Effect of Blackcurrant Juice on Perceived Stress and Mood among Medical Students - A Randomized Controlled Trial

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ABSTRACT

The high polyphenol content in blackcurrants is the most important component which makes it favorable for better mood enhancement and reduce perceived stress among medical students. There are a few randomized trials indicating that blackcurrant juice has a positive effect on mood. However, there are limited evidence showing that blackcurrant juice plays a role in reducing perceived stress. This pilot study utilized a randomized, single blind and placebo-controlled design to find out the effect of blackcurrant juice on mood and perceived stress. A total of 65 medical students were randomized into the intervention group (n=32) where they received blackcurrant juice for three consecutive days and into the control group (n=33) where they received placebo for three consecutive days as well. Evaluation of mood and perceived stress was done after three days by using Bond-Lader visual Analogue Scale, Positive and Negative Affect Schedule (PANAS), and Perceived Stress Scale (PSS). Results show the blackcurrant group had a higher score in terms of calmness in subjective mood, as measured by the Bond-Lader Visual Analogue Scale at post-intervention [mean difference 8.60; 95% CI 0.25 to 16.95; P=0.044]. However, there was no significant difference between the groups with regards to positive and negative affect of mood, alertness and contentment of subjective mood, and perceived stress, as measured by the PANAS and perceived stress scale at post-intervention. When comparing the baseline and post-intervention, participants in the group receiving blackcurrant juice showed significant difference in mood based on the Bond-Lader Visual Analogue Scale and perceived stress. Around 15.6% of blackcurrant juice group had the side effects such as gas/bleaching. In a nutshell, blackcurrant juice poses a good effect on the overall mood and perceived stress.

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INTRODUCTION

Blackcurrant, which belongs to the Grossulariaceae family, is a berry that originated from Europe and Northern Asia. It contains anthocyanins, which are polyphenols that have been found to have beneficial effects on humans. These effects are due to the berry's anti-inflammatory, antioxidant, and antibacterial properties [1]. When compared to other types of berry fruits, blackcurrant has a high concentration of polyphenols, with the major phenolic constituents being the 3-O-glucosides and 3-O-rutinoside of the anthocyanins delphinidin and cyanidin, as well as flavonols and polyunsaturated fatty acids [2].

Polyphenols are compounds found in most plant-based foods, including flavonoids, phenolic acids, lignans, and stilbenes. Currently, there are approximately 8,000 types of polyphenols that have been identified [3]. Fruits and beverages such as fruit juice, wine, tea, coffee, chocolate, and beer are the primary sources of polyphenols in the human diet, with vegetables, dry legumes, and cereals contributing lesser amounts [4]. Research has shown that when intact polyphenols are consumed, various compounds can be detected in the urine, indicating their bioavailability in the human body. In the case of blackcurrant juice consumption, between 5%–57% of polyphenols can be detected in urine, while 75%–95% are not detected. Polyphenols that are not absorbed in the stomach or small intestine will be carried to the colon, while those that are absorbed will undergo metabolism in the liver and be excreted via bile [5].

Mood refers to the way one feels at a particular moment, and it is considered a short-term experience. A study suggested that a large proportion of medical students, approximately 80%, experience mood disturbances, which can lead to mood disorders and a poor quality of life [6]. Previous research has shown that consuming foods rich in flavonoids can enhance one's mood [7]. Blackcurrants are abundant in flavonoids, which can increase cerebral blood flow [8]. Increased cerebral blood flow to a particular region of the frontal lobe, which is the dorsolateral prefrontal cortex (DLPFC) is strongly linked to cognitive control [9] and emotional regulation [10], and can strengthen neural circuitry in the frontal lobes. Furthermore, flavonoids can inhibit Monoamine Oxidase (MAO), which is responsible for the breakdown of neurotransmitters involved in mood regulation (such as serotonin, dopamine, and norepinephrine) [11]. Hence, consuming fruits rich in flavonoids can reduce MAO activity, increase the circulation of monoamines, and potentially improve one's mood.

The World Health Organization defines stress as any change that causes physical, emotional, or physiological strain. A study found that stress levels among Malaysian medical students were alarmingly high, with 56% reporting experiencing stress [12]. Although there is limited research on the effects of flavonoids on stress, recent studies have indicated that polyphenols may play a significant role in reducing stress in both animal models and human trials. Consequently, consuming foods rich in polyphenols may help prevent stress-related health issues [13].

Blackcurrants are less expensive and more readily available in Western countries than in Malaysia, where they are often considered a luxury item. However, many juices containing blackcurrant extracts are widely used among Malaysians. Medical students, who are often under significant stress due to their studies and have limited time to prepare fresh juice, may find it particularly challenging to incorporate pure fruit juice into their daily routine. Preparing a cup of blackcurrant juice from cold-pressed or frozen blackcurrants can be time consuming. Therefore, many students choose to purchase blackcurrant extract concentrate, which is easily available in the Malaysian market, and dilute it with water when they crave blackcurrant juice. Few studies have suggested that blackcurrant juice can improve mood [1,2], however, there is limited information about its effect on stress. It is crucial to determine how blackcurrant juice affects the perceived stress levels and mood. Therefore, this randomized controlled trial was conducted to examine the effect of blackcurrant juice on the perceived stress and mood of medical students.

METHODS

Study design, setting and population

We conducted a pilot, single-blinded, parallel randomized controlled trial to investigate the impact of blackcurrant juice on the perceived stress levels and mood of clinical year medical students, in comparison to a placebo drink. The study was conducted at the Muar Campus of Manipal University College Malaysia (MUCM) between December 2022 and January 2023. MUCM has a total of 1027 students, with 423 students in semesters 1-4 at the Melaka campus, 232 students in semesters 5-7 at the Muar campus, and 372 students in semesters 8-10 at the Melaka campus. We invited 70 participants from the clinical year medical students who are in semesters 5, 6, and 7 at the Muar campus.

Sample size, sampling and randomization

We conducted a pilot study and invited a total of 70 students by using a non-probability, convenience sampling technique. We selected our study sample based on the inclusion and exclusion criteria, which included MBBS students from clinical years of any age, gender, ethnicity, and nationality. Exclusion criteria were individuals who had allergies to blackcurrant or berries, pregnant or lactating females, medical students with pre-existing medical conditions like asthma, cancer, sleep apnea, diabetes, or hypertension, those currently taking medications for psychiatric illness or mood disorders, active smokers and vapers, those who consume caffeine more than 400 mg per day, those who consume alcohol or recreational drugs, students with obesity or metabolic syndrome, recent history of COVID-19 infection, and those appearing for class or end posting examination. A total of 65 participants provided the informed consent and were randomly divided into two groups using block randomization, and 32 students were randomly assigned to the intervention group and 33 students to the control group.

Intervention procedures

Prior to the start of the intervention, all participants were asked to gather to complete a demographic data form and sign an informed consent form. Those who met the inclusion criteria and did not have any exclusion criteria were selected as subjects for the study. The 65 medical students who met these criteria were randomly assigned to either the intervention group (32 participants) or the control group (33 participants) using block randomization [Figure 1]. The intervention group received diluted blackcurrant extract concentrate, while the control group received a placebo consisting of a glucose solution with blackcurrant flavoring. The participants were informed about the study process and were given the option to withdraw at any time. They were asked to complete three printed assessment questionnaires on perceived stress and mood such as perceived stress scale, Bond-Lader visual analogue scale, and Positive and Negative Affects Schedule to record their baseline levels.

During the three consecutive days of the study, investigators prepared the intervention and placebo drinks. Opaque paper cups with lids were used to practice single-blind methodology. The cups and lids for both the intervention and control groups were matched in color, volume, size, and design. The blackcurrant juice for the intervention group was prepared by mixing 40 ml of 25% blackcurrant extract with 160 ml of water (1:4 ratio) per cup, while the control group received a solution containing 28.8 grams of sugar dissolved in 195 ml of water, with 5 ml of blackcurrant flavor added. Participants were asked to assemble at 1:00 pm for three consecutive days and they were required to consume their drinks within 15 minutes.

Food diary questionnaires were provided to all participants through Google form for convenience. Participants were informed to complete the diary every night during the intervention period so that their daily polyphenol and antioxidant intake could be recorded and calculated for data analysis. The investigators checked the submission of food diaries every night, and sent a reminder through WhatsApp to those who had not submitted their diaries.

On the third day of the study, participants gathered in the evening at 5:00 pm to complete the printed questionnaires on perceived stress and mood based on their experience after consuming the intervention drinks.

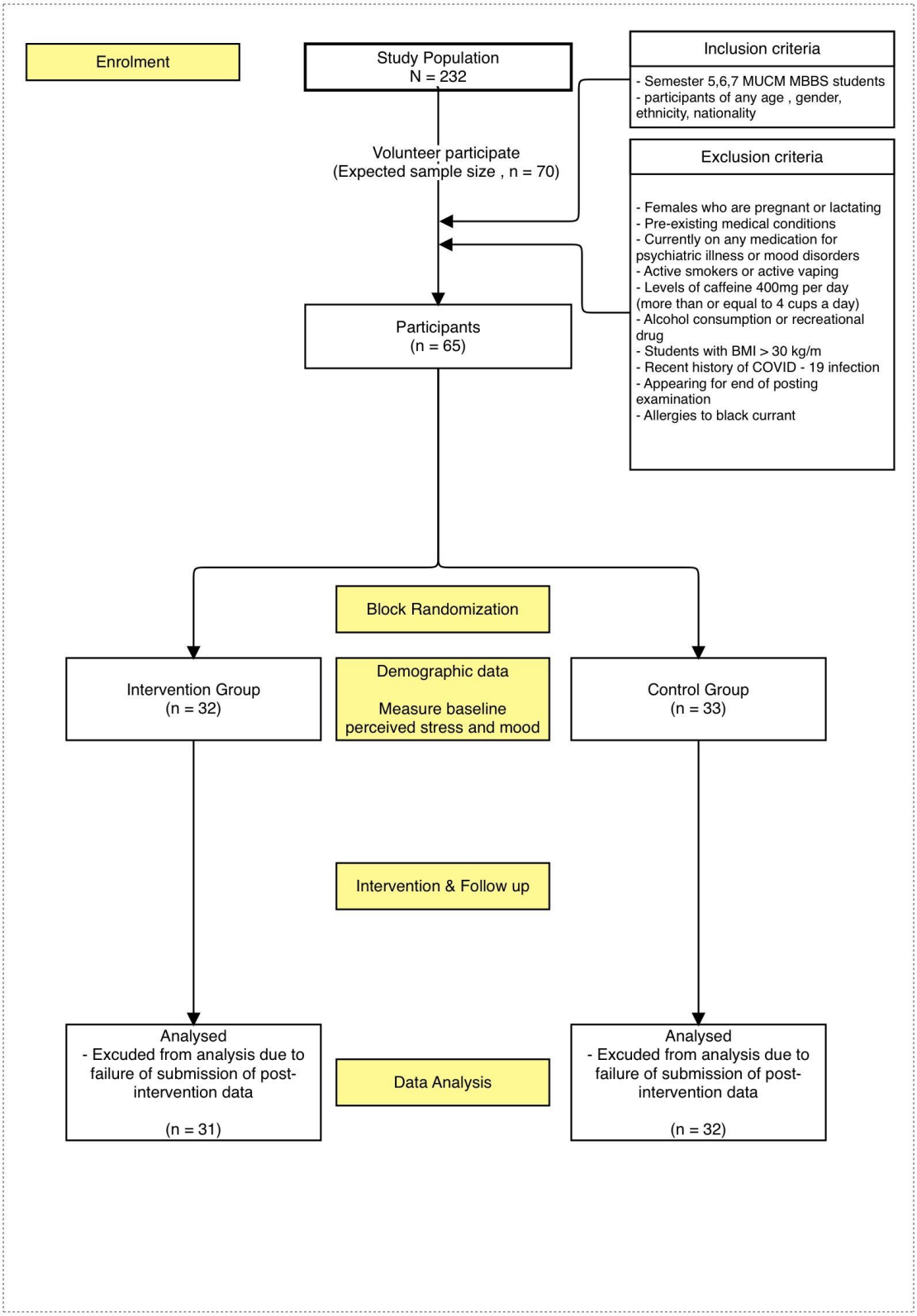

Figure 1: Consort flow diagram

Data collection

The participants were asked to complete a demographic data questionnaire on Google Forms to provide information on their age, gender, weight, height, and ethnicity, which was used to create their demographic profile. To assess and compare participant's perceived stress levels before and after consuming blackcurrant juice, as well as their stress levels, we used a validated questionnaire such as Perceived Stress Scale (PSS) [14]. To measure participants' subjective mood, we used two validated questionnaires such as the Positive and Negative Affects Schedule (PANAS) [15] and the Bond-Lader Visual Analogue Scale (BLVAS) [16]. These questionnaires were distributed to all participants on the first and third day of the study. We also recorded the participants' intake of polyphenols and antioxidant-rich foods at baseline and every day throughout the study period. A list of foods was categorized into high, medium, and low levels of polyphenols and antioxidants.

Data analysis

Microsoft Excel was used to enter and process the data and Epi Info software version 7.2 was used to analyze the data. Frequency and percentage were calculated for categorical data like gender, ethnicity, nationality, daily supplement intake, food diary data, and side effects of the intervention juice and placebo. For quantitative data such as the scores of the Positive and Negative Affect Scale, Bond-Lader Visual Analogue Scale, and Perceived Stress Scale, mean and standard deviation were calculated. Inferential statistics were calculated using the independent t-test to compare the baseline and post-intervention subjective mood and perceived stress between the intervention and control groups. Relative risk was also calculated. A p-value of less than 0.05 was considered statistically significant, and a 95% confidence interval was used to estimate parameters.

Ethical consideration

The written informed consent form contained all the necessary and relevant details, including the objectives, procedures, confidentiality measures, outcomes measured, and contact information of all investigators (for reporting side effects and emergencies). Participants who voluntarily took part in the study signed the form, and no incentives were offered to attract the students to participate. As indicated in the informed consent form, all data collected from participants throughout the study would be kept confidential. The participants were informed that they could withdraw from the study at any time during the study period. Furthermore, the investigational products were checked to ensure that they were "halal" and suitable for both Muslim and non-Muslim participants to consume for three consecutive days during the study. The Research and Ethics Committee of Manipal University College Malaysia (MUCM) approved this research (MUCM/ Research and Ethics Committee – 086/2022).

RESULTS

A total of 32 students were randomized to the intervention group (blackcurrant) and 33 students were randomized to control group. The baseline characteristics of the participants among intervention and control groups is described in table 1. The mean age of blackcurrant group is 21.9 years while control group is 21.8 years. Females comprised 53.1% of the intervention group and 75.8% of the control group. Table 2 shows the baseline intake of polyphenol and antioxidant containing food between blackcurrant group and control group. [Table 1 & 2]

Table 3 presents the subjective mood and perceived stress of the students at baseline, comparing the intervention and control groups. There was no significant difference between the groups in terms of positive affect of mood measured using PANAS, subjective mood such as alertness, contentment, calmness, and perceived stress. However, the intervention group had a higher negative affect score of PANAS [mean difference -4.00; 95% CI -7.84 to -0.16; P=0.042]. [Table 3]

According to Table 4, the blackcurrant group had a higher score in terms of calmness in subjective mood, as measured by the Bond-Lader Visual Analogue Scale at post-intervention [mean difference 8.60; 95% CI 0.25 to 16.95; P=0.044]. However, there was no significant difference between the groups with regards to positive and negative affect of mood, subjective mood, and perceived stress, as measured by the PANAS and perceived stress scale at post-intervention. [Table 4]

Table 5 indicates that the blackcurrant group had a significantly higher score in terms of alertness, contentment, and calmness in subjective mood, and lower perceived stress post-intervention. However, there was no significant difference in positive and negative affect score as measured by the PANAS between baseline and post-intervention in the intervention group. [Table 5]

Table 6 illustrates that the control group had a lower negative affect score, as measured by the PANAS, post-intervention. Additionally, the alertness, contentment, and calmness scores were significantly higher at post-intervention. However, there was no significant difference with regards to perceived stress between baseline and post-intervention. [Table 6]

Table 7 presents that there was no significant difference observed in the occurrence of side effects, such as headache, diarrhea, gas, or belching, between the intervention and control groups. [Table 7]

Table 1: Baseline characteristics of participants between blackcurrant drink group (n=32) and control group (n=33)

Variables	N (%)	
	Blackcurrant	**Control**
Age		
Mean (SD)	21.9 (1.0)	21.8 (1.0)
Gender		
Male	15 (46.9%)	8 (24.2%)
Female	17 (53.1%)	25 (75.8%)
Ethnicity		
Malay	1 (3.1%)	0
Chinese	9 (28.1%)	6 (18.2%)
Indian	15 (46.9%)	18 (54.6%)
Others	7 (21.9%)	9 (27.3%)
BMI		
Mean (SD)	22.6 (2.9)	22.5 (3.5)
Nationality		
Malaysian	25 (78.1%)	26 (78.8%)
International	7 (21.9%)	7 (21.2%)
Daily supplements		
Yes	7 (21.9%)	27 (81.8%)
No	25 (78.1%)	6 (18.2%)
Daily-Exercise, Yoga, Meditation		
Yes	15 (46.9%)	21 (63.6%)
No	17 (53.1%)	12 (36.4%)
Daily Gaming		
Yes	13 (40.6%)	6 (18.2%)
No	19 (59.4%)	27 (81.8%)
Daily routine - Sleep		
Not enough	6 (18.8%)	10 (30.3%)
Just enough	23 (71.9%)	22 (66.7%)
Extended	3 (9.4%)	1 (33.0%)

Table 2: Baseline intake of polyphenol and antioxidant containing food between blackcurrant group (n=32) and control group (n=33)

Variables	N (%)	
	Blackcurrant	**Control**
High polyphenol food		
Yes	2 (6.3%)	5 (15.2%)
No	30 (93.8%)	27 (81.8%)
Moderate polyphenol food		
Yes	11 (34.5%)	21 (63.6%)
No	21 (65.6%)	11 (33.3%)
Low polyphenol food		
Yes	25 (78.1%)	23 (69.7%)
No	7 (21.9%)	10 (30.3%)
High antioxidant food		
Yes	8 (25.0%)	11 (33.3%)
No	24 (75.0%)	22 (66.7%)
Moderate antioxidant food		
Yes	12 (37.5%)	14 (42.4%)
No	20 (62.5%)	19 (57.6%)
Low antioxidant food		
Yes	22 (68.8%)	18 (54.6%)
No	10 (31.3%)	15 (45.5%)

Table 3: Baseline subjective mood and perceived stress between blackcurrant drink group (n=32) and control group (n=33)

Variables	Mean (SD)		Mean difference (95% CI)	*P*
	Blackcurrant	Control		
PANAS				
Positive affect score (10-50)	32.0 (6.6)	31.8 (6.1)	0.20 (-2.95, 3.35)	0.899[a]
Negative affect score (10-50)	22.8 (8.0)	26.8 (7.5)	-4.00 (-7.84, -0.16)	0.042[a]
Subjective mood (BLVAS**)**				
Alertness	46.1 (12.0)	44.1 (13.1)	2.00 (-4.23, 8.23)	0.524[a]
Contentment	49.2 (14.2)	49.3 (13.0)	-0.10 (-6.84, 6.64)	0.977[a]
Calmness	46.2 (17.9)	43.7 (12.8)	2.50 (-5.19, 10.19)	0.519[a]
Perceived stress scale	20.1 (4.7)	20.8 (3.9)	-0.70 (-2.84, 1.44)	0.515[a]

[a]Independent t-test; P<0.05 is statistically significant

Table 4: Post-intervention subjective mood and perceived stress between blackcurrant drink group and control group

Variables	Mean (SD)		Mean difference (95% CI)	*P*
	Blackcurrant	Control		
PANAS	**(n=31)**	**(n=32)**		
Positive affect score (10-50)	33.2 (8.5)	30.4 (8.0)	2.80 (-1.36, 6.96)	0.183[a]
Negative affect score (10-50)	21.0 (8.3)	21.6 (6.8)	-0.60 (-4.42, 3.22)	0.754[a]
Subjective mood (BLVAS**)**	**(n=32)**	**(n=33)**		
Alertness	65.0 (20.4)	65.9 (14.7)	-0.90 (-9.69, 7.89)	0.839[a]
Contentment	62.3 (16.9)	57.0 (15.4)	5.30 (-2.71, 13.31)	0.191[a]
Calmness	68.1 (15.3)	59.5 (18.2)	8.60 (0.25, 16.95)	0.044[a]
Perceived stress scale	**(n=31)**	**(n=32)**		
	17.1 (6.5)	19.3 (4.1)	-2.20 (-4.96, 0.56)	0.116[a]

[a]Independent t-test; P<0.05 is statistically significant

Table 5: Comparison of baseline and post-intervention subjective mood measured and perceived stress among blackcurrant drink group

Variables	Mean (SD)		Mean difference (95% CI)	*P*
	Baseline	Post-intervention		
PANAS (n=31)				
Positive affect score (10-50)	31.7 (6.6)	33.2 (8.5)	1.50 (-1.99, 4.83)	0.402[b]
Negative affect score (10-50)	23.1 (7.9)	21.0 (8.3)	-2.10 (-5.00, 0.80)	0.150[b]
Subjective mood (BLVAS**)** (n=32)				
Alertness	46.1 (12.0)	65.0 (20.4)	18.90 (9.36, 28.54)	<0.001[b]
Contentment	49.2 (14.2)	62.3 (16.9)	13.10 (4.75, 21.37)	0.003[b]
Calmness	46.2 (17.9)	68.1 (15.3)	21.90 (13.38, 30.42)	<0.001[b]
Perceived stress scale (n=31)	20.1 (4.8)	17.1 (6.5)	-3.00 (-5.02, -0.98)	0.005[b]

[b]Dependent t-test; P<0.05 is statistically significant

Table 6: Comparison of baseline and post-intervention subjective mood and perceived stress among control group (n=33)

Variables	Mean (SD)		Mean difference (95% CI)	*P*
	Baseline	Post-intervention		
PANAS (n=32)				
Positive affect score (10-50)	31.8 (6.2)	30.4 (8.0)	-1.40 (-3.98, 1.23)	0.290[b]
Negative affect score (10-50)	27.0 (7.4)	21.6 (6.8)	-5.40 (-8.28, -2.54)	0.001[b]
Subjective mood (BLVAS**)** (n=33)				
Alertness	44.1 (13.1)	65.9 (14.7)	21.80 (14.22, 29.53)	<0.001[b]
Contentment	49.3 (13.0)	57.0 (15.4)	7.70 (0.29, 15.13)	0.042[b]
Calmness	43.7 (12.8)	59.5 (18.2)	15.80 (6.94, 24.72)	0.001[b]
Perceived stress scale (n=32)	20.8 (3.9)	19.3 (4.1)	-1.50 (-3.27, 0.21)	0.083[b]

[b]Dependent t-test; P<0.05 is statistically significant

Table 7: Comparison of side effects between blackcurrant drink group (n=32) and control group (n=33)

Side effect	N (%)		P value
	Blackcurrant	Control	
Headache			
Yes	3 (9.4)	3 (9.1)	0.968[c]
No	29 (90.7)	30 (90.9)	
Diarrhea			
Yes	1 (3.1)	1 (3.0)	0.982[c]
No	31 (96.9)	32 (97.0)	
Gas/belching			
Yes	5 (15.6)	1 (3.0)	0.080[c]
No	27 (84.4)	32 (97.0)	

[c]Chi-square test; P<0.05 is statistically significant

DISCUSSION

A pilot study with a single-blind parallel randomized controlled design was conducted among medical students to investigate the impact of blackcurrant juice on mood and perceived stress. The study evaluated participant's mood and perceived stress using the Bond-Lader Visual Analogue Scale and the Positive and Negative Affect Schedule (PANAS) for mood, and the Perceived Stress Scale (PSS) for perceived stress.

Effect of blackcurrant juice on subjective mood

Our study found that there was no significant difference in subjective mood, as measured by the Positive and Negative Affect Schedule (PANAS) Scale, between blackcurrant juice and placebo over three consecutive days of intervention. However, based on the subjective mood measured by Bond-Lader Visual Analogue Scale, there were no significant differences in alertness and contentment between the blackcurrant juice and placebo groups, but a noteworthy difference was observed in the calmness factor. The mean score for calmness in the blackcurrant juice group was higher than the placebo group. Previous studies have also shown that consuming foods high in polyphenols can significantly improve the calmness factor in the Bond-Lader scale [17, 18]. Our study adds to this evidence and demonstrates that blackcurrant juice can positively affect the mood of medical students.

When comparing the subjective mood of the blackcurrant juice and placebo groups before and after the intervention, we found that the mean positive affect score of the intervention group increased, while the control group's score decreased, although the difference was not significant. Additionally, although the post-intervention negative affect score decreased compared to the pre-intervention score, the reduction was less significant in the intervention group than in the control group. A previous study, which measured mood using PANAS, and assessed the consumption of high polyphenol on mood, found no significant effect on the positive affect score but a significant negative affect score [19]. This is in contrast to our study, and the difference might be due to various confounding factors. For instance, the control group in the previous study was asked to note their snack intake, which might have influenced the outcome. Eating snacks can increase serotonin levels, which can improve mood, and emotional distress can cause carbohydrate cravings [20]. Additionally, the gender ratio between male and female was almost equal in the previous study, while there were more female participants in the control group of our study. Female participants might have more emotional fluctuations than male participants, and their depression levels can fluctuate with estrogen levels, leading to more perceived mood variation [21]. Another study over four weeks of intervention, which assessed the effect of food rich in flavonoids on mood using PANAS, found no significant effect on the positive and negative affect scores [22]. The study had more female participants than male participants, which might have affected the outcome. The previous study had a small sample size, compared to our study. This could explain why our study found a significant difference in the negative affect score, while the previous study did not.

The analysis of the Bond-Lader Visual Analogue Scale in this study yielded interesting results regarding the effects of blackcurrant juice. The study found significant differences between the blackcurrant juice and placebo groups in all three categories, which are alertness, contentment, and calmness. However, only the mean score differences in the contentment and calmness factors were higher in the blackcurrant juice group compared to the placebo group. While both groups exhibited an increase in the alertness factor, the intervention group showed a smaller increase compared to the control group. A previous randomized, double-blind, placebo-controlled study on blackcurrant supplementation and mood also demonstrated significant differences in the alertness factor [11]. Similarly, another randomized, double-blind, placebo-controlled study on a fruit that is high in polyphenols showed a significant effect on the alertness factor [23].

Effect of blackcurrant juice on perceived stress

To date, there have been no prior investigations into the effects of blackcurrant juice on perceived stress. In our pilot study, we aimed to examine the impact of blackcurrant juice on perceived stress and obtained some mixed results. We found that there were no significant differences of perceived stress score between the blackcurrant juice and placebo groups after the intervention. However, our study showed that the mean perceived stress score was lower in the blackcurrant group than in the control group. Additionally, although both groups showed a reduction in perceived stress levels, the decrease was twice as much in the blackcurrant juice group compared to the placebo group.

A controlled clinical study was conducted to evaluate the impact of polyphenol-rich foods on perceived stress among students, which revealed that female students experienced a significant reduction in perceived stress over a two-week period [24]. Another study found that individuals who consume a diet high in polyphenols tend to have lower perceived stress levels [25]. Furthermore, previous study found that a high intake of polyphenols can effectively lower levels of salivary cortisol and epinephrine, thereby reducing stress levels [26]. A study examining the relationship between fruit and vegetable intake and perceived stress indicated that those who consume a high amount of fruits and vegetables tend to have lower perceived stress levels than those who consume a low amount [27]. In addition, a study investigating the consumption of specific types of fruits and vegetables and perceived stress found that the odds of experiencing high perceived stress are low with regular consumption of fruits and vegetables [28]. These findings are supported by a study that evaluates the contribution of fruits and vegetables to dietary intake of polyphenols and antioxidants, which suggests that fruits and vegetables are significant sources of these compounds [29]. Based on these findings, it can be concluded that blackcurrant juice can effectively reduce perceived stress levels.

We also determine the side effects experienced by participants in the blackcurrant juice group and the placebo group. We did not find any significant side effects such as headaches, diarrhea, or gas/belching. A review of the literature has highlighted the potential side effects of blackcurrant seed's high content of Gamma-linolenic acid (GLA) and alpha-linolenic acid (ALA), including headaches, soft stools, constipation, flatulence, and belching [30]. Moreover, a randomized crossover study showed that the most common gastrointestinal symptoms after consuming 400 mL of natural mineral water mixed with 50 mL of sugar-free blackcurrant-flavored squash were stomach bloating and belching [31].

Our study had some limitations that should be noted. Firstly, the time period during which we conducted the study was short, as we only had three days to assess the effects of blackcurrant juice on mood and perceived stress among medical students. To obtain a more precise evaluation of the impact of blackcurrant juice on these variables, it is advisable to conduct studies with a longer duration and a larger sample size. Additionally, it would be beneficial to carry out similar studies in more diverse populations in different settings to generalize the findings.

The study revealed that although some people experienced adverse effects from consuming blackcurrant juice, its positive impact on mood and perceived stress was considerable. Blackcurrant juice was found to enhance mood and lower perceived stress levels in medical students. Taking into account both the potential negative effects and the benefits shown in this study, we suggest that blackcurrant juice is a beneficial beverage for the students, as it has significant positive effects on perceived stress and subjective mood.

CONCLUSION

In this randomized controlled trial, the impact of blackcurrant juice on subjective mood and perceived stress was investigated. Post-intervention measurements indicated that the blackcurrant group had better subjective mood (positive and negative affect, contentment, calmness) and lower perceived stress compared to the control group, although the intervention group scored lower on alertness than the control group. However, the differences were not statistically significant, except for calmness. When comparing the mean score difference between pre- and post-intervention of the blackcurrant group, the results indicate that subjective mood measured using BLVAS and perceived stress is statistically significant, while the positive and negative affect score measured by PANAS is not significant. Overall, blackcurrant juice was found to have a greater positive effect on perceived stress and the positive affect of mood, contentment, and calmness factors of subjective mood, compared to the negative affect of mood and alertness factors.

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