Volume 10, Issue 8, August – 2025 International Journal of Innovative Science and Research Technology
ISSN No: 2456-2165 https://doi.org/10.38124/ijisrt/25aug795

The Effect of Basil Leaf Extract *(Ocimum sanctum L)* Mouthwash on Gingivitis and Salivary PH in Orphanage Adolescents

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Publication Date: 2025/08/23

Abstract: According to the 2023 Indonesian Health Survey (SKI), the prevalence of bleeding gums in Central Java reached 5.3%, with the highest rate found among adolescents aged 10–14 years at 6.2%. Gingivitis in adolescents is generally caused by uncleaned plaque and calculus, as well as bacterial activity that lowers salivary pH and promotes the growth of pathogenic bacteria. One preventive effort involves the use of natural mouthwash, such as basil leaves *(Ocimum Sanctum L)*, which contain flavonoids, tannins, and essential oils with anti-inflammatory and antibacterial properties, and the ability to stabilize salivary pH. Objective to develop a basil leaf extract *(Ocimum Sanctum L)* mouthwash as an alternative therapy for gingivitis and salivary pH changes in adolescents living in orphanages. The method used a Quasi-Experimental design with a Pretest-Posttest Control Group. A total of 48 adolescents aged 12–20 years were selected using Purposive Sampling based on the Lameshow formula and divided into four groups, each consisting of 12 participants: intervention with 5% basil leaf extract (X1), 10% basil leaf extract (X2), positive control with Chlorhexidine (C+), and negative control with aquadest (C-). Each group used 10 mL of mouthwash every morning for 30 seconds over 7 consecutive days. Results the use of basil leaf extract mouthwash showed a significant decrease in gingival index scores in both the 5% (p=0.002) and 10% (p=0.000) concentrations, as well as in the Chlorhexidine group (p=0.001). Meanwhile, the aquadest group showed no significant change (p=0.072). However, there was no significant difference in salivary pH changes across all groups. Conclusion basil leaf extract *(Ocimum Sanctum L)* mouthwash is effective as an alternative therapy for gingivitis compared to chlorhexidine and aquadest. However, it does not significantly affect salivary pH.

Keywords: *Gingivitis; Salivary pH; Mouthwash; Basil Leaf.*

How to Cite: Cut Lieddya Rahmita; Ari Suwondo; Endah Aryati Eko Ningtyas (2025). The Effect of Basil Leaf Extract *(Ocimum sanctum L)* Mouthwash on Gingivitis and Salivary PH in Orphanage Adolescents. *International Journal of Innovative Science and Research Technology*, 10(8), 998-1004. https://doi.org/10.38124/ijisrt/25aug795

I. INTRODUCTION

Gingivitis, characterized by inflammation of the gingival tissues, is predominantly induced by the accumulation of bacterial plaque and remains a significant public health concern in Indonesia. The metabolic byproducts of bacterial activity within dental plaque, particularly organic acids, contribute to a reduction in salivary pH. This acidic shift creates a microenvironment favorable for the proliferation of pathogenic microorganisms, thereby exacerbating periodontal tissue inflammation and compromising overall oral health. Data from the 2023 Indonesian Health Survey indicate that Central Java Province has a bleeding gum prevalence of 5.3%, with the highest rates observed among adolescents aged 10–14 years (6.2%)[1]. Although these rates demonstrate a decline compared to the 2018 Basic Health Research (Riskesdas) findings, the persistently high prevalence in the adolescent population underscores the need for targeted preventive strategies and early intervention programs[2].

Gingivitis develops when dental plaque is not adequately removed and subsequently undergoes mineralization into calculus, whose rough surface facilitates further plaque retention and bacterial colonization, thereby perpetuating the inflammatory process. A distinct form commonly observed in adolescents during puberty, known as puberty gingivitis, is characterized by an exaggerated gingival inflammatory response to local irritants due to hormonal fluctuations associated with this developmental stage. Evidence indicates that elevated salivary concentrations of steroid hormones are positively correlated with the prevalence and severity of gingivitis in pubertal individuals[3].

Preliminary observations conducted during the early phase of this study revealed that adolescents residing in orphanages generally exhibited poor oral hygiene practices. Many reported brushing their teeth only once a day, with some admitting to occasionally forgetting to brush altogether. The use of mouthwash, dental floss, or tongue cleaners was virtually absent. Moreover, several adolescents stated that they did not replace their toothbrushes regularly and had

ISSN No: 2456-2165 https://doi.org/10.38124/ijisrt/25aug795

never undergone routine dental check-ups. These suboptimal oral hygiene habits were further exacerbated by limited health education and the lack of caregiver supervision over daily oral hygiene routines.

One promising natural agent for oral health improvement is basil leaves (*Ocimum sSanctum* L.), which contain bioactive compounds such as flavonoids, alkaloids, tannins, saponins, and essential oils, known for their antibacterial and anti-inflammatory properties[4]. *In vitro* studies have demonstrated that basil leaf extract effectively inhibits the growth of oral pathogenic microorganisms, such as *Porphyromonas gingivalis*[5]. Tannins in basil contribute to the reinforcement of gingival tissues and prevention of further irritation, while its essential oils can stimulate salivary secretion and enhance buffering capacity, thereby playing a beneficial role in maintaining salivary pH stability.

II. METHOD

This study employed a quasi-experimental design using a pretest–posttest control group format and involved four treatment groups. Two intervention groups received basil leaf *(Ocimum Sanctum L.)* mouthwash at concentrations of 5% (X1) and 10% (X2). The two control groups comprised a positive control using chlorhexidine (C+) and a negative control using distilled water (C−). Each group was administered 10 mL of the assigned mouthwash every morning for seven consecutive days, with a rinsing duration of 30 seconds. The preparation of the basil leaf extract mouthwash was conducted at the STIFAR Laboratory, while the intervention procedures were carried out at five orphanages that served as the research sites.

III. RESULTS

A. The Results of Organoleptic of Basil Leaf Extract

Table 1 Organoleptic Test

No	Mouthwash Formulation	Color	Aroma	Taste	Form	Clarity
1	5%	Dark green	Typical basil	A pronounced mint taste with a subtle bitter note	Liquid	Turbid
2	10%	Light brown	Typical basil	A pronounced mint taste with a subtle bitter note	Liquid	Clear

According to table 1, the results of the organoleptic assessment revealed differences in color between the various mouthwash concentrations. The 5% concentration exhibited a dark green color, whereas the 10% concentration appeared brown. Both concentrations demonstrated the characteristic basil aroma, a slightly bitter and pungent taste, and a liquid consistency. The 5% concentration still contained fine sediment, while the 10% concentration was clear, indicating that higher concentrations tend to produce a clearer mouthwash solution.

B. pH Test Result of Basil Leaf Extract

Table 2 PH Test

Concentrations	Result
5%	4,11
10%	4,44

According to table 2, the pH test results for the basil leaf *(Ocimum Sanctum L.)* extract mouthwash at both 5% and 10% concentrations showed a pH value of 4.

C. The Result of the Homogeneity Test of Basil Leaf Extract

Table 3 Homogeneity Test

Concentrations	Result
5%	Heterogeneous
10%	Homogeneous

According to table 3, the homogeneity test results showed that the 5% basil leaf *(Ocimum Sanctum L.)* extract mouthwash was non-homogeneous due to the presence of fine sediment, whereas the 10% concentration demonstrated homogeneity.

D. Stability Test Results of Basil Leaf Extract

Table 4 Stability Test

Concentrations	Result
5%	Separation present
10%	No separation

ISSN No: 2456-2165 https://doi.org/10.38124/ijisrt/25aug795

According to Table 4, the stability test results showed that the 5% basil leaf *(Ocimum Sanctum L.)* extract mouthwash exhibited phase separation. In contrast, the 10% concentration showed no phase separation, indicating that the 10% formulation demonstrated greater stability.

E. The Results of the Hedonic Test of Basil Leaf Extract

Hedonic test results of basil leaf extract mouthwash according to color, aroma, taste, and clarity.

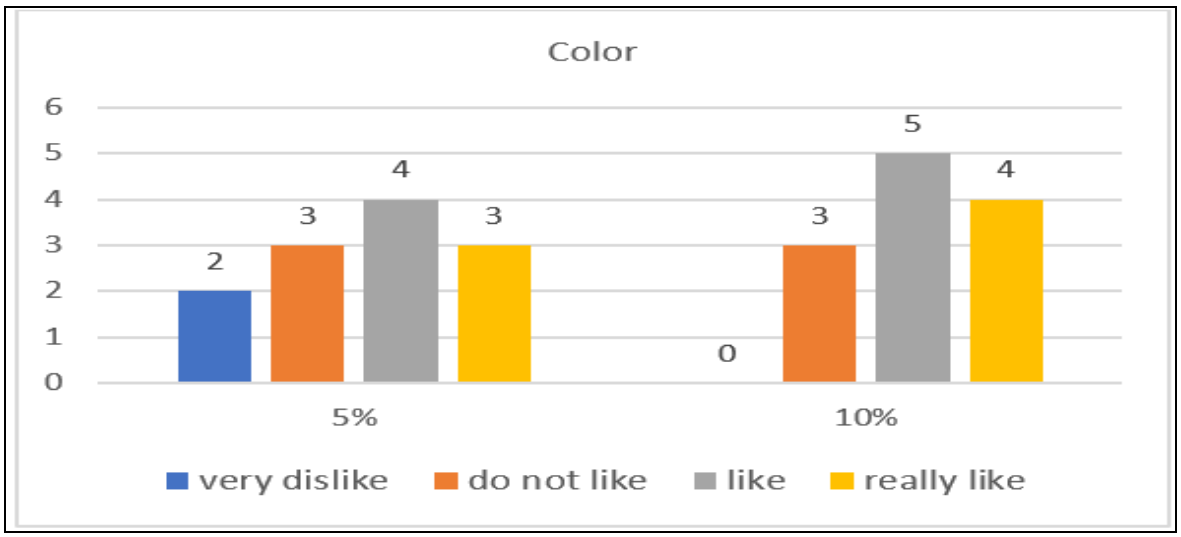

Fig 1 The Results of the Hedonic Test on the Color of Basil Leaf Extract

Figure 1 shows that, among the 12 respondents in the 5% concentration group, 4 indicated that they liked the basil leaf (Ocimum sanctum L.) extract mouthwash, whereas in the 10% concentration group, 6 respondents reported liking it.

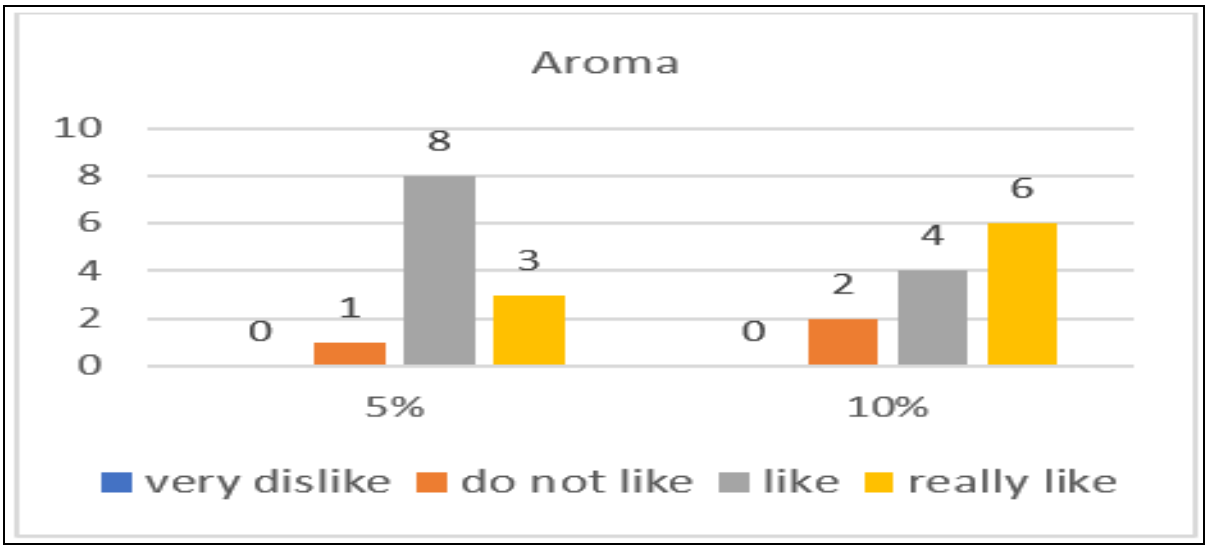

Fig 2 The Results of the Hedonic Test on the Aroma of Basil Leaf Extract

Figure 2 shows that, in the 5% concentration group, 8 out of 12 respondents liked the aroma of the basil leaf extract mouthwash, while in the 10% concentration group, 6 respondents reported that they strongly liked its aroma.

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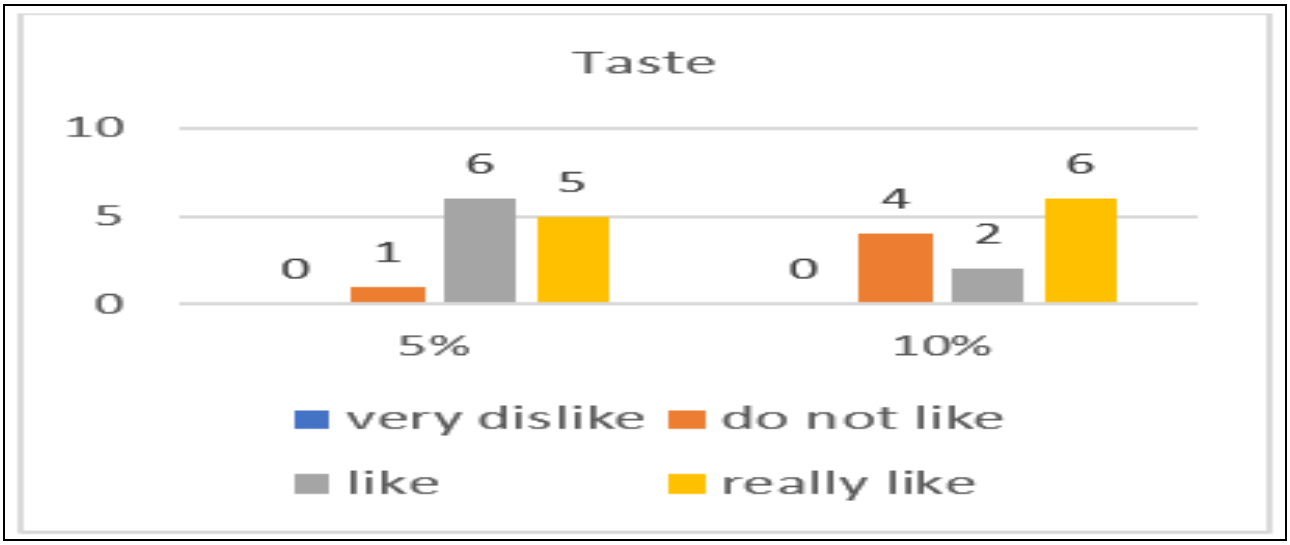

Fig 3 The Results of the Hedonic Test on the Taste of Basil Leaf Extract

Figure 3 shows that, in the 5% concentration group, 6 respondents liked the taste of the basil leaf extract mouthwash, whereas in the 10% concentration group, 6 respondents reported strongly liking its taste.

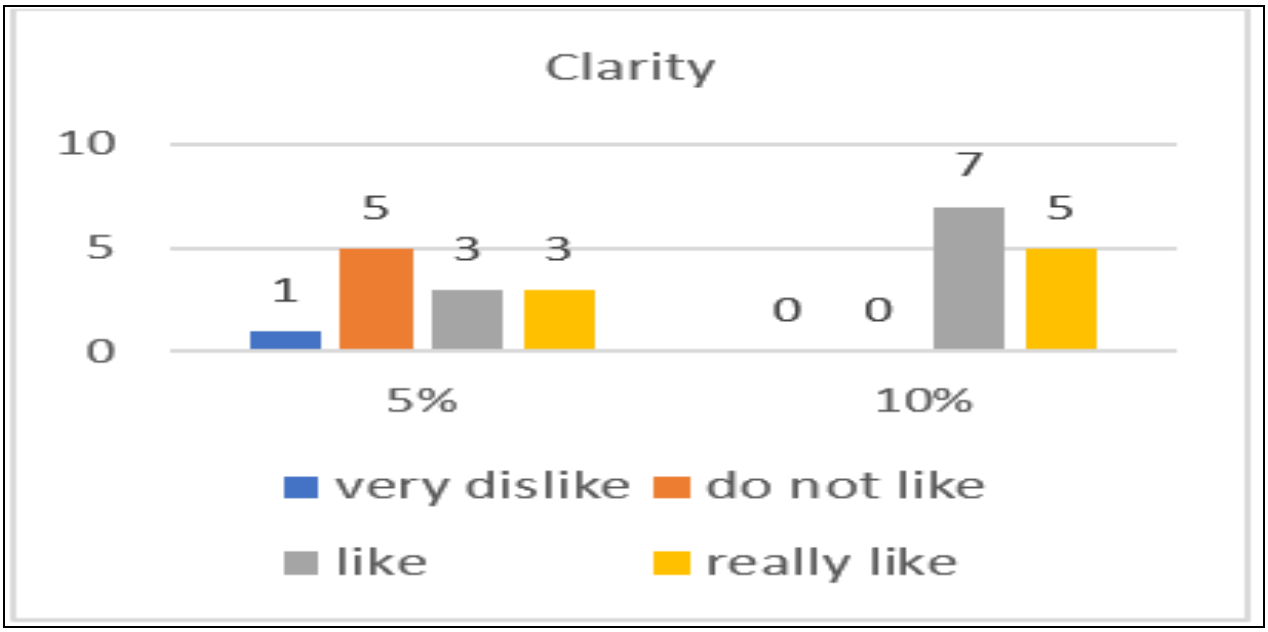

Fig 4 The Results of the Hedonic Test on the Clarity of Basil Leaf Extract

Figure 4 shows that, in the 5% concentration group, 5 respondents disliked the clarity of the basil leaf extract mouthwash, whereas in the 10% concentration group, 7 respondents reported liking its clarity.

F. Effectiveness of Basil Leaf Extract Mouthwash on Gingivitis and Salivary Ph

Table 5 Gingival Index by Group

No	Group	Gingiva Index		Sig.
		Pretest Mean±SD	***Posttest Mean±SD***	
1	Concentrations 5%	1.64±2.32	0.11±0.13	0.002
2	Concentrations 10%	1.00±0.24	0.27±0.17	0.000
3	Chlorexidine	0.85±0.55	0.40±0.39	0.001
4	Aquadest	1.21±0.45	1.05±0.32	0.072

According to Table 5, the p-value of the gingival index in the 5%, 10%, and chlorhexidine groups was $p < 0.05$, indicating a statistically significant difference in gingival index scores after rinsing with basil leaf *(Ocimum Sanctum L.)* extract mouthwash at concentrations of 5% and 10%, as well as with chlorhexidine. In contrast, the aquadest group showed no significant difference.

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Table 6 Results salivary Test by Group

No	Group	PH Saliva		Sig.
		Pretest Mean±SD	***Posttest Mean±SD***	
1	Concentrations 5%	7.50±1.73	7.17±0.57	0.427
2	Concentrations 10%	7.58±2.31	7.33±1.07	0.704
3	Chlorexidine	7.75±1.48	6.92±0.66	0.603
4	Aquadest	7.25±1.54	7.08±0.90	0.098

According to Table 6, the p-value for salivary pH in the 5%, 10%, chlorhexidine, and aquadest groups was $p > 0.05$, indicating no statistically significant difference in salivary pH after rinsing with basil leaf extract mouthwash at concentrations of 5% and 10%, chlorhexidine, or aquadest.

Table 7 Results of Kruskall-Wallis Test

No	Variable	Kruskal Wallis	df	Sig
1	Gingival Index	22.743	3	0.000
2	pH salivary	1.129	3	0.770

According to Table 7, the Kruskal–Wallis test for the gingival index yielded a significance value of 0.000 ($p < 0.05$), indicating a statistically significant difference in gingival index scores after rinsing with basil leaf extract mouthwash at concentrations of 5% and 10%, chlorhexidine, and aquadest. In contrast, the salivary pH results yielded a significance value of 0.770 ($p > 0.05$), indicating no statistically significant difference.

Table 8 Mann–Whitney Test of 5% Basil Leaf Extract Mouthwash Compared with Chlorhexidine and Aquadest

No	Group	N	*Mean rank*	*Sum of ranks*	Sig.
Gingival index					
1	Concentrations 5%	12	16.2	195	0.008
	Chlorexidine	12	8.71	104	
	Concentrations 5%	12	18.0	216	0.000
	Aquadest	12	7.00	84.0	
pH salivary					
2	Concentrations 5%	12	11.3	136	0.409
	Chlorexidine	12	13.6	164	
	Concentrations 5%	12	12.5	151	0.953
	Aquadest	12	12.4	149	

According to Table 8, the results showed $p < 0.05$, indicating a statistically significant difference in gingival index scores between groups. In contrast, the salivary pH results between groups yielded $p > 0.05$, indicating no statistically significant difference.

Table 9 Mann–Whitney Test of 10% Basil Leaf Extract Mouthwash Compared with Chlorhexidine and Aquadest

No	Group	N	*Mean rank*	*Sum of ranks*	Sig.
Gingival index					
1	Concentrations 10%	12	15.6	188	0.027
	Chlorexidine	12	9.33	112	
	Concentrations 10%	12	17.7	212	0.000
	Aquadest	12	7.29	87.5	
pH salivary					
2	Concentrations 10%	12	11.6	140	0.558
	Chlorexidine	12	13.3	160	
	Concentrations 10%	12	12.8	154	0.814
	Aquadest	12	12.1	146	

According to Table 9, the results showed $p > 0.05$, indicating no statistically significant difference in gingival index scores between groups. Similarly, the salivary pH results between groups also yielded $p > 0.05$, indicating no statistically significant difference.

ISSN No: 2456-2165 https://doi.org/10.38124/ijisrt/25aug795

Fig 5 Basil Leaf *(Ocimum sanctum L.)* Extract Mouthwash

IV. DISCUSSION

A. Organoleptic test

The physical evaluation of the basil *leaf (Ocimum Sanctum L.)* extract formulated as a mouthwash met the established quality parameters. The 5% concentration exhibited a dark green color, while the 10% concentration appeared brown. Although the 5% concentration was less clear compared to the 10% formulation, it was still favored by respondents due to its characteristic fresh basil tea-like aroma. This finding aligns with the study by Jumain, which reported

that higher extract concentrations result in more intense color, aroma, and taste[6].

B. pH test

The pH measurements indicated that both concentrations had a pH value of 4, which falls within the acidic range. This acidity may be attributed to the presence of phenolic compounds such as flavonoids and tannins in basil extract, which possess acidic properties, combined with the absence of basic buffering components in the formulation.

C. Homogeneity test

The 5% basil extract mouthwash was found to be non-homogeneous due to the presence of fine sediment. However, respondents reported that the sediment was not perceptible during rinsing, and they remained comfortable while using it. In contrast, the 10% concentration was homogeneous, suggesting that higher extract concentrations tend to produce a more uniform formulation.

D. Stability test

Phase separation was observed in the 5% concentration due to the presence of fine sediment, indicating reduced formulation stability. Conversely, no phase separation occurred in the 10% concentration, suggesting greater stability compared to the 5% formulation.

E. Hedonic test

As illustrated in Figure 1, higher extract concentrations influenced the mouthwash's color, with the 5% formulation displaying a darker green hue and the 10% formulation exhibiting a lighter brown shade similar to basil tea.

Figure 2 shows that the aroma of both concentrations was equally well-received, characterized by a pleasant basil tea-like scent.

Figure 3 indicates that the 10% concentration was preferred in terms of taste, despite both concentrations exhibiting a slightly pungent and bitter flavor. This bitterness is likely due to the use of Tween 80 in the formulation, which imparts a bitter and spicy taste but is partially masked by the inclusion of xylitol and saccharin as sweeteners, as well as peppermint oil, which provides a refreshing sensation.

Figure 4 shows that the 10% concentration was clearer compared to the slightly turbid 5% formulation.

F. Basil Leaf Extract Mouthwash

According to Table 7, there was a significant difference between pre- and post-treatment conditions following the use of the basil leaf extract mouthwash, with a p-value of 0.000 ($p < 0.05$), indicating that this preparation is effective as an alternative therapy for gingivitis. Kumalasari (2020) reported that basil leaf extract tested positive for the presence of bioactive compounds such as flavonoids, alkaloids, saponins, and tannins[6].

This finding is consistent with Hanum's statement, as cited in Theodora, which notes that the mechanism of tannins involves microbial enzyme inhibition, deprivation of nutritional substrates, and interference with microbial metabolism through disruption of oxidative phosphorylation. Meanwhile, flavonoids exhibit bacteriostatic and antioxidant properties, and are capable of damaging microbial cell walls by forming complexes with polysaccharides[4]. Additionally, these compounds exert anti-inflammatory effects by suppressing the release of pro-inflammatory cytokines such as IL-1β and TNF-α.

ISSN No: 2456-2165 https://doi.org/10.38124/ijisrt/25aug795

Although the basil leaf extract mouthwash did not produce statistically significant results in certain parameters, previous studies have reported relevant findings. Agnes demonstrated that 4% basil extract could increase salivary pH; however, this effect was transient[7]. Changes in salivary pH following rinsing persisted for only 15–60 minutes due to the efficient action of the salivary buffering system, which quickly restores pH homeostasis.

Basil leaves contain flavonoids and essential oils (such as eugenol) known to stimulate salivary secretion. Flavonoids impart a bitter and astringent taste, which chemically stimulates the salivary glands, whereas essential oils act through the autonomic nervous system to promote saliva secretion. The increase in salivary flow rate may indirectly contribute to an enhanced buffering capacity of saliva[8].

V. CONCLUSION

The basil leaf extract *(Ocimum Sanctum L.)* mouthwash formulations at concentrations of 5% and 10% demonstrated effectiveness as alternative therapeutic agents for gingivitis, as indicated by statistical test results showing p-values of 0.002 and 0.000, respectively ($p < 0.05$).

Conversely, the basil leaf extract mouthwash at both 5% and 10% concentrations did not significantly affect salivary pH, with p-values of 0.427 and 0.704 ($p > 0.05$), indicating no meaningful changes in salivary pH.

A statistically significant difference was observed between the 5% and 10% basil leaf extract mouthwashes and chlorhexidine as well as aquadest in their effectiveness as alternative therapies for gingivitis, with a p-value of 0.000 ($p < 0.05$).

However, no significant difference was found between the 5% and 10% basil leaf extract mouthwashes, chlorhexidine, and aquadest with respect to salivary pH, as evidenced by a p-value of 0.770 ($p > 0.05$), suggesting that all treatment groups exerted a similar effect on changes in salivary pH.

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