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Design Development and Evaluation of MCT Oil Emulsion

Shreya Patel, Krupa Patel, Kathan Raval, Kevin Dudhagara, Sagar Thakar, Komal K Raval
[1,2,3,4,5]*Student, K. B. Raval College of Pharmacy*
[6]*Assistant Professor, Department of Pharmaceutics, K. B. Raval College of Pharmacy*
Corresponding Author: Shreya patel

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ABSTRACT: This research paper is about benefits of MCT Oil emulsion in premature baby,The MCT (medium chain triglycerides) have garnered their recognition for their unique physico chemical properties and potential health benefits. Despite their classification as saturated fats, they stand apart from other saturated fatty acids due to their distinctive characteristics, positioning them as a valuable component in nutrition. While traditional dietary fats contain LCT (long chain triglycerides), MCTs are fatty acids that naturally found in coconut and palm oils. The structural dissimilarity grants MCTs advantageous attributes, encompassing rapid digestion and absorption, providing a swift source of energy It also provides the nutritional benefits to the premature babies for healthy weight gain and growth. The addition of MCT is preferable as they are more easily digested and quickly absorb in bloodstream than long chain fat and provide ready supply of energy by increasing fatty acid bioavailability and because of that fat supplementation of human milk with MCT oil promotes the weight gain in preterm infants. including its efficacy in managing gastrointestinal disorders and promising roles in anticancer, neuroprotective, and antimicrobial effects.

KEYWORDS:MCT oil, preterm infants, coconut oil, nutrition, energy source

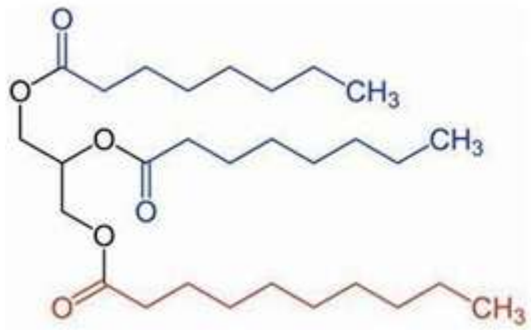
I. INTRODUCTION

In this paper the benefits and sources of MCT oil is described, the formulation and evaluation parameters that are examined of MCT Oil emulsion.

Source of MCT Oil:

MCT (Medium-Chain Triglyceride) oil is primarily derived from coconut oil and palm kernel oil. These oils naturally contain medium-chain fatty acids, which are extracted and purified to produce MCT oil. Coconut oil is the most common source, as it has a high concentration of MCTs, particularly caprylic acid (C8) and capric acid (C10), which are rapidly absorbed and used for energy.

Structure of MCT Oil:



Introduction of MCT Oil:

Along with carbohydrates and proteins, lipids, belong to the most principal nutrients in the human diet with a plethora of key biological functions. In addition to serving as a source of energy and building blocks of bio membranes, they also participate in numerous cellular signaling pathways and activation of transcription factors, thus significantly impacting human physiology and pathophysiology.

Additionally, lipids play a crucial role in influencing the sensory characteristics of food products. In this context, they contribute to the mouthfeel and texture of various food items. Moreover, owing to their excellent biocompatibility, lipids are commonly utilized as safe vehicles for food bioactive ingredients and drug delivery.

However, it is important to note that excessive consumption of lipids is linked with development of obesity which strongly contributes to several diseases, including cardiovascular diseases (atherosclerosis, hypertension), type 2 diabetes, liver diseases, cancer (breast and colon cancer) and other disorders. Chemically, lipids consist of fatty, waxy, or oily compounds that exhibit solubility in nonpolar (organic) solvents while being completely insoluble in water.

This structurally and functionally heterogeneous group includes: (1) fats and oils (triglycerides, TGs),

(2) phospholipids, (3) waxes, and (4) steroids. Dietary lipids are predominantly present in the form of TGs, also known as neutral fats, triacylglycerols, or triacyl glycerides. They consist of a glycerol (a 3-carbon sugar alcohol/polyol) backbone esterified with three fatty acids (FAs) (Woodbury 2012). In industrially developed countries, TGs serve as the primary source of dietary lipids, and their average daily consumption ranges from approximately 100 to 150 g, accounting for around 30% of an individual daily caloric intake.

The physico-chemical characteristics and biological properties of FAs are strongly determined by the degree of saturation (i.e., number of double bonds in the carbon chain) and the length of the aliphatic chain. Based on these aspects, FAs can be classified as (1): saturated (i.e., SFAs), monounsaturated (i.e., MUFA), and polyunsaturated (i.e., PUFA), and as (2): short- (SC), medium- (MC), long- (LC) or very long-chained (VLC), respectively. This comprehensive study offers an in-depth exploration of coconut-derived MCT oil potential, focusing on its chemical composition, production from coconut oil, unique physico-chemical properties and metabolism features, health benefits and safety. To compile this paper, an extensive literature search was conducted, drawing from internationally recognized databases like Medline/PubMed, Web of Science, Science Direct/Elsevier, and Springer. Additionally, resources like Google Books and Google Scholar were consulted. To gauge the state of coconut oil production in 2020, data from FAOSTAT was analyzed.

MCT Oil emulsion:

An emulsion is a mixture of two or more liquids that are normally immiscible due to differences in their properties.

MCT Oil is a beneficial in many ways, one of them is for premature baby's growth.It helps to provide the nutritional strength in premature baby.It develops the muscle growth.So, for babies it is beneficial source for the nutrition.

Other than that, it also had a beneficial for adults. Due to its ability of help dieters stay in ketosis it include into keto diet and because of that it help in weight loss.It is kind of energy source for adults.MCT oil could help lower calorie intake.MCT oil could affect body composition and weight.

MCT Oil could be a good energy source.MCT might help the body burn fat for energy.

MCT could help manage epilepsy, Alzheimer and autism.MCT contains fatty acids that fight yeast and bacterial growth.All of these are main benefits of MCT oil.

The purpose of making MCT oil emulsion is to masking the unpleasant taste of the oil.It is suggested to take MCT oil with the food.It has a strong aroma in it which is not preferable in terms of mix it with the food. So by making the emulsion formulation it is easy to mask its taste and make it more convenient to mix it into the food.It also has the sweet taste, so it can also be taken directly.

II. MATERIALS USED IN FORMULATION OF MCT OIL EMULSION

1) MCT OIL: To provide nutrition
2) Xanthan gum: as a stabilizer and thickening agent
3) Sodium benzoate: as a preservative
4) Span: non-ionic emulsifier
5) Stevia: as a sweetening agent
6) Rose oil: aromatic agent
7) Water: facilitates emulsion formulation and enhance texture

III.PROCEDURE FOR MCT OIL EMULSION:

Certainly! Here's simplified chart outlining the procedure for making MCT Oil emulsion:

1)Firstly,take a small portion of water base and weigh the xanthan gum then stir until fully dispersed to prevent clumping.

2)Then in the same mortar pestle add the weighed sodium benzoate and stevia (add the water dropwise if needed)

3)Slowly add span into the water phase while stirring, mix well until fully incorporated.

4)Start stirring the mixture at high speed and slowly add the MCT Oil and blend thoroughly for 5-10 minutes and add 2-3 drops of rose oil and stir again for few minutes to form a stable emulsion. Adjust with water up to mark.

Total 11 formulations were prepared using different excipient ratios. Which is shown in the below table.

Ingredients	Formulations										
	1	2	3	4	5	6	7	8	9	10	11
Xanthan gum	0.09 gm	1gm	_	_	0.06 gm	0.12 gm	0.12 gm	0.12 gm	0.12 gm	0.12 gm	0.12 gm
Sodiumbenzoate	0.15 gm	0.03 gm	_	_	0.06 gm	0.06 gm	0.06 gm	0.06 gm	0.06 gm	0.06 gm	0.06 gm
Stevia	0.06 gm	_	_			0.1 gm	0.1 gm	0.1 gm	0.1 gm	0.1 gm	0.06 gm
Span	0.6 ml	0.45 Ml	0.4 ml	2ml	3ml	4ml	4ml	4ml	4ml	4ml	4ml
MCTOil	3 ml	7.5 ml	3 ml	5.9ml	5.9ml	5.9ml	5.9ml	5.9ml	5.9ml	5.9ml	5.9ml
Vanillaessence	_						3-4drops	3-4drops			
Vanillapowder								2gm			
Orangeoil									4-5 drops		
Roseoil										2ml	4-5drops
Water	26ml	21.9 ml	26.5 ml	22.8 ml	20.9 ml	19.8 ml	19.7ml	17.8ml	17.8 ml	14.8 ml	17.8 ml
Observation	Unstable&waterconsistency	Wateryconsistency	Phase separation, incosistent	Consistentcyquitegoodbutemulsification ispoor	Stabilitybetterthan F4	MoreStablethananothersunpleasant odour	Itsnotcapableformasking the odour	It makesthestrongfragrancewhichhas weird aroma	Orangeoilstaysimmisciblewiththesolution	Formulationseparatesquicklybecauseofexcessroseoil	it doesnotseparateoutquicklyanditalsocovers the odour

Formulation table

IV. EVALUATION:

A) To assess its stability, texture, and effectiveness. Once the emulsion is formed, several evaluation tests can be conducted to assess its stability, texture, and effectiveness.

1.Appearance

•**Procedure:** Observe the emulsion visually under good lighting conditions. Note the color, clarity, and homogeneity.

•Acceptance Criteria: Should appear uniform, free from phase separation, and of consistent color and texture.

2.pH Level

Procedure

Calibrate a pH meter with standard buffer solutions (pH 4.0 and pH 7.0)Immerse the electrode in the emulsion sample.Record the pH value once it stabilizes. ORTake pH Paper and dip it into the emulsion,Let it rest for a while, after some time pH paper will change its color according to the pH of the emulsionCompare the color of pH paper with ideal color chart and note the pH value.Acceptance Criteria: Typically, in the range of 5.0 to 7.0, depending on the formulation.

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3.Viscosity
Procedure:

Use a viscometer (Brookfield or equivalent). Measure the viscosity of the emulsion at a specified shear rate and temperature (e.g.,25°C)Acceptance Criteria: Should meet the viscosity range specified for the formulation.

4.Texture and Spreadability
Procedure:

Use a texture analyzer or manual assessment.Evaluate the Spreadability on a glass plate using a specified weight and measure the spread diameter.

Acceptance Criteria: Should exhibit smooth texture and adequate spreadability without grittiness.

5.Viscosity at Different Temperatures
Procedure

Measure viscosity at various temperatures (e.g., 5°C, 25°C, and 40°C). Use a controlled temperature bath for uniform heating or cooling.

Acceptance Criteria: Consistent viscosity within the defined limits at different temperatures.

6.Storage Stability
Procedure:

Store samples under different conditions (e.g., room temperature, 40°C, and refrigeration).Periodically assess for changes in appearance, pH, viscosity, and stability over a defined period (e.g., 1 month or more).Acceptance Criteria: No significant changes in quality parameters during the storage period.by performing these tests, the quality of the castor oil emulsion can be thoroughly evaluated and ensured for its intended use.

7.Emulsion Stability
Procedure:

Centrifuge the emulsion at 3000 rpm for 30 minutes.
Observe for phase separation or creaming.
Acceptance Criteria: No phase separation or significant creaming observed.

8.Particle Size Distribution
Procedure:

Use a laser diffraction analyzer or optical microscope. Measure the average droplet size and distribution.

Acceptance Criteria: Droplet size should be within thespecified range (e.g., 1-100 µm for fine emulsions).

Additional Tests for MCT Oil Emulsion
Dye Test
Purpose: To determine the type of emulsion (oil-in-water or water-in-oil).
Procedure:

Add a water-soluble dye (e.g., amaranth) or an oil-soluble dye (e.g., Sudan III) to a small amount of emulsion.Observe under a microscope or visually.

Interpretation:

If the continuous phase takes up the dye, the emulsion type is identified:
Water-soluble dye → Oil-in-water (O/W) emulsion.
Oil-soluble dye → Water-in-oil (W/O) emulsion.
Dilution Test
Purpose: To confirm the type of emulsion.

Procedure:
Add a small quantity of water to the emulsion and mix gently.Observe for any phase separation.
Interpretation:
If the emulsion dilutes easily with water, it is an O/W emulsion.
If it resists dilution with water, it is likely a W/O emulsion.

Conductivity Test
Purpose: To differentiate between O/W and W/O emulsions based on their ability to conduct electricity.
Procedure:
Insert electrodes of a conductivity meter into the emulsion sample.Record the conductivity reading.
Interpretation:

High conductivity indicates an O/W emulsion (water is the continuous phase)Low or no conductivity indicates a W/O emulsion (oil is the continuous phase)

V. RESULT AND DISCUSSION

1.Appearance
Light pink in color. rosy aroma, Homogeneous solution.

2.pH Level
According to pH paper testing, pH of our emulsion is between 6.5-7.0

3.Emulsion Stability
There is no presence of creaming or phase separation
in MCT oil emulsion.

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4.Particle Size Distribution
MCT oil emulsion has ideal droplet size of between 1-100 micrometres.

5.Viscosity
Viscosity of MCT Oil emulsion is intendent to be medium to high.

6.Texture and Spreadability
MCT oil emulsion has smooth texture and adequate spreadibility.

7.Viscosity at Different Temperatures
viscosity of emulsion stays the same at different temperatures.

8.Storage Stability
MCT Oil emulsion is a stable under all this mentioned condition.

9.Dye Test
This is a oil in water type of a emulsion.

10. Dilution Test
The emulsion easily dilutes with the water hence it is oil in water emulsion.

11.Conductivity Test
it has conductivity, that indicates it is an oil in water emulsion.

Qualityparameter	Form.1	Form.2	Form.3	Form.4	Form.5	Form.6	Form.7	Form.8	Form.9	Form.10	Form.11
appearane	SmoothbutPhaseseparated	SmoothbutPhaseseparated	SmoothbutPhaseseparated	SmoothbutPhaseseparated	SmoothbutPhaseseparated	Smooth, uniform and nophaseseparation	SmoothbutPhaseseparated	SmoothbutPhaseseparated	SmoothbutPhaseseparated	SmoothbutPhaseseparated	Smooth,uniformand nophaseseparation
pHlevel	6.3	6.3	6.5	6.4	6.6	7	6.8	6.3	6.5	6.9	6.5-7
Viscosity	medium	low	medium	medium	medium	Slightly high	medium	medium	low	medium	high
Emulsionstability	Unstable,Creaming	Creaming, Phaseseparation	Creaming, Phaseseparation	Creaming, Phase separation	Creamig, Phase separation	Nocreaming,Nophaseseparation	Creaming Phaseseparation	Creaming Phaseseparation	Creaming Phaseseparation	Creaming Phase paration	Nocreaming Nophase separation
Particlesize distribution	<1µm	<1µm	<1µm	<1µm	<1µm	<1µm	<1µm	<1µm	<1µm	<1µm	<1µm
Texture &spreadibility	Nongreasy,runny,smooth	Veryrunny,smooth,	Nongreasy,runny,smooth	Nongreasy,runny, smooth	Nongreasy,runny,smooth	Smooth, Easilyspreadable,	Nongreasy,runny,smooth	Nongreasy,runny,smooth	Runny, Smooth,Greasy	Nongreasy,runny,smooth	Smootheasilyspreadable
Viscosityat differenttemperature	Stable	stable	stable	stable	Stable	stable	unstable	unstable	unstable	unstable	Stable
Storagestability	Texturechange,Phaseseparation	Texturechange,Phaseseparation	Texturechange,Phaseseparation	Texturechange,Phaseseparation	Texturechange,Phaseseparation	Nochangesand nophaseseparation	Texturechange, Phaseseparation	Texturechange, Phaseseparation	Texturechange, Phaseseparation	Texturechange,Phaseseparation	Nochangesand nophaseseparation

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VI. CONCLUSION

In conclusion, the formulation of MCT Oil emulsion utilizing xanthan gum, stevia, sodium benzoate, rose oil, offers a well-rounded approach to MCT oil emulsion.

MCT oil provides the nutrition. Xanthan gum acts as thickening and stabilizing agent. Sodium benzoate is used as a preservative, span acts as the natural emulsifying, stevia is a natural sweetener with zero calories.

The addition of rose oil provided both fragrance and flavour to the MCT oil emulsion.

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