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Effects of Daily Intake of Plant and Animal Oils on the Incidence of Depression in Adult Mice

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ABSTRACT

Background: Depression is a complicated disturbance affected by a collection of biological and environmental factors. The first aim of psychiatric studies is to recognize biological markers that could be utilized to predict improvement and increase reactions to antidepressant treatments. Diet affects different aspects of health, including depression. The aim of study was to determine antidepressant-like effects of some consumable oils, the effects of oils on depression were compared. **Methods:** Thirty-two male and female mice (Mus musculus (BALB/c)) weighing 25- 35 g were randomly divided into 8 groups (4 mice in each group, 2 male and 2 female, A: Laden sunflower liquid oil, B: 50% vegetable oil + 50% olive oil, C: Kermanshah Rojin animal oil, D: Spring frying oil, E: Distilled water, F: BAHAR solid vegetable oil, G: Olive oil, H: 50% Kermanshah animal oil + 50% of olive oil). In different groups, 30 g of vegetable or animal oil was gavaged every day at 1:00 pm. Five types of vegetable and animal oils among the high consumption oils in the market were selected, including spring frying oil (used for several times in 305˚f, usually used in eastern Asia countries), Laden sunflower liquid oil, olive oil, Kermanshah Rojin animal oil, and BAHAR solid vegetable oil. After 6 weeks of using the oils diet, the forced swim test was utilized as a test of depression like behavior. **Results:** There was a significant difference between all groups ($P < 0.0001$). Based on the results, the latency time of immobility in group A significantly decreased in comparison with groups C ($P < 0.02$), D ($P < 0.003$), and G ($P < 0.001$). However, it increased in groups B and C compared to group H ($P < 0.02$). Also, this parameter in group D increased significantly compared to groups E ($P < 0.01$), F ($P < 0.05$), and H ($P < 0.002$). **Conclusion:** The results indicated that olive oil had a preventive effect against forced swimming-induced depression-like symptoms.

Keywords: *Animal oils; Depression; Forced swim test; Immobility*

Introduction

Depression is the most common mood disorder; it is the major cause of disability and premature death worldwide (Hiraki *et al.*, 2019, Ritter *et al.*, 2020, Saki *et al.*, 2014,

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Sánchez-Vidaña *et al.*, 2019, Shinohara *et al.*, 2013). According to the World Health Organization (WHO) report, approximately 450 million people suffer from a mental or behavioral disorder, and only a small minority of patients receive the basic treatment (Brundtland, 2001). Clinical depression is a brain-based illness involving the prefrontal cortex as well as other key brain regions (George *et al.*, 1994). Findings suggest that dietary fat type affects the behavioral signs of anxiety fairly rapidly (Mizunoya *et al.*, 2013). Obesity and high fat diet (HFD) have been linked to depression, with both epidemiological and clinical studies, demonstrating a positive association between these two disorders (Vagena *et al.*, 2019). HFD can also affect hypothalamus, neuronal plasticity and connectivity, reducing dendritic spine density and decreasing synaptic markers in the prefrontal cortex (Bocarsly *et al.*, 2015). Emerging research has established an association between omega-3 fatty acids (alpha-linolenic, eicosapentaenoic, and docosahexaenoic) and major depressive disorder (Freeman, 2009). Evidence from epidemiological, laboratory, and clinical studies have suggested that dietary lipids and other associated nutritional factors may affect vulnerability and outcome in depressive disorders (Logan, 2004). There are two kinds of edible oil, including vegetable oil (such as olive oil, sunflower oil, solid vegetable oil) and animal oil (such as Kermanshah animal oil).

The forced swim test (FST) was a rodent behavioral test used for evaluating depression (Yankelevitch-Yahav *et al.*, 2015). Mice were placed in an inescapable transparent tank filled with water and their escape related mobility behavior was measured. The FST was straight forward to conduct reliably, requiring minimal specialized equipment. Successful implementation of the FST required adherence to certain procedural details and minimization of unwarranted stress to the mice. The protocol description explained how to conduct the mouse version of this test with emphasis on potential pitfalls that may be detrimental to the interpretation of results and how to avoid them. Additionally, the way of assessing the manifested behaviors in the test were explained (Can *et al.*, 2012, Hassan *et al.*, 2019, Ruanpang *et al.*, 2018, Takase *et al.*, 2016).

In this study, the types of liquid sunflower oil, spring frying oil, olive oil, vegetable solid oil, and animal oil of Kermanshah were separately studied.

Materials and Method

Selection of edible oil: Five types of vegetable and animal oils were selected which were among the most widely used oils in the market, including spring frying oil, Laden sunflower liquid oil, olive oil, Kermanshah Rojin animal oil , and BAHAR solid vegetable oil (Table1) (Orsavova *et al.*, 2015).

Animals and experimental diets: Thirty-two male and female mice (Mus musculus (BALB/c)) weighing 25-35 g were randomly divided into 8 groups (4 mice in each group, 2 male and 2 female). The mice were housed under controlled conditions of temperature (27°C), relative humidity (60–40 ± 10%), lighting (12-hour light-dark cycles), and well-ventilated. After two weeks of standardization with the same nutrition in all groups (soybeans and corn regime daily), they were fed 100 mg of cheese and 5 g of cucumber every other day. In different groups, 30 g of vegetable or animal oil was gavaged every day at 1:00 pm:

A: Laden sunflower liquid oil
B: 50% vegetable oil + 50% olive oil
C: Kermanshah Rojin animal oil
D: Spring frying oil
E: Distilled water
F: BAHAR solid vegetable oil
G: Olive oil
H: 50% Kermanshah animal oil + 50% of olive oil

Behavioral test; FST: After 6 weeks of using the oils diet, the forced swim test was conducted according to the study ethical rules, especially ethical code No. 5014/710 / D dated 11/23/2015 as a standard of FST rules. Among all animal models, the FST is one of the most widely used tools for screening antidepressants (Kulkarni and Dhir, 2007).

The forced swim aperture is a cylindrical container with a length of 25 cm and width of 12 cm and a height of 8 cm filled with 25 °C water. At the beginning, the mouse was placed in the water at a height of 20 cm. Cutting off the movement of the mouse's hands and feet is typically considered the mouse immobility.

The total FST time was 10 minutes, the first two minutes was the time when the mouse adapt to the environment and no data was recorded. After two minutes of testing, the time of 10 minutes was divided into two five-minute periods and the animal's movements were recorded with an accurate chronometer. During 5 minutes, swimming (score=1), immobilization (score=0), and trying to climb (score=2) were recorded every 15 seconds.

Ethical considerations: Ethical committee of Shahid Beheshti University of Medical Sciences approved this study (approval number: IR.SBMU.REC.1398.109).

Data analysis: The data were expressed as the mean ± standard deviation (SD). Comparisons among groups were performed by one-way ANOVA, followed by a Tukey's HSD post-hoc and multiple comparison tests, when appropriate. A P-value of < 0.05 was considered to be significant.

Results

Latency of immobility: There was a significant difference between all the study groups (P < 0.0001). Based on the results, the latency time of immobility in group A significantly decreased in comparison with groups C (P < 0.02), D (P < 0.003), and G (P <0.001). However, it increased in groups B and C compared to group H (P < 0.02). Also, this parameter significantly increased in group D compared to groups E (P < 0.01), F (P < 0.05), and H (P < 0.002). In addition, groups E and F showed a significant decrease compared to group G (P < 0.001) (**Figure 1**). The highest amount of Latency of immobility was seen in the group consuming olive oil and the lowest value was seen in the group consuming Laden sunflower liquid oil.

Total immobility time: The data showed that total immobility in groups B (P < 0.004), D (P < 0.04), F (P < 0.002), G (P < 0.001), and H (P < 0.006) compared to group A decreased. There were no differences between other comparisons. The lowest amount belonged to the group receiving olive oil and the highest value was seen in the group consuming Laden sunflower liquid oil (**Figure 2**).

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Table 1. Fatty acids composition of tested oils.

FAs [%]	SAF	GRP	SIL	HMP	SFL	WHG	PMS	SES	RB	ALM	RPS	PNT	OL	COC
C6:0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.52
C8:0	nd	0.01	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	7.6
C10:0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.01	nd	nd	5.5
C12:0	nd	0.01	0.01	nd	0.02	0.07	nd	nd	nd	0.09	nd	nd	nd	47.7
C14:0	0.10	0.05	0.09	0.07	0.09	nd	0.17	nd	0.39	0.07	nd	0.04	nd	19.9
C15:0	nd	0.01	0.02	nd	nd	0.04	nd	nd	nd	nd	0.02	nd	nd	nd
C16:0	6.7	6.6	7.9	6.4	6.2	17.4	13.1	9.7	20.0	6.8	4.6	7.5	16.5	nd
C17:0	0.04	0.06	0.06	0.05	0.02	0.03	0.13	nd	nd	0.05	0.04	0.07	nd	nd
C18:0	2.4	3.5	4.5	2.6	2.8	0.7	5.7	6.5	2.1	2.3	1.7	2.1	2.3	2.7
C20:0	nd	0.16	2.6	nd	0.21	nd	0.47	0.63	nd	0.09	nd	1.01	0.43	nd
C22:0	nd	nd	nd	nd	nd	nd	nd	0.14	nd	nd	nd	nd	0.15	nd
C16:1 (n-7)	0.08	0.08	0.05	0.11	0.12	0.21	0.12	0.11	0.19	0.53	0.21	0.07	1.8	nd
C17:1 (n-7)	nd	nd	0.03	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
C18:1cis (n-9)	11.5	14.3	20.4	11.5	28.0	12.7	24.9	41.5	42.7	67.2	63.3	71.1	66.4	6.2
C18:1trans (n-9)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.14	nd	nd	nd
C20:1(n-9)	nd	0.40	0.15	16.5	0.18	7.91	1.08	0.32	1.11	0.16	9.1	nd	0.30	nd
C18:2cis (n-6)	79.0	74.7	63.3	59.4	62.2	59.7	54.2	40.9	33.1	22.8	19.6	18.2	16.4	1.6
C18:3 (n-3)	0.15	0.15	0.88	0.36	0.16	1.2	0.12	0.21	0.45	nd	1.2	nd	1.6	nd
C18:3 (n-6)	nd	nd	nd	3.0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
SFAs	9.3	10.4	15.1	9.2	9.4	18.2	19.6	16.9	22.5	9.3	6.3	10.7	19.4	92.1
MUFAs	11.6	14.8	20.7	28.1	28.3	20.9	26.1	42.0	44.0	67.9	72.8	71.1	68.2	6.2
PUFAs	79.1	74.9	64.2	62.8	62.4	61.0	54.3	41.2	33.6	22.8	20.9	18.2	18.0	1.6
n-3 PUFAs	0.2	0.2	0.9	0.4	0.2	1.2	0.1	0.2	0.5	0.0	1.2	0.0	1.6	0.0
n-6 PUFAs	79.0	74.7	63.3	62.4	62.2	59.7	54.2	40.9	33.1	22.8	19.6	18.2	16.4	1.6

[1] Data are expressed as percentages of total fatty acid methyl esters (FAMEs); nd means that FAs was not determined. Abbreviations of the samples mean: SAF—safflower, GRP—grape, SIL—*silybum marianum*, HMP—hemp, SFL—sunflower, WHG—wheat germ, PMS—pumpkin seed, SES—sesame, RB—rice bran, ALM—almond, RPS—rapeseed, PNT—peanut, OL—olive, and COC—coconut oils.

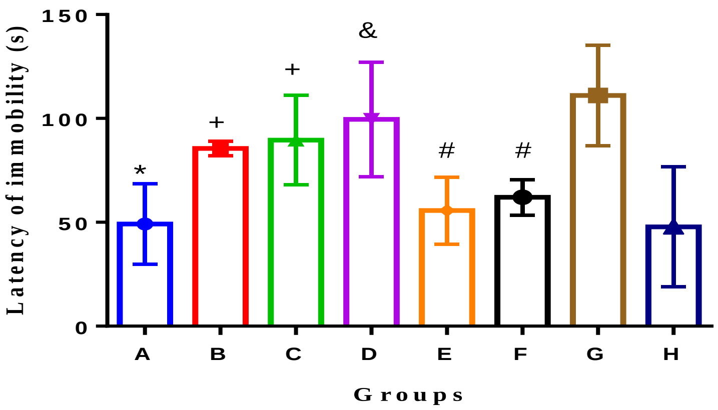

Figure 1. Mean ± SD of latency of immobility time between the experimental groups. * Group A vs. groups C ($P < 0.02$), D ($P < 0.003$), G ($P < 0.001$). + Groups B and C vs. group H ($P < 0.02$). & group D vs. groups E ($P < 0.01$), F ($P < 0.05$), and H ($P < 0.002$). # groups E and F vs. group G ($P < 0.001$).

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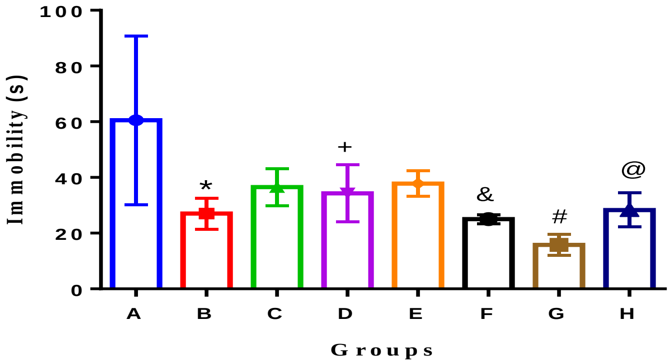

Figure 2. Mean ± SD of immobility time between the experimental groups, groups B, D, F, G, and H decreased significantly in comparison with group A; * B vs. A 24 ($P < 0.004$), + D vs. A ($P < 0.04$), & F vs. A ($P < 0.002$), # G vs. A ($P < 0.001$), and @ H vs. A ($P < 0.006$).

Discussion

Diet is an environmental factor with high ability to affect the brain and behavior in both positive and negative ways. Research in the field of animals is essential to discovery this correlation and how it may be beneficial to mental health in humans. One of the most investigated challenges is whether diet, specifically a HFD, which can mutate behavior in tasks, such as the FST, that recognize stress confronting.

Previous studies have demonstrated that diet rich in processed meats, sugary foods, and high-fat dairy products is associated with an increased risk for depression (Akbaraly *et al.*, 2009).

Men who utilized a diet with high processed meats, fried food, and carbohydrates had more incidence of symptoms of depression (Le Port *et al.*, 2012). Longitudinal studies have shown that women who consume a high sugar diet have more prevalence of depression (Gangwisch *et al.*, 2015).

The FST is known as a test of depression like behavior in order to improve the research regarding novel antidepressant pharmacotherapies. The test was based on this finding that rodents, upon being placed in water from which they cannot escape, will eventually stop swimming and become immobile. To perform the FST, a rodent was placed in a container of water deep enough that the animal cannot touch the bottom. The duration of the test and number of exposures per animal varies. The rodent's activity during the test was scored as swimming, climbing, or floating. The amount of time spent performing each of the three activities was calculated and latency for the first episode of immobility was also recorded (in some studies). A variety of different factors can lead to more-active (swimming and climbing) or more-passive (floating) coping. These factors can include both experimental variables, such as diet, sex, drugs, or stress, as well as those incidental to the laboratory environment, such as handling experience, swim tank dimensions, water temperature, time of day, and time of year (Biselli *et al.*, 2021, De Kloet and Molendijk, 2016, Hashimoto *et al.*, 2006, Larrieu and Layé, 2018, Lloyd and Reyes, 2020, Petit-Demouliere *et al.*, 2005).

Sanchez-Vidana et al. (2019) demonstrated that lavender essential oil ameliorates depression-like behavior and increases neurogenesis and dendritic complexity in rats (Sánchez-Vidaña *et al.*, 2019).

The present study demonstrated that the intake of a diet containing olive oil during exposure to chronic forced swim stress induced an apparent preventive antidepressant-like effect and alleviated the stress. This study revealed the antidepressant effect of olive oil consumption. Indeed, among these oils, olive oil consumption was accompanied with the significant reduction of immobility time, while the most immobility time was related to laden sunflower liquid oil consumption.

Also, consuming BAHAR solid vegetable oil, 50% vegetable oil + 50% olive oil, 50%

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Kermanshah animal oil + 50% of olive oil had more effect on immobility time reduction than Kermanshah Rojin animal oil and spring frying oil.

Conclusion

The present study revealed that the daily consumption of olive oil in diet can prevent the stress-induced signs of depression in mice. The study also indicated that olive oil would be an appropriate and beneficial food supplement to retain the brain healthy without depression.

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Authors' contributions

Teymourian H, Ashrafi F and Behnaz B participated in analysis, preparing the concept and design. Azizi Faresani H and Rezaee-Tazangi F included in data collection and manuscript writing. Sotoudeh N and Taghizabet N assisted in data collection. Mohseni G was responsible for supervision and protocol development.

Conflict of interest statement

The authors declare no conflict of interest.

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