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# Effect of Caffeinated Coffee on Tear Production

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**ABSTRACT**

*Caffeine is a widely used substance, valued for its stimulating effects. The world's primary source of caffeine is the coffee bean from which coffee is brewed. The effect of caffeinated coffee on tear production was carried out on 50 subjects (25 males, 25 females), aged between 18years and 30years, using the Schirmer Test. The tear production was evaluated before and after the intake of 60mg of caffeine, contained in 4g of caffeinated coffee, dissolved in 150ml of warm water. The post-test was at 30, 45, 60, 75, and 90 minutes. A reduction in tear production from the mean baseline value (24.90±5.37mm) were observed to be 30 (23.70±5.71mm); 45 (22.50±5.68mm); 60 (19.50±5.41mm); 75 (21.90±4.91mm); and 90 (24.50±5.50mm). This effect was found to be significant (P>0.05; Z = 5.007) using the Z-test statistical analysis. These results showed that caffeine caused a significant reduction on tear production. Consequently, subjects suffering from, particularly, dry eye syndrome should avoid caffeinated substances so as not to aggravate their condition.*

**Keywords: caffeine, coffee, schirmer test, tear production**

## INTRODUCTION

Caffeine presents as an anhydrous, odourless white powder, and it is the most widely used stimulant in the world[1]. In its isolated form, caffeine is a white alkaloid with an intensely bitter taste[2]. Caffeine, a xanthine alkaloid compound, is found in plants where it acts as a natural pesticide, paralyzing and killing certain insects[1,3]. The most commonly used caffeine containing plants are coffee, tea, and to some extent cocoa. Other less commonly used sources of caffeine include the yerba mate and guarana plants[4]. It is contained in most of the things we eat and drink. Examples include cola drink, tea, cocoa, and some medications. The world's primary source of caffeine is the coffee bean (the seed of the coffee plant), from which coffee is brewed. Coffee has been reported to be the highest source of consumed caffeine in adults[5]. Even decaffeinated coffee is not totally free of caffeine because decaffeination is a process that does not actually remove all the caffeine contained in coffee beans.

The effects of caffeine on the human body include stimulation of the central nervous system (CNS), increase in blood pressure and heart rate, smooth muscle relaxation (bronchodilator), diuresis, sleep disruption, and enhancement of physical activity like in sports. Caffeine also has some effects which may be unrelated to adenosine but are attributable to its three primary metabolites - paraxanthine, theobromine and theophylline. These effects include increase in blood sugar, increase in gastric acid and pepsin secretion, increased plasma levels of fatty acids, cortisol and epinephrine, raised intra-ocular pressure and loss of calcium leading

to bone loss[6,7]. Thus, caffeine may contribute to the development of certain diseases or aggravate existing ones. Pregnant women and people suffering from hypertension or other cardiovascular diseases, diabetes, open angle glaucoma, insomnia should avoid coffee[9]. On the other hand, caffeine can be used in the treatment of neonatal apnea and dyspnea. It serves as an adjuvant in several pharmaceutical preparations such as analgesics and antipyretics[8]. In its raw form, coffee has some cardio-protective effect in individuals who are not hypertensive[9].

The eye receives both sympathetic and parasympathetic innervations from the autonomic nervous system. Both sympathetic and parasympathetic systems contribute to the innervations of the lacrimal gland, which is responsible for tear production. Normal tear flow appears to be under sympathetic control, chiefly due to vasoconstriction. Emotional weeping, which is a unique human characteristic is believed to originate from parasympathetic control within the gland itself[10]. With each blink, tears move upwards and downwards across the conjunctiva and cornea, to replenish the precorneal tear film. A continuous stream also comes from the temporal side towards the puncta. Closure of the palpebral fissure takes place initially on the temporal side, sweeping tears towards the inner canthus. The puncta use capillary attraction to take in liquid. Tears move to the lacrimal sac by means of suction when the sac flattens during blinking. Tears flow from the lacrimal sac through the nasolacrimal duct under the influence of gravity on the liquid and air pressure in the nose. Normally, most of the tears are absorbed by the mucosa of the lacrimal passages[10].

## MATERIALS AND METHODS

The study was an experimental clinical research. Fifty young adults between the ages of 18years and 30years who fulfilled the inclusion and exclusion criteria of this experiment were used for the study. The subjects were selected using the simple random sampling technique. The materials and instruments used in this study included a Snellens visual acuity chart, pen light, ophthalmoscope, schirmer strips, a stop watch and 4gm weight of Nescafe coffee granules, and warm water.

The schirmer test was performed before the intake of caffeinated coffee. The Schirmer test involves the use of filter paper strips that are bent and placed over the lower eyelid margins approximately one-third of the distance from the outer canthus. After 5 minutes, the strips are gently removed and the linear distance of moistness on the strip is measured. A less than 10mm of wetting is indicative of aqueous deficiency, while less than 5mm of wetting indicates inadequate aqueous production. A measure of 10-15mm without anaesthesia is regarded as normal tear production[11,12].

The results obtained before the intake of caffeinated coffee served as the baseline tear production data. After this measurement was taken, the patient was given 60mg of caffeine as contained in 4g of coffee dissolved in 150ml of warm water. Subsequent tear production measurements were taken with the schirmer test strips at 30, 45, 60, 75, and 90 minutes after the ingestion of the coffee drink.

## RESULTS

Fifty young adults (25 males and 25 females), within the age group of 18years to 30years were used for this study. Schirmer test results revealed that before caffeine intake, the mean value was 24.90 mm. After 30 minutes, it reduced to 23.70 mm; 22.50 mm after 45 minutes; 19.50 mm after 60 minutes, rising to 21.90 after 75 minutes and 24.50 mm after 90 minutes. Data analysis using the Z-test statistics showed that the Z-tabulated value of the normal distribution at 95% confidence interval was ±1.96, $\alpha$=0.05. At the peak period of 60 minutes, the Z-calculated value for the paired test after

intake of caffeine was 5.07. Since Z-calculated does not fall within the range of +1.96 to -1.96, the null hypothesis was rejected. Thus, there is a significant difference between the mean baseline tear production and the induced tear production after intake of caffeinated coffee.

## DISCUSSION

In this study, the effects of caffeine on tear production at 30 and 45 minutes were due to the time of onset of caffeine in the body. The absorption of caffeine from the gastrointestinal tract is reported to be rapid and reaches the blood stream within this time[13]. The peak effect of coffee occurred after 60 minutes, which could be explained by the fact that caffeine attains maximum plasma concentration within 60 minutes[14].

This effect of caffeine on tear production is believed to result in the stimulation of the release of noradrenaline from both adrenal glands and sympathetic nerves thereby producing an increase in sympathetic activation[15]. Sympathetic stimulation affects the quality and quantity of tear production, leading to a reduced rate of tear production. Another factor is its effect on increase renal blood flow which results to the rate at which fluids are excreted from the body (diuresis)[16].

The results obtained in this study also showed that there was a difference in tear production between males and females. Males produced more tears than females during the baseline and induced measurements. Changes in tear production were observed to be slightly more in females than in males (Table 4). This difference in tear production between males and females was found to be significant at a 95% confidence level. A contributing factor to this could be the sex-related differences that exist in the lacrimal glands of males and females. Some of these differences include - the variations in the structure profile, functional capacity, secretory activity and disease susceptibility of these tissues. Other factors could also be due, in part, to androgen deficiency and the influence of endogenous or exogenous estrogen[17].

As observed in this experiment, the effect of caffeine on tear production was short lived as tear production returned back to near normal at the 90th minute. Nonetheless, caffeine has been observed to cause significant reduction in tear production.

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**TABLES**

Table 1: Age and gender distribution of subjects

| | **MALES** | | **FEMALES** | |
|---|---|---|---|---|
| **Age Group** | **Frequency** | **%** | **Frequency** | **%** |
| 18-21 | 6 | 12 | 11 | 22 |
| 22-24 | 8 | 16 | 8 | 16 |
| 25-27 | 5 | 10 | 6 | 12 |
| 28-30 | 6 | 12 | 0 | 0 |
| Total | 25 | 50 | 25 | 50 |

Table 2: Statistical values for Schirmer Test before and after intake of caffeine

| **Caffeine Intake (mins)** | **Mean (mm)** | **S.D (mm)** | **Variance** | **Min. Value** | **Max. Value** | **Range** |
|---|---|---|---|---|---|---|
| Before | 24.90 | 5.375 | 28.890 | 16 | 35 | 19 |
| After 30 | 23.70 | 5.711 | 32.610 | 13 | 32 | 19 |
| After 45 | 22.50 | 5.680 | 32.250 | 11 | 33 | 22 |
| After 60 | 19.50 | 5.410 | 29.250 | 10 | 30 | 20 |
| After 75 | 21.90 | 4.910 | 24.090 | 12 | 30 | 18 |
| After 90 | 24.50 | 5.500 | 30.250 | 15 | 34 | 19 |

Table 3: Mean and percentage mean difference with base line schirmer test results at time intervals after intake of caffeine

| **Time (mins)** | **Mean (mm)** | **Mean difference (mm)** | **(%)** |
|---|---|---|---|
| 30 | 23.70 | -1.20 | 4.82 |
| 45 | 22.50 | -2.40 | 9.64 |
| 60 | 19.50 | -5.40 | 21.69 |
| 75 | 21.90 | -3.00 | 12.05 |
| 90 | 24.50 | -0.40 | 1.61 |

**Table 4:** Gender variation for percentage mean difference of schirmer test result

| **Gender** | **Mean before intake (mm)** | **Mean after intake (mm)** | **Mean difference(mm)** | **(%)** |
|---|---|---|---|---|
| Male | 26.40 | 24.00 | -2.40 | 9.09 |
| Female | 23.40 | 20.96 | -2.44 | 10.43 |