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The Impact of Spirulina Supplementation on Iraqi Obese Females: A Cohort Study

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ABSTRACT: ***Background:*** *Spirulina, a type of blue-green algae, has been recognized for its dense nutritional profile and purported health benefits. Furthermore, the effects of spirulina on individuals who are obese have been a subject of interest in scientific research.* ***Objective:*** *This study was to examine the impact of spirulina supplements on obese females in the Iraq population. The research adopted related treatments in cohort study design utilizing spirulina.* ***Methods:*** *The seventy-five obese female participants aged between 25-55 years were administered spirulina supplements for eight months. Cholesterol, triglyceride, High density lipid (HDL), Risk-1, Risk-2, Thyroid stimulated hormones (TSH), and hemoglobin-A1c (HBA1c) were examined before and after administering the supplements.* ***Results:*** *The current study revealed a significant effect on levels of all parameters. Specifically, cholesterol, very low-density lipid (VLDL), and Risk were significantly decreased in their levels, with a reduction of the body mass index (BMI) in the obese females after administration. However, the level of HBA1c and TSH slightly decreased after the spirulina. According to HDL was increased level after administration of spirulina in obese females compared to before.* ***Conclusions:*** *Spirulina could be considered a good supplement to increase the metabolism of the body and decrease BMI with improved health.*

KEYWORDS: *Obesity; Spirulina; Lipid; HbA1c; TSH*

INTRODUCTION

Humans have been consuming microalgae for centuries, with Spirulina being harvested from Lake Texcoco and sold in Tenochtitlan (now Mexico City) as far back as the sixteenth century [1], [2]. However, spirulina, a cyanobacteria known as blue-green algae, is among the oldest organisms on Earth [3]. This organism thrives in freshwater and marine environments and is recognized for its abundant protein and vitamin levels. Current literature indicates that spirulina was found to effectively reduce body fat, waist circumference, body mass index, and hunger. Additionally, it has shown considerable benefits in decreasing blood lipids [4]–[6].

Today, microalgae are increasingly included in various food products, often for marketing purposes or as coloring agents [7]. However, Spirulina and its derivatives have shown promise as ingredients for developing new functional foods, a leading trend in the food industry [4]–[6]. Several human intervention studies have highlighted Spirulina's potential in preventing or treating metabolic syndrome-related disorders [8]–[10].

Several studies have found that although Spirulina's proteins have similar caloric values to carbohydrates, their synthesis requires more energy/ATP, leading to a decrease in the biomass's protein

content when phosphorus is limited [11]. Spirulina is renowned for its high protein content, which has made it particularly well-known among average consumers. Numerous food products enriched with Spirulina-derived proteins are currently on the market [12]. Spirulina boasts one of the highest protein contents ever recorded, along with a high concentration of essential amino acids as defined by the FAO and World Health Organization's composition of an "ideal" protein. Under optimal conditions, Spirulina's protein content can reach up to 70% on a dry weight basis [13].

Spirulina is an affordable nutritional supplement that has not been shown to cause any significant side effects. With the increasing prevalence of metabolic syndrome, dyslipidemia and obesity are key factors in its development. While many supplements are being studied for their lipid-lowering and weight loss effects, spirulina offers additional benefits, including antiviral, anticancer, antioxidant, antidiabetic, anti-inflammatory, hepatoprotective, cardioprotective, and immunity-boosting properties [14], [15].

Spirulina, a rich source of nutrients found in blue-green algae and packed with antioxidants, has gained popularity for its potential health benefits [16]. Several studies suggested that incorporating spirulina into one's diet could provide various healthy advantages such as its antioxidant, anti-inflammatory, and immune modulating properties [17]–[19]. However, there is limited understanding of how spirulina might impact on BMI of obese females [20]. Furthermore, Spirulina was first categorized as part of the plant kingdom because of its abundant plant pigments and capability to undergo photosynthesis. However, it was subsequently reclassified into the bacterial kingdom (cyanobacteria) based on its genetic, physiological, and biochemical characteristics [4]–[6], [21].

This study aims to investigate the impact of spirulina food supplements on the body mass index of obese females in the Iraq population. Additionally, we seek to enhance the current understanding of potential health advantages associated with spirulina consumption and its effect on patient outcomes by examining various laboratory parameters before and after spirulina supplementation Laboratory testing, including triglycerides, HDL cholesterol, total cholesterol, TSH, and HbA1c, are crucial for identifying and tracking different medical disorders.

MATERIALS AND METHODS

This study is the first that will use a before-and-after treatment design to investigate the effects of Spirulina supplementation on biomarkers in Iraqi women with obesity. An eight-month-long (pre-and post-supplementation study) was conducted to reflect on alterations in laboratory parameters for 75 female patients who took Spirulina supplements. We had a random sample 75 of female subjects aged 25-55 years with obesity but were in good health. The study was conducted in Baghdad, Iraq, specifically at the Health Diet Center for Nutrition and Beauty. Obesity was determined based on a body mass index (BMI) higher than 30 kg/m^2. The protocol utilized was the one provided in the box from Now company, which recommends taking two capsules daily, each containing 500 mg of green food.

Intervention: Every subject received eight months of Spirulina supplements. The amount and method of Spirulina administration were unchanged throughout the experiment in a bid to ensure consistency of intervention. Regularity of the Spirulina routine during the entire duration of the intervention was monitored.

Outcome Measures: Some laboratory parameters such as triglycerides, HDL cholesterol, total cholesterol, TSH levels, and HbA1c. First, blood samples were collected from all subjects before Spirulina supplements and then in a separate experiment conducted for 2 months to investigate the effects of this supplement. The laboratory analysis was performed under a sensitive condition, using reliable protocols to prevent errors and ensure quality. All items tested were supported by Roch company, Germany.

RESULTS AND DISCUSSION

Our study enrolled that 75-patient investigation of the effects of Spirulina supplementation for up to 8 months on some selected laboratory measurements, which revealed that the patients showed sudden changes towards better metabolic health and thyroid function. We found a consistent decrease in triglyceride levels, that was significantly below the initial measurement. On completing the Spirulina intervention for an eight-month duration, a clear increase in HDL cholesterol levels could be demonstrated, with high statistical significance ($p<0.001$). The Spirulina supplementation led to a significant decrease in total cholesterol levels as compared to the initial levels, the t-test revealed a significant difference between pre and post-therapy values ($p=0.002$), as shown in Table 1

Table 1. Comparison between before and after obese females treated by Spirulina supplementation

Lipid profiles	**Before**	**After**	***P-value***
	Mean ±SE		
Cholesterol(mg/ml)	205.2±5.0	179.6±4.1	0.001
Triglyceride (mg/ml)	375.2±10.9	237.3±7.0	
HDL (mg/ml)	38.6±1.2	49.7±1.2	
VLDL (mg/ml)	125.1±2.5	79.1±3.4	
LDL (mg/ml)	41.4±1.2	50.8±2.3	
Risk-1	6.3±1.0	4.2±0.9	
Risk-2	10.5±1.1	5.6±1.3	

and Figure 1. Throughout the study period a decrease in thyroxine-stimulating hormone (TSH) levels after the therapy was observed, ($p = 0.009$). In addition, patients on Spirulina showed considerably lower levels of HbA1c compared to the baseline and control groups ($p<0.001$), thereby suggesting improved blood sugar management in the long run

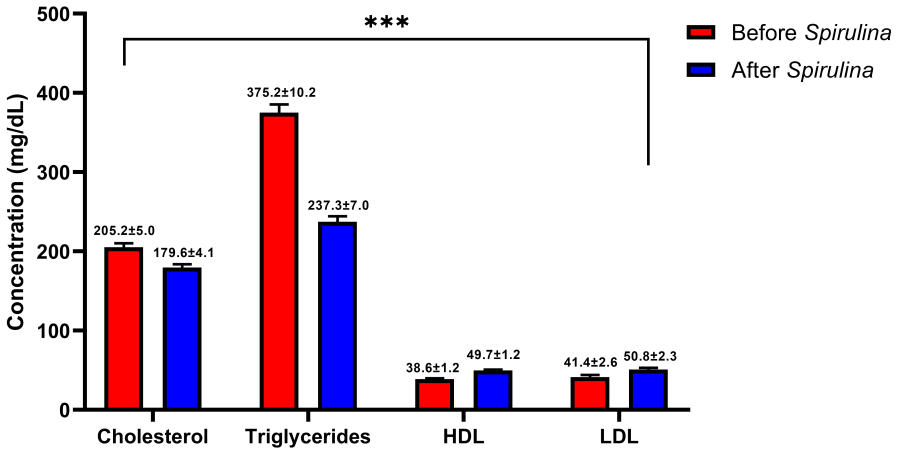

Figure 1. Comparison between lipid profile of patients and control group

Spirulina supplementation not only normalizes the levels of metabolic parameters like TG, HDL-C, Total-C, TSH, and HbA1c in local patients with metabolic disorders but also highlights the beneficial effects of Spirulina on these laboratory parameters.

The results investigating the effects of spirulina supplementation on body weight and hormone levels in obese females provide valuable insights into the potential therapeutic of spirulina and its effect on many laboratory parameters. The study presented data on lipid profiles, HBA1c, TSH, and their descriptive statistics, also comparisons before and after spirulina treatment, thus shedding light on the impact of spirulina on female health [22], [23].

Figure 2 compares body weight and BMI before and after spirulina treatment, providing a visual representation of the changes seen in response to supplementation. The results showed that spirulina may affect metabolic indices, overall health, and regulation of body weight in overweight women. Thus, spirulina displayed a potent therapeutic effect, which makes it an attractive supplementary therapy to achieve better metabolic health as well as to normalize the endocrine gland's function [24].

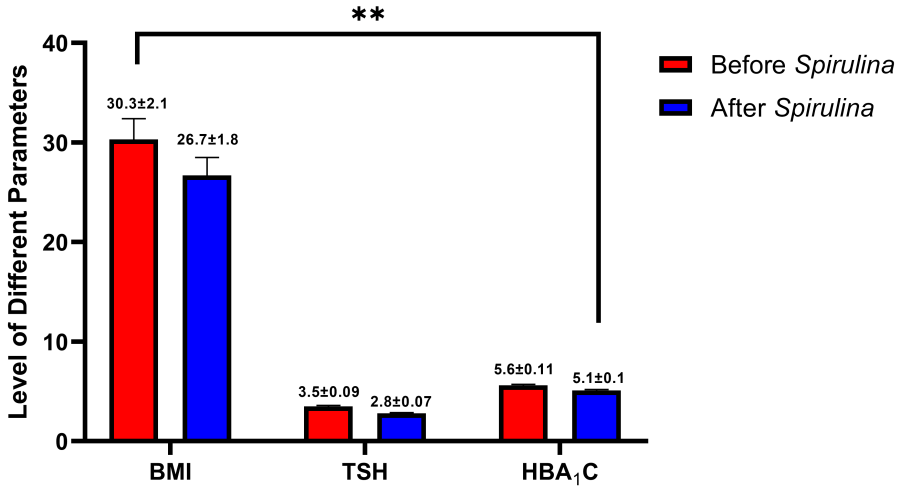

Figure 2. Levels of different parameters (ng/ml) in the study

Due to its high antioxidant content, spirulina aids in the fight against oxidative stress, a factor in the development of cholesterol plaques within the arteries. Low-density lipoprotein (LDL) cholesterol and triglyceride levels can be improved by using spirulina since it lowers oxidative stress. One fatty acid that spirulina has that may be good for the heart is gamma-linolenic acid (GLA). By influencing lipid metabolism, GLA can reduce liver production of triglycerides and low-density lipoprotein cholesterol. In addition to its distinctive blue-green hue, spirulina contains phycocyanin, a pigment that has been demonstrated to have a lipid-lowering impact. The levels of the so-called "bad" cholesterol (LDL), total cholesterol (TC), and triglycerides can all be decreased with the help of phytocyanin, while the levels of the so-called "good" cholesterol (HDL) can be increased [25], [26].

Table 1, and Figure 2 show improvements in lipid profiles after spirulina treatment, with reductions in Body mass index (BMI), body weight, and triglycerides, increases in HDL cholesterol, and overall favorable changes in cholesterol levels. These findings attribute to spirulina a potential role in regulating lipid metabolism and improving cardiovascular health. previously reported that spirulina is an effective means for improving blood lipid profile [27]. Additionally, the study found that spirulina may be a good supplement for type 2 diabetic patients [28]. In two study there are examined a group of elderly individuals who were in good health and had normal levels of blood glucose shortly after fasting [29]. The studies found a correlation between the consumption of spirulina supplements and a reduction in fasting blood glucose levels. However, another study found no decrease in fasting blood glucose levels among individuals with type 2 diabetes. Similar to the findings of the current investigation, they discovered that spirulina has a significant impact on controlling HBA1C levels and other lipids. The findings of this study align with previous research undertaken in many nations [30]–[32]. In a study conducted the levels of triglyceride, total cholesterol, and LDL-cholesterol in the serum of elderly Korean individuals were considerably decreased after a 24-week intervention with spirulina [33]. Similarly, research conducted on humans has shown a significant reduction in total cholesterol, LDL-cholesterol, and triglyceride levels. These findings are consistent with our observations. According to other research, spirulina's impact on lipoprotein metabolism may be the reason for its ability to reduce triglycerides [34]. When spirulina-treated rats were compared to those fed a high-fructose diet, the results indicated a noteworthy increase in lipoprotein lipase activity. Diabetes etiology may be significantly influenced by free radicals [35]–[37].

CONCLUSION

The results of this intervention study demonstrated that supplementing obese Iraqi women with Spirulina improved their metabolic and thyroid health. Thus, spirulina could be used to help treat metabolic disorders linked to obesity and ultimately improve thyroid function. These effects encompass lower triglycerides, higher HDL cholesterol, lower total cholesterol, lower TSH levels, and better control of HbA1c. Therefore, our findings support the concept that spirulina could be used as a supplement together with more traditional medical treatments.

SUPPLEMENTARY MATERIAL

None.

AUTHOR CONTRIBUTIONS

Each author made significant contributions to the research and manuscript preparation. Abdullah Salim Al-Karawi: Conceptualized the study, designed the experiments, and supervised the project. Ali Saad Kadhim: Conducted the experiments, and collected and analyzed the data. Ali Abdulma wjood Mohammed: Assisted in data analysis, interpretation, and editing of the manuscript. Fakhri Alajeeli and Giuseppe Lippi: Provided critical revisions and contributed to the final approval of the version to be published. All authors have read and approved the final manuscript.

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DATA AVAILABILITY STATEMENT

None.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ETHICAL APPROVAL

This study received approval from the Scientific Research Ethics Committee, Biology Branch, Department of Science, College of Basic Education, under administrative order number 6, dated January 4, 2024.

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