



Comparing the Effectiveness of herbal and fluoridated dentifrices on Dental caries- A Systematic Review

DR. SHIVASHANKAR.K*, DR. MEIGNANA ARUMUGHAM.I**

*Post Graduate, Department of Public health dentistry, Saveetha Dental college and hospitals, Chennai, India.**
 Reader, Department of Public health dentistry, Saveetha Dental college and hospitals, Chennai, India.

shiva.free@gmail.com

ABSTRACT: BACKGROUND: Dental caries is a global oral health problem which has a distinctive variation. Cariogenic microorganisms like *Streptococcus mutans* and *Lactobacillus acidophilus* are the primary causative microorganism for the development of dental caries. These cariogenic microorganisms encourage the accumulation and adherence of plaque biofilm by metabolizing sucrose into sticky glycan. The microorganisms in dental plaque degrade the dietary carbohydrates producing lactic acid leading to localized demineralization and the eventual formation of dental caries. Chemical plaque control like dentifrices used as an adjuvant to Mechanical plaque control is the most effective method of removing biofilm, thereby preventing dental caries. Various chemically derived antimicrobial agents are incorporated to dentifrices which includes Triclosan, zinc chloride etc. Other agents like fluoride, calcium phosphates are added to improve the anticariogenic properties of dentifrices. In recent times, there has been renewed interest in naturally occurring products. There are some dozen brands that claim or position themselves as natural, chemical-free, made of herbs. **AIM:** The aim of this systematic review was to analyse the existing literature to compare the effectiveness of herbal and conventional dentifrices on dental caries. **MATERIALS AND METHODS:** SEARCHSTRATEGY. The Data Bases of PubMed and Google scholar were searched up to September 2015 for the related topic. **SELECTION CRITERIA.** Randomized controlled trials, comparative clinical trials and In-vitro studies in which the effectiveness of herbal and conventional dentifrices on dental caries. **RESULTS:** The systematic search revealed a total of 19 publications from PubMed and Google Scholar which were scrutinized based on pre-set inclusion and exclusion criteria. Nine publications fulfilled all the inclusion criteria and 10 publications were excluded from the review. Out of nine studies, three studies were clinical studies and three were In-vitro studies. All the studies used Microbiological analysis for determination of cariogenic microorganisms in plaque and saliva whereas; one study used pH of plaque and saliva. Among the included studies, three studies had high risk of bias with level 2 evidence. **CONCLUSION:** With the evidences available it can be concluded that herbal toothpastes can be used as an alternative to fluoridated toothpaste and both has the similar kind effect on cariogenic microflora.

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Keywords: Comparing; Effectiveness; herbal and fluoridated dentifrices; Dental; Systematic Review

INTRODUCTION

Dental caries is a global oral health problem which has a distinctive variation (Baelum et al, 2007). Dental caries is the most common oral disease that affects significant number of Indian population. The prevalence of dental caries in India is reported as 31.5% to 89% (Shourie KL et al 1941; Damle SC, 1994; Antia FE, 1962; Tewari A et al, 1977; Dash JK et al, 2002; Dhar V et al, 2007; Saravanan S et al, 2008). Dental caries is widely recognised as a multifactorial infectious disease. The main aetiology of dental caries are; a) cariogenic bacteria, b) fermentable carbohydrates, c) a susceptible tooth and host and d) time (Rebecca Harris et al, 2004). Cariogenic microorganisms like *Streptococcus mutans* and *Lactobacillus acidophilus* are the primary causative

microorganism for the development of dental caries. These cariogenic microorganisms encourage the accumulation and adherence of plaque biofilm by metabolizing sucrose into sticky glycan. The microorganisms in dental plaque degrade the dietary carbohydrates producing lactic acid leading to localized demineralization and the eventual formation of dental caries (Namita P et al, 2012; Taylor PW et al, 2005 in Anita et al, 2014).

Poor oral hygiene is one of the reasons for accumulation of plaque in the oral cavity thereby harbouring microbes. The methods used for plaque control are chemical and mechanical method. Besides mechanical cleaning of teeth, the use of chemical agents with antiplaque or antimicrobial activity into dental products has been proposed as a potential

prophylactic method of reducing plaque-mediated disease by limiting the cariogenic bacteria in the oral cavity (Priya S et al, 2012)

Various chemically derived antimicrobial agents are incorporated to dentifrices which includes Triclosan, zinc chloride etc. Other agents like fluoride, calcium phosphates are added to improve the anticariogenic properties of dentifrices. Fluoride was first added to toothpastes in the 1890's. Consumers who wish to avoid the artificial ingredients commonly found in regular toothpastes use the herbal toothpastes. Many herbal toothpastes do not contain fluoride or sodium lauryl sulfate. The ingredients found in natural toothpastes vary widely but often include baking soda, aloe, eucalyptus oil, myrrh, plant extract (strawberry extract), and essential oils.

In recent times, there has been renewed interest in naturally occurring products. There are some dozen brands that claim or position themselves as natural, chemical-free, made of herbs. They claim to have the same or even more anticariogenic and antiplaque effect without adding any chemicals. Hence, the aim of the present systematic review was to compare the effectiveness of herbal and conventional toothpastes on Dental caries.

AIM:

The aim of this systematic review was to analyse the existing literature to compare the effectiveness of herbal and conventional dentifrices on dental caries.

MATERIALS AND METHODS:

STRUCTURED QUESTION:

- Is there any difference between effectiveness of herbal and fluoridated toothpastes on oral micro flora.
- PICO Analysis
 - Population-** Dental caries
 - Intervention-** herbal toothpastes
 - Comparison-** fluoridated/ commercial toothpastes
 - Outcome-** whether there is a significant reduction in cariogenic microflora and subsequently inhibiting dental caries development.

INCLUSION CRITERIA

Criteria for considering studies for the Review

- Randomized controlled trials and clinical trials comparing the effectiveness of herbal and fluoridated toothpastes on dental caries.
- In vitro studies.
- Literature in other languages which can be translated by the reviewer were included

EXCLUSION CRITERIA

- Studies evaluating the effectiveness of herbal and fluoridated dentifrices on Gingivitis, Periodontitis, Oral Malodour and Pericoronitis patients.
- Animal study.
- Reviews.
- Literatures in other languages which cannot be translated by the reviewer were excluded.

SOURCES USED: The Data Bases of PubMed and Google scholar were searched up to July 2015 for the related topic.

On-going Trials Registers:

- We used free-text terms to search the following on-going trial registers:
- US National Institutes of Health Trials Register ([http:// clinicaltrials.gov](http://clinicaltrials.gov))
- The WHO Clinical Trials Registry Platform (<http://apps.who.int/trialsearch/default.aspx>)
- Clinical Trial Registry of India (<http://ctri.nic.in/Clinicaltrials/advsearch.php>)
- Only articles in English and human species were applied during the electronic search to include all the possible clinical trials that are relevant for the search phase of the systematic review. Reference list of the identified randomized trials were also checked for possible additional studies.
- **SEARCH METHODOLOGY:**

Figure 1-Screenshot of PubMed search

Pubmed- dental caries OR caries dental OR decay dental OR dental cavities OR dental decay OR enamel caries OR dentin caries AND herbal toothpaste OR herbal extract OR Ayurveda toothpaste OR herbal dentifrices OR natural toothpaste AND fluoride toothpaste OR commercial toothpaste OR fluoridated dentifrices OR fluoride containing toothpaste AND streptococcus mutans OR lactobacillus OR anticariogenic effect OR caries inhibitory effect OR cariogenic microflora OR salivary ph OR ph of saliva OR plaque ph OR ph of plaque OR oral microflora OR plaque micro organisms.

Search	Add to builder	Query	Items found
#32	Add	Search ((((((((((dental caries) OR caries dental) OR decay dental) OR dental cavities) OR dental decay) OR enamel caries) OR dentin caries)) AND (((((herbal toothpaste) OR herbal extract) OR Ayurveda toothpaste) OR herbal dentifrices) OR natural toothpaste)) AND (((((fluoride toothpaste) OR commercial toothpaste) OR flouridated dentifrices) OR fluoride containing toothpaste)) AND ((((((((((streptococcus mutans) OR lactobacilus) OR anticariogenic effecct) OR caries inhibitory effecct) OR cariogenic microflora) OR salivary ph) OR ph of saliva) OR plaque ph) OR ph of plaque) OR oral microflora) OR plaque micro organisms)	9
#31	Add	Search ((((((((((streptococcus mutans) OR lactobacilus) OR anticariogenic effecct) OR caries inhibitory effecct) OR cariogenic microflora) OR salivary ph) OR ph of saliva) OR plaque ph) OR ph of plaque) OR oral microflora) OR plaque micro organisms	112954
#30	Add	Search plaque micro organisms	267
#29	Add	Search oral microflora	2105
#28	Add	Search ph of plaque	51261
#27	Add	Search plaque ph	51261
#26	Add	Search ph of saliva	34315
#25	Add	Search salivary ph	36255
#24	Add	Search cariogenic microflora	88
#23	Add	Search caries inhibitory effecct	494
#22	Add	Search anticariogenic effecct	263
#21	Add	Search lactobacilus	20
#20	Add	Search streptococcus mutans	9581
#19	Add	Search (((fluoride toothpaste) OR commercial toothpaste) OR flouridated dentifrices) OR fluoride containing toothpaste	2457
#18	Add	Search fluoride containing toothpaste	707
#17	Add	Search flouridated dentifrices	0
#16	Add	Search commercial toothpaste	162
#15	Add	Search fluoride toothpaste	2392
#14	Add	Search (((herbal toothpaste) OR herbal extract) OR Ayurveda toothpaste) OR herbal dentifrices) OR natural toothpaste	8395
#13	Add	Search natural toothpaste	125
#12	Add	Search herbal dentifrices	57
#11	Add	Search Ayurveda toothpaste	0
#10	Add	Search herbal extract	8218
#9	Add	Search herbal toothpaste	54
#8	Add	Search ((((((((((dental caries) OR caries dental) OR decay dental) OR dental cavities) OR dental decay) OR enamel caries) OR dentin caries	53647
#7	Add	Search dentin caries	4377
#6	Add	Search enamel caries	7068
#5	Add	Search dental cavities	52703
#4	Add	Search dental decay	49924
#3	Add	Search decay dental	49924
#2	Add	Search caries dental	49264
#1	Add	Search dental caries	49264

Figure 2-Screenshot of Google Scholar search

G214QD15

efficacy of a herbal, homeopathic and a conventional toothpaste - Google Scholar

Toothpaste wars: To assess the efficacy of a herbal, homeopathic and a conventional toothpaste in the control of plaque and gingivitis-A clinico-biochemical study.V Doodwad, S Malhotra... - *Indian Journal of ...*, 2011 - [search.ebscohost.com](#)

Abstract Introduction: Gingivitis is a chronic inflammatory process limited to the gingiva without either attachment loss or alveolar bone loss. It is one of the most frequent oral diseases, affecting more than 90% of the population, regardless of age, sex or race. The ...

Cited by 2 Related articles Cite Save

Bleeding risks of herbal, homeopathic, and dietary supplements: a hidden nightmare for plastic surgeons?WW Wong, A Gabriel, GP Maxwell... - *Aesthetic Surgery ...*, 2012 - [asj.oxfordjournals.org](#)

... Editor-in-Chief, Foad Nahal, MD, Associate Editor, Jeffrey M. Kenkel, MD. Impact factor 2.034. Published on behalf of the. Bleeding Risks of Herbal, Homeopathic, and Dietary Supplements: A Hidden Nightmare for Plastic Surgeons?

Cited by 20 Related articles All 4 versions Cite Save

At least one herbal or homeopathic active agent and a pharmaceutically acceptable solid bioadhesive carrierAJ Domb, JS Wolnerman - *US Patent 7,943,169*, 2011 - [Google Patents](#)

... pressure sores, but without de double-blind clinical trials showing effectiveness to support ... of monoterpenes with three unsaturations to the oral cavity will provide efficacy in various ... Therefore, additional efficacious compositions and methods of treatment for these purposes are ...

Cited by 20 Related articles All 5 versions Cite Save

Comparison of clinical efficacy of a dentifrice containing calcium sodium phosphosilicate to a dentifrice containing potassium nitrate and to a placebo on dentinal ...AR Pradeep, A Sharma - *Journal of Periodontology*, 2010 - *Am Acad Periodontology*

... Because calcium sodium phosphosilicate showed greater reduction in sensitivity compared to highly efficacious potassium nitrate, it may provide a new direction for the treatment ... (2015)

Comparative evaluation of the effectiveness of desensitizing ... (2014) Comparative efficacy of a ...

Cited by 68 Related articles All 4 versions Cite Save

Evaluation of the safety and efficacy of complete care herbal toothpaste in controlling dental plaque, gingival bleeding and periodontal diseasesM Mazumdar, A Chatterjee, S Majumdar... - *J Homeop Ayurv ...*, 2013 - [omicsgroup.org](#)

... Conclusion: The effectiveness of Complete Care Herbal Toothpaste was evaluated in subjects with dental problems. ... The efficacy of the Complete Care Herbal Toothpaste can be attributed to the synergistic activity of the potent herbs which have analgesic ...

Cited by 5 Related articles All 3 versions Cite Save More

Herbal remedies for the treatment of periodontal disease-a patent reviewP Kumar, SH Ansari, J Ali - *Recent patents on drug delivery & ...*, 2009 - [ingentaconnect.com](#)

... Clinical trials for assessment of safety and efficacy of these herbal remedies are in its infant stage. These herbal remedies are expected to be widely used in future. ... The evaluation of Chinese herbal medicine effectiveness on periodontal pathogens. ...

Cited by 24 Related articles All 3 versions Cite Save

Should we be concerned about herbal remediesM Elvin-Lewis - *Journal of Ethnopharmacology*, 2001 - [Elsevier](#)

... JavaScript is disabled on your browser. Please enable JavaScript to use all the features on this page. *Journal of Ethnopharmacology*, Volume 75, Issues 2-3, May 2001, Pages 141-164. Cover Image Cover Image. Should we be concerned about herbal remedies. ...

Cited by 263 Related articles All 12 versions Cite Save

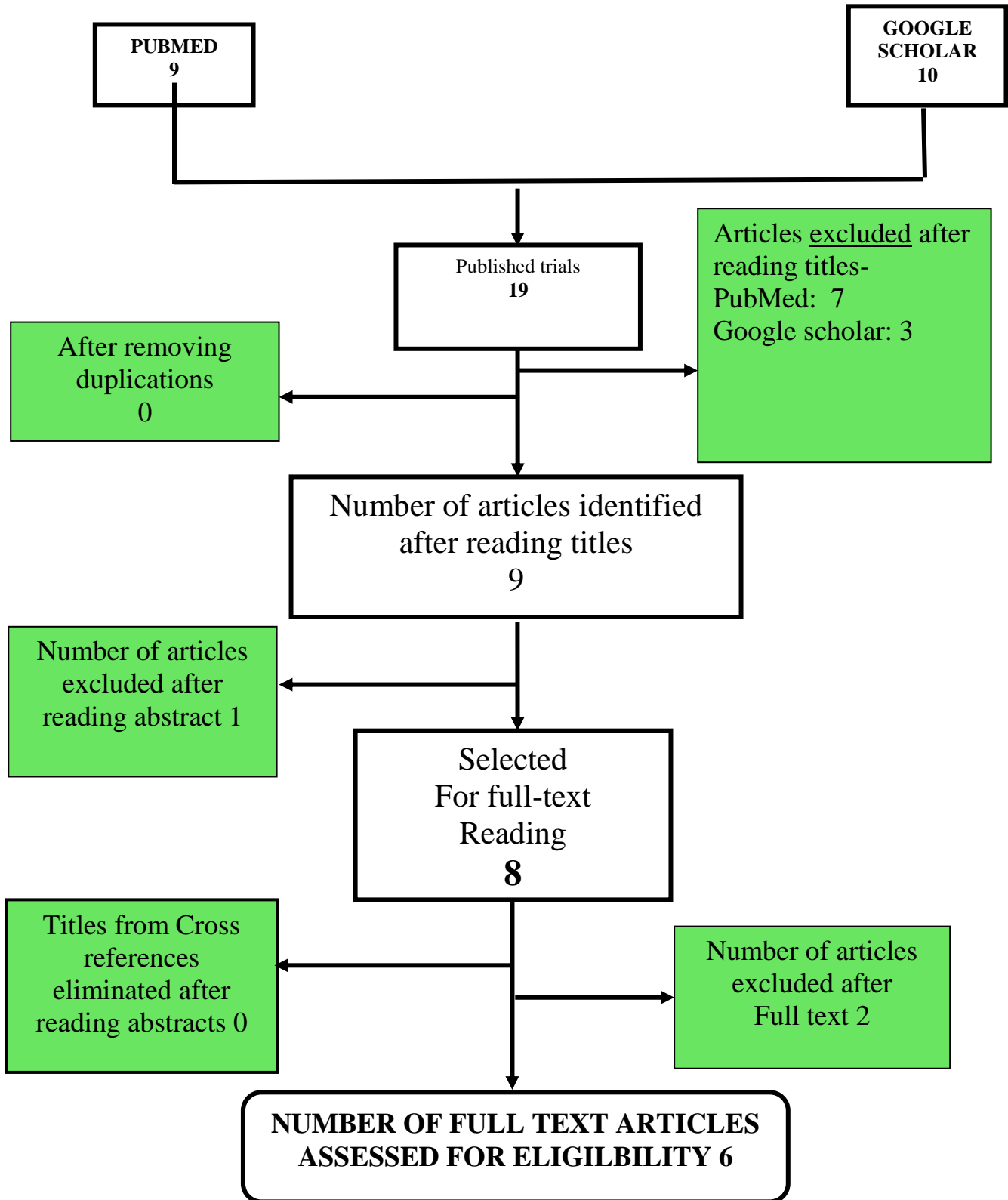
Comparison of Antimicrobial Efficacy of Triclosan-Containing, Herbal and Homeopathy Toothpastes-An Invitro StudyB Anushree, MA Pawaz, R Narahari... - *Journal of clinical and ...*, 2015 - [ncbi.nlm.nih.gov](#)

... Formulations VII, VIII and IX are homeo- based products and exhibited least effectiveness compared to ... Ingredients are considered to be the sole reason of their antimicrobial efficacy [22]. ...

A systematic review by Moran et al., concluded that herbal toothpastes had shown less anti ...

Cite Save

Flow search chart



Data Collection and Analysis Screening and Selection

Electronic search was carried out using the keywords in the Search engines- PubMed and Google Scholar which yielded a total of 19 articles. Hand search was done in caries research, which yielded zero articles. Based on pre-set inclusion and exclusion criteria, the titles of the studies identified from the search were assessed independently by two review authors (Dr. K. Shivashankar, Dr. I. Meignana Arumugham) Conflicts concerning inclusion of the studies were resolved by discussion. Nineteen titles were identified from the search after excluding duplications. Ten articles were excluded after reading titles. Abstracts of selected articles were reviewed independently. One article was excluded after reading abstract. Full text articles were retrieved for eight relevant studies. After reviewing the articles independently, two articles were excluded after full text reading. Finally seven articles were selected based on eligibility criteria.

The reference list of the full text articles were reviewed for identifying additional studies. Titles of articles relevant to the review were selected by discussion. Abstracts of the two selected articles were reviewed. Difference of opinion concerning inclusion of a study was resolved by discussion and one article was eliminated after reviewing abstracts. Quality Assessment criteria to evaluate the studies were decided by two review authors in accordance with CONSORT guidelines. The risk of bias for each study was independently assessed by the review authors and conflicts concerning risk of bias were sorted by discussion.

Data Extraction

Data extraction for general characteristics of studies and variables of outcome was done.

For each trial the following data were recorded:

- Author and Journal
- Study Design
- Sample Size
- Participants and Group
- Methodology
- Parameters
- Statistical Analysis
- Results

TABLE 1: VARIABLES OF INTEREST:

S.No	VARIABLES OF INTEREST
1.	DMFT and DMFS score.
2.	Streptococcus and lactobacillus colony counts.
3.	Salivary pH and plaque pH
4.	Minimum zone of inhibition (in-vitro studies)

QUALITY ASSESSMENT

(Higgins and Green. Cochrane reviewer's hand book 2009)

The quality assessment of included trials was undertaken independently as a part of data extraction process. Four main quality criteria were examined.

1. **Method of Randomization**, recorded as
 - a) YES- Adequate as described in the text
 - b) NO- Inadequate as described in the text
 - c) Unclear in the text
2. **Allocation Concealment**, recorded as
 - a) YES- Adequate as described in the text
 - b) NO- Inadequate as described in the text
 - c) Unclear in the text
3. **Outcome assessors Blinded to intervention**, recorded as
 - a) YES- Adequate as described in the text
 - b) NO- Inadequate as described in the text
 - c) Unclear in the text
4. **Completeness of Follow up** (was there a clear explanation for withdrawals and dropouts in each treatment group) assessed as
 - a) YES- Dropouts were explained
 - b) NO- Dropouts were not explained
 - c) None- No Dropouts or withdrawals.

Other methodological criteria examined included:

1. Presence or Absence of sample size calculation.
2. Comparability of Groups at the start.
3. Clear Inclusion or Exclusion criteria.
4. Presence or Absence of estimate of measurement error.

RISK OF BIAS IN INCLUDED STUDIES

The study was assessed to have a "High risk" of bias if it did not record a "Yes" in three or more of the four main categories, "Moderate Risk" if two out of four categories did not record a "Yes", and "Low Risk" if all the four categories recorded if randomization assessor, Blinding and Completeness of follow up were considered Adequate. In case of non-randomized and clinical trials without control group, it is recorded as Not applicable.

RESULTS:**TABLE:1 GENERAL CHARACTERISTICS OF THE STUDIES**

Article	Study groups	Method of evaluation	Outcome	Limitations/ Future Scope
Toothpaste formulation efficacy in reducing oral flora J Okpalugo, K Ibrahim, US Inyang (Nigeria, 2009)	Test group: 7 different toothpaste which included 6 fluoridated and 1 herbal toothpaste. Control group: positive controls (agar plates containing some mouth flora: Staphylococcus aureus and Streptococcus pneumoniae) cultured using the pour plate technique and negative controls (agar plates containing only nutrient agar, sabouraud dextrose agar, plate count agar, sterile water and normal saline)	Nutrient agar (Fluka Biochemika, Spain). Plates were incubated upside down in an incubator at 37°C for 24 h and oral bacterial Flora counted after 24 h	Differences in teeth and salivary bacterial count before using the toothpaste and after using tooth for 3 consecutive times with a 12 hour variation is evaluated. Tooth bacterial count after using all the dentifrices T001 160,000 108,800 51,200 T002 200,000 120,000 60,000 T003 118,000 73,160 44,840 T004 400,000 236,000 164,000 T005 230,000 165,600 64,400 T006 260,000 132,600 127,400 T007 120,000 92,400 27,600 Salivary bacterial count after using the dentifrices T001 300,000 405,000 0 0 05,000 T002 360,000 435,000 0 0 75,000 T003 500,000 480,000 20,000 T004 700,000 800,000 0 0 00,000 T005 800,200 900,500 0 0 00,300 T006 540,800 508,325 32,475 6 0 T007 400,000 520,000 0 0 120,000	The study population is not randomized and washout period also was not mentioned.
Comparison of two commercially available toothpastes on the salivary streptococcus mutans count in urban preschool children - an in vivo study.	Test group : Himalaya herbal dental cream (n=50) Control group : cheerio gel (n=50)	Microbial analysis for mutans streptococci in saliva.	Baseline: Group I had a mean Streptococcus mutans count of 53720 counts/ml. Group II had 48520 counts/ml. After 15 days: Group I had a mean bacterial count of 28640 counts/ml and Group II had a mean bacterial count of 27780 counts/ml. After 30 days: Group I had a mean bacterial count of 19640 counts/ml and Group II a	Bacterial resistance developing to these products need to be monitored carefully.

Sudha Patil, Karthik Venkataraghavan , A. Anantharaj, Shankargouda Patil (Bangalore, 2010)			mean bacterial count of 19420 counts/ml. After 90 days: Group I had a mean bacterial count of 10200 counts/ml and Group II a mean bacterial count of 10490 counts/ml. After 150 days: Group I had a mean bacterial count of 5750 counts/ml and Group II had a mean bacterial count of 5000 counts/ml.	
The Effect of Miswak and Fluoride Toothpastes on Dental Plaque, A Comparative Clinical and Microbiological Study WafaK.M.Talha , ManalElsaid, Ola M. Omar and Somaiya A. Eissa. (Egypt, 2013)	The fluoride group (n = 20) The miswak group (n = 20).	Bacterial count, Plaque and saliva pH	Plaque pH: mean pH value at baseline (before treatment) was (4.3±0.4) in fluoride group and (4.6±0.6) in miswak group. The mean pH value after treatment was (4.4±0.4) and (4.8±0.5) respectively. Saliva pH: The mean pH value at baseline (before treatment) was (7±0.7) in fluoride group and (7.1±0.4) in miswak group. The mean pH value after treatment was (7.2±0.6) and (7.2±0.5) respectively. Streptococcus mutans count: The mean log ₁₀ SM count at baseline (before treatment) was (6±1.3) in fluoride group and (6.4±1) in miswak group. The mean log ₁₀ SM count after treatment was (5.6±1.3) and (6.1±1.2) respectively. Lactobacillus count: The mean log ₁₀ LB count at baseline (before treatment) was (2.4±0.4) in fluoride group and (2.5±0.5) in miswak group. The mean log ₁₀ LB count after treatment was (2.2±0.5) and (2.3±0.4) respectively.	Long term studies are needed to quantify the efficacy of miswak toothpaste among children. Further researches with larger sample sizes are needed to evaluate the benefits of Miswak toothpaste use for children

TABLE: 2 DATA EXTRACTION TABLE

Sl no	Article	Author and Journal	Study Design	Sample Size	Participants and Group	Methodology	Parameters	Statistical Analysis	Results
1.	Toothpaste formulation efficacy in reducing oral flora (Nigeria, 2009)	J Okpalugo, K Ibrahim, US Inyang Tropical Journal of Pharmaceutical Research, February 2009; 8 (1): 71-77	Clinical trial	Sample size calculation not mentioned	Samples: 8 participants Test group : 7 different toothpaste which included 6 fluoridated and 1 herbal toothpaste. Control group : positive controls (agar plates containing some mouth flora: Staphylococcus aureus and Streptococcus pneumoniae) cultured using the pour plate technique and negative controls (agar plates containing only nutrient agar, sabouraud dextrose agar, plate count agar, sterile water and normal	Subjects were asked to use a toothpaste brand 12hourly on three consecutive occasions as the only source of oral hygiene, and then switched over to another brand. Mouth swaps and saliva before and after brushing was taken, plated by the pour plate technique, incubated at 37°C and then counted on nutrient agar after 24 h. Percentage bacterial reduction was calculated from the	Mouth swaps and saliva before and after brushing was taken, plated by the pour plate technique, incubated at 37°C and then counted on nutrient agar after 24 h. Percentage bacterial reduction was calculated from the difference in bacterial counts before and after brushing.	Chi Test was used to test for independence. The statistical significance level was established at $P < .05$.	71% of the toothpaste brands were found to significantly ($p=0.068$) increase saliva bacteria counts. No brand of toothpaste removed teeth bacteria by up to 50%. On average, the two triclosan-containing toothpaste brands exerted a greater reduction in mouth bacteria than non-triclosan toothpaste brands. This was followed by the herbal toothpaste. The toothpaste brands that contained only fluoride were the least effective in reducing mouth bacteria.

					saline)	difference in bacterial counts before and after brushing.			
2.	Comparison of two commercially available toothpastes on the salivary streptococcus mutans count in urban preschool children - An in vivo study. (Bangalore, 2010)	Sudha Patil, Karthik Venkataraghavan, A. Anantharaj, Shankargouda Patil. International Dentistry Sa Vol. 12, No. 4 P 78-88	In-vivo study.	Sample size calculation not mentioned	Samples: 100 participants in the age group of 4-6 years with dmf = 0 were selected from the R.V. Public school, Bangalore. Test group : Himalaya herbal dental cream (n=50) Control group : cheerio gel (n=50)	The 100 participants were randomly divided into two groups with 50 participants in each group. Group I was provided with Himalaya Herbals Dental cream containing Neem, Group II was provided with 458 ppm containing fluoride toothpaste Cheerio gel. The toothpastes and toothbrush were provided over a period of 5 months for home care use.	The WHO proforma 1997 dentition status assessment was used to calculate DMF. Saliva collection (to assess the microbial count) was done at the period of Baseline, 15 days, 30 days, 90 days and 150 days. A washout period of 2 weeks was given prior to the Baseline count wherein the children brushed their teeth with their regular brush, but without a toothpaste.	Independent t-test was used. The statistical significance level was established at $P < .05$.	There was a steady decrease in the bacterial count over a period of 5 months; the overall percentage decrease in Group I being 90.69% and Group II being 89.69%. However, between the toothpastes there was no statistically significant difference in the bacterial count and both the toothpastes were efficacious in reducing the bacterial count.

						Instructions were given to the parents on brushing technique, amount of paste to be used and twice daily brushing with the pastes, with specific instructions that the child should not use other toothpastes during these 5 months. The saliva sample was then collected and streptococcus mutans estimated in 4 phases, 1) 15 days 2) 30 days 3) 90 days 4) 150 days.	Saliva collection: Three students at a time were made to sit comfortably on the chair. After swallowing pre-existing saliva, subjects were given paraffin wax to chew to stimulate salivary flow which was then collected by expectorating in a sterile disposable measuring cup over the next 5 minutes.		
3.	The Effect of Miswak and Fluoride Toothpastes on Dental Plaque, A Comparative Clinical and Microbiological Study (Egypt,	WafaK.M.Talha , ManalElsaid, Ola M. Omar and Somaiya A. Eissa. Nature and Science 2013;11(9)	In-vivo study)	Sample size calculation not mentioned	The fluoride group (n = 20) The miswak group (n = 20).	Children were randomly allocated into either the fluoride group (n = 20) or the miswak	Bacterial count was calculated by using Two types of media which are, Mitis Salivarius Agar Base for	Student's t-test was used to compare between the two groups. Paired t-test was used to study the changes after	There was no statistically significant increase in the mean Plaque pH after using fluoridated toothpaste. While miswak group, showed a statistically significant increase in mean plaque pH after 2

	2013)					group (n = 20). The antimicrobial effect of both miswak and fluoridated toothpaste used in this study was determined. Children were asked to brush their teeth twice daily for 2 weeks.	S. mutans, and tomato agar (ROGOSA AGAR) for Lactobacillus. Plaque and saliva pH were measured using a portable pH meter.	treatment within each group. Percent change data showed non-normal (nonparametric) distribution, so Mann-Whitney U test was used to compare between the two groups. This test is the non-parametric alternative to Student's t test.	weeks. Although the mean saliva pH values of both groups increased slightly yet it was statistically not significant. As regards fluoride group, there was a statistically significant reduction in mean log ₁₀ values of S. mutans CFU count after treatment. While miswak group, showed no statistically significant reduction in mean log ₁₀ values of S. mutans CFU count after treatment. Both fluoride and miswak group, showed a statistically significant reduction in mean log ₁₀ values of Lactobacillus CFU count after treatment.
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Table 3 Evidence Level of Selected articles

(The United States department of health and human services 2012)

Sl no	Author & Year	Study Design	Level of Evidence
1	J Okpalugo et al 2009	Clinical trial.	2
2	Sudha Patil et al 2010	Clinical trial.	2
3	WafaK.M.Talha et al 2013	Clinical trial	2

TABLE 4: RISK OF BIAS- MAJOR CRITERIA

S.No	Study	Randomization	Allocation concealment	Assessor Blinded	Drop outs described	RISK OF BIAS
1	J Okpalugo et al (Nigeria, 2009)	NO	NO	NO	NONE	HIGH
2.	Sudha Patil et al (Bangalore, 2010)	NO	NO	NO	NONE	HIGH
3.	WafaK.M.Talha et al (Egypt, 2013)	NO	NO	NO	NONE	HIGH

TABLE 5: RISK OF BIAS- MINOR CRITERIA

S.No	Study	Sample justified	Baseline comparison	I/ E criteria	Method of error
1	J Okpalugo et al (Nigeria, 2009)	NO	YES	YES	NO
2	Sudha Patil et al (Bangalore, 2010)	NO	YES	YES	NO
3	WafaK.M.Talha et al (Egypt, 2013)	NO	YES	YES	NO

Table 6: SUMMATION OF OUTCOME OF VARIABLES

Outcome	Herbal vs fluoridated toothpaste				
	Total studies	Herbal superior	Fluoridated superior	Fluoridated with triclosan	No difference
Streptococcus Mutans (colony forming units)	3	--	--	1	2
Plaque pH	1	1	--	--	--
Saliva pH	1	--	--	--	1

Discussion:

Dental caries being a multifactorial disease can be prevented by maintaining proper oral hygiene. Brushing is an important in-house method of maintaining oral hygiene. Often this mechanical plaque control method of brushing is associated with chemical plaque control of using toothpaste. Fluoride is the most popular active ingredient in toothpaste to prevent dental cavities. The additional fluoride in toothpaste has beneficial effects on the formation of dental enamel and bones. It is also reported that Fluoride-containing toothpaste can be toxic if swallowed in large amounts. Reports have suggested triclosan, an active ingredient in many toothpastes, can combine with chlorine in tap water to form chloroform, which the United States Environmental Protection Agency classifies as a probable human carcinogen. Sodium lauryl sulfate alters taste perception. It can break down phospholipids that inhibit taste receptors for sweetness, giving food a bitter taste (Rule KL et al, 2005).

Due to these side effects or ill effects of commercially available fluoride and triclosan toothpastes there is an increased migration of people using fluoride toothpaste to herbal toothpastes. The herbal products are extracted from medicinal plants which are antimicrobial in nature. These herbal products act as an alternative to the commercially available synthetic products. In the recent years, there is also an increased trend of using natural products. Hence this systemic review is done to compare the effect of herbal and fluoridated toothpastes on dental caries.

The hierarchy of evidence has assessed Randomized Controlled Trials above other forms of study (Faggion CM Jr et al, 2007) but there were no available RCT's on comparing the effectiveness of herbal and fluoridated toothpaste on dental caries. Hence, available clinical and in-vitro studies are included in this systematic review.

The results of the clinical studies included for review compared herbal and fluoridated toothpastes in reduction of cariogenic microflora and DMF(T) score salivary pH, and plaque pH. The results of the in-vitro study included in the review compared the zone of inhibition for various cariogenic microflora.

The clinical study of Sudha Patil et al (Bangalore, 2010) concluded that there was a steady decline in the bacterial count over a period of 5 months; the overall percentage decrease in herbal toothpaste being 90.69% and fluoridated toothpaste being 89.69%. However, between the toothpastes there was no statistically significant difference in the bacterial count and both herbal and fluoridated toothpastes were efficacious in reducing the bacterial count. Another clinical study done by J Okpalugo et al

(Nigeria, 2009) revealed that 71% of the toothpaste brands were found to increase salivary bacterial counts, which may be due to addition of ingredients like sodium saccharin and other sweeteners in the toothpastes. No brand of toothpaste was found to make the tooth, devoid of bacteria up to 50%. On average, the two triclosan-containing toothpaste brands exerted a greater reduction in oral bacteria than non-triclosan toothpaste brands. This was followed by the herbal toothpaste. The toothpaste brands that contained only fluoride were the least effective in reducing mouth bacteria. The study done by WafaK.M.Talha et al (Egypt, 2013) revealed that there was no statistically significant increase in the mean plaque pH after using fluoridated toothpaste, while miswak group, showed a statistically significant increase in mean plaque pH after 2 weeks. Although the mean saliva pH values of both fluoridated and miswak group increased marginally yet it was statistically not significant. As regards fluoride group, there was a statistically significant reduction in mean log₁₀ values of *S. mutans* Colony Forming Unit count after the treatment. In contrary miswak group, showed statistically no significant reduction in mean log₁₀ values of *S. mutans* Colony Forming Unit count after treatment. Both fluoride and miswak group, showed a statistically significant reduction in mean log₁₀ values of *Lactobacillus* Colony Forming Unit count after treatment.

The in-vitro study conducted by Basu Anushree et al (India, 2015) suggested that antimicrobial activity of the toothpaste containing both triclosan and fluoride (1000ppm) as active ingredients showed a significant difference ($p < 0.05$) against all four tested microflora compared to that of with lower fluoride-concentration or sodium monofluorophosphate. Of herbal groups, the dentifrice containing several phytochemicals only was found to be significantly effective and comparable to triclosan-fluoride (1000ppm) formulation. Another in-vitro study conducted by Mohankumar KP et al (India, 2013) suggested that there is variation in antibacterial efficacy against *S. Mutans* and *L. Acidophilus* among various herbal and conventional dentifrices, which can be attributed to the effect of various components of the dentifrices and their efficacy to inhibit various organisms. It was observed that the dentifrice with multiple herbal components (H4) is more effective in inhibiting both the organisms. The in-vitro studies conducted by Rahul R.Deshpande et al (India, 2014) suggested that fluoride toothpaste had maximum antimicrobial activity at all concentrations when compared to herbal toothpaste which was statistically significant.

INTERPRETATION OF METHODOLOGY:

In clinical studies done by WafaK.M.Talha et al (Egypt, 2013) and Sudha Patil et al (Bangalore, 2010) Standardisation of the salivary collection technique was followed. Stimulated saliva was collected in study done by Sudha Patil et al (Bangalore, 2010) whereas unstimulated saliva was collected in the study done by J Okpalugo et al (Nigeria, 2009) and WafaK. M.Talha et al (Egypt, 2013). The time between brushing and swabbing; toothbrush/cup type, amount of toothpaste used, brushing method, brushing time, and the bacterial count method used were kept constant in the study done by J Okpalugo et al (Nigeria, 2009). In addition to saliva, pooled plaque samples were collected from buccal surface of clinically sound upper incisors and molars using sterile toothpicks for bacterial count in the study done by WafaK.M.Talha et al (Egypt, 2013). Salivary pH, plaque pH and plaque microflora which play an important role in development of dental caries were not recorded in the study done by Sudha Patil et al (Bangalore, 2010) and J Okpalugo et al (Nigeria, 2009).

In-vitro studies, salivary samples or pure culture of microorganisms were collected and incubated. Zone of inhibition was measured in all the studies done by Basu Anushree et al (India, 2015), Mohankumar KP et al (India, 2013) (pure culture) and Rahul R. Deshpande et al (India, 2014) (salivary samples). The size of the zone of inhibition is usually related to the level of antimicrobial activity present in the product (dentifrice).

INTERPRETATION OF RESULTS:

There were 3 clinical studies in this systematic review with a total sample size of 148 subjects with predominantly children (140) with age ranging from 4 to 9 years of age. In the study done by Sudha Patil et al (Bangalore, 2010) and WafaK.M.Talha et al (Egypt, 2013) it was concluded both the herbal tooth paste and fluoridated toothpaste has same level of antimicrobial effect and reduces streptococcus mutans count whereas in the study done by J Okpalugo et al (Nigeria, 2009) toothpaste containing fluoride and triclosan reduced microbial count more efficiently followed by herbal and last by fluoride toothpaste. The variation in the results between these studies may be due to the reason that Sudha Patil et al (Bangalore, 2010) collected stimulated saliva whereas J Okpalugo et al (Nigeria, 2009) and WafaK.M.Talha et al (Egypt, 2013) collected unstimulated saliva. There is a change in the salivary composition between stimulated (contains more proteins) and unstimulated saliva.

The in-vitro studies done by Mohankumar et al (India, 2013) the herbal tooth pastes have similar and slightly better antibacterial activity compared to the

conventional tooth pastes. In study done by Rahul R. Deshpande et al (India, 2014) fluoridated toothpaste had more antimicrobial effect than herbal toothpastes. In a study done by Basu Anushree et al (India, 2015) fluoride toothpaste exhibited significant reduction in microbial count. Only one herbal toothpaste among three herbal toothpastes had similar effect to fluoride toothpaste. This change in result between these studies may be since pure culture was used in studies done by Mohankumar et al (India, 2013), Basu Anushree et al (India, 2015) whereas salivary sample were incubated for microbial growth in the study done by Rahul R. Deshpande et al (India, 2014) ⁽¹⁹⁾.

REPORT ON QUALITY OF EVIDENCE LOOKED UPON

Out of the eight studies, 3 were in-vivo studies or clinical trials and have level 2 evidence; the remaining six studies were in-vitro studies and have level 3 evidence.

In spite of numerous numbers of clinical trials comparing herbal and commercial products on gingivitis, there are less number of clinical trials and almost no Randomized control trials comparing the effectiveness of herbal and fluoridated toothpastes on dental caries. Hence further studies should be encouraged in this field.

LIMITATIONS:

The present systematic review limits the studies in English language only. This systematic review includes only the published data or researches for interpretation. This limited the number of studies assessing the aim of this review. There are no available Randomized Control Trials comparing the herbal and fluoridated dentifrices on dental caries, hence In-vitro studies are included in the review which reduces the level of evidence to 3. Due to lack of clinical studies comparing the anticariogenic properties of fluoridated and herbal dentifrice, heterogeneous outcome variables are included in the study.

Conclusion:

A total of 6 studies were included in this review out of which 3 were clinical studies with level 2 evidence and 3 were in-vitro studies. Based on Cochrane risk assessment all the 3 clinical trials had a high risk of bias. With the evidences available it can be concluded that herbal toothpastes can be used as an alternative to fluoridated toothpaste and both has the similar kind effect on cariogenic microflora.

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