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Effect of Resistance Training and Red Wine Intake on Lipid Profile in Mice

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ABSTRACT

Nascimento RL, Moreira SR, Carneiro MVO, Numata Filho ES, Oliveira RA, Lirani LS. Effect of Resistance Training and Red Wine Intake on Lipid Profile in Mice. **JEPonline** 2018;21(1):112-121. It is believed that resistance training and moderate intake of red wine are associated with improvement of health. The purpose of this study was to verify the effect of resistance training and red wine intake on the lipid and glycemic profile in rats divided into the control group (CG, n = 20), wine group (WG, n = 20), exercise group (EG, n = 20), and the wine and exercise group (WEG, n = 20). The rats trained for 8 wks on a vertical ladder at an 80º slope 3 times·wk^{-1}. The ingestion of wine occurred every day. Body mass of the groups increased significantly at week 8 vs. week 1 ($P<0.05$). The findings indicate that LDL was decreased in the WEG compared to the EG ($P<0.05$), HDL was increased in the EG and the WEG compared to the CG ($P<0.01$), total cholesterol increased in the EG relative to the CG, WG, and the WEG ($P<0.05$), triglyceride was decreased in the WEG at ($P<0.01$, week 4 and $P<0.05$ week 8), and glycemia was decreased in the WEG relative to the CG ($P<0.05$). Resistance training and red wine consumption may help reduce the risk of heart disease by improving lipid profile.

Key Words: Lipids, Muscle Mass, Obesity, Resistance Training

INTRODUCTION

There is an increase in the number of research papers published about the benefits of regular exercise, particularly with regards to the improvement in health (1). Among the benefits is the discussion that highlights the lipid profiles that are directly related to quality of life and well-being (2). Individuals who have blood lipid profile concentrations considered within an ideal standard are less likely to suffer cardiovascular events (3).

One of many different types of exercise that has contributed to the improvement of the lipid profile is resistance training (RT), which presents significant results of improvement in organic functioning (4). Resistance training helps to maintain the integrity of the musculoskeletal system. It also has positive effects on the maintenance, improvement, and prolongation of other physiological mechanisms with respect to health as well (1,7). On the other hand, the lack of RT, decreased lean muscle mass and low physical fitness are linked to certain metabolic disorders and poor health (5).

Another strategy that has gained increased attention in the scientific community is nutritional intervention. According to American Dietetic Association (2), the nutritional aspects involve any substance or some type of component of a food that will potentiate health benefits (13). For example, red wine (RW) is reported to be associated with several improvements in health (11), including the prevention of cardiometabolic diseases (16).

The RW presents phenolic compounds and antioxidants that help to provide cardiovascular protection, the reduction in blood pressure, and the improvement in lipid concentrations among other functions related to the human organism (11). Soares-Filho et al. (15) found significant improvements in hypertensive rats with a decrease in systolic blood pressure levels, but the training used in the experiment was aerobic exercise.

The purpose of this study was to investigate the effect of 8 wks of RT and RW intake on the lipid profile of Wistar rats. This study is important in that it appears to be one of the few studies involving the ingestion of the RW associated with RT.

METHODS

Subjects

The study consisted of 80 male rats (Rattus norvegicus var. Albinos, Rodentia Mamalia) of the Wistar lineage from the Biotério of the Federal University of the São Francisco Valley - UNIVASF.

Procedures

All animals had an average weight of 350 gm at the beginning of the experiment at an age of 90 to 100 days, which characterized them as young animals. The animals were fed standard ration for rodents and water ad libitum that was changed daily. Methodological procedures were performed at the same time of the day in the evening period. The rats were kept in cages containing 5 animals each having a temperature between about 22 to 24°C and a light and dark cycle of 12/12 hrs.

This study was submitted to and approved by the Ethics and Deontology Committee in Studies and Research - CEDEP and the Ethics Committee on the Use of Animals - CEUA of the Federal University of the São Francisco Valley, under protocol 0006/180714. It followed the standards set forth in the Guide to the Care and Use of Laboratory Animals (Institute of Laboratory Animal Resources, National Academy of Sciences, Washington, DC, 1996) and the Ethical Principles of Animal Experimentation.

The training apparatus used in the experiment was developed by Grossman et al. (10) that over time some modifications occurred in his initial designer according to Duncan et al. (8). The apparatus used in this study was 1.1 m high, 18 to 20 cm wide. The box measured 20 x 20 x 20 cm with an 80° inclination that favoured a good adaptation for the animals to carry out the proposed exercise dynamically (17).

One week before starting the intervention, the animals went through individual weighing as well as adapting to climb the vertical ladder. The procedure adopted for learning included the following characteristics: (a) during the first attempt, the animal was placed at a height of ~35 to 40 cm from the top of the ladder; (b) during the second attempt, a height equivalent to 55 to 60 cm; and (c) in the third attempt, the animal was positioned at the base of the ladder. This procedure aimed at a better adaptation of the animals with the RT apparatus that was similarly employed with all the animals. If necessary, new attempts were made so that the animals could actually perform the proposed exercise in accordance with the study objectives (10). The figure below demonstrates the entire process of adaptation.

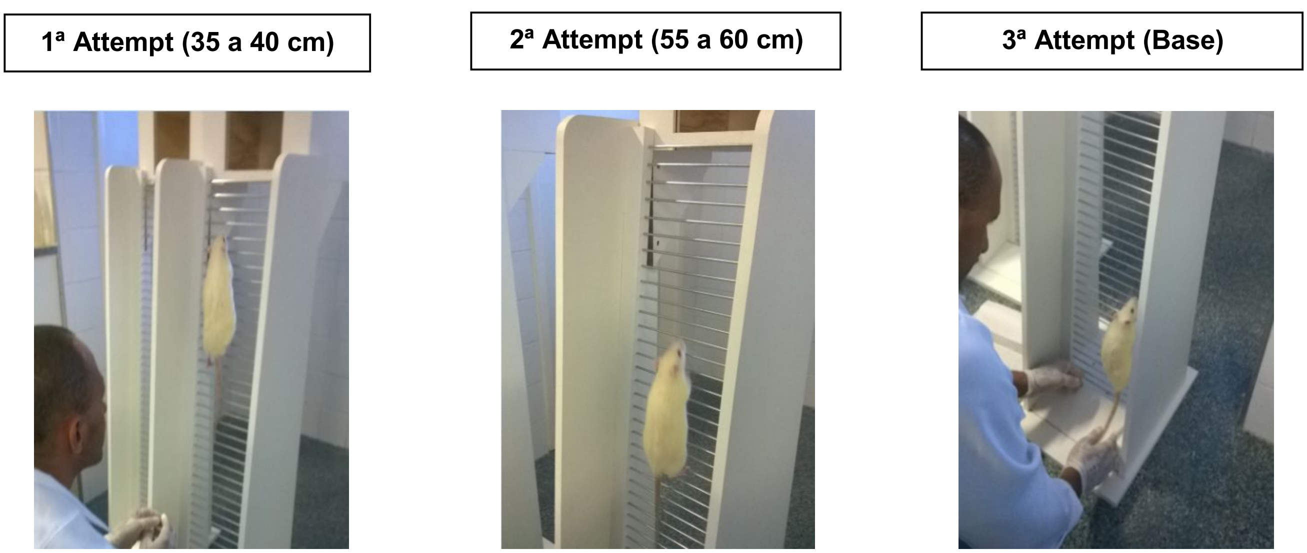

Figure 1. Adaptation of the Animals with the Training Apparatus.

One week after the animal familiarization sessions with the ladder (Training Apparatus), two sessions were performed with the rats on alternate days with a 48-hr interval using a load that corresponded to 50% of the body mass of each animal. The load was readjusted in the following weeks during the intervention period to 75% and adding another 30 gm for all animals in the groups: wine group (WG) and the wine group plus exercise (WEG).

Each session of the RT consisted of 4 sets of climbing with a recovery of 2 min between them. The ladder length allowed the animals to perform between 8 to 12 dynamic movements continuously with progressive loading and with estimated time for climbing of ~4 to 6 sec in duration. No external stimuli were used for the animals to perform the training protocol.

All the animals underwent the same process of familiarizing the gavage, where in the first week of adaptation the procedure of the gavage technique containing one ml of water was carried out, aiming to better adapt to the intake of RW (15). The technique of gavage consists of introducing a particular food or nutrient through the throat of the animal that is receiving some means of intervention, reaching the stomach directly.

All animals in the RT intervention plus wine intake (WEG) obeyed the following protocol: RW intake every day for 8 wks and weight training 3 $d \cdot wk^{-1}$ alternately (Monday, Wednesday, and Friday). Regarding wine consumption, the animals were weighed once a week on Saturday in a standardized way. The wine intake was based on the animal's weight, and was administered individually by means of the gavage method that was calculated by the following equation 3.715 $mL \cdot kg^{-1} \cdot d^{-1}$ (15). The wine used was the Rio Sol Syrah Safra 2013 with 13% alcohol content in its composition. It was produced in the Region of the Valley of São Francisco - PE, Brazil.

Statistical Analyses

The data were distributed in mean and standard deviation. The Shapiro-Wilk test was used to verify the normality of the data and variables. Subsequently, the ANOVA test was applied with Bonferroni *post hoc* to find possible differences between the different moments (weeks) and groups. Statistical significance was set an alpha level of $P<0.05$.

RESULTS

The results identify the behavior of the variable body mass investigated at all times in the respective groups. Table 1 presents the monitoring of the animals' body mass in the four groups during weeks 1, 4, and 8. As can be observed, there was an increase in body mass at different moments, but the significance was evidenced in the comparison between weeks 1 and 8 in all groups. The values for the lipid variables are shown in Table 2.

Table 1. Comparison of the Body Mass between the Moments of Each Group.

Body Mass	CG	F	WG	F	EG	F	WEG	F
Week 1	387.20 ± 29.6	--	381.55 ± 30.5	--	359.80 ± 41.6	--	391.40 ± 37.3	--
Week 4	421.50 ± 30.2	--	407.00 ± 30.6	--	395.40 ± 42.6	--	413.00 ± 36.7	--
Week 8	458.30 ± 27.7**	12.58	440.33 ± 34.9*	3.24	446.00 ± 42.7**	6.58	441.90 ± 36.8*	4.66

CG = Control Group; **WG** = Wine Group; **EG** = Exercise Group; **WEG** = Wine and Exercise Group. ANOVA One Way and Bonferroni *post hoc* test. Values represent mean ± standard deviation. *P<0.05 compared to initial value between weeks; **P<0.01 compared to baseline between weeks.

Table 2. Comparison of Lipid Variables between the Moments of Each Group.

Variables Blood Profile	CG (n=20)	WG (n=18)	EG (n=20)	WEG (n=20)	F	P	Eta Parcial
Week 1 LDL	206.1 ± 118.6	206.1 ± 118.6	206.1 ± 118.6	206.1 ± 118.6	--	1.00	0.00
Week 4 LDL	251.3 ± 167.5	260.2 ± 123.0	294.1 ± 235.1[d]	156.6 ± 207.4[c]	1.56	0.04	0.04
Week 8 LDL	232.8 ± 126.9	213.8 ± 197.9	141.8 ± 83.2	110.6 ± 83.2	1.49	0.04	0.04
Week 1 HDL	59.9 ± 5.5	59.9 ± 5.5	59.9 ± 5.5	59.9 ± 5.5	--	1.00	0.00
Week 4 HDL	60.8 ± 12.4[d]	53.1 ± 12.0[d]	59.3 ± 14.2[d]	75.1 ± 11.5[a,b,c]	8.66	0.00	0.19
Week 8 HDL	50.0 ± 7.9[c,d]	44.8 ± 6.7[c,d]	67.4 ± 11.0[a,b]	73.1 ± 13.0[a,b]	18.27	0.00	0.34
Week 1 Cholesterol	113.4 ± 13.4	113.4 ± 13.4	113.4 ± 13.4	113.4 ± 13.6	--	1.00	0.00
Week 4 Cholesterol	113.3 ± 26.1[c]	103.7 ± 18.4[c]	187.3 ± 23.7[a,b,d]	102.3 ± 16.1[c]	3.24	0.02	0.08
Week 8 Cholesterol	96.8 ± 22.3	97.7 ± 17.3	99.6 ± 18.2	97.6 ± 14.9	0.00	1.00	0.00
Week 1 Triglycerides	132.5 ± 51.9	132.5 ± 51.9	132.5 ± 51.9	132.5 ± 51.9	--	1.00	0.00
Week 4 Triglycerides	121.1 ± 37.3[d]	104.2 ± 25.7	131.6 ± 63.5[d]	69.2 ± 21.6[a,c]	3.54	0.01	0.09
Week 8 Triglycerides	125.4 ± 66.3[d]	90.0 ± 32.4	89.0 ± 32.9	79.3 ± 32.9[a]	1.93	0.02	0.05
Week 1 Glucose	264.3 ± 62.4	264.3 ± 62.4	264.3 ± 62.4	264.3 ± 62.4	--	1.00	0.00
Week 4 Glucose	272.6 ± 77.5[d]	250.3 ± 46.9	233.1 ± 41.9	214.9 ± 48.9[a]	1.75	0.03	0.04
Week 8 Glucose	308.8 ± 29.2[c,d]	279.0 ± 68.3	231.3 ± 76.6[a]	248.4 ± 43.3[a]	3.39	0.02	0.08

CG = Control Group; **WG** = Wine Group; **EG** = Exercise Group; **WEG** = Wine and Exercise Group. Significant values for the ANOVA (two-way) test. [a]Significant difference (ANOVA two-way, *post hoc* Bonferroni) with the Control Group. [b]Significant difference (ANOVA two-way, *post hoc* Bonferroni) with the Wine Group. [c]Significant difference (ANOVA two-way, *post hoc* Bonferroni) with Exercise Group. [d]Significant difference (ANOVA two-way, *post hoc* Bonferroni) with the Wine and Exercise Group.

The LDL did not present significant results across the weeks within each group. However, the LDL for the WEG was significantly lower at week 4 vs. the EG at week 4. The HDL profile showed significance for both groups and moments. The CG and the WG presented significant values with increases compared to week 1 compared to week 8, but the EG even showing improvements in this variable did not indicate significance. At week 4 the group that presented the best result was the WEG being the only one to indicate difference in this period. On the other hand, the CG presented reduction of HDL in comparison of week 4 and 8. The EG did not indicate a significant change in HDL.

For the total cholesterol, no significant results were identified for both groups when compared to the effect of the intervention during the weeks, but what was not expected there was an increase of the concentration in the EG compared to the others in week 4. The group that responded best to the triglyceride values was WEG, presenting significant results with reduction when compared to week 1 with 4 and week 1 with 8, in the other groups it was not possible to identify such results significantly in neither one two moments. The glucose behavior for both groups did not present significant results when compared to the weeks, but intra groups significant difference were pointed out, the EG and the WEG indicated a significant reduction for this variable.

DISCUSSION

The results presented in the present study demonstrate that the RT associated with the intake of the RW potentiates the improvement of the components related to the lipid profile in animal Wistar rats. In addition, studies have already shown the relationship of RW with blood pressure reduction and improvements in lipid concentrations (15), associated to aerobic exercises differently from our work that used the RW attached to the RT.

For the variable body mass that was followed during the experiment in both groups, serving as the basis for other measures and verify the possible changes of the same. The CG, WG, EG, and WEG groups showed increases at different moments, but these differences were only significant in relation to week 1 compared to 8. According to Grans et al. (9), where the authors followed animals for 12 wks the initial weight of the rats were similar between the groups, however at the end of the experiment the trained groups had their weights significantly increased in relation to the control group, different from the present study, where no different results were found between the groups. In the study by Patrocínio et al. (14), the authors present results similar to ours, where the initial and final body mass of the animals had increases in all groups with duration of 5 wks.

Behavior of LDL during the moments and groups, the results indicated reduction with significance between the EG as compared to the WEG at week 4. The other groups did not present a statistically significant difference. According to Leite et al. (11), when analyzing the effects of 12 wks with a 3-fold weekly frequency of RT in ovariectomized rats, the authors found significant results for all lipid profile variables, especially LDL reduction. In this sense, there is evidence that RT stimulates lipid oxidation, due to the activation of protein kinase (AMP) and the negative regulation of the pathway of lipogenic enzymes by expression of the hepatic gene (9,18). Perhaps, this mechanism may explain in part the reduction of LDL in the WEG since that was not the case in the other groups.

Regarding HDL, there was interaction between the groups. The EG and WEG showed increases in HDL when compared to the CG at week 8, but WEG also indicated a difference at week 4 for the same group. In this sense, Donatto et al. (7) showed similar results to the present study, indicating significant increases of HDL in relation to the control, the investigation had duration of 8 wks of RT in animals of the Wistar lineage of tumors.

The EG also indicated an increase compared to the WG at week 8. The training with weights potentiated the increase of HDL, which was verified by the results demonstrated here. In the same sense, regarding the mechanisms of action of RT and ingestion of RW, WEG presented different results when compared to WG at weeks 4 and 8 with significant increases of 22 $mg \cdot dL^{-1}$ and 29 $mg \cdot dL^{-1}$, respectively. The WEG showed an increase of 6 $mg \cdot dL^{-1}$ in relation to the EG.

The results in the present study point to an improvement in HDL. It has been postulated that for each 1 to 3 $mg \cdot dL^{-1}$ of HDL increase, the adverse effects of the cardiovascular system are reduced by 5 to 10%. Yet, interestingly, total cholesterol did not show significant results at different times. However, there was a significant interaction between the groups. The EG compared to the CG, WG, and the WEG presented values with a significant difference in week 4, indicating an increase in this variable. In the experiment by Speretta et al. (18), opposite results were found. They indicated a significant reduction of total cholesterol in the trained group compared to the control, perhaps the non-dietary control of our work may explain in part the non-reduction of this variable.

The results of the present study indicate an increase in total cholesterol concentration in the EG, which was not expected. This increase may be related to the higher HDL value of this group, which was evidenced at week 8 compared to week 1, this may have influenced the increase of this variable in the respective group.

The triglyceride responses showed significance between the moments, being pointed to the WEG in week 1 compared to 8 and the week 1 in relation to week 4. Among the groups there was a significant difference, comparing the WEG and CG in weeks 4 and 8 and WEG compared with EG at week 4. The WG did not lead to significant results in comparison to the others. These findings are considered to be important from a metabolic function perspective, since the reduction in triglyceride concentrations can reduce the risk of cardiovascular diseases. On the other hand, values considered to be non-standard can lead to fat deposition and complications in the blood vessels. Corroborating with our findings, Leite et al. (11) also demonstrated reduced values of triglycerides in the training group in relation to the others.

The results of the present study demonstrated an interesting association between RT and the consumption of wine (WG) in the animal model. It is very tempting to conclude that RT plus wine ingestion may induce AMPK activation with a reduction in the expression of transcription factors related to lipogenesis, which would provide an improvement in fat oxidation in the liver and, consequently, a reduction in the content of lipids that may favor the reduced values found for the triglyceride variable in the present investigation.

Another variable investigated was glucose, which between the different moments did not indicate significance. However, there was a significant reduction among the groups, the WEG showed a reduction in relation to weeks 4 and 8. Also, the WEG showed significant decrease in weeks 4 and 8 compared to the CG, and the EG in relation to the CG. Similarly, when Donatto et al. (7) analyzed the behavior of tissue sensitivity to insulin in young Wistar rats, they showed significant results for the trained group in comparison to the control. Glycemic decay was indicated for the intervention group of which the authors credit their results to RT on vertical ladder. This is important in that a reduction in glucose may help attenuate possible diabetic complications.

CONCLUSIONS

The findings in this study give rise to the conclusion that RT coupled to RW consumption may be successfully incorporated in the improvement of some variables of blood and glycemic lipid profiles.

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