

Comparative Evaluation Of Commercial And Herbal (Tulsi And Aloe Vera) Mouthwash On Plaque Inhibition In Children..

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ABSTRACT

Dental plaque is the principal etiological factor for gingivitis and dental caries. Chlorhexidine is an effective antiplaque agent; however, its long-term use may be associated with adverse effects, creating a need for safe herbal alternatives in children. Thus, the aim of our study was to compare the effectiveness of 0.2% chlorhexidine, Tulsi–Aloe vera herbal mouthwash, and 0.9% normal saline on plaque inhibition and gingival/oral-hygiene status among 150 healthy children aged 8–13 years, who were randomly allocated into three groups of 50 each: Group I, 0.9% normal saline; Group II, 0.2% chlorhexidine; and Group III, Tulsi–Aloe vera herbal mouthwash. Plaque Index (PI), Gingival Index (GI), and Simplified Oral Hygiene Index (OHI-S) were recorded at baseline and on days 10, 20, and 30. We have found that, a significant intergroup differences among GI and PI scores at all study intervals ($p < 0.001$). Chlorhexidine showed significantly lower GI scores than normal saline and herbal mouthwash throughout the follow-up period. Both chlorhexidine and herbal mouthwash demonstrated significantly lower PI scores than normal saline at all intervals ($p < 0.001$). No significant difference in PI was found between chlorhexidine and herbal mouthwash at baseline, day 10, day 20, or day 30 ($p > 0.05$). OHI-S scores were significantly different up to day 20 but became comparable among groups on day 30 ($p = 0.642$). Hence, we have come to conclude that, Tulsi–Aloe vera mouthwash showed plaque-inhibitory efficacy comparable to chlorhexidine and may be a useful natural adjunct for plaque control in children, while chlorhexidine remained superior for reducing gingival inflammation.....

Keywords: Aloe vera, Chlorhexidine, Children, Dental plaque, Tulsi

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INTRODUCTION

Dental plaque is a structured microbial biofilm that adheres to tooth surfaces and is the principal etiological factor in plaque-induced gingivitis and other common oral diseases.¹ In children, inadequate plaque control can result in gingival inflammation, bleeding, halitosis, and an increased risk of dental caries.² Although regular toothbrushing remains the foundation of oral hygiene, children may have inconsistent brushing skills, poor compliance, and difficulty cleaning all tooth surfaces effectively.³ Therefore, antimicrobial

mouthrinses may be used as adjuncts to mechanical plaque control to improve plaque removal and gingival health. Moreover, chlorhexidine gluconate is widely regarded as the gold-standard chemical antiplaque mouthrinse because of its broad-spectrum antimicrobial activity and substantivity within the oral cavity.⁴ A systematic review found high-quality evidence that chlorhexidine used alongside routine oral-hygiene measures produces a substantial reduction in dental plaque and reduces gingivitis

after 4–6 weeks of use.⁵ However, its prolonged or repeated use may be limited by adverse effects such as extrinsic tooth staining, taste alteration, mucosal irritation, and increased calculus formation. These limitations are particularly relevant in children, in whom acceptability, safety, and long-term adherence are important considerations; hence, safer herbal alternatives are being actively explored. In addition to above, tulsi (*Ocimum sanctum*) and Aloe vera are medicinal plants with reported antimicrobial, anti-inflammatory, and antiplaque properties. Tulsi contains bioactive constituents such as eugenol, ursolic acid, and carvacrol, which may contribute to inhibition of oral microorganisms and reduction of gingival inflammation.⁶ In a randomized controlled trial, *Ocimum sanctum* mouthrinse demonstrated significant reductions in plaque, gingival, and bleeding indices over 15 and 30 days and showed clinical performance comparable to chlorhexidine.⁷ Likewise, clinical trials of Aloe vera mouthrinses have reported significant reductions in plaque and gingival scores, with some studies finding no statistically significant difference from chlorhexidine.⁸ A systematic review of six randomized clinical trials involving 1,358 participants concluded that Aloe vera can reduce plaque and gingival inflammation with minimal adverse effects, although the available evidence suggests that chlorhexidine may retain a modest advantage for plaque reduction in some studies.^{9,10} Despite the individual evidence supporting Tulsi and Aloe vera, limited clinical evidence is available regarding a

combined Tulsi–Aloe vera mouthwash in children. Children aged 8–13 years represent an important preventive-care population because mixed dentition, developing oral-hygiene practices, and variable manual dexterity can predispose them to plaque accumulation and gingival inflammation. Moreover, comparison with both 0.2% chlorhexidine as an active reference standard and 0.9% normal saline as a negative control is necessary to determine the true clinical benefit of the herbal formulation. Therefore, the present study was undertaken to compare the effectiveness of 0.2% chlorhexidine, Tulsi–Aloe vera herbal mouthwash, and 0.9% normal saline on plaque inhibition, gingival status, and oral-hygiene status among children.

AIM

To compare the effectiveness of 0.2% chlorhexidine, a Tulsi–Aloe vera herbal mouthwash, and 0.9% normal saline on plaque inhibition and gingival/oral-hygiene status among children aged 8–13 years.

MATERIAL AND METHODS

This parallel-group, in vivo comparative clinical study was conducted among 150 medically healthy children aged 8–13 years from the Government Higher Secondary Girls School in Vidyadhar Nagar and Krishna Happy School in Shastri Nagar, Jaipur as shown in figure 1 & 2



FIGURE 1 : STUDY SETTING GOVERNMENT HIGHER SECONDARY GIRLS SCHOOL



FIGURE 2 : STUDY SETTING KRISHNA HAPPY SCHOOL

who fulfilled the eligibility criteria were randomly allocated into three groups of 50 participants each: Group I received 0.9% normal saline mouthrinse as shown in figure 3,



FIGURE 3 : NORMAL SALINE MOUTHWASH

Group II received commercially available 0.2% chlorhexidine mouthwash (Dentosys Advanced, Dr. Morepen) as shown in figure 4,



FIGURE 4 : CHLORHEXIDINE MOUTHWASH

and Group III received a formulated herbal mouthwash containing 10% Tulsi (*Ocimum sanctum*) extract and 10% Aloe vera (*Aloe barbadensis*) extract as shown in figure 5.



FIGURE 5 : HERBAL (TULSI + ALOE VERA) MOUTHWASH

The herbal formulation also contained cocamidopropyl betaine, ethyl alcohol, sugar, distilled water, sodium benzoate, and spearmint flavouring. Written informed consent was obtained from the parent/guardian before enrolment. Clinical examinations were performed using sterilized diagnostic instruments as shown in figure 6.



FIGURE 6 : INSTRUMENTS FOR RECORDING PLAQUE ,ORAL HYGIENE INDEX SIMPLIFIED AND GINGIVAL INDICES

Plaque Index (PI), Gingival Index (GI), and Simplified Oral Hygiene Index (OHI-S) were recorded at baseline (day 1) and on days 10, 20, and 30. The Plaque Index was assessed on distofacial, facial, mesiofacial, and lingual tooth surfaces after air drying, while OHI-S was recorded using the recommended representative index teeth or appropriate substitutes in mixed dentition.

INCLUSION CRITERIA

Those with aged 8–13 years.
Children with no supragingival calculus.
Those having fair plaque scores at baseline.
Patients those were willing to use the allotted mouthwash regularly.

EXCLUSION CRITERIA

Those who all were unwilling to participate or whose parents/guardians.
History of systemic antibiotic intake during the preceding one month.
Presence of cellulitis, dentoalveolar abscess, draining sinus, or need for emergency dental treatment.
Any systemic condition or medication likely to affect salivary flow.
Known hypersensitivity or allergy to chlorhexidine, herbal ingredients, or any study mouthwash component.
Those who all were wearing removable or fixed prostheses or orthodontic appliance.
History of professional oral prophylaxis within the preceding 15 days.

STATISTICAL ANALYSIS

Data were entered into Microsoft Excel and analysed using appropriate statistical software. Continuous variables, including age, Plaque Index, Gingival Index, and OHI-S scores, were summarized as mean and standard deviation (mean $\pm$ SD), whereas categorical variables such as sex were presented as frequency and percentage. Intergroup comparisons of mean PI, GI, and OHI-S scores among the normal saline, chlorhexidine, and herbal mouthwash groups at each assessment point (day 1, 10, 20, and 30) were performed using one-way analysis of variance (ANOVA). When ANOVA showed a statistically significant difference, Tukey's honestly significant difference (HSD) post-hoc test was used for pairwise comparison between groups. Changes in PI, GI, and OHI-S scores within each group over the four time points were assessed using repeated-measures analysis of variance, followed by appropriate pairwise post-hoc comparisons. A p-value of less than 0.05 was considered statistically significant, while $p < 0.001$ was considered highly statistically significant.

RESULT

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Descriptives					
Age					
	N	Mean	Std. Deviation	Minimum	Maximum
Nacl	50	10.1600	1.51671	8.00	13.00
Chlorhexidine	50	10.2400	1.49229	8.00	13.00
Herbal	50	10.2000	1.71429	8.00	13.00

TABLE 1 : MEAN AGE IN GROUPS

Table 1 showed that, the mean age of the participants was 10.16 ± 1.52 years in the normal saline (NaCl) group, 10.24 ± 1.49 years in the chlorhexidine group, and 10.20 ± 1.71 years in the herbal mouthwash group. Each group comprised 50 children, and the age range was identical across all groups, varying from 8 to 13 years. The closely comparable mean ages and standard deviations indicate that the three groups were similar with respect to age at baseline.

			Groups			Total
			Nacl	Chlorhexidine	Herbal	
Gender	Male	Count	22	14	26	62
		% within Groups	44.0%	28.0%	52.0%	41.3%
	Female	Count	28	36	24	88
		% within Groups	56.0%	72.0%	48.0%	58.7%
Total		Count	50	50	50	150
		% within Groups	100.0%	100.0%	100.0%	100.0%

TABLE 2 : GENDER DIFFERENTIATION

Table 2 showed that, 62 (41.3%) were male and 88 (58.7%) were female. In the normal saline (NaCl) group, 22 (44.0%) participants were male and 28 (56.0%) were female; in the chlorhexidine group, 14 (28.0%) were male and 36 (72.0%) were female; and in the herbal mouthwash group, 26 (52.0%) were male and 24 (48.0%) were female. Thus, female participants predominated in the overall sample and in both the NaCl and chlorhexidine groups, whereas the herbal group showed a slightly higher proportion of male participants.

ANOVA						
		Sum of Squares	df	Mean Square	F	P value
Day 1 GI	Between Groups	3.692	2	1.846	58.716	<0.001**
	Within Groups	4.622	147	.031		
	Total	8.315	149			
Day 10	Between Groups	2.491	2	1.245	53.899	<0.001**
	Within Groups	3.397	147	.023		
	Total	5.887	149			
Day 20	Between Groups	1.740	2	.870	46.969	<0.001**
	Within Groups	2.723	147	.019		
	Total	4.462	149			
Day 30	Between Groups	.513	2	.256	14.935	<0.001**
	Within Groups	2.522	147	.017		
	Total	3.035	149			

TABLE 3 : INTERGROUP COMPARISON OF GINGIVAL INDEX SCORES BETWEEN GROUPS

Table 3 showed that, there was a highly statistically significant difference in Gingival Index (GI) scores among the normal saline, chlorhexidine, and herbal mouthwash groups at all follow-up time points. The intergroup differences were significant on day 1 ($F = 58.716$, $p < 0.001$), day 10 ($F = 53.899$, $p < 0.001$), day 20 ($F = 46.969$, $p < 0.001$), and day 30 ($F = 14.935$, $p < 0.001$). These findings indicate that the mean GI scores differed significantly among the three groups throughout the study period; however, ANOVA alone does not identify which specific group pairs differed, and therefore post-hoc pairwise comparisons are required for detailed interpretation.

Multiple Comparisons							
Tukey HSD							
Dependent Variable	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	P value	95% Confidence Interval	
						Lower Bound	Upper Bound
Day 1 GI	Chlorhexidine	Nacl	-.27180	.03546	<0.001**	-.3558	-.1878
		Herbal	-.37120	.03546	<0.001**	-.4552	-.2872
	Nacl	Chlorhexidine	.27180	.03546	<0.001**	.1878	.3558
		Herbal	-.09940	.03546	.016	-.1834	-.0154
	Herbal	Chlorhexidine	.37120	.03546	<0.001**	.2872	.4552
		Nacl	.09940	.03546	.016	.0154	.1834
Day 10	Chlorhexidine	Nacl	-.21100	.03040	<0.001**	-.2830	-.1390
		Herbal	-.30880	.03040	<0.001**	-.3808	-.2368
	Nacl	Chlorhexidine	.21100	.03040	<0.001**	.1390	.2830
		Herbal	-.09780	.03040	.005	-.1698	-.0258
	Herbal	Chlorhexidine	.30880	.03040	<0.001**	.2368	.3808
		Nacl	.09780	.03040	.005	.0258	.1698
Day 20	Chlorhexidine	Nacl	-.17520	.02722	<0.001**	-.2396	-.1108
		Herbal	-.25840	.02722	<0.001**	-.3228	-.1940
	Nacl	Chlorhexidine	.17520	.02722	<0.001**	.1108	.2396
		Herbal	-.08320	.02722	.007	-.1476	-.0188
	Herbal	Chlorhexidine	.25840	.02722	<0.001**	.1940	.3228
		Nacl	.08320	.02722	.007	.0188	.1476
Day 30	Chlorhexidine	Nacl	-.14160	.02620	<0.001**	-.2036	-.0796
	dine	Herbal	-.08920	.02620	.002	-.1512	-.0272
		Chlorhexidine	.14160	.02620	<0.001**	.0796	.2036
	Nacl	Herbal	.05240	.02620	.116	-.0096	.1144
		Chlorhexidine	.08920	.02620	.002	.0272	.1512
	Herbal	Nacl	-.05240	.02620	.116	-.1144	.0096

TABLE 4 : INTRA GROUP COMPARISON OF GINGIVAL INDEX SCORES BETWEEN GROUPS

Table 4 showed that the chlorhexidine group had significantly lower Gingival Index (GI) scores than both the normal saline and herbal mouthwash groups at day 1, day 10, day 20, and day 30 ($p < 0.001$ for chlorhexidine versus normal saline at all time points; $p < 0.001$ at days 1–20 and $p = 0.002$ at day 30 for chlorhexidine versus herbal mouthwash). The normal saline group also demonstrated significantly lower GI scores than the herbal group on day 1 (mean difference = -0.0994 ; $p = 0.016$), day 10 (mean difference = -0.0978 ; $p = 0.005$), and day 20 (mean difference = -0.0832 ; $p = 0.007$); however, this difference was not statistically significant on day 30 (mean difference = 0.0524 ; $p = 0.116$). Overall, chlorhexidine

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produced the greatest reduction in gingival inflammation throughout the study, while the herbal mouthwash showed improvement and achieved GI scores comparable to normal saline by day 30.

ANOVA						
		Sum of Squares	df	Mean Square	F	P value
Day 1 PI	Between Groups	.782	2	.391	11.539	<0.001**
	Within Groups	4.980	147	.034		
	Total	5.762	149			
Day 10	Between Groups	1.016	2	.508	20.119	<0.001**
	Within Groups	3.713	147	.025		
	Total	4.729	149			
Day 20	Between Groups	1.433	2	.717	24.527	<0.001**
	Within Groups	4.296	147	.029		
	Total	5.729	149			
Day 30	Between Groups	1.169	2	.584	16.478	<0.001**
	Within Groups	5.212	147	.035		
	Total	6.381	149			

TABLE 5 : INTERGRUP COMPARISON OF PLAQUE INDEX SCORES BETWEEN GROUPS

Table 5 revealed a highly statistically significant difference in Plaque Index (PI) scores among the normal saline, chlorhexidine, and herbal mouthwash groups at every assessment interval. Significant intergroup differences were observed at day 1 ($F = 11.539$, $p < 0.001$), day 10 ($F = 20.119$, $p < 0.001$), day 20 ($F = 24.527$, $p < 0.001$), and day 30 ($F = 16.478$, $p < 0.001$). These findings indicate that the three mouthwash groups differed significantly in their mean plaque scores throughout the 30-day study period, suggesting that the interventions had different effects on plaque accumulation; subsequent post-hoc pairwise comparisons are required to identify the specific groups between which significant differences exist.

Multiple Comparisons							
Tukey HSD							
Dependent Variable	t(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	P value.	95% Confidence Interval	
						Lower Bound	Upper Bound
Day 1 PI	Chlorhexidine	NaCl	-.12400	.03681	.003	-.2112	-.0368
		Herbal	.04720	.03681	.407	-.0400	.1344
	NaCl	Chlorhexidine	.12400	.03681	.003	.0368	.2112
		Herbal	.17120	.03681	.000	.0840	.2584
	Herbal	Chlorhexidine	-.04720	.03681	.407	-.1344	.0400
		NaCl	-.17120	.03681	<0.001**	-.2584	-.0840
Day 10	Chlorhexidine	NaCl	-.17940	.03179	<0.001**	-.2547	-.1041
		Herbal	-.01000	.03179	.947	-.0853	.0653
	NaCl	Chlorhexidine	.17940	.03179	<0.001**	.1041	.2547
		Herbal	.16940	.03179	<0.001**	.0941	.2447
	Herbal	Chlorhexidine	.01000	.03179	.947	-.0653	.0853
		NaCl	-.16940	.03179	<0.001**	-.2447	-.0941
Day 20	Chlorhexidine	NaCl	-.21800	.03419	<0.001**	-.2989	-.1371
		Herbal	-.02320	.03419	.776	-.1041	.0577
	NaCl	Chlorhexidine	.21800	.03419	<0.001**	.1371	.2989
		Herbal	.19480	.03419	<0.001**	.1139	.2757
	Herbal	Chlorhexidine	.02320	.03419	.776	-.0577	.1041
		NaCl	-.19480	.03419	<0.001**	-.2757	-.1139

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Day 30	Chlorhexi dine	Nacl	-.19240	.03766	<0.001**	-.2816	-.1032
		Herbal	-.01080	.03766	.956	-.1000	.0784
	Nacl	Chlorhexidine	.19240	.03766	<0.001**	.1032	.2816
		Herbal	.18160	.03766	<0.001**	.0924	.2708
	Herbal	Chlorhexidine	.01080	.03766	.956	-.0784	.1000
		Nacl	-.18160	.03766	<0.001**	-.2708	-.0924

TABLE 6 : INTRAGROUP COMPARISON OF PLAQUE INDEX SCORES BETWEEN GROUPS

Table 6 demonstrated that the chlorhexidine group had significantly lower Plaque Index (PI) scores than the normal saline group at day 1 (mean difference = -0.1240; $p = 0.003$), day 10 (-0.1794; $p < 0.001$), day 20 (-0.2180; $p < 0.001$), and day 30 (-0.1924; $p < 0.001$). Similarly, the herbal mouthwash group showed significantly lower PI scores than the normal saline group at all intervals, including day 1 (mean difference = -0.1712; $p < 0.001$), day 10 (-0.1694; $p < 0.001$), day 20 (-0.1948; $p < 0.001$), and day 30 (-0.1816; $p < 0.001$). However, no statistically significant difference in PI scores was observed between the chlorhexidine and herbal mouthwash groups at day 1 ($p = 0.407$), day 10 ($p = 0.947$), day 20 ($p = 0.776$), or day 30 ($p = 0.956$), indicating that both chlorhexidine and the herbal mouthwash were comparably effective in reducing plaque accumulation and were superior to normal saline throughout the study period.

ANOVA						
		Sum of Squares	df	Mean Square	F	P value
day 1 OHIS	Between Groups	.957	2	.478	18.763	<0.001**
	Within Groups	3.748	147	.025		
	Total	4.705	149			
day 10	Between Groups	.606	2	.303	9.454	<0.001**
	Within Groups	4.676	146	.032		
	Total	5.281	148			
	Between Groups	.708	2	.354	8.589	<0.001**
	Within Groups	5.850	142	.041		
	Total	6.557	144			
	Between Groups	.031	2	.015	.445	.642
	Within Groups	4.283	125	.034		
	Total	4.314	127			

TABLE 7 : INTERGROUP COMPARISON OF SIMPLIFIED ORAL HYGIENE INDEX SCORES BETWEEN GROUPS

Table 7 demonstrated statistically significant differences in mean Simplified Oral Hygiene Index (OHI-S) scores among the normal saline, chlorhexidine, and herbal mouthwash groups at day 1 ($F = 18.763$, $p < 0.001$), day 10 ($F = 9.454$, $p < 0.001$), and day 20 ($F = 8.589$, $p < 0.001$). However, at day 30, the difference in mean OHI-S scores among the three groups was not statistically significant ($F = 0.445$, $p = 0.642$). These findings indicate that although the groups differed significantly in oral hygiene status during the initial 20 days of the study, their OHI-S scores became comparable by the end of the 30-day follow-up period.

Multiple Comparisons							
Tukey HSD							
Dependent Variable	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	P value	95% Confidence Interval	
						Lower Bound	Upper Bound

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day 1 OHIS	Nacl	Chlorhexidine	.02780	.03194	.660	-.0478	.1034
		Herbal	.18160*	.03194	<0.001**	.1060	.2572
	Chlorhexi dine	Nacl	-.02780	.03194	.660	-.1034	.0478
		Herbal	.15380*	.03194	<0.001**	.0782	.2294
	Herbal	Nacl	-.18160*	.03194	<0.001**	-.2572	-.1060
		Chlorhexidine	-.15380*	.03194	<0.001**	-.2294	-.0782
day 10	Nacl	Chlorhexidine	-.09960*	.03579	.017*	-.1843	-.0149
		Herbal	.05447	.03597	.287	-.0307	.1396
	Chlorhexi dine	Nacl	.09960*	.03579	.017*	.0149	.1843
		Herbal	.15407*	.03597	<0.001**	.0689	.2392
	Herbal	Nacl	-.05447	.03597	.287	-.1396	.0307
		Chlorhexidine	-.15407*	.03597	<0.001**	-.2392	-.0689
day 20	Nacl	Chlorhexidine	-.11687*	.04143	.015*	-.2150	-.0187
		Herbal	.04977	.04122	.451	-.0479	.1474
	Chlorhexi dine	Nacl	.11687*	.04143	.015*	.0187	.2150
		Herbal	.16664*	.04122	<0.001**	.0690	.2643
	Herbal	Nacl	-.04977	.04122	.451	-.1474	.0479
		Chlorhexidine	-.16664*	.04122	<0.001**	-.2643	-.0690
day 30	Nacl	Chlorhexidine	-.01750	.04168	.907	-.1164	.0814
		Herbal	.01936	.04001	.879	-.0755	.1143
	Chlorhexi dine	Nacl	.01750	.04168	.907	-.0814	.1164
		Herbal	.03686	.03918	.616	-.0561	.1298
	Herbal	Nacl	-.01936	.04001	.879	-.1143	.0755
		Chlorhexidine	-.03686	.03918	.616	-.1298	.0561

TABLE 8 : INTRAGROUP COMPARISON OF SIMPLIFIED ORAL HYGIENE INDEX SCORES BETWEEN GROUPS

Table 8 showed that, on day 1, the herbal mouthwash group had significantly lower OHI-S scores than both the NaCl group (mean difference = -0.1816; $p < 0.001$) and chlorhexidine group (mean difference = -0.1538; $p < 0.001$), whereas the NaCl and chlorhexidine groups did not differ significantly ($p = 0.660$). On days 10 and 20, the chlorhexidine group showed significantly higher OHI-S scores than the NaCl group ($p = 0.017$ and $p = 0.015$, respectively) and the herbal group ($p < 0.001$ at both time points), while the difference between the NaCl and herbal groups remained non-significant ($p = 0.287$ and $p = 0.451$, respectively). By day 30, no statistically significant differences in OHI-S scores were found between any pair of groups ($p > 0.05$), indicating that the oral hygiene status of participants became comparable among the normal saline, chlorhexidine, and herbal mouthwash groups at the end of the study period.

DISCUSSION

The present study findings demonstrated significant differences in Plaque Index (PI) and Gingival Index (GI) scores among the three groups at all assessment intervals. Chlorhexidine produced significantly lower GI scores than both normal saline and the herbal mouthwash throughout the 30-day follow-up, indicating its superior effect in reducing gingival inflammation. This finding is consistent with the established antiplaque substantivity and broad antimicrobial action of chlorhexidine. In contrast, the herbal mouthwash showed significantly lower plaque scores than normal saline at all time points and demonstrated plaque inhibition comparable to chlorhexidine, as no statistically significant difference in PI was observed between the chlorhexidine and herbal groups on days 1, 10, 20, or 30. These results suggest that the combined Tulsi–Aloe vera formulation may be an effective adjunct for plaque control in children.¹¹

The comparable antiplaque effect of the herbal formulation is supported by the known properties of its constituents.

Tulsi (*Ocimum sanctum*) contains bioactive compounds such as eugenol, carvacrol, ursolic acid, flavonoids, and tannins, which may inhibit microbial growth, interfere with bacterial adherence, and exert anti-inflammatory effects. Aloe vera contains polysaccharides, saponins, anthraquinones, vitamins, and phenolic compounds that have been associated with antibacterial, anti-inflammatory, antioxidant, and wound-healing activity.¹² The present findings are in agreement with the a study wherein a separate Tulsi and Aloe vera mouthrinses showed reductions in plaque, gingival, and bleeding indices over 30 days and were clinically comparable with chlorhexidine at the end of follow-up.¹³ Similarly, a study found significant reductions in plaque and gingival scores with both Aloe vera and chlorhexidine mouthwashes, with no significant difference between the active groups, while both were superior to placebo.¹⁴

With respect to gingival inflammation, chlorhexidine was significantly more effective than the herbal mouthwash at all follow-up visits in the present study, although the difference between herbal mouthwash and normal saline became non-significant by day 30. This finding contrasts with another study, who reported that Tulsi, Aloe vera, and chlorhexidine were equally effective in reducing gingival and bleeding indices at 30 days.¹¹ The difference may be explained by variations in study population, age group, baseline plaque and gingival status, formulation and concentration of herbal extracts, rinsing frequency and duration, supervision of oral-hygiene practices, and whether professional scaling was performed before the intervention. The cited study was conducted in adults aged 18–45 years with mild-to-moderate gingivitis and included professional scaling before twice-daily rinsing,¹¹ whereas the present study was carried out among schoolchildren aged 8–13 years. Therefore, the comparatively greater anti-inflammatory effect of chlorhexidine in this pediatric population may reflect its strong substantivity as well as differences in compliance and plaque-control ability among children.

The OHI-S findings showed significant intergroup differences until day 20. However, the scores were comparable among all groups by day 30. This may indicate that repeated oral-health monitoring, mouthrinse use, and reinforcement of oral-hygiene instructions improved overall hygiene practices in all participants, including those using normal saline. Nevertheless, the persistent superiority of chlorhexidine for GI reduction and the equivalence of the herbal rinse with chlorhexidine for PI reduction are clinically meaningful. Evidence from a triple-blinded randomized trial among schoolchildren also showed that a 4% Tulsi formulation significantly reduced plaque and gingival scores compared with placebo and produced antiplaque and antigingivitis effects comparable to a conventional fluoridated dentifrice after 21 days.¹⁵ Thus, the present study supports the potential use of a Tulsi–Aloe vera mouthwash as a natural and acceptable plaque-control adjunct, particularly when prolonged chlorhexidine use is undesirable because of staining, taste alteration, or mucosal adverse effects; however, larger, well-standardized, and

longer-term pediatric trials are needed to confirm its sustained anti-gingivitis efficacy.

Henceforth, Tulsi–Aloe vera mouthwash demonstrated plaque-inhibitory efficacy comparable to 0.2% chlorhexidine and superior to normal saline, whereas chlorhexidine remained more effective for reduction of gingival inflammation.

CONCLUSION

Within the limitations of this 30-day in vivo study among children aged 8–13 years, both 0.2% chlorhexidine and the Tulsi–Aloe vera herbal mouthwash demonstrated significant plaque-inhibitory effects and were superior to 0.9% normal saline in reducing Plaque Index scores. No statistically significant difference in plaque reduction was observed between the chlorhexidine and herbal mouthwash groups at any follow-up interval, indicating comparable antiplaque efficacy. Chlorhexidine, however, showed significantly lower Gingival Index scores than both the herbal and normal saline groups throughout the study, suggesting greater effectiveness in reducing gingival inflammation. The herbal mouthwash provided measurable clinical improvement and may be considered a promising natural adjunct for plaque control in children, particularly where the adverse effects associated with prolonged chlorhexidine use are a concern. Nevertheless, larger, long-term randomized clinical trials with standardized herbal formulations and microbiological assessment are required before recommending the Tulsi–Aloe vera mouthwash as a complete substitute for chlorhexidine

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