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Antimicrobial Potential of Ethanol Extract from Avocado Seeds (persea americana mill.) on The Healing of Socket Wounds from Tooth Extraction in Male Wistar Rat

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Abstract: Healing of tooth socket wounds after tooth extraction is a complex process involving phases of inflammation, proliferation, and tissue remodeling. Avocado seeds (Persea Americana Mill.) are known to contain bioactive compounds, including flavonoids, saponins, tannins, and triterpenoids, which have the ability to accelerate the wound healing process. This study aims to determine the effectiveness of avocado seed ethanol extract gel on changes in body weight, socket wound diameter, and socket depth after tooth extraction. This study used a laboratory experimental design with a post-test only control group design using male Wistar rats as test animals. The samples were divided into five groups, consisting of a negative control, a positive control (Gengigel), and treatment groups with avocado seed ethanol extract gel at concentrations of 10%, 20%, and 30%. Body weight was measured from day 1 to day 14. The diameter and depth of the socket wound were also measured periodically. Data analysis used the Paired Samples T-Test, Welch ANOVA, and Dunnett T3 Posthoc test in accordance with the results of normality using the Shapiro-Wilk test and data homogeneity using the Levene test. Based on the results of the study, it was found that 10% ethanol extract gel from avocado seeds was most effective in maintaining the stability of the body weight parameters of the test animals, and 30% ethanol extract gel from avocado seeds was most effective in accelerating the reduction in wound diameter and depth, with results comparable to the gold standard (Gengigel). It can be concluded that ethanol extract gel from avocado seeds, especially at a concentration of 30%, is effective in accelerating the healing process of socket wounds after tooth extraction.

Keywords: Avocado seeds; Ethanol extract; Tooth extraction; Socket healing.

Introduction

Tooth extraction causes complications from various factors and is classified as intraoperative, immediate, and long-term after extraction (Ahmed et al., 2021). The primary reasons patients undergo tooth extraction are periodontal disease (32.3%) and dental caries (38.4%). However, most people tend to neglect their oral health, preferring to extract damaged teeth rather than seek treatment. Tooth loss can lead to disadvantages such as reduced chewing efficiency, rotation, and migration (Wiantari et al., 2018).

Several risk factors that cause complications after tooth extraction include age, root condition, and systemic diseases. Bleeding, dry socket, fracture, and pain are common complications following tooth extraction (Ahmed et al., 2021). Damage or injury following tooth extraction causes a basic response called inflammation, which leads to tissue repair through the replacement of dead cells with fibrous tissue. The main cells involved in the healing process following tooth extraction are fibroblasts. Fibroblasts migrate to the wound site, proliferate, and produce a matrix that repairs damaged tissue (Halim et al., 2019). The wound

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healing process has several phases, including proliferation and inflammation. One factor that accelerates wound healing is external factors. In terms of external factors, wound irrigation can be administered with physiological solutions (0.9% NaCl) and natural and synthetic medications (Ibraheem et al., 2022).

Based on the above description, researchers are interested in further investigating the antimicrobial potential of ethanol extracts from avocado seeds (Persea Americana Mill.) on tooth extraction sockets in male Wistar rats. In addition to this interesting description, the abundant availability of avocado seeds in Indonesia makes it easy for researchers to obtain them.

Method

This true laboratory experimental study used a post-test only control group design and was conducted from January to June 2025 in several laboratories of the University of North Sumatra, including the Medan Herbarium (MEDA) for plant determination, the Pharmaceutical Biology and Pharmaceutical Technology Laboratory, Faculty of Pharmacy, and the Anatomical Pathology Laboratory, Faculty of Medicine. Ethical approval was obtained prior to the study. The experimental subjects consisted of 15 healthy male Wistar rats (Rattus norvegicus) aged 2–3 months and weighing 150–200 g. Sample selection used a non-probability purposive sampling technique based on inclusion and exclusion criteria. Inclusion criteria included healthy male Wistar rats without systemic disease or oral infection, while rats experiencing systemic infection, unrelated trauma, or death during the study were excluded. Sample size determination followed the Resource Equation formula ($E = N - G$), resulting in $E = 10$, which is within the acceptable range of 10–20. The animals were randomly divided into five groups ($n = 3$ per group): a negative control (no treatment), a positive control (Gengigel®), and three treatment groups receiving avocado seed (Persea americana Mill.) ethanol extract gel at concentrations of 10%, 20%, and 30%.

The data sources in this study consisted of primary and secondary data. Primary data were obtained directly by measuring the rats' body weight, socket wound diameter, and socket depth after tooth extraction on days 1, 3, 5, 7, 9, 11, and 14 using a digital scale, digital calipers, and a UNC-15 periodontal probe. Secondary data were obtained from scientific literature, previous research journals, and pharmacopoeial references and laboratory standards that support the extraction procedures, gel formulation, and statistical analysis methods used in this study. Data were analyzed using SPSS software. Normality was assessed using the Shapiro–Wilk test, followed by Levene's test for homogeneity. Comparisons within groups were analyzed using a paired-sample t-test. If the homogeneity assumption was violated, Welch's ANOVA was applied for intergroup comparisons, followed by Dunnett's T3 post hoc testing. Statistical significance was set at $p < 0.05$. The research procedure was carried out in the following steps:

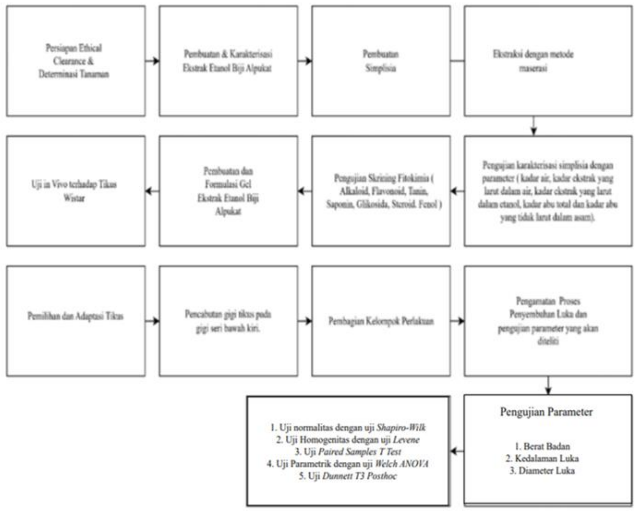

Figure 1. Research flow

Result and Discussion

Results of Phytochemical Screening Tests of Ethanol Extracts from Avocado Seeds

Phytochemical screening was performed to identify the secondary metabolites present in the ethanol extract of avocado seeds (*Persea americana* Mill.). The results of this analysis are presented in Table 1.

Table 1. Results of Phytochemical Screening Tests of Ethanol Extracts from Avocado Seeds

Active compound	Reagent	Result
Alkaloid	*Bourchardat*	-
	Meyer	-
	Dragendof	-
Flavonoid	*MgHCl +* H_2SO_4	+
Triterpenoid/steroid	*Lieberman-Bouchardat*	+
Glikosida	*Molish+* H_2SO_4	+
Saponin	*Aquades*	+
Tanin	$FeCl_3$	+

Antioxidant Activity Test using the DPPH (Diphenylpicrylhydrazil) Method

Antioxidant activity testing of avocado seed extract was conducted using the DPPH method with a maximum wavelength of 515.5 nm. Measurements were taken at four sample concentrations, namely 0.75 ppm, 1.5 ppm, 3 ppm, and 6 ppm. The absorbance of the control (DPPH without sample) was obtained at 0.9800.

Homogeneity Test of Ethanol Extract Gel from Avocado Seeds

The results showed that the ethanol extract gel groups of avocado seeds with concentrations of 10%, 20%, 30%, and homogeneous gengigel were characterized by the absence of coarse particles in the preparation.

Dispersibility Test of Ethanol Extract Gel from Avocado Seeds

The results of the spreading power test on ethanol extract gel preparations of avocado seeds at concentrations of 10%, 20%, 30%, and gengigel The results of the spreading power test showed that the ethanol extract gel preparations of avocado seeds at concentrations of 10%, 20%, and 30% had a spreading power of 2.7 cm; 4.9 cm; and 5.7 cm, respectively, while the spreading power of gengigel was 3.7 cm.

Viscosity Test of Ethanol Extract Gel from Avocado Seeds

A viscosity test was conducted to evaluate the physical characteristics of the ethanol extract gel of avocado seeds (*Persea americana* Mill.). The results of the viscosity measurements for each group are presented in Table 2.

Table 2. Results of Viscosity Test of Ethanol Extract Gel from Avocado Seeds

Group	Viscosity Measurement Results (Cps)
10%	8782.3
20%	9789.3
30%	9789.3
Gengigel	9778.7

The viscosity test results show that the 10% concentration ethanol extract gel group of avocado seeds has a viscosity of 2.7 Cps, while the 20% and 30% concentration ethanol extract gel groups of avocado seeds both have the highest viscosity of 9789.3 Cps. The viscosity value in the gengigel group was 9778.7 Cps.

pH Test

The pH test results showed that the 10%, 20%, and 30% ethanol extract gel groups had pH values of 6.05, 6.16, and 6.18, respectively, while the pH of the gel was 6.41.

Organoleptic Test

The results of the organoleptic aroma test showed that the 10%, 20%, and 30% ethanol extract gel groups had a distinctive avocado aroma, while the gengigel also had a distinctive aroma. The 10% and 20% ethanol extract gel of avocado seeds were brown in color, the 30% concentration was dark brown, and the gel had a light blue color. All groups had a gel form with homogeneous consistency.

Body Weight Normality Test Results

A normality test was performed on body weight data using the Shapiro–Wilk test to determine whether the data were normally distributed before further statistical analysis. The results of the normality test are presented in Table 3.

Table 3. Results of Shapiro-Wilk Normality Test for Body Weight

Observation Time	Treatment Group	Sig value range.	Description
Day 0 (Pre-Extraction)	K-,K+,K1,K2,K3	0.052 – 0.927	Normal
Day 1	K-,K+,K1,K2,K3	0.266 – 0.951	Normal
Day 3	K-,K+,K1,K2,K3	0.399 – 1.000	Normal
Day 5	K-,K+,K1,K2,K3	0.206 – 1.000	Normal
Day 7	K-,K+,K1,K2,K3	0.312 – 0.935	Normal
Day 9	K-,K+,K1,K2,K3	0.363 – 1.000	Normal
Day 11	K-,K+,K1,K2,K3	0.132 – 0.537	Normal
Day 14	K-,K+,K1,K2,K3	0.058 – 1.000	Normal

Based on Table 3, all treatment groups at each observation time showed significance values greater than 0.05. This indicates that the body weight data were normally distributed, and therefore parametric statistical tests could be applied for further analysis.

Body Weight Homogeneity Test Results

A homogeneity test was conducted using Levene's test to determine whether the variance of body weight data among groups was equal before performing further comparative analysis. The results of the homogeneity test are presented in Table 4.

Table 4. Results of Levene's Homogeneity Test for Body Weight

Observation Day	Test Method	Sig value.	Description
Day 0	*Based on Mean*	0.359	Homogeneous
Day 1	*Based on Mean*	0.294	Homogeneous
Day 3	*Based on Mean*	0.053	Homogeneous
Day 5	*Based on Mean*	0.126	Homogeneous
Day 7	*Based on Mean*	0.025	Not Homogeneous
Day 9	*Based on Mean*	0.007	Not Homogeneous
Day 11	*Based on Mean*	0.014	Not Homogeneous
Day 14	*Based on Mean*	0.005	Not Homogeneous

Based on Table 4, the body weight data on days 0, 1, 3, and 5 showed significance values greater than 0.05, indicating homogeneous variance among groups. However, on days 7, 9, 11, and 14, the significance values were less than 0.05, indicating non-homogeneous variance. Therefore, for observation days with unequal variances, statistical analysis using Welch ANOVA was applied.

Results of the T-Test for Body Weight

A paired samples t-test was conducted to determine whether there was a significant difference in body weight between day 0 (pre-extraction) and day 14 (post-treatment). The results of the paired samples t-test are presented in Table 5.

Table 5. The Results of the Paired Samples T-Test

Pair	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference (Lower)	95% Confidence Interval of the Difference (Upper)	t	df	Sig. (2-tailed)
Pair 1 BB_H0 - BB_H14	61.86667	43.61171	11.26049	37.71531	86.01802	5.494	14	.000

Based on Table 5, the mean difference in body weight between day 0 and day 14 was 61.86667 ± 43.61171. The significance value was 0.000 ($p < 0.05$), indicating a statistically significant difference in body weight before and after the treatment period. The 95% confidence interval ranged from 37.71531 to 86.01802, confirming the reliability of the observed difference.

Welch ANOVA Test Results for Body Weight

Since the homogeneity assumption was not met on several observation days, Welch ANOVA was applied to analyze differences in body weight among the treatment groups. The results of the Welch ANOVA test are presented in Table 6.

Table 6. Welch ANOVA Test Results for Body Weight

Observation Day	Sum of Squares	df	Mean Square	F	Sig.
Day 0	60566.000	4	15141.500	5.987	0.010
Day 1	55888.933	4	13972.233	5.534	0.013
Day 3	43035.733	4	10758.933	5.379	0.014
Day 5	41465.733	4	10366.433	3.873	0.038
Day 7	36810.400	4	9202.600	3.151	0.064
Day 9	33363.067	4	8340.767	2.999	0.072
Day 11	34453.333	4	8613.333	3.135	0.065
Day 14	20983.067	4	5245.767	2.133	0.151

Based on Table 6, statistically significant differences in body weight among treatment groups were observed on days 0, 1, 3, and 5 ($p < 0.05$). However, on days 7, 9, 11, and 14, the significance values were greater than 0.05, indicating no statistically significant differences among groups on those observation days. Therefore, post hoc analysis was necessary for the days showing significant differences to determine which specific groups differed.

Results of Dunnett T3 Post Hoc Test for Body Weight

The group with the smallest p-value shows the most statistically significant difference in effect. Based on the results of the Dunnett T3 Post Hoc test, the EEBA 10% group most often showed the smallest p-value on several observation days, so it can be interpreted as the most effective group.

Wound Depth Normality Test Results

A normality test was conducted on wound depth data using the Shapiro–Wilk test to determine whether the data were normally distributed prior to further statistical analysis. The results of the normality test are presented in Table 7.

Table 7. Shapiro-Wilk Normality Test Results for Wound Depth

Observation Time	Treatment Groups	Sig. Value Range	Description
Day 1	K-,K+,K1,K2,K3	0.463 – 1.000	Normal
Day 3	K-,K+,K1,K2,K3	0.637 – 1.000	Normal
Day 5	K-,K+,K1,K2,K3	0.637 – 1.000	Normal
Day 7	K-,K+,K1,K2,K3	0.637 – 1.000	Normal
Day 9	K-,K+,K1,K2,K3	0.637 – 1.000	Normal
Day 11	K-,K+,K1,K2,K3	1000 – 1.000	Normal
Day 14	K-,K+,K1,K2,K3	0.637 – 1.000	Normal

Based on Table 7, all treatment groups at each observation time showed significance values greater than 0.05, indicating that the wound depth data were normally distributed. Therefore, parametric statistical tests could be applied for subsequent analysis.

Wound Depth Homogeneity Test Result

A homogeneity test was performed using Levene's test to determine whether the variance of wound depth data among treatment groups was equal prior to further statistical analysis. The results of the homogeneity test are presented in Table 8.

Table 8. Results of Levene's Homogeneity Test for Wound Depth

Observation Day	Test Method	Sig. Value	Description
Day 1	*Based on Mean*	0.222	Homogeneous
Day 3	*Based on Mean*	0.769	Homogeneous
Day 5	*Based on Mean*	0.171	Homogeneous
Day 7	*Based on Mean*	0.854	Homogeneous
Day 9	*Based on Mean*	0.999	Homogeneous
Day 11	*Based on Mean*	1.000	Homogeneous
Day 14	*Based on Mean*	0.854	Homogeneous

Based on Table 8, all observation days showed significance values greater than 0.05, indicating homogeneous variance among treatment groups. Therefore, parametric statistical tests assuming equal variances could be applied for further analysis of wound depth data.

Welch ANOVA Test Results for Wound Dept

To evaluate differences in wound depth among treatment groups at each observation day, statistical analysis was performed using ANOVA. The results of the analysis are presented in Table 9.

Table 9. Welch ANOVA Test Results for Wound Depth

Observation Day	Sum of Squares	df	Mean Square	F	Sig.
Day 1	60.933	4	15.233	1.888	0.189
Day 3	4.667	4	1.167	0.761	0.574
Day 5	14.267	4	3.567	1.216	0.363
Day 7	8.267	4	2.067	1.632	0.241
Day 9	9.067	4	2.267	2.473	0.112
Day 11	8.400	4	2.100	2.100	0.156
Day 14	16.667	4	4.167	3.289	0.058

Based on Table 9, all observation days showed significance values greater than 0.05 ($p > 0.05$), indicating that there were no statistically significant differences in wound depth among the treatment groups from day 1 to day 14. Although the significance value on day 14 ($p = 0.058$) approached the threshold of significance, it remained above 0.05 and therefore was not considered statistically significant.

Results of Dunnett T3 Post-hoc Test for Wound Depth

The EEBA treatment group with the highest concentration (K3 – EEBA 30%) showed the smallest significance value compared to the other groups, so it can be concluded that this group was the most effective in accelerating the healing process of socket wounds. The EEBA 20% group (K2) showed better effectiveness than EEBA 10% (K1), but was still lower than EEBA 30%. Meanwhile, the negative control group (K−) and positive control group (K+) showed larger p-values, indicating that their effectiveness in healing socket wounds was still lower than that of the EEBA treatment groups, especially at higher concentrations.

Wound Diameter Normality Test Results

A normality test was conducted on wound diameter data using the Shapiro–Wilk test to assess whether the data were normally distributed prior to further statistical analysis. The results of the normality test are presented in Table 10.

Table 10. Results of Shapiro-Wilk Normality Test for Wound Diameter

Observation Time	Treatment Groups	Sig. Value Range	Descrip-tion
Day 1	K-,K+,K1,K2,K3	0.298 – 1.000	Normal
Day 3	K-,K+,K1,K2,K3	0.144 – 1.000	Normal
Day 5	K-,K+,K1,K2,K3	0.637 – 1.000	Normal
Day 7	K-,K+,K1,K2,K3	0.637 – 1.000	Normal
Day 9	K-,K+,K1,K2,K3	0.463 – 1.000	Normal
Day 11	K-,K+,K1,K2,K3	0.637 – 1.000	Normal
Day 14	K-,K+,K1,K2,K3	0.637 – 1.000	Normal

Based on Table 10, all treatment groups at each observation time showed significance values greater than 0.05. This indicates that the wound diameter data were normally distributed from day 1 to day 14. Therefore, parametric statistical tests could be applied for further analysis.

Wound Diameter Homogeneity Test Results

A homogeneity test was conducted using Levene's test to determine whether the variance of wound diameter data among treatment groups was equal before performing comparative statistical analysis. The results of the homogeneity test are presented in Table 11.

Table 11. Results of Levene's Homogeneity Test for Wound Diameter

Observation Day	Test Method	Sig. Value	Description
Day 1	*Based on Mean*	0.028	Not Homogeneous
Day 3	*Based on Mean*	0.022	Not Homogeneous
Day 5	*Based on Mean*	0.773	Homogeneous
Day 7	*Based on Mean*	0.778	Homogeneous
Day 9	*Based on Mean*	0.972	Homogeneous
Day 11	*Based on Mean*	0.688	Homogeneous
Day 14	*Based on Mean*	0.589	Homogeneous

Based on Table 11, the significance values on days 1 and 3 were less than 0.05, indicating non-homogeneous variance among treatment groups on those days. Meanwhile, on days 5, 7, 9, 11, and 14, the significance values were greater than 0.05, indicating homogeneous variance. Therefore, for days 1 and 3, statistical analysis using Welch ANOVA was required, whereas for the remaining days, standard One-Way ANOVA could be applied.

Welch ANOVA Test Results for Wound Diameter

Based on the results of the homogeneity test, Welch ANOVA was performed to analyze differences in wound diameter among treatment groups at each observation time. The results of the Welch ANOVA test are presented in Table 12.

Table 12. Welch ANOVA Test Results for Wound Diameter

Observation Day	Sum of Squares	df	Mean Square	F	Sig.
Day 1	1.935	4	0.484	3.742	0.041
Day 3	0.543	4	0.136	1.049	0.430
Day 5	0.111	4	0.028	1.122	0.399
Day 7	0.024	4	0.006	0.507	0.732
Day 9	0.035	4	0.009	1.029	0.438
Day 11	0.017	4	0.004	0.243	0.908
Day 14	0.043	4	0.011	0.955	0.472

Based on Table 12, a statistically significant difference among treatment groups was observed only on day 1 ($p = 0.041 < 0.05$). This indicates that the treatments had a significant effect on wound diameter on the first day of observation. Meanwhile, on days 3, 5, 7, 9, 11, and 14, the significance values were greater than 0.05, indicating no statistically significant differences among treatment groups on those days.

Results of Dunnett T3 Post Hoc Test Wound Diameter

Based on the results of the Dunnett T3 post hoc test on the wound diameter parameter, it can be concluded that the EEBA 30% treatment group (K3) consistently showed the smallest p-value on almost all observation days. This indicates that EEBA 30% is the most effective group in accelerating the healing of socket wound diameter after tooth extraction, compared to the control group and lower concentrations of EEBA.

Analysis of phytochemical content and bioactive potential of avocado seeds

Avocado seed ethanol extract has been shown to contain active compounds such as flavonoids, tannins, saponins, glycosides, and steroids/triterpenoids. These compounds support the bioactive potential of avocado seeds in wound healing. Flavonoids act as anti-inflammatories and antioxidants, tannins play a role in wound closure, and saponins enhance angiogenesis and collagen formation. These findings are consistent with Djasmasari (2020) who reported significant antioxidant activity of avocado seed extract using the DPPH method, indicating the presence of strong radical scavenging compounds. In addition, Wulansari and Fatharani Mintarjo (2023) demonstrated that ethanol extract of avocado seeds possesses notable biological activity against microbial biofilms, further supporting its therapeutic potential. Thus, avocado seed extract gel has a mechanism comparable to other herbal plants that are effective in controlling inflammation during the wound healing process.

Effectiveness of avocado seed extract gel on body weight

Statistical test results show that the body weight of mice in all treatment groups is normally distributed. Based on the Welch ANOVA test, there is a significant difference in average body weight in the early phase of observation, namely days 1 to 5. This difference is thought to be related to the initial response after tooth extraction, such as stress, pain, and decreased food intake, which are common physiological responses following dental extraction procedures (Lestari et al., 2023).

The use of white rats (Rattus norvegicus) as experimental animals is appropriate because their physiological response patterns are well-characterized in biomedical research (Aisyah et al., 2023; Wang et al., 2023). From day 7 to day 14, the Welch ANOVA test concluded that there was no significant difference in average body weight between treatment groups. This indicates that the administration of avocado seed ethanol extract gel did not have a negative effect on the systemic condition of the test animals.

Thus, it can be concluded that the use of avocado seed extract gel is relatively safe and does not affect the nutritional status or general condition of rats during the study period.

Effectiveness of avocado seed extract gel on wound diameter (Wound Contraction)

Based on the results of the Welch ANOVA test on socket wound diameter, there was a statistically significant difference between treatment groups on day 1 after tooth extraction ($p < 0.05$). This indicates that in the early phase of wound healing, the application of avocado seed extract gel was able to influence the process of wound diameter reduction. However, from day 3 to day 14, there were no significant differences in the mean wound diameter between treatment groups ($p > 0.05$). This condition indicates that in the proliferation and remodeling phases, the wound healing process was relatively uniform across all groups. However, the results of the Dunnett T3 post hoc test showed that the EEBA 30% treatment group consistently had the smallest significance value compared to other groups.

This biological tendency is supported by studies showing that plant-based gel formulations containing bioactive compounds can enhance wound contraction and tissue repair (Herdiania et al. 2022). This indicates that higher concentrations of extract tend to provide better wound contraction effects. These findings are in line with the research by Halim et al. (2019), which reported that herbal gel preparations containing flavonoids can accelerate the reduction in wound diameter after tooth extraction.

Effectiveness of Avocado Seed Extract Gel on Socket Wound Depth (Granulation Tissue Formation)

Based on the Welch ANOVA test, there were no statistically significant differences in the mean wound depth between treatment groups at all observation times. Although not statistically significant, the results of the Dunnett T3 post hoc test concluded that the 30% EEBA group had the smallest significance value compared to the other groups. This indicates a tendency that higher concentrations of extract have the potential to accelerate granulation tissue formation and wound socket deepening. Granulation tissue formation is influenced by fibroblast proliferation, angiogenesis, and collagen deposition. Thungmungmee and Wisidsri (2025) reported that avocado seed extract supports fibroblast cell viability. In addition, Karini et al. (2024) demonstrated that herbal nanoemulgel preparations can increase fibroblast activity in post-extraction wounds. Furthermore, Mutiarani (2023) emphasized the importance of collagen synthesis and fibroblast proliferation in oral mucosal healing. These findings support the potential role of flavonoids and saponins in stimulating granulation tissue formation.

Comparative Analysis: The Potential of Avocado Seed Extract Compared to the Gold Standard (Gengigel)

In this study, Gengigel was used as a positive control representing the gold standard therapy for healing post-extraction sockets. Gengigel contains hyaluronic acid, which plays a role in tissue regeneration and cell migration. Gel formulations are widely used in oral wound management because they provide adequate adhesion and drug release at the wound site (Agustiani et al. 2022). The effectiveness of herbal gel formulations is also influenced by the type and concentration of gelling agents used (Wahidah et al. 2024).

Based on the results of the study, the effectiveness of avocado seed extract gel, particularly at a concentration of 30%, showed a tendency comparable to Gengigel in several parameters, such as a decrease in wound diameter and socket depth. Although not all parameters showed statistically significant differences, post hoc results indicated that EEBA 30% had better wound healing potential than lower concentrations. These findings indicate that avocado seed extract gel has promising potential as an alternative herbal-based therapy in post-extraction wound management.

Conclusion

The administration of avocado seed (Persea americana Mill.) ethanol extract gel showed different effectiveness in each observation parameter. For body weight parameters, a concentration of 10% (EEBA 10%) was the most effective preparation in maintaining the stability of the test animals' body weight, followed by concentrations of 20% and 30%. This effectiveness is thought to be related to the lower levels of bioactive compounds so that it does not cause local irritation and does not interfere with the test animals' feed intake. Meanwhile, for the parameters of wound diameter (wound contraction) and socket wound depth (granulation tissue formation), a concentration of 30% (EEBA 30%) showed the highest effectiveness in accelerating the wound healing process after tooth extraction. This result was followed by concentrations of 20% and 10%, which showed a gradual healing response as the concentration increased. Overall, the 30% concentration of avocado seed ethanol extract gel provided the best results in accelerating the socket wound healing process, while the 10% concentration was more optimal in maintaining the stability of the test animals' physiological condition throughout the study period.

Author Contributions

All parties who contributed to completing this writing.

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Conflicts of Interest

The author declares no conflict of interest.

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