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ORIGINAL RESEARCH

Assessment of the tear film in normal eye subjects after consumption of a single dose of hot peppermint drink

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Objective: To test the effect of a single dose of hot peppermint consumption on the tear film in normal eye subjects.

Methods: Thirty healthy male subjects aged 18–39 years (23.20±2.17 years) were enrolled. Also, an age-matched control group of 30 male subjects (19–39 years, 23.50±0.70 years) was enrolled to test the effect of the hot water. Tear meniscus height (TMH), noninvasive tear breakup time (NITBUT), and tear ferning (TF) tests were performed for each patient 30 mins before and 60 mins after they drank hot peppermint.

Results: Mean TMH measurements were higher postintervention (0.32±0.07) than preintervention (0.27±0.04 mm). Similarly, mean TF grades were significantly higher (2.07±1.20) postintervention than preintervention (0.84±0.71). By contrast, mean NITBUT was lower postintervention than preintervention (11.57±3.17 and 15.84±3.36, respectively). TMH measurements increased in 90% of the subjects. Conversely, NITBUT decreased in 96.7% of the subjects. For the control group that tests the effect of drinking hot water, the scores did not differ significantly in the three tests pre- and postintervention ($P<0.05$). TF grades increased in 93.3% of the subjects, postintervention.

Conclusion: Tear film quality decreases significantly after peppermint beverage consumption. A similar observation has been made on the consumption of hot green tea drink.

Keywords: peppermint drink, tear film, tear ferning test, phenol red thread test, eye dryness, polyphenols

Introduction

The peppermint plant, *Mentha* × *piperita*, has a strong sweetish taste and odor, and it grows in various parts of the world.[1] Dried peppermint and its oil are used to flavor various products such as toothpaste, chewing gum, and many pharmaceuticals.[2] Peppermint has a variety of health benefits and is commonly used in traditional medicine.[3,4] Peppermint contains various flavonoid and phenolic compounds.[5,6] Free radicals containing oxygen can be produced within the human body as a result of various metabolic and biological processes. Such oxygenated free radicals lead to the damage of proteins, lipids, and DNA through oxidation processes.[7,8] Phenolic compounds act as free radical scavengers, and therefore, they are considered as antioxidants.[9] Antioxidants are associated with reduced risks for various diseases, such as cancer and diabetes.[10–12] In addition, phenolic compounds demonstrate various biological activities and can be used as antimicrobial and antiviral drugs.[13–15]

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Dry eye is associated with a deficiency in tear production or excessive tear evaporation that disturbs tear stability and osmolarity.[16,17] The most common dry eye symptoms include damage to the ocular surface, blurriness, discomfort, and visual disturbance.[18] The detection of eye dryness is highly challengeable, and a combination of various tests should be used.[17] Various tests and techniques can be used to assess the tear film. Some of these tests detect the quality of tears and others detect tear quantity.[19–28]

As a continuation of our research in the field of the tear film, we recently reported the effect of vitamin A supplement[29] and a single dose of green tea consumption[30] on the tear film stability. In this study, we report, for the first time, the effect of a single-dose hot peppermint drink consumption on the quantity and quality of tears in normal subjects. Peppermint contains a high percentage of polyphenols which is hypothesized to have a negative effect on the tear filmy.

Methods

Subjects

All participants signed an informed consent form prior to the commencement of the research. The subjects were treated in accordance with the Helsinki Declaration.[31] Ethical approval was obtained from the College of Applied Medical Sciences Ethics Committee (CAMS-063–3738), King Saud University. All tests were performed in the same room which was equipped with a central air conditioner at room temperature (23°C) in which humidity was <40%.[28] The measurements were performed by the same examiner under normal conditions. The trial was not registered since peppermint is a popular hot drink in Saudi Arabia, and only a single dose was consumed by each subject. A slit lamp was used to examine abnormalities within the eyelids, eyelashes, conjunctiva, cornea, and iris. The ocular surface disease index (OSDI) questionnaire for assessing dry eye symptoms was completed by all participants, and the scores were recorded. Dry eye was diagnosed for scores over 12. Thirty male subjects who ranged in age from 18 to 39 years (mean±SD =23.20±2.17) were enrolled in the study. An age-matched control group (30 subjects) aged between 19 and 39 years (mean±SD =23.50±0.70 years) was enrolled to test the effect of hot water on the tear film. All the subjects were healthy, had no ocular diseases, and did not wear contact lenses. The exclusion criteria included subjects who had recently used eye lubricants, undergone ocular surgery, or taken medications. Subjects were also excluded if they were diagnosed with dry eye on the basis of the OSDI and slit-lamp examination results.

Tear meniscus height (TMH) and noninvasive tear breakup time (NITBUT) tests

TMH and NITBUT tests were assessed using OCULUS Keratograph 4 (OCULUS Inc, Wetziar, Germany). Fluorescein was added into the subject's eye. For TBUT, the subject was asked to refrain from blinking, while the tear film was observed. A yellow barrier filter was used to enhance the visibility of the tear film breakup. TBUT was recorded as the number of seconds that elapsed between the last blink and the appearance of the first dry spot in the tear film. The inferior TMH images were captured and measured perpendicular to the lid margin at the central point relative to the pupil center using an integrated ruler (mm). Dry eye was defined if the height of tears in the lower lid was <0.2 mm for TMH and tear breakup time was <10 s for NITBUT measurements. Both tests were performed for both eyes, and no significant differences were observed in the measurements (Kolmogorov–Smirnov test, $P>0.05$) between the two eyes. Therefore, the average for measurements from the right eye was used.[32]

Tear ferning (TF) test

A glass capillary tube (10 µL, Sigma-Aldrich Chemical Company, Poole, UK) was used to collect a tear sample (1 µL) from the lower meniscus of the right eye of each patient. The tear sample was left to dry under normal condition (23°C and humidity <40%). A digital microscope (Olympus DP72, Olympus Optical Co., Ltd., Tokyo, Japan) at a magnification level of 10× was used to observe the TF patterns. The ferns were graded according to a 5-point TF grading scale, using increments of 0.1.[25]

The TMH, NITBUT, and TF tests were performed 30 mins before consumption of a peppermint drink (Lipton; 2.0 g in 150 mL of hot water), in a closed vessel to avoid the effect of the steam, and repeated 1 hr after consumption. The TMH and NITBUT tests were performed before the collection of tear samples to perform the TF test to avoid disturbing the tears. The tests were separated by 10-min breaks.

Statistical methods

Data were collected using Microsoft Excel 2010 (Microsoft Office, Microsoft Corp., Redmond, WA, USA). The

Statistical Package for the Social Sciences software (IBM Software, version 22, Armonk, NY, USA) was used to analyze the data. The data were normally distributed (Kolmogorov–Smirnov test, $P<0.05$) for all tests. The mean ±SD was used to describe the results. Correlation coefficients were described as strong (0.50–1.00), medium (0.30–0.49), and small (0.10–0.29).[33]

Results

Thirty male subjects were enrolled in the study, and their ages ranged from 18 to 39 years (mean±SD =23.20±2.17 years). An age-matched control group of 30 male subjects (19–39 years; mean±SD =23.50±0.70 years) was enrolled to test the effect of hot water (150 mL) on the tear film. The mean ± SD values for OSDI questionnaire scores, TMH measurements, NITBUT measurements, and TF grades are shown in Table 1. The mean TMH measurements after hot peppermint consumption were higher (mean±SD =0.32±0.07 mm) compared with those obtained before consumption (mean±SD =0.27±0.04 mm). Similarly, the mean TF grades were significantly higher (mean±SD =2.07±1.20) after hot peppermint consumption than before (mean±SD =0.84±0.71). By contrast, the mean NITBUT measurements were lower after the hot peppermint consumption than before (mean±SD =11.57±3.17 and 15.84±3.36, respectively). For the control group, no significant differences were observed in the scores for the three tests before and after hot water consumption ($P>0.05$).

Significant differences (Kolmogorov–Smirnov test, $P<0.05$) were observed for all tests before and after hot peppermint consumption. The TMH measurements increased in 90% of the subjects ($N=27$) and decreased in the other 10% ($N=3$) after hot peppermint consumption. The TF grades increased in 93.3% of the subjects ($N=28$) after hot peppermint consumption. Sixteen subjects (53.3%) exhibited a TF pattern indicating dry eye (TF grade ≥2) after hot peppermint consumption. By contrast, the NITBUT measurements decreased in 96.7% of the subjects ($N=29$). The TF images obtained from one of the subjects in the study group before and after hot peppermint consumption and from one of the subjects in the control group before and after hot water consumption are shown in Figure 1. Box plots of the TMH readings, NITBUT readings, and TF grades before and after hot peppermint consumption are shown in Figure 2, 3, and 4, respectively.

Correlation of TMH, NITBUT, and TF scores ($N=30$) is shown in Table 2. A strong correlation was observed for the TMH measurements ($r=0.850$), TF grades ($r=0.763$), and NITBUT scores ($r=0.562$) before and after hot peppermint drink consumption.

Table 1 Average (mean±SD) questionnaire, TMH, NITBUT, and TF test results

Test	Mean±SD	
	Study group (*N*=30)*	**Control group (*N*=30)****
OSDI scores	4.60±2.60	3.00±1.40
TMH1 (mm)	0.27±0.04	0.27±0.07
TMH2 (mm)	0.32±0.07	0.28±0.07
NITBUT1 (s)	15.84±3.36	14.90±3.60
NITBUT2 (s)	11.57±3.17	12.70±2.10
TF1 grades	0.84±0.71	0.75±0.70
TF2 grades	2.07±1.20	0.87±0.80

Note: * $P<0.05$; ** $P>0.05$.

Abbreviations: TMH, tear meniscus height; NITBUT, noninvasive tear breakup time; TF, tear ferning; TMH1, NITBUT1, and TF1, the measurements before peppermint drink consumption for the study group and before hot water consumption for the control group; TMH2, NITBUT2, and TF2, the measurements after peppermint drink consumption for the study group and after hot water consumption for the control group.

Discussion

Dry eye disease can result from tear film dysfunction caused by either tear deficiency or excessive tear evaporation.[16] Dry eye patients experience discomfort, itchiness, and redness. Such symptoms can be controlled by the use of artificial tears. However, in severe cases, corneal damage can occur. Therefore, early detection of eye dryness is essential and helps in the management of the associated symptoms. In the present study, the mean values for both TF grades and TMH measurements after hot peppermint consumption were higher compared with those obtained before the hot peppermint consumption. However, the mean value for NITBUT measurements was lower after the hot peppermint consumption compared to that obtained before the consumption. The TF grades and TMH increased in 93. and 90% of the subjects, respectively, after hot peppermint consumption. In addition, unhealthy TF patterns (TF grades ≥2) were observed in 16 subjects (53.3%). No significant differences ($P>0.05$) were found in the scores for the three tests within the control group before and after hot water consumption.

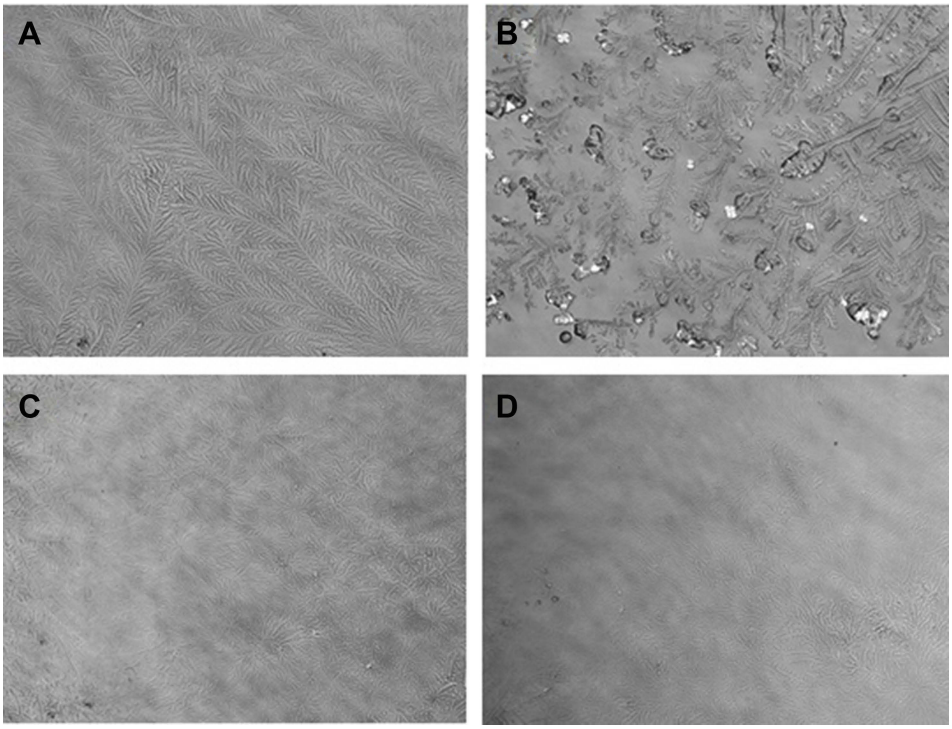

Figure 1 Tear fering images obtained from one of the subjects before (**A**) and after (**B**) hot peppermint drink consumption and from one of the subjects in the control group before (**C**) and after (**D**) hot water consumption.

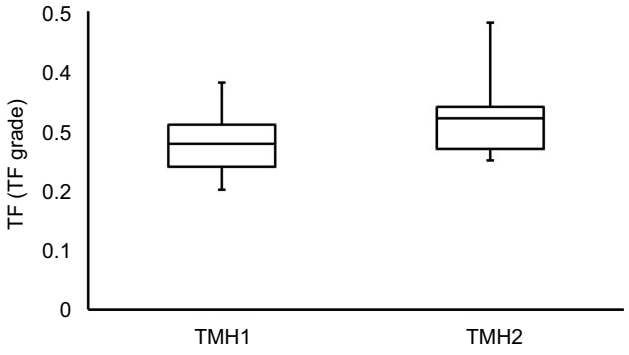

Figure 2 Side-by-side boxplot of the TMH measurements. Statistical significance at $P<0.05$.
Abbreviation: TMH1 and TMH2, tear miscues highest measurements before and after peppermint drink consumption, respectively, for the study group.

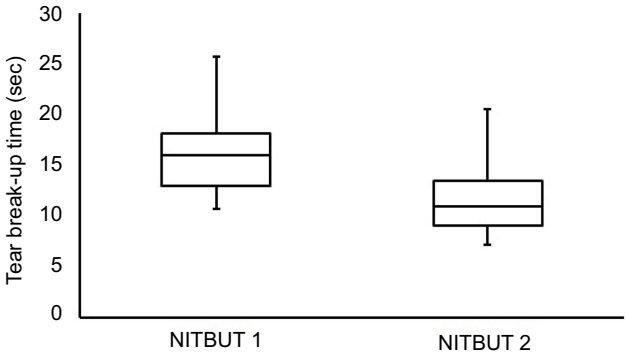

Figure 3 Side-by-side boxplot of the NITBUT measurements. Statistical significance at $P<0.05$.
Abbreviation: NITBUT1 and NITBUT2, noninvasive tear breakup measurements before and after peppermint drink consumption, respectively, for the study group.

Polyphenols and flavanones in peppermint[34] have a variety of benefits to health, acting as antioxidants[35] and demonstrating antitumor, antiviral, antiallergenic, antibacterial, and fungicidal activities.[3] Polyphenols have been found to reduce lipids (eg, total cholesterol and triacylglycerols) and inhibit fat accumulation in animals.[36,37] In humans, research has indicated that polyphenols lead to a reduction in body weight.[38,39] In addition, (-)-epicatechin, a phenolic compound present in peppermint, has been found to reduce the total cholesterol, low-density lipoprotein cholesterol, triglycerides, chronic inflammation, and lipid peroxidation in hyperlipidemic rats.[40] Conversely, it increases the concentration of high-density lipoprotein cholesterol.[40] Peppermint extract leads to a reduction in glucose serum concentration in Wistar rats exposed to high temperatures.[41] A correlation has been observed between glucose serum concentration and lipid levels.[41] Polyphenols have been found to reduce serum lipid concentration in rats[42] and help in the production of oxidized lipids.[39] In addition, polyphenols have a high affinity for complexation with metals such as iron and can

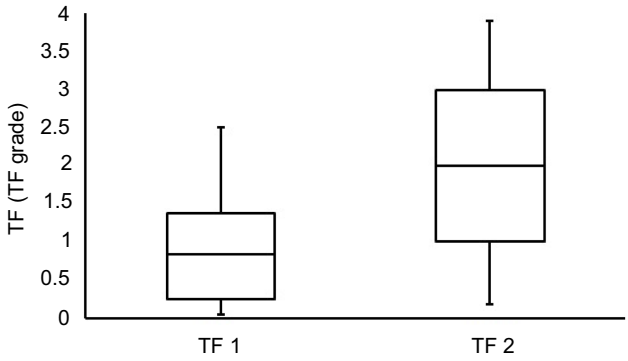

Figure 4 Side-by-side boxplot of the tear ferning grades. Statistical significance at $P<0.05$.
Abbreviation: TF1 and TF2, tear ferning grades before and after peppermint drink consumption, respectively, for the study group.

considerably reduce their content.[43] Consumption of peppermint has been reported to strongly inhibit nonheme iron absorption.[44] The present study suggests a link between peppermint consumption and the reduction of tear quality. Again, polyphenols could be responsible for the harmful effects of peppermint on the tear film.[30,45]

Very recently, consumption of a single dose of hot green tea, which contains polyphenols in high proportion, was found to have a negative effect on the tear film stability.[30] It was reported that the average score from phenol red thread test was found to be lower after the consumption of green tea drink.[30] In addition, the average TF grade from TF test has been increased after the consumption of green tea indicating dry eye symptoms.[30] The disruption in the concentrations of electrolytes (eg, iron) and lipids might be the reason for the reduction of tear film quality after peppermint drink consumption. A future study is needed to assess the effect of hot peppermint drink on the tear film of dry eye subjects. Also, a large number of both male and female should be recruited and the effect of peppermint consumption on the tear film should be monitored for a longer time than 1 h.

Conclusion

The present study suggests that peppermint drink consumption exerts a negative effect on the tear film; tear quality was reduced after peppermint drink consumption. This effect could be due to disruption of the lipid layer within the tear film and the concentration of electrolytes. However, a more detailed study is necessary to establish a direct link between peppermint drink consumption and the quality and volume of the tear film. Future studies

Table 2 Correlation of TMH (mm), NITBUT (sec), and tear ferning (TF grade) test scores (N=30)

Test/Correlation	TMH1	TMH2	NITBUT1	NITBUT2	TF1	TF2
TMH1						
PC	1	0.850[a]	0.346	0.10	–0.037	–0.015
Significance	—	0	0.061	0.957	0.844	0.936
TMH2						
PC	0.850[a]	1	0.256	0.093	0.214	0.069
Significance	0	—	0.172	0.626	00.257	00.719
NITBUT1						
PC	0.346	0.256	1	0.562[a]	0.125	0.157
Significance	0.061	0.172	—	0.001	0.512	0.408
NITBUT2						
PC	0.010	0.093	0.562[a]	1	0.029	0.19
Significance	0.957	0.625	0.001	—	0.877	0.921
TF1						
PC	–0.037	–0.214	0.125	0.029	1	0.763[a]
Significance	0.844	0.257	0.512	0.877	—	0
TF2						
PC	–0.015	–0.069	0.157	0.019	0.763[a]	1
Significance	0.936	0.719	0.408	0.921	0	—

Note: [a] Correlation was significant at the level of 0.01 (two-tailed).
Abbreviations: PC, Pearson correlation coefficient; TMH, tear meniscus height; NITBUT, noninvasive tear breakup time; TF, tear ferning; TMH1, NITBUT1, and TF1, the measurements before peppermint drink consumption for the study group; TMH2, NITBUT2, and TF2, the measurements after peppermint drink consumption for the study group.

should involve larger sample sizes and use various other tests to determine the quality and volume of tears.

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Disclosure

The authors report no conflicts of interest in this work.

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