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ORIGINAL ARTICLE

EFFECTS OF α-MANGOSTIN AS AN ORAL ANTIBACTERIAL AGAINST *FUSOBACTERIUM NUCLEATUM*

Efectos de la α-mangostina como antibacteriano oral contra *Fusobacterium nucleatum*

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ABSTRACT

Background: Tooth extraction is a common dental procedure that results in an open socket, creating a susceptible environment for microbial contamination. Such open wounds are vulnerable to colonization by pathogenic microorganisms, which can impede the normal wound-healing process. Among these pathogens, *Fusobacterium nucleatum* is of interest and can contribute to postoperative infection. *F. nucleatum* is active in producing toxic substances such as endotoxins and liposaccharides that can induce cellular events, such as increasing osteoclast activity and decreasing osteoblast activity, which can cause alveolar bone resorption. Alpha mangostin, which contains xanthone, is one of the potent antibacterial substances found in the mangosteen plant and can be beneficial in treating bacterial infections. **Aim:** To analyze the antibacterial activity of α-mangostin compound on the growth of the bacterium *Fusobacterium nucleatum*.

Material and Methods: This study was an *in vitro* laboratory experimental study with three groups: a positive control (amoxicillin), a negative control (distilled water), and treatment groups with eight concentrations of α-mangostin. The data were collected and statistically analyzed using SPSS.

Results: The inhibition zone varied across groups. The 100% α-mangostin treatment produced the second largest zone after the positive control, with an average diameter of 15.94 ± 0.35 mm (range: 15.44–16.35 mm).

Conclusions: Alpha mangostin has antibacterial properties with the greatest antibacterial activity at a concentration of 100%.

Keywords: *Garcinia mangostana; Plant extracts; Anti-bacterial agents; Disk diffusion antimicrobial tests; Fusobacterium nucleatum; Tooth extraction.*

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RESUMEN

Introducción: La extracción dental es un procedimiento odontológico común que produce un alvéolo abierto, creando un ambiente susceptible a la contaminación microbiana. Estas heridas abiertas son vulnerables a la colonización por microorganismos patógenos, lo que puede dificultar la cicatrización normal. Entre estos patógenos, destaca *Fusobacterium nucleatum*, que puede contribuir a la infección postoperatoria. *Fusobacterium nucleatum* produce sustancias tóxicas como endotoxinas y lipopolisacárido, que pueden inducir eventos celulares, como el aumento de la actividad osteoclástica y la disminución de la actividad osteoblástica, lo que puede causar la resorción ósea alveolar. La alfa-mangostina, que contiene xantona, es una de las potentes sustancias antibacterianas presentes en la planta del mangostán y puede ser beneficiosa en el tratamiento de infecciones bacterianas. **Objetivo:** Analizar la actividad antibacteriana del compuesto α-mangostina sobre el crecimiento de la bacteria *Fusobacterium nucleatum*.

Materiales y Métodos: Este estudio fue un experimento de laboratorio *in vitro* con tres grupos: un control positivo (amoxicilina), un control negativo (agua destilada) y grupos de tratamiento con ocho concentraciones de α-mangostina. Los datos se recopilaron y analizaron estadísticamente mediante SPSS.

Resultados: La zona de inhibición varió entre los grupos. El tratamiento con 100 % de α-mangostina produjo la segunda zona más grande después del control positivo, con un diámetro promedio de 15,94 ± 0,35 mm (rango: 15,44–16,35 mm).

Conclusiones: La α-mangostina posee propiedades antibacterianas, con la mayor actividad antibacteriana a una concentración del 100%.

Palabras clave: *Garcinia mangostana; Extractos vegetales; Antibacterianos; Pruebas antimicrobianas de difusión por disco; Fusobacterium nucleatum; Extracción dental.*

INTRODUCTION

Dry socket is one of the complications that can occur after tooth extraction.[1] Dry socket is a failure to maintain blood clot in the socket, often caused by fibrinolysis from anaerobic bacteria.[1] An open socket with a sensitive condition can lead to pain and unpleasant mouth odor.[2] The prevalence of dry socket is approximately 5%, with a higher occurrence in the mandible (75%) compared to the maxilla (25%).[3]

The oral cavity harbors various types of bacteria such as *Streptococcus mutans, Staphylococcus aureus, Porphyromonas gingivalis*, and many others.[4-5] The microorganisms that play a significant role in oral diseases are primarily Gram-negative anaerobic bacteria, including *Fusobacterium nucleatum*.[6]

Fusobacterium nucleatum is a Gram-negative, rod-shaped opportunistic bacterium that is specific to and primarily inhabits the oral cavity and gastrointestinal tract.[7] This bacterium is closely associated with periodontal diseases through the formation of biofilms, host infections, and host responses.[7] In the oral cavity, *F. nucleatum* can establish a symbiotic relationship with the host in a healthy state.[7]

However, *F. nucleatum* can disrupt the balance and transform into a pathogen, interacting

with other pathogens and exacerbating oral diseases.[8,9] During the inflammatory stage of wound healing, *F. nucleatum* remains active in releasing its toxins, such as endotoxins or lipopolysaccharides.[4] These toxin products can induce cellular events, including stimulation of alveolar bone, leading to the induction of increased osteoclast activity and decreased osteoblast activity, ultimately causing alveolar bone resorption.[4]

Antibiotics are generally used as a therapy for diseases that arise due to bacteria because of their ability to inhibit bacterial growth and thereby lower inflammatory responses.[10] However, antibiotics when given at the wrong dose can cause side effects, such as resistance.[10] Consequently, there is a demand for alternative medicine made of natural or herbal substances that can be used as therapy.[10-12] Several studies have been conducted to investigate the content and benefits of natural substances with antibacterial properties that can aid and expedite the wound healing process, such as the components found in the mangosteen plant.[10]

The mangosteen plant (*Garcinia mangostana*) is a fruit that grows in tropical regions and belongs to the Clusiaceae family.[10] It is known as the *"queen of fruits"* due to its delicious taste.[10] Mangosteen has been traditionally used as a medicinal ingredient in various countries such as Malaysia, Indonesia, and Sri Lanka.[10] One of its beneficial parts is the peel, which contains compounds known as xanthones.[13] Xanthones are active substances in mangosteen peel that have been proven to possess pharmacological activities such as antibacterial, anti-inflammatory, antifungal, antioxidant, antitumor, and anti-allergic properties.[13]

Xanthones isolated from the mangosteen pericarp include α-mangostin, β-mangostin, and γ– mangostin.[13] Among these derivatives, α-mangostin is reported to be the xanthone with the strongest pharmacological activity.[13] α-mangostin has demonstrated antibacterial activity against microorganisms by rapidly inducing damage to bacterial membranes.[13] The antibacterial activity of α-mangostin occurs through targeting cyto-plasmic enzymes.[13] It has also been shown to inhibit the activity of anaerobic bacteria, including methicillin resistant strains of *S. aureus,* through the targeting of cytoplasmic enzymes.[13]

To demonstrate the effectiveness of the antibacterial properties of α-mangostin in inhibiting bacterial growth, a diffusion test is employed.[14] Disk diffusion testing is one of the methods used to determine antibacterial activity.[14] The test results are determined by the presence or absence of clear zones formed around the paper disks, indicating the inhibition zone for bacterial growth.[14] Researchers employ disk diffusion testing because it can be completed more rapidly and allows for simpler measurement of the extent of the inhibition zone formed since bacteria are active not only on the surface of the nutrient agar but also penetrate deeper.[14]

Since α-mangostin has exhibited various biological activities, researchers hypothesize that the antibacterial potency of α-mangostin can inhibit the growth of Fusobacterium nucleatum. The primary objective of this research is to identify the precise concentration percentage required to inhibit and eliminate the growth of *Fusobacterium nucleatum.* It is hoped that this study can serve as a reference for scientists and practitioners in utilizing or developing α-mangostin as an antibacterial agent.

MATERIALS AND METHODS

This *in-vitro* experimental laboratory study with a post-test only control group design was conducted in June-July 2022 at the Research Center of the Faculty of Dental Medicine Airlangga University. Ethical clearance (762/HRECC.FODM/XI/2022) was approved byZ The Health Research Ethical Clearance Commission (HRECC) Faculty of Dental Medicine, Airlangga University. This study was carried out on ten groups, consisting of a negative control (K(-)) group with distilled water, a positive control (K(+)) group with amoxicillin, and eight α-mangostin treatment groups at different concentrations.

The Federer formula was used to determine the sample size where the minimum sample required for each group was 2.6 replications. To ensure the reliability of the findings, five replicates were performed for each group.

Bacterial Strain and Antimicrobial Agents

Fusobacterium nucleatum ATCC 25586 (Product number R4602010, Thermo) was obtained from the Research Center of the Faculty of Dental Medicine Airlangga University. Furthermore, α-mangostin M3824 used in this study was purchased from Sigma-Aldrich (St. Louis, MO, USA) where each group requires sample preparation of α-mangostin up to eight concentrations namely 100%, 50%, 25%, 12.5%, 6.25%, 3.125%, 1.5625%, and 0.78125%.

Bacterial Preparation

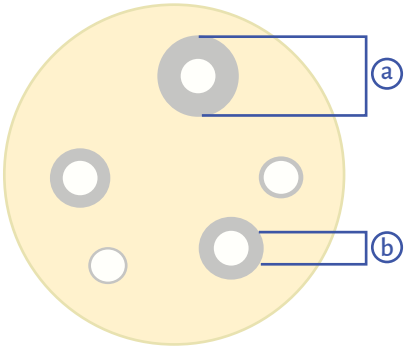
Fusobacterium nucleatum bacteria were cultured on tryptic soy broth (TSB) CM0129 (Oxoid) media in anaerobic condition for 48 hours at 37°C until turbidity was observed. Following anaerobic incubation, the bacterial suspension was standardized to a 0.5 McFarland standard. ($0,5x10^8$ CFU ml^{-1}). Then, bacteria were cultured on solid Mueller-Hinton agar (MHA) using swab technique.

Diffusion Method

Diffusion was carried out serially by adding 0.01 mg/ml of α-mangostin into 0.01 ml of distilled water until a sample concentration of 100%, 50%, 25%, 12.50%, 6.25%, 3.12%, 1.56%, 0.78% was obtained. For sample preparation, 10 mg of amoxicillin powder (derived from a 500 mg dose) was dissolved in 0.01 mL of distilled water. Susceptibility testing requires sterile paper disks impregnated with α-mangostin test samples from each concentration, with 0.01 ml of amoxicillin on the ones that served as a positive control, and with 0.01 ml of distilled water on the ones used as a negative control.

The paper disks were then placed on the surface of Mueller-Hinton agar (MHA) followed by incubation for 48 hours anaerobically at 37°C. Then, the diameter of the inhibition zone formed around the paper disc

Figure 1. Flow diagram of the research method



Descripction:
a. Diamenter of the inhibition zone.
b. Diameter of the paper disc.

was observed and measured using a vernier caliper. The measurement of the inhibition zone diameter is obtained using lines a, b, A, and B. The calculation begins by subtracting the horizontal diameter of the inhibition zone from the horizontal diameter of the disk (a - A) and the vertical diameter of the inhibition zone from the vertical diameter of the disk (b - B). The sum of these two results is then divided by two. (Figure 1)

Statistical Analysis

IBM SPSS Statistics version 20.0 for Windows was used for the statistical analysis. The Shapiro-Wilk and Levene test was used to assess the data's homogeneity and normality.

Analysis of variance (ANOVA) can be used to evaluate hypotheses if the data satisfies the preliminarily established assumptions. If not, the Kruskal-Wallis test and the Mann-Whitney advanced test were used to evaluate the data using non-parametric analysis in order to find the significant difference between groups.

With a significance threshold $p<0.05$, a probability method can serve as a basis for de-

Figure 2. Flow diagram of the research method

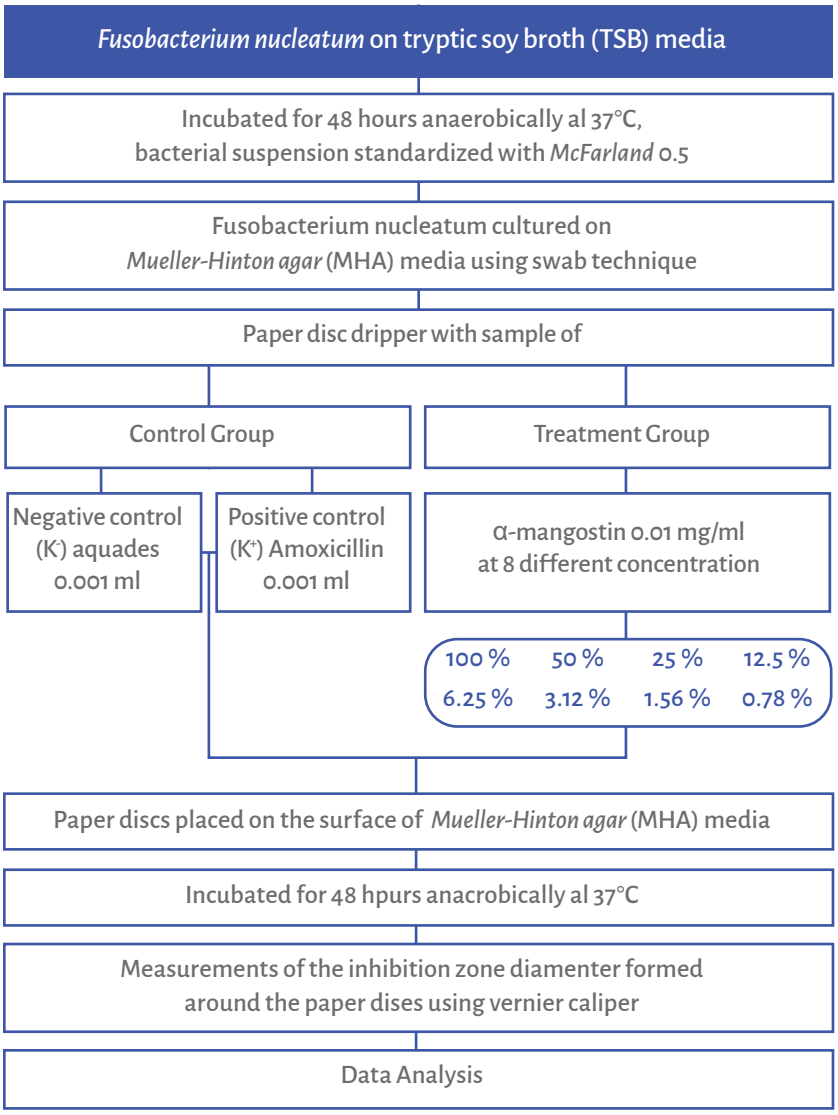


Figure 3. The formation of inhibition zones of *Fusobacterium nucleatum* by α-mangostin

Table 1

Characteristics of the inhibition zones induced by of α-mangostin on the growth of *Fusobacterium nucleatum*

Variable	Concentration of α-mangostin	Minimum (mm)	Maximum (mm)	Mean + SD (mm)
Inhibitory Zone	K (-)	0.00	0.00	0.00+0.00
	K (+)	18.4	20.51	19.57+0.99
	100%	15.44	16.35	15.94+0.35
	50%	12.22	12.80	12.55+0.24
	25%	10.4	10.95	10.69+0.21
	12.5%	6.6	7.78	7.15+0.51
	6.25%	0.00	0.00	0.00+0.00
	3.125%	0.00	0.00	0.00+0.00
	1.56%	0.00	0.00	0.00+0.00
	0.78%	0.00	0.00	0.00+0.00

Table 2

Results of the normality test of the *Fusobacterium nucleatum* growth inhibition zones.

Group	N	Significance
K (+)	5	0.105
100%	5	0.900
50%	5	0.586
25%	5	0.875
2.5%	5	0.396

Table 3
Significance result of growth Inhibition Zone of *Fusobacterium nucleatum*

Group	Average	*p*-value
K (+)	19.57	
100%	15.95	
50%	12.56	0.01
25%	10.69	
12.5%	7.1	

Table 4
Putative classification of the minimum and maximum diameters of the four concentrations of the control group and the positive control group

α-Mangostin Concentration	Inhibition Zone Diameter	Results
(+) Control Group	18.4 mm	Sensitive (S)
	20.51 mm	Sensitive (S)
100%	15.44 mm	Moderately sensitive (MS)
	16.35 mm	Moderately sensitive (MS)
50%	12.22 mm	Resistant (R)
	12.80 mm	Resistant (R)
25%	10.4 mm	Resistant (R)
	10.95 mm	Resistant (R)
12.5%	6.6 mm	Resistant (R)
	7.78 mm	Resistant (R)

cision-making. (Figure 2)

RESULTS

Ten treatment groups were used in this study, with distilled water serving as the negative control and amoxicillin as the positive control, and eight concentrations of α-mangostin: 100%, 50%, 25%, 12.5%, 6.25%, 3.12%, 1.56%, and 0.78%, (Figure 3).

In Table 1, it was found that the positive control group had the largest average diameter of the inhibition zone for the growth of *Fusobacterium nucleatum* (19.57+0.99 mm), with a minimum diameter of 18.4 mm and a maximum diameter of 20.51.

The α-mangostin group with a concentration of 100% showed the second-best inhibition zone growth for *Fusobacterium nucleatum* bacteria after the positive control, with an average diameter of 15.94+0.35 mm, a minimum diameter of 15.44 mm, and a maximum diameter of 16.35 mm.

The α-mangostin group with a concentration of 50% also exhibited the third-best inhibition zone growth for *Fusobacterium nucleatum* bacteria after the positive control, with an average diameter of 12.55 + 0.24 mm, a minimum diameter of 12.76 mm, and a maximum diameter of 12.22 mm. The α-mangostin group with a concentration of 25% had an average diameter of 10.69 + 0.21 mm, a minimum diameter of 10.95 mm, and a maximum diameter of 10.40 mm.

Lastly, the α-mangostin group with a concentration of 12.5% had an average diameter of

7.14 + 0.51 mm, a minimum diameter of 7.78 mm, and a maximum diameter of 6.6 mm. The normality test used in this study used the Shapiro-Wilk test with a significant p=0.05. Based on Table 2, it was found that all data groups were p>0.05 which can be concluded that the normality test was fulfilled.
Table 3 with the Kruskal-Wallis test (p<0.05) or H0 is rejected. This means that there was a significant decrease in the average activity of Fusobacterium nucleatum bacteria in teh presence of α-mangostin.

This study has put the clinical laboratory standards for inhibition zone diameter according to the National Committee for Clinical Laboratory Standards, (Table 4).

DISCUSSION

Mangosteen peel extract (*Garcinia mangostana*) has been reported to exhibit broad-spectrum antibacterial activity against Grampositive and Gram-negative bacteria.[15,16] Additionally, xanthone compounds have been shown in numerous investigations to exhibit outstanding pharmacological properties as an antibacterial agent,[15-17] and α-mangostin, as one of its main active compounds, has been shown to possess various bioactivities and reported to have inhibitory effects against putative periodontopathogens.[18]

For that reason, this study attempts to make use of these natural compounds in the hope that this study can serve as a referen-ce in utilizing or developing α-mangostin as an antibacterial agent for use in the field of dentistry. The study was carried out to determine the antibacterial efficacy of α-mangostin against the growth of *Fusobacterium nucleatum* bacteria utilizing the disc diffusion method. The use of the disc diffusion method has the advantage that the test is relatively easy, fast, and can be tested with a large number of samples in a single trial.[19]

In this study, distilled water was used as a negative control and amoxicillin was used as a positive control. The choice of distilled water as the negative control is because it is the solvent used to dilute the material being tested, and it is proven that the addition of distilled water has no effect on the outcome or results.[20] The study's findings demonstrated an absence of an inhibitory zone in the negative control group, indicating that the distilled water did not contain antibacterials.

Amoxicillin was used as a positive control because amoxicillin is a broad-spectrum penicillin antibiotic and is frequently prescribed as the antibiotic of choice for mild to moderate odontogenic infections due to its effectiveness against various facultative anaerobic bacteria, its low level of toxicity, and long half-life.[21] The study's findings showed that the positive control group produce the largest diameter of inhibition zone with an average diameter of 19.57 ± 0.99 mm, a maximum diameter of 20.51 mm, and a minimum diameter of 18.4 mm.
According to the average number of *Fusobacterium nucleatum* bacterial colonies (Table 1) among the eight α-mangostin concentration, the growth of bacterial colonies was found with the average calculation results decreasing as the concentration of α-mangostin increased. This was in line with a study by Tangsuksan *et al.*,[18] where the fungicidal and bactericidal mechanisms of their α-mangostin soluble film were shown to be concentration-dependent and increased in a dose-dependent manner.

Another study by Nguyen *et al.*,[20] reported that the addition of α-mangostin concentrations could increase antibacterial properties because substances with large molecules and weights could not penetrate the bacteria so they were rejected by the oral coatings present in the bacterial cells.

The present study revealed that the minimum inhibitory concentration (MIC) of α-mangostin against *F. nucleatum* colonies was 12.5%. According to previous research, the MIC of α-mangostin against *A. actinomycetemcomitans* bacteria is 0.01953%.[23] Our observation demonstrated that the minimum bactericidal concentration (MBC) which results in microbial death was obtained at a concentration of 25%. The bactericidal effect follows a previous *in vitro* test of α-mangostin against *S. aureus* which is the rapid bactericidal activity of α-mangostin against *S. aureus* persister cells and found that α–mangostin proficiently suppresses the gene involved in *S. aureus* persister formation.[24]

The ability of α-mangostin to inhibit and kill bacteria comes from xanthone compounds which have quite high cytotoxic activity against bacteria.[16] Xanthones are capable of coagulating proteins that cause the bacterial cytoplasmic membrane to become lysis due to the leakage of the intracellular components of bacteria.[23] Anti-microbial activity may involve three mechanisms of action. Firstly, the potential effects of cytoplasmic membrane disruption and increased permeability. Secondly, inhibits β-lactamase activity. Finally, also damages the peptidoglycan structure.[25]

These mechanisms can reduce the permeability of bacterial cell walls, which will cause the bacteria to experience nutritional deficiency, which will ultimately cause the bacteria to die.[16] It was found that α-mangostin test groups with concentrations of 6.25%, 3.12%, 1.56%, and 0.78% did not affect bacterial growth. Meanwhile, the positive control group and other test groups with higher concentrations (100%, 50%, 25% and 12.50%) responded by forming an inhibition zone around the paper disc. The inhibition zone indicates that α-mangostin contains anti-bacterial properties against the growth of *Fusobacterium nucleatum*. The diameters of the zones of inhibition were measured using vernier calipers to the nearest whole millimeter as recommended by the National Committee for Clinical Laboratory Standards.[25,26]

The sensitivity status of bacteria was determined according to the specifications of the Clinical and Laboratory Standards Institute (CLSI) which divided into 3 categories, namely sensitive (≥18 mm), moderately sensitive (14 – 17 mm), and resistant (≤ 13mm).[27,28]

According to the results of this study, paper disc with 100% α-mangostin concentration droplets produce the second largest inhibition zone after the positive control group with an average diameter of 15.94 + 0.35 mm, a maximum diameter size of 16.35 mm, and a minimum diameter size of 15.44 mm. In the range of minimum and maximum diameter values formed, the results are moderately sensitive, which means that the therapeutic response of the bacteria is low and there is a possibility of failure to achieve this response. When compared with the concentrations of the other treatment groups, concentrations of 50%, 25% and 12.5% showed resistant results where the bacteria did not respond to the antibiotics given and therefore were included in the failure of the therapeutic response.

Thus, our observation demonstrated that α-mangostin exhibits concentration-dependent bactericidal activity, whereby increasing

the dose will maximize the rate and extent of bactericidal activity.[29,30] Dosing regimens such as raising the dose or the frequency of drug administration, or both, are required to intensify drug exposure to a bacterium and possibly enable equivalent effi-cacy at greater convenience.

This approach represents a novel strategy to mitigate the emergence of antibiotic resis-tance. There are several limitations to this study, including a wide gap in the range of α-mangostin concentration used, leading to less precise minimum concentrations that can be classified within the sensitivity categories.
Another disadvantage was the fact that this study was carried out *in vitro* and was restricted to a single species of bacterium, so it could not be generalized to clinical settings.

In the meantime, the normal flora of the oral cavity is highly complex and does not consist of a single type of bacteria, hence testing of α-mangostin activities on multispecies of dental biofilms should be carried out to mimic the oral cavity *in vivo*. Further, mechanisms involved in the antimicrobial activity of the α-mangostin should be determined in future studies.

CONCLUSIONS

According to the findings of the study, α-mangostin can inhibit the growth of the bacterium *Fusobacterium nucleatum in vitro* with the strongest antibacterial power at a concentration of 100%.
However, failure to achieve a therapeutic response is still possible even at the maximum dose. Further *in vivo* studies regarding toxicity, pharmacokinetic profiles, and bioavailability in normal subjects and those with other pathogenic bacteria still need to be explored.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

ETHICS APPROVAL

Study was approved by The Health Research Ethical Clearance Commission (HRECC) Faculty of Dental Medicine, Airlangga University (762/HRECC.FODM/XI/2022).

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AUTHORS' CONTRIBUTIONS

Kurnia Ramadhani Mujiono: Concept, design, data acquisition, statistical analysis, article preparation, editing, and review.

Eka Pramudita D: Concept, design, data acquisition, statistical analysis, article preparation, editing, and review.

Andra Rizqiawan: Concept, design, article preparation, editing, and review, Data acquisition, statistical analysis.

Coen Pramono: Concept, design, article preparation, editing, and review. Finally, all authors had given approval for publication.

Yayun Siti Rochmah: Concept, design, article preparation, editing, and review.

Mohammad Zeshaan Rahman: Concept, design, article preparation, editing, and review.

Ahmad K.M Humidat: Concept, design, article preparation, editing, and review.

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REFERENCES

1. Chow O, Wang R, Ku D, Huang W. Alveolar Osteitis: A Review of Current Concepts. J Oral Maxillofac Surg. 2020;78(8):1288-1296. https://doi.org/10.1016/j.joms.2020.03.026. Epub 2020 Apr 5. PMID: 32348729.
2. Poluan CF., Aninsita PS., Mintjelungan CN. Dry Socket in Smokers after Odontectomy. e-Gigi 2022;10(2):176. https://doi.org/10.35790/eg.v1 0i 2.39676
3. Kasus S, Kuin P, Banjarmasin R, Septiana AR, Khatimah H, Sukmana BI. Perbedaan Angka Kejadian Dry Socket Pada Pengguna Kontrasepsi Hormonal Dan Yang Tidak Menggunakan Kontrasepsi Hormonal. Dentino Jurnal Kedokteran Gigi. 2016;1(1):21-26. https://doi.org/10.20527/dentino.v1i1.415.g337
4. Ayu KV. Efek Induksi LPS Terhadap Jumlah Osteoblas Pada Resorpsi Tulang Alveolar Tikus Putih Jantan (Rattus norvegicus) Galur Sprague Dawley. Interdental Jurnal Kedokteran Gigi. 2018;14(1):13-17. https://doi.org/10.46862/interdental.v14i1.368
5. Revisiting Socransky's Complexes: A Review Suggesting Updated New Bacterial Clusters (GF-MoR Complexes) for Periodontal and Peri-Implant Diseases and Conditions. Micro-organisms. 2024; 12(11):2214.
6. Abed J, Maalouf N, Manson AL, Earl AM, Parhi L, Emgård, JEM, Klutstein M, Tayeb S, Almogy G, Atlan KA, Chaushu S, Israeli E, Mandel-boim O, Garrett WS, Bachrach G. Colon Cancer-Associated Fusobacterium nucleatum May Originate From the Oral Cavity and Reach Colon Tumors via the Circulatory System. Frontiers in Cellular and Infection Microbiology. 2020;10:1-12. https://doi.org/ 10.3389/fcimb.2020.00400
7. Dukka H, Saleh MHA, Ravida A, Greenwell H, Wang HL. Is bleeding on probing a reliable clinical indicator of peri-implant diseases? J. Periodontol 2021;92(12):1669-1674. https://doi.org/10.1002/JPER.20-0890
8. Lamont RJ, Koo H, Hajishengallis G. The oral microbiota: dynamic communities and host interactions. Nat Rev Microbiol 2018;16(12):745-759. https://doi.org/10.1038/s41579-018-0089- x
9. Stokowa-Soltys K, Wojtkowiak K, Jagiello K. Fusobacterium nucleatum—Friend or foe? J. Inorg. Biochem 2021;224:111586. https://doi.org/10.1016/j.jinorgbio.2021.111586
10. Kamal A, Omar M, Samsudin AR. Management of Dry Socket: New regenerative techniques emerge while old treatment prevails. Dent Rev 2022;2(1):100035. https://doi.org/10.1016/j.dentre.2022.100035
11. Zhang C, Yu G, Shen Y. The naturally occurring xanthone α-mangostin induces ROS- mediated cytotoxicity in non-small scale lung cancer cells. Saudi journal of biological sciences 2018;25(6):1090-1095. https://doi.org/10.1016/j.sjbs.2017.03.005
12. Influence of the Probiotic L. reuteri in the Nonsurgical Treatment of Periodontal Disease: A Systematic Review. Microorganisms. 2023, 11(6), 1449. https://doi.org/10.3390/microorganisms11061449
13. The Strategic Role of Biotics in Dental Caries Prevention: A Scoping Review. Food Sci Nutr. 2024, 12(11):8651-8674. https://doi.org/10.1002/fsn3.4473
14. Koh JJ, Qiu S, Zou H, Lakshminarayanan R, Li J, Zhou X, Tang C, Saraswathi P, Verma C, Tan DT, Tan AL, Liu S, Beuerman RW. Rapid bactericidal action of alpha-mangostin against MRSA as an outcome of membran targeting. Biochimica et biophysica acta. 2013;1828(2):834-844. https://doi.org/10.1016/j.bbamem.2012.09.004
15. Sayekti M, Rizqiawan A, Soesilawati P, Mira NP, Kamadjaja DB, Rahman MZ. The effect of alpha-mangostin on interleukin-10 and collagen 1A1 gene in the inflammation process: An experimental in-vitro study. J Int Oral Health 2022;14(4):403. https://doi.org/10.4103/JIOH.JIOH_48_22
16. Sultan OS, Kantilal HK, Khoo SP, Davamani AF, Eusufzai SZ, Rashid F, Jamayet NB, Soh JA, Tan YY, Alam MK. The potential of α-mangostin from Garcinia mangostana as an effective antimicrobial agent—a systematic review and meta-analysis. Antibiotics 2022;11(6):717. https://doi.org/10.3390/antibiotics11060717
17. López-Valverde N, López-Valverde A, Montero J, Rodríguez C, de Sousa BM, Aragoneses JM. Antioxidant, anti-inflammatory and antimicrobial activity of natural products in periodontal disease: a comprehensive review. Front Bioeng Biotechnol 2023;11. https://doi.org/10.3389/fbioe.2023.1226907
18. Indrianingsih AW, Rosyida VT, Ratih D. In Vitro Study of Antioxidant and Antimicrobial Activities of Garcinia Mangostana L. Peel Extract. In 5th International Conference on Food, Agriculture and Natural Resources. 2020;194:152-155. https://doi.org/10.2991/aer.k.200325.031
19. Tangsuksan P, Srichana T, Kettratad M, Nittayananta W. Antimicrobial and anti-zinflammatory effects of α-mangostin soluble film. J Int Soc Prev Community Dent 2022; 12(2):189. https://doi.org/10.4103/jispcd.JISP CD_ 222_21
20. Nurhayati LS, Yahdiyani N, Hidayatulloh A. Perbandingan Pengujian Aktivitas Antibakteri Starter Yogurt dengan Metode Difusi Sumuran dan Metode Difusi Cakram. J Teknol Has Peternak. 2020;1(2):41. https://doi.org/10.24198/jthp.v1i2.27537

21. Kaharap AD, Mambo C, Nangoy E. Uji efek antibakteri ekstrak batang akar kuning (Arcangelisia flava Merr.) terhadap bakteri *Staphylococcus aureus* dan Escherichia coli. J e-Biomedik. 2016;4(1).
22. MT, Astuti RD, Handayani BT. Pengaruh Suhu Penyimpanan Kombinasi Amoksisilin Dan Asam Klavulanat Dalam Sediaan Dry Sirup terhadap Daya Hambat Bakteri (*Staphylococcus aureus*). Jurnal Kesehat Poltekkes Palembang. 2021;16(1):40–9. https://doi.org/10.36086/jpp.v16i1.690
23. Nguyen PT, Nguyen MT, Bolhuis A. Inhibition of biofilm formation by alpha-mangostin loaded nanoparticles against *Staphylococcus aureus*. Saudi J Biol Sci. 2021;28(3):1615-21. https://doi.org/10.1016/j.sjbs.2020.11.061
24. Larsuprom L, Rungroj N, Lekcharoensuk C, Pruksakorn C, Kongkiatpaiboon S, Chen C, Sukatta U. In vitro antibacterial activity of mangosteen (Garcinia mangostana Linn.) crude extract against *Staphylococcus pseu*. dintermedius isolates from canine pyoderma. Vet Dermatol. 2019;30(6):487-e145. https://doi.org/10.1111/vde.12783
25. Felix, LO, Mishra, B, Khader, R, Ganesan, N, Mylonakis, E. In Vitro and In Vivo Bactericidal and Antibiofilm Efficacy of Alpha Mangostin Against *Staphylococcus aureus* Persister Cells Front Cell Infect Microbiol 2022;12:898794. https://doi.org/10.3389/fcimb.2022.898794
26. Cui T, Luo W, Xu L, Yang B, Zhao W, Cang H. Progress of antimicrobial discovery against the major cariogenic pathogen Streptococcus mutans. Curr Issues Mol Biol 2019;32(1):601-44. https://doi.org/10.21775/cimb.032.601
27. Ahmad MI, Keach JE, Behl T, Panichayupakaranant P. Synergistic effect of α-mangostin on antibacterial activity of tetracycline, erythromycin, and clindamycin against acne involved bacteria. Chin Herb Med 2019;11(4):412-6. https://doi.org/10.1016/j.chmed.2019.03.013
28. Samprasit W, Chamsai B, Settharaksa S, Opanasopit P. Synergistic antibacterial activity of alpha mangostin and resveratrol loaded polymer-based films against bacteria infected wound. J Drug Deliv Sci Technol 2020;57:101629. https://doi.org/10.1016/j.jddst.2020.101629
29. Phitaktim S, Chomnawang M, Sirichaiwetchakoon K, Dunkhunthod B, Hobbs G, Eumkeb G. Synergism and the mechanism of action of the combination of α-mangostin isolated from Garcinia mangostana L., and oxacillin against an oxacillin-resistant *Staphylococcus saprophyticus*. BMC microbiology 2016;16(1):1-4. https://doi.org/10.1186/s12866-016-0814-4
30. Chae HS, Kim EY, Han L, Kim NR, Lam B, Paik JH, Yoon KD, Choi YH, Chin YW. Xanthones with pancreatic lipase inhibitory activity from the pericarps of Garcinia mangostana L. (Guttiferae). Eur J Lip Sci Tech. 2016;118(9):1416-21. https://doi.org/10.1002/ejlt.201500516
31. Pohan DJ, Rahmawati F. The effect of mangosteen pericarp (Garcinia mangostana Linn) extract on inhibits the growth of bacteria *Escherichia Coli* ATCC 25922 and bacteria *Staphylococcus Aureus* ATCC 25923. Int J Pharm Pharm Sci. 2022;7(2):29-38.
32. Ansori AN, Fadholly A, Hayaza S, Susilo RJ, Inayatillah B, Winarni D, Husen SA. A review on medicinal properties of mangosteen (*Garcinia mangostana L.*). Res J Pharm Technol 2020;13(2):974-82. https://doi.org/10.5958/0974-360X.2020.00182.1