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Development of functional yogurt drink fortified with medium chain triglyceride oil and study its quality attributes

Kusuma N Waded and VR Sinija

Abstract
Medium chain triglyceride (MCT) extracted from virgin coconut oil (VCO) was incorporated to develop a yogurt drink. MCT oil was added at two different concentrations of 0.5 and 1% (MY1, MY2) and maintained at incubation temperature of 43 °C (T). The effect of concentration of MCT and incubation temperature on the properties of the developed yogurt drink was studied. Incubation temperature caused an increase in fermentation rate. The pH of yogurt samples was decreased from 6.9 to 4.3 in MY1 and MY2 within 5 hours at 43C. Addition of MCT did not significantly affect the colour parameters and TSS range from 8.78 to 7.33° Brix did not showed significant difference. PH was decreased over a period of time and titrable acidity (TA) was increased in control sample than MCT oil incorporated yogurt sample. Physico-chemical analysis was not showed significant difference in the prepared yogurt drink, while protein content did not affect with MCT oil addition. The sample with 1% of MCT oil at incubation temperature of 43 °C showed the best results when compared to control sample with acceptable sensory characteristics. The present study noticeably demonstrates the effective use of MCT for creating distinctive health benefits and nutraceutical rich food products.

Keywords: MCT, fortification, yogurt, physicochemical properties, sensory

1. Introduction
Structured lipid-containing MCFA which comprises of MCT and MLCT is one of the main research focuses in lipid sciences. MCT and MLCT are healthful lipids that found to exert excellent physiological benefits with multiple functions as compared to conventional oils and fats. A considerable number of studies claimed that the consumption of MLCT and MCT were able to suppress visceral fat accumulation while providing the body with a rapid source of energy alternative to sugar (Nagao and Yanagita 2010), [8] (Tang *et al.* 2011) [11]. As dietary oils and fats are important and essential to provide energy, fat soluble vitamins and essential fatty acids, the health benefits provided by MLCT and MCT are fundamental, particularly, in fighting the prevalence of metabolic diseases such as obesity, CVD, and diabetes that arises from the overconsumption of dietary oils and fats. MCT's appear to be colorless, odorless and bland in flavor just like the common vegetable or animal oils and fats (Lee *et al.* 2021) [6].
Yogurt is a widely consumed fermented dairy product in which proteins coagulated by lactic acid producing bacteria (Ghoneem *et al.* 2018) [4]. Most consumers prefer yogurt over normal milk due to its easily digestible protein, availability of probiotic and bioavailability of different minerals and vitamins (A. Martí *et al.*, 2015) [2]. It's having beneficial effects on consumers such as reducing the levels of β-glucuronidase and other carcinogens, protection of bowl against inflammatory disease, and preventing the allergies (Fazilah *et al.* 2018) [3]. Most of health awareness consumers are now switching towards healthier options of food products. Beneficial health effects of structured triacylglycerols are receiving considerable attention. Triacylglycerols helps to improve immune function, reduce cholesterol, improve nitrogen balance and reduce the cancer risk (Akoh and Kim 2002) [1]. Nutritional products are mainly useful for people on modified diets requiring nutritional enrichment (Osborn, Shewfelt, and Akoh 2003) [10]. There are several nutritional products available as health supplement, which can be consumed with meals or in between meals as important source of nutrition. The main aim of the present study was to introduce Medium chain triglycerides in the products, which can easily metabolized energy source to the body at the same time offering extra benefits to lead healthy diet. Nielsen, Debnath, and Jacobsen (2007) [9] studied the oxidative stability of fish oil enriched yogurt after addition of antioxidants such as vitamin K, citric acid ester and

EDTA. Sensory analysis and peroxide value tests revealed stability of yogurt at 5 °C for 19 days and the addition of antioxidant increased the stability to 29 days. Effect of addition of antioxidant, EDTA in milk drink-type emulsions was reported to improve stability of milk drink coupled with structured triacylglycerides (Timm-Heinrich *et al.*, 2003) [12]. Therefore, the present study was undertaken to develop a functional based yogurt drink fortified with medium chain triglyceride oil (MCT's). Bio-chemical and sensory evaluations of prepared yogurt drink were examined.

2. Materials and Methods

2.1 Raw materials

MCT oil has extracted from virgin coconut oil. Skim milk with protein (3.5%) and fat (0.2%) was procured from the local market, Thanjavur. Combination of Streptococcus thermophiles, Lactobacillus cremoris and Lactobacillus bulgaricus (1:1:1) starter culture were purchased from M/s. Alla's Posh Flavours, India. All the chemicals were purchased of analytical grade from HiMedia Laboratories Pvt. Ltd, India.

2.2 Preparation of yogurt drink

To 100 ml of pasteurized milk 0.25 g of mother culture was added and kept under refrigerated condition. The low- fat skimmed milk was used to prepare yogurt drink; first the milk was pasteurized under double boiling method at 80ºC for half an hour then cooled down at 45 ºC. Each glass bottle contains 50 ml of pasteurized milk, sugar and 1 ml yogurt culture (*S. Thermophillus* and *L. bulgaricus*). Then incubated for 5hrs at 43±1 °C. Further, 1 % of MCT oil were incorporated to the each sample and homogenized for 3 minute at 8000 rpm, cooled down and store in refrigerator for further analysis.

Table 1: Experimental design for the development of MCT incorporated yogurt drink

Milk type	Temperature (°C)	Milk (ml)	Starter Culture (ml)	MCT (%)
Skim milk	43	100	2	0
		99.05	2	0.5
		99	2	1

2.3 PH and TSS

pH of yogurt was determined by using digital pH meter (King's lab, Model; KLPHM-114).5 ml of yogurt sample was placed in measuring cup of the pre-calibrated pH meter and analyzed at room temperature and the samples were read in triplicates. TSS measurement of prepared yogurt drink was taken 2 drops of sample was placed in hand held digital refract meter which directly shows the reading and is expressed in ºBrix.

2.4 Proximate analysis

All the analysis was conducted in triplicates. According to AOAC 2005, the protein was estimated using the Kjeldhal method. For the determination of moisture content, known amount of sample was taken and oven dried at 130 °C for 2 hours until constant mass. Ash was evaluated in a muffle furnace. Sample was pre heated at 100 °C for about 1 hour in crucibles and asked for 5 hours at 525 °C. Fat content of yogurt was analyzed using the Rose Gottlieb method.

2.5 Colour analysis

The color parameter was determined using Hunter Lab colorimeter, where L*, a* and b* signifies lightness and darkness (L*), redness and greenness (a*) and measures the yellow and blue intensity (b*).

2.6 Texture analysis

Texture attributes of yogurt drink incorporated by MCT oil were analyzed by using a texture analyser, TA. XT. Plus with a 5 kg load cell. The cylinder shaped probe with diameter of 35 mm with speed of 1.0 mm/s, penetration distance 25 mm and surface trigger at 10 g by firmness, consistency, cohesiveness, work of cohesiveness and intrinsic viscosity was estimated by using test X pert software 2018.

2.7 Sensory evaluation

Sensory estimation of the developed yogurt incorporated with MCT oil was carried out. The yogurt samples were coded and evaluated by 25 panelists consisting of male and female students. Each samples were evaluated based on the selected quality attributes including flavor, sweetness, sourness, texture, appearance and overall acceptability. The sensory assessment was conducted for each parameter on a 9 point hedonic scale, 9 were the highest score (very liked) and 1 was the lowest score (very much dislike). All panelists received information on how to conduct a hedonic assessment of a specific product prior to the evaluation. The panelists received samples in glass containers of approximately 15 ml with assigned code numbers and kept them chilled. Between each taste, a glass of water was offered to rinse the palate.

2.8 Statistical analysis

Experiments were conducted in triplicate and the data are expressed as means ± standard deviation of three independent experimental runs.With Minitab version 18, using Tukey's analysis. The level of significance was determined at (p<0.05).

3. Result and Discussion

3.1 Effect of pH on yogurt with MCTs during fermentation

Yogurt was kept in incubator shaker and the fermentation carried out at 43 °C temperature in different concentration of MCT as shown in (Fig 1). PH is an important key point during fermentation in the development of yogurt. There were significant changes in pH at 43 °C. The pH of prepared yogurt was significantly decreased from 6.9 to 4.48 within 5 hour. While the pH decreases, products are come into contact of pathogenic contamination. Hence, the fermentation process was stopped at pH 4.5 by storing it at refrigeration condition (5 °C).

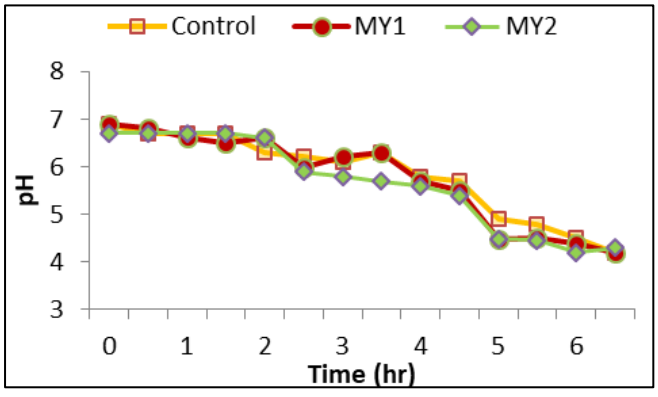

Fig1: Effect of MCT incorporated yogurt during fermentation

3.2 PH, Titrable acidity and TSS

Customers' interest in yogurt drinks has grown as a result of their health advantages. Dairy products, especially low-fat ones, are becoming more popular. In the current investigation, yogurt that had MCT oil added to it was made, and its pH and TSS levels were measured. The obtained results represented in Table 1 showed the pH range from 4.72±0.05 to 3.59±01, pH is the important parameter for bacterial count and it can influence biological functioning, nutritional availability. The yogurt drink kept at 5 °C for future analyses. The pH values of yogurt drink significantly decreased over the storage time. While in MCT added samples MY1 and MY2 showed decreased pH at 43 °C respectively. The increase in acidity and decrease in pH of yogurt drink during storage is a result of abiding lactic acid formation, which results lactose fermentation. Similar findings of the pH remaining constant for a peach-flavored yogurt beverage made from low-fat milk in the presence of structured triglycerides were reported by Gonzalez *et al.* (2011). The total soluble solids (TSS) was differed significantly $p<0.05$ from the yogurt drink due to the addition of MCT oil and sugar. There was no difference between the different proportions of yogurt samples, the total solid soluble value ranged from 8.78 to 7.33°Brix.

Titrable acidity is determined and showed in the range of 0.145 to 0.165 respectively. TA is inversely related to pH which means as pH decreased significantly Titrable acidity will increase for yogurt drink samples. TA was significantly increased in control sample than in MCT added yogurt samples (0.252 to 0.176). Moreover, MCT added samples were stable with a limited level and then increased slightly with storage time within a specified level of 1.11% of lactic acid

Table 2: PH, TSS and Titrable acidity of yogurt sample with and without MCT addition

Samples	pH	TSS (°Brix)	TA
Control	4.72±0.05	8.78±0.2	0.252±0.02
MY1	3.59±0.01	7.26±0.5	0.182±0.01
MY2	3.69±0.01	7.33±0.5	0.176±0.01

Note: Control-without addition of MCT oil; MY1-0.5% of MCT oil and MY2-1 % of MCT oil.
SD± Means analyze with Tukey's test ($p<0.05$)

3.3 Physicochemical properties of MCT yogurt

The physicochemical properties of prepared yogurt products observed were moisture, colour, ash and protein as given below in table 3. Hunter Lab color measurements of the produced yogurt sample are reported. There was no significant change observed in lightness value of sample as compared to control product. Increase in the MCT oil percent resulted a slight decrease in L*, a* and b* values. The control showed the highest whiteness of 85.31±0.02 at 43 °C respectively. But in the prepared yogurt drink sample (MY1 and MY2) showed 87.42 and 85.57 respectively. Also, fermentation time and temperature did not come into contact with the quality of MCT incorporated yogurt samples after refrigerated conditions.

The protein content of MCT yogurt samples was observed as for MY1 3.32±0.06 and for MY2 3.33±0.07 was observed. The slight decrease of protein can weaken the bonding between the water molecules which cause syneresis during the storage condition (Jeske, *et al.* 2018) [5]. The addition of MCT showed a control on the moisture content in yogurt samples. The increased moisture content was showed in MY1 with 90.57±0.95 and MY2 showed 89.23±0.07 which showed that between these two samples no significant difference. The total ash content of food is used to examine its mineral content. The ash content varied from 0.43 to 0.46% with concentration of MCT in the yogurt samples at fermentation temperature of 43 °C.

Table 3: Physico-chemical properties of MCT incorporated yogurt

Samples	Protein	Ash	Moisture	Colour		
				L*	A*	B*
Control	3.40±0.04^{b}	0.43±0.10^{a}	84.32±2.88^{a}	85.31±0.02	-2.01±0.01	5.45±0.004
MY1	3.32±0.06^{a}	0.37±0.05^{b}	90.57±0.95^{a}	85.57±0.02	1.51±0.03	4.64±0.01
MY2	3.33±0.07^{a}	0.46±0.08^{b}	89.23±0.07^{a}	83.13±0.17	-1.53±0.04	4.53±0.10

Note: ± SD following by same letters in column does not vary with Tukey's test ($p<0.05$). All analyses were conducted in triplicate

3.4 Texture analysis of yogurt drink

The firmness, consistency, cohesiveness, work of cohesion and intrinsic viscosity of yogurt incorporated with MCT with varying concentration and temperature along with control samples were presented in table 4. Textural parameters are vital sensory attributes for the acceptance of consumers. As the concentration of MCT increases, a significant decreases in textural characteristics observed, especially hardness (Mousavi *et al.* 2019) [7]. This can be caused by the increased interaction between oil and water molecules. The highest firmness was observed in the MY2 and MY1 samples with 23.65±1.02 and 25.35±0.64 at 43 °C respectively with no significant difference ($p<0.05$) between control samples. In the case of consistency, the samples treated showed increased values mainly in MY2 with values of 574.21±1.22, respectively with no significant difference with other samples. Similarly, firmness, consistency indicated a significant difference ($p<0.05$) in MY1 and MY2 as compared to control. Simultaneously, hardness and cohesiveness showed a negative correlation between the samples at 43 °C ($P<0.05$).

Table 4 Textural analysis of yogurt drink made of MCT oil

Treatment	Firmness	Consistency	Cohesiveness	Cohesion
Control	18.64±0.55	453.4±2.34	-8.20±0.02	-7.78±1.02
MY1	25.45±0.64	541.38±4.31	-8.11±0.11	-8.88±0.72
MY2	23.65±1.02	574.21±1.22	-9.85±0.16	-6.20±0.12

3.5 Sensory evaluation

The panelists assessed the developed yogurt drink's sensory evaluation. The sensory characteristics of each parameter in the produced yogurt drink were measured using a nine-point hedonic scale. Figure 2 displays the sensory evaluation's

result. Control sample was without addition of MCT oil and MY1 and MY2 were with addition MCT oil of which percentage is (0.5% and 1%). Concerning the results from sensory analysis the best hedonic score was for MY2 yogurt drink (1% of MCT oil) followed MY1. MY2 yogurt drink had the good overall acceptability than control and MY1. There was no significant difference between MY1 and MY2 in terms of color, aroma, appearance and taste. Sensory attributes had increased with addition of sugar to yogurt drink. However, a yogurt drink prepared from skimmed milk and supplemented with 1% MCT oil (MY2) was determined to be the best. There were no significant differences of all yogurt drink fortified with MCT's.

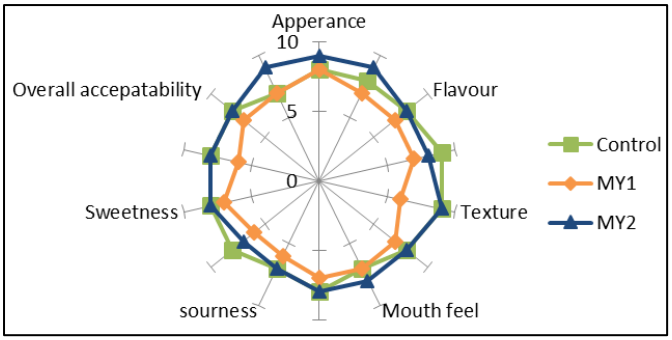

Fig 2: Sensory evaluation of yogurt shake

4. Conclusion

The demand for ready to drink products high in food markets currently. Yogurt drink is easy convenience and healthy probiotic rich product. The MCT oil incorporated in yogurt drink was developed in this study. Incorporation of medium chain triglyceride oil (MCT) to the yogurt drink was an effective approach for food industry which enhances the nutraceutical properties of yogurt drink. From this research work development of yogurt drink with MCT oil and added sugar gained very high acceptance considering the sensory evaluation and nutritional quality characteristics. The MCT incorporated in stirred yogurt drink showed a constructive correlation with chemical, physical and textural characteristics. The proposed formulations can take the role of replace the existing products while providing added benefits of MCT.

5. Acknowledgment

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6. Conflict of Interest

The authors have no conflict of interest to declare.

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