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RESEARCH

The effect of vinegar on the *Sarcoptes scabiei* parasite: in vitro killing activity

Sarcoptes scabiei paraziti üzerine sirkenin etkisi: in vitro öldürücü aktivitesi

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Abstract

Purpose: The aim of this study was to evaluate the in vitro scabicidal activity of vinegar at concentrations of 100%, 50%, and 25%, and to compare its efficacy with 5% permethrin to determine its potential as an alternative therapeutic option

Materials and Methods: A total of 50 intact and motile *Sarcoptes scabiei* mites were included. The mites were extracted from patients' burrows under dermoscopic guidance using a 22G needle, and only intact, actively moving specimens were selected. Five groups were tested: Group I (100% vinegar), Group II (50% vinegar), Group III (25% vinegar), Group IV (5% permethrin; positive control), and Group V (oil immersion; negative control). Survival time was defined as the interval from exposure to the test solution until the complete cessation of mite movement, and this was monitored in real time using a digital microscope. Ten mites were evaluated in each group.

Results: In Group I (100% vinegar; 0.6 ± 0.1 min), Group II (50% vinegar; 11.8 ± 1.4 min), and Group IV (5% permethrin; 336 ± 37.2 min), complete mortality of *Sarcoptes scabiei* was achieved within the first eight hours of exposure. In contrast, mites in Group III (25% vinegar; 1782 ± 87.9 min) and Group V (oil immersion; 1836 ± 82.3 min) remained viable at the 8-hour evaluation. Both undiluted and 50% vinegar exhibited markedly greater scabicidal activity compared with the other groups.

Conclusion: Although undiluted vinegar carries a risk of irritant contact dermatitis, 50% diluted grape vinegar retains substantial scabicidal efficacy. It exhibited a significantly greater killing effect compared with 5% permethrin while simultaneously reducing the risk of skin irritation, thereby representing a potentially safer alternative.

Keywords:. Scabies, Sarcoptes scabiei, vinegar, irritant dermatitis, in vitro

Öz

Amaç: Bu çalışmanın amacı, %100, %50 ve %25 konsantrasyonlarındaki sirkenin *Sarcoptes scabiei*'ye karşı in vitro skabisidal etkilerini araştırmak ve etkinliğini %5 permetrin ile karşılaştırarak alternatif bir tedavi seçeneği olma potansiyelini değerlendirmektir.

Gereç ve Yöntem: Toplam 50 sağlam ve hareketli *Sarcoptes scabiei* akarı çalışmaya dahil edildi. Akarlar, dermoskopi eşliğinde 22G iğne kullanılarak hastaların tünellerinden çıkarıldı ve yalnızca bütünlüğü bozulmamış ve aktif hareket eden bireyler seçildi. Beş grup değerlendirildi: Grup I (%100 sirke), Grup II (%50 sirke), Grup III (%25 sirke), Grup IV (%5 permetrin; pozitif kontrol) ve Grup V (yağ immersiyonu; negatif kontrol). Yaşam süresi, akarın çözeltiye maruz kalma anından hareketinin tamamen durmasına kadar geçen süre olarak tanımlandı ve bu süreç dijital mikroskopla gerçek zamanlı olarak izlendi. Her grupta 10 akar incelendi.

Bulgular: Grup I'de (%100 sirke; 0,6 ± 0,1 dk), Grup II'de (%50 sirke; 11,8 ± 1,4 dk) ve Grup IV'te (%5 permetrin; 336 ± 37,2 dk) maruziyetten sonraki ilk sekiz saat içinde tüm Sarcoptes scabiei akarlarının ölümü gerçekleşti. Buna karşılık, Grup III'te (%25 sirke; 1782 ± 87,9 dk) ve Grup V'te (yağ immersiyonu; 1836 ± 82,3 dk) akarlar sekizinci saatte canlılığını korudu. Hem seyretilmemiş hem de %50 oranında seyreltilmiş sirke, diğer gruplara kıyasla belirgin derecede daha yüksek skabisidal aktivite gösterdi.

Sonuç: Seyretilmemiş sirke irritan kontakt dermatit riski taşımaktadır. Bununla birlikte, %50 oranında seyreltilmiş üzüm sirkesi belirgin skabisidal etkinliğini korumakta, %5 permetrinden anlamlı derecede yüksek öldürücü etki göstermekte ve aynı zamanda cilt iritasyonu riskini azaltarak daha güvenli bir alternatif oluşturma potansiyeli taşımaktadır.

Anahtar kelimeler: Uyuz, Sarcoptes scabiei, sirke, irritan dermatit, in vitro

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INTRODUCTION

Recent publications highlight the global increase in scabies cases[1,2]. Additionally, treatment failure has emerged as a significant concern, leading to a rise in chronic scabies sufferers and posing a considerable public health issue. Consequently, both clinicians and patients are actively seeking alternative or complementary treatment options[2-4].

Through online forums dedicated to scabies and direct patient interactions, we have observed that the self-treatment practice of using vinegar is common, particularly among individuals whose conditions do not improve with established medical treatments. In addition to these anecdotal observations, peer-reviewed studies have also reported the antimicrobial and antiparasitic properties of vinegar and acetic acid[5-7]. However, the use of vinegar can lead to contact dermatitis, exacerbating skin symptoms and increasing itchiness in affected individuals. Although vinegar has been used as an antiseptic for many years, there is no consensus regarding its application in dermatology, particularly as a scabicidal agent. Our literature review revealed no information on the use of vinegar for scabies treatment. We therefore designed this study to: (1) prevent the unnecessary use of vinegar and its side effects if it has no scabicidal effect, or (2) if its effectiveness can be validated, to standardize this traditional treatment method, which is readily accessible to patients, by determining the concentrations at which it is most effective.

The use of vinegar in the treatment of various dermatological conditions and wound care dates back to the Hippocratic era. For centuries, it has been widely employed both as a preservative and as a seasoning. Moreover, vinegar has been shown to possess antioxidant and antimicrobial properties, which may provide benefits for individuals with cancer, hypertension, diabetes, and skin disorders[8].

The primary active component of vinegar is acetic acid (AA), which is considered safe for human use. Regulations generally mandate a minimum acidity of 4–5%. In Turkey, commercially available vinegars typically contain 4–7% AA. In this study, we used grape vinegar that fell within this acidity range[8].

Several studies have investigated the antimicrobial properties of various vinegar types, including mulberry, grape, apple, pomegranate, and rice vinegar, as well as traditionally produced commercial vinegars. These studies indicate that vinegar's antimicrobial efficacy varies depending on its type, production method, and concentration, and that different vinegar varieties exhibit activity against both gram-positive and gram-negative microorganisms[9].

Although the antimicrobial, antifungal, and antiparasitic properties of vinegar are well documented, its scabicidal effect has not previously been investigated in a scientific study. This gap in the literature underscores the novelty of our work. Based on this background, we hypothesized that vinegar at different dilutions (100%, 50%, and 25%) would exhibit measurable in vitro scabicidal activity against *Sarcoptes scabiei* compared with 5% permethrin.

Therefore, the aim of this study was to evaluate the in vitro scabicidal efficacy of vinegar at different concentrations and to compare it with permethrin, with the goal of determining whether vinegar may serve as a standardized and accessible alternative treatment option for scabies.

MATERIALS AND METHODS

The study was conducted at the Department of Dermatology, Kuşadası State Hospital. All procedures were performed in accordance with institutional protocols and ethical standards, ensuring the reliability and confidentiality of patient records. Sampling and experimental procedures were conducted by dermatology physicians.

Materials

Our study used vinegar with an acidity level ranging from 4% to 7%, which is commonly available on the market. To ensure consistency and minimize variability, the same commercial brand and batch of grape vinegar were used for all experiments. Five experimental groups were established. Group 1 was treated with undiluted vinegar, while Groups 2 and 3 received vinegar diluted to 50% and 25% with normal tap water, respectively. Based on the acetic acid content of commercial vinegar (4–7%), we predefined 50% (~2–3.5% AA) to reflect a commonly used 1:1 household dilution and 25% (~1–1.75% AA) to test a lower, potentially less irritant concentration.[10] These formulations were intended to replicate the typical home-use conditions of our patients. The positive control group (Group 4)

was exposed to 5% permethrin, whereas the negative control group (Group 5) was subjected only to oil immersion. The movements of the mites were observed using a digital microscope.

Sample

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Non-Interventional Clinical Research Ethics Committee of Istanbul Medipol University (decision no. 71, dated 03/02/2022). The authors recruited the remaining diagnostic samples from scabies patients for the trial. Between March 2022 and June 2022, patients who presented to our dermatology outpatient clinic with complaints of itching, were diagnosed with scabies by dermoscopic detection of characteristic burrows, and consented to participate in the study were included. Patients with systemic or dermatological comorbidities (e.g., immunodeficiency, severe eczema, or other concurrent skin infections) were excluded to minimize possible confounding factors. From consenting scabies patients, diagnostic samples were collected by carefully extracting the parasites from burrows with a 22G needle under dermoscopic guidance. In total, more than 200 samples were obtained. Only intact and motile mites were included, while fragmented or immobile ones were excluded. Finally, 50 live mites were selected, enabling ten experimental repetitions for each of the five study groups.

Procedure

Only parasites that remained intact during sampling (meaning they were neither fragmented nor exhibited impaired mobility) were considered for the study. Parasites that were immobile, showed reduced movement, were fragmented, infested with other mites, or accompanied by extraneous material were excluded. The study included only fully active mites and samples that were free from any substances (e.g., skin appendages) that could potentially interfere with the application of the agent.

Samples were taken by extraction method in order not to damage the parasite[11]. Dermoscopy was used to locate the parasite, which was then carefully extracted from the tunnel using a 22G needle. Instead of scraping the tunnel all the way through, the parasite was targeted directly by this method. The efficiency of retrieving live parasites from samples collected through the curettage method was comparatively low. Therefore, the extraction method was employed. The black reflection produced by the parasite at the tunnel's endpoint was detected with the naked eye. The overlying skin was carefully lifted with a 22G needle without causing bleeding. The lack of bleeding is essential for accurately detecting the parasite. This method, intended to exclusively capture the parasite, minimized the accumulation of extraneous materials like skin fragments, blood, and other substances that might impact the study.

The samples were examined using a digital microscope with a magnification of up to 1600x (Bresser, LCD digital microscope). To minimize external influences and preserve the parasite as much as possible, no coverslip was used during the microscopic examination. A digital microscope was used for real-time monitoring of the parasite's movements. Survival time (ST) was defined as the duration from the mite's initial exposure to the study solution until all movement ceased. Throughout the experiments, no interventions were performed on the mites. The average ST was analyzed across various solutions to evaluate their in vitro killing effectiveness. Utilizing a digital microscope enabled uninterrupted monitoring and recording of every stage of the intervention. Since monitoring the parasite's movements for two days was required, conducting this study with a standard microscope would have been highly inconvenient for the researchers.

Statistical analysis

The research data were analyzed using SPSS (Statistical Package for the Social Sciences for Windows, version 30.0; SPSS Inc., Chicago, IL). Descriptive statistics were presented as mean (±) standard deviation. The normality of the data distribution was assessed using the Shapiro–Wilk test.

The primary variable analyzed was the mean survival time (minutes) of mites in each treatment group. The normality of the survival time data within groups was assessed using the Shapiro–Wilk test. For intergroup comparisons, Group 1 (100% vinegar) versus Group 4 (5% permethrin) was analyzed using the Mann–Whitney U test due to non-normal distribution. Comparisons between Group 2 (50% vinegar) and Group 3 (25% vinegar), Group 2 (50% vinegar) and Group 4 (5% permethrin), and Group 3 (25% vinegar) and Group 4 (5% permethrin) were performed using the Independent Samples t-test

(Student's t-test). A p-value <0.05 was considered statistically significant.

RESULTS

With the exception of Group 3 (25% vinegar) and Group 5 (oil immersion), complete mortality of *Sarcoptes scabiei* was achieved within the first eight hours of exposure. The mean (± SD) survival times for Groups 5, 4, 3, 2, and 1 were 1836 ± 82.3 minutes, 336 ± 37.2 minutes, 1782 ± 87.9 minutes, 11.8 ± 1.4 minutes, and 0.6 ± 0.1 minutes, respectively (Figure-1). The killing effect of undiluted vinegar (Group 1) was significantly higher than that of 5% permethrin (Group 4) (p <0.001). Similarly, 50% vinegar (Group 2) demonstrated a significantly higher killing effect compared with both 5% permethrin (Group 4) and 25% vinegar (Group 3) (both p <0.001). The killing effect observed with 25% vinegar (Group 3) did not differ significantly from that of 5% permethrin (Group 4), although the difference approached statistical significance (p = 0.051) (Table-1).

In Group 1, six out of ten mites exhibited immediate mortality upon contact with vinegar, whereas the remaining four showed markedly reduced motility until death. In contrast, 25% vinegar (Group 3) failed to exert any observable killing effect.

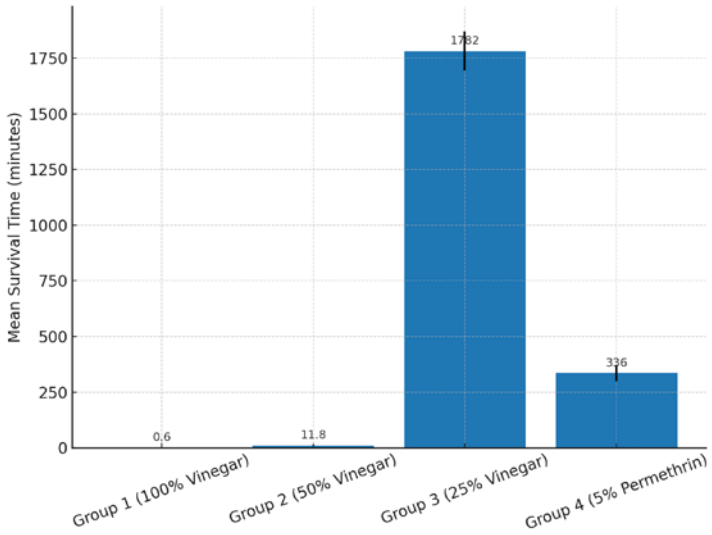

Figure 1. Bar chart illustrating the mean survival times (minutes) of *Sarcoptes scabiei* in different treatment groups, with 95% confidence intervals.

Table 1. Comparison of mean survival times (minutes) of Sarcoptes scabiei in treatment groups

Comparison	Mean Survival Time (minutes)	*p*	*95% Confidence Interval*	
			Lower	*Upper*
Group 1 (100% Vinegar)-Group 4 (5% Permethrin)	0.6 ± 0.1 - 336 ± 37.2	< 0.001[a]	-359	-309
Group 2 (50% Vinegar)-Group 4 (5% Permethrin)	11.8 ± 1.4 - 336 ± 37.2	< 0.001[b]	-348.91	-299.48
Group 2 (50% Vinegar)-Group 3 (25% Vinegar)	11.8 ± 1.4 - 1782 ± 87.9	< 0.001[b]	-1828.61	-1711.78
Group 3 (25% Vinegar)-Group 4 (5% Permethrin)	1782 ± 87.9 - 336 ± 37.2	0.051[b]	-360.10	-310.69

p: statisitcal singificance, a: Mann-Whitney U test, b: İndependent sample t tests.

DISCUSSION

Recently, the effectiveness of permethrin, a first-line treatment for scabies, has been called into question, prompting clinicians to explore alternative treatment options[1,12]. A study conducted in Australia revealed a decline in the sensitivity of scabies patients to permethrin, underscoring the need to investigate new therapeutic regimens[3]. The search for alternative treatments is not limited to healthcare professionals; patients often turn to traditional methods and explore new solutions to alleviate their condition. One of the most commonly used traditional remedies is vinegar. However, its unregulated use may result in additional dermatological problems, particularly contact dermatitis. At present, there is no standardization for the application of vinegar. Although its antimicrobial properties are recognized, there is no clinical consensus on its role in the treatment of scabies. In our study, using previously defined standardized methods, we found that vinegar containing 4–7% AA exhibits a strong scabicidal effect when diluted to 50% (2–3.5% AA), whereas this effect was absent at a 25% dilution (1–1.75% AA). Furthermore, the killing effect of 50% vinegar was significantly greater than that of 5% permethrin ($p < 0.001$), indicating its potential as a more effective alternative under in vitro conditions[12,13].

Since ancient times, vinegar has been utilized as an antiseptic agent for healing wounds and combating infections. Often referred to as "sour beer" in Mesopotamia, "hequa" in Egypt, and "acetum" in Rome, vinegar is produced through the oxidation of fermentable sugars by yeasts to create ethanol, which is subsequently oxidized to acetic acid by acetic acid bacteria. The bioactive components in vinegar exhibit a range of beneficial effects, including antioxidative, antidiabetic, antimicrobial, antitumor, antiobesity, antihypertensive, and cholesterol-lowering properties. The antimicrobial effect of vinegar is primarily attributed to its AA content. Research indicates that the polyphenol compounds present in vinegar, such as ferulic acid and sinapic acid, contribute to its antimicrobial properties. These polyphenols interact with peptidoglycan and the phospholipid bilayer in the outer membrane of bacteria, thereby disrupting the integrity of their cell membranes. AA demonstrates bacteriostatic activity at a concentration of 0.1%, while its bactericidal activity is observed at concentrations between 2.5% and 10%, although the precise mechanism behind its bactericidal action remains incompletely understood[8,10].

A study was carried out on the antimicrobial effects of industrial and homemade mulberry vinegars against Escherichia coli, Listeria monocytogenes, Salmonella Typhimurium, Staphylococcus aureus, Bacillus subtilis, Enterococcus faecalis, and Pediococcus acidilactici. The results showed that the antimicrobial activity of industrial mulberry vinegar was higher against all tested microorganisms compared with homemade mulberry vinegar[14].

Using the minimal inhibition test, Baldas and Altuner investigated the antimicrobial effects of apple and grape vinegars against the following microorganisms: Bacillus subtilis, Candida albicans, Enterobacter aerogenes, Enterococcus faecalis, Escherichia coli, Listeria monocytogenes, Pseudomonas aeruginosa, Pseudomonas fluorescens, Salmonella enteritidis, Salmonella Typhimurium, Staphylococcus aureus, Klebsiella pneumoniae, and Salmonella kentucky. The results were compared with Halamid®, a commercial surface disinfectant that can also be used to disinfect vegetables and fruits. Consequently, grape vinegar exhibited antimicrobial activity against all microorganisms, with a minimum inhibitory concentration of 12.5–50 μg/Ml[15].

In a recent study, more than one-quarter (27%) of patients with epidermolysis bullosa (EB) reported adding substances to their bathing water, with vinegar concentrations ranging from 0.002% to 0.156%. An international panel of experts outlined 17 recommendations for wound care in EB patients, including a specific suggestion for wound cleansing with diluted vinegar at concentrations of 0.25–1%, applied either in the bath or via a compress for 15–20 minutes. Furthermore, a study involving 19 patients who developed hypergranulation tissue after Mohs surgery demonstrated that daily application of 1% AA for one to two weeks resulted in complete wound healing[5].

Other studies have demonstrated the antiparasitic properties of vinegar. Beyhan et al. reported that a 1% concentration of AA was insufficient to affect the viability of Ascaris eggs. However, they observed that a 3% AA concentration achieved 95% efficacy after 30 minutes, while all eggs became non-viable with a 5% solution. They concluded that, for optimal treatment results, AA should be applied at a

concentration of 4.8% for 30 minutes or 4.3% for 60 minutes[6]. Another study showed that at 21 ± 1 °C, no Giardia duodenalis cysts remained viable after treatment with undiluted vinegar for 60 minutes, whereas treatment with 1:1, 1:15.6, and 1:62.5 vinegar–water mixtures reduced relative viability to 1.8%, 19.4%, and 56.4%, respectively[7].

In the current study focusing on Sarcoptes scabiei mites, the objective was to establish a standardized recommendation for vinegar, which many patients commonly use in the treatment of scabies. The findings indicated that the scabicidal efficacy of vinegar required higher AA concentrations compared with its bactericidal effectiveness. The application of undiluted vinegar frequently causes contact dermatitis; therefore, it is essential to use diluted vinegar to minimize this adverse effect. Notably, the 50% diluted vinegar solution demonstrated a killing effect significantly greater than that of 5% permethrin ($p < 0.001$), underscoring its potential as a more effective and safer alternative under in vitro conditions.

This study contains certain limitations. The design of the current study included only in vitro experiments. Future clinical studies in everyday practice will provide more comprehensive data. Additionally, we were unable to observe the ovicidal effect in our study. Furthermore, potential variability in vinegar composition, such as differences in polyphenol content or pH between batches, may have influenced the results and should be considered in future research. The relatively small sample size is another limitation, as the number of viable mites obtainable was restricted. Finally, microscopic observations were not performed in a blinded manner, which may also be considered as a methodological limitation.

In conclusion, the antimicrobial, antifungal, and antiparasitic properties of vinegar are well established. However, to date, there has been no research examining its scabicidal effects. This gap in knowledge has led to uninformed and potentially harmful applications of vinegar by patients. In our study, 50% vinegar demonstrated in vitro scabicidal activity with a mean time-to-death of 11.8 minutes, which was significantly higher than that of 5% permethrin ($p < 0.001$). Future research should focus on well-designed clinical trials to assess its safety and efficacy in patients, as well as ovicidal studies to determine its effect on mite eggs. Such investigations will be essential to define the role of vinegar among scabicidal therapies. We believe that an industrial product will make a significant contribution to industry–science collaboration by expanding its use.

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