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Improvement of Stress-Induced Changes Related To Mood and Cognitive Function in Healthy Young Adults Following Supplementation With *Ajwa* Dates

Nurlaily, A.,
Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia, Level 13, Menara B, Jalan Pandan Utama, 55100 Pandan Indah, Kuala Lumpur, Malaysia;
[*]*Corresponding author email: azila@usim.edu.my*

Mokhtar, R.H.,
Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia, Level 13, Menara B, Jalan Pandan Utama, 55100 Pandan Indah, Kuala Lumpur, Malaysia;

Marwan, A.A.
Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia, Level 13, Menara B, Jalan Pandan Utama, 55100 Pandan Indah, Kuala Lumpur, Malaysia;

Noh, N.A.
[1]*Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia, Level 13, Menara B, Jalan Pandan Utama, 55100 Pandan Indah, Kuala Lumpur, Malaysia;*

Abstract

This study tested the effects of Ajwa dates supplementation on stress-induced changes to mood and cognitive functions in healthy young adults. 20 young adults were selected to receive seven dates per day for six weeks. Subjects completed measures of mood (POMS and DASS-21 questionnaires), and cognitive functions (simple reaction time, Stroop, n-back tests) before and after six weeks of supplementation: following an acute stressor task (Trier Social Stress test). Analysis of coronary risk and renal profiles were also done before and after six weeks of supplementation. Parameters related to mood including tension subscale in POMS, and stress subscale in DASS-21 significantly improved from baseline to week six. Significant improvements were also observed in the mean reaction time of Stroop, 1-back and 2-back tests after week six. There were no changes in coronary risk and renal profile after six weeks of supplementation. Our findings indicate that Ajwa dates supplementation has the potential to alleviate stress-induced changes in mood and cognitive functions in healthy young adults without adverse effect on renal functions.

Keywords: *Anti-stress, Cognition, Dates, Mood, Phoenix dactylifera*

Introduction

Phoenix dactylifera L. also known as date palm, is an important food in certain regions of the world that it has become a staple especially in the Middle East and North Africa regions. Since long time, date palms have benefited the life of Middle-East population by providing material for house-building for their ancestors and foods from the leaves and fruits. Date palms are also deemed as important in the Islamic tradition, that the plant have been mentioned few times in the Quran and hadiths. There is an authentic hadith about the benefit of eating date fruits:

Narrated Sa'd: I heard Allah's messenger saying, "Whoever eats seven 'Ajwa dates in the morning, will not be effected by magic or

poison on that day." (Hadith. Al-Bukhari. Sahih Bukhari : Book 76: #91).

Till now, Muslims around the world have been accustomed to start and break their fast with date fruits especially during the mandatory fasting month, Ramadhan. Consumption of date fruits during fasting month is believed to help protect the stomach lining from the damaging effect of gastric acid (El Hadrami et al. 2012). Apart from the association with Islamic tradition, date palm and its fruits have been traditionally used as medicine to treat variety of illness, such as common cold, sore throat, and infertility (El Hadrami et al. 2012).

Although there are many varieties date palms worldwide, their fruits are specially characterized with high percentage of carbohydrate (44-88% of total sugar), protein (2.3-5.6%), fat (0.2-9.3 %), fiber (6.4-11.5 %), essential minerals and vitamins (El Hadrami et al. 2012). Date fruits are also rich in phytochemicals that could be responsible for their variety of biological activities. In recent years, there is a grown interest in studying date fruits biological activities using in-vivo and in-vitro method such as anti-inflammatory (Rahmani et al. 2014), anti-microbial (Shakibaa et al. 2011) and anti-cancer (Eid et al. 2014; Ishurd & Kennedy 2005). While majority of animal studies on date fruits showed promising results (Nurlaily et al. 2016), studies on human are very limited especially on stress response. Study on stress response is critical as there is an alarming rise in the number of individuals with mental disorders related to neurological, behavioural and substances usage. At a global level, over 300 million people were estimated to suffer from depression, equivalent to 4.4 % of the world's population (WHO 2017). Apart from researching new affective drugs to combat stress and mental disorder, there is a global interest in searching for functional foods that can enhance well-being and reduce the risk of various diseases and disorders.

Therefore, this study is aimed to evaluate the effects of date fruits consumption on the stress-induced changes related to mood and cognition in young healthy adults. Participants of this study consumed seven Ajwa dates each day for six weeks. The effects of Ajwa dates consumption on stress-induced response were determined by self-reported mood states using Profiles of Mood States (POMS) and Depression, Anxiety and Stress Scale (DASS-21) questionnaires as well as reaction time while doing computerized cognitive tasks.

Participants and Methods

Participants

Twenty individuals (male/female) aged 18-30 years old were recruited for the study. We limited our participants to those who generally healthy without chronic illness. Exclusion criteria included pregnancy, history of psychiatry disorder, and usage of hormones therapy.

Study design

This one-group study (no control) used repeated measures design with Time (pre-; post- supplementation) as within subject factor. Participants consumed seven Ajwa dates/day for six weeks. Participants completed two test sessions, one before Ajwa dates supplementation and two after six weeks of Ajwa dates supplementation. Each test session involved stress manipulation, cognitive tasks and mood measures. All test sessions were done in EEG Lab, Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia. This study was approved by the Ethics Committee of Universiti Sains Islam Malaysia.

Mood Measures

The *Profile of Mood States (POMS)* Questionnaire was used to assess subjective mood and arousal states of the participants. Participants rated 65 mood-related adjectives on a five point Likert scale which factor into six subscales: anger, depression, tension, fatigue, confusion and vigour. This study used the validated Bahasa Malaysia version of POMS (Bahri et al. 2007).

The *Depression, Anxiety and Stress Scale – 21 (DASS-21)* was used to assess stress level of the participants. The questionnaire contains three subscales: depression, anxiety and stress. It has 4 points Likert scale. This study also used the validated Bahasa Malaysia version of DASS-21.

Cognitive Tasks

In this study, the *Stroop* task was designed using SuperLab version 5 and consisted of two conditions: congruent and incongruent. Participants were required to press 'yes' button if the colour and word presented on computer screen was not conflicted (congruent) and 'no' button if the colour and word presented was conflicted (incongruent). Total trials in Stroop task was 80 with 2 seconds of each trial. The reaction time of correct responses were recorded.

The *N-back* task requires the participant to answer 'yes' or 'no' by pressing the respective button on the response pad in which, participants had to decide whether the current stimulus is the same as the one presented N-trials ago. In this study, the N-back task used position match as stimulus factor and consisted of two versions: 1-back and 2-back. Participants were presented with sequence of blue box which changes location after 2 seconds on computer screen. The N-back was also designed using SuperLab version 5 which recorded the reaction time of correct responses.

For simple reaction time test, we used Deary-Liewald reaction time software (Deary et al. 2011). Participants are required to press spacebar whenever 'X' is presented on the computer screen.

Stress-manipulation: Trier Social Stress Test (TSST)

The TSST is a validated procedure to induce acute stress in laboratory setting (Kirschbaum et al. 1993). The procedure consists of 5-minutes preparatory stage, 5-minutes public speaking task in front an interviewer and 5-minutes mental calculation task. In this study, participants were told that they were going to undergo a mock interview and that the session will be video recorded for behavioural evaluation. The participants were blinded to the TSST's true purpose to ensure the success of stress manipulation procedure.

Procedure

During test session, participants undergo the TSST procedure first. Then, participants were required to do simple reaction time test, Stroop and the N-back tasks. Then, participants were required to complete both questionnaires; POMS and DASS-21. After the first test session, participants were supplemented with Ajwa dates and instructed to minimize changes to diet and lifestyle activity for six weeks.

The final test session took place after six weeks of Ajwa dates supplementation and identical to the first session. During both test session, 10 ml of blood were collected from participant for blood analysis of cardiovascular risk marker and renal profile. The blood analysis was carried out by a private laboratory (Pathlab Sdn Bhd., Malaysia).

Statistical analysis

Data were analyzed using Student's t-test and a value of $P < 0.05$ was considered significant. The analyses were carried out using SPSS version 23.

Results

Table 1 shows the result of blood analysis of cardiovascular risk marker and renal profile. There was no significant difference between pre-and post Ajwa dates supplementation in blood parameters related to cardiovascular risk and renal profile. (refer appendix 1)

Figure 1 and Figure 2 show the effects of Ajwa dates supplementation on mood states as assessed by POMS and DASS-21 questionnaires. Overall the POMS scores on negative mood subscales like anger, tension, confusion, fatigue, depression were found to be reduced after Ajwa dates supplementation. Our results also indicate that Ajwa dates supplementation significantly reduced POMS score of tension subscale. Our results show that there was a reducing pattern in the mean scores of all subscales in DASS-21, however mean scores for stress subscale were reduced significantly after six weeks of Ajwa dates supplementation. (Refer appendixes 1 and 2)

Figure 3 shows that mean reaction time pre- and post-supplementation of Ajwa dates. The results show no significant differences between pre- and post-supplementation of Ajwa dates. (refer appendix 3)

Figure 4 shows the mean reaction time of correct responses pre- and post-supplementation of Ajwa dates while doing Stroop, 1-back and 2-back. Our results show that there were significant reductions in reaction time of correct responses of Stroop, 1-back and 2-back after six weeks supplementation of Ajwa dates. (refer appendix 4)

Discussion

The main goal of this study is to evaluate the effects of six weeks Ajwa dates supplementation on stress-induced changes related to mood and cognition in young healthy adults. Our results demonstrated that Ajwa dates supplementation improved the stress-induced cognitive functions and mood states.

We found that six weeks of Ajwa dates consumption improved stress-induced cognitive functions significantly as seen by reduced reaction time of correct responses while doing cognitive tasks related to working memory (N-back) and attention (Stroop). Exposure to acute stress has been reported to affect cognitive functions such as working memory (Shansky & Lipps 2013) and cognitive flexibility (Lee & Winston 2016). Acute stress increases cortisol secretion which travels to the central nervous system, then disrupt the typical prefrontal cortical functions (Vogel et al. 2016). A meta-analysis done by Shields et al. (2015) found that cortisol administration impaired working memory, provided that the delay between cortisol administration and cognitive assessment is short (less than one hour). Although we did not measure cortisol activity, the delay between TSST procedure and our cognitive assessments was within one hour. Besides that, the TSST protocol has been reported to increase cortisol level 10 minutes after cessation of stress exposure (Allen et al. 2014). Supplementation of Ajwa dates may modulate the cortisol secretion after the initiation of acute stress hence improved the stress-induced cognitive functions.

Improved stress-related cognition shown by Ajwa dates supplementation may also due to phytochemicals found in Ajwa dates. In a study done using Alzheimer's disease (AD) mice, long term supplementation with diet-rich dates (from Oman variety) have shown to improve cognitive impairment of the AD mice such as improved learning and memory deficits (Subash et al. 2014). Other study has found that date fruits extracts to attenuate cognitive deficits of ischemic stroke rats (Pujari et al. 2014). Rats supplemented with date fruits extract has shown improvement in working memory compared to control as assessed by Morris water maze test.

Our study showed that six weeks of Ajwa dates supplementation improved mood states and stress level as shown by significant reduced of score on tension and stress subscale on POMS and DASS-21, respectively. Stress is known to affect mood including augmenting negative feelings such as tension, anxiety and anger. Phenolic compounds found in Ajwa dates, such as quercetin (flavonoid) and ferulic acid (hydroxycinnamate) have been studied extensively in animal experiments for their antidepressant activity (Zeni et al. 2012; Kawabata et al. 2010). The improved mood states seen in our participants may due to the actions of active compounds in Ajwa dates. In one study, ferulic acid treatment has shown to increase mRNA level of brain-derived neurotrophic factor (BDNF) in the hippocampus of corticosterone-induced mice hence improved the stress-induced depression like behaviour in those mice (Yabe et al. 2010). Other study that used flavonoids-contain *Polygonum minus* extract has observed significant improvement in mood states particularly in tension, depression and anger (Yahya et al. 2017). The rich vitamins and minerals found in Ajwa dates such as magnesium and vitamin B could play a role in improving the stress-induced mood states in our participants. Multivitamins formulation also has been associated with reduced negative mood symptom among elderly (Harris et al. 2011).

Although there was no significant changes in blood biomarkers related to coronary risk after six weeks consumption of Ajwa dates, absence of changes in renal profile could mean that moderate consumption of Ajwa dates (seven per day) did not pose adverse effects on renal functions.

Conclusions

The six weeks Ajwa dates supplementation significantly improved stress-induced changes related to mood especially tension and stress. Improvements in stress-related cognition related to working memory and attention were also observed. Further investigation in determining the mechanism of Ajwa dates modulation on stress responses is strongly recommended.

Acknowledgement

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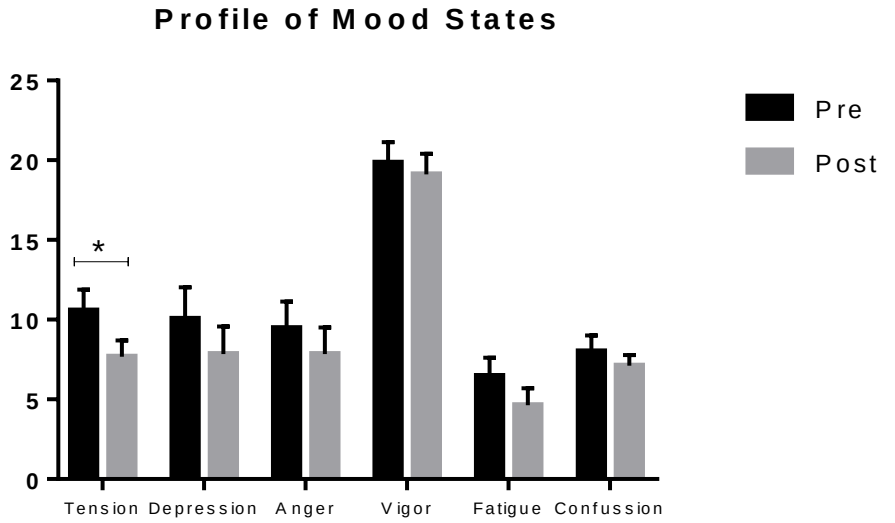
Appendices

Table 1 Data on blood biomarkers related to renal profile and coronary risk marker at baseline and week six (mean ± SD).

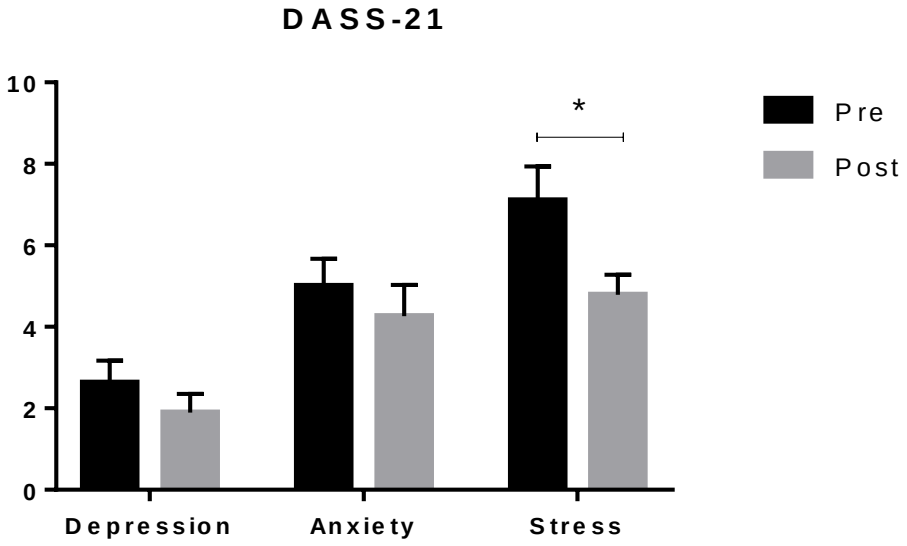
Parameters	Baseline (mean±SD)	Week 6 (mean±SD)
Renal Profile		
Urea (mmol/L)	3.7 ± 1.0	3.8± 1.0
Creatinine (umol/L)	63.1 ± 16.1	66.0 ± 17.1
Calcium (mmol/L)	2.4 ± 0.1	2.4 ± 0.1
Inorganic Phospate (mmol/L)	1.2 ± 0.2	1.2 ± 0.2
Uric acid (mmol/L)	0.3 ± 0.1	0.3 ± 0.1
Sodium (mmol/L)	141.2 ± 1.9	141.1 ± 3.1
Potassium (mmol/L)	4.5 ± 0.5	4.5 ± 0.5
Chloride (mmol/L)	104.1± 2.9	104.5 ± 2.5
Coronary Risk Marker		
Total Cholestrol (mmol/L)	4.9 ± 0.6	5.0 ± 0.6
HDL (mmol/L)	1.5 ± 0.3	1.5 ± 0.3
LDL (mmol/L)	3.0 ± 0.4	3.1 ± 0.5
Triglycerides (mmol/L)	0.8 ± 0.3	1.0 ± 0.3
Total/HDL Ratio	3.4 ± 0.6	3.5 ± 0.6

Figure 1 Mood states (POMS) pre- and post-supplementation of Ajwa dates (mean ± SEM).



*significantly different at p <0.05 compared to baseline (pre)

Figure 2 Psychosocial status (DASS-21) pre- and post-supplementation of Ajwa dates (mean ± SEM).



*significantly different at p <0.05 compared to baseline (pre)

Figure 3 Reaction time while doing Simple Reaction Time Task (mean ± SEM).

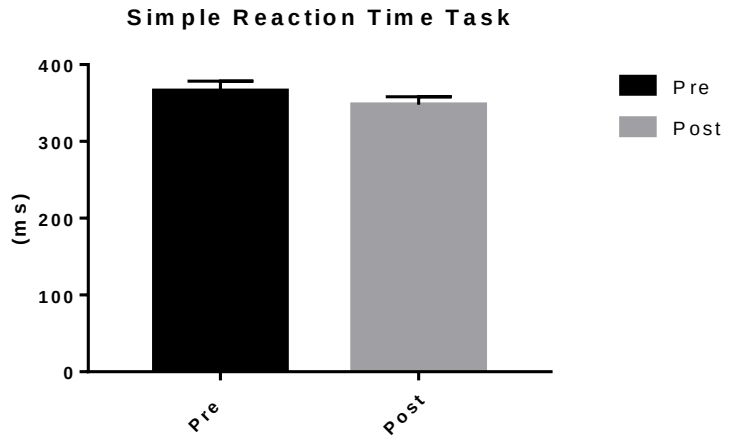
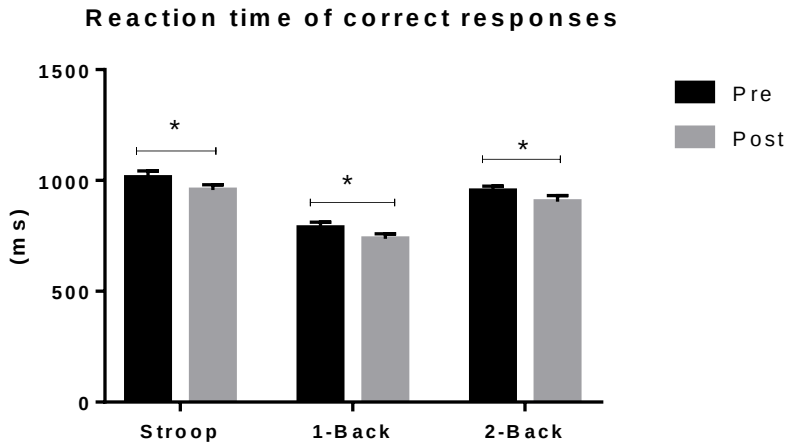


Figure 4 Reaction time of correct responses while doing Stroop, 1-back and 2-back pre- and post-supplementation of Ajwa dates (mean ± SEM).



*significantly different at p <0.05 compared to baseline (pre)