



Indonesian Journal of Multidisciplinary Research



Journal homepage: <http://ejournal.upi.edu/index.php/IJOMR/>

Effect of Onion Peel Tea Supplementation and Exercise Against Hypercholesterolemia and Cardiovascular Risk Factors in Obese Women: Education and Randomized Control Trial

Muhammad Ahsan¹, Muhammad Wasim Tasleem^{2,*}, Sehrish Rana Rajpoot³, Hafiz Muhammad Ayub⁴,
Mehboob Ahmad⁵, Qaisar Irshad⁵, Tasleem Kanwal⁶

¹Department of Epidemiology and Public health, University of Agriculture Faisalabad, Pakistan

²Department of Zoology, Islamia University Bahawalpur, Pakistan

³University College of Conventional Medicine, Islamia University Bahawalpur, Pakistan

⁴Department of Plant Pathology, University of Agriculture Faisalabad, Pakistan

⁵Department of Zoology, Cholistan University of Veterinary and Animal Science, Pakistan

⁶Department of Botany, University of Agriculture Faisalabad, Pakistan

*Correspondence: E-mail: Professor4463@gmail.com

ABSTRACTS

This study aims to evaluate the effectiveness of onion peel tea supplementation on body composition, lipid profile, serum glucose concentration, blood glucose level, hypercholesterolemia-related risk factors, cardiovascular disorders in obese, and overweight females. Females attending Diabetic center National Hospital with a Basal metabolic index greater than 25 are randomly selected, assigned to the control group, aerobic training (AT), Onion Peel tea Supplementation (OPT), as well as AT and OPT groups. OPT group received 33 mg of onion peel tea supplementation after every meal a day in addition to AT for 6 months including 90 min of AT sessions that helped get 80% of the target heart rate. One week before the study and 3 days after the last AT session, all participants were subjected to take their blood samples. In comparison to control group weight, total body fat percentage including visceral fat and subcutaneous fat, body mass index (BMI), high-density lipoproteins (HDL), low-density lipoproteins, blood pressure, heart rate, and triglycerides show a significant decrease in AT and AT+OPT groups. No significant changes were obtained in HDL and waist to hip ratio. AT gave beneficial effects in improving Cardiovascular risk factors, hypertension, and LDL.

ARTICLE INFO

Article History:

Received 10 Aug 2021

Revised 14 Sep 2021

Accepted 16 Sep 2021

Available online 18 Sep 2021

Keyword:

Hypercholesterolemia,
Cardiovascular risk factors,
Obese women,
Onion peel tea supplementation,
Exercise.

1. INTRODUCTION

Obesity is an increasing global health problem and has been associated with metabolic syndrome (Mets), diabetes, cardiovascular disease, hypertension, and cancer (Vucenik & Stains, 2012). The increasing incidence of obesity suggests that this epidemic is likely to worsen in the future.

Some plant foods extract including onion peel tea, be useful in the suppression and prevention of Mets. (Sae-Tan *et al.*, 2011). Onion peel Tea is also a common drink and can easily be included in a diet to alleviate or avoid the symptoms of Mets. Sae-Tan *et al.*, (2011) One of the major polyphenolic compounds found in onion is Quercetin and useful for handling major MetS conditions like obesity, type 2 diabetes, and cardiovascular risk factors (Thielecke & Boschmann, 2009). Onion is another potentially beneficial food. Quercetin can regulate lipid metabolism and suppress hyperglycemia and diabetes (Corzo-Martinez *et al.*, 2007). Earlier research linked quercetin, a flavonoid found in onion peel, to the anti-obesity effects of onion (Corzo-Martinez *et al.*, 2007; Seiva *et al.*, 2012; Kim *et al.*, 2012). Thus, cardiovascular risks factors can be suppressed by the beneficial effects of tea obtained from onion peel (OPE). Anti-obesity effects were evaluated in the present study by supplementation of Onion Peel tea Supplementation (OPT). In addition, blood parameters as Blood Glucose, low-density lipoproteins (LDL), high-density lipoproteins (HDL), TG are also examined. Maintaining energy balance by lifestyle medications by balance energy intake and energy expenditure helps improve obesity and related metabolic syndromes. It is difficult for an individual to the maintenance of their basic energy level through diet and exercise alone where there are many incidences of energy-dense, Processed and ultra-processed foods with a sedentary lifestyle. Regular exercise with supplementation of some plants extracts proves to be beneficial in lowering body weight is recommended for weight loss strategies. A recent study reveals that exercise is an effective strategy in weight management and its negative health outcomes.

Analysis of the and overall importance of those two factors AT+OPT in cardiovascular weight loss programs and their metabolic risks, especially for people willing to use medicinal herbs, (Nogueira *et al.*, 2017; Lee *et al.*, 2011). Studies differ in this respect, especially as regards food supplement type and dosage (Cardoso *et al.*, 2013; Rosen & Spiegelman, 2006), and the supplement types, dosages (Cardoso *et al.*, 2013; Gnacińska *et al.*, 2009), and exercise design concerning their duration and intensity (Corzo-Martinez *et al.*, 2007; Gnacińska *et al.*, 2009). Furthermore, in related studies, inconsistencies are investigated and a proper solution to weight loss and cardiovascular health improvement is needed for society. Thus, the present study aims to explore the effect of OPT, in addition, to exercise on Lipid profile and obesity outcomes in overweight and Obese females.

2. METHODS

The experimental procedure is presented in **Figure 1**.

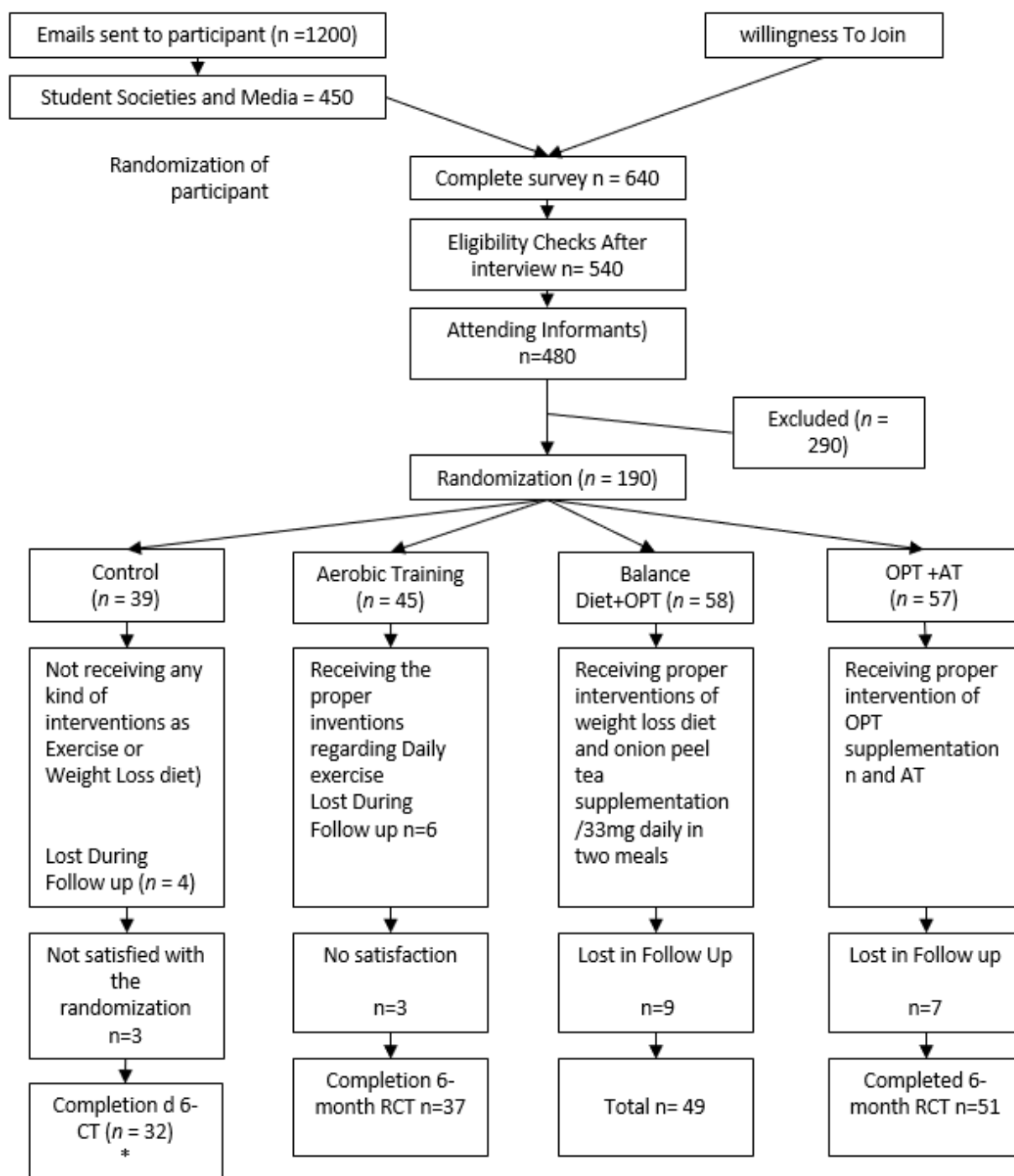


Figure 1. Procedure.

2.1. Participants

The project was launched in April 2020 in Diabetic center National Hospital Faisalabad. Participants were recruited and reimbursed for their participation in the project from the urban slum areas of Faisalabad and its surrounding communities. A total of 199 people were randomized to either an exercise/ onion tea supplement or a control condition for 6 months. 199 participants aged 18 to 36 years with a body mass index (BMI; kg/m²) of 23 to 34.4 were overweight/moderately obese participated in the study and all laboratory tests were done before and after completion of training sessions. Participants met or surpassed the 85th percentile of triceps Skinfold, proposed by the 2nd National health and nutrition survey. Skinfold measurements help to evaluate the difference between individuals who are thin and muscular rather than obese or overweight. All the participants have a sedentary lifestyle and do not exceed 450 kcal of physical training a day, measured with the help of physical training recall questionnaires.

2.2 Control Group

Controls were subject to similar tests as ex-subject to a 6-month training programs testing. They were instructed to keep their usual physical activity and dietary intake patterns throughout the study.

2.3 Exclusion and Inclusion Criteria

Participants (n=10) are excluded from the study because of the presence of any chronic disease as diabetes and heart disorders and high blood pressure (>140/90mm hg) fasting glucose level (<150), elevated Lipid profile (Cholesterol <270mg/dl, TG<500 mg/dL). All the participants who are moderately obese or overweight without incidence of any chronic disease are included in the study. Furthermore, the participant was also excluded based on smoking, alcohol consumption, Take Medication or supplements that reduce physical training or metabolism (i.e., Corticosteroids), or if they are won't show their willingness or lack capability of performing laboratory tests and moderately intense exercise. Randomization of participants is occurred by 2:1:1 ratio as 50% in exercise and onion peel tea supplementation group and 25% in exercise and control group under the strict supervision of clinicians and project investigatory committee. All respondents are provided with informed consent from the human subject committee at the university of agriculture Faisalabad and national Hospital Faisalabad.

2.4. Measurements

The height and weight of the participants were measured by digital height and weight scale (SECA, Germany). The BMI was determined by dividing the body weight (kg) by the height in square m². Triceps brachia, quadriceps, and thigh were used for subcutaneous fats estimation. (SH5020, South Korea). Calculation of body fat percentage by the Siri equation. After a minimum of five minutes of rest by a blood pressure instrument, the participant's blood pressure was assessed in a sitting position (ALPK2, model 300-V-EU, Japan). The waist circumference (WC) with the individual in place standing was decided at a halfway point between the lowest rib and the iliac crest. At the beginning and end of the trial, after 12 hours of fasting, 5mL of subject blood was removed from the elbow vein. A sampling of the blood was carried out between 8 and 10 am. A sampling of the blood was carried out between 8 and 10 am.

Baseline blood glucose homeostasis checks included Fasting Blood Sugar (FBS) (mg/dL). Using glucosidase-peroxidase methods and an autonomous analyzer (Hitachi, Japan) with a complete automating procedure, the blood glucose tests were performed with a BIO device (Spain) kit. Blood lipid testing such as HDL, LDL, Total Cholesterols, and triglycerides has been carried out by photometric method Pars Simon kit pack.

2.5. Exercise Interventions

The exercises consisted of a mixture of mobility, stability, equilibrium, and endurance training based on the American Sports medicine Guidelines. The trained case managers assessed each participant's physical health based on many factors (handgrip strength, gait speed, upper and lower body flexibility, lower extremity strength, balance and leg strength, and volume of physical activity). The participants received personal exercise requirements and handy tools (e.g., resistance a band, grip ball, and pedometer) from licentiate physiotherapists to improve fitness levels. It was proposed that approximately 4 to 7 workouts a week should be conducted for each session (5 to 60minutes) or repeat workouts to meet the needs of the participants. A 6-month home-based training has been encouraged for all participants in the training and combination classes. The daily exercise success was documented in a workout journal.

2.6. Onion Peel Supplementation

In the onion peel tea Supplementation group, participants received 33mg OPT a day after their main meals. Every seventh day the OPT was supplied to check the sub-designs of the study. At the end of eight weeks, each volunteer was given eight packs of OPT. The study was done daily with the social network and text messages to consume the OPT in every meal, two Times a Day. In preparation of the capsules, OP was powdered and the pack filled with the main OP polyphenols. For the efficient and recommended 33mg use of OPT.

2.7. Statistical Analysis

The demographic baseline and health-related features of participants were represented in the assigned groups as mean $\pm$ standard deviation (SD) or number(percentage) for continuous variables or categorical variables.

To assess the differences in the baseline measurements among the designated groups were done by ANOVA. And, post-hoc LSD test revealed the differences between the groups. The statistical significance of all tests has been measured at a predetermined 0.05 significance level.

3. RESULTS

3.1. Women Are Selected for Intervention

Female participants n=199 were randomly distributed to either AT, AT + OPT group, OPT group, or control group participants and basic characteristics were reported. A tendency, blood pressure, and biochemical variables between groups were not significantly affected. Cardiovascular analysis shows that body weight, body fat percentage (BF percent), Body mass index, triglyceride, LDL, and cardiovascular parameters were shown to be quite different among the groups ($P < 0.05$; **Tabel 1**). However, no significant differences existed between the parameters ($P < 0.05$). The LSD test showed that the weight fat mass, triglyceride, and cardiovascular parameters were significantly different for the body and the C Group as well as for the AT, OPT, and Pathogroup. There were considerable differences between groups 1 and 3, and between groups 2 and 3, but the differences were much more significant in

groups 1 and 3. Exercise may be suggested, but OPT was a successful remedy against cardiovascular risk factors. However, no changes in the parameters between the pretests and post-tests could be found in the C category. In comparison with the control group ($P < 0.02$), serum glucose concentration is also lower in comparison to the control group. These are seen much clear in group 3 with OPT and exercise proves beneficial against obesity and hypercholesterolemia for cardiovascular risk factors. Mean T-Cho in OPT group is also lower as compared to other groups ($p < 0.05$). From the complete study, after 6 months it was seen there is a significant reduction in LDL, TG, and Fasting blood glucose in OPT and exercise group compare to control groups. OPT+AT group show significant result that shows their joint effect on weight loss and cardiovascular risk factors by decreasing the LDL, TG concentration. While there are no significant changes occurred in HDL concentration. It is recommended that OPT with the addition of aerobic training (AT) could help in preventing obesity and related metabolic syndromes especially cardiovascular disorders, diabetes, and Hypertension.

At the end of the study, a significantly higher mean serum ALP (alkaline phosphatase) concentrates in OPT groups than the control group ($P < 0.01$). The mean serum TG levels in the OPT group were less than those in the control group, although these variations did not have a statistically significant difference. At the end of the study, there were no statistically significant variations in ALT, AST, GGT, which shows the serum leptin levels of the OPT group, the leptin amount between the control group (1.9 ± 0.5 ng/ml) and OPT group (1.6 ± 0.2 ng/ml) was not significantly distinguished. In the control group, the average leptin serum concentration was considerably greater at the end with comparison to OPT and the exercise group. OPT group mean leptin levels were slightly lower in serum (2.8 ± 0.03 ng/ml) than the control group concentrations (4.8 ± 1.0 ng/ml) ($P < 0.05$).

Table 1. The Mean $\pm$ Standard Deviation of different parameters of participants.

Parameters	Groups	Control Group n=18	AT group n=21	OPT	AT+OPT group n=28	P-Value
Weight	Pre	84.41 $\pm$ 11.89 ^a	83.67 $\pm$ 9.7	83.4 $\pm$ 5.10	85.67 $\pm$ 8.43 ^a	<0.002
	Post	85.61 $\pm$ 10.81 ^a	81.43 $\pm$ 10.3 ^b	81.76 $\pm$ 9.87 ^b	80.73 $\pm$ 9.21 ^b	
BMI kg/m ²	Pre	32.4 $\pm$ 4.21 ^a	31.9 $\pm$ 4.93 ^a	31.8 $\pm$ 3.98 ^a	31.7 $\pm$ 4.84 ^a	<0.001
	Post	29.9 $\pm$ 3.78	29.6 $\pm$ 5.12	30.1 $\pm$ 4.21	27.4 $\pm$ 4.62 ^b	
Body Fat (%)	Pre	40.1 $\pm$ 2.12 ^{ad}	39.8 $\pm$ 2.17 ^a	38.7 $\pm$ 2.76 ^a	38.9 $\pm$ 2.37 ^a	<0.003
	Post	39.9 $\pm$ 1.98 ^a	37.9 $\pm$ 2.01 ^c	37.1 $\pm$ 2.31 ^c	35.8 $\pm$ 2.12 ^b	
Waist to hip Ratio	Pre	0.87 $\pm$ 0.03 ^{ace}	0.86 $\pm$ 0.04 ^{ac}	0.86 $\pm$ 0.03 ^{ac}	0.87 $\pm$ 0.05 ^{ac}	<0.006
	Post	0.86 $\pm$ 0.04 ^{ac}	0.83 $\pm$ 0.03 ^d	0.84 $\pm$ 0.04 ^f	0.81 $\pm$ 0.04 ^b	
Waist circumference	Pre	85.6 $\pm$ 12.3	85.9 $\pm$ 11.98	85.3 $\pm$ 10.9	86.1 $\pm$ 12.4	0.800
	Post	86.1 $\pm$ 11.7	84.3 $\pm$ 11.76	84.1 $\pm$ 9.7	82.1 $\pm$ 12.1	
SBP	Pre	113.9 $\pm$ 7.1	127.6 $\pm$ 5.43 ^a	124.2 $\pm$ 5.92	126.4 $\pm$ 6.12 ^a	<0.006
	Post	115.2 $\pm$ 6.8	117.3 $\pm$ 5.41	113.7 $\pm$ 5.78	109.3 $\pm$ 6.13 ^b	
LDL	Pre	114.3 $\pm$ 13.2 ^a	115.2 $\pm$ 14.2 ^{ac}	116.3 $\pm$ 13.8 ^{ac}	116.1 $\pm$ 11.9 ^{ac}	<0.003
	Post	113.7 $\pm$ 11.9 ^a	109.2 $\pm$ 13.8 ^d	110.2 $\pm$ 13.6	106.9 $\pm$ 12.1 ^b	
TG	Pre	134.8 $\pm$ 15.07 ^a	135.1 $\pm$ 14.6 ^{ac}	134.9 $\pm$ 15.9 ^a	134.9 $\pm$ 16.13 ^a	<0.001
	Post	133.2 $\pm$ 14.4 ^a	127.6 $\pm$ 15.8 ^d	128.1 $\pm$ 15.32	123.5 $\pm$ 15.41 ^b	
HDL	Pre	39.43 $\pm$ 2.71	39.21 $\pm$ 2.87	39.34 $\pm$ 2.98	39.32 $\pm$ 3.12	<0.700
	Post	38.9 $\pm$ 2.63	37.2 $\pm$ 2.34	37.3 $\pm$ 2.67	35.1 $\pm$ 2.97	
Rest heart rate	Pre	78.67 $\pm$ 11.2 ^a	78.91 $\pm$ 10.8 ^a	78.34 $\pm$ 10.4 ^a	79.1 $\pm$ 9.87 ^{ac}	<0.001
	Post	77.86 $\pm$ 9.4	75.7 $\pm$ 10.1 ^d	76.1 $\pm$ 11.2	74.8 $\pm$ 9.91 ^b	
FBS	Pre	81.69 $\pm$ 9.8 ^a	83.34 $\pm$ 10.2 ^{ac}	84.56 $\pm$ 9.67 ^{ac}	79.1 $\pm$ 11.2	<0.003
	Post	82.43 $\pm$ 9.7 ^a	78.1 $\pm$ 9.8 ^d	79.2 $\pm$ 9.54 ^d	77.2 $\pm$ 11.2 ^b	
DBP mmHg	Pre	77.30 $\pm$ 3.88 ^a	77.9 $\pm$ 3.21 ^a	77.6 $\pm$ 4.21 ^a	78.1 $\pm$ 3.88 ^{ad}	<0.001
	Post	76.30 $\pm$ 3.81 ^a	74.8 $\pm$ 3.32 ^c	74.2 $\pm$ 4.21 ^c	72.9 $\pm$ 3.67 ^b	

(a, b) (c, d) superscript show statistically significant difference ($P < 0.05$)

4. DISCUSSION

In this analysis, dietary OPT is shown to prevent the increase in body weight and Total fat percentage, leading factor to obesity and its related metabolic syndrome. A high-fat diet is an important contributor to obesity in rodents (Nogueira *et al.*, 2017). The results of this study show that dietary OPTs can reduce body weight and cardiovascular risk factors. It has been suggested previously that onion-treated as dietary supplementation can be beneficial to human lipid metabolism; (Lee *et al.*, 2008; Lee *et al.*, 2011) have shown that quercetin-rich onion peel extract (OPE) can alter the expression of the cholesterol genes. It has also been shown that OPE reduces blood low-density lipoprotein cholesterol by increasing the expression of low-density mRNA lipoprotein receptors and mRNA encoding the ATP-binding cassette transporter A1 genes (Lee *et al.*, 2012). In addition, observed a reduction in blood Glu, TG, and T-Cho in diet-induced obesity models (Sae-Tan *et al.*, 2011).

The findings of this study show that Glu, TG, and T-Cho blood rise in individuals fed the high-fat diet with a sedentary lifestyle have been suppressed by OPT along with induction of aerobic exercise. Recent studies in a diet-induced obesity mouse model, Marques *et al.* (Marques *et al.*, 2010) showed that blood ALP levels were raised. The relationship between obesity and a rise of ALP in blood has not been fully clarified to the best of our understanding. Added studies in this regard are expected. tumor necrosis factor- α , interleukin-6, resisting, leptin, and adiponectin were previously reported to be a secretion of a variety of proteins called adipocytokines (Fasshauer *et al.*, 2003). Plasma leptin concentrates are positively linked to increases in human weight and adiposity (excessive body fat) (Gnacińska *et al.*, 2009). Adiponectin contributes to the immunity to insulin and fatty acid oxidation and circulating adiponectin concentrations are inversely linked with body weight (Rosen & Spiegelman, 2006; Arita *et al.*, 1999). OPT has been shown to inhibit leptin secretion from adipocytes by results of the current research suppression of leptin secretion may have reduced the weight of the body and the epididymal fat tissue in the OPT group. Managements, type-2 diabetes mellitus, and other hazardous disease causes have been closely associated with a high intake of plant feed (e.g. mushrooms, vegetables, and fruit) containing flavonoids and polyphenolic compounds, and are among the richest sources of flavonoid in the human diet (Hertog *et al.*, 1993; Knekt *et al.*, 1993; Mink *et al.*, 2007) among these plant feed (*Allium cepa*). Quercetins have been shown to have antioxidative, anti-inflammatory, and lipid regulatory properties (Hertog *et al.*, 1993; Zern *et al.*, 2005; Lee *et al.*, 2008; Rivera *et al.*, 2008; Stewart *et al.*, 2008), and it is a major flavone abundant in plant products, especially onions. Several reports involving clinical studies, animal studies, or in-vitro tests have shown significant anti-inflammatory and anti-obesity properties of phenols, including quercetin (Rivera *et al.*, 2008; Hsu *et al.*, 2007; Yen *et al.*, 2011). Quercetin (1.15 mg/g) is rich in OPT. Quercetin can be used as one potential mechanism by which OPT has effects against obesity. Exercise with OPT supplementation shows significant changes in loss of body weight, total body fat percentage. Alone exercise show benefits in lowering the LDL, TG, and bodyweight but in addition to OPT, show a significant reduction in LDL TG, total body fat, and body weight. AT+OPT group at the end of the study shows prevention of cardiovascular risk factors by lowering cholesterol levels. Almost 95% weight loss comes by total body fat percentage reduction by 22-23%. We can assume that the advantages of this study are fruitful for the AT+OPT group. Recent research reveals that reduction in body weight is linked to the reduction of cardiovascular risks as Coronary heart disorders, Angina, or related risk factors heart attack and hypertension. Higher cardiorespiratory health shows the

reduction in metabolic syndrome and risk associated with BMI and total body fat percentage (Lee *et al.*, 1998; Lee *et al.*, 1999).

5. CONCLUSION

Consumption of onion peel tea has been shown beneficial effects on obesity and cardiovascular risk factors. This study aims to evaluate the effectiveness of onion peel tea supplementation on body composition, lipid profile, serum glucose concentration, blood glucose level, and hypercholesterolemia-related risk factors, cardiovascular disorders in obese and overweight females. Females (n=97) attending Diabetic center National Hospital with a Basal metabolic index greater than 25 are randomly selected for the study. They are assigned to the control group, AT, OPT, and AT+OPT groups. Each group has received specific interventions as OPT group receives 33mg (about the weight of a grain of rice) onion peel tea supplementation after every meal a day with addition to aerobic training for 6 months including 90 minutes of Aerobic training sessions that helpful in getting 80% of target heart rate. One week before the study and 3 days after the last Aerobic training session, all participants are subjected to take their blood samples. In comparison to control group weight, Total body fat percentage including visceral fat and subcutaneous fat, BMI, HDL, LDL, blood pressure, heart rate, and triglycerides show a significant decrease in AT and AT+OPT ($p < 0.05$). No significant changes were seen in HDL and waist to hip ratio ($p < 0.05$). Aerobic training shows beneficial effects in improving Cardiovascular risk factors, i.e., hypertension, HR, and LDL. However, the addition of OPT shows much more benefits in lowering the lipid profile and ameliorated cardiovascular risks factors. The addition of OPT in the diet of obese could improve the negative outcomes of obesity and overweight. It was concluded that OPT and AT+OPT were very beneficial for the obese man by reducing obesity also reduce cardiovascular risks.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

7. REFERENCES

- Arita, Y., Kihara, S., Ouchi, N., Takahashi, M., Maeda, K., Miyagawa, J. I., Hotta, K., Shimomura, L., Nakamura, T., Miyaoka, K., Kuriyama, H., Nishida, M., Yamashita, S., Okubo, K., Matsubara, K., Muraguchi, M., Ohmoto, Y., Funahashi, T., and Matsuzawa, Y. (1999). Paradoxical decrease of an adipose-specific protein, adiponectin, in obesity. *Biochemical and Biophysical Research Communications*, 257(1), 79-83.
- Cardoso, G. A., Salgado, J. M., Cesar, M. D. C., and Donado-Pestana, C. M. (2013). The effects of green tea consumption and resistance training on body composition and resting metabolic rate in overweight or obese women. *Journal of Medicinal Food*, 16(2), 120-127.
- Corzo-Martínez, M., Corzo, N., and Villamiel, M. (2007). Biological properties of onions and garlic. *Trends in food science & technology*, 18(12), 609-625.
- Fasshauer, M., and Paschke, R. (2003). Regulation of adipocytokines and insulin resistance. *Diabetologia*, 46(12), 1594-1603.

- Gnacińska, M., Małgorzewicz, S., Stojek, M., Łysiak-Szydłowska, W., and Sworczak, K. (2009). Role of adipokines in complications related to obesity. A review. *Advances in Medical Sciences (De Gruyter Open)*, 54(2), 150-157.
- Hertog, M. G., Feskens, E. J., Kromhout, D., Hollman, P. C. H., and Katan, M. B. (1993). Dietary antioxidant flavonoids and risk of coronary heart disease: the Zutphen Elderly Study. *The Lancet*, 342(8878), 1007-1011.
- Hsu, C. L., and Yen, G. C. (2007). Effects of flavonoids and phenolic acids on the inhibition of adipogenesis in 3T3-L1 adipocytes. *Journal of agricultural and food chemistry*, 55(21), 8404-8410.
- Kim, O. Y., Lee, S. M., Do, H., Moon, J., Lee, K. H., Cha, Y. J., and Shin, M. J. (2012). Influence of quercetin-rich onion peel extracts on adipokine expression in the visceral adipose tissue of rats. *Phytotherapy Research*, 26(3), 432-437.
- Knekt, P., Kumpulainen, J., Järvinen, R., Rissanen, H., Heliövaara, M., Reunanen, A., Hakulinen, T., and Aromaa, A. (2002). Flavonoid intake and risk of chronic diseases. *The American Journal of Clinical Nutrition*, 76(3), 560-568.
- Lee, C. D., Blair, S. N., and Jackson, A. S. (1999). Cardiorespiratory fitness, body composition, and all-cause and cardiovascular disease mortality in men. *The American Journal of Clinical Nutrition*, 69(3), 373-380.
- Lee, C. D., Jackson, A. S., and Blair, S. N. (1998). US weight guidelines: Is it also important to consider cardiorespiratory fitness?. *International journal of obesity and related metabolic disorders: Journal of the International Association for the Study of Obesity*, 22, S2-S7.
- Lee, K. H., Kim, Y. H., Park, E. J., and Cho, S. R. (2008). Study on dietary habit and effect of onion powder supplementation on serum lipid levels in early diagnosed hyperlipidemic patients. *Journal of the Korean Society of Food Science and Nutrition*, 37(5), 561-570.
- Lee, K. H., Kim, Y. H., Park, E. J., and Hwang, H. J. (2008). Effect of onion powder supplementation on lipid metabolism in high fat-cholesterol fed SD Rats. *Preventive Nutrition and Food Science*, 13(2), 71-76.
- Lee, K. H., Park, E., Lee, H. J., Kim, M. O., Cha, Y. J., Kim, J. M., Lee, H., and Shin, M. J. (2011). Effects of daily quercetin-rich supplementation on cardiometabolic risks in male smokers. *Nutrition research and practice*, 5(1), 28-33.
- Lee, S. M., Moon, J., Do, H. J., Chung, J. H., Lee, K. H., Cha, Y. J., and Shin, M. J. (2012). Onion peel extract increases hepatic low-density lipoprotein receptor and ATP-binding cassette transporter A1 messenger RNA expressions in Sprague-Dawley rats fed a high-fat diet. *Nutrition research*, 32(3), 210-217.
- Marques, C. M. M., Motta, V. F., Torres, T. S., Aguila, M. B., and Mandarim-de-Lacerda, C. A. (2010). Beneficial effects of exercise training (treadmill) on insulin resistance and nonalcoholic fatty liver disease in high-fat fed C57BL/6 mice. *Brazilian Journal of Medical and Biological Research*, 43, 467-475.
- Mink, P. J., Scrafford, C. G., Barraj, L. M., Harnack, L., Hong, C. P., Nettleton, J. A., and Jacobs Jr, D. R. (2007). Flavonoid intake and cardiovascular disease mortality: a prospective study in postmenopausal women. *The American Journal of Clinical Nutrition*, 85(3), 895-909.

- Nogueira, L. D. P., Nogueira Neto, J. F., Klein, M. R., and Sanjuliani, A. F. (2017). Short-term effects of green tea on blood pressure, endothelial function, and metabolic profile in obese prehypertensive women: A crossover randomized clinical trial. *Journal of the American College of Nutrition*, 36(2), 108-115.
- Rivera, L., Morón, R., Sánchez, M., Zarzuelo, A., and Galisteo, M. (2008). Quercetin ameliorates metabolic syndrome and improves the inflammatory status in obese Zucker rats. *Obesity*, 16(9), 2081-2087.
- Rosen, E. D., and Spiegelman, B. M. (2006). Adipocytes as regulators of energy balance and glucose homeostasis. *Nature*, 444(7121), 847-853.
- Sae-Tan, S., Grove, K. A., and Lambert, J. D. (2011). Weight control and prevention of metabolic syndrome by green tea. *Pharmacological Research*, 64(2), 146-154.
- Seiva, F. R., Chuffa, L. G. A., Braga, C. P., Amorim, J. P. A., and Fernandes, A. A. H. (2012). Quercetin ameliorates glucose and lipid metabolism and improves antioxidant status in postnatally monosodium glutamate-induced metabolic alterations. *Food and Chemical Toxicology*, 50(10), 3556-3561.
- Stewart, L. K., Soileau, J. L., Ribnicky, D., Wang, Z. Q., Raskin, I., Poulev, A., Majewski, M., cefalu. W. T., and Gettys, T. W. (2008). Quercetin transiently increases energy expenditure but persistently decreases circulating markers of inflammation in C57BL/6J mice fed a high-fat diet. *Metabolism*, 57, S39-S46.
- Thielecke, F., and Boschmann, M. (2009). The potential role of green tea catechins in the prevention of the metabolic syndrome—a review. *Phytochemistry*, 70(1), 11-24.
- Vucenik, I., and Stains, J. P. (2012). Obesity and cancer risk: Evidence, mechanisms, and recommendations. *Annals of The New York Academy of Sciences*, 1271(1), 37.
- Yen, G. C., Chen, Y. C., Chang, W. T., and Hsu, C. L. (2011). Effects of polyphenolic compounds on tumor necrosis factor- α (TNF- α)-induced changes of adipokines and oxidative stress in 3T3-L1 adipocytes. *Journal of agricultural and food chemistry*, 59(2), 546-551.
- Zern, T. L., Wood, R. J., Greene, C., West, K. L., Liu, Y., Aggarwal, D., Shachter, N. S., and Fernandez, M. L. (2005). Grape polyphenols exert a cardioprotective effect in pre-and postmenopausal women by lowering plasma lipids and reducing oxidative stress. *The Journal of Nutrition*, 135(8), 1911-1917.