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# The Effect of Resistance Training with Black Seed Supplementation on Glycemic Indices in Overweight Women

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ABSTRACT

**Introduction:** Today, obesity and insulin resistance are recognized as significant factors in the development of metabolic diseases. This study aimed to examine the effects of resistance training combined with black seed consumption on specific glycemic indicators in overweight women.

**Methods:** In this quasi-experimental study, the researchers randomly assigned 48 overweight and obese women to control, training, black seed, and combined training and black seed groups. The two training groups (with and without black seed supplementation) performed a resistance training program at 50–80% of 1RM, three sessions per week. The black seed group consumed two 1000 mg capsules daily. Tukey's post-hoc test and one-way ANOVA were used for intergroup data analysis, while intragroup analysis was performed using a paired-sample t-test with SPSS version 26.

**Results:** Compared to their pre-test values and the control group, all three experimental groups showed a reduction in blood glucose, insulin, and the insulin resistance index after eight weeks. A significant decrease was observed in the insulin resistance index ($p = 0.0001$), insulin ($p = 0.001$), and glucose ($p = 0.001$) levels in the resistance training + black seed group. Furthermore, the training + black seed group exhibited a significant reduction in blood glucose ($p = 0.001$) and the insulin resistance index ($p = 0.01$) compared to the resistance training group alone.

**Conclusion:** Resistance training combined with black seed consumption can improve blood glucose levels, insulin levels, and the insulin resistance index in overweight or obese individuals predisposed to diabetes and cardiovascular diseases.

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## Introduction

Experts believe that environmental, metabolic, hormonal, and genetic factors play a significant role in the prevalence of obesity and overweight, with an imbalance between energy intake and expenditure being a key contributing factor (1). Obesity is a common consequence of sedentary and inactive lifestyles, requiring appropriate intervention and treatment (2). Both obesity and overweight increase the risk of various cancers, type 2 diabetes, musculoskeletal disorders, and cardiovascular diseases. Metabolic syndrome (MetS), which involves the clustering of cardiac risk factors such as high blood pressure, abdominal obesity, insulin resistance, impaired glucose tolerance, and dyslipidemia or hyperglycemia, significantly increases the likelihood of diseases such as cancers, cardiovascular diseases, and premature mortality (3).

Type 2 diabetes is closely associated with obesity and overweight, with over 80% of type 2 diabetes patients classified as overweight or obese based on body mass index (4). Physical activity and exercise are considered essential approaches for weight and obesity management, alongside proper nutrition. The American Diabetes Association recommends at least 150 minutes of moderate-intensity aerobic exercise per week, spread across three days, to control weight, improve glucose regulation, and reduce the risk of cardiovascular diseases (5). However, physical limitations, lack of time, and low motivation are common barriers that prevent many adults with obesity from achieving these goals (6). In recent years, exercise training has been widely recognized as beneficial for blood glucose control and weight loss (7). In this context, Li et al. (2024) demonstrated that resistance training significantly improves fasting glucose,

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2-hour glucose levels, and insulin resistance in diabetic patients (7). Similarly, Fathi et al. (2015) found that resistance training led to reductions in glucose, insulin, and insulin resistance in the experimental group (8). However, Basami et al. (2013) reported that resistance training had no significant effect on reducing insulin resistance in young men (9). This inconsistency in results may be influenced by various factors, such as the type and intensity of training, hormonal levels, inflammatory conditions, fat distribution, and other variables (10).

In addition to physical activity, researchers have increasingly turned to herbal supplements to address factors related to overweight and obesity. Black seed, scientifically known as Nigella sativa L., has been used in traditional medicine and is included in pharmaceutical formulations for individuals with hyperlipidemia (11). Black seed contains fats, vitamins, minerals, proteins, and carbohydrates. It is a rich source of essential and unsaturated fatty acids, particularly linoleic acid and oleic acid. Other compounds found in black seed include phospholipids, carotene, calcium, iron, and potassium. Treatment of rats with black seed oil or its active ingredient, thymoquinone, has been shown to increase antioxidant activity and reduce cholesterol, triglycerides, and lipid peroxidation (12). Due to its anti-inflammatory and antioxidant properties, black seed can enhance insulin secretion (thereby preserving pancreatic beta cells) and reduce insulin resistance, resulting in improved blood sugar control and diabetes management (13).

In a clinical trial, the consumption of black seed capsules at doses of 2 and 3 grams per day for 12 weeks in patients with type 2 diabetes led to improvements in glycemic indices, insulin resistance, pancreatic beta-cell function, and blood lipid parameters (14). While some studies have separately investigated the effects of resistance training combined with black seed consumption on glycemic indices in obese individuals, few have examined their combined effects. Therefore, the present study aimed to investigate the impact of resistance training alongside black seed consumption on serum insulin, glucose, and insulin resistance levels in overweight women.

## Materials and Methods

This was an applied, semi-experimental study with three experimental groups and one control group. Initially, open calls were made in public places and gyms in Gachsaran city to invite overweight young women (BMI >25) to participate in the study. Volunteers were then invited for initial evaluations. Based on the results of the general health questionnaire and a physician's clinical assessment, 48 individuals with good physical and mental health were selected and randomly assigned to one of four groups (n=12 per group): a control group, a black seed group, and two resistance training groups, one with black seed consumption and one without. The experimental groups (black seed consumption, resistance training, and resistance training + black seed consumption) followed the prescribed training program and consumed black seed as per the protocol throughout the study. The placebo group continued their daily activities without intervention. The individuals in the black seed consumption and combined training + black seed groups consumed two 1000 mg capsules of black seed supplement (manufactured in Iran by Essence Giah Co.) daily (15). The control group received a placebo containing corn flour during the study period.

Blood samples were collected at two stages: 24 hours before the initiation of training and 48 hours after the final training session in the intervention groups. Both 8 cc blood draws were performed at the training site following an overnight fast of 10 hours, between 8 and 9 AM.

Fasting glucose was measured using the Pars Azmoon kit with the glucose oxidase method. Serum insulin levels were quantified using ELISA. Insulin resistance was assessed using the HOMA-IR formula (16).

$$HOMA\text{-}IR = [\text{Fasting glucose (mmol/l)} \times \text{Fasting insulin } (\mu U/mL)] / 405$$

### *Resistance Training Protocol*

The maximum muscular strength of the subjects was estimated using the Brzycki formula, as follows. First, the subjects attended two gym sessions to familiarize themselves with the movement patterns, resistance training environment, and equipment. Proper weightlifting techniques and the use of weight machines were taught to the subjects. The participants then performed exercises to determine their one-repetition maximum (1RM). Based on the number of repetitions and the load lifted in each movement, the maximum muscular strength for each exercise was calculated using the Brzycki formula.

*One-repetition maximum (1RM) (kg) =*
*Weight ÷ (1.0278 - (0.0278 × Number of repetitions ))*

The resistance training program for the experimental group included upper body exercises such as the bench press, pull-ups on a pulley, bicep curls, and triceps extensions with a barbell. Lower body exercises included leg curls and leg extensions using a pulley machine. Additionally, sit-ups were incorporated to strengthen the abdominal and trunk muscles.

The training sessions followed a cyclical structure, adhering to the overload principle. In Week 1, training was performed at 50% of 1RM intensity across three sets, with 1–2 minute rests between sets and 8–12 repetitions per set. Additionally, a 3–5 minute rest was provided between each complete cycle (after performing all seven movements). The intensity was increased by 5% of 1RM each week, reaching 80% of 1RM by Week 8. A 10-minute warm-up program was included at the beginning of each session, and each session concluded with a 10-minute cool-down. Due to muscular adaptation and increased strength by the end of Week 4, the subjects' 1RM was recalculated, and the training intensity was adjusted based on the new 1RM (17).

Data distribution normality was assessed using the Kolmogorov-Smirnov (KS) test. If the data followed a normal distribution, one-way ANOVA was used for between-group analysis, with Tukey's post-hoc test for pairwise comparisons. Within-group analysis was conducted using a paired-sample t-test. Data analysis was performed using SPSS version 26, with a significance criterion of $P \leq 0.05$.

## Results

The mean weight and body mass index of the subjects of the study are presented in Table 1.

**Table 1.** Mean and standard deviation of age, height, and pre-test and post-test weight and BMI in the study groups

| | Age (years) | Height (cm) | Pre-test weight (kg) | Post-test weight (kg) | Pre-test BMI (Kg/m$^2$) | Post-test BMI (Kg/m$^2$) |
|---|---|---|---|---|---|---|
| Placebo control | 32.17 ± 1.81 | 159.08 ± 0.44 | 75.41 ± 4.88 | 75.86 ± 4.52 | 29.82 ± 1.31 | 30.00± 1.44 |
| Black seed | 31.58 ± 1.62 | 160.06 ± 0.52 | 76.41 ± 5.40 | 76.11 ± 5.19 | 29.84 ± 1.46 | 29.73 ± 1.85 |
| Training | 33.42 ± 1.98 | 161.07± 0.67 | 74.97 ± 4.79 | 75.58 ± 4.92 | 28.92± 1.82 | 29.15 ± 1.64 |
| Training+ Black seed | 31.89 ± 1.33 | 161.88 ± 0.78 | 75.66 ± 5.74 | 76.11 ± 2.84 | 28.87 ± 1.57 | 29.04 ± 1.64 |

### *Analysis of Glycemic Indices*

The Shapiro-Wilk test indicated normal distribution in the data for all four groups. No significant differences were found in the pre- and post-test glucose and insulin levels, as well as the HOMA-IR index (p = 0.221, p = 0.403, and p = 0.271, respectively), in the control group. However, the black seed group showed significant reductions in glucose and insulin levels and the HOMA-IR index (p = 0.001, p = 0.001, and p = 0.001, respectively) post-test. Similarly, the resistance training group demonstrated significant reductions in glucose and insulin levels and the HOMA-IR index (p = 0.001, p = 0.001, and p = 0.001, respectively) post-test. The resistance training + black seed consumption group also exhibited significant reductions in post-test glucose and insulin levels and the HOMA-IR index (p = 0.0001, p = 0.0001, and p = 0.0001, respectively).

One-way ANOVA revealed significant differences in glucose (F = 27.55, p = 0.001), insulin levels (F = 55.41, p = 0.001), and the HOMA-IR index (F = 56.28, p = 0.001) among the research groups. Tukey's post-hoc test results for pairwise comparisons are presented in Figures 1 to 3.

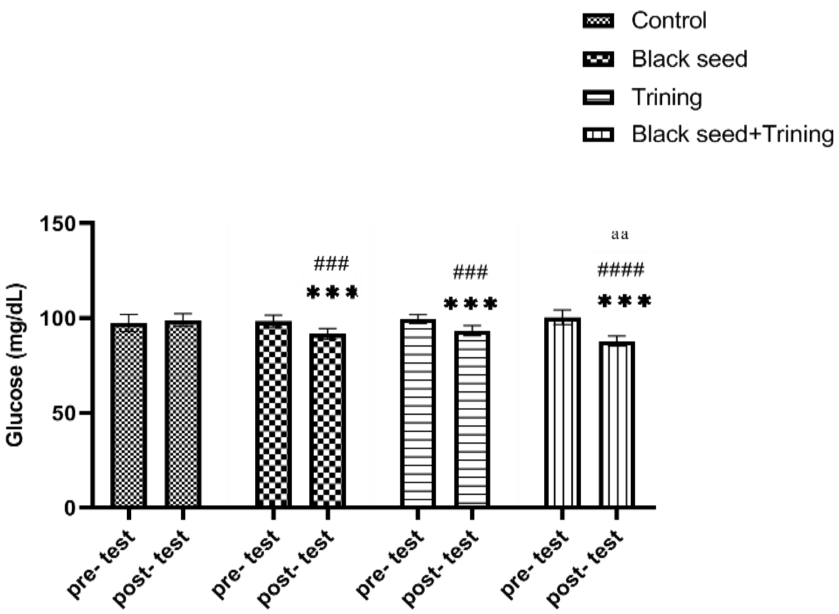


**Figure 1**. Mean and standard deviation of blood glucose levels (mg/dL)
***(p=0.001) difference is significant vs pre-test. ###(p=0.001) difference is significant vs placebo group in post-test. #### (p=0.0001) difference is significant vs placebo group in post-test. [a a a] (p=0.001) difference is significant vs training group and black seed group.

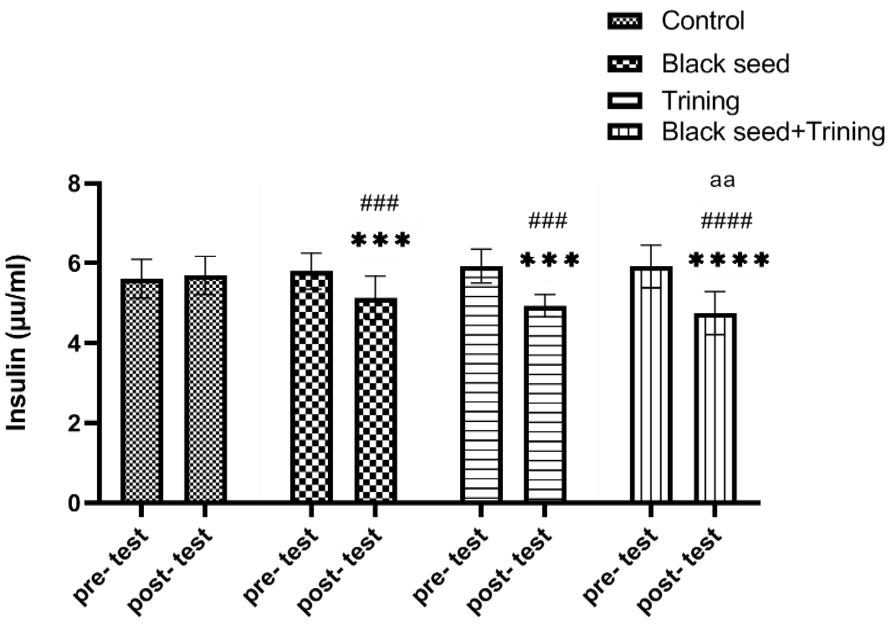


**Figure 2.** Mean and standard deviation of insulin levels (µU/ml)
***(p=0.001) difference is significant vs pre-test. ****(p=0.0001) Significant difference compared to the pre-test group. ###(p=0.001) difference is significant vs placebo group in post-test. #### (p=0.0001) difference is significant vs placebo group in post-test. [a a] (p=0.01) difference is significant vs training group and black seed group.

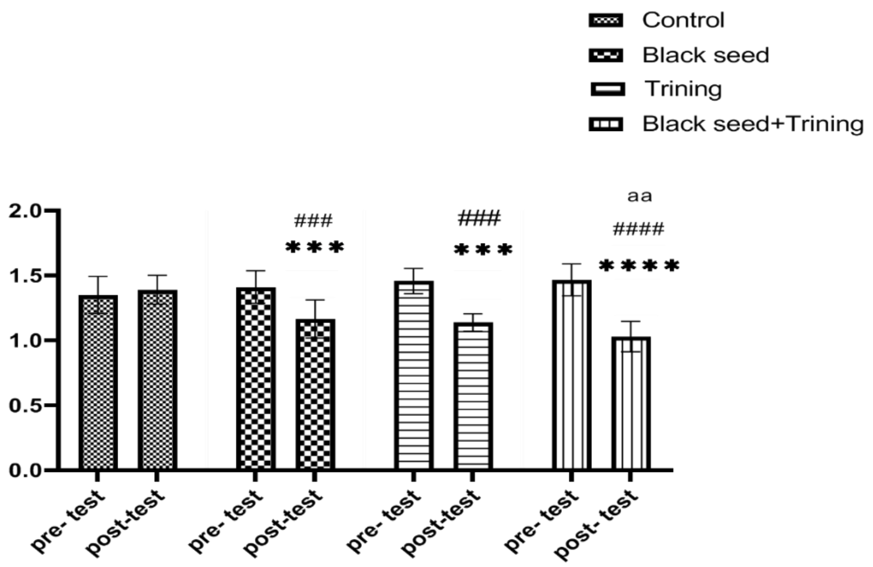


**Figure 3.** Mean and standard deviation of insulin resistance index (HOMA-IR)
***(p=0.001) difference is significant vs pre-test .****(p=0.0001) Significant difference compared to the pre-test group. ###(p=0.001) difference is significant vs placebo group in post-test. #### (p=0.0001) difference is significant vs placebo group in post-test. [a a] (p=0.01) difference is significant vs training group and black seed group.

## Discussion

The present study aimed to investigate the effects of eight weeks of resistance training combined with black seed consumption on glycemic indices in overweight and obese women. The results demonstrated that eight weeks of resistance training significantly reduced serum blood glucose, insulin levels, and the insulin resistance index in these women. Comparisons between the resistance training group's pre-test and post-test results, as well as with the control group, showed significant reductions in insulin and glucose levels and the insulin resistance index. These findings are consistent with the studies by Patel et al. (2020) and Goto et al. (2009) (18,19). In the survey conducted by Goto et al. (2009), a single session of acute resistance training resulted in a significant increase in blood glucose levels (19). The discrepancy between our findings and those of Goto et al. may be attributed to differences in training intensity, the gender of the subjects, the number of training sessions, and the subjects' fitness levels. In the present study, participants followed an eight-week resistance training protocol. In contrast, Goto et al. used a single progressive session, which led to an increase in blood glucose levels following the session. Additionally, the results of this study are consistent with those of Monroe et al. (2020), Samani et al. (2024), and Saremi et al. (2016) (20,21,22). Exercise training may improve skeletal muscle glucose transport, insulin function, glucose tolerance, and whole-body insulin sensitivity, leading to enhanced glucose metabolism both with and without insulin mediation. These responses are likely associated with increased GLUT4 protein expression and the selective activation of enzymes involved in glucose phosphorylation and oxidation. Physical activity induces functional changes in insulin signaling, facilitating the translocation of GLUT4 to the cell membrane, which increases glucose uptake by skeletal muscles (23, 20). The gradual increase in muscle mass, a key benefit of resistance training, may contribute to glycemic control and enhance glucose metabolic capacity. Studies have shown that eight weeks of resistance training increase strength and reduce blood glucose levels. The observed reduction in blood glucose is likely due to the insulin-like effects of resistance training, which promote the re-synthesis of glycogen stores in muscle cells, ultimately maintaining blood glucose levels within the normal range (24).

In the present study, resistance training improved insulin sensitivity and reduced serum insulin levels. Previous research has demonstrated that resistance training enhances glucose homeostasis not only by lowering insulin resistance but also by increasing the mass and function of beta cells (25).

Our results demonstrated a reduction in serum blood glucose, insulin levels, and the insulin resistance index in obese and overweight women following black seed consumption. In the black seed group, a significant decrease in insulin, glucose, and the insulin resistance index was observed compared to both the control group and pre-test values. These findings are consistent with the studies by Parhizkar et al. (2011) and Shah et al. (2012) (26, 27), as well as previous research reporting that black seed extract inhibits hepatic gluconeogenesis, suggesting potential therapeutic hypoglycemic effects for the treatment of type 2 diabetes (26, 27). Recent studies on the mechanisms of action of medicinal plants have revealed that some possess insulin-like properties and can reduce the absorption of carbohydrates and fats from the small intestine (28). Furthermore, the presence of polysaccharides, flavonoids, glycoproteins, polypeptides, steroids, alkaloids, and pectin in medicinal plants may help explain the hypoglycemic properties of plants such as black seed, which can prevent blood biochemical alterations associated with diabetes (29). Black seed also regulates liver enzymes involved in glucose metabolism, thereby reducing hepatic gluconeogenesis. Specifically, it increases the activity of liver hexokinase while reducing the activity of fructose-1,6-bisphosphatase and glucose-6-phosphatase, both key enzymes in gluconeogenesis. Additionally, black seed enhances the activity of glucose-6-phosphate dehydrogenase, an enzyme involved in the intracellular pentose phosphate pathway (30, 31). Black seed also activates adenosine monophosphate-activated protein kinase (AMPK), which inhibits the gluconeogenesis pathway and reduces hepatic glucose production. In muscle tissue, increased AMPK activation promotes the synthesis and translocation of the GLUT4 transporter, thereby enhancing glucose uptake by muscle cells. Another beneficial effect of black seed is the inhibition of intestinal glucose absorption (32). Moreover, black seed may exert anti-diabetic effects in skeletal muscle cells, liver cells, and adipocytes through the peroxisome proliferator-activated receptor gamma (PPAR-γ), AMPK, and insulin signaling pathways (33).

Other findings of the study indicated that resistance training combined with black seed consumption in obese and overweight women reduced serum insulin, blood glucose levels, and the insulin resistance index. Our results showed that after eight weeks of resistance training and black seed consumption, serum glucose levels and the insulin resistance index in the resistance training + black seed group decreased significantly compared to the resistance training group, control group, and black seed consumption group. Additionally, serum insulin levels decreased significantly in the resistance training + black seed group compared to both the control group and the black seed consumption group. Given the effects of resistance training and black seed consumption, the combined impacts likely involve mechanisms from both. Accordingly, in addition to its antioxidant properties, black seed consumption, when combined with resistance training, enhances glucose uptake into muscle cells. This effect persists even after training, as the pathways stimulating glucose uptake remain active for hours post-exercise (34). Consistent with our findings, Zaoui et al. (2002) showed that after 12 weeks of training and black seed consumption, animals in the experimental group exhibited a significant decrease in serum glucose compared to the control group (35). Furthermore, research indicates that regular training leads to significant reductions in plasma glucose levels, increased insulin sensitivity, and improved insulin resistance (36). One limitation of the present study is the lack of control over the participants' calorie intake and diet, which may have influenced the results. Therefore, we recommend that future studies incorporate strict control over participants' caloric intake and diet.

## Conclusion

Our findings indicated that resistance training combined with black seed consumption can improve key factors such as insulin resistance, insulin levels, and blood glucose in overweight or obese individuals at risk for various types of diabetes and cardiovascular diseases. Additionally, the insulin resistance index significantly decreased following resistance training and black seed consumption, which may provide substantial benefits for individuals with impaired insulin regulation.

Notably, the results of this study, for the first time, demonstrate that the simultaneous consumption of black seed with resistance training has a more significant effect than either resistance training or black seed consumption alone. This distinction sets our study apart from existing research, as no prior studies have explored this combined approach, making the present study the first to investigate this area.

## Declarations

### *Conflicts of Interest*

The authors declare no conflicts of interest.

### *Authors Contributions*

Drafting of the manuscript and screening: DN and KA

Conception and design: DN, KA, and MA

Critical revision of the manuscript: DN and KA

### *Consent for publication*

Not applicated.

### *Ethical Consideration*

The Marvdasht Islamic Azad University Ethics Committee approved this study (No. IR.IAU.M.REC.1404.074).

### *Availability of Data and Materials*

All data generated in this study are available in the published article as well as in the supplementary files.

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