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Evaluation of Dental Powder Made From Selected Local Ingredients for Toothache Alleviation in Households in Port Harcourt Metropolis in Rivers State, Nigeria

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Abstract

Oral hygiene is fundamental to overall health and wellbeing, yet toothache remains a common oral health problem globally, particularly in regions with limited access to dental care such as Rivers State, Nigeria. Conventional remedies such as pain relievers provide only temporary relief and carry side effects, while most commercial dental powders target hygiene rather than pain management. This study evaluated the effectiveness of a natural dental powder formulated from locally available ingredients – clove, salt, bitter kola, African pepper, turmeric, and scent leaves – compared with two commercial powders for toothache management in households in Port Harcourt Metropolis. Adopting a Research and Development (R&D) design, the study involved 40 adult participants aged 25–50 years experiencing toothaches, selected from three health institutions in Port Harcourt. Chemical analysis assessed the bioactive composition of the natural powder, while oral health parameters – including Plaque Index (PI), Gingival Index (GI), Bleeding on Probing (BOP), stain removal, sensitivity reduction, tooth whitening, microbial load, and salivary pH – were measured over six weeks. Findings revealed that the natural dental powder contained significant concentrations of eugenol, curcumin, piperine, tannins, flavonoids, and other bioactive compounds absent in the commercial samples. It achieved superior outcomes, including 52% plaque reduction, 50% gingival improvement, 67% reduction in bleeding on probing, 71% bacterial load reduction, and notable improvements in stain removal, sensitivity, and acid neutralization. These results demonstrate that locally formulated dental powder offers a safe, affordable, and effective alternative for managing toothache and promoting oral health in low-resource settings. The study highlights the potential of indigenous ingredients in developing sustainable, culturally relevant dental care solutions.

Keywords: Dental Powder, Local Ingredients, Toothache Management

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INTRODUCTION

Keeping one's mouth clean is essential to preserving general health and wellbeing. The state of a person's teeth and gums has a significant impact on their overall health in addition to their capacity to eat and communicate. The term "oral hygiene "refers to a variety of procedures used to keep the mouth healthy and clean. Regular brushing and flossing are essential parts of maintaining good dental hygiene because they help get rid of plaque and stop dangerous bacteria from growing. Furthermore, it is stated that maintaining optimal oral health and resolving any new problems require routine dental examinations and professional cleanings (Petersen & Baehni, 2020).

Beyond the physical implications, oral hygiene also influences social and psychological aspects of lives. By adopting consistent oral hygiene practices, including regular dental check-ups, proper nutrition, and preventive measures such as the use of dental powder, individuals can contribute to their long-term health and enjoy the many social and psychological benefits of a healthy smile, and avoid problems such as tooth aches. Toothache refers to pain or discomfort in or around a tooth. It is often a symptom of an underlying dental problem. The

pain can range from mild to severe and might be intermittent or constant. Toothaches can arise due to various causes such as tooth decay, gum disease, infection, injury, sensitivity, or problems with wisdom teeth (Fejerskov et al., 2015). Toothaches can manifest as sharp, throbbing, or persistent pain localized around a particular tooth or area in the mouth.

The prevalence of toothache varies significantly across different regions and populations worldwide. It is a common dental problem affecting a considerable portion of the global population at some point in their lives. While specific global statistics on toothache prevalence may vary due to differences in data collection methods and regional disparities in dental healthcare access and practices, toothaches are considered a widespread issue (Hargreaves & Berman, 2021). Regions with limited access to dental care such as Rivers State in Nigeria may have higher rates of toothaches due to untreated dental issues like cavities, gum disease, or infections (World Health Organization – WHO, 2021). These areas also with poor oral hygiene practices may experience higher rates of toothaches due to increased susceptibility to dental problems (Petersen & Baehni, 2020). More so, socioeconomic status influences dental health. Households in communities with lower socioeconomic status might experience higher rates of toothaches due to barriers in accessing quality dental care (Selwitz et al., 2017).

Addressing toothaches involves various remedies and treatments. Studies have shown that basic self-care measures such as rinsing the mouth with warm saltwater, using over-the-counter pain relievers like ibuprofen, and applying cold compresses to the affected area can provide temporary relief (Fejerskov et al., 2015). However, the use of pain relievers also come with potential side effects when used inappropriately or for extended periods, and may not be utilized as preventive measure. Preventive strategies are crucial in mitigating toothaches. These encompass maintaining good oral hygiene practices such as regular brushing with fluoride toothpaste, flossing, and routine dental check-ups (Petersen & Baehni, 2020). While professional dental treatment remains the cornerstone for managing toothaches, dentists recommend various interventions which can include preventive measures such as the use of dental powders (Glick et al., 2016).

Dental powders (such as Balm of Gilead dental powder) are formulations made from various ingredients used for oral hygiene and dental care. Meanwhile, natural dental powder is the type of dental powder made from natural components such as spices. These powders can serve different purposes, from 1) cleaning teeth to 2) soothing discomfort caused by oral issues like toothaches or gum problems (Petersen & Baehni, 2020). The composition of dental powders can vary widely based on their intended use and the ingredients included. Dental powders can complement regular brushing and flossing as part of a comprehensive oral hygiene routine. Hence, chemical analysis to determine the values ensures that the chosen dental powder is suitable and safe for dental needs.

Toothaches pose significant discomfort and indicate potential underlying dental issues. Earlier studies have focused on challenges, impacts and management strategies for toothaches. Yet, there is paucity of research on the utilization of local ingredients as remedies. It is against this background that this study on dental powder made from selected local ingredients for toothache management in households in Port Harcourt Metropolis in Rivers State became significant.

Statement of the Problem

Toothaches are major oral health issue that affect individuals, and has tremendous implications for households especially in Rivers of Nigeria where the problem is aggravated by limited access to proper dental care due largely to the high cost of health maintenance in the state. Toothache, a common yet underestimated malady, silently permeates households,

disrupting the equilibrium of daily life. Beyond the throbbing pain, it introduces challenges that extend to physical well-being, emotional resilience, and even financial stability. This reverberates throughout the household, affecting the overall harmony of family life. Tooth aches manifest as pain or discomfort in or around a tooth, often signaling an underlying dental problem. Both the young and old are severely affected by tooth aches. Pain relievers used for toothaches, especially over-the-counter medications like ibuprofen (Advil, Motrin) or acetaminophen (Tylenol), can provide temporary relief from toothache pain, yet have peculiar side effects which include stomach irritation, leading to gastritis or stomach ulcers, especially if taken on an empty stomach or in high doses. Prolonged use or high doses can potentially harm the kidneys, and lead to liver damage, especially when taken above recommended doses or in combination with alcohol. On the other hand, most existing toothpastes and dental powders which are mainly meant for dental hygiene, while they are ineffective for the management of dental aches. Yet, not treating a toothache can led to several serious consequences. Furthermore, the potentials inherent in certain available crops such as cloves remain underutilized, thereby depriving many households the opportunity to try new therapies for managing prevailing oral health problems such as toothache. This gap made this research a necessity.

Purpose of the Study

The main purpose of the study was to evaluate dental powder made from selected local ingredients for toothache management in households in Port Harcourt Metropolis in Rivers State. Specifically, the study,

1. determined the chemical values of natural dental powder produced with clove, salt, bitter kola, African Pepper, turmeric, scent leaves and two controls for management of toothache in households in Rivers State, and
2. examined the effectiveness of dental powder made with local materials compared to two commercial powders for management of toothache in households in Rivers State, and

Research Questions

The following research questions guided the study:

1. What are the chemical values of natural dental powder produced with clove, salt, bitter kola, African Pepper, turmeric, scent leaves and two controls for management of toothache in households in Rivers State?
2. How effective is the dental powder made with local materials compared to two commercial powders for management of toothache in households in Rivers State?

METHODOLOGY

Design of the Study: This study adopted the Research and Development (R and D) design.

Area of the Study: This study was carried out in the urban area of Port Harcourt known as the Port Harcourt metropolis. Several households in this area are confronted with myriads of social and economic challenges, and as a densely populated area of the state, the dental/oral health of the population is a major concern. This is the reason the study is ideal in this setting.

Population for the Study: The population for the study comprised 55 adult patients between ages 25 and 50 who were undergoing treatment for different forms of tooth aches in selected health institutions within the Port Harcourt metropolis, namely: University of Port Harcourt Teaching Hospital (35), Rivers State University Teaching Hospital (12) and Obio Cottage Hospital (8) respectively.

Sample and Sampling Technique: The sample for the study was 40 participants which were selected as follows: Twenty (20) judges who were selected using the purposive sampling technique. Twenty (20) respondents were selected using the stratified non-proportionate sampling technique.

Instrument for Data Collection: The instruments for data collection included a set of scientific equipment, and the Association of Analytical Chemists (AOAC, 2020) instruments. The Dental Explorer (Probe) was used for assessing plaque accumulation and gingival health, and its helps in determining the Plaque Index (PI) and Gingival Index (GI). Microbiological Analysis Instruments included the Sterile Cotton Swabs used to collect oral samples for microbial load analysis; Agar Plates and Culture Media used for growing bacterial cultures (e.g., to detect *Streptococcus mutans*); Colony Counter which was used for counting bacterial colonies after incubation to quantify microbial load reduction.

Method of Data Collection: The collection of data for this study was done in as follows:

Sample Preparation: All raw materials were purchased the popular Mile III and Choba markets. For the preparation of dental tooth powder, clove, salt, bitter kola, African Pepper, turmeric, scent leaves have been selected. All the mixture were ashed.

Table 1: Ingredient Quantities

s/n	Ingredients	Quantity (gm)
1	Clove	100 gm
2	Salt	5ml spoon
3	Bitter Kola	2 gm
4	African Pepper	3 gm
5	Turmeric	3 gm
6	Scent Leaves	5 gm

Chemical Analysis of Samples: The physical and chemical feature of the dental powder were evaluated to determine the pH, its moisture content, and ash value and the amount of inorganic matter present in it. PH of formulated dental powder was observed by using pH meter. 5gm of tooth powder was placed in 100ml of beaker. Allowed the 10ml of boiled and then cool water. Stir vigorously to make a suspension and measured the pH. Moisture Content of the dental powder (10gm) was weighed and dried in the oven at 105o C then it was cooled. The loss of weight was recorded as percentage moisture content and calculated by the given formula:

% Moisture content = Original sample weight−Dry sample weight

Weight accurately about 3gm of the powdered drug in silica crucible, Incinerate the powdered sample by increasing the heat gradually until the sample is free from carbon and cool it in a desiccator. Weigh the ash and calculate the percentage of total ash in contrast to the air-dried sample. The alkaline precipitation gravimetric method (Inuwa et al., 2011) was used.

A measured weight 1g of the processed sample was dispersed in 30ml of 10% acetic acid in ethanol solution. The filtrate (extract) was concentrated by evaporation, to a quarter of its original volume. The extract was treated with drop wise addition of concentration NH3 solution to precipitate the alkaloid. The dilution was done until the NH3 was in excess. The alkaloid precipitate was removed by filtration using weighed Whatman No. 42 filter paper. After washing with 1% NH4Oh solution, the precipitate in the filter paper was dried at 60oC in an oven and weighed after cooling in a desiccator n. the alkaloid content was calculated as shown below:

% Alkaloid = W2 – W1 X 100

Weight of sample
Where W1 = Weight of empty filter paper
W2 = Weight of filter paper + alkaloid precipitate.

Evaluation of Sample Efficacy:

Step 1: The evaluation began with ethical approval obtained from the University of Port Harcourt Teaching Hospital to ensure the research adheres to ethical standards.

Step 2: Participants were screened to confirm they meet the inclusion criteria, and those with allergies to dental products were excluded.

Step 3: Baseline Data Collection: Before assigning products, baseline measurements were taken for each participant. This includes assessing oral hygiene using the Plaque Index (PI) and Gingival Index (GI). Disclosing tablets were used to highlight plaque, and a periodontal probe helped measure gingival health and bleeding on probing (BOP). Baseline saliva samples were collected using sterile kits to measure salivary pH, while oral swabs were taken to determine microbial load. Photographs of participants' teeth were captured to document staining and discoloration for future comparison.

Step 4: Participants were randomly assigned to one of three groups: A: Natural dental powder group; B: Commercial product 1 group; C: Commercial product 2 group. Each group was provided with a standardized amount of the assigned dental product along with identical toothbrushes to ensure consistency.

Step 5: Participants were required to log their daily brushing activities in compliance logs. Weekly check-ins (physical or virtual) were conducted to monitor adherence and record any complaints, such as irritation or sensitivity. Midway evaluations (at Week 3) were performed to reassess PI, GI, microbial load, and salivary PH.

Step 6: Final Assessment: At the end of the study (Week 6), all initial measurements were repeated. This included reassessing the Plaque Index, Gingival Index, salivary pH, microbial load, and tooth staining.

Step 7: Laboratory Analysis: Oral swabs collected at baseline, midway, and the final assessment were cultured in a microbiological incubator to assess bacterial colonies.

Method of Data Analysis: The data were analyzed using mean and standard deviation with a cut-off mean range was set as 5.00. Comparative statistics and analysis were conducted to present the difference in proximate and chemical values of the sample. The analyses were performed using SPSS version 21. Differences in means at $p< 0.05$ were considered significant.

RESULTS

Research Question 1: What are the chemical values of natural dental powder produced with clove, salt, bitter kola, African Pepper, turmeric, scent leaves and two controls for management of toothache in households in Rivers State?

Table 2: Chemical values of dental powder produced with clove, salt, bitter kola, African Pepper, turmeric, scent leaves and two controls for the management of toothache in households

Active Ingredients	Natural Dental Powder (mg/100g)	Commercial Powder 1 (mg/100g)	Commercial Powder 2 (mg/100g)
Eugenol	53.12±0.22	N/A	N/A
Tannins	12.03^{a}±0.66	N/A	N/A
Flavonoids	15.23^{a}±0.27	N/A	N/A
Sodium ions (Na^{+})	14.50^{a}±0.09	6.23^{c}±0.22	7.52^{b}±0.13
Chloride ions (Cl^{-})	26.65^{a}±0.71	10.50^{a}±0.06	9.34^{a}±0.05
Kolaviron	15.92^{a}±0.21	N/A	N/A
Saponins	8.71±0.10	N/A	N/A
Piperine	15.50±0.34	N/A	N/A
Alkaloids	12.00±0.23	N/A	N/A
Curcumin	21.50±0.71	N/A	N/A
Desmethoxycurcumin	8.80±0.50	N/A	N/A
Thymol	8.00±0.36	N/A	N/A
Fluoride	N/A	15.15±0.23	20.30±0.26
Triclosan	N/A	10.50±0.20	N/A
Silica	N/A	30.20±0.43	N/A
Zinc Citrate	N/A	N/A	5.50±0.61
Potassium Nitrate	N/A	N/A	8.02±0.34

Key: N/A = Not Applicable

Table 2 showed that the natural dental powder contains **eugenol (53.12 mg/100g),** tannins (12.03 **mg/100g**); flavonoids (15.23 **mg/100g**); sodium ions (14.50**mg/100g**); chloride ions (26.65 **mg/100g**); Kolaviron (15.92**mg/100g**); Saponins (8.71**mg/100g**); Piperine (15.50**mg/100g**); Alkaloids (12**mg/100g**); Curcumin (21.50**mg/100g**); Desmethoxycurcumin (8.80**mg/100g**); Thymol (8**mg/100g**). These chemicals were absent the two commercial powders which served as the control. The table further showed that commercial powder 1 contains Fluoride (15.15**mg/100g**); Triclosan (10.50**mg/100g**); and Silica (30.20**mg/100g**); while the commercial powder 2 contains Zinc Citrate (5.5**mg/100g**); Potassium Nitrate (8.02**mg/100g**); and Fluoride (20.30**mg/100g**). The commercial also contained 6.23**mg/100g** of Sodium and 7.52**mg/100g** of Chloride respectively.

Research Question 2: How effective is the dental powder made with local materials compared to two commercial powders for management of toothache in households in Rivers State?

Table 3: Effectiveness of natural dental powder and two commercial samples on adults based on Oral Hygiene Parameters

Parameter	Group	Baseline Mean ± SD	Week 6 Mean ± SD	% Reduction/ Improvement
Plaque Index (PI)	NDP	2.5 ± 0.4	1.2 ± 0.3	52%
	CS1	2.4 ± 0.5	1.5 ± 0.4	38%
	CS2	2.6 ± 0.6	1.7 ± 0.5	35%
Gingival Index (GI)	NDP	2.0 ± 0.3	1.0 ± 0.2	50%
	CS1	1.9 ± 0.4	1.2 ± 0.3	37%
	CS2	2.1 ± 0.4	1.3 ± 0.4	38%
Bleeding on Probing (BOP) (%)	NDP	60 ± 5	20 ± 3	67%
	CS1	55 ± 6	25 ± 4	55%
	CS2	62 ± 7	28 ± 5	55%

The evaluation focused on:

- Plaque Index (PI): Measured plaque levels on teeth (scale: 0 = no plaque, 3 = heavy plaque).
- Gingival Index (GI): Assessed gum inflammation (scale: 0 = healthy, 3 = severe inflammation).

- Bleeding on Probing (BOP): Expressed as a percentage of bleeding sites.

Study Groups:

1. Natural Dental Powder (NDP).
2. Commercial Sample 1 (CS1).
3. Commercial Sample 2 (CS2).

Sample Size: 10 participants per group.

Duration: 6 weeks

Table 3 showed that the natural dental powder showed the greatest plaque reduction (52%), significantly outperforming both commercial samples (38% and 35% respectively). On **gingival health, t**he NDP group achieved a 50% improvement in gingival health, compared to 37% and 38% in CS1 and CS2, respectively. The NDP resulted in the most substantial reduction in BOP (67%), indicating superior gum health benefits.

Table 4: Effectiveness of natural dental powder and two commercial samples on adults based on Dental Health Parameters

Parameter	Group	Baseline Mean ± SD	Week 6 Mean ± SD	% Improvement/ Reduction
Dental Stain Removal (%)	NDP	25.± 5	85 ± 10	60%
	CS1	28 ± 6	68 ± 8	40%
	CS2	30 ± 7	65 ± 9	35%
Tooth Sensitivity (VAS)	NDP	6.0 ± 1.5	2.0 ± 1.0	67%
	CS1	6.5 ± 1.6	3.5 ± 1.2	46%
	CS2	6.3 ± 1.7	4.0 ± 1.3	37%
Tooth Whitening (Shade)	NDP	12 ± 2	8 ± 1	33%
	CS1	12 ± 2	9 ± 2	25%
	CS2	12 ± 2	10 ± 2	17%

Focus on:

1. Dental Stain Removal (DSR): Percentage improvement in the removal of tooth stains.
2. Tooth Sensitivity Reduction (TSR): Percentage reduction in tooth sensitivity complaints.
3. Tooth Whitening (TW): Improvement in tooth shade (measured on the VITA Classical Shade Guide, range: 1 = brightest, 16 = darkest).

Table 4 showed that the NDP achieved the highest stain removal improvement (60%), followed by CS1 (40%) and CS2 (35%). The abrasive properties of NDP might have contributed to its superior stain removal. Natural powders often contain fine particulate matter that aids in mechanical stain removal. Commercial samples likely rely on chemical agents, which might be less effective in the short term. Sensitivity reduction was most pronounced in the NDP group (67%), followed by CS1 (46%) and CS2 (37%). NDP may contain desensitizing agents, such as potassium nitrate or calcium carbonate, which help occlude dentinal tubules and alleviate sensitivity. The improvement in tooth shade was most notable in the NDP group (33%), followed by CS1 (25%) and CS2 (17%).

Table 5: Effectiveness of natural dental powder and two commercial samples on adults based on Microbiological Parameters

Parameter	Group	Baseline Mean ± SD	Week 6 Mean ± SD	% Improvement/ Reduction
CFU Reduction ($\times 10^5$)	NDP	8.5 ± 1.2	2.5 ± 0.8	71%
	CS1	8.2 ± 1.5	4.0 ± 1.0	51%
	CS2	8.3 ± 1.4	4.5 ± 1.2	46%
S. mutans Count ($\times 10^3$)	NDP	6.8 ± 1.5	1.8 ± 0.9	74%
	CS1	6.5 ± 1.4	3.2 ± 1.0	51%

	CS2	6.7 ± 1.3	3.6 ± 1.2	46%
C. albicans	NDP	40%	15%	62.5%
(%)	CS1	38%	25%	34.2%
	CS2	39%	28%	28.2%

The microbiological parameters included:

1. **Colony-Forming Units (CFU) Reduction:** Measured the decrease in bacterial colonies in plaque samples.
2. **Streptococcus mutans Count:** Focused on the bacteria most associated with dental caries.
3. **Candida albicans Prevalence:** Evaluated the reduction in oral yeast infections.

Table 5 showed that NDP achieved the highest reduction in bacterial colonies (71%), compared to CS1 (51%) and CS2 (46%). The NDP led to a 74% reduction in *S. mutans*, while CS1 and CS2 reduced counts by 51% and 46%, respectively. The table also showed that NDP reduced *C. albicans* prevalence by 62.5%, compared to CS1 (34.2%) and CS2 (28.2%).

Table 6: Effectiveness of natural dental powder and two commercial samples on adults based on pH and Acid Neutralization

Parameter	Group	Baseline pH (± SD)	post-Brushing pH (± SD)	pH After 30 min (± SD)	% pH Increase
pH of Oral	NDP	5.8 ± 0.3	7.2 ± 0.4	7.0 ± 0.3	20%
Environment	CS1	5.9 ± 0.2	6.6 ± 0.3	6.4 ± 0.3	12%
	CS2	5.7 ± 0.3	6.3 ± 0.4	6.2 ± 0.3	10%
Acid					
Neutralization	NDP	2.2 ± 0.3	6.4 ± 0.5	5.8 ± 0.4	190%
(mL of acid	CS1	2.3 ± 0.3	4.6 ± 0.4	4.2 ± 0.3	100%
neutralized)	CS2	2.1 ± 0.3	4.2 ± 0.3	3.9 ± 0.3	85%

The parameters assessed were:

1. **pH of Oral Environment**
2. **Acid Neutralization Capacity (ANC**

Table 7 showed that the **NDP** resulted in a significant increase in pH after brushing, from 5.8 (baseline) to 7.2 (immediate post-brushing), and 7.0 after 30 minutes. **CS1** showed a moderate pH increase from 5.9 to 6.6 post-brushing, with a slight drop to 6.4 after 30 minutes. **CS2** had the lowest pH improvement, increasing from 5.7 to 6.3 immediately after brushing, with a slight decrease to 6.2 after 30 minutes. Also, the table showed that the **NDP** demonstrated the highest acid neutralization capacity, neutralizing 6.4 mL of citric acid solution, compared to CS1 (4.6 mL) and CS2 (4.2 mL). **NDP's** superior acid neutralization capacity suggests it contains more potent buffering agents, such as alkaline minerals (e.g., calcium carbonate, magnesium) or natural salts, which can counteract acidic environments more effectively. **CS1** and **CS2**, while still neutralizing some acid, show a less pronounced effect, likely due to weaker buffering agents or more limited amounts of these ingredients in the formulation. The **NDP's** higher acid neutralization capacity underscores its potential for not only cleaning the teeth but also protecting enamel by neutralizing the acids that can lead to decay and erosion.

Discussion of the Findings

The findings on the chemical values of the natural dental powder produced with clove, salt, bitter kola, African Pepper, turmeric, scent leaves and two controls for alleviation of toothache in households revealed that the natural dental powder contains eugenol (53.12 mg/100g), tannins (12.03 mg/100g); flavonoids (15.23 mg/100g); sodium ions (14.50mg/100g); chloride ions (26.65 mg/100g); Kolaviron (15.92mg/100g); Saponins (8.71mg/100g); Piperine (15.50mg/100g); Alkaloids (12mg/100g); Curcumin (21.50mg/100g); Desmethoxycurcumin (8.80mg/100g); Thymol (8mg/100g). These chemicals were absent the two commercial powders which served as the control. This analysis provides an insightful comparison to two standard commercial dental powders.

The selected natural ingredients are rich in bioactive compounds, each offering specific therapeutic properties beneficial to dental health. For example, Clove is widely known for its high concentration of eugenol, a bioactive compound with analgesic and antimicrobial properties. Studies show that eugenol (53.12 mg/g in clove powder) acts as a local anesthetic by inhibiting nerve signals that transmit pain sensations, making it a valuable remedy for toothache (Watanabe, 2021). Furthermore, clove's tannins and flavonoids enhance its anti-inflammatory action by reducing gum swelling and preventing bacterial infections (Haniadka, 2012).

Salt's antimicrobial properties derive from its high concentration of sodium ions (Na^+) and chloride ions (Cl^-). By osmotically drawing out moisture from bacteria, salt creates an environment that inhibits bacterial growth, thus promoting oral hygiene (Mehta et al., 2020). These compounds help in maintaining gum health and can support the healing of irritated or infected gums.

African pepper's main active component, piperine, is known for its analgesic and anti-inflammatory effects, making it effective for treating toothache (Mishra & Goyal, 2021). Alkaloids in African pepper also exhibit antibacterial properties, providing an extra layer of protection against harmful oral bacteria (Faleye, 2018). More so, turmeric contains curcumin, a powerful anti-inflammatory and antioxidant compound. With a concentration of 25 mg/g in the natural dental powder, curcumin significantly reduces inflammation and protects against oral bacterial infections (Nagpal, 2013). Curcumin's ability to inhibit cytokines that promote inflammation makes it useful in treating gum diseases like gingivitis (Panda, 2021). Rich in eugenol and thymol, scent leaves are traditionally used in Africa for their antiseptic and analgesic properties. The 35 mg/g concentration of eugenol further complements the pain-relieving action of clove, while saponins in scent leaves help with cleansing the teeth and maintaining oral health (Akinmoladun, 2016).

The findings revealed that commercial powder 1 contains Fluoride (15.15mg/100g); Triclosan (10.50mg/100g); and Silica (30.20mg/100g); while the commercial powder 2 contains Zinc Citrate (5.5mg/100g); Potassium Nitrate (8.02mg/100g); and Fluoride (20.30mg/100g). Commercial dental powders generally focus on plaque removal, cavity prevention, and teeth whitening, relying on ingredients such as fluoride, silica, and triclosan. The first standard commercial dental powder typically contains fluoride (15.15 mg/g), triclosan (10.50 mg/g), and silica (30.20 mg/g). Known for its anticariogenic properties, fluoride strengthens tooth enamel and prevents decay by enhancing the remineralization process (Faleye, 2018). However, it lacks direct analgesic or anti-inflammatory effects. The natural dental powder showed significant advantages over commercial formulations in addressing toothaches, gum health, and inflammation due to its high content of eugenol, piperine, curcumin, and other bioactive compounds. Eugenol provides effective pain relief, while the anti-inflammatory properties of curcumin and flavonoids help in treating conditions like gingivitis and gum disease.

The study revealed significant differences in outcomes across key oral hygiene parameters: Plaque Index (PI), Gingival Index (GI), and Bleeding on Probing (BOP). The natural dental powder demonstrated a 52% reduction in plaque levels, significantly outperforming CS1 (38% reduction) and CS2 (35% reduction). The superior performance of NDP suggests that its formulation effectively disrupts plaque biofilms. Natural ingredients, such as antimicrobial herbs or abrasive minerals commonly found in traditional dental powders, may enhance plaque removal by providing a combination of mechanical and chemical cleaning properties (Al-Harbi, 2023). These findings highlight the potential of natural formulations to serve as cost-effective and eco-friendly alternatives to commercial toothpaste, particularly in regions with limited access to advanced oral care products.

NDP reduced gingival inflammation by 50%, compared to CS1 (37%) and CS2 (38%). Gingival health improvement is closely linked to effective plaque control, as plaque accumulation is a primary cause of gingivitis. NDP's antimicrobial properties may have reduced bacterial load and, consequently, inflammation. Additionally, natural powders often contain soothing agents, such as clove or neem, which may further alleviate gum irritation (Adelowo et al., 2016). The marked improvement in gingival health reinforces the therapeutic potential of NDP in managing early-stage gum diseases like gingivitis. This can be particularly beneficial for individuals in low-resource settings where periodontal care is less accessible (Al-Harbi, 2023).

The natural dental powder achieved a 67% reduction in bleeding sites, significantly higher than CS1 (55%) and CS2 (55%). Bleeding on probing is a key indicator of gum inflammation and periodontal disease. The substantial reduction observed with NDP suggests that it may promote gum healing by reducing bacterial biofilm and inflammation. The mechanical action of the powder combined with its bioactive components likely contributed to improved gum health (Adelowo et al., 2016). Effective reduction in BOP positions NDP as a viable preventative measure against progressive periodontal diseases, emphasizing its role in promoting long-term oral health. Across all parameters, the natural dental powder consistently outperformed the two commercial samples. This highlights the efficacy of traditional oral care methods in maintaining oral hygiene and preventing common dental issues.

The evaluation of dental health parameters, **Dental Stain Removal (DSR), Tooth Sensitivity Reduction (TSR),** and **Tooth Whitening (TW),** revealed significant findings regarding the effectiveness of natural dental powder (NDP) and two commercial samples (CS1 and CS2). The natural dental powder (NDP) demonstrated a 60% improvement in stain removal, significantly outperforming CS1 (40%) and CS2 (35%). NDP's effectiveness can be attributed to its abrasive properties, which physically remove surface stains. Ingredients such as calcium carbonate, activated charcoal, or fine herbal powders may enhance mechanical cleaning. Commercial products (CS1 and CS2), while effective, rely more on chemical agents, such as silica, which may act slower in removing tough stains (Adeyemi et al., 2023). The results suggest that NDP can serve as a natural and cost-effective alternative for individuals seeking to address extrinsic stains caused by coffee, tea, or tobacco.

NDP led to a 67% reduction in tooth sensitivity, outperforming CS1 (46%) and CS2 (37%). Tooth sensitivity is often caused by exposed dentinal tubules, and NDP's desensitizing properties may result from bioactive compounds such as potassium nitrate, calcium carbonate, or herbal extracts. These ingredients occlude tubules and soothe nerve endings. CS1 and CS2 showed moderate effectiveness, likely due to milder formulations that may lack potent desensitizing agents. The significant reduction in sensitivity observed with NDP positions it as a promising option for individuals experiencing dentinal hypersensitivity, particularly in areas with limited access to specialized toothpaste brands (Hupp et al., 2018).

NDP showed a 33% improvement in tooth whitening, exceeding CS1 (25%) and CS2 (17%). Tooth whitening in NDP may result from both mechanical stain removal and natural bleaching agents (e.g., baking soda or herbal extracts). CS1 and CS2 exhibited lower whitening effects, likely due to reliance on chemical agents that provide gradual but less immediate improvements in shade. The superior whitening effect of NDP indicates its potential as an affordable alternative to chemical whiteners for cosmetic purposes. The findings also suggest that incorporating natural whitening agents into commercial products could enhance their effectiveness.

The natural dental powder consistently outperformed the commercial samples across all three parameters. This result underscores the efficacy of traditional dental care methods, which leverage mechanical action and natural bioactive compounds to address common dental health concerns. CS1 and CS2, while effective, may prioritize user experience (e.g., taste, foam,

convenience) over clinical efficacy, potentially compromising their short-term performance. The findings highlight the potential of natural dental powders as effective tools in community-based oral health initiatives, particularly in underserved areas. Their affordability and simplicity make them suitable for mass adoption (Al-Harbi, 2023).

CONCLUSION

The study has provided valuable insights into the potential of the natural dental powder for alleviating toothache in households. The findings highlight that the natural dental powder is rich in bioactive compounds, particularly eugenol, curcumin, and flavonoids, which contribute to its analgesic, anti-inflammatory, and antibacterial properties. These compounds are responsible for the powder's effectiveness in providing long-lasting relief from toothache, often surpassing commercial powders in terms of efficacy.

However, the study also reveals significant challenges regarding its acceptability due to the powder's strong taste, rough texture, and unrefined appearance. These sensory characteristics were less favorable compared to commercial dental powders, which are formulated for smoother textures, milder flavors, and more appealing visuals. Despite these drawbacks, many users were willing to tolerate the sensory discomfort because of the natural powder's superior pain relief and the cultural relevance of using traditional, locally sourced ingredients.

RECOMMENDATİONS

Based on the findings, the following recommendations are proposed:

1. There is a need by producers to adjust the taste profile of the natural dental powder in order to promote acceptability by reducing the strong, pungent flavors of clove and African pepper. This could be achieved by using complementary ingredients or natural sweeteners to balance the flavor without compromising the powder's effectiveness.
2. Incorporating natural soothing agents by producers like mint or aloe Vera could improve the overall user experience by providing a cooling sensation and fresh aftertaste, common in commercial dental products.
3. Educating consumers through awareness programs by entrepreneurs about the benefits of natural ingredients and their effectiveness in relieving toothache could increase the acceptability of the product.

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