# Effect of Yoghurt and Spirulina-Enriched Ice Cream on Serotonin Levels in Alloxan-Induced Diabetic Male Rats

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**Abstract:**
The study sought to evaluate the effects of yoghurt and ice cream with spirulina on the level of serotonin hormone in male rats with diabetes induced by Alloxan. The experiment consisted of 20 rats, divided into four groups: a healthy control group, an untreated diabetes group, and two groups that received Spirulina-Fortified Nutritional Treatment, which were verbally administered. The results indicated that the group treated with yoghurt enriched with 1.5% spirulina, showed a significant increase in serotonin levels compared to other groups, followed by the group that received ice cream fortified with 2% spirulina. This improvement is responsible for the high content of the amino acid tryptophane in Spirulina, which serves as a precursor for serotonin synthesis. Additionally, Spirulina is rich in antioxidants that help reduce oxidative stress associated with type 2 diabetes. In contrast, the untreated diabetic group showed the lowest serotonin levels, highlighting the harmful effects of diabetes on the nerve balance. The findings of this study underline the ability of spirulina-rich foods as a promising approach to increase neurological and psychological health in individuals of diabetes. The study recommends further research to detect the detailed mechanism of action and determine the optimal dose to ensure maximum therapeutic benefits from these functional food products.

## .1Introduction:

Serotonin, also known as a 5-hydroxitriptamine (5-HT), is a monoamine neurotransmitter found in the central nervous system. Its biosynthesis depends on the availability of essential amino acids tryptophane, which cannot be produced endogenously by the body and must be obtained through the diet. Serotonin is secreted in the central nervous system, where it acts as a chemical transmitter between neurons, which contributes to the regulation of mood, feelings, hunger, sleep, waking cycles and memory [1]. Serotonin includes stress, aggression, and emotions such as anger and fear, as well as sexual pleasure, pain regulation and its role in the feeling of body temperature control [2]. The role of serotonin in regulating these aspects of life makes it important for the good of mice, and the findings of the study can create sympathy in the audience towards the position of mice. At the peripheral level, serotonin also acts as a topical hormone that affects many organs; For example, more than 90% of the body's total serotonin is produced in the digestive system cells, which control intestinal movements and secretions. [1] A balanced level of serotonin has several health benefits, including maintaining a positive mood and psychological stability, improving hunger and digestion, ensuring regular healthy sleep and supporting metabolism and energy processes in the body. [2] It leads to an imbalance in the

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level of serotonin in the body, leading to a broad spectrum of health disorders. Low serotonin concentration is closely combined with mood disorders, such as depression and anxiety disorder [3]. Symptoms of serotonin deficiency include depressed mood, excessive anxiety, sleep disturbances, memory loss and impulsive behavior [3]. In contrast, excessive serotonin can be serotonin syndrome, which is characterized by mental confusion and rapid heartbeat. [1[

Recent research has shown that serotonin system dysfunction may be associated with the development of diabetes complications, both central and peripheral serotonin contribute to blood sugar regulation and affect [4]. People with diabetes were found to have lower serotonin levels than healthy people [5]. Animal studies have also shown that mice with diabetes by Indian Alloxan experienced a significant decrease in serotonin levels [6] Problems with the current research and treatment method are the low level of serotonergic produced by Indian alloxan e, which damages insulin-produced beta cells [4]. Since low serotonin is associated with many psychological and neurological complications, current research will use curd and ice cream with spirulina in specific proportions as a natural dietary method to increase serotonin levels. The importance of this study is to detect natural nutritional solutions to support neurological and psychological health of people with diabetes by increasing the level of serotonin by consuming foods that are composed with spirulina, which is rich in essential amino acids such as Tryptophan, which is a foretold to the production of serotonin [7], [8.[

.2Objective of the study:

This study aims to determine the effect of eating spirulina-fortified yoghurt and ice cream on serotonergic levels in male rats with alloxan-induced diabetes, as stated in the way ice cream is made [9.[

.3Materials and Methods:

Males used white rats of the Albino type at the age of 10-12 weeks, may weigh 150-200 g, and has been used in this biological experiment; 20 male rats were equipped from the animal house of the Faculty of Veterinary Medicine - University of Tikrit, was conducted medical tests by the veterinarian specialized in the center to ensure its health and safety and free of any disease before use in the study. Five male rats were isolated for standard treatment. The remaining 15 rats were then injected subcutaneously with Indian Oloxan to be infected with alloxan-induced diabetes that was present at the time of injection at a concentration of 100 mg/kg of the total body weight of the animal, as it was dissolved by 1 g of Alloxan in (10 ml .(

The substance of the physiological solution is Normal saline after stopping the food from the animals to starve them for a period of )12 hrs. (before injection, as stated in the method [10]. After the injection, she was immediately fed, and a 5% glucose solution was used as an alternative to drinking water for twenty-four hours in order to reduce the severity of shock after treatment with Alloxan [11]. The next day, we checked the random sugar level of all the rats that were injected with Alloxan by using the One Call Plus sugar screening device of Chinese origin in order to ensure that all of them were infected with the disease, after confirming the infection, the rats were distributed on eight plastic cages with a metal cover and a clip with dimensions (45, 28, 24) cm, after conducting a process of disinfection and sterilization of them with ethanol solution

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at a concentration of (70%) and the floor was covered with sawdust Which was changed up to twice a week and regularly, all plastic cages were placed in five infected rats other than the first and second cages in which the four uninfected and untreated infected animals were placed as a control group, and this group was fed on the standard diet, after which labels were placed on each cage in which the group number and type of transaction were mentioned, and all groups were provided with water and fed with the specific diet for each treatment throughout the duration of the 28-day experiment, and The follow-ups carried out under the supervision of me as well as the competent person in the animal house until the completion of the experiment.

3.1Division of the animal:

In this study, 20 male rats were used, divided equally into four groups, each of which included five rats.

- Group No. (1) is the proper control group 5 rats
- Group No. (2) is the control group infected with five rats
- Group (3) is the infected group treated with yoghurt and spirulina by 1.5% of five rats
- Group No. (2) is the group infected and treated with ice cream and spirulina by 2% of five rats

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3.Estimation of the percentage of serotonin:

The level of serotonin was estimated according to the method he developed [14.[

3.4Statistical analysis:

According to a fully random design, statistical analysis of data was done using the prepared statistical program [15]. CRD) The average of the coefficient was compared to Duncans multi-range test [16], the purpose of which was to determine the significant difference between the average of factors studied on the importance level ($P \leq 0.05$.(

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3.2Drawing blood samples after the expiry of the period:

Compulsory fasting was enforced on the animals for a duration of 12 hours. Following this, the final weight was recorded, chloroform ether was administered, and 10 ml blood samples were collected from each animal directly from the eye in a scientific and controlled manner, as per the time specified by the researcher.[12], blood samples were drawn using 5 ml wine syringes. After 28 days of mice infection with diabetes and after feeding on yoghurt, spirulina, and ice cream, 2 ml was collected in special tubes containing anticoagulant potassium EDTA for blood studies. The part which was placed in plastic tubes free from the anticoagulant plan tube, and to obtain sufficient amount of blood serum, was separated in centrifuge at a speed of 3000 rpm for 15 minutes; A micropipette separated the erythrocyte-free serum. The serum was divided into several clean and sterile tubes. It was kept in cold at 20 ° C at the laboratory freezer at the laboratory freezer for a purpose of conducting a serotonergic test. As stated in the method [13.[

3.5Results and Discussions:

The results of the statistical analysis of serotonin levels in Table (1) showed clear significant differences between the studied coefficients. The proper control group (A) recorded the highest average of (22.88 a), while the group infected and treated with also

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fortified with 1.5% spirulina, The control group with untreated diabetes (B) had the lowest average serotonergic hormone (12.64 C). Plants below the average indicate the actual significant difference between the groups, according to the multi-range test of Duncan at the significance level (P <0.05

**Table (1) shows the statistical analysis of serotonin in blood serum(.**

| Variables | Sample group |
|---|---|
| **22.88 a** | **A** |
| **12.64 c** | **B** |
| **22.64 b** | **AB1.5** |
| **20.78 b** | **AB2** |

The significant increase in serotonin levels in groups fed with spirulina-fortified products of also and ice cream is also attributed to the high levels of spirulina's amino acid tryptophane, which is the building block for the manufacture of serotonin within the body, as shown by several studies [1] [7]. Powerful antioxidants in Spirulina play an additional role in reducing oxidative stress, which contributes to improving the physical environment required for serotonin production [17]. In addition, previous results have proved that fermented milk products, such as yoghurt, contribute to an increase in the use of compounds and better absorption of essential amino acids [18]. This can explain why the level of serotonin in the curd group is much higher than the ice cream group. In contrast, the decrease in serotonin concentration in untreated affected groups was the destruction of pancreatic cells and an estimated result of the dissolution of neurological and hormonal routes caused by Alloxan -induced diabetes, indicated by [19] [20.[

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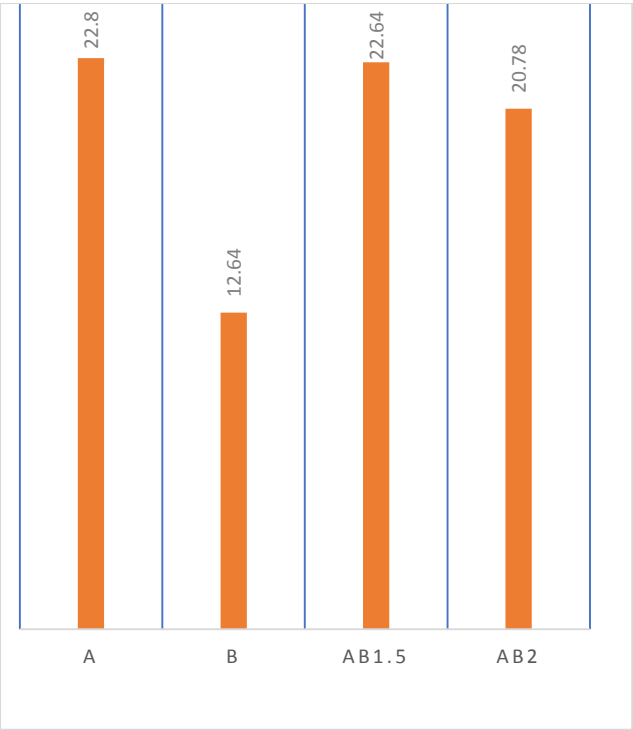


**Figure (1) The serotonin hormone diagram**

It can be concluded that fortifying food products with spirulina effectively contributes to improving the neurological status of people with diabetes by supporting serotonin synthesis pathways, which supports the future trend towards relying on functional foods as a support in the management of chronic diseases and improving the quality of life.

**3.6Conclusions:**

.1 The results of the study showed that yoghurt with Spirulina effectively raised the level of hormone serotonin in diabetic mice as compared to other groups, which reflects the effectiveness of this functional food in improving the nerve state.

.2Spirulina-fortified ice cream also increased serotonin levels but to some extent compared to yogurt. This indicates that the type of food product and the way it is manufactured can affect the efficiency of absorption and use of active compounds.

.3The results confirmed that the incidence of siloxane-inspired diabetes led to a significant decrease in hormone serotonin levels, which highlights the severity of the effect of diabetes on mental and nervous health.

.4The results suggest that Spirulina plays an important role in promoting serotonin synthesis and reducing the effects of diabetes - related oxidative stress, thanks to its amino acid Tryptophan and antioxidants.

.5The results of the study support the tendency to use spirulina-Fortified foods as a natural food supplement to improve the quality of life in diabetic patients by increasing the level of hormone serotonin and strengthening neurological functions.

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[1]

Kanova, M., & Kohout, P. (2021). Serotonin—its synthesis and roles in the healthy and the critically ill. International Journal of Molecular Sciences, 22(9), 4837.

[2]Shajib, M. S., & Khan, W. I. (2015). The role of serotonin and its receptors in activation of immune responses and inflammation. Acta Physiologica, 213(3), 561–574.

[3] John, C. N., Dieterich, A., Maita, I., Boley, A. M., Rios, M., & Samuels, B. A. (2017). The role of 5-HT receptors in depression. Molecular Brain, 10(1), 28 .

[4]Cai, Y., Ma, J., Sun, Z., Han, X., & Jiang, X. (2022). The serotonergic system dysfunction in diabetes mellitus. Frontiers in Cellular Neuroscience, 16, 899069 .

[5]Gupta, D., Radhakrishnan, M., Kurhe, Y., & Gupta, R. (2014). Ondansetron, a 5-$HT_3$ receptor antagonist, reverses depression and anxiety-like behavior in streptozotocin-induced diabetic mice: Possible implication of serotonergic system. European Journal of Pharmacology, 744, 59–66 .

[6]Cicin-Sain, L., & Jernej, B. (1996). Reduction of gastrointestinal serotonin in alloxan-diabetic rats: Reversal by 5-hydroxytryptophan treatment. Behavioural Brain Research, 73(1–2), 285–288. https://doi.org/10.1016/0166-4328(95)00154-9

[7]Demelash, S. (2018). Spirulina as a primary source of tryptophan for mental illness: Improving the level of serotonin through tryptophan supplementation. Global Journal of Medicine and Public Health, 7(2), 1–6.

[8]El-Sherbiny Atya, A. A., Ahmed, M. M., Soliman, S. M., & Mansour, H. A. (2023). The mechanism of action of spirulina as antidiabetic: A narrative review. Italian Journal of Medicine, 17(2), 1–8.

[9]Hussein, F. F., & Fadhil, N. J. (2017). Manufacture ice cream from camel milk with inulin and study its processing, sensory, and therapeutic properties. Tikrit Journal for Agricultural Sciences, 17 (Proceedings of the Sixth Scientific Conference of Agricultural Sciences.(

[10]Owoyele, B. V., Negedu, M. N., Akanji, M. A., & Olatunji, S. Y. (2005). Analgesic and anti-inflammatory properties of honey: A review. African Journal of Traditional, Complementary and Alternative Medicines, 2(2), 209–214 .

| [11]Kavy, S., & Kabih, S. (2018). Inducing diabetes with aloxan in rats: a practical approach. Journal of Empirical Research, 6(2), 89–95.

[12]Jamil, M. A., & Mustafa, A. A. (2025, February). The Effectiveness of Therapeutic Feeding with Omega-3 and Silymarin on Male Rats with Induced Diabetes. In IOP Conference Series: Earth and Environmental Science (Vol. 1449, No. 1, p. 012159). IOP Publishing.

[13]Parasuraman, S., Raveendran, R., & Kesavan, R. (2010). Blood sample collection in small laboratory animals: A review. Journal of Pharmacology & Pharmacotherapeutics, 1(2), 87–93 .

[14]Thomas, S., Varkey, J., & Augustine, L. F. (2014). A review of the role of spirulina in the management of diabetes mellitus. Journal of Diabetes & Metabolism, 5(4), 1–5 .

[15]SAS Institute Inc. (2012). SAS/STAT® 9.3 User's Guide. Cary, NC: SAS Institute Inc.

[16]Duncan, D. B. (1955). Multiple range and multiple F tests. Biometrics, 11(1), 1–42 .

[17]El-Sherbiny Ateya, A. M., Abdel-Razek, A. G., El-Beltagy, A. E., & El-Metwally, M. M. (2023). Physicochemical and microbiological evaluation of yoghurt

enriched with Spirulina platensis. Journal of Food and Dairy Sciences, 14(2), 101–109.

[18]Barkallah, M., Dammak, M., Louati, I., Hentati, F., Hachicha, R., Bayoudh, A., ... & Fendri, I. (2017). Effect of Spirulina platensis fortification on physicochemical, microbiological, and sensory properties of yoghurt during cold storage. Innovative Romanian Food Biotechnology, 21, 33–45.

[19]Cai, M., Lin, Y., Luo, Y., Wang, Y., & Li, D. (2022). Effect of Spirulina platensis addition on the quality and antioxidant properties of set-type yoghurt during refrigerated storage. LWT - Food Science and Technology, 155, 112966 .

[20]Cicin-Sain, L., & Jernej, M. (1996). Marine biotechnology and developing countries. Technology in Society, 18(3), 295–312

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