



Research Article

Some components and bioactive properties of gel and green leaf parts of *A. vera*

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ARTICLE INFO

Article history

Received: 12 September 2024

Revised: 17 October 2024

Accepted: 05 May 2025

Keywords:

Aloe Vera; Antimicrobial;

Antioxidant; Phytochemical

Composition; Vitamins

ABSTRACT

Aloe vera (L.) Burm. f., known as the plant of immortality, is a perennial and succulent plant. This study aimed to investigate potential alternatives to synthetic antibiotics and antioxidants due to the increasing resistance of microorganisms to these drugs and the negative effects of synthetic antioxidants. So phytochemical characteristics and antimicrobial activities of the gel and green leaf parts of *A. vera* have been measured. Vitamin A, E, lycopene, β -carotene, and 4-hydroxyneonal (4-HNE) that were determined by high-performance liquid chromatography (HPLC) were found to be 0.17 ± 0.03 , 3.6 ± 0.57 , 7.6 ± 1.50 , 0.63 ± 0.14 , and 5.6 ± 1.07 $\mu\text{g/g}$ in the green leaf part of *Aloe vera* and 0.26 ± 0.05 , 1.1 ± 0.09 , 0.07 ± 0.01 , and 3.68 ± 0.74 $\mu\text{g/g}$ in the gel, respectively. Total phenolics, flavonoids, 2,2'-Azino-bis-3-ethylbenzothiazoline-6-sulfonic (ABTS), and 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity that were determined using a UV-Vis spectrophotometer were found to be 0.17 ± 0.01 , 0.96 ± 0.15 , 133.9 ± 7.08 , and 25.1 ± 2.28 in the green leaf part of the plant, while they were found to be 407.95 ± 9.42 , 0.95 ± 0.67 , 0.04 ± 0.00 , and 0.26 ± 0.05 in the gel, respectively. The antimicrobial activities of *A. vera* were determined by the disc-diffusion method. The green leaf part of *A. vera* had the most powerful effect on *Bacillus megaterium*, with an inhibition zone measuring 11.6 ± 0.32 mm in diameter. While the gel had the strongest effect on *Staphylococcus aureus*, with a 20.0 ± 0.29 mm zone of inhibition. Therefore, we can conclude that *vera* serves as a valuable source of antioxidant and antimicrobial activity, suitable for both medicinal and cosmetic applications.

Cite this article as: Tahseen Yaseen H, Kırbağ S, Karataş F. Some components and bioactive properties of gel and green leaf parts of *A. vera*. Sigma J Eng Nat Sci 2026;44(4):2974–2981.

INTRODUCTION

There are around 420 species of the genus *Aloe*, and they have been placed in the, Aloaceae families, including *Aloe vera* (L.) Burm. f. [1]. Although *Aloe barbadensis* Miller

is the more common name, *A. vera* is the correct name according to international regulations of botanical nomenclature [2]. The leaves of the plant are tall and pointed. There is a green shell and a transparent pulp within each

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This paper was recommended for publication in revised form by
Editor-in-Chief Ahmet Selim Dalkilic



leaf. The pulp, which makes up the bulk of the leaf, seems to be both transparent and mucilaginous. For medicinal reasons, this portion of the plant is most often used [3]. Light green in color; this perennial plant resembles both shrubs and trees. It is xeric and succulent [4]. It is believed that the Arabic words “alloeh” or “alloe” and the Hebrew word “allal,” meaning “bitter” are the origins of the Greek word “aloe” (aloi). Arabic “wahrē” means “real” or “genuine,” and the Latin word “vera” comes from this source. In Anatolia, it is called “sari sabre” because of its typically yellow petals, and its name in common use is derived from the Arabic word “sabre” meaning “sword” in reference to its sword-shaped leaves. Its native habitats in Turkey are the southern Turkish coast and Antalya’s Demre area [5, 6]. It is thought that the plant *A. vera* originated in Sudan and was later transferred to the Mediterranean and other warm regions of the globe. A clay tablet from 2100 BC in Mesopotamia is the first known written evidence of the medicinal power of *Aloe*. Papyrus Ebers, an Egyptian record from 1550 BC, provide the earliest extensive description of the plant’s medical significance, including several *Aloe*-containing concoctions for the treatment of exterior and interior illnesses. The Greek herbalist Dioscorides (ca. Seventy AD) described the *A. vera* plant and advocated its use in treating wounds, hair loss, vaginal ulcers, and hemorrhoids [7]. According to a variety of recent study, this species not only protects teeth from UV rays but also reduces inflammation, fights germs and fungi, modulates the immune system, and inhibits the growth of cancer cells [8–12]. Despite its widespread cultivation today, the *Aloe barbadensis* Miller plant the “plant of immortality” actually originates from Africa, the Arabian Peninsula, and the islands of the Indian Ocean. This plant is a member of the Asphodelaceae family [13]. Over 2000 years ago, Egyptian scientists dubbed *A. vera* “the herb of immortality,” while Greeks called it “the universal panacea”. Approximately 99.0–99.5% of the substance is water. Since it can hold a lot of water, it may be used to keep the skin hydrated, and its gel can be used to treat skin injuries since it aids in wound healing and promotes cell reproduction. Several properties of *A. vera* contribute to its capacity to hasten wound healing, including moistening effects, increased cell motility, and enhanced collagen production [14]. Furthermore, it is employed in the treatment of a broad spectrum of diseases, for instance inflammation, digestive issues, constipation, thermal burns, sunburns, radiation damage, skin diseases, diabetes, and ulcers. Nearly 200 active substances and 75 nutrients, encompassing both water- and fat-soluble vitamins, minerals, enzymes, mono- and polysaccharides, phenolic compounds, and organic acids, have been reported to make up the remaining 0.5–1.0% instead of the typical 99.0–99.5% water [15]. Polyphenols, flavonoids, tannins, saponosides, steroids/terpenes have been identified in *A. vera* [16]. *Aloe vera* has been reported to contain high levels of bioactive compounds, including phenols, flavonoids, tannins, saponins, anthraquinones, and ascorbic acid, as well as essential

mineral elements. In addition, its gel has demonstrated notable biological activities, such as anti-influenza effects in the Madin–Darby Canine Kidney (MDCK) cell line and inhibitory action against the growth of various pathogenic microorganisms [17]. The medicinal properties of *A. vera* gel may be attributed to the presence of molecules with a high molecular weight [18]. The plant has an exterior covering that is visible from the outside and a parenchyma *Aloe* gel that is visible from the inside of the same covering. Both *in vivo* and *in vitro* studies have shown that these two constituents have therapeutic effects. Antibacterial, antifungal, anti-inflammatory, and anti-arthritic properties have been shown in studies of the plant’s entire extract [19]. The wound healing properties of *A. vera* gel were determined using experimental animals [20]. By preventing the production of oxygen radicals, *A. vera* is thought to have immunomodulatory effects [21]. Different *A. vera* fractions, as well as the unfractionated entire gel, have been claimed to have antioxidant benefits by a number of writers. The antioxidant properties of the *A. vera* gel may stem from the presence of glutathione peroxidase activity, superoxide dismutase, and phenolic antioxidant [22]. There are several components of *A. vera* that are responsible for its antioxidant properties. These components include α -tocopherol, carotenoids, ascorbic acid, flavonoids, tannins and vitamin E [23]. In this study, some components and biological activities of the *A. vera* were determined.

MATERIALS AND METHODS

Sample Preparation

Plant samples were obtained from Planet Shop in Elazığ City, Türkiye. The plant leaves were rinsed under running water to eliminate dust and insect larvae. The gel was manually extracted from fresh *A. vera* leaves after they were chopped using a knife. One gram of the gel and one gram of the green leaf part were used for testing water soluble vitamins, vitamins A, E, β -carotene, lycopene and 4-HNE. While 15 grams of samples were extracted using methanol in Soxhlet to prepare for antioxidant tests.

Chemicals and Equipment

Standard and chemical reagents, including butylated hydroxy toluene, flavone, perchloric acid, gallic acid, aluminum chloride, quercetin (dehydrate), potassium persulfate, sodium nitrate, aluminum chloride, gallic acid, and perchloric acid, were acquired from Sigma-Aldrich or Merck, respectively. All the water used in the process was double-distilled (dd H₂O).

Because of the potential for contaminants in the solvent to obscure the sample peak in the HPLC chromatogram, only analytical-grade solvents were used for the sample preparation. The liquid chromatography solvents were of the HPLC kind. For HPLC, the mobile phase always consists of a solvent that has been filtered via a

membrane filter and degassed in an ultrasonic bath. The SHIMADZU Prominence-LC-2020C 3D Model was used for HPLC analysis together with a PDA detector. A UV-VIS spectrophotometer was used for the spectrophotometric measurements.

Determination of Vitamins A, E, β -carotene, Lycopene and 4-HNE

After adding 1.0 g of sample to a tube, 5.0 mL of C_2H_5OH was added, and the mixture was sonicated for 10 min then vortexed and centrifuged for 6 min at 7,500 rpm. After that, we added 1.0 mL of n-hexane to the sample, gave it a good vortex, and then extracted the n-hexane phase twice. The n-hexane phases were collected, evaporated in a vacuum, and diluted in 1.0 mL of methanol before being analyzed using a combination of methanol and water (95:5) as the mobile phase. An Inertsil ODS-3 column with dimensions of 25.0 cm x 4.6 mm x 5.0 μ m was designed for analysis [24].

Extraction of Samples

The samples were being extracted using 15 g of sample and 250 mL of methanol in a Soxhlet device for 6 h. Methanol was then extracted using a rotating evaporator operating at 40 °C under vacuum. After drying the extract, it was weighed before dissolving it in 10 mL of CH_3OH and storing the resulting solution at 4 °C in a refrigerator [25].

Determination of Total Phenolic Content

The spectrophotometric determination of total phenolic material followed the Folin-Ciocalteu technique with adjustments made by Dewanto et al. [26] The following was combined and shaken: 0.50 mL of distilled water, 0.250 mL of sample or gallic acid, and 0.125 mL of Folin-Ciocalteu reagent. To achieve volume of 3.00 mL, distilled water was added after 6 min, and 1.250 mL of 7% sodium carbonate solution was added. After 90 min, the ultraviolet-visible spectrophotometer read the absorption at 760 nm. It was determined how varied quantities of gallic acid would affect the graph. The TPC of the samples was calculated, and the findings were reported in micrograms of gallic acid equivalents per gram (μ g GAE/g) [26].

Determination of Total Flavonoids

Spectrophotometric analysis, as reported by Dewanto et al. [26], was used to calculate total flavonoid content. The absorbance at 510 nm was measured after mixing a 0.025 mL sample of quercetin with 1,250 mL of distilled water, 0.075 mL of a 5% sodium nitrite solution, and 0.150 mL of a 10% solution of aluminum chloride; the mixture was allowed to stand for 5 min. Then, 0.500 mL of a 1.0 M sodium hydroxide solution was added. Different amounts of quercetin were used to create a usable graph. Total flavonoids content was calculated using the working graph, and the findings were expressed as micrograms of quercetin compounds per gram [26].

Total Antioxidant Capacity DPPH Method

The DPPH method of Antioxidant capacity was measured utilizing the approach published by Nile et al. [27], which is depend on the scavenging activity of the stable DPPH free radical. The absorption of a DPPH solution made by dissolving 25 μ g/mL of DPPH in (CH_3OH) methyl alcohol was measured at 510 nm. The absorbance at 510 nm was measured after the DPPH solution had been placed in the dark area for thirty minutes with varying concentrations of sample extracts. IC_{50} (μ g/mL) values were reported, which represent the concentration of the antioxidant chemical that inhibits 50% of the DPPH radical in the medium. High antioxidant activity is shown by low IC_{50} values [27].

Total Antioxidant Capacity ABTS Method

The antioxidant activity inherent in the samples was assessed employing the ABTS radical cation decolorization assay, a method initially detailed by Re et al. [28] and subsequently adapted with minor procedural adjustments. The generation of the $ABTS^{\bullet+}$ radical cation involved the combination of a 7.0 mM ABTS solution with 2.4 mM potassium persulfate. This mixture was subsequently allowed to react under dark conditions at ambient temperature for a duration of 12–16 hours, thereby facilitating the complete formation of the desired radical species. Before conducting the analysis, the $ABTS^{\bullet+}$ solution required dilution with a phosphate buffer (pH 7.4) until an initial absorbance of 0.80 ± 0.02 at 734 nm was achieved. In the assay procedure, 2.0 mL aliquots of the diluted $ABTS^{\bullet+}$ solution were dispensed into individual test tubes. This was followed by the introduction of either the sample extract or a Trolox standard solution in varying volumes (25, 50, 75, and 100 μ L). These reaction mixtures were incubated at room temperature for 15 minutes, subsequent to which their absorbance was quantified at 734 nm employing a UV-Vis spectrophotometer. To serve as a reference, a control sample comprising solely the $ABTS^{\bullet+}$ solution, without the incorporation of any sample or standard, was prepared under conditions identical to those used for the test samples. The antioxidant capacity for each sample was then computed utilizing a Trolox calibration curve, with the results articulated as micromoles of Trolox equivalents per gram of sample (μ mol TE/g) [28].

Screening of Antimicrobial Activities

Test microorganisms

For the tests, we used different kinds of organisms, including both Gram-positive and Gram-negative bacteria. Specifically, the Gram-positive types were *Staphylococcus aureus* COWAN 1 FMC 16 and *Bacillus megaterium* DMS 32. As for the Gram-negative bacteria, we had *Pseudomonas aeruginosa* DMS 50071 SCOTTA, *Escherichia coli* ATCC 25922, *Klebsiella pneumoniae* FMC 5, and *Proteus vulgaris* FMC 1. We also included one type of yeast *Candida albicans* FMC 17 in our tests. All these microorganisms came

from the Microbiology Laboratory Culture Collection at Firat University's Department of Biology.

Extract preparation

Fresh plant tissue (10 g gel and green leaf part) was macerated for 24 h in 150 mL of methanol solvent with rotary agitation. The substances were filtered through Whatman No. 1 to clarify. The solvent was evaporated to dryness under vacuum at 37 °C. The recovered materials were dissolved in dimethyl sulfoxide (DMSO) and stored at 4 °C until further use. Each prepared extract was dispensed at a pre-validated controlled volume of 20 µl on to antibiotic assay discs (6 mm, Schleicher & Schüll No. 2668). Antimicrobial activity was compared with standards of streptomycin sulphate and nystatin. The amount of solvent to be injected in to the disc is regulated by controls, which stipulate that only 20 µL of solvent will be administered. Streptomycin sulfate and nystatin are the standard substances used in this process.

Preparation of microbial cultures and test

After 24 h in nutrient broth and 48 h in malt extract broth, bacterial and yeast strains were inoculated. To use the disc-diffusion method, the test bacteria and yeasts were placed on Mueller Hinton agar (for bacteria) and Malt extract agar (for yeast) at concentrations of 10^5 bacteria/mL and 10^4 yeast/mL, respectively. The solid agar medium was covered with the disc by gently pushing it down. After 2 h at 4 °C, the petri dishes were incubated at 35 ± 0.1 °C for 24 h, while the yeast was incubated at 25 ± 0.1 °C for 3 days. The inhibitory zones were measured in millimeters at the beginning of the period [29].

Statistical Analysis

The analyses were replicated three times, and the findings are reported as the mean $\pm$ error. The findings were subjected to one-way ANOVA analysis using SPSS 26.0 for MS Windows. The significance of differences between group means was assessed using the Tukey HSD test, and statistical significance was indicated by a $p \leq 0.05$. Different letters were used to highlight significant differences between table rows, whereas similar letters imply that there is no statistical difference between groups.

RESULTS AND DISCUSSION

Fat-Soluble Vitamins (A & E), β -carotene, Lycopene and 4-HNE

Based on the findings of this study, vitamins A and E were detected in various part of the plant as shown in (Table 1). The concentration of vitamin A obtained in the green leaf part and gel of *A. vera* were 0.17 ± 0.03 µg/g and 0.26 ± 0.05 µg/g. There was no significant difference in the concentration of vitamin A between the plant gel and green leaf portions ($p < 0.05$). A research study conducted in Indonesia on the *Aloe chinensis baker* plant found that fresh gel of 7-8 months old *A. vera* (raw material) contains 4.59 IU (1.38 µg/g) of vitamin A content. [30]. It seemed to be higher when compared to the results of this study. This could be due to genus variations.

While Vitamin E concentration was 3.6 ± 0.57 µg/g in the green leaf part and was 1.1 ± 0.09 µg/g in the gel of the *A. vera*. The vitamin E contents of the gel and green leaf portions of the plants were not significantly different from one another ($p > 0.05$). Research conducted in 2011 found that 100 g of *A. vera* gel has a vitamin E level of 0.192 IU/100g (1.29 µg/g) [31]. The results of this study align with it. Furthermore, it is clear that gel had a higher vitamin A concentration than green leaves. On the other hand, the green leaf part generally had higher vitamin E levels than the gel of *A. vera*. Table 1. shows that the 0.63 ± 0.14 µg/g of β -carotene level observed in the green leaf part of plant while in gel was 0.07 ± 0.01 µg/g. The β -carotene contents of the gel and green leaf portions of the *A. vera* were not significantly different from one another ($p > 0.05$). In 2009, Ozsoy et al. [32] found that the aqueous extract of *A. vera* leaves had a β -carotene content of (15.5 ± 12.39 µg/g FW). It seemed to be higher when compared to the results of this study. It could be because of the maturation stage of plant ,solvent or laboratory procedures used. The nutritional values discovered in this study are at odds with what is already known from the literature. The concentration of lycopene was 7.6 ± 1.50 µg/g in the green leaf part of *A. vera*; on the other hand, gel contained 3.01 ± 0.69 µg/g of lycopene (Table 1). Statistically, there is no significant difference in the lycopene level of the gel and green leaf part components of

Table 1. Amount of vitamin A, E, β -carotene, lycopene and 4-HNE concentrations µg/g

	Green leaf part	Gel
Vitamin A	^a 0.17 ± 0.03	^a 0.26 ± 0.05
Vitamin E	^a 3.6 ± 0.57	^b 1.1 ± 0.09
β -Carotene	^a 0.63 ± 0.14	^b 0.07 ± 0.01
Lycopene	^a 7.6 ± 1.50	^b 3.01 ± 0.69
4-HNE	^a 5.6 ± 1.07	^a 3.68 ± 0.74

Statistical significance level was expressed as $p < 0.05$. Different letters in the rows indicate a statistical difference, while the same letters indicate that there is no statistical different

the *A. vera* plant ($p>0.05$). The green leaf part of the plant contains higher levels of β -carotene and lycopene than the gel. Martinez-Sánchez et al. [33] studied the bioactive component of *A. vera* flowers at three stages of development: the first stage is immature; the second stage is mature, and the third stage is mature. The lycopene concentration was found to be the lowest in the third stage, while in Stage I, immature, it was found to be the highest [33]. The green leaf part of *A. vera* has a (5.6 ± 1.07 $\mu\text{g/g}$) concentration of 4-Hydroxynonena(4-HNE); on the other hand, the gel shows a (3.68 ± 0.74 $\mu\text{g/g}$) level for 4-HNE (Table 1). Statistically, there is no significant difference in the 4-HNE value of the gel and green leaf part components of the *A. vera* plant ($p>0.05$). Thus, the gel showed a higher 4-hydroxynonena level. No published or rare information on the concentrations of these compounds in *A. vera* was found. According to the findings, the nutritional qualities are higher in the green leaf part of *A. vera* than the gel.

Total Phenolic, Total Flavonoid, DPPH & ABTS Content

The total amount of phenolic compounds is provided as μg of Gallic acid equivalent/g of extract and is represented in (Table 2). The green leaf part of *A. vera* showed a higher level of total phenolic content (0.17 ± 0.01 $\mu\text{g/g}$) than the gel that has (0.04 ± 0.00 $\mu\text{g/g}$) of total phenolic content. The quantities of total phenolic content in the *A. vera*'s green leaf part and gel were found to be significantly different ($p<0.05$). The lowest estimated amount of total phenolic content was 97.95 ± 21.5 $\mu\text{g GAE/mg}$, while the maximum value was 332.4 ± 32.6 $\mu\text{g GAE/mg}$, according to another study done in Pakistan, examined various fractions of *A. vera* leaf [34]. It seems to be higher with a considerable difference when compared to the results of this research; this might be because of the effects of climate change or the plant's maturity stage.

The total amount of flavonoid compounds is provided as μg of Quercetin equivalent/g and is represented in (Table 2). TFC in the green leaf part of *A. vera* was obtained as (0.96 ± 0.21 $\mu\text{g/g}$). On the other hand, the gel was estimated at (0.26 ± 0.07 $\mu\text{g/g}$). The green leaf part of *Aloe vera* contain a higher amount of flavonoid content than the gel. The total flavonoid content of the gel and green leaf portions of the plant is not significantly different from one another

($p>0.05$). A study conducted in 2003 by Hu et al. [21] examined *A. vera* plant samples taken at various stages of maturity. The researchers discovered that *A. vera* plant that were three years old had a greater amount of flavonoid content that estimated as (4.70 ± 0.48 g/kg), and four years old *A. vera* had (4.28 ± 0.18 g/kg) flavonoid concentration, in the other hand two years old plant had (3.63 ± 0.38 g/kg) of flavonoid content [21].

The common purpose of this experiment is also to find out how well different sample extracts scavenge radicals. The premise of the experiment focused on the capacity of the extract to lower DPPH and ABTS radicals. The ability of four distinct concentrations of *A. vera* samples from 50 to 200 μL for DPPH and ABTS radical scavenging was evaluated. According to the findings, the effects of the *A. vera* extracts start at a concentration of 50 μL and increase with concentration, as shown by the findings. As shown in (Table 2), the methanolic extract of green leaf part of *A. vera* was 133.9 ± 7.08 $\mu\text{g/mL}$, on the other hand the methanolic extract of gel showed 407.95 ± 9.42 $\mu\text{g/mL}$, of DPPH radical scavenging activity. So, the green leaf part of *A. vera* has a higher ability to scavenge DPPH radicals. According to Zahra et al. [35] *A. vera* powder extract was showed that at doses of 20–100 $\mu\text{g/mL}$, water extracts showed a % inhibition (DPPH) of 10.23–35.80, while methanol extracts showed 12.84–44.96. A statistically significant difference was discovered in the DPPH radical scavenging activity between the green leaf section and the gel of *A. vera* ($p<0.05$). As shown in (Table 2), methanolic extract of green leaf part of *A. vera* showed 25.1 ± 2.28 $\mu\text{mole trolox/g}$, on the other hand the methanolic extract of gel showed 0.95 ± 0.67 $\mu\text{mole trolox /g}$, of ABTS radical scavenging activity respectively. Therefore, the green leaf part of *A. vera* have a higher ability to scavenge ABTS radicals. Jairath et al. [36] determined that the capacity of the aqueous methanolic *A. vera* gel to scavenge ABTS radicals was 96.14%. Although there was no significant difference in the ABTS radical scavenging activity across various parts of the *A. vera* ($p>0.05$). The findings of this study were consistent with those of previous studies. Studies on *A. vera* have shown that the radical scavenging capacity of a plant is proportional to the concentration of the studied compound. In terms of radical scavenging action, the green leaf portion of *A. vera* is generally considered more potent than the gel.

Table 2. Amount of total phenolic $\mu\text{g/g}$, total flavonoid $\mu\text{g/g}$, DPPH $\mu\text{g/mL}$ and ABTS $\mu\text{mole trolox/g}$

	Green leaf part	Gel
Total phenolic	^a 0.17 ± 0.01	^b 0.04 ± 0.00
Total Flavonoid	^a 0.96 ± 0.15	^b 0.26 ± 0.05
DPPH	^a 133.9 ± 7.08	^b 407.95 ± 9.42
TEAC	^a 25.1 ± 2.28	^b 0.95 ± 0.67

Statistical significance level was expressed as $p<0.05$. Different letters in the rows indicate a statistical difference, while the same letters indicate that there is no statistical different.

Table 3. Antimicrobial activity of *A. vera* (mm)

	Green leaf part	Gel	Standard
<i>Bacillus megaterium</i>	^a 11.6±0.32	^b 19.0±0.35	^c 24.3±0.33
<i>Pseudomonas aeruginosa</i>	^a 8.9±0.13	^b 15.5±0.29	^c 18.5±0.29
<i>Escherichia coli</i>	^a 8.3±0.30	^b 16.2±0.17	^c 25.3±0.33
<i>Klebsiella pneumoniae</i>	^a 9.3±0.17	^b 17.4±0.20	^c 18.9±0.47
<i>Proteus vulgaris</i>	^a 9.0±0.29	^b 15.5±0.29	^c 18.2±0.20
<i>Staphylococcus aureus</i>	^a 10.0±0.35	^b 20.0±0.29	^b 20.2±0.20
<i>Candida albicans</i>	^a 9.2±0.20	^b 17.5±0.29	^c 21.8±0.39

Statistical significance level was expressed as $p < 0.05$. Different letters in the rows indicate a statistical difference, while the same letters indicate that there is no statistical different.

Antimicrobial Activity

The disc diffusion technique was used to ascertain the antibacterial and antifungal properties of the extracts of various portions of the *A. vera* plant that were utilized in the study. The results of this determination are shown in (Table 3). The diverse sections of the plant, namely the green leaf portion and the gel, were shown to be effective in preventing the growth of yeast and bacteria. The extract of the green leaf component of the *A. vera* plant had the greatest impact on *Bacillus megaterium* (11.6±0.32 mm), while it had the least impact on *Escherichia coli* (8.3±0.30 mm). It was shown that the extract of the gel component had the most impact on *Staphylococcus aureus* (20±0.29 mm), while it had the least impact on *Pseudomonas aeruginosa*, and *Proteus vulgaris* (15.5±0.29 mm). The antimicrobial abilities of *A. vera* plant's gel, green leaf part and standard were found to be significantly different ($p < 0.05$). In the study by Kaithwas et al. [37] *A. vera* gel has been shown to limit the development of some germs such as *Escherichia coli* (6 mm), *Staphylococcus aureus* (9.56 mm), *Pseudomonas aeruginosa* (6 mm), and *Proteus vulgaris* (6 mm). It has been determined that *A. vera* gel inhibits the growth of *Bacillus cereus*, *B. subtilis*, *L. monocytogenes*, *Micrococcus luteus*, *Staphylococcus aureus* [16]. The results of this study, specifically the gel, demonstrated the most potent antimicrobial activity when compared to the literature. This study's investigations to determine the antimicrobial capacity of various parts of *A. vera* yielded different results from the literature. This discrepancy may be due to experiments being conducted in different regions, under different climatic conditions.

CONCLUSION

Aloe vera has become of interest because of its wide range of applications, especially its medicinal, cosmetic, and food uses. The number of scientific studies on it is continually growing. Gel has stronger potential antibacterial activity than the green leaf portion of *Aloe vera*, which might be utilized to treat the increasing resistance of microbes to

synthetic antibiotics, according to this research. However, the green leaf component of *Aloe vera* is a better antioxidant source. People are becoming aware of the growing resistance of microbes to synthetic antibiotics and the negative effects of synthetic antioxidants, which causes severe health issues. So, researchers have begun looking for natural alternatives to antimicrobials and antioxidants in order to reduce the negative effects of synthetic drugs. As a result, it is anticipated that this work will provide valuable insights for future research aimed at discovering alternative antioxidants and antimicrobials.

AUTHORSHIP CONTRIBUTIONS

Authors equally contributed to this work.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

STATEMENT ON THE USE OF ARTIFICIAL INTELLIGENCE

Artificial intelligence was not used in the preparation of the article.

REFERENCES

- [1] Dagne E, Bisrat D, Viljoen A, Van Wyk B. Chemistry of Aloe species. *Curr Org Chem* 2000;4:1055–1078. [\[CrossRef\]](#)
- [2] Sahu P, Giri D, Singh R, Pandey P, Gupta S, Shrivastava A, Kumar A, et al. Therapeutic and medicinal uses of aloe vera: a review. *Pharmacol Pharmacy* 2013;4:599–610. [\[CrossRef\]](#)
- [3] Ni Y, Turner D, Yates K.M, Tizard I. Isolation and characterization of structural components of Aloe vera L. leaf pulp. *Int Immunopharmacol* 2004;20:41745–41755.
- [4] Kostekçi Ö.Ç. Determination the proctective effect of Aloe vera application on drosophila melanogaster against trifluraline in with various parameters. *Brazil Arch Biol Technol* 2023;66:e23210311.
- [5] Kumar S, Purohit CS, Kulloli RN. Aloe trinervis sp. nov.: A new succulent species from Indian Desert (Asphodelaceae). *J Asia-Pacific Biodivers* 2020;13325–13330. [\[CrossRef\]](#)
- [6] Tunçaylı HA, Kaya Gİ. Usage of Aloe vera (L.) Burm. F. (Sarisabır) Plant in Phytotherapy. *J Fac Pharm* 2002;45:674–698.
- [7] Lanka S. A review on Aloe vera- the wonder medical plant, *J Drug Deliv Ther* 2018;8:94–99. [\[CrossRef\]](#)
- [8] Tudose A, Celia C, Cardamone F, Vono M, Molinaro R, Paolino D. Regenerative properties of Aloe vera juice on human keratinocyte cell culture. *Farmacia* 2009;57:590–597.
- [9] Joseph B, Raj S.J. Pharmacognostic and phytochemical properities of Aloe vera LINN - an overview Taxonomy. *Enzymes* 2010;4:106–110.
- [10] Badakhsh S, Eskandarian T, Esmailpour T. The use of Aloe vera extract as a novel storage media for the avulsed tooth. *Iran J Med Sci* 2014;39:327–332.
- [11] Chelu M, Musuc AM, Aricov L, Ozon EA, Iosageanu A, Stefan LM, et al. Antibacterial Aloe vera based biocompatible hydrogel for use in dermatological applications. *Int J Mol Sci* 2023;24:3893. [\[CrossRef\]](#)
- [12] Johri A, Kumar A, Singh D, Tiwari K, Arora N. Clinical uses of Aloe vera in veterinary medicine. *Indian Farmer* 2023;10:198–200.
- [13] Wasim A, Saif A, Atul Pratap S. A Comprehensive review of Aloe vera: health benefits, mechanisms of action and future perspectives. *Int J Res Dev Technol* 2023;1:1–18.
- [14] Komatsu D, Mistura DV, Motta A, Domingues JA, Hausen MA, Duek E. Development of a membrane of poly (L-co-D,L lactic acid-co-trimethylene carbonate) with Aloe vera: An alternative biomaterial designed to improve skin healing, *J Biomater Appl* 2017;32:311–320. [\[CrossRef\]](#)
- [15] Periferakis A, Periferakis K, Badarau IA, Petran EM, Popa DC, Caruntu A, et al. Kaempferol: antimicrobial properties, sources, clinical, and traditional applications. *Int J Mol Sci* 2022;23:1–39. [\[CrossRef\]](#)
- [16] Konkobo FA, Barry PR, Zongo S, Ouedraogo ER, Roamba NE, Dakuyo R, et al. Biochemical characterization and antimicrobial properties of extracts from four food plants traditionally used to improve drinking water quality in rural areas of Burkina Faso. *Biochem Res Int* 2025;9994531:11. [\[CrossRef\]](#)
- [17] Al-Eisa RA, Sami R, Bedaiwi RI, Kadi RH, Abushal SA, Johari DM, et al. Anti-influenza effects of Aloe vera gel on MDCK cells: protective efficacy against ultraviolet-C exposure and analysis of biochemical characteristics and microbial activities. *Front Sustain Food Syst* 2025;8:1508809. [\[CrossRef\]](#)
- [18] Rosca-Casian O, Parvu M, Vlase L, Tamas M. Antifungal activity of Aloe vera leaves. *Fitoterapia* 2007;78:219–222. [\[CrossRef\]](#)
- [19] Danish P, Ali Q, Hafeez M, Malik A. Antifungal and antibacterial activity of Aloe vera plant extract. *Biol Clin Sci Res J* 2020;1:1–8. [\[CrossRef\]](#)
- [20] Arafa NMS, Hummadi HMA, Badr GM. The potential of aloe vera gel utilization for skin wound healing in rats based on GC-MS and HPLC chemical profile. *JoBAZ* 2025;86:6. [\[CrossRef\]](#)
- [21] Hu Y, Xu J, Hu Q. Evaluation of antioxidant potential of Aloe vera (Aloe barbadensis Miller) extracts. *J Agric Food Chem* 2003;51:7788–7791. [\[CrossRef\]](#)
- [22] Langmead L, Makins RJ, Rampton DS. Anti-inflammatory effects of Aloe vera gel in human colorectal mucosa in vitro. *Aliment Pharmacol Ther* 2004;19:521–527. [\[CrossRef\]](#)
- [23] Eshun K, He Q. Aloe vera: a valuable ingredient for the food, pharmaceutical and cosmetic industries - a review. *Crit Rev Food Sci Nutr* 2004;44:91–96. [\[CrossRef\]](#)
- [24] Ibrahim MS, Ibrahim YI, Mukhtar ZG, Karatas F. Amount of vitamin A, vitamin E, vitamin C, malondialdehyde, glutathione, ghrelin, beta-carotene, lycopene in fruits of Hawthorn, Midland (Crataegus laevigata). *J Hum Nutr Food Sci* 2017;5:1112–1117.
- [25] Wang L, Weller CL. Recent advances in extraction of nutraceuticals from plants. *Trends Food Sci Technol* 2006;17:300–312. [\[CrossRef\]](#)
- [26] Dewanto V, Xianzhong W, Adom KK, Liu RR. Thermal processing enhances the nutritional value of tomatoes by increasing total antioxidant activity. *J Agric Food Chem* 2002;50:3010–3014. [\[CrossRef\]](#)
- [27] Nile SH, Kim SH, Ko EY, Park SW. Polyphenolic contents and antioxidant properties of different grape (V. vinifera, V. labrusca, and V. hybrid) cultivars. *Biomed Res Int* 2013;1:1–5. [\[CrossRef\]](#)
- [28] Re R, Nicoletta P, Anna P, Ananth P, Min Y, Catherine RE. Antioxidant activity applying an improved ABTS radical cation decolorization assay. *Free Radic Biol Med* 1999;26:1231–1237. [\[CrossRef\]](#)
- [29] Gorski FI, Kausar T, Murtaza MA. Evaluation of antibacterial and antioxidant activity of Aloe vera (Aloe barbadensis Miller) gel powder using different

- solvents. *Pesqui Agropecu Bras* 2019;8:1265–1270. [\[CrossRef\]](#)
- [30] Hendrawati TY. Aloe vera powder properties produced from aloe chinensis baker, Pontianak, Indonesia. *J Eng Sci Technol* 2015;10:47–59.
- [31] Ali Kamel Mohamed E. Antidiabetic, antihypercholestermic and antioxidative effect of Aloe vera gel extract in alloxan induced diabetic rats. *Aust J Basic Appl Sci* 2011;5:1321–1327.
- [32] Ozsoy N, Candoken E, Akev N. Implications for degenerative disorders. *Oxid Med Cell Longev* 2009;2:99–106. [\[CrossRef\]](#)
- [33] Martínez-Sánchez A, López-Cañavate ME, Guirao-Martínez J, Roca MJE. Aguayo, Aloe vera flowers, a byproduct with great potential and wide application, depending on maturity stage. *Foods* 2020;9:1542. [\[CrossRef\]](#)
- [34] Tariq H, Zia M, Muhammad SA, Khan SA, Fatima N, Mannan A, et al. Kinase inhibition potential in Aloe vera L. *Biomed Res Int* 2019;6478187. [\[CrossRef\]](#)
- [35] Zahra N, Saeed MK, Shahzad K, Firdous S, Ahmad I, Ashraf M, et al. DPPH assay and reducing power activity of water extract of (mentha longifolia) mint. *Lahore Garrison Univ J. Life Sci* 2022;6:38–47. [\[CrossRef\]](#)
- [36] Jairath G, Chatli MK, Biswas AK. Comparative study on in vitro and in vivo evaluation of antioxidant potential of apple peel extract and Aloe vera Gel. *J Food Process Preserv* 2016;40:607–614. [\[CrossRef\]](#)
- [37] Kaithwas G, Kumar S, Pandey AH, Acharya AK, Singh M, Bhatia D, et al. Investigation of comparative antimicrobial activity of Aloe vera gel and juice. *Pharmacol* 2008;1:239–243.