Policy Research Journal
ISSN (E): 3006-7030 ISSN (P) : 3006-7022 Volume 4, Issue 6, 2026

THERAPEUTIC POTENTIAL OF AJWAIN (*TRACHIPTERUS AMMI*) AGAINST DIET-INDUCED OBESITY AND DYSLIPIDEMIA IN RAT

Aimen Shabbir[*1], Huma Ali[2], Khadija Tul Kubra[3], Arawat Fatima[4], Muhammad Asif[3], Muhammad Rehan Arif[5], Sabah Mansoor[6], Noor Nabi[7]

*[*1]Department Of Food Science and Technology, NFC-Institute of Engineering and Technology, Multan*
[2]Department Of Biomedicine, Atta Ur Rehman School of Applied Biosciences (ASAB), National University of Science and Technology (NUST), Pakistan
[3]National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan
[4]Department Of Food Science, Government College University, Faisalabad, Pakistan
[5]Key Laboratory of Green Prevention and Control of Tropical Agriculture and Forestry Disasters, School of Tropical Agriculture and Forestry Hainan University, Danzhou, China
[6]Department Of Allied Sciences, University of Home Economics Lahore, Pakistan
[7]Department Of Zoology, Faculty of Life Sciences University of Okara, Pakistan.

[*1]aimenshabbir111@gmail.com

DOI: https://doi.org/10.5281/zenodo.20729734

Keywords
obesity, hyperlipidemia, ajwain

Article History
Received: 19 April 2026
Accepted: 30 May 2026
Published: 17 June 2026

Corresponding Author: *
Aimen Shabbir

Abstract

The aim of present study was to assess the protective effect of carom seed powder against obesity and hyperlipidemia by using animal model. Sixteen rats were given high-fructose and high-fat diet to induce obesity, then powder of carom seeds was given to the treatment groups, G_1, G_2 and G_3 according to their per kg body weight are about to 100 mg, 300 mg and 500 mg respectively. This trial period was continued for 6-weeks on daily basis. During this practice serum leptin, blood glucose and lipid profile were checked 0, 21 and 42 day and anthropometric measurements were taken 0, 21, 28, 42 days. The data thus obtain was analyzed statistically. The effect was seen in G_3 (500 mg carom powder) that reduced low density lipoprotein cholesterol (69.75 mg/dl to 57.50 mg/dl), triglycerides (50.75 mg/dl to 39.50 mg/dl), total cholesterol (79.01 mg/dl to 42.25 mg/dl), serum leptin (19.20 ng/ml to 13.57 ng/ml), serum blood glucose (119.0 mg/dl to 78.75 mg/dl), body weight (213.9 g to 179.1 g) and body mass index (151.32 g/cm^2 to 140.10 g/cm^2). The data has shown significant decreased in LDL, triglycerides, cholesterol, blood glucose, serum leptin and body weight while significant increase in high density lipoprotein HDL (20.01 mg/dl to 25.06 mg/dl) due to uptake of carom powder. It is concluded from present study that carom powder has ability to influence the above-described obesity biomarkers. Concisely, carom powder has the quality to lower the causes of some metabolic ailments such as hyperlipidemia and hyperglycemia complications.

1. Introduction

Immense amount of fat gathered in adipose tissues is a medical condition that causes deviations in body mass index that may have inimical effect on health leading to and escalated probability for several non-contagious malady including hypertension, hyperlipidemia, diabetes mellitus, cancer, cardiac malady and osteoarthritis that decreased expectancy of life. Obesity is considered as the major key factor of in essential deaths and morbidity. The lipids elevated level in the blood called hyperlipidemia and this condition is closely integrated with high adipose fat storage (Deguchi and Miyazaki, 2010)

Pakistan has been categorized 9th most obese country out of 188 countries. Most of the global deaths are caused by obesity linked with high lipid profile, so rising obesity in Pakistan is a matter of great concern these days. Approximately 36 % of adults in Pakistan suffer from the problem of obesity. Obesity is higher in urban areas as compared to rural areas (Ogden *et al.*, 2015).

The accessibility of fat rich diet and increase consumption of fat rich foods have been blamed for this medical problem. Hyperlipidemia and obesity caused when energy intake exceeds from daily needs of an individual and body fat stored in the adipose tissues become large in size. Leptin is the hormone released from the adipocytes and primary homeostatic signal activates hypothalamic centers that manage intake of energy and energy spending (Horvath *et al.*, 2010).

On the report of World Health Organization, 25% of medicines are manufactured from plant sources and 80% of traditional medicines are used by the population to attain their primary healthcare needs. Herbs from primitive time to till today have been used as a cure for many diseases and problems (Jain, 2017). The use of herbs for prevention and treatment of diseases is as old as human kind and some synthetic drugs are of plant origin. The medicinal desirability of these plants was usually due to the presence of phytochemical contents (Essien *et al.*, 2017).

Caromis originated in Egypt and cultivated in India, Iran, Iraq, Afghanistan and Pakistan (Jeet *et al.*, 2012). Various components of phytochemicals mainly phenolic compounds and volatile oil (thymol) are found in carom seeds. Carom essential oil showed the presence of (60%-80%) thymol components (Singh *et al.*, 2012). Carom powder is investigated to have the anti-hyperglycemic, hypolipidemic, antitussive, anti-oxidant, anti-inflammatory, antifungal, antibacterial and anthelmintic properties (Niaz *et al.*, 2013).

2. Material and Methods

2.1 Procurement of raw material

The experimentation work was accomplished in the National Institute of Food Science and Technology, University of Agriculture, Faisalabad. For the purpose, carom seeds were procured from the local market on the basis of good quality characteristics (i.e. infection free).

2.2 Preparation of raw material

Carom seeds were finely powdered in an electric grinder and mix with meal (Bhandari *et al.*, 2013).

2.3 Procurement of experimental animal

The effectuality of powdered carom seed on adipose fat and hyperlipidemia was analyzed experimental model was planned. For this purpose, sixteen rats were attained and accommodated in animal room of National Institute of Food Science and Technology, University of Agriculture, Faisalabad. Rats were adapted for a period of 1 week by the providing of regular diet and water ad libitum.

2.4 Diet-induced obesity

For the purpose of induction of obesity, we fed them on high-fat diet (ghee 2 grams) and high-fructose (4 grams) for the period of 10 days (Noeman *et al.*, 2011).

2.5 Experimental modeling

To evaluate the role of carom seed powder on fat reduction like obesity and hyperlipidemia, rat experimental model was designed. Purposely, sixteen rats were required and divided into four groups (G_0, G_1, G_2 and G_3)**:** each group contains four rats (Table 1). All groups were fed on high-fat diet for specific period to induce obesity and baseline values for different biomarkers were obtained. For 6 weeks trial of experiment, G_0 were fed normal diet as control group, G_1, G_2 and G_3 were fed normal diet with carom seeds powder 100 mg, 300 mg and 500 mg respectively, to assess the effect on obesity and hyperlipidemia.

2.6 Biochemical evaluation
Blood sample were collected on 0-day, 21 day and 42 days of trial period and following parameters were determined:

2.6.1 Serum lipid profile
Serum lipid profile of rats was estimated with commercial kits (Randox) (Lin *et al.*, 2005).

2.6.2 Serum leptin
Serum leptin was measured by ELISA method (Iwase *et al.*, 2000).

2.6.3 Blood glucose
Blood glucose was checked in glucometer (Xu, 2013)

2.7 Anthropometric measurements
Anthropometric measurements were analyzed by collecting the following data:

2.7.1 Body weight
Body weight of rats was measured in grams on weighing balance (Utkualp and Ercan, 2015).

2.7.2 Body length
Body length was measured from nose to anus by Lee Index method (Gerbaix *et al.*, 2010).

2.7.3 Body mass index
BMI of rats were calculated by dividing the weight in gram on length of rats in cm^2. Body mass index was calculated by using this formula (Gerbaix *et al.*, 2010).

2.8 Statistical analysis
All the data attained for each parameter were analyzed using appropriate statistical models (Montgomery, 2008).

3. Results
3.1 Serum lipid profile
3.1.1 High Density Lipoprotein (HDL)
Analysis of high-density lipoprotein (HDL) by the consumption of carom powder has been presented in (Table 1). Mean square revealed that diet, days and their interaction have significant effect on HDL value of rats. The statistical analysis showed that carom-based regimen is good in the management of HDL levels. There was a significant change in group, days and group verses days.

Mean value of HDL cholesterol summarizes in table 1. In normal group, HDL value was 20.62 mg/dl at 0 day and 22.18 mg/dl at 42 days. In group 1, HDL level was 20.2 mg/dl at 0 day and after 42 day it became 20.9mg/dl. In group 2 HDL level was increased from 21.0mg/dl to 23.5mg/dl at end of efficacy. Group 3 has been shown increased in HDL level from 20.0 mg/dl at 0 day to 25.0mg/dl at 42 day of study.

Highest value of HDL observed in G3 where 500mg carom powder was provided to the rats. There was little increase in HDL level in G2 while G1 has shown no change in HDL level.

3.1.2 Low Density Lipoprotein (LDL)
Mean square revealed that diet, days and their interaction have significant effect on LDL value of rats. The time period of treatment highly significantly affects the LDL level, whereas combined effect of days and treatment was significant with reference to LDL level. Statistical analysis showed that carom-based regimen is good in the management of LDL levels.

Mean value of LDL cholesterol summarizes in (Table 1). In normal group, LDL value was 69.0mg/dl at 0 day and 69.5mg/dl at 42 day. In group 1, the LDL level was 68.5mg/dl at 0 day and after 42 day it becomes 67.7mg/dl. Group 2 shown decreased in LDL level from 70.0mg/dl to 65.7mg/dl at initial and end of efficacy. Group 3 has been shown increased in LDL level from 68.5mg/dl at 0 day and 57.5mg/dl at 42 day of study.

3.1.3 Triglyceride
Mean square revealed that diet, days and their interaction have significant effect on TG value of rats. The time period of treatment highly significantly affects the TG level, whereas combined effect of days and treatment was significant with reference to TG level. This statistical analysis showed that carom-based regimen is good in the management of TG levels. There was a significant change in group, days and group verses days ($P<0.05$).

Mean value of TG cholesterol summarizes in table 1. In normal group, TG value was 50.5mg/dl at 0 day and 52.0mg/dl at 42 day. In group 1, TG level was 52.0mg/dl at 0 day and decreased after 42 day it was 50.5mg/dl. Group 2 has shown decrease in TG level from 52.2mg/dl to 46.2mg/dl at initial and end of efficacy. Whereas group 3 have been shown increased in TG level from 50.7mg/dl at 0 day and 39.5mg/dl at 42 day of study.

Significant decreased of TG observed in G3 where 500mg carom powder provided to rats. G2 TG level was little decreased by the effect of 300mg carom powder. G1 group has less decreased in TG level as compared to G2 and G3.

3.1.4 Cholesterol

Mean square revealed that diet, days and their interaction have significant effect on TC value of rats. The time period of treatment highly significantly affects the TC level, whereas combined effect of days and treatment was significant with reference to TC level. This statistical analysis showed that carom-based regimen is good in the management of TC levels. There was a significant change in group, days and group verses days ($P<0.05$).

In normal group, TC value was 78.2 mg/dl at 0 day and 80.2mg/dl at 42 day. In group 1, shown decrease in TC level was 80.0mg/dl at 0 day and after 42 day it becomes 77.0mg/dl. Group 2 shown decrease in TC level from 79.7 to 75.0mg/dl at the end of efficacy. Whereas group 3 shown increase in TC level from 79.0 mg/dl at 0 day to 42.2mg/dl at 42 day of study.

Value of TC has been observed in G3 where 500mg carom powder provided to rats then G2 TC level decreased by the effect of 300mg carom powder. G1 group has less decreased in TG level as compared to G2 and G3 while highest level observed in rats treated with normal diet.

3.2 Serum Leptin

Mean square revealed that diet, days and their interaction have significant effect on serum leptin value of rats. The time period of treatment highly significantly affected the serum leptin level, whereas combined effect of days and treatment was significant with reference to serum leptin level. This statistical analysis showed that carom-based regimen was good in the management of serum leptin levels. There was a significant change in group, days and group verses days ($P<0.05$).

Mean value of serum leptin summarizes in table 1. In normal group, serum leptin value was 18.6ng/ml at 0 day and 19.3ng/ml at 42 day. There was a significant reduction in serum leptin level of group 1 from 18.6 at 0 day to 18.4ng/ml at 42 day. Group 2 shown decrease in serum leptin level from 18.9ng/ml to 17.1ng/ml at the end of efficacy. G3 has shown no decrease in serum leptin level from 19.2ng/ml at 0 day to 13.5ng/ml at 42 day of study.

3.3 Blood glucose

Analysis of variance of glucose by the consumption of carom powder has been presented in (Table 1). Mean square revealed that diet, days and their interaction have significant effect on glucose value of rats. The time period of treatment highly significantly affects the glucose, whereas combined effect of days and treatment was significant with reference to glucose level. The statistical analysis showed that carom-based regimen is good in the management of glucose levels. There was a significant change in groups, days and group verses days ($P<0.05$).

Mean value of glucose summarizes in (Table 1). In normal group, glucose value was 114.0mg/dl at 0-day and117.7 mg/dl at 42 day. In group 1 show decreased in glucose level was from 112.5mg/dl to111.7mg/dl. Group 2 shown decreased in glucose level from 113.5mg/dl to 108.2mg/dl at the end of efficacy. Whereas group 3 shown decrease in glucose level from 119.0mg/dl at 0 day and 78.7mg/dl at 42 day of study.

Table 1Effect of carom powder on different biochemical variables of rats

Groups	HDL (mg/dl)	LDL (mg/dl)	TG (mg/dl)	TC (mg/dl)	Leptin (ng/ml)	Glucose (mg/dl)
G0	19.2±0.43	69.5±2.32	52.0±2.23	79.2±2.29	19.3±0.2	117.7±1.4
G1	20.5±0.21[c]	67.7±4.31[b]	50.5±3.31[a]	77.0±3.22[a]	18.4±0.1[a]	111.7±1.4[a]
G2	23.5±0.78[b]	65.7±2.32[c]	46.2±1.23[b]	75.0±2.98[ab]	17.1±0.9[ab]	108.2±1.8[b]
G3	25.0±0.433[a]	57.5±1.33[d]	39.5±1.09[d]	42.2±2.33[c]	13.5±0.7[d]	78.7±1.7[c]

3.4 Anthropometric measurement

3.4.1 Body weight

Analysis of variance of body weight by the consumption of carom powder has been presented in table 2. Mean values for body weight are illustrated in (Table 2). Mean square revealed that diet, days and their interaction have significant effect on body weight value of rats. The time period of treatment highly significantly affects the body weight, whereas combined effect of days and treatment was significant with reference to body weight. This statistical analysis showed that carom-based regimen is good in the management of body weight. There was a significant change in group, days and group verses days ($P<0.05$). Mean value of body weight summarizes in table 1. In normal group, body weight value was 212.5g at 0 day and 214.0g at 42 day. In group 1, decreased in body weight level was 216.0g at 0 day and after 42 day it was 204.0g. Group 2 showed decrease in body weight from 213.2g to 196.5g at the end of efficacy. Group 3 have been increased in body weight level from 213.6g at 0 day to 179.0g at 42 day of study. The study has shown the significant weight reduction by increasing the function of lipolysis.

3.4.2 Body length

Mean value of body length summarizes in table 2. In normal group, body length was13.4cm at 0 day and 13.5cm at 42 day. In group 1, there was no significant change in body length. It was 13.4cm at 0 day and after 42 day it has become 13.4cm. Group 2 shown no increase or decrease in body Length and values were 13.4cm to 13.5cm at the end of efficacy.

Table Effect of carom powder on anthropometric measurement

Groups	Body weight (g)	Body length (cm)	BMI (g/cm^2)
G0	214.0±0.87	13.5±0.2	0.76±0.42
G1	204.0±0.52[a]	13.4±0.7[b]	0.69±0.33[a]
G2	196.5±0.99[b]	13.5±0.3[b]	0.66±0.23[b]
G3	179.0±0.28[d]	13.6±0.7[b]	0.59±0.17[d]

Whereas group 3 has shown minor increase in body length from 13.6cm at 0-day to13.6cm at 42 day of study. Lowest value of the body length was observed in G3 where 500 mg carom powder provided to rats. Body length of G2 and G1has not decreased or increased significantly by the effect of 300 mg-100mg carom powder respectively. Days along with treatment not significantly affected the body length.

3.4.3 Body mass index

Analysis of variance of BMI by the consumption of carom powder has been presented in (Table 2). Mean square revealed that diet, days and their interactions have significant effect on BMI of rats. The time period of treatment highly significant effect on the BMI level, whereas combined effect of days and treatment was significant with reference to BMI level. The statistical analyses showed that carom-based regimen is good in the management of BMI levels. There was a significant change in group, days and group verses days (P<0.05). Mean value of BMI summarizes in (Table 2). In normal group, BMI value was 0.77g/cm^2 at 0 day and 0.76 g/cm^2 at 42 day. In group 1, BMI level was 0.78g/cm^2 at 0 day and after 42 day it becomes 0.69 g/cm^2. Group 2 has shown decreased in BMI level from 0.78g/cm^2 to 0.66g/cm^2 at end of efficacy. Group 3 has shown decreased in BMI level 0.78g/cm^2 at 0 day to 0.59g/cm^2 at 42 day. Lowest value of BMI observed in G3 where 500mg carom powder provided to rats, BMI level of G2 decreased by the effect of 300mg carom powder. G1 group has little decreased in BMI level.

4. Discussions

Obesity is a main health sickness with high prevalence throughout the world. The important elements in the initiation of obesity are lifestyle modification, surplus energy intake, unhealthy eating behavior and decreased physical activity. Dietary patterns, usually uncontrolled fat intake, have been responsible for the elevation of adiposity (Klop *et al.*, 2013). The main lipoprotein is high-density lipoproteins which are complex and composed of various proteins which transfer the lipid molecules to the body. They are made up of 80 proteins per particle and transport to hundreds of fat molecule particles (Ismael *et al.*, 2014). LDL cholesterol is a vital component of cell membrane, steroid hormone and precursor of bile acids. Exogenous and endogenous origination of cholesterol moved to outer cells that contain lipoproteins in plasma. The serum LDL level is not measured directly but instead is estimated from its cholesterol concentration, a measure of the total amount of cholesterol contained in LDL particles (Silverman *et al.*, 2016). The clinical study analysis has been provided powerful evidence; serum LDL was reduced by inhibiting enzyme (HMG-CoA reductase) with low fat dosage that lower the chances of hyper-lipidemia that was corresponding to the total immensity of LDL reduction (Ference *et al.*, 2012).

Earlier study was held to investigate mechanism of carom based dietary remedy in the management of lipid biomarker. In study, scientist was identified that carom raised the oxidation of lipids and value of receptors of low-density lipoprotein in liver which mitigated the triglyceride in the blood serum of animal sample (Alfenas *et al.*, 2013). Increased metabolism of fats can reduce the accumulation of lipids in the liver and less chances to get liver ailments like cirrhosis. The study demonstrated that the carom powder increased the breakdown of the lipids and maintained the triglyceride level in the body (Rogne *et al.*, 2014). The cholesterol lowering properties of plant-based herbs due to the presence of thymol oil contents. It reduced the low-density lipoprotein from the blood and increased the process of lipolysis. Natural herbs were considerably attenuated the cholesterol of animals (Maki, *et al.*, 2010). Serum leptin plays an important part in the body; it maintains the energy intake and energy output. This hormone secreted in blood and has been shown high amount in the blood of obese subjects. Serum leptin is normal in the blood of normal body mass index subjects. Leptin released to signal the CNS that managed the balance of glucose energy. Endocrine gland discharged leptin in the section of fat mass storage and shown good effects on peripheral nutrients (Rogne *et al.*, 2014). Fiber and phenolic components of carom lessen the elevated glucose in the blood. The results of the experiment revealed that carom was significantly control hyperlipidemia, obesity and fat mass storage in the body of experimental animals (Maki *et al.*, 2013)

Body weight of the rats was measured in grams on weighing balance. Herbal products increased the metabolism of the body that initiated the internal metabolic activity to reduced body fat mass (Zheng *et al.*, 2011).

Simvastatin (0.6 mg per kg weight of body) was used as an artificial cholesterol decreasing drug. Moreover, extraction of ether has shown more potent on the basis of elevating level of HDL cholesterol and lowered the LDL cholesterol than methanolic extraction of carom. Initiation of arteriole fatty deposits was more effectually minimized by chloroform extraction (Saravanan et al., 2015).

Conclusion

The study revealed that the carom and its components have nutraceutical worth to address various diet related obesity and hyperlipidemia. In the current research carom-based remedy proved effective in the management of obesity and obesity biomarkers. This remedy was also improved the HDL cholesterol of rats. Carom powder has the quality to lessen the causes of some metabolic ailments such as high blood pressure and hyperglycemia complications.

References

Deguchi, Y. and K. Miyazaki. 2010. Anti-hyperglycemic and anti-hyperlipidemic effects of guava leaf extract. Nutrition and Metabolism. 7:9-10.

Ogden, C.L., M.D. Carroll, C.D. Fryar and K.M. Flegal. 2015. Prevalence of obesity among adults and youth: United States, 2011-2014. National Center for Health Statistics. 30:1-8.

Horvath, T.L., B. Sarman, C.G. Caceres, P.J. Enriori, P. Sotonyi, M. Shanabrough and P.T. Pfluger. 2010. Synaptic input organization of the melanocortin system predicts diet-induced hypothalamic reactive gliosis and obesity. Proceedings of the National Academy of Sciences. 107:14875-14880.

Jain, D. 2017. Recent advance in antiobesity herbs.International Journal of Pharmaceutical and Biological Archive. 8: 1-5.

Essien, E.B., E.N. Onyeike, D.E. Ugbeyide and I.C. Eneke. 2012. Effect of aqueous extract of *Occimumbasilicum*leaves on some hematological and biochemical parameters of albino rats. Canadian Journal on Scientific and Industrial Research.3:256-264.

Jeet, K., N. Devi, T. Narender, T. Sunil, S. Lalit and T. Raneev. 2012. *Trachyspermumammi (ajwain)* : a comprehensive review. International Research Journal of Pharmacy. 3:133-138.

Singh, G., S. Maurya, C. Catalan and M.P. Lampasona. 2004. Chemical constituents, antifungal and antioxidative effects of ajwain essential oil and its acetone extract. Journal of Agricultural and Food Chemistry. 52:3292-3296.

Niaz, K., S. Gull and M.A. Zia. 2013. Anti-hyperglycemic/hypoglycemic effect of celery seeds (*ajwain*) in *streptozotocin* induced diabetic rats. Journal of Rawalpindi Medical College. 17:134-137.

Bhandari, U., J.K. Grover and J.N. Sharma. 2002. Effect of indigenous drugs on changes in morphology and cholesterol level of aorta in early atherosclerotic progression. HamdardMedicus. 4:56-59.

Noeman, S.A., H.E. Hamooda and A.A. Baalash. 2011. Biochemical study of oxidative stress markers in the liver, kidney and heart of high fat diet induced obesity in rats. Diabetology and Metabolic Syndrome. 3:17-22.

Lin, C.Y., C.Y. Tsai and S.H.Lin. 2005. Effects of soy components on blood and liver lipids in rats fed high-cholesterol diets. World Journal of Gastroenterology. 11:5548-5549.

Iwase, M., K. Kimura, R. Komagome, N. Sasaki, K. Ishioka, T. Honjoh and M. Saito. 2000. Sandwich enzyme linked immunosorbent assay of canine leptin. Journal of Veterinary Medical Science. 62:207-209.

Xu, Zhi. 2013. Optical spectroscopy device for non-invasive blood glucose detection and associated method of use. U.S. Patent.8:552.

Utkualp, N. and I. Ercan. 2015. Anthropometric measurements usage in medical sciences. Biomedical Research International. 1:1-7.

Gerbaix, M., L. Metz, E. Ringot and D. Courteix. 2010. Visceral fat mass determination in rodent: validation of dual-energy X-ray absorptiometry and anthropometric techniques in fat and lean rats. Lipids in Health and Diseases. 9:140-144.

Montgomery, D.C. 2008. Design and analysis of experiments.7th Ed. John Wiley and Sons.Inc. Hookon, NJ, USA.1-656.

Klop B., J.W. Elte and M.C. Cabezas. 2013. Dyslipidemia in obesity: mechanisms and potential targets. *Nutrients.*5:1218-40

Ismael, O.E., E.A. Hashish and H.A. Ali. 2014. Lipid profile and lipogenesis following corn oil truffle oil or wheat germ oil administration in albino rat. Global Veterinaria. 12:461-469.

Silverman, M.G., B.A.Ference, K.Im, S.D.Wiviott, R.P.Giugliano, S.M.Grundy, E.Braunwald and M.S. Sabatine. 2016. Association between lowering LDL-C and cardiovascular risk reduction among different therapeutic interventions: a systematic review and meta-analysis. JAMA. 316:1289-1297

Ference, B.A., W. Yoo, I. Alesh, N. Mahajan, K.K. Mirowska, A. Mewada, J. Kahn, L. Afonso, K.A. Williams and J.M. Flack. 2012. Effect of long-term exposure to lower low-density lipoprotein cholesterol beginning early in life on the risk of coronary heart disease: a mendelian randomization analysis. Journal of American College of Cardiology. 60:2631-2639.

Alfenas R.G. and R.D. Mattes. 2013. Effect of fat sources on satiety. Obesity Research. 11:183-187.

Rogne, M. and K. Tasken. 2014. Compartmentalization of cAMP signaling in adipogenesis, lipogenesis and lipolysis. Hormone and Metabolic Research. 46:833-840.

Maki, K.C., J.M. Beiseigel, S.S. Jonnalagadda, M.S. Reeves, M.V. Farmer and T.M. Rains. 2010. Whole grains ready to eat cereal, as a part of a dietary program for weight loss, reduces low density lipoprotein cholesterol in adults with overweight and obesity. Journal of the Academy of Nutrition and Dietetics.110: 205-214.

Rogne, M. and K. Tasken. 2014. Compartmentalization of cAMP signaling in adipogenesis, lipogenesis and lipolysis. Hormone and Metabolic Research. 46:833-840

Maki, A.L. 2013. Phytochemical attenuation of hyperglycemia induced retinal oxidative stress and NF-B activation in streptozotocin-induced diabetic rats. 2013. Journal of Evidence Based Complementary Alternate Medicine. 3:194-203.

Zheng, W., D.F. Mclerran, B. Rolland, X. Zhang, M. Inoue and K. Matsuo. 2011. Association between body mass index and risk of death in more than 1 million Asians. Nutrition of England Journal of Medicine. 364:719-729.

Saravanan, S. and L. Pari. 2015. Role of thymol on hyperglycemia and hyperlipidemia in high fat diet-induced type 2 diabetic C57BL/6J mice. European Journal of Pharmacology. 761:279-287.