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Formulation and evaluation of chewable Toothpaste Tablets

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ABSTRACT: In this study, we present the Formulation and Evaluation of Chewable Toothpaste Tablets as a sustainable alternative to conventional toothpaste. Chewable toothpaste tablets are an innovative alternative to traditional toothpaste, offering portability, convenience, and environmental sustainability by eliminating the need for plastic tubes. This project focuses on the formulation and evaluation of chewable toothpaste tablets designed to provide effective oral hygiene. This formulation incorporates key ingredients such as strawberry and xylitol for cavity prevention, calcium carbonate as an abrasive for plaque removal, binders for tablet integrity, and natural sweeteners and flavoring agents for enhancing user experience. The development process includes optimizing the tablets' hardness, friability, disintegration time, and taste profile to ensure ease of use and efficacy. A comprehensive evaluation is conducted to assess physicochemical properties, antimicrobial activity, and stability under varying conditions. Additionally, user acceptability studies are performed to gauge consumer satisfaction. Tablets are compared with conventional toothpaste to highlight advantages in terms of functionality, sustainability, and convenience. This review article aims to explain and explore dental problems with sparing on a modified tablet dosage form that is a chewable toothpaste tablet, which will be helpful to reduce plastic waste, will be eco-friendly, cost-effective, and improve dental health.

KEYWORD: Chewable toothpaste tablets, Cavity prevention, Plaque removal.

I. INTRODUCTION:

Cosmetics is defined as the 'substances of diverse origin, which is scientifically compounded and used to cleanse, relieve skin issues, conceal in imperfections, beautify and are used in a wider sense to include oral hygiene as well". A toothpaste tablet is a small, chewable tablet designed to replace traditional toothpaste. It dissolves in the mouth when chewed and, when combined with water, creates a paste-like consistency for brushing teeth. Toothpaste tablets are typically formulated with cleaning agents, fluoride (in some cases), abrasives, and other ingredients like xylitol or essential oils for oral hygiene. They offer a convenient, eco-friendly alternative to conventional toothpaste tubes, often packaged in recyclable or compostable materials, making them a popular choice for travelers and environmentally conscious consumers.

Using lyophilized (freeze-dried) strawberries in chewable toothpaste tablets is an innovative way to incorporate natural ingredients into oral care. Freeze-drying preserves the beneficial compounds in strawberries while keeping them in a stable, powder form that can be easily integrated into tablet formulations incorporating strawberry extract into toothpaste, the natural bioactive compound can offer a complementary approach to conventional fluoride-based formulation, enhancing overall oral health and providing a flavorful, natural alternative. Combining strawberry extracts with proven agents like xylitol maximizes their protective effects. The caries-protective effect of strawberries in toothpaste is an emerging area of interest, particularly due to the natural bioactive compounds found in strawberries.

II. PLANTPROFILE

STRAWBERRY (Fragaria × ananassa)

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Taxonomical classification
Kingdom: Plantae
Family: Rosaceae
Genus: Fragaria
Species: Fragaria× ananassa
Order: Rosales

Cavity protection and tooth whitening action of strawberry

Oral health is an essential part of overall well-being, yet it is often neglected, leading to awide range of oral health problems. These issues not only affect the teeth and gums but canal so have a profound impact on general health, nutrition, and quality of life. By incorporating strawberry extract into toothpaste, the natural bioactive compound can offer a complimentary approach to conventional fluoride-based formulation, enhancing overall oral health and providing a flavorful, natural alternative.

Strawberries are a rich source of vitamin C and several other antioxidant compounds. Strawberry fruit and leaves are efficacious as natural skin whiteners, and teeth enamel whiteners and prevent tartar build-up. The popularity of strawberries as a fruit plant is primarily the result of are unique aroma, sweet taste, bright color, and nutritional value. These quality characteristics are largely determined by the metabolic composition of the fruit. Fore xample, strawberries are known to be a valuable source of polyphenolic compounds, mainly flavonoids. Approximately 70% of the total phenolics accumulated in ripe fruit correspond to proanthocyanidins (PAs), anthocyanins, flavanols, and other phenolics (i.e., p-coumaric acid, ellagic acid) .

Advantages of chewable toothpaste tablets

- Each tablet is a pre-measured dose, eliminating the need to squeeze out the right amount of toothpaste.
- The packaging of toothpaste tablets is often designed to be reused or recycled, making them a zero-waste alternative to traditional toothpaste tubes, which often end up in landfills.
- Since toothpaste tablets are solid, they typically have a longer shelf life than paste or gel toothpaste, as they are less prone to drying out or contamination once opened.
- The small, solid form of toothpaste tablets takes up much less space compared to traditional toothpaste tubes, making them easier to store in small spaces.
- Toothpaste tablets are compact, light weight, and do not need to comply with liquid restrictions, making them ideal for travel.

III. METHODOLGY

1. Weigh calcium carbonate, xylitol, lactose, saccharine, sodium benzoate, sodiumlauryl sulphate to exact required amount and pass separately through sieve no.10.

2. Triturate all powdering redients into mortarforsize reduction and uniform mixing.

3. Prepare starch slurry using a sufficient quantity of water. The nadd starch paste in above blend, and mix well to produce coherent mass.

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4. Pass coherent mass through sieve no.10 and granules were dried at 60ºC for 1 hr.

5. Then, precisely weighed talc, magnesiumstearate, menthol and strawberry powder was added to dry granules and combined.

6. Then place butter paper at bottomand arrangesieves no.22and 44 byascendingorder.Then pass the dried granules through sieve no. 22 below which sieve no.44 is kept. The granules retained on sieveno.44 are the desired granules and powder which pass through sieve no. 44 are fines retained on butter paper.

7. Toothpaste tablet were produced by punching above dried granules with tablet punching machine.

SL.NO	INGREDIENTS	F1(mg)	F2(mg)	F3(mg)
1	Strawberry extract	240	220	200
2	Calcium Carbonate	120	120	130
3	Sodium Benzoate	3	3	3
4	Xylitol	80	90	80
5	Starch	50	60	60
6	Menthol	3	3	6
7	Saccharine	6	6	6
8	Talc	18	18	25
9	Magnesium Stearate	12	12	12
10	Sodium lauryl sulphate	18	18	18
11	Lactose	50	50	60
12	Purified Water	q.s	q.s	q.s

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IV. EVALUATION

1. Pre compression factor

1. Angle of repose

The angle of repose is defined as the maximum angle possible between the surface of apile of powder and the horizontal plane. The frictional force in a loose powder or granules can be measured by the angle of repose is an indicator of the powder flow property.

$$\tan \theta = H / R$$
$$\theta = \tan^{-1}(H/R)$$

2. Bulk Density

The bulk density is defined as the ratio of the mass of the powder by the bulk volume incm3 The sample was carefully introduced into a 50 ml graduated measuring cylinder. This cylinder was dropped at 2 seconds intervals onto a hardwood surface 3 times from a height of 1inch. The bulk density of each formulation was then obtained by dividing the weight of the sampleingrams by the final volume in cm3 of the sample which is contained in the measuring cylinder. It was calculated by using the following equation.

Bulk density=Mass/Bulk volume

3. Tap Density

The tap density is defined as the ratio of the mass of the powder by the tapped volume incm3. The sample was carefully introduced into a 50ml graduated measuring cylinder. This cylinder was dropped at 2 seconds intervals onto a hardwood surface 100 times from a height of 1inch.The tapped density of each formulation was then obtained by dividing the weight of the sample in grams by the final tapped volume in cm3of the sample which is contained in the measuring cylinder. It was calculated by using the following given equation.

Tap density=Mass/Tap volume

4. Carr's Index

Carr's index which is also called as % compressibility index is an indirect method of measuring the flow of granules using the bulk densities. It was developed by Carr. The compressibility of a powder was a direct measure of the potential powder or bridge strength and the stability of the granules. Carr's index of each formulation was calculated by using the following equation.

% Compressibility=Tap density–Bulk density/Tap density×100

5. Hausner Ratio

Hausner predict the flow properties of powder by using inter particle friction. This is a simple index that can be determined on small quantities of powder. It is calculated by following formula:

Tapped density/Bulk density

6. Flow Rate

The rate at which a specific mass passes through a funnel's appropriate diameter aperture is known as the powder's flow rate. The flow rate of granules of each formulation was measured by carefully pouring precisely weighed amounts of granules into a funnel with an 8 mm diameter aperture. The time taken for the entire granule mass to come out of theorifice is noted using a stopwatch. The equation that follows was used to determine the flow rate.

Flow rate=Weight of the granules/Times in seconds

2. Post compression factor

1. Weight variation

Weight variation was done to check whether different batches of tablets have uniformity. Weighed 20 tablets individually, calculated the average weight, and compared the individual tablet weight to average. If not more than two tablets are outside the percent age limit and none of the tablets differ by more than two times the Percentage limit, the tablets meet the test.

2. Hardness

The hardness of the tablet was evaluated by using a Monsan to hardness tester. It consists of a barrel containing a compressible spring held between two plungers. A lower plunger was placed in close contact with the tablet and a zero reading was taken. By turning a threaded bolt, the upper plunger was forced against a spring until the tablet fractures. The force of fracture was recorded.

3. Friability

Roche friabilator is used to evaluate the friability of 10 tablets from each formulation. Pre weighed tablets were placed in the friabilator plastic chamber andthefriabilatorwasrunfor4minutesat 25 rpm.

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%Friability=$\frac{\text{Initial weight-Final weight}\times 100}{\text{Final weight}}$

4. Foamability

The foamability of the formulated product was estimated by adding a tablet into a100 ml graduated measuring cylinder containing the required amount of distilled water. The initial volume of the measuring cylinder was recorded. Then the measuring cylinder was shaken 10 times. The final volume was recorded after the production of foam.

Foamability=V2-V1

5. pH

The Ph of solution in distilled water was determined at room temperature 25°C. The pH was measured by using digital pH Meter.

6. Disintegration

The disintegration test is used to show how quickly the tablet breaks down into smaller particles, allowing for a greater surface area and availability of the drug when taken by a patient.

V. RESULT AND DISCUSSION

1. Preformulation studies

Trail No.	Angle of repose	Bulk Density (g/m)	Tapped Density (g/m)	Carr's Index(%)	Hausner's Ratio (g/m)
F1.	28.50^0	0.518	0.605	14.21	1.16
F2.	31.47^0	0.598	0.613	2.44	1.02
F3.	33.73^0	0.578	0.633	8.68	1.09

2. Post evaluation studies

TrailNo.	Weight variation (g)	Hardness (Kg)	Friability (%)	Foamabilityy(ml)	pH	Disintegration (time)
F1.	610	4	0.92%	12	6.8	5min24sec
F2.	625	2.5	1.2%	10	7.2	4min32sec
F3.	612	3.5	0.94%	7	6.5	8min44sec

Discussion

1. Preformulation test

Angle of Repose: The angle of repose of powder blend was performed using the fixed funnel method. The flow characteristics of formulations F1 and F2 was found to be passable. The formulation F1 has the lowest angle of repose and good flow characteristics

Bulk Density: The bulk density were in the range of 0.518-0.578 g/m are good accordance to the standard range in Indian pharmacopoeia.

Tapped Density: The tapped Density of powder was in the range of 0.605-0.633g/m are good accordance to the standard range in Indian pharmacopoeia.

Carr's index: It is found that the carr's index of formulation F1is good.TheformulationF2and F3 were found to have excellent flow properties and carr's index in the range of less than 10.

Hausner's Ratio: All the formulations, Hausner's ratio was found to be in the range of 1 to 1.18 which shows excellent flow characteristic.

2. Preformulation studies

Weight variation test was performed and the result were within the pharmaceutical limit and hence all the formulation prepared had passed the test. It ranges from 600-625. F1 was the excellent range

Hardness of the formulation was in the range of 2.5-4 which indicate that prepared tablet were within the pharmaceutical limit of chewable toothpaste tablets.

Friability of F1 and F2 was found to be in the range 0.92-0.94% which was less than 1% indicate that the formulated tablets were having good strength and can best able for long period of time.

Foamability was performed as per the procedure described in methodology section. The formulated chewable toothpaste tablet having good foamability and all the formulations foam height is >20 ml .

VI. CONCLUSION

It is concluded from the current research work entitled "FORMULATION AND EVALUATION OF CHEWABLE TOOTHPASTE TABLETS", as a better alternative to conventional toothpastes. They provide an accurately measured dosage of the active ingredient in convenient portable packages and can be designed to protectunstable medications or disguise unpalatable ingredients. By incorporating innovative ingredients, embracing digital integration, and promoting preventive approaches, toothpaste tablets have the potential to revolutionize oral hygiene practises and improve overall oral health outcomes.

The 600mg toothpaste tablet was prepared

by wet granulation method. Precompression parameters like the angle of repose, bulk density, tap density, compressibility index, Hausner's ratio were conducted on the powder blend. The formulated tablets were evaluated for post compression tests like weight variation, hardness, friability, and pH and disintegration test. The results obtained from each stage of formulation were utilized and the best formulations F1 were selected.

The research confirms that Chewable toothpaste tablet can be successfully formulated with desirable properties for cleaning efficiency and user's satisfaction. They provide a convenient, portable and eco-friendly alternative to conventional toothpaste while maintaining effective cleaning and oral health benefits.

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