

## The Effect of Swimming Training with Cinnamon Extract on Hematological Factors in Diabetic Rats

Ghobad Hassanpour<sup>1\*</sup>, Seyed Ali Hosseini<sup>1</sup>, Faridegh Keikhosravi<sup>1</sup>, Mehdi Noura<sup>1</sup>

<sup>1</sup> Department of Sport Physiology, Marvdasht Branch, Islamic Azad University, Marvdasht, Iran.

### \*Correspondence:

Ghobad Hassanpour, Department of Sport Physiology, Marvdasht Branch, Islamic Azad University, Marvdasht, Iran.

**Tel:** (98) 917 308 5873

**Email:** ghobadhasanpour@yahoo.com

**Received:** 27 August 2017

**Accepted:** 15 September 2017

**Published in December 2017**

### Abstract

**Objective:** Diabetes is one of the most common metabolic diseases which can lead to cardiovascular disorders. The purpose of this study was to evaluate the effect of swimming training with cinnamon extract on hematological factors in diabetic rats.

**Materials and Methods:** 60 diabetic rats selected and divided into six group of: (1) control, (2) swimming training, (3) 60mg / kg of cinnamon, (4) 40 mg / kg of cinnamon, (5) swimming training with 60mg / kg cinnamon and (6) swimming training with 40 mg / kg cinnamon. Groups 2, 5 and 6 (five sessions per week for eight weeks) swam for 10 minutes and 30 minutes in the first two weeks and in the remaining six weeks respectively. Groups 3, 4, 5 and 6 received the prescribed amount of cinnamon extract daily. For statistical analysis of data used one way analysis variance and Tukey post hoc test ( $P \leq 0.05$ ).

**Results:** Swimming training, 40 and 60 mg/kg cinnamon extract, swimming training with 40 and 60 mg/kg cinnamon extract have significant effect on reduction of HbA1c ( $P$ -value:0.001) and have no significant effect on WBC ( $P$ -value:0.28), RBC ( $P$ -value:0.66) and platelets ( $P$ -value:0.07) in diabetic rats and 60 mg/kg cinnamon extract is more effective than 40 mg/kg cinnamon extract ( $P$ -value:0.001) and swimming training ( $P$ -value:0.007) in reduction of HbA1c in diabetic rats.

**Conclusion:** Swimming training and cinnamon extract can improve HbA1c in diabetic rats.

**Keywords:** Swimming training, Cinnamon, Hematological factors, Diabetes

### Introduction

Diabetes is one of the most common endocrine disorders (1). Changing lifestyle and diets caused diabetes prevalence rise throughout the world. It is reported that the prevalence of diabetes in the world will be about 320 million people in 2025. Furthermore the prevalence of diabetes in Iran is also increasing and includes about

5.5% of the population (2). The diabetes disease, besides cardiovascular complications, will also contribute to high blood pressure, nephropathy, neuropathy, retinopathy, hormonal disorders and iron deficiency anemia (3,4). Hemoglobin, white blood cells (WBC), especially neutrophils and hematocrits decrease in patients with diabetes, and these

patients are at risk of iron deficiency anemia and infection (4-6). Despite available diabetes treatments, Studies indicate that most diabetic patients use herbal medicine more than other types of complementary medicine (7). The cinnamon, known as Verum, is a shrub plant and it belongs to the family of Lauraceae, Lurales. Cinnamon is a native plant of Sri Lanka and South India, and its inner bark is used as spice (8). Various studies examined the effects of cinnamon herbal remedies in diabetic patients. For example, Haghghan et al (2010) stated that daily consumption of 1.5 gr of cinnamon improved hematologic factors in patients with type 2 diabetes (9), Faramoushi et al (2016) concluded that cinnamon extract reduced low density lipoprotein (LDL) and very low density lipoprotein (VLDL) Streptozotocin induced diabetic rat (5), Nevertheless, Zahmetsaz et al (2011) and Mirfiyeh et al (2013) have reported contrary results and stated that cinnamon has no significant effect on blood glucose and lipid profile in diabetic patients (10). Generally, diabetes management and risk control are possible. Today, experts believe that diets and drugs are not sufficient to treat and control diabetic patients. They strongly believe that exercise and physical activity should also be added to the daily schedule in diabetic patients. Regular exercise can play a key role in reducing the complications of diabetes including obesity, high blood pressure, hyperlipidemia and hyperinsulinemia; and in increasing insulin sensitivity in target tissues (2). Some studies showed that exercise activities have significantly improved hematocrit, hemoglobin and the number of red blood cells (RBC) in pregnant women (11), athletes (12), patients with type 2 diabetes (6), and streptozotocin induced diabetic (13). It was reported that exercise activities have no significant effect on lipid profile and blood glucose in men with type 1 diabetes (14). So far, researchers were not able to decisively recommend an appropriate exercise program to improve hematological factors in diabetic patients. Identification, enhancement and

improvement of hematologic factors in the treatment and prevention of progression of diabetes mellitus and also reducing the cost of treatment are considered very important and therefore, conducting various types of research in this area is necessary. Consequently the present study aimed to evaluate the effect of swimming training with cinnamon extract on hematological factors in streptozotocin induced diabetic.

## Materials and Methods

In this experimental study, 60 male Sprague dawley rats were purchased from the animal house of Islamic Azad University of Marvdasht branch and transferred to the sport physiology laboratory unit of this university. Rats were kept in lab cages for one week in order to adapt to the environment and were only removed when the cages were being cleaned and washed. For diabetes induction injected 60 mg/kg streptozotocin made by sigma. Four days after the injection of Streptozotocin, the fasting blood sugar (FBS) level was measured with glucocard device by cutting the end of the rat's tails. Therefore, all rats had a blood glucose level over 300 mg/dl. In addition, rats were divided into six group of: (1) control group, (2) swimming training, (3) 60 mg/kg cinnamon extract, (4) 40 mg/kg cinnamon extract, (5) swimming training with 60 mg/kg cinnamon extract and (6) swimming training with 40 mg/kg cinnamon extract. For a period of eight weeks, Groups 2, 5 and 6 swam five sessions per week for 10 minutes per session in the first two weeks and five sessions per week for 30 minutes in the remaining six weeks. It should be noted that in present study swimming trainings was forced swimming trainings. Also, groups 3 to 6 received a specified amount of aqua cinnamon extract daily. In this study, aqua extract of cinnamon was performed according to the protocol of Hosseini et al (2014) (8). The study period was eight weeks. After this period, blood samples all the rats were collected for measure the variables research. The control group was considered in order to

compare other groups with its biochemical variables. On the other hand, these groups were assigned to control the environmental factors affecting the variables studied in the research design. For statistical analysis one-way analysis of variance (ANOVA) and Tukey post hoc test ( $P$ -value<0.05) were used.

## Results

The levels of HbA1c, platelets, WBC and RBC in rats were presented in Table 1. The results of one-way ANOVA showed a significant difference in the HbA1c levels of the studied groups (F:18.02,  $P$ -value:0.001). Tukey's post hoc test results showed that HbA1c levels in the groups of swimming training, 60 mg/kg cinnamon extract, 40 mg/kg cinnamon extract, swimming training with 60 mg/kg cinnamon extract and swimming training with 40 mg/kg cinnamon extract were significantly lower than the control group ( $P$ -value:0.001) and HbA1c levels in the group of 60 mg/kg extract cinnamon extract were significantly lower than the groups of 40 mg/kg cinnamon extract ( $P$ -value:0.001) and swimming group ( $P$ -value:0.007). Also, the results of one-way ANOVA showed no significant difference in the number of WBC (F:1.28,  $P$ -value:0.28), the RBC (F:1.01,  $P$ -value:0.66) and the

number of Platelets (F:2.16,  $P$ -value:0.07).

## Discussion

The results of this study showed that eight weeks of swimming training significantly reduced HbA1c in diabetic rats. However, has was no significant effect on the number of the RBC, WBC and platelets in diabetic rats. It was reported that diabetic rats get iron deficiency anemia (4). In animals which their pancreatic beta cells have been damaged by streptozotocin, glucose enters into the muscle and fat tissues; therefore, glucose blood increases, and as a result animals may get a sympathetic neuropathic disorder. This reduces the amount of norepinephrine and epinephrine secretion from the end of the nerves to the kidney clotting device, in particular the erythropoietin secreting cells. Removing the effect of catecholamine on the adjacent clotting device reduces the release of erythropoietin, thereby contributing to the production of RBC, hemoglobin, and other hematological quantities (4). In this regard, Shahrakchi et al (2008) reported that induction of diabetes with a dose of 65 mg/kg streptozotocin leads to a significant reduction in the number of WBC, RBC, hemoglobin and hematocrit in wistar rats (4). In some studies, according to the findings of the present study,

**Table 1. Levels of HbA1C, platelets, WBC and RBC in rats after treatment**

Study Groups	Hb <sub>A1C</sub> (%)	Number of wight blood cells (in cubic millimeters)	Number of Red blood cells (in cubic millimeters)	Number of Platelets (in cubic millimeters)
Swimming training	8.5±0.65*	10400±3209.59	5897142.85±1211125.01	547428.57±199107.05
Received 60mg/kg cinnamon extract	5.37±0.60*¥	9462.50±2710.91	7035000±402740.91	844000±148302.77
Received 40mg/kg cinnamon extract	8.86±0.70*	6980±2489.89	7468000±921506.01	734400±157002.61
Swimming training with 40 mg/kg cinnamon extract	6.75±2.41*	8814.28±1684.66	6890000±1022138.28	756428.57±122765.16
Swimming training with 60mg/kg cinnamon extract	7.08±0.77*	10200±2732.52	7783000±315877.96	742700±180475.32
Control	11.98±2.82*	8220±2096.98	7067000±786723.86	740400±227431.16

\* Significant decrease compared to the control group

¥ Significant decrease compared to swimming training groups and crecived mg/kg cinnamon

physical activities have led to improved levels of HbA1c in diabetes (13,15-18). However, contrary to the findings of the present study, diabetes induction led to an increase in the number of lymphocytes and neutrophils in rats, but decreased significantly following the uptake of WBC levels (19). It was reported that in diabetic rats with high-fat diet, levels of WBC and its subunits such as lymphocytes and monocytes increase, and neutrophil levels are significantly reduced. However, 10 weeks, 5 sessions per week, and 60 minutes each session of the swimming training resulted in a significant decrease in WBC and its subunits, such as lymphocytes and monocytes in a way that these factors returned to their initial state (20). The researchers argued that the decrease of neutrophil was probably due to the displacement and relocation of these materials into inflamed cells, or neutrophil movement and relocation into adipose tissue (20). In addition to the above studies, three weeks exercise activity had no significant effect on the levels of RBC, WBC and hematocrit in streptozotocin-induced diabetic rats (21). The reason for the coherence of results in noted study with the present study can be due length of research period, which is similar to each other. The duration of this study (21) is shorter than the other studies (19,20).

Also, the results of this study showed those eight weeks and 60 mg/kg consumption have a significant effect on reduction of HbA1c levels in streptozotocin- induced diabetic rats; however, it has no significant effect on number of RBC, WBC and platelets. It has been shown in laboratory studies that cinnamon extract increases the phosphorylation of beta-insulin receptor and, on the other hand, decreases the activity of tyrosine phosphatase and thus shows insulin-like properties. It has also been reported that cinnamon polyphenols, such as insulin hormone, stimulate glucose uptake and stimulate glycogen biosynthesis by activating the glycogen synthase enzyme and inhibiting glycogen synthase kinase activity (7). Various studies have investigated the effects of

cinnamon extract on different doses, which have controversial results and some of them are consistent with results of present study (7,9,23,24); for example, it was reported that the 100 and 200 mg/kg cinnamon aqueous extract consumption resulted in a significant decrease in fasting glucose, hemoglobin, red blood cells and hematocrit levels in wistar malealloxan-induced diabetic rats (22), daily intake of 1.5 g cinnamon powder for 60 days resulted in a significant reduction of HbA1c in patients with type 1 diabetes (9), four months of daily intake of 3g of cinnamon powder had no significant effect on HbA1c in patients with type 2 diabetes (23); Daily intake of 1 g cinnamon for 60 days did not have a significant effect on glucose and HbA1C levels in women with type 2 diabetes (7). Also, eight weeks consumption of two 500 mg capsules of cinnamon daily has no significant effect on glucose and HbA1C levels in type 2 diabetic patients (24). Differences in the results of reported studies can be due to the type of subject, initial levels of research variables, consumption dosage, as well as duration of herbal supplements. In contradiction with the findings of this study, have reported that the consumption of 500 mg/kg cinnamon extract for 30 days resulted in a significant increase in the number of red blood cells, hemoglobin and platelets in diabetic rats (25). One reason for this discrepancy can be high dose of cinnamon in comparison with the present study (300 mg/kg cinnamon versus 40 mg/kg and 60 cinnamon consumption), which could indicate that likely the effect of cinnamon intake could be dose-dependent (25). Therefore, the findings of this study indicated that 60 mg/kg cinnamon extract compared to 40 mg/kg cinnamon extract had a greater effect on HbA1c levels reduction in streptozotocin induced diabetic rats.

Concerning the interactional effects of swimming training with cinnamon consumption, the findings of this study indicated that swimming training with cinnamon extract had a significant effect on

reduction of HbA1c diabetic. Also, swimming training along with cinnamon extract did not have a significant effect on number of red blood cells, white blood cells and platelets in streptozotocin-induced diabetic rats. Muscle contractions have been reported to have insulin-like effects, leading to an increase in glucose entering the cells to help generate energy. In fact, muscle contractions increase the permeability of the membrane to glucose due to an increase in the number of glucose transporters (Glut 4). Sport activities, through increased muscle mass, lead to more glucose absorption due to insulin-induced muscle tissue stimulation, in a way that exercise activities through increased muscle mass can have a significant effect on HbA1C levels (6). It has also been reported that cinnamon has intrinsic insulin effects and its insulin energy is more than 20 times greater than any other substance. Cinnamon derivatives stimulate glycogen synthesis and increase glucose uptake. It also activates and reduces insulin kinase and insulin dephosphorylation receptors respectively and decreases glucose levels as well as HbA1c in diabetic patients (26). These two issues indicate the probable interactions of cinnamon consumption and sport activities. Although no study has been conducted to examine the interactive effects of cinnamon consumption and sport activities in order to compare the results with the findings of this

study, it seems that the lack of effects of cinnamon intake and swimming training in the present study is due to the short course period of the study, as well as the doses of cinnamon intake. Therefore, it is suggested for the future studies to consider cinnamon interactions and swimming exercises with doses higher than 60 mg/kg cinnamon intake, as well as swimming training with duration of more than 30 minutes.

## Conclusions

Based on the results of this study, it can be concluded that swimming training with simultaneous consumption of cinnamon extract have interactional effects on the improvement of HbA1c in diabetic rats and have no effects on number of white blood cells, red blood cells and platelets in diabetic rats.

## Acknowledgements

Considering the fact that the present study was carried out under the title of a research project approved by the Islamic Azad University of Marvdasht Branch, we thank and appreciate the financial and spiritual assistance of the research deputy as well as the experts of the laboratory of this university department, Mrs. Fatemeh Farokhami and Mr. Omidreza Salehi.

## References

- Hosseini SA, Zar A, Kheirdeh M, Arayesh Oliaei A. Effect of endurance training on vaspine and glycemic indexes in diabetic rats. *Qom Univ Med Sci J* 2017;10(11):17-24.
- Zar A, Hoseini SA, Amir Hosseini SA, Siavashi N. The effects of eight weeks of endurance training on BDNF, insulin and insulin resistance in rats. *Yasuj Med Sci Univ J* 2016;21(3):238-48.
- Ghaibi N, Sofi Abadi M, Sirati Sabet M, Jahani Hashemi H, Karimfar M. Study of amygdalus lycioides root extract on blood glucose concentration in intact and diabetic rats. *SJIMU* 2014;22(2):32-8.
- Shahraki MR, Mirshekari H, Shahraki E, Shahraki AR. Review the hematologic factors in male streptozotocin induced diabetic rats. *IJDLD* 2009;7(3):283-7.
- Faramoushi M, Amir Sasan R, Vahid SS, Karimi P. Effect of simulated intermittent altitude on the metabolic and hematologic parameters in streptozotocin induced diabetic rats. *Ardabil Univ Med Sci J* 2016;16(1):53-64.
- Hasanvand B, Karami K, Khodadi A, Valipour M. Impact determination of strength and resistance training on Glycoside hemoglobin and blood sugar on patients with type II diabetes. *Yafte J*. 2011;13(3):75-81.
- Hasanzade F, Tolyat MM, Emami A, Barakchi A, Emamimoghaadam Z. Effect of cinnamon on HbA1c in type 2 diabetes patients. *Arak Univ Med Sci J* 2013;2(4):303-11.

8. Hosseini SE, Tavakoli F, Karami M. Medicinal plants in the treatment of diabetes mellitus. *CE* 2014;2(2):64-89.
9. Khadem Haghighian H, Farsad Naimi A, Pourghassem Gargari B, Ali-Asgharzadeh A, Nemati A. Effect of cinnamon on glycemic control and insulin resistance in type II diabetes patients: A randomized clinical trial. *Ardabil Univ Med Sci J* 2010;10(4):295-302.
10. Aghamohammadi D, Fakhari S, Bilehjani E, Hassanzadeh Sh. The effects of honey and cinnamon mixture on improving the quality of life in breast cancer. *Crescent J Med Biol Sci* 2017;4(2):74-9.
11. Heidari A, Jali M, Bagheryan M. Effects of a period of selected aerobic exercise on the levels of hemoglobin, hematocrit and red blood cells in pregnant women. *Koomesh J* 2011;13(1):127-33.
12. Nazar Ali P, Srori S, Ramezan Khani A. The effect of one period of high endurance activity on hemorehologic factors of triathlon national team athletes. *Sport Biol Sci J* 2013;15(4):67-75.
13. Hosseini SA, Nikbakht H, Azarbayjani MA. The effect of aqua extract of saffron with resistance training on glycemic indexes of streptozotocin induced diabetic rats. *Yasuj Med Sci Univ J* 2014;18(4):284-94.
14. Sardar M, Gaeini A, Ramezani J. The effect of 8 weeks of regular physical activity on blood glucose, body mass index, maximal oxygen uptake (Vo<sub>2</sub>max) and risk factors cardiovascular diseases in patients with type of 1 diabetes mellitus. *Iranian J End Met* 2008;10(2):91-7.
15. Heo M, Kim E. Effects of Endurance Training on Lipid Metabolism and Glycosylated Hemoglobin Levels in Streptozotocin-induced Type 2 Diabetic Rats on a High-fat Diet. *J Phys Ther Sci* 2013;25(8):989-92.
16. Ghiasi R, Ghadiri Soufi F, Somi M hossein. Swim Training Improves HOMA-IR in Type 2 Diabetes Induced by High Fat Diet and Low Dose of Streptozotocin in Male Rats. *Adv Pharm Bull* 2015;5(3):379-84.
17. Teixeira-Lemos E, Nunes S, Teixeira F, Reis F. Regular physical exercise training assists in preventing type 2 diabetes development: focus on its antioxidant and anti-inflammatory properties. *CVD* 2011;10:12-24.
18. Shehab M, Abd El-Kader. Aerobic versus resistance exercise training in modulation of insulin resistance, adipocytokines and inflammatory cytokine levels in obese type 2 diabetic patients. *J Adv Res* 2011;2(2):179-83.
19. Crespilho DM, de Almeida Leme JAC, de Mello MAR, Luciano E. Effects of physical training on the immune system in diabetic rats. *Int J Diabetes Develop Count* 2010;30(1):33-7.
20. Ghiasi R, Ghadiri Soufi F, Mohaddes G, Somi M, Ebrahimi H, Alihemmati A et al. Effects of regular swimming on WBC profile, inflammatory mediators and histopathology of pancreatic tissue of high fat induced diabetes in adult male rats. *Bull Env Pharmacol Life Sci* 2014;10(3):14-20.
21. Nazirog˘lu M, Butterworth PJ. Protective effects of moderate exercise with dietary vitamin C and E on blood antioxidative defense mechanism in rats with streptozotocin- induced diabetes. *Can J Appl Physiol* 2005;30(2):172-85.
22. Longe AO, Momoh J, Adepoju PA. Effect of cinnamon aqueous extract on blood glucose level, liver biomarker enzymes, hematological and lipid profile parameters in Alloxan- insuced diabetic male albino rats. *Eur Sci J* 2015;1(1):418-26.
23. Mang B, Wolters M, Schmitt B, Kelb K, Lichtinghagen R, Stichtenoth DO, et al. Effects of a cinnamon extract on plasma glucose, HbA<sub>1c</sub>, and serum lipids in diabetes mellitus type 2. *Eur J Clin Invest* 2006;36(5):340-4.
24. Zahmatkesh M, Fallah Huseini H, Hajiaghaee R, Heidari M, Mehrafarin A, Tavakoli-far B. The effects of cinnamomum zeylanicum J. presl on blood glucose level in patients with type 2 diabetes, a double-blind clinical trial. *JMP* 2012;1(41):258-63.
25. Mhammad HA, Saleh Jubrail AM, Najeeb MK. Impact of cinnamon extract on hyperlipidemic and diabetic rats. *Int J Chem Biomol Sci* 2015;1 (3):96-106.
26. Mirfeizi M, Mehdizadeh torzani Z, Mirfeizi Z, Asghari Jafar Abadi M, Rezvani H, Shovghi M. The effect of cinnamon in control of glucose and blood lipid in type 2 diabetic patients A double blind, randomized clinical trial. *Mashhad Univ MedSci J* 2015;57(3):533-41.