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Effect of addition of milk on total polyphenolic content of tea beverage

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Abstract
Tea is one of the most widely consumed drinks in the world as a mood enhancer. In India, generally, people prefer tea with milk. The present study aimed to investigate the effect of the addition of milk on the total polyphenolic content of tea beverage. In the present study, milk tea was prepared by adding 2% tea powder in boiled milk and the polyphenolic content in the different stages were analyzed. The result showed that there is a significant reduction in the total polyphenolic content and protein content in milk tea beverages compared with black tea and milk sample. From the nutritional point of view, it is suggested that the consumption of milk or black tea is better than milk tea beverages for getting maximum benefits from both.

Keywords: Milk, tea, protein, polyphenol

1. Introduction
Tea is considered the most popular refresher beverage consumed in the world after water. Tea has been derived from the leaves of the plant *Camellia sinensis* for almost 50 centuries ago. Different varieties of tea are available in the market based on climatic difference and processing methods account for differences in the composition and degree of anti-oxidative behavior. Based on the fermentation process tea may be classified into three: green (non-fermented), red (semi-fermented), and black tea (fully fermented) [1]. Physicochemical parameters and sensory attributes of the infusion depend on the fermentation process.
Tea has lots of health benefits due to the presence of polyphenols such as anti-carcinogenic effects, anti-oxidative potential and mitigation of cardiovascular diseases, atherosclerosis, anti-bacterial effect, and cholesterol-lowering effect. Tea polyphenols are regarded as the quality parameters or indicators of tea [2]. Compared to other tea, black tea is widely used due to its stronger flavor.
Milk is generally used for preparing tea in India, Pakistan, and certain Middle Eastern countries. Milk is a complete food with a good source of proteins and minerals. The principal milk protein casein contains high levels of proline residue are reported to have a greater binding affinity with polyphenols [3]. Several controversies have been raised regarding the nutritional impact of adding milk to tea and are still in debate for many years. Hence a study was conducted to evaluate the effect of the addition of milk on total polyphenol content of tea beverage.

2. Materials and methods
2.1 Materials
1. **Samples:** Milk and tea powder purchased from the local market.
2. **Chemicals:** Analytical grade chemicals obtained from HiMedia Laboratories Pvt. Ltd., Mumbai.
3. **Glassware:** Glassware of Borosilicate was used throughout the chemical analysis. They were thoroughly cleaned using a detergent solution, rinsed under running water, and dried in a hot air oven before use.

2.2 Preparation of tea
The milk tea was prepared by heating 100 ml of milk in a vessel. At the time of boiling, 2 % of tea powder was added and brewed for 2 minutes. At the end of brewing, milk tea was strained through a strainer and the filtered tea is used for further analysis. Black tea and milk were used as control.

2.3 Compositional Analysis
Milk was analyzed for its fat, protein, lactose, pH, and ash as per IS: SP: 18 [Part XI], 1981 [4] and the tea powder were analyzed for its total polyphenol content as per ISO 14502 [5]. The prepared milk teas were analyzed for its total polyphenolic content and protein content.

3. Results
The milk used for the study was analyzed for its composition which is shown in Table 1. The tea powder was analyzed for its total polyphenolic content. The total polyphenolic content of the tea powder was 18.31±0.1 mgGAE/ml. The milk tea was analyzed for its protein content and total polyphenolic content which is shown in fig 1 and 2.

Table 1: Compositional analysis of the milk

Parameter	Milk
Fat	3.46±0.009 %
Protein	3.42±0.009 %
Lactose	4.55±0.02 %
pH	6.66±0.01
Ash	0.75±0.2 %

Values are expressed in Mean ± Standard Error of three replicates

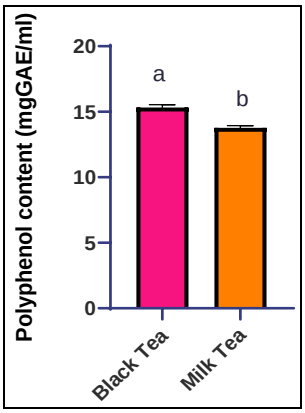

Fig. 1: Total polyphenol content in black tea and milk tea

Each bar represents the mean ± standard error (n=3).Letters (a-b) indicates significant difference at p <0.05.

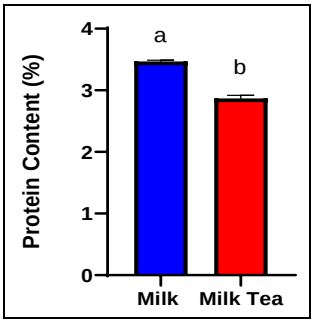

Fig. 2: Protein content in milk and milk tea

Each bar represents the mean ± standard error (n=3).Letters (a-b) indicates significant difference at p <0.05.

4. Discussion
4.1 Total polyphenolic content
The total polyphenolic content of milk tea(13.93±0.021 mgGAE/ml) was reduced significantly as compared to black tea(15.32±0.12 mgGAE/ml) with p-value <0.05 which is depicted in figure 1. The reduction in polyphenolic content might be due to the interaction of milk protein which further leads to precipitation of protein-polyphenol complex which may be filtered out in the tea spent. Sharma *et al*., (2008) [6] mentioned that the interaction between plant phenolics and proteins, either covalently or non-covalently, has resulted in the masking effect of polyphenol. However, the precipitation of proteins may result either way; due to multidentate interactions (one phenolic bound to multiple protein sites or protein molecules) or else multisite interactions (multiple phenolics bound to one protein molecule).

4.2 Protein content
The protein content of milk samples was 3.42±0.009 % which got significantly reduced to 2.89±0.01 % after the tea powder addition (Figure 2). This may be due to the milk protein polyphenol interaction. Brown and Wright (1963) [7] described that soluble casein–polyphenol complexes are formed due to the principal interaction of tea polyphenols with the α-casein complex and the β-casein. But if casein is absent, soluble or insoluble protein-polyphenol complexes are formed as polyphenols interact with the whey proteins α-lactalbumin and β-lactoglobulin, based on the proteins and polyphenols proportions in the mixture.

5. Conclusion
Milk tea exhibits a significant difference in polyphenol content and protein content as compared to black tea and milk. This indicates a clear interaction pattern between milk protein and tea polyphenols which lead to the reduction in both the parameters in milk tea. Hence the nutritional value of milk got reduced while tea preparation. So it is suggested that milk and black tea can be consumed alone instead of milk tea.

6. Acknowledgment
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