruses by a silver-thiosulfate complex. *Met Based Drugs.* 1994; 1(5-6): 511.
60. **Orlowski P, Tomaszewska E, Gniadek M et al.:** Tannic acid modified silver nanoparticles show antiviral activity in herpes simplex virus type 2 infection. *PLoS One.* 2014; 9(8): e104113.
61. **Ouf SA, El-Adly AA, Mohamed AH:** Inhibitory effect of silver nanoparticles mediated by atmospheric pressure air cold plasma jet against dermatophyte fungi. *J Med Microbiol.* 2015; 64(10): 1151–1161.
62. **Panáček A, Kolár M, Vecerová R et al.:** Antifungal activity of silver nanoparticles against *Candida* spp. *Biomaterials* 2009; 30: 6333–6340.
63. **Pandian SRK, Deepak V, Kalishwaral K, Viswanathan P, Gurunathan S:** Mechanism of Bactericidal Activity of Silver Nitrate - A concentration dependent bifunctional molecule. *Braz J Microbiol* 2010; 41: 805–809.
64. **Park S, Ko YS, Lee SJ, Lee C, Woo K, Ko G:** Inactivation of influenza A virus via exposure to silver nanoparticle-decorated silica hybrid composites. *Environ Sci Pollut Res Int.* 2018; 25(27): 27021–27030.
65. **Partlow J, Blikslager A, Matthwes C et al.:** Effect of topically applied *Saccharomyces boulardii* on the healing of acute porcine wounds: a preliminary study. *BMC Res Notes* 2016; 9 (210). <https://doi.org/10.1186/s13104-016-2012-8>.
66. **Percival SL, McCarty SM:** Silver and Alginates: Role in Wound Healing and Biofilm Control. *Adv Wound Care (New Rochelle).* 2015; 4(7): 407–414.
67. **Percival SL, Finnegan S, Donelli G, Vuotto C, Rimmer S, Lipsky BA:** Antiseptics for treating infected wounds: Efficacy on biofilms and effect of pH. *Crit Rev Microbiol.* 2016; 42(2): 293–309.
68. **Priyadarshni KC, Mahalingam PU:** Antimicrobial and anticancer activity of silver nanoparticles from edible mushroom: A review. *Asian J Pharm Clin Res* 2017; 10(3): 37–40.
69. **Pulit J, Banach M, Szczygłowska R, Bryk M:** Nanosilver against fungi. Silver nanoparticles as an effective biocidal factor. *Acta Biochim Pol.* 2013; 60(4): 795–8.
70. **Qian Y, Yu H, He D et al.:** Biosynthesis of silver nanoparticles by the endophytic fungus *Epicoccum nigrum* and their activity against pathogenic fungi. *Bioprocess Biosyst Eng.* 2013; 36(11): 1613–9.
71. **Rahisuddin Al-Thabaiti SA, Khan Z, Manzoor N:** Biosynthesis of silver nanoparticles and its antibacterial and antifungal activities towards Gram-positive, Gram-negative bacterial strains and different species of *Candida fungus*. *Bioprocess Biosyst Eng.* 2015; 38(9): 1773–81.

72. **Raho R, Nguyen NY, Zhang N et al.:** Photo-assisted green synthesis of silver doped silk fibroin/carboxymethyl cellulose nanocomposite hydrogels for biomedical applications. *Materials science & engineering. C, Materials for biological applications* 2020; 107 (110219). Date of Publication: 1 Feb 2020.
73. **Rodrigues AG, Ping LY, Marcato PD, et al.:** Biogenic antimicrobial silver nanoparticles produced by fungi. *Appl Microbiol Biotechnol.* 2013; 97(2): 775–782.
74. **Rónavári A, Igaz N, Gopisetty MK, et al.:** Biosynthesized silver and gold nanoparticles are potent antimycotics against opportunistic pathogenic yeasts and dermatophytes. *Int J Nanomedicine.* 2018; 13: 695–703.
75. **Schwarzkopf A:** Systematik der Infektionsbekämpfung in Dissemond J, Kröger K (Hrsg.) *Chronische Wunden. Diagnostik – Therapie – Versorgung.* 1. Aufl. 2020; Elsevier GmbH; ISBN 978-3-437-25641-7; 195–201.
76. **Sharma V, Kaushik S, Pandit P, Dhull D, Yadav JP, Kaushik S:** Green synthesis of silver nanoparticles from medicinal plants and evaluation of their antiviral potential against chikungunya virus. *Appl Microbiol Biotechnol.* 2019;103(2): 881–891.
77. **Shimizu F, Shimizu Y, Kumagai K et al.:** Specific inactivation of herpes simplex virus by silver nitrate at low concentrations and biological activities of the inactivated virus. *Antimicrob Agents Chemother.* 1976; 10(1): 57–63.
78. **Singh R, Kumar D, Kumar P, Chacharkar MP:** Development and evaluation of silver-impregnated amniotic membrane as an antimicrobial burn dressing. *J Burn Care Res* 2008; 29 (1): 64–72.
79. **Spagnoletti FN, Spedaliere C, Kronberg F, Giacometti R:** Extracellular biosynthesis of bactericidal Ag/AgCl nanoparticles for crop protection using the fungus *Macrophomina phaseolina*. *J Environ Manage.* 2019; 231: 457–466.
80. **Speshock JL, Murdock RC, Braydich-Stolle LK, Schrand AM, Hussain SM:** Interaction of silver nanoparticles with Tacaribe virus. *J Nanobiotechnology.* 2010 ; 8: 19.
81. **Spivak ES, Hanson KE:** *Candida auris*: an emerging fungal pathogen. *J Clin Microbiol* 2018; 56: e01588–17.
82. **Stefic K, Bouvin-Pley M, Essat A, et al.:** Sensitivity to Broadly Neutralizing Antibodies of Recently Transmitted HIV-1 Clade CRF02_AG Viruses with a Focus on Evolution over Time. *J Virol.* 2019; 93(2): e01492–18.
83. **Sujitha V, Murugan K, Paulpandi M et al.:** Green-synthesized silver nanoparticles as a novel control tool against dengue virus (DEN-2) and its primary vector *Aedes aegypti*. *Parasitol Res.* 2015; 114(9): 3315–25.
84. **Thati B, Noble A, Rowan R, et al:** Mechanism of action of coumarin and silver(I)-coumarin complexes against the pathogenic yeast *Candida albicans*. *Toxicol In Vitro.* 2007; 21(5): 801–8.
85. **Thiruchelvi R, Das A:** Modus operandi for rehabilitating aids with tetrasilver tetroxide molecular crystal devices. *Res J Pharm Technol* 2019; 12(3): 1418–1424.
86. **Thomas S, McCubbin P:** A comparison of the antimicrobial effects of four silver-containing dressings on three organisms. *J Wound Care* 2003; 12(3):101–107.
87. **Townsend EM, Sherry L, Kean R et al:** Implications of Antimicrobial Combinations in Complex Wound Biofilms Containing Fungi. *Antimicrob Agents Chemother.* 2017; 61(9): e00672–17.
88. **Toy LW, Macera L:** Evidence-based review of silver dressing use on chronic wounds. *J Am Acad Nurse Pract* 2011; 23(4): 183–92.
89. **Trefry JC, Wooley DP:** Silver nanoparticles inhibit vaccinia virus infection by preventing viral entry through a macropinocytosis-dependent mechanism. *J Biomed Nanotechnol.* 2013; 9(9): 1624–35.
90. **Verma VC, Kharwar RN, Gange AC:** Biosynthesis of antimicrobial silver nanoparticles by the endophytic fungus *Aspergillus clavatus*. *Nanomedicine (Lond).* 2010; 5(1): 33–40.
91. **Wiegand C, Zieger M, Ulbricht H, Horchler H, Hipler UC:** In vitro evaluation of antimicrobial activity and cell compatibility of the bioactive wound dressings balance® and bioactive®. *Mycoses* (2012) 55 (Suppl. 4): 122.
92. **Wong VW, Martindale RG, Longaker MT, Gurtner GC:** From germ theory to germ therapy: skin microbiota, chronic wounds, and probiotics. *Plast Reconstr Surg.* 2013; 132(5): 854e-861e
93. **Wright JB, Lam K, Hansen D, Burrell RE:** Efficacy of topical silver against fungal burn wound pathogens. *Am J Infect Control* 1999; 27(4): 344–350.
94. **Wypij M, Czarnecka J, Dahm H, Rai M, Golinska P:** Silver nanoparticles from *Pilimelia columellifera* subsp. *pallida* SL19 strain demonstrated antifungal activity against fungi causing superficial mycoses. *J Basic Microbiol.* 2017; 57(9):793–800.
95. **Xiang DX, Chen Q, Pang L, Zheng CL:** Inhibitory effects of silver nanoparticles on H1N1 influenza A virus in vitro. *J Virol Methods.* 2011; 178(1-2): 137–42.
96. **Xiang D, Zheng Y, Duan W et al.:** Inhibition of A/Human/Hubei/3/2005 (H3N2) influenza virus infection by silver nanoparticles in vitro and in vivo. *Int J Nanomedicine.* 2013; 8: 4103–13.
97. **Yan X, Li F, Hu KD et al.:** Nacre-mimic Reinforced Ag-reduced Graphene Oxide-Sodium Alginate Composite Film for Wound Healing. *Sci Rep* 2017; 7(1) 13851.
98. **Yang XX, Li CM, Huang CZ:** Curcumin modified silver nanoparticles for highly efficient inhibition of respiratory syncytial virus infection. *Nanoscale.* 2016; 8(5): 3040–8.