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Gum Arabica and Coffee Consumption Effects on Serum Melatonin Levels

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ABSTRACT

Caffeine intake reduces sleep quality and melatonin secretion, the hormone responsible for regulating sleep. Chewing gum increases alertness and improves concentration. This study aims to investigate the impact of coffee consumption and gum chewing on serum melatonin levels in a study population of 40 Jordanian subjects (mean age, 21.15±3.21 years), including 23 males and 17 females. A total of 40 participants volunteered and met the inclusion criteria and were divided into four groups; a control group did not consume espresso coffee and chewed gum during the study period, a second group consumed two cups of espresso coffee (240 ml), and the third group chewed Gum constantly throughout the procedure; finally, the fourth group consumed two cups of espresso coffee and chewed Gum constantly throughout the process. Melatonin serum levels were measured one hour before and one hour after the completion of the study; the duration was five hours. The findings revealed that the coffee plus chewing gum participants had the lowest serum levels of melatonin (13.1± 2.0). Among the intervention groups, the coffee group and the last group regarding melatonin levels were the chewing gum group, 15.3± 1.2 and 19.2± 2.2, respectively. In conclusion, Significant differences existed between the interventions and control groups ($P < 0.05$). Furthermore, there were significant differences between coffee plus chewing gum and the coffee group and the chewing gum group ($P < 0.002$, $P < 0.02$, $P < 0.004$, respectively).

Keywords: Coffee, Gum, Melatonin, University students.

INTRODUCTION

Melatonin is a hormone produced by the pineal gland; a small gland located in the brain. It plays a crucial role in regulating the sleep-wake cycle, as it is involved in the timing and synchronization of circadian rhythms. Melatonin is synthesized and released in response to darkness, with peak levels occurring during the night, and is suppressed by exposure to light [1,2,3].

Melatonin acts on specific receptors in the brain, primarily in the suprachiasmatic nucleus (SCN), which is the body's "master clock" that controls the timing of various physiological processes. It also has antioxidant properties and is involved in immune system function and regulating mood and cognitive performance [4,5,6]. Research has shown that melatonin has several other essential bodily functions, including antioxidant and anti-inflammatory effects, immune system regulation, blood pressure regulation, and glucose metabolism [5,7]. Additionally, melatonin has been studied for its potential role in treating various health conditions, including sleep disorders [8] jet lag [9], seasonal affective disorder [2,3,4]and certain types of cancer [10].

Melatonin is available as a dietary supplement, and its use has become increasingly popular in recent years as a natural sleep aid [11]. While melatonin supplements are generally considered safe, it is essential to use them appropriately and under the guidance of a healthcare professional, as they can interact with certain medications and may not be appropriate for everyone [12,13,14].

Gum Arabica, also known as Gum acacia, is a natural gum made from the sap of the *Senegalia senegal* (*Acacia senegal*) and

Vachellia seyal trees, native to the African Sahel region. Due to its unique properties, it is widely used in various industries, including food, pharmaceuticals, and cosmetics [15]

Gum Arabica is a complex mixture of polysaccharides and glycoproteins soluble in water. It has a high molecular weight and viscosity, giving it excellent emulsifying, stabilizing, and thickening properties. In the food industry, it is commonly used as a food additive to thicken and stabilize products such as soft drinks, ice cream, and candy. It is also used as a coating for food products to enhance their appearance and texture. In addition to its use in the food industry, Gum Arabica has also been found to have potential therapeutic properties [16]. It has been shown to have prebiotic effects, which means it can promote the growth of beneficial gut bacteria. It has also been studied for its potential anti-inflammatory, antioxidant, and cholesterol-lowering effects. Despite its widespread use, Gum Arabica is generally considered safe for consumption [16–18]. However, some individuals may be allergic to it, and excessive intake may cause digestive discomfort. Overall, Gum Arabica is a versatile natural product with a range of valuable properties, and its continued use and study will likely yield further applications in various industries.

Coffee, consumed widely across the globe, could potentially significantly impact the population's health due to its high consumption. The effects of coffee on health have produced mixed results, varying depending on the outcome examined [19]. The complexity of roasted coffee, which contains over a thousand bioactive compounds, includes some compounds with potentially therapeutic effects such as antioxidant, anti-inflammatory, antifibrotic, or anticancer effects. Active compounds found in coffee include caffeine, chlorogenic acids, cafestol, and kahweol. Caffeine is a natural stimulant that can help increase alertness and reduce fatigue. It also contains other compounds, such as antioxidants and polyphenols that have been linked to various health benefits, such as reducing the risk of type 2 diabetes, Parkinson's disease, and certain types of cancer. The biochemical properties of coffee have been well-documented in other literature [20,21,22].

The present study aims to investigate the impact of espresso coffee consumption and Gum chewing on serum melatonin levels and compare their effect on serum melatonin levels among university students.

MATERIALS AND METHODS

Assessment of serum melatonin level

In the private Laboratory (Irbid, Jordan), the commercial enzyme-linked immunosorbent assay (ELISA) (IBL, Hamburg, Germany) was used to determine a participant's serum melatonin levels. Briefly, 50 µL of the plasma samples and the serially diluted standards were applied to each well. Each reagent was added, incubated, and then measured at 450 nm with a m microplate reader (SpectraMax i3, Molecular Devices, Sunnyvale, CA). Blood samples were immediately stored at 4 °C for 15 minutes, centrifuged at 2000 rpm for 10 minutes, and the extracted serum was stored at -8 - -6°C, at dark, until assayed. Each sample was measured in intra-assay. Serum levels of melatonin were detected by using commercially available human-melatonin (MT)-ELISA kits (Creative Diagnostics, USA, CD) according to the manufacturer's instructions (DEIA2238), as shown in Table 1. All procedures of serum collection and storage, materials required for melatonin level measurement, Dilution of Samples, and other notes were followed according to the manufacturer's instructions.

Table 1: Serum Melatonin levels According to manufacturer's instructions (DEIA2238)

Sample	Mean	SD
Low	23.11pg/ml	2,2
Medium	141.6pg/ml	8.614
High	270.6pg/ml	16.987

Through a single-blind, parallel randomization method, participants who previously agreed to participate in this study and did not consume coffee, other medications, or natural supplements that might affect melatonin serum levels were divided into four groups (10 participants in each). A control group did not consume espresso coffee and chewed gum during the study period, a second group consumed two cups of espresso coffee (240 ml), and the third group chewed Gum that told to chew constantly throughout the procedure; Trident gum was provided.; finally, the fourth group consumed two cups of espresso coffee and chewed Gum constantly throughout the process. To investigate the effect of espresso coffee consumption and Gum chewing on serum melatonin levels. All studying groups had their melatonin serum levels measured one hour before and one hour after the study; the study duration was five hours. The study procedure was performed at 8 am.

Study population

This study was conducted at Jadara University, Irbid, Jordan, between March and May 2023. Among the 40 participants at Jadara University, 23 were males, and 17 were females. Those participating ranged in age between 18 and 28, with a mean age of 21.15±3.21 years. Inclusion and exclusion criteria were used to select participants. To be included in the study, participants had to meet specific criteria, which included not having a self-reported history of psychiatric, neurological, or endocrine disorders, having a body-mass index below 30, never taking multivitamins that could affect the study results, fasting 9-12 hours before staring the study and maintaining a regular sleep-wake rhythm (excluding shift work). Moreover, none of the participants had previously administered medications that could affect the alertness and melatonin serum level. They had not consumed coffee before starting the study. Further, none of the participants have ever smoked cigarettes or water pipes.

The ethical approval was obtained from Jadara University's pharmacy faculty (Irbid, Jordan) (No. S.R100\2023) and was conducted in accordance with the Declaration of Helsinki. After being informed of the study's purpose, participants who met the inclusion criteria were asked if they were interested in participating. In addition, consent forms for those willing to discuss the possibility of enrolling in the study had been submitted.

Statistical analysis

The statistical analysis results are expressed as the mean ± standard deviation, frequencies, and percentages. The Mann-Whitney U test was used to compare the serum melatonin levels between the four groups before and after the study; serum melatonin levels were compared using a paired sample t-test. Two-tailed P values (P<0.05) indicated a statistically significant difference.

RESULTS AND DISCUSSION

Characteristics of the study participants

An assessment of the participant demographic characteristics showed that 90.2% were undergraduates, 9.8% were university graduates, 75.6% were between 18 and 21 years old, and the remaining were 22 and 28. Besides, 10.3% of individuals were overweight, 70.7% were of average weight, and 19% were underweight. As shown in Table 2.

Table 2: Demographic characteristics

Variables	Control group (n = 10)	Coffee group (n = 10)	Gum group (n= 10)	Coffee plus Gum group (n = 10)
Age (year)	10 (18–28)	10 (18–28)	10 (18–28)	10 (18–28)
Male (n (%))	4 (10%)	6 (15%)	5 (12.5%)	5 (12.5%)
Female (n (%))	6 (15%)	4 (10%)	5 (12.5%)	5 (12.5%)
Undergraduate Education Level (n (%))	5 (12.5%)	7 (17.5%)	6 (15%)	2 (5%)
University graduates (n (%))	5 (12.5%)	3 (7.5%)	4 (10%)	8 (20%)
Underweight (n (%))	2 (5%)	4(10%)	5(12.5%)	4(10%)
Normal weight (n (%))	5(12.5%)	4(10%)	5(12.5%)	5(12.5%)
Overweight (n (%))	3(7.5%)	2(5%)	0 (0%)	1 (2.5%)

As shown in Table 3, all participants in all studying groups were within normal serum melatonin level range during the first-time stage (7 am) of examining blood samples. However, the differences in melatonin serum levels were found in the second-time stage (12 pm), where the coffee plus chewing gum participants had the lowest serum levels of melatonin (13.1± 2.0). Among the intervention groups, the coffee group and the last group regarding melatonin levels were the chewing gum group, 15.3± 1.2 and 19.2± 2.2, respectively. Significant differences existed between the interventions and control groups (P < 0.05). Furthermore, there were significant differences between coffee plus chewing gum and the coffee group and the chewing gum group (P < 0.002,P < 0.02, P < 0.004, respectively).

Table 3: Melatonin serum level (pg/ml/3 h)

Study Group	Melatonin serum level at 7:00 am	Melatonin serum level at 12:00 pm	Significance
Control group	95.9 ± 2.5	23.1± 1.2	
Coffee group	105.1 ±1.9	**15.3± 1.2**	P < 0.02[a,b]
Gum group	113.0 ± 1.5	19.2± 2.2	P < 0.004 [a]
Coffee plus Gum group	120.9 ± 2.2	13.1± 2.0	P < 0.002 [a,b,c]

Melatonin serum level (pg\ml), (a): comparison between group 1 with group 2, (b) comparison group 2 with group 3, (c) comparison between group 1 with groups 2 and 3.

To our knowledge, this is the first study to evaluate the effect of chewing gum on serum melatonin levels among healthy young individuals. Furthermore, we assessed the differences between the impact of coffee and chewing gum on serum melatonin levels.

The present study revealed that consuming coffee reduces the serum level of melatonin, which is in concordance with previous studies [23–25], according to several studies conducted to investigate the mechanisms by which sleep is interrupted after coffee consumption had shown that Caffeine consumption by day causes a reduction in 6-sulfatoxymelatonin (the primary metabolite of melatonin) on a next night [23,26–28].

Coffee consumption has been shown to have an inhibitory effect on melatonin secretion. This is because coffee contains caffeine, a stimulant that can interfere with the body's natural sleep-wake cycle and inhibit melatonin production [23]. Several studies have investigated the effects of caffeine on melatonin secretion, and the results consistently show that caffeine can significantly reduce melatonin levels [23,27,28]. One study found that consuming caffeine at night delayed the onset of melatonin secretion by up to 40 minutes, while another study found that caffeine consumption during the day reduced melatonin levels by up to 50% [23,29]. It is important to note that the effects of coffee consumption on melatonin secretion can vary depending on factors such as the amount and timing of consumption, individual sensitivity to caffeine, and other sleep-disrupting factors.

While there is no direct relationship between Gum and melatonin secretion, certain dietary factors, such as tryptophan, may influence melatonin production. Tryptophan is an essential amino acid precursor to serotonin, which is then converted to melatonin [30–32]. More research is needed to fully understand the mechanisms involved and the potential impact of other dietary factors, such as Gum, on melatonin secretion [33-35].

Chewing gum in the present study revealed a significant reduction in serum melatonin levels compared to the control group. As mentioned previously, it is the first study to evaluate this effect. The suggested mechanism of the effect could be due to the impact of

chewing gum on serotonin levels [36]. Several studies have shown that chewing gum reduces serotonin levels, where serotonin is a melatonin precursor. Furthermore, a reduction in serotonin level will finally lead to a decrease in melatonin serum level.

Finally, the present study revealed that no association between body weight and serum melatonin levels in contrast to other previous studies [37,38].

CONCLUSION

While coffee consumption and chewing gum can negatively affect serum melatonin levels, further research is needed to fully understand the mechanisms involved and the variability of the effect in different individuals. Furthermore, larger study samples are required to confirm the present study's findings. Avoid consuming coffee or other caffeine-containing beverages in the evening may be advisable for individuals who have trouble sleeping or suffer from sleep disorders. In addition, for sleepy university students that encounter problems in early lectures regarding loss of concentration, chewing gum may resolve these situations.

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Conflict of interest:

The authors declare no conflicts of interest for this study.

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