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Review Article

CHOCOLATE DRUG DELIVERY SYSTEM: A REVIEW

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Abstract:

One of the most popular food all over the world is chocolate and it has highly nutritious energy, fast metabolism and good digestibility. Nowadays, most important trend is healthy foods. Chocolate is derived from cocoa beans, central to the fruit of cocoa tree, theobroma cacao. Chocolate characters not only originate in flavor precursors present in cocoa beans, but are generated during post-harvest treatments and transformed into desirable odor notes in the manufacturing processes. In its many forms chocolate may be consumed as a beverage, as a syrup, as a flavoring, as a coating. When consumed as part of a balanced and varied diet, chocolate can be both a source of nutrients as well as pleasure, and can be considered as being part of a healthful, wholesome diet. Medicated chocolate formulation is widely used for pediatric administration and it increases the patient's desire to consume the medication. Medicated chocolate is prepared by using chocolate base and drug is incorporated to prepared chocolate base. The medicated chocolate can be evaluated for its appearance, moisture content, viscosity, blooming test, drug content determination and in vitro drug release. This review paper focused on health importance and usage of medicated as well as conventional chocolates.

Key Words: Chocolate, Medicated chocolate, Cocoa, Pediatric, Drug delivery

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INTRODUCTION [1,2]

Chocolates are semisolid suspensions of fine solid particles from sugar and cocoa (and milk, depending on type), making about 70% in total, in a continuous fat phase. Cocoa solids are derived from beans obtained from the fruit of *Theobroma cacao*, with world production dominated by Forastero types, made up of small, flattish and purple beans. Another type, Criollo, is presently rare in production; Trinitario, a disease-resistant hybrid of Criollo and Forastero, regarded as a flavour bean. Primary chocolate categories are dark, milk and white that differ in content of cocoa solid, milk fat and cocoa butter. The outcome is varying proportions of carbohydrate, fat and protein. Chocolate manufacturing processes differ due to variation in national consumer preferences and company practices. Central to chocolate character is continuous phase lipid composition, which influences mouthfeel and melting properties. Chocolate triglycerides are dominated by saturated stearic acid (34%) and palmitic acid (27%) and monounsaturated oleic acid (34%). Chocolates are solid at ambient (20–25°C) and melt at oral temperature (37°C) during consumption, giving a smooth suspension of particulate solids in cocoa butter and milk fat. This constrains lipid composition. The oral epithelia are also sensitive to gradations of smoothness, which selects for desirable lipid crystal forms. Despite high lipid and sugar contents, chocolate consumption makes a positive contribution to human nutrition through provision of antioxidants, principally polyphenols including flavonoids such as epicatechin, catechin and notably the procyanidins. White chocolates differ from milk and dark through the absence of cocoa nibs containing antioxidants, reducing the product's shelf-life. Chocolates also contain minerals, specifically potassium, magnesium, copper and iron. Differences in the sensory characters of chocolate can be attributed to use of different cocoa types, variations in ingredient proportions, use of milk crumb instead of milk powder, blending techniques and processing methods. Specifications depend on type of chocolate and its intended use. As chocolates melt in the mouth, the continuous fat phase inverts into the oral continuous aqueous phase mixing with saliva that dissolves the sugar particles. Lipids and cocoa solids coat oral epithelial surfaces. Oral particle dissolution influences perception of coarseness and solvation at rates corresponding to size and work input such as mastication, tongue compression and swallowing. Particle size distribution and ingredient composition therefore influence perception of primary taste (gustation) and oral volatiles release with retronasal flavour characters in magnitude and temporal profile. Rheological properties of chocolate are important in

manufacturing process for obtaining high-quality products with well-defined texture. Chocolates with high viscosity have a pasty mouthfeel, persisting in the mouth. Viscosity relates to composition, processing strategy and particle size distribution. Apparent viscosity in aqueous solutions influences flavour 'by mouth' and taste intensity during consumption, thus rheological measurements often give information related to sensory character of chocolate.

TYPES OF CHOCOLATE [3]

1. Milk chocolate: The use of predominantly medium roast West African beans with Ecuadorian beans is advised. This blend would deliver a good clean cocoa with nutty and slightly fruity undertones. It is important to note that the addition of the highly acidic Brazilian and Malaysian beans would negatively contrast with the milky notes desired.
2. Light milk chocolate: This product could be made from lightly roasted Java beans that are known for their light colour and very mild overall flavour with distinctive nutty overtones. This would help attain a good standard of identity for milk chocolate, as the coating would be several shades lighter than a 100% West African bean.
3. High-quality semisweet chocolate: The use of predominantly West African stock is advised for its cocoa character and slightly nutty undertones (light to medium roast) to heighten desirable notes and limit burnt/bitter notes. This blend when complemented by Caracas and Trinidad beans would contribute floral and slightly spicy notes to create a balanced yet unique profile.
4. Bittersweet chocolate: This product is mainly designed for use on very sweet and highly flavoured cream centres as it produces very bitter coatings.
5. Semisweet cookie drop: The use of the dominant West African beans is advised in this product to provide a good cocoa impact. The strong profiles of the Brazilian and Sanchez components complement and contrast the West African component. In this application, a robust flavour is desirable for contrast in the baked cookies.

THERAPEUTIC BENEFITS OF CHOCOLATE [4-12]

1. Diuretic properties - Theobromine acts a diuretic. This acts as effective therapy in cases of fluid accumulation in tissues (oedema) or removal of excess water and salts from the body through urination or in the reduction of high blood pressure due to increased water content of the fluid connective tissues.
2. Vasodilation - Theobromine helps in the increased dilation of blood vessels. This helps improve blood

flow, and thereby contributes to the reduction of blood pressure.

3. Improving cardiac functioning - Theobromine has been known for its properties for improving the functioning of the heart. The American Journal of Clinical Nutrition states that theobromine can be used for treating various cardiac problems such as arteriosclerosis, vascular disorders, angina, hypertension.

4. Fighting against tooth decay - Theobromine has been found to be extremely effective in fighting tooth decay, by acting against those micro-organisms which cause oral cavities.

5. Muscle relaxation - Theobromine possesses relaxant properties. It induces relaxation of the smooth muscles of the cardiac tissues.

6. Anti-cancer and anti-inflammatory properties - Dark chocolate is rich in antioxidants such as flavonoids and polyphenols. These compounds display anti-cancer and anti-inflammatory properties by inhibiting excessive and uncontrolled cell division and reducing inflammation by neutralizing the production of free radicals respectively.

7. Prevention of heart disease - Chocolate is a rich source of nutrients such as iron, copper, magnesium, zinc, etc. All these elements play a key role in the prevention of Coronary Heart Disease (CHD).

8. Reduction of food cravings - Dark chocolate is bitter to taste, and also possesses a sizable calorie count and fat content. Therefore, consumption of dark chocolate has been found to reduce cravings for

various sweet, salty, and oily foods.

9. Anti-depressant properties - Consumption of chocolates enhances the production of endorphins. The production of these neurotransmitters results in an individual experiencing a feeling of positivity, thereby acting against depression. Chocolates are also a rich source of serotonin, another neurotransmitter which possesses anti-depressant properties.

10. Improving memory - Consumption of hot chocolate has a positive effect on the functioning of the brain and memory enhancement by improving neurovascular coupling (response of blood flow to brain activity) in the white matter of the brain as well as cognitive functioning. This positive effect of chocolate consumption on the functioning of the brain may also play a role in the prevention of brain degenerative disorders such as Alzheimer's disease.

CHOCOLATE MANUFACTURING PROCESSES [13]

Chocolate manufacturing processes generally share common features (Figure 1) such as:

- (1) Mixing
- (2) Refining
- (3) Conching of chocolate paste
- (4) Tempering and depositing
- (5) Moulding and demoulding

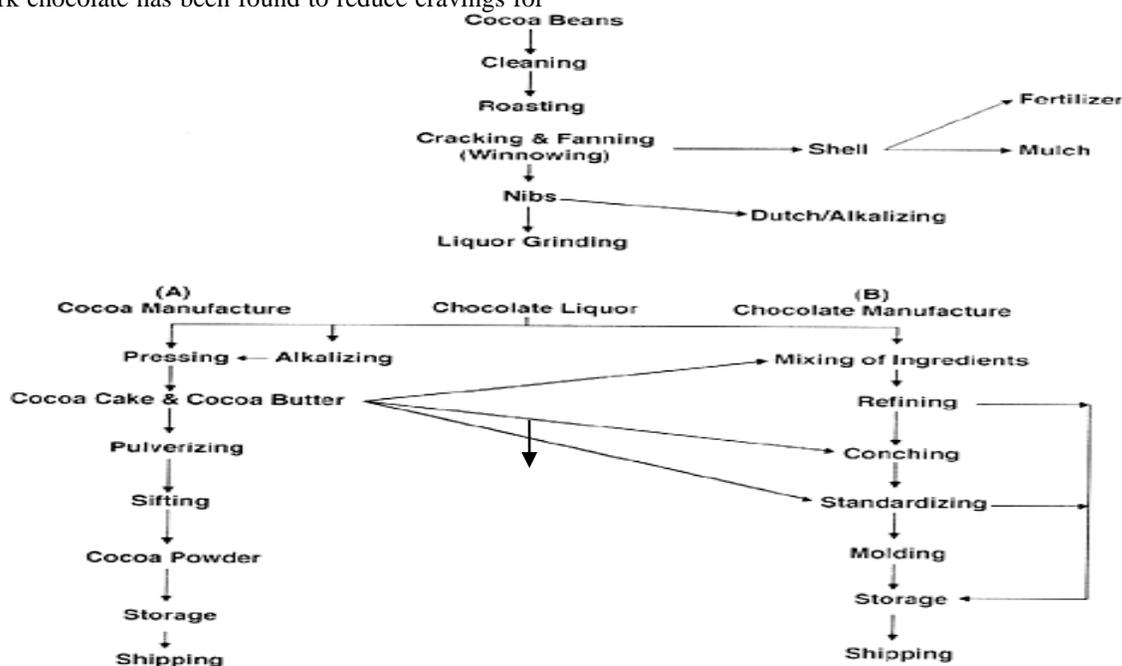


Fig 1: Flowchart of Chocolate Manufacture

METHOD OF PREPARATION [13]

Oven is set to 50°C. In a beaker, sugar and water is taken and kept in the oven for 4-5 min and syrup is prepared. Then cocoa butter is taken and kept in the beaker in the oven for 1 min. Then sugar syrup is removed from the oven, and cocoa powder is added and mixed well. Careful attention is paid to the chocolate manufacturing process to ensure that the temperature of the mixture is not too high. Then above mixture of chocolate base is cooled up to semisolid consistency and then flavor is added.

EVALUATION OF CHOCOLATE BASE [14]**Viscosity determination of chocolate base**

Brookfield Rotational digital viscometer is used to measure the viscosity (cps) of the prepared chocolate base. The spindle is rotated at 20rpm; samples of chocolate base are heated at 50°C before the measurements are taken.

Taste, texture and mouth feel characteristics assessment

Taste, texture & mouth feel characteristics of chocolate are evaluated by taking panel of 10 human volunteers on a rating scale of 1-5 (Table 1).

EVALUATION OF MEDICATED CHOCOLATES [14]**General Appearance**

The general appearance of a chocolate formulation, its visual identity and overall “elegance,” is essential (i) For Consumer acceptance (ii) For control of lot to lot uniformity and (iii) For monitoring trouble free manufacturing. The control of the general appearance of a chocolate involve the measurement of number of

attributes such as chocolate’s color, presence or absence of an odor, taste, surface texture and physical flaws.

Dimensions

The dimension of chocolate is measured by Vernier’s caliper.

Moisture content determination

Moisture content of chocolate formulation is determined by using digital Karl Fischer titrator. These instruments are designed to calculate percentage (%) water content by using formula:
Water = [Volume (mL) TS of water determination consumed x f (mg/m)/weight of sample (mg)]

$$\times 100 (\%)$$

Where,

f = The number of mg of water (H₂O) corresponding to 1ml of water

Determination TS,

TS= Water determination test sample

Blooming test**Fat bloom**

When a thin layer of fat crystals forms on the surface of the chocolate formulation. This will cause the chocolate to lose its gloss and a soft white layer will appear, giving the finished article an unappetizing look. Fat bloom is caused by the recrystallization of the fats and/or a migration of a filling fat to the chocolate layer. Storage at a constant temperature will delay the appearance of fat bloom.

Sugar bloom

This is a rough and irregular layer on top of the chocolate formulation. Sugar bloom is caused by condensation (when the chocolate is taken out of the refrigerator). This moisture will dissolve the sugar in the chocolate. When the

Table 1: Taste, Texture and Mouth Feel Characteristics Assessment

Characters	Criteria	Scale
Appearance	Glossy, even shine; no streaks, dots, cracks or “fog”	1-5 with 5 being the best.
Aroma or Smell	Chocolaty with only a light scent of any flavorings; fresh with no burnt, smoky, chemical smells	1-5 with 5 being the best.
Snap	Break clean without crumbling or layering; ideally a crisp pop when broken (loudest for dark chocolate)	1-5 with 5 being the best.
Taste	Chocolaty, flavors not overpower the chocolate taste. Good after taste	1-5 with 5 being the best.
Texture	Creamy and smooth, not waxy; promptly and evenly melts in mouth	1-5 with 5 being the best.

water evaporates afterwards, the sugar recrystallizes into rough, irregular crystals on the surface. This gives the chocolate an unpleasant look.

In vitro drug Release

In vitro drug release study of chocolate formulation is performed in USP dissolution apparatus Type 1 (Basket), using 0.1N HCl as a dissolution media. The vessel of the dissolution apparatus is filled with 900 ml of 0.1N HCl is placed and allowed to attain a temperature of $37\pm 0.5^\circ\text{C}$ and 50rpm. A chocolate formulation is placed in the basket. At predetermined time interval samples are withdrawn and volume is replaced with equal quantity of fresh medium. The collected samples are filtered and analyzed by UV Spectroscopy.

CONCLUSION

The new trend in food manufacturing is functional or health-promoting foods. These foods prevent illnesses such as heart disease, osteoporosis, cancer, diabetes, etc. Epidemiological studies have shown that consumption of diets rich in fruits promotes lower risk of chronic diseases, including cancer, heart disease, stroke, and also diabetes control and reduced risk of obesity. Chocolate flavour resides not only in a volatile aromatic fraction of flavour-active components but also in non-volatile compounds influencing taste perception. Its complex composition depends on the cocoa bean genotype, specifically on contents of bean storage proteins, polysaccharides and polyphenols. The organoleptic characteristics of bitter and unpleasant flavors of drug can be masked by chocolate. Thus chocolate drug delivery is a promising tool for delivery of drug through oral route.

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