

EFFECT OF INGESTION OF CAFFEINE AND MILK ON SOME LUNG FUNCTION INDICES

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ABSTRACT

Caffeine has been reported to be a respiratory stimulant; there is paucity of literatures relating the effect of ingestion of a mixture of caffeine and milk on lung function. This study is therefore aimed at evaluating the effect of combination of milk and caffeine on lung function. The doses of caffeine used for this study were 187.3mg, 374.6mg and 2g, 4g of milk respectively. Forced expiratory volume in one second (FEV_1), forced vital capacity (FVC) and peak expiratory flow rate (PEFR) were studied in 40 undergraduate students of University of Benin between the ages of 18-24years. Pre-and post-ingestion tests were done after drinking the caffeine alone and combination of caffeine and milk, using a Computerized digital Spirometer. The result showed that FEV_1 , FVC and PEFR increased significantly ($p < 0.001$) in all the subjects who took either caffeine alone or the mixture of milk and caffeine when compared with control. Furthermore, the FEV_1 , FVC and PEFR were significantly higher ($p < 0.01$) in subjects who took caffeine alone than subjects who took caffeine and milk. This therefore suggests that ingestion of caffeine and milk have a positive effect on the lung function, but the degree of effect was reduced when compared to caffeine alone.

INTRODUCTION

Caffeine is a trimethylated xanthine (1,3,7 trimethyl xanthine) found naturally in coffee seeds, "beans", tea leaves, kola nuts, cocoa beans and ilex plants¹. Generally it is classified as a natural nervous system psycho-stimulant. Claims attributed to the health benefit of caffeine, include reduced risk of developing Parkinson disease, type II diabetes, hepatic diseases and cardiovascular diseases,² Other effects have been linked to be a mild stimulant of the central nervous system and cardiac muscle, relaxes bronchial

smooth muscle, increases gastric secretion as well as produces diuresis.²

There is a belief among some members of the public that the consumption of milk and dairy products increases the production of mucus in the upper and lower respiratory tracts and therefore, should be removed from the diet. This belief dates back to the Jewish physician Moses Maimonides in the 12th Century³. However, some other traditional medicine physicians attribute it to humidifying effect of milk in human. It is believed that this humidity will thicken the mucus with time. It is also a common observation that most people prefer taking mixture of coffee and milk, to taking coffee alone. This therefore raises the issue of whether this mixture will reduce or increase the beneficial effects of caffeine; hence this study.

KEYWORDS: Caffeine, Milk, Lung function

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Milk is a white complex physiological liquid produced by the mammary gland of mammals and from plant products; various

types of milk include: whole milk, reduced fat milk and soya milk. The precise nutrient composition of milk varies by species, environmental factors as well as processing methods. However, it contains significant amount of saturated fat, protein, calcium, carbohydrate as well as varying amounts of vitamins, especially vitamin C.

Cow milk which was used for this study has a pH ranging from 6.4 to 6.8 making it slightly acidic⁴. There are growing evidences of the role of milk in the regulation of satiety, food intake and obesity related disorders. Milk proteins, peptides, calcium and other minerals can significantly reduce blood pressure⁵. Milk fat like sphingolipids and their active metabolites may exert antimicrobial effects either directly or upon digestion.

Caffeine has been shown to interfere with the enzyme phosphodiesterase which inactivates cyclic AMP, an intercellular messenger⁶. Caffeine has also been reported to be a respiratory stimulant³. Caffeine being a monoamine oxidase inhibitor (MAOI) can pass through the blood brain barrier to affect the central nervous system function directly including the respiratory centres⁷, however, its effects on the respiratory system are under debate. This study is meant to contribute to the available knowledge on the subject.

MATERIALS AND METHODS

Forty (40) subjects comprising of 20 males and 20 females of the University of Benin, who were between the ages of 18-24 years, participated in this study. They were non-athletes, non-regular users of caffeine, non-smokers and apparently healthy subjects, who had no history of cardiopulmonary diseases. Health information was obtained from self reported health history and life style questionnaire. Subjects were told to abstain from dietary coffee whose major active ingredient is caffeine, for the period of the research.

The anthropometric, physiological and pharmacological measurements were carried out in the Physiology laboratory, University of Benin. Ethical Committee approval was obtained.

Since pure caffeine was not readily available, coffee was used as studies have shown that caffeine form about 71% of the constituent of coffee⁸. The soluble instant coffee commonly found in Nigeria (NESCAFE INSTANT COFFEE MADE IN COTE D'VOIRE) and (COWBELL POWDERED MILK MADE IN NIGERIA) was used in this study. However, Etang et al⁹ reported that a milligram of instant soluble coffee (NESCAFE INSTANT COFFEE) contains an equivalent of 0.09366mg of caffeine, hence 2g (a tea spoon) and 4g (2 tea spoons) of coffee contain 187.3mg and 374.6mg of caffeine respectively¹⁰. These varying doses of caffeine and the powdered milk which was obtained using an electric weighing machine were administered to the subjects upon prior dissolution in 200ml of warm water. They were given at a week interval for four weeks so as to prevent carry-over effect. A pre-and post-ingestion measurement of the lung function tests were done, before and after administration of the dose of either caffeine alone or mixture of caffeine and milk, to the subjects depending on the required dose for that week. The test was usually done between 45minutes and 1 hour after the ingestion¹¹. The readings of the parameters (FEV₁, FVC, PEFr) were displayed on the screen of the computerized digital spirometer.

STATISTICAL ANALYSIS

Mean \pm standard error of the mean was determined for all variables. Analysis was done using the paired sample t-test. All statistical analysis was performed by the Statistical Package for the Social Science (SPSS), Chicago IL USA (2007) Excel Statistical Package. The probability level for all the above tests was set at P<0.001, P< 0.01, and P< 0.05 to indicate significance.

Table 1: Shows the mean \pm S.E.M of the Anthropometric measurement of the male and female subjects (N = 40).

Variable	Males	Females
Age (Years)	22.55 \pm 0.49	22.45 \pm 0.26
Height (cm)	173.30 \pm 1.50	169.00 \pm 1.30
Weight (kg)	64.25 \pm 1.80	62.60 \pm 1.4
Body Mass Index (kg/m ²)	21.35 \pm 0.41	21.86 \pm 0.36

RESULTS

The results from this experiment showed that the ingestion of varying doses of caffeine alone (187.3mg and 374.6mg) or the combination caffeine and milk (187.3mg caffeine and 2g of milk, 374.6mg caffeine and 4g of milk) caused a significantly higher increase ($p < 0.01$) in FEV₁ in both the male and female subjects when compared to the control (i.e. pre-caffeine administration). Also, when the mean value of the 187.3mg of caffeine alone was compared with the mean value of the combination 187.3mg caffeine and 2g of milk, the latter caused decreases in FEV₁ in both the male and female subjects, but these decreases were only statistically significant ($P < 0.001$) in the female subjects (figure 1) A similar trend was also observed when 375mg dose of caffeine alone and the mixture of 375.6mg dose of caffeine and 4g of milk was administered (figure 2). However, when both the mean value of the combination of 374.6mg caffeine and 4g of milk and the mean value of 187mg of caffeine and 2g of milk were compared, no significant change was recorded in either the male or female subjects.

For the FVC, significant increases ($p < 0.01$) were observed when both doses of caffeine alone were compared to the control, as shown in figures 3 and 4. Also, significant increases ($p < 0.001$) occurred when either the combination of 374.6mg caffeine and 4g milk or when the combination of 187.3mg caffeine and 2g milk ($P < 0.01$) was administered. However, a significant decrease ($p < 0.01$) was observed when the mean value of the combination of 187.3mg caffeine and 2g milk and the combination of 374.6mg caffeine and 4g milk were compared.

For the PEF_R parameter, significant increases ($p < 0.001$) were observed when both doses of caffeine alone were compared to the control as shown in figures 5 and 6 in all the subjects and also significant increases ($p < 0.001$) were observed when either the mixture of 187.3mg caffeine and 2g milk or 374.6mg caffeine and 4g milk was administered. However, significant decrease ($p < 0.05$) was only observed in the female subjects when the mean value of the combination of 187.3mg caffeine and 2g of milk was compared with the mean value of the combination of 374.6mg caffeine and 4g of milk.

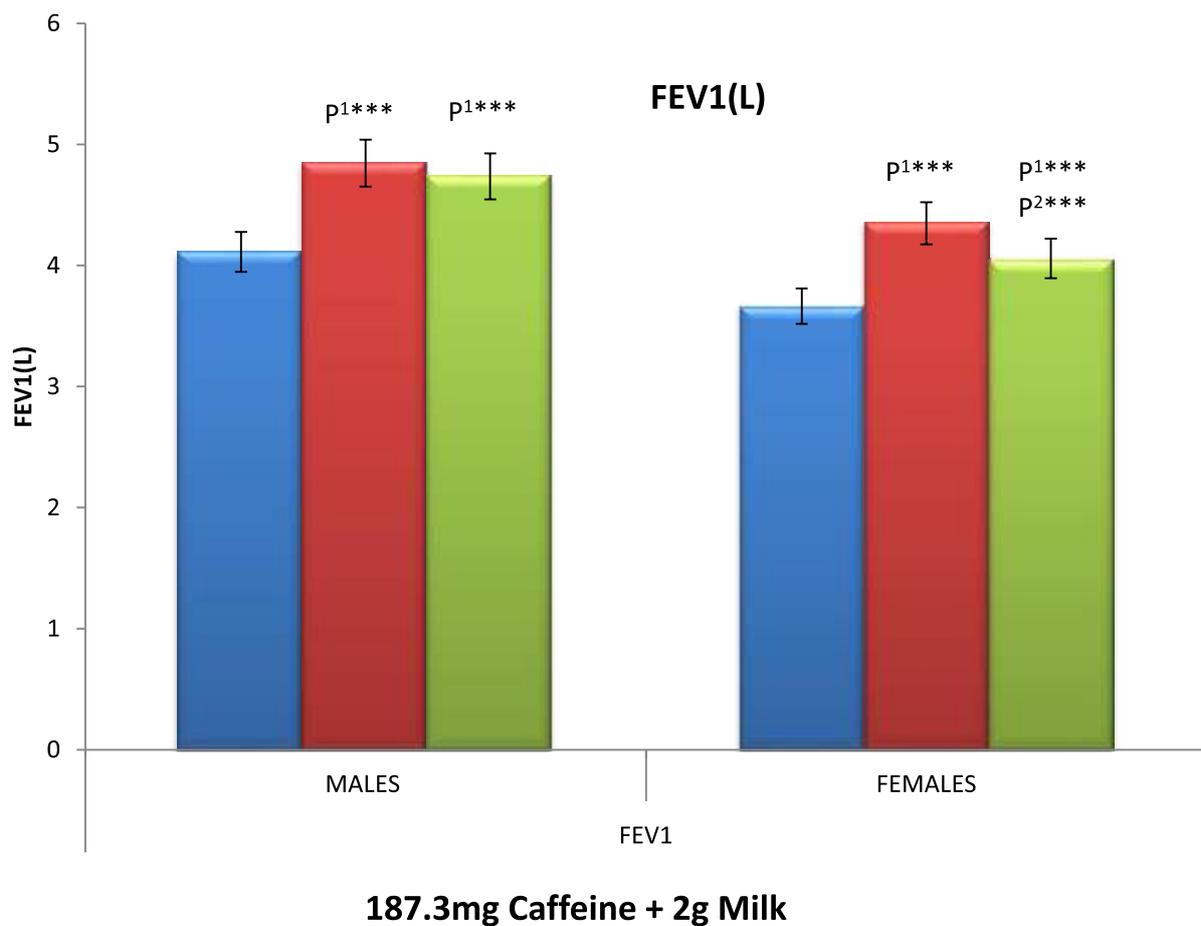


Figure 1 Shows the effect of 187.3mg Caffeine+ 2g Milk administration on FEV₁.

Legend: ■ PRE
■ caffeine
■ caffeine+milk

FEV=Force expiratory volume in 1 seconds

Caffeine vs Control in both male and female = (P<0.001) P^{1***}

Caffeine +Milk vs Control in both male and female = (P<0.001) P^{1***}

Caffeine +Milk vs Caffeine in female = (P<0.001) P^{2***}

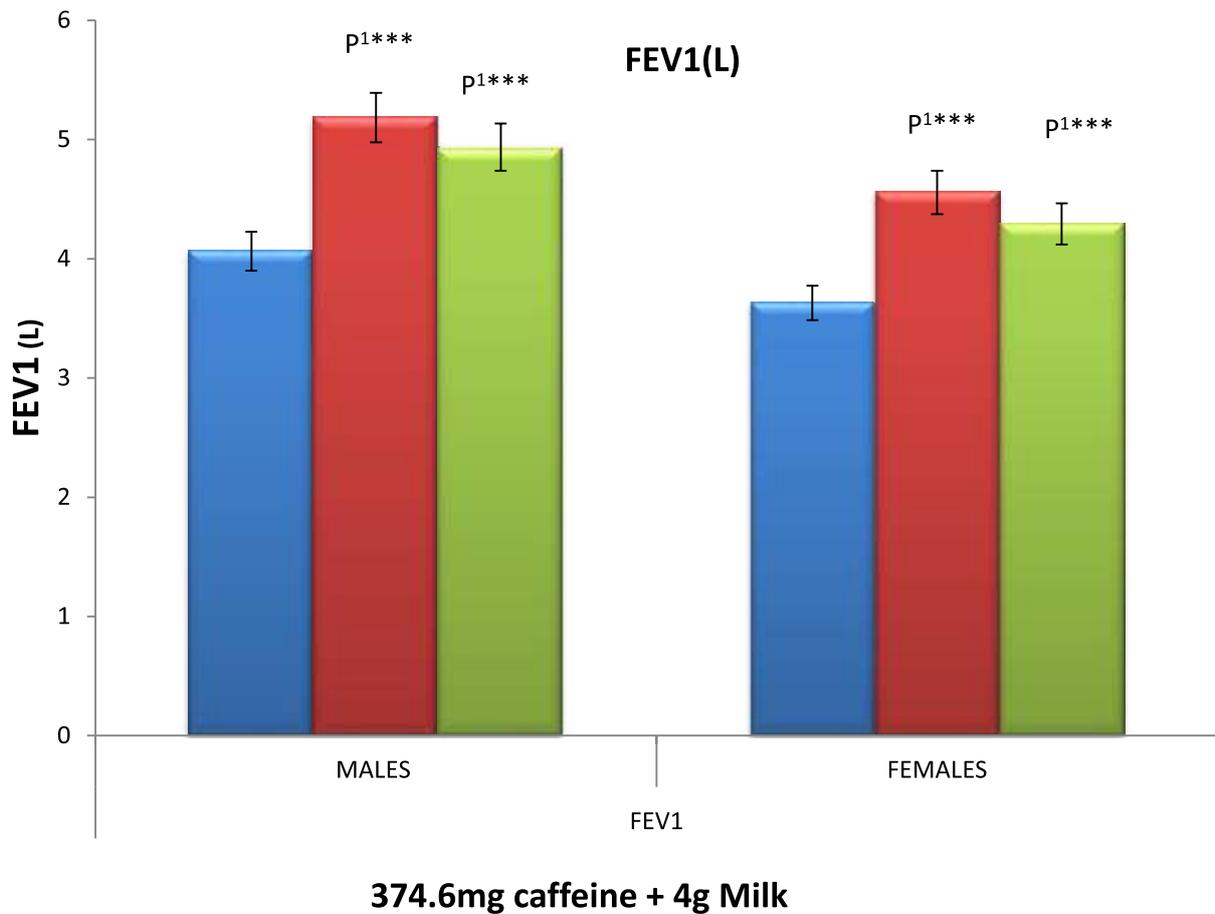


Figure 4: shows the effect of 374.6mg Caffeine+ 4g Milk administration on FEV1

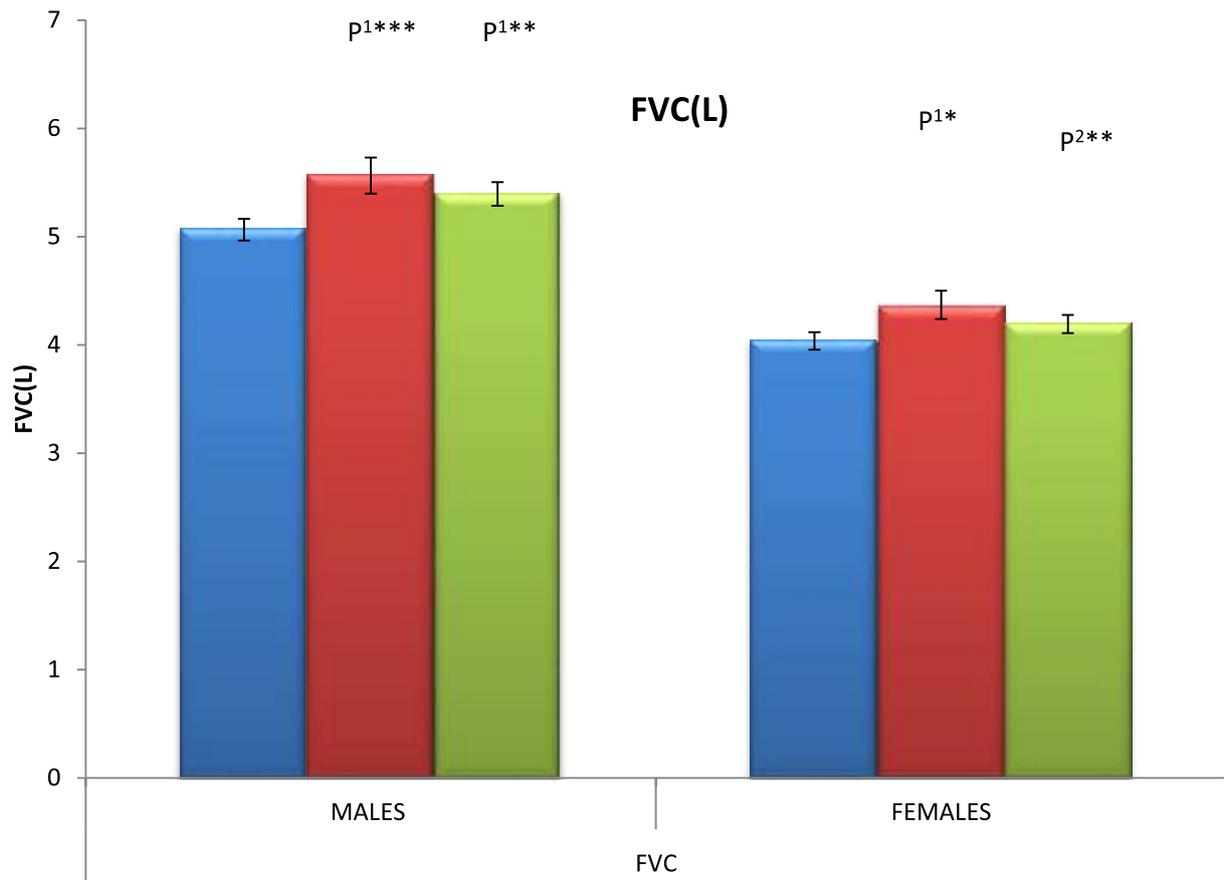
Legend: ■ PRE
 ■ caffeine
 ■ caffeine +milk

FEV₁=Force expiratory volume in 1 seconds

*** = Significant level at P<0.001

Caffeine vs Control in both male and female = (P<0.001)P^{1***}

Caffeine +Milk vs Control in both male and female = (P<0.001)P^{1***}



187.3mg caffeine +2g Milk

Figure 5: Shows the effect of 187.3mg Caffeine+ 2g Milk administration on FVC

Legend: ■ PRE
■ caffeine
■ caffeine+milk

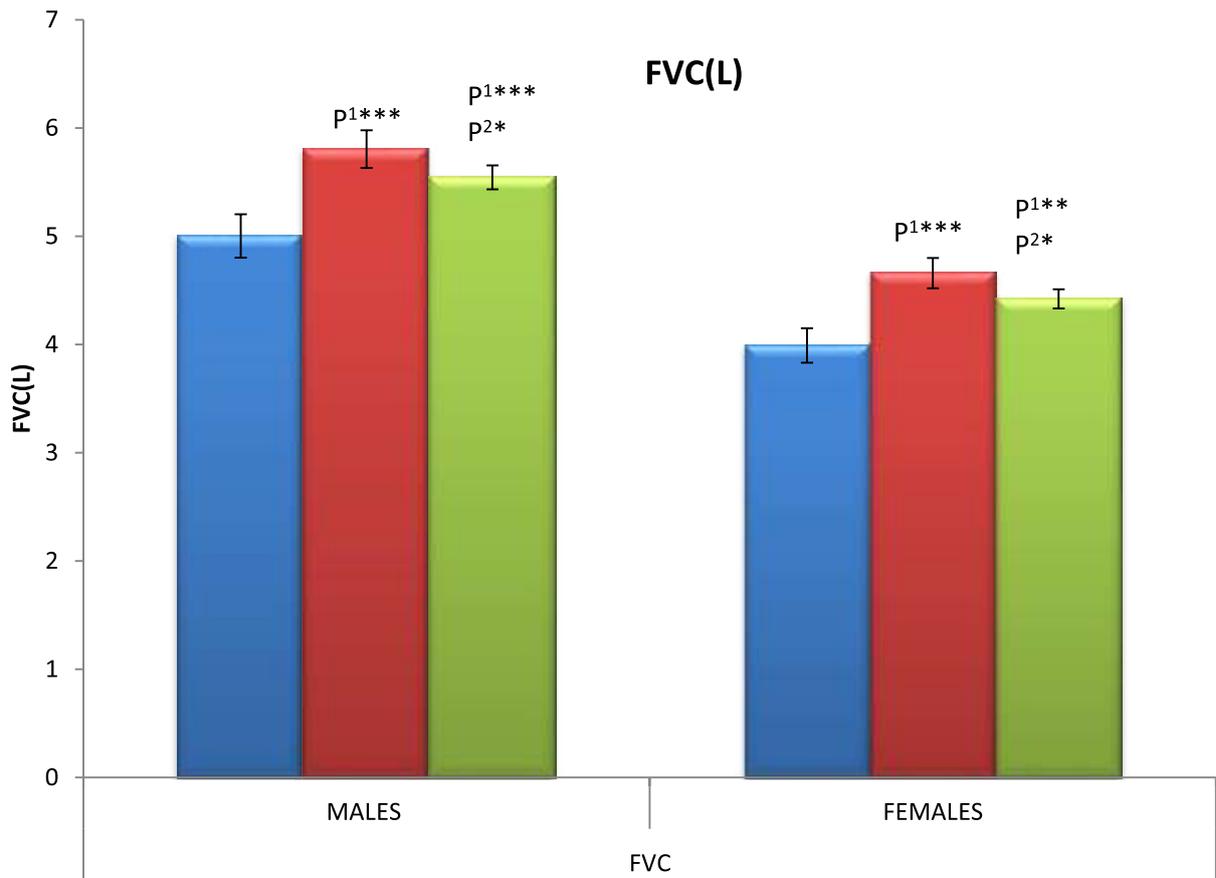
FVC=Forced vital capacity.

Caffeine vs Control male = (P<0.001) P^{1***}

Caffeine +Milk vs Control in both male and female = (P<0.01) P^{1**}

Caffeine vs Control in female = (P<0.05) P^{1***}

Caffeine +Milk vs control in Caffeine female = (P<0.01) P^{2**}



374.6mg caffeine + 4g Milk

Figure 6: Shows effect of 374.6mg Caffeine+ 4g Milk administration on FVC

Legend: ■ PRE
 ■ caffeine
 ■ caffeine+milk

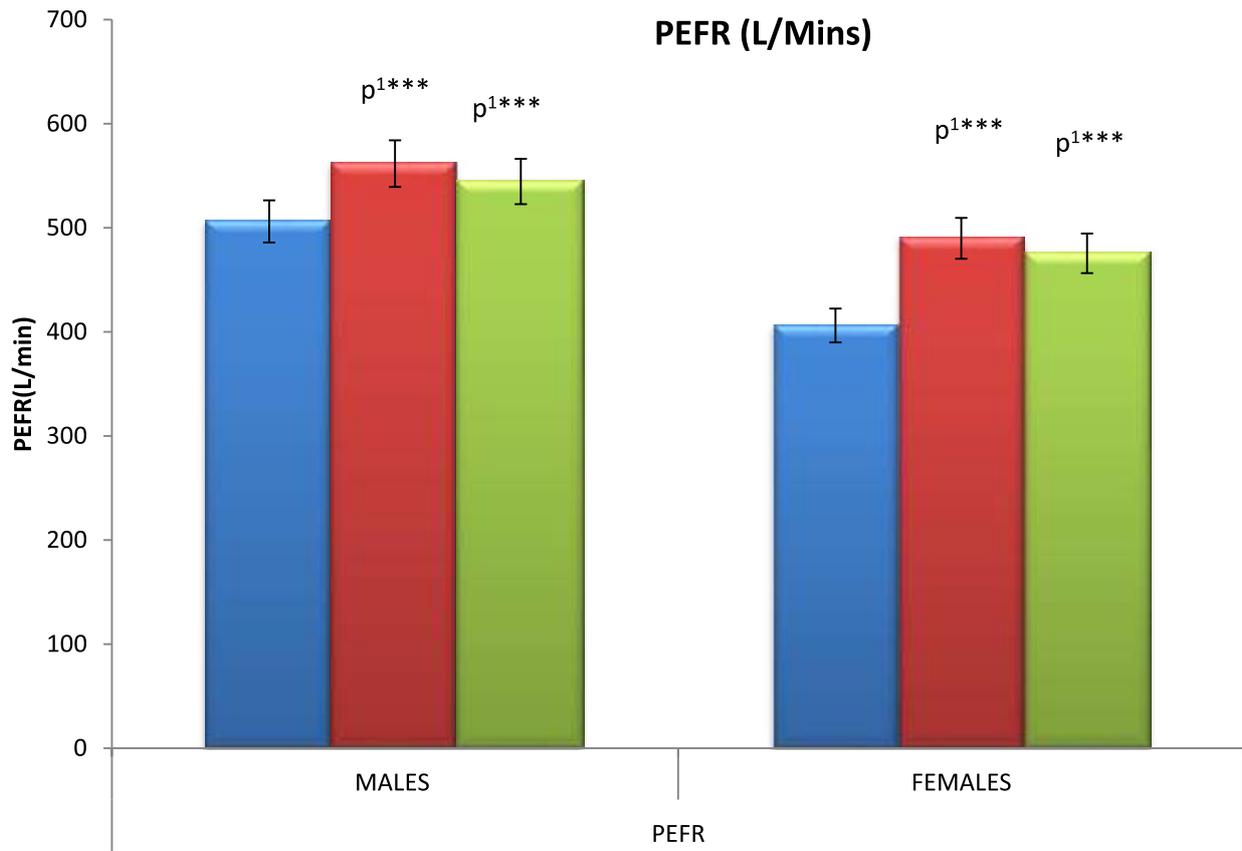
FVC=Forced vital capacity.

Caffeine vs Control in both male and female subjects = (P<0.001)P^{1***}

Caffeine +Milk vs Control in male = (P<0.01) P^{1***}

Caffeine +Milk vs Control in female = (P<0.01) P^{1**}

Caffeine +Milk vs Caffeine in both male and female subjects = (P<0.05) P^{2*}



187.3mg caffeine + 2g Milk

Figure 7: Shows the effect of 187.3mg Caffeine+ 2g Milk administration on PEFR

Legend: ■ PRE
■ caffeine
■ caffeine+milk

PEFR=Peak expiratory flow rate

Caffeine vs Control in both male and female subjects = (P<0.001) P^{1***}

Caffeine +Milk vs Control in both male and female subjects = (P<0.001) P^{1***}

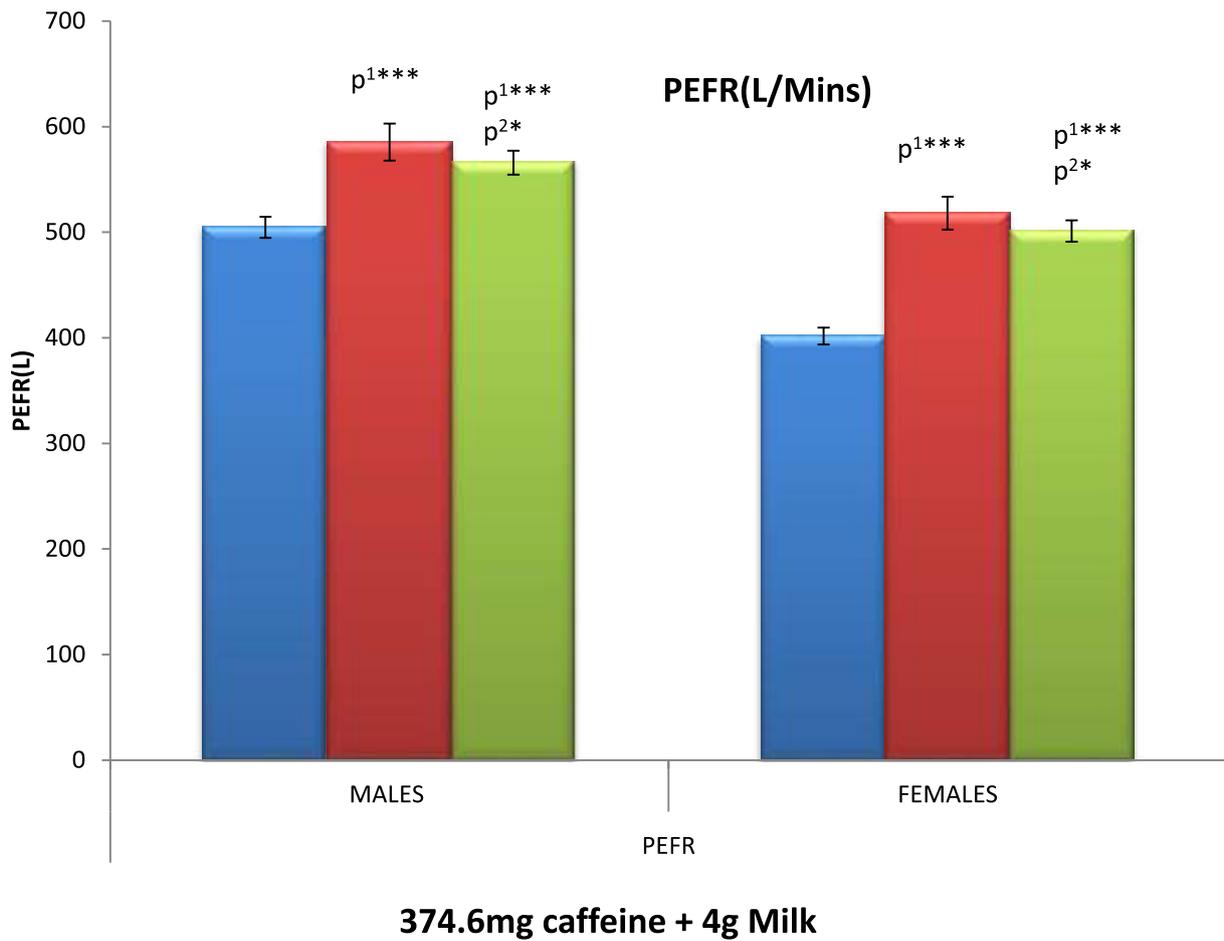


Figure 8: Shows effect of 374.6mg Caffeine+ 4g Milk administration on PEFR

Legend: ■ PRE
 ■ caffeine
 ■ caffeine+milk

PEFR=Peak expiratory flow rate

Caffeine vs Control in both male and female subjects = (P<0.001) P^{1***}

Caffeine +Milk vs Control in both male and female subjects = (P<0.001) P^{1***}

Caffeine +Milk vs Caffeine in both male and female subjects = (P<0.05) P²

DISCUSSION

The increases in FEV₁, FVC and PEFR observed in this study when either caffeine alone or the combination of caffeine and milk was consumed using both doses (187.3mg caffeine and 374.6mg caffeine) in both male and female subjects, when compared to the control, is an indication that both caffeine and the combination of caffeine and milk are capable of stimulating the respiratory system, though there have not been any claim as to whether milk have any effect on bronchodilation/bronchoconstriction. The bronchodilator effect observed in this study when the combination of milk and caffeine was administered was due to the presence of the caffeine in the combination. The mechanism by which this occurs could be by direct stimulation of the respiratory center, due to the fact that caffeine can pass through the blood brain barrier and affect the respiratory centres in the central nervous system⁷. This is in line with the studies in which it was established that Caffeine is a respiratory stimulant^{7,11,12 13,14} and as such, affect the respiratory system positively. The bronchodilator effect of caffeine, and the combination of caffeine and milk may explain the increase in FEV₁ and PEFR seen, while the stimulant effect on the respiratory centre may explain the increase in FVC. Also, there was an observed reduction in bronchodilation when the combination of caffeine and milk was given; this was particularly pronounced in the female subjects. However, studies have shown that females have higher rate of metabolism and shorter half life of caffeine when compared with their male counterparts¹⁵, and also addition of milk to caffeine may inhibit the vascular protective effect of caffeine¹⁶ by binding and inhibiting the absorption of the antioxidant agent of caffeine.

It is thought in some quarters that consumption of milk can lead to increased mucus production in the upper and lower

respiratory tract narrowing the airway, which is in line with the findings of Farber and Finberg.¹⁰ However, this is not wholly accepted as other researchers have also reported that the consumption of milk alone cannot lead to increased mucus production, but rather symptoms seen in these subjects were generally due to food allergy mediated by IgE^{17,18}.

Thus the reduction observed in these respiratory parameters (FVC, FEV₁ and PEFR) when a combination of caffeine and milk was ingested as against the observation when only caffeine was given, could possibly be explained by considering milk as having a "dilution effect" on the quantity of caffeine absorbed and its concentration in the circulation, thus reducing the net effect of caffeine on target organs (respiratory center and airway).

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