ORIGINAL ARTICLE

Formulation and Evaluation of Novel Antibacterial Tooth Powder

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Abstract

Introduction: The current novel research work aims in preparing various formulations of antibacterial tooth powder and evaluates for the best formulation among the fabricated formulations. **Materials and Methods:** The antibacterial agents chosen were thymol and camphor, bentonite for detoxification, calcium carbonate for abrasion, peppermint oil for flavoring, sodium saccharin for sweetness, and sodium lauryl sulfate for foaming. A total of six formulations were done by naming F1 to F6 with various combinations of all the agents. Carr's index, angle of repose, moisture content determination, foaming power determination, physical appearance/visual inspection, pH determination, bulk density and tapped density determination, and *in vitro* antibacterial activity against *Staphylococcus aureus* by agar well-diffusion method were all used to assess each formulation. **Results and Discussion:** Based on a comprehensive analysis of all formulation evaluations, F3 is deemed the best due to its superior antibacterial activity, foaming power, and all other evaluations. A 24-h incubation period confirms the antibacterial activity. **Conclusion:** F3 might yield extremely positive and encouraging outcomes in achieving the current work's goal.

Key words: Antibacterial tooth powder, calcium carbonate, camphor, foaming power, peppermint oil, sodium saccharin, *Staphylococcus aureus*, thymol

INTRODUCTION

Products used for oral hygiene are among the oldest inventions made by humans. The ancient Egyptians created dental tooth powder between 3000 and 5000 B.C. Many materials, including eggshells and ox bones, can be ground into ashes and used as tooth powder.[1] Dental decay resulting from oral infections is a major concern for adults and the elderly and can occasionally be the cause of premature mortality. Yeast and bacteria that form plaque in the oral cavity are the primary causes of these diseases.[2] The simplest, least expensive, and oldest preparations are tooth powders.

Tooth powder serves a variety of purposes in promoting good oral hygiene, including abrasive tooth cleaning, polishing teeth, preventing tooth decay, reducing periodontal disease, freshening breath, and preventing or removing dental plaque and callus. Several ingredients are added to achieve the desired result because one ingredient is unable to meet all of the requirements. These ingredients may include an abrasive, a surfactant or detergent, a sweetening agent, flavor, color, etc. Various chemicals are added to tooth powders to aid in oral cavity cleaning. Given that they are all composed of tiny particles and have exceptional physiochemical properties.

Maintaining good oral hygiene is essential for maintaining one's appearance, self-perception, and confidence. The abrasive property of tooth powders is their basis; when

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applied to teeth, the powder rubs against the teeth, helping to remove deposited food debris and minerals.[3]

Although mechanical plaque control techniques have the potential to maintain a sufficient level of oral hygiene, population-based studies and clinical experience have demonstrated that few people actually use these techniques. To control bacterial plaque, numerous chemoprophylactic agents, including oils and powders, have been developed.[4] Tooth powder is a dentifrice preparation that has been used for centuries to clean and polish teeth. Some of the earliest tooth powders that have been found still contain finely ground or powdered, occasionally burned materials such as pumice, horns, bones, hooves, eggshells, and the shells of mollusks such as murex and oysters.[5]

When using baking soda or bicarbonate of soda ($NaHCO_3$) as a tooth powder, our great-grandparents would frequently find comfort. Baking soda is considered "An ingredients of oral health" due to its antibacterial, cleansing, polishing, and deodorizing properties.

Ideal properties[6]

Tooth powder should have certain ideal qualities, such as having a good abrasive effect, being nontoxic and nonirritating, providing a long-lasting result, maintaining a clean and fresh mouth, without discoloring teeth, and being reasonably priced and easily available.

Types of tooth powder[7]

Tooth powder is classified into two types.
1. Foaming,
2. Non-foaming.

The tooth powder shall be smooth, uniform, free following fine powder, and free from foreign matter. It shall be fine from abrasive materials. Tooth powder in granular or coarse powder foam is also marketed like Gopal tooth powder. The particle size depends on the costumer's choice, since psychologically a coarse powder is preferred to have abrasive action.

Requirements of tooth powder

The basic requirements of tooth powder are as follows:

It will sufficiently clean the teeth, removing foreign objects, plaque, and food particles. The mouth and teeth shall be left with fresh and clean feeling. The cost must be such that regular and frequently use is not debarred by price consideration. For the commercial shelf life, it needs to be stable in storage and able to be packed affordably. Main requirement of costumer is to protect against decay of teeth and gum troubles.[7]

MATERIALS AND INSTRUMENTS

Materials

Antibacterial agent such as thymol and camphor (SD fine chemicals), bentonite as detoxifying agent, calcium carbonate as abrasive agent, peppermint oil as flavoring agent, sodium saccharin as sweetening agent, and sodium lauryl sulfate as foaming agent. All the ingredients used in the research were laboratory grade.

Preparation of tooth powder[8]

All the powder ingredients are size reduced to fine powder using mortar and pestle and pass through 85 mesh (sieve). Now weigh all the required quantity of ingredients separately using weighing balance. Transfer all the weighed ingredients in a mortar and pestle according to their weights in ascending order and triturate with the help of pestle, until all ingredients are homogenously mixed and finally add fragrance for good flavor. Composition of tooth powder is shown in Table 1 and preparation of tooth powder is shown in Figure 1.

Evaluation of tooth powder[9,10]

Physical appearance/visual inspection

The formulation was made, and its stability,[9] appearance,[11] and color were all noted.

Determination of pH

In order to measure the pH, 50 mg of tooth powder was taken in a 100 ml beaker and 10ml of boiled and cooled distilled water was added. After giving it stirring to create a suspension, pH was measured.[12]

Determination of bulk density

The weight of a powder volume unit is typically given as g/cm^3, kg/m^3, or g/100 mL. After a suitable weight of powder has undergone standardized tapping, its volume is typically measured in a 250 ml graduated cylinder to ascertain its bulk density[13] and is determined by the given below formula.

$$Bulk\ density = \frac{Mass\ of\ the\ powder}{Bulk\ volume\ of\ powder}$$

Determination of tapped density[14,15]

The higher bulk density obtained by mechanically tapping the powder sample container is known as the "tapped density." Once the original powder's volume or mass has been noted, mechanically tap the measuring cylinder or container to record the volume or mass until nearly no more changes are noted.

Table 1: Composition of tooth powder

S. No	Ingredients in tooth powder	F1	F2	F3	F4	F5	F6
1.	Thymol	0.1	0.2	0.3	0.4	0.5	0.6
2.	Camphor	0.6	0.5	0.4	0.3	0.2	0.1
3.	Bentonite	1.25	1.25	1.25	1.25	1.25	1.25
4.	Calcium carbonate	94.05	94.05	94.05	94.05	94.05	94.05
5.	Sodium lauryl sulfate	2	2	2	2	2	2
6.	Saccharin sodium	1.5	1.5	1.5	1.5	1.5	1.5
7.	Peppermint oil	0.5	0.5	0.5	0.5	0.5	0.5

Figure 1: Preparation of tooth powder

Tapped density can be calculated using the formula:

$$Tapped\ density = \frac{Mass\ of\ the\ powder}{Volume\ of\ \ powder\ after\ tapping}$$

Determination of Carr's index

(Carr's index) is a metric for a powder's tendency to compress. It is ascertained using the tapped and bulk densities. Theoretically, a material has greater flowability the less compressible it is. It is therefore a measurement of the proportional significance of interparticulate interactions. Such interactions are typically less relevant in a free-flowing powder because the values of the bulk and tapped densities will be closer. Greater interparticle interactions are often found in poorer-flowing materials, which will result in a larger gap between the bulk and tapped densities.[16]

Carr's index can be calculated using formula,

$$\%Carr's\ index = \frac{(Tapped\ \ density - Bulk\ \ density)}{(Tapped\ \ density)} \times 100$$

Determination of angle of repose[14]

The angle created by the granule pile's edge and the bench surface's horizontal base forms the angle of repose. The

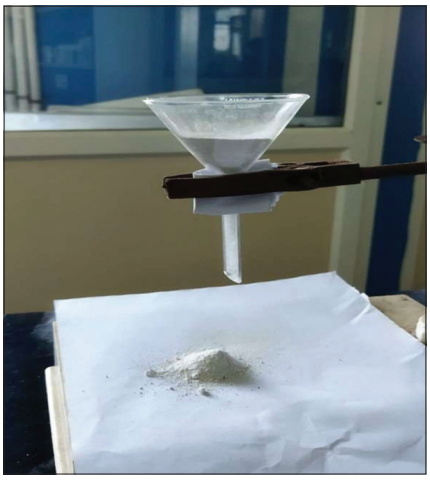

Figure 2: Determination of angle of repose

funnel that was employed was made of stainless steel, with an orifice size of 10 mm and a height of 111 mm from the beginning to the end. The funnel was secured in position, 4 cm above the surface of the bench. The height of the granules creating the cone (h) and the radius (r) of the base was measured after the cone was constructed using 5 g of material as shown in Figure 2. Findings were only regarded as legitimate in the event that a symmetrical powder cone developed.

$$\text{Angle of repose } (\theta) = \tan^{-1}\left(\frac{h}{r}\right)$$

Where, 'h' is the height of heap and 'r' is the radius of heap made by powder.

Determination of moisture content[17]

Oven drying was used to measure the powder's moisture content. The powder was weighed in triplicate, and each sample weighed 25 mg. The samples were subsequently dried for 24 h at 70°C in a vacuum oven. Samples were taken out of the oven, allowed to cool in a desiccator, and weighed. Until a steady weight was achieved, the drying and weighing procedures were repeated and the moisture content was determined using the given below formula.

$$\text{Moisture content} = \frac{\text{Original sample weight} - \text{Dry sample weight}}{\text{Original sample weight}} \times 100$$

Determination of foaming power[18]

A little amount of preparation mixed with water was placed in a measuring cylinder, the initial volume was documented, and the product was shaken ten times to test its foaming ability. The amount of foam at the end was recorded.

Foaming power can be calculated using formula: Foaming power = V_1-V_2

V_1= Initial volume, V_2=Foam volume

In vitro anti-bacterial activity[10]

The microbial strains' 24-h-old culture was applied to cotton swabs to seed Petri plates with 20 mL of LB agar. Cut wells (6 mm in diameter) were filled with 20 µL of various test samples and standard concentrations. The plates were then incubated at 37°C for a day. The diameter of the inhibition zone that developed around the well was used to gauge the antimicrobial activity in terms of millimeters (mm) around the diameter of the inhibition zone. Diameter of plate taken is 90 mm, diameter of well-made is 6 mm, and microorganism selected for study is *Staphylococcus aureus*.

Table 2: Analysis of the formulation's pH and physical characteristics

S. No	Formulation	Physical appearance	pH
1	F1	White	7.85
2	F2	White	7.62
3	F3	White	7.89
4	F4	White	7.75
5	F5	White	7.65
6	F6	White	7.51

RESULTS AND DISCUSSIONS

The current project aims to create a tooth powder with antibacterial activity using camphor and thymol. Physical appearance, pH, bulk density, tapped density, Carr's index, angle of repose, moisture content, foaming power, and *in vitro* antibacterial investigations were assessed for the prepared antibacterial tooth powder.

Physical appearance/visual inspection

The prepared formulations had a white appearance [Table 2].

Determination of pH

At room temperature (25°C), the tooth powder's PH was measured, and the results showed that the PH range was 7.51–7.89 [Table 2].

Determination of bulk density

Using a formula, the bulk density was calculated and found to be between 0.87 and 0.99 g/mL [Table 3].

Determination of tapped density

The tapped density was determined using formula and it was found to be 1.15–1.28 g/mL [Table 3].

Determination of Carr's index

Using a formula, Carr's index was calculated, and the result was 20.16–24.34 [Table 3].

Determination of angle of repose

After analysis, the formulation's angle of repose was found to be between 33.5° and 38.1° [Table 3].

Determination of moisture content

Using a formula, the moisture content was calculated and found between 0.49% and 0.72% [Table 3].

Table 3: Evaluation of formulation for micrometric properties, moisture content, foaming power

S. No	Formulation	Bulk density (g/mL)	Tapped density (g/mL)	Carr's index (%)	Angle of repose (Degree)	Moisture content (%)	Foaming power (mL)
1	F1	0.87	1.15	24.34	38.1	0.72	0.65
2	F2	0.95	1.19	20.16	33.5	0.49	0.42
3	F3	0.96	1.23	21.95	34.6	0.51	0.48
4	F4	0.99	1.28	22.65	35.8	0.56	0.58
5	F5	0.93	1.21	23.14	36.3	0.58	0.59
6	F6	0.89	1.17	23.93	37.5	0.62	0.61

Table 4: *In vitro* antibacterial activity

S. No	Formulation	Concentration (µg/mL)	Zone of inhibition (mm)	Positive control (mm)
1	F1	700	-	20.5
2	F2	700	10	20.5
3	F3	700	10.5	20.5
4	F4	700	10.2	20.5
5	F5	700	10	20.5
6	F6	700	9.5	20.5

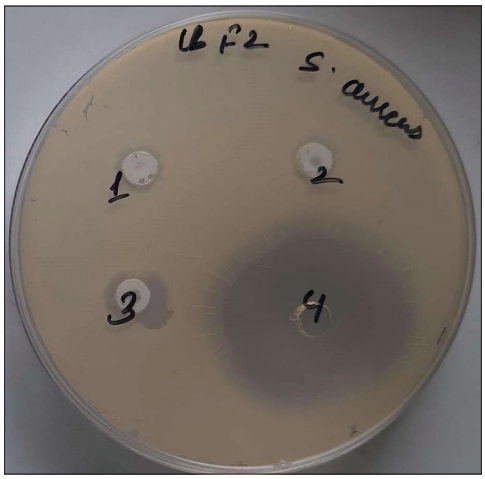

Figure 3: Antibacterial activity of F1, F2, F3

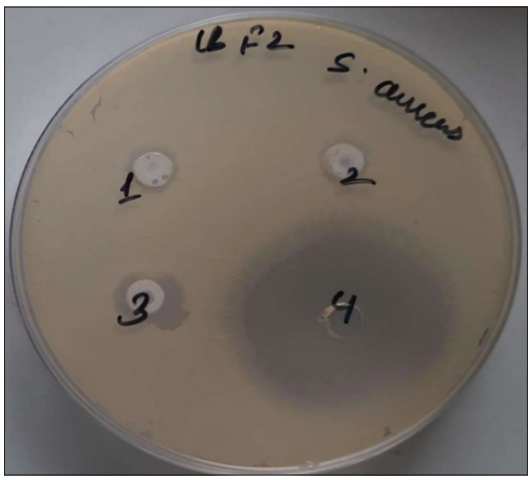

Figure 4: Antibacterial activity of F4, F5, F6

Determination of foaming power

The foaming power was determined using formula and it was found to be 0.42–0.65 [Table 3].

Antibacterial activity against *S. aurous*

Using the agar medium, the prepared tooth powder formulations were exposed to the antimicrobial activity of the agar well-diffusion method. To investigate this antimicrobial activity, 100 mg/ml was utilized. Formulation F3 was found to have a minimum zone of inhibition that was successfully observed to be 10.5 mm, larger than the other formulations. This antibacterial activity results are shown in Table 4, Figures 3 and 4.

CONCLUSION

The goal of the current work is to create and assess an antibacterial tooth powder using two antibacterial agents, such as camphor and thymol, in different combinations. After incubating for 24 h, formulation F3's zone of inhibition against *S. aureus* was maximum when compared to other formulations. Its antibacterial activity efficiency might be mediocre. As a result, formulation F3 has satisfied the goals of the current investigation and may be promising for future research.

AUTHORS CONTRIBUTIONS

All the authors have contributed equally

AVAILABILITY OF SUPPORTING DATA

The datasets of this study are available from the corresponding author on reasonable request.

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