Effect of some herbal plants on hyperlipidimia in rats

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Abstract: Elevation of lipids or fatty substances in the blood is known as hyperlipidemia, mainly in the form of cholesterol and triglycerides. The fatty materials during their passage in the circulation can conjugated with proteins, then it known as hyperlipoproteinemia. **Objective**: The current work was designed to explore the impact of amla and cinnamon of nutritional status on albino rats suffering from hyperlipidemia. **Material and Methods**: cinnamon and amla which purchased from local market in Cairo Egypt. Thirty sex male albino rats (200g) were used in this research and divided for two main groups. The first main group (6 rats) was kept as control negative group and was fed on basal diet. The 2nd main group (30 rats) was fed on high fat diet (19% saturated fat+1% oil) for 4 weeks to induce hyperlipidemia. After 4 weeks, hyperlipidemic rats were classified into 4 subgroups. Subgroup (1): fed on high fat diet and kept as positive control group. Subgroups (2,3): fed on high fat diet containing 1% and 1.5% cinnamon, respectively). Subgroups (4,5) fed on high fat diet containing 1% and 1.5% amla, respect.). **Results:** The chemical composition of amla showed a higher value of moisture, carbohydrate, protein, while cinnamon showed a higher value of carbohydrate, fiber and protein. A significant decrease in body weight, triglycerides, total cholesterol, LDL cholesterol, liver enzymes and significant increase in high density lipoprotein. **Conclusion:** Increasing the awareness of people with regard to the treatment effect of Amla and Cinnamon against diseases specially hyperlipidemia. Because these plants play an important role in the improvement of HDL- cholesterol.
[Hoda M. El Gezery and Asmaa E. Mostafa. **Effect of some herbal plants on hyperlipidimia in rats.** *Nat Sci* 2018;16(11):190-196]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 25. doi:10.7537/marsnsj161118.25.

Keywords: Amla - cinnamon - hyperlipidemia.

1. Introduction

Hyperlipidemia or hypercholesterolemia/ hyperlipoproteinemia is a medical state characterized by an increase of one or all lipid profile and/or lipoproteins in the serum. Even if increased in LDL (low density lipoprotein cholesterol) is considered the most excellent sign of atherosclerosis risk, from other side, dyslipidemia (drop in lipids in the blood) can in addition explain an elevation in the total cholesterol (TC) or triglycerides (TG), or low levels of HDL (high density lipoprotein cholesterol) **(Amit et al., 2011).**

Many authors reported that Hyperlipidemia is responsible for occurring of cardiovascular diseases (CVDs) which is the main cause of 1/3 of mortality in the world and may the major cause of mortality and disability by the year 2020 worldwide **(Ginghina, et al., 2011 and Jorgensen, 2013).**

Hyperlipidemia may be attributed to many factors, either due to genetic disorders and/or feeds containing high levels of saturated fats and cholesterol. The high in fat content in the diet in many developing countries worldwide is the main cause of elevated lipid levels in the population **(Norma, 2005).** Feeding on HFD for about 3-4 weeks HFD was adequate to initiate obesity in experimental animals, and this model of obesity was strongly similar to that occur in human beings. The obesity induced dyslipidemia model was effectively settled in our work as shown by significant increase of cholesterol (TC), triglyceride (TG), DL-c **(Bhatt et al., 2006).**

Amla (*Emblica officinalis)* is a small size perennial plant which height doesn't exceed one meter which original natural home is in Asia, Africa and South America. It is a black pear-shaped fruit that looks like nutmeg fruit. It tastes good so similar to hibiscus in taste and smell. Amla has a high nutritional value for containing vitamin C and some other minerals such as calcium, iron and phosphor. It also contains the phenol compounds such as Tanning – Ratin and all parts of the plants are used for medical purposes **(Krishanaveni and Mirunalin, 2010).**

Cinnamon *(Cinnamomum zeylanicum),* belongs to the Lauraceae family and considered the unending tree of tropical medicine,. Cinnamon is one of the mainly imperative spices consumed daily by individuals in the world. The main compositions of cinnamon are vital oils and other components, like cinnamic acid, cinnamaldehyde, and cinnamate **(Pasupuleti and Siew, 2014).** Cinnamon is a small tree grown in many tropical countries. Cinnamon is harvested from the inner bark of trees that have been dried to sticks and grind to a fine powder **(Dugoua et al., 2007)**. In addition, **Anderson et al. (2004)** reported that cinnamon contains polyphenolic polymers that possess antioxidant activity

representing in it is ability to diminish oxidative stress in dose dependent way through suppression of 5-lipoxygenase enzyme.

The current work was designed to investigate the impact of two levels of dried amla and cinnamon on albino rats suffering from hyperlipidemia.

2. Material and Methods

This study was carried out using amla and cinnamon which purchased from local market in Cairo Egypt. Casein, vitamins, minerals, methionine and choline choleride were purchased from El-Gomhoreria Company. Oil and starch were obtained from local market in Cairo Egypt.

Kits were purchased from Gamma trade company Cairo Egypt.

Amla and cinnamon used in this study were chemically analyzed for its content of protein, moisture, ash, fat, fiber and carbohydrate.

Analytical methods:

Moisture, protein, ash, fat, fiber and carbohydrate were determined by the methods described by **A.O.A.C. (1990).**

Biological investigation:

Experimental animals: Thirty six male albino rats spargue dawley strain weighing (200 ± 10 g) were housed individually in wire cages under hygienic condition and fed on basal diet for one week for adaptation.

The basal diets were prepared according to the methods of **Reeves et al., (1993).** Basal diet consist of protein (14%), fat (4%), salt mixture (3.5%), vitamin mixture (1%) choline-chloride (0.25%) cellulose (5%), L-cystein (0.18%) and the remainder was starch. The salt and vitamin mixture were prepared according to **A. O.A.C. (`1975).**

Preparation of Hyperlipidemia rats:

After feeding on basal diet for one week for adaptation, rats were divided into two groups. The first group (6 rats) was fed on basal diet; the second group (30 rats) were fed on high fat diet (19% saturated fat + 1% oil) for four weeks to induce obesity and hyperlipidemia The rats in the second main group were divided into (6subgroups):

Subgroup (1): hyperlipidemic rats fed on high fat diet as positive control group.

Subgroup (2): hyperlipidemic rats fed on high fat diet containing 1% amla.

Subgroup (3): hyperlipidemic rats fed on high fat diet containing 1.5% amla.

Subgroup (4): hyperlipidemic rats fed on high fat diet containing 1% cinnamon.

Subgroup (5): hyperlipidemic rats fed on high fat diet containing1.5 % cinnamon.

At the end of the experiment (6 week), biological value of different diets was assessed by determination of feed intake and body weight percent, according to the method of **Chapman et al., (1959)** using the following equation:-

$$BWG\ \% = \frac{Final\ weight - Initial\ weight}{Initial\ weight} X100$$

Biological Evaluation:

At the end of the experiment the rats were starved for 12 hour, and then sacrificed under ether anesthetized. Blood samples were collected from portal vein by the means of fine capillary glass tubes according to the method described by **Schermer (1967).**

Blood samples were received into clean dry centrifuge tube and left to clot at room temperature, then centrifuged for 10 minutes at 3000 r.p.m to separate the serum. Serum was carefully separated into dry clean Wasserman tubes by using a Pasteur pipette and kept frozen at (-20^{o} C) till analysis.

Biochemical Analysis:

Serum samples in all groups were analyzed for the following Biochemical parameters i.e.

Serum cholesterol according to **Allain et al. (1974).** triglycerides according to **Fossati and Principe (1982).** HDL-c was determined according to **(Albers et al., 1983).** According to **(Fridewald et al., 1972),** low density lipoprotein cholesterol was calculated as follows; LDL-c (mg / dl) = Total cholesterol - (Triglycerides /5 + HDL-c), and very low density lipoprotein cholesterol was calculated as follows; VLDL-c (mg / dl) = Triglycerides /5.

Statistical analysis:

The results expressed as mean ± SD, arid performing using student (t) test. The obtained results will be analyzed to determine the degree of significances between different groups ($p \leq 0.05$) using one way analyzing of various (ANOVA) **(SAS, 1985).**

3. Results and Discussion:

Chemical composition of cinnamon and amla (g/100g on dry weight basis) were shown in table (1). Results indicated that moisture, protein, fat, ash, fiber and carbohydrate in cinnamon and amla were (2.06, 3.99, 1.24, 1.05, 8.00 and 83.66 g/100g) and (80.2, 1.5, 0.1, 4.1, 3.4 and 14.1 g/100g) respectively.

In this respect **Margaret, (2011)** found that cinnamon bark is associated with several important nutritional benefits, and rich with essential elemnets like vitamin K and iron, and in addition, contains manganese, calcium, and dietary fiber. Cinnamon is physically low in sugar and fat, and have an ability to insert taste and appetite to food with no increasing in the levels of fat, sugar or calories. In addition to

cinnamon is also an excellent source of manganese, calcium, iron and dietary fiber **(Dugoua et al., 2007).**

Phytochemical screening of *Emblica officinalis* indicated that it contains alkaloids, tannins, amino acids, carbohydrates and phenolic compounds. Whereas, fruit juice of *Emblica officinalis* holds the highest content of vitamin C (478.56 mg/100 ml), in addition to several essential components were isoolated from *Emblica officinalis* such as ellagic acid, gallic acid, 1-O-galloyl-beta- D-glucose, 3,6-di-O-galloyl-Dglucose, quercetin, chebulinic acid, corilagin, chebulagic acid, and isostrictiniin **(Khan, 2009)**. Another study showed that *Emblica officinalis* has nutritious and dietary source of minerals and amino acids. It contains calcium, carbohydrates, fats, gallic acid, glutamic acid, magnesium, protein, sulphur, and tannins **(Jha, 2007).**

Table (1): Chemical composition of Cinnamon and Amla (g/100gdry weight basis).

Analysis	Moisture	Protein	Fat	Ash	Fiber	Carbohydrate
Cinnamon	2.06	3.99	1.24	1.05	8.00	83.66
Amla	80.2	1.5	0.1	4.1	3.4	14.1

Data in table (2) revealed that the average value of feed intake for normal rats (control negative) and untreated hyperlipidemic group (control positive) were 14.94±1.1 g/day & 14.61±1.0 g/day respectively. Feed intake was increased in hyperlipidmic group that treated with 1% cinnamon and 1.5% amla, while there was no significant differences were observed between hyperlipidemic groups that treated with 1.5% of cinnamon and 1% of amla and control negative and positive groups.

The results in this table showed that, body weight gain% for healthy rats group (control negative) was 29.66±2.94 g/day. While, the body weight gain % for untreated hyperlipidemic group (control positive) was 28.33±2.94 g/day. It could be observed that there were no significant variation in body weight gain% among control negative and positive groups. The highest weight gain% was recorded for group that treated with 1.5% of amla, followed by group treated with 1% of cinnamon. Even, there were a statistical significant differences were recorded between them and control positive and negative groups.

Vafa, et al. (2012) indicated that consuming (3gram) daily of cinnamon for a period of 8 weeks resulted in a significant drop in anthropometric parameters in comparison with basic body weight which decreased by 1.19%, while BMI recorded a drop of about 1.54%, whereas, fat body mass reduced by 1.36%) in 44 subjects suffering from diabetes type 2. Moreover, **Couturier et al. (2010)** found that addition of cinnamon can alters body contents in an involvement with enhanced insulin sensitivity in experimental animals fed a high fat or high fructose diet to provoke insulin resistance.

Table (2):- Effect of Cinnamon and Amla on daily feed intake and body weight gain% of hyperlipidemic rats.

Parameters Groups		**Daily feed intake (g)**	**Body weight gain %**
Control (-)		14.94±1.1^{b}	29.66±2.94^{bc}
Control (+)		14.61±1.0^{b}	28.33±2.94^{c}
Cinnamon	1%	17.16±1.7^{a}	33.0±5.76^{b}
	1.5%	14.82±1.7^{b}	25.66±4.96^{d}
Amla	1%	13.46±2.9^{b}	24.0±6.69^{d}
	1.5%	18.71±3.6^{a}	43.0±13.25^{a}

The results presented in table (3) showed that the average value of serum cholesterol and triglycerides elevated significantly in hyperlipidemic group which fed on high fat diet, in comparison with healthy group (174.29±10.08 and 126.41±3.62 mg/dl) (84.28±6.19 and 70.27±3.78mg/dl) respectively.

Treatment hyperlipidmic groups with two levels of cinnamon and amla significant decreased in lipid profile as compared to control group (untreated group). The lowest in serum cholesterol was recorded for group treated with 1.5% of amla followed by 1% of cinnamon, while the lowest serum triglycerides were recorded for group treated with 1% of amla and 1.5% cinnamon.

Cinnamon may improve lipid profile by inhibiting hydroxymethylglutaryl Co A (HMG-COA) reductase involves in cholesterol syntheses **Kannappan, et al. (2006).** Also, **Qin et al. (2003)** showed that cinnamon possesses lipid inhibiting affect through lipase action. **Khan, et al. (2010)** showed that 1.5 g cinnamon /day led to significantly reduce in the mean values of glucose, triglycerides and cholesterol, while HDL and LDL cholesterol were not affected in fourteen diabetic individuals.

Sonia, et al. **(2013)** found that supplementation with 15% cinnamon powder lowering significantly the serum TC (12%, P<0.01), TG (11%, P<0.01) and LDL-C (14%, P<0.05) of fatty combination diet fed rats; while HDL-C intensity was not altered significantly, Moreover, **Soheir et al. (2010)** given 15% of cinnamon powder in a diet for hypercholesterolemic diabetic rats, and observed that plasma cholesterol dropped from 268 to 121 mg/dL (54%), TG concentration from 228 mg/dL to 100 mg/dL (56%) and LDL-C decreased from 211 mg/dL to 61 mg/dL (71%) and HDL-C elevated from 36 mg/dL to 63 mg/dL (75%).

Walia, et al. (2015) reported ethanolic extract of *Emblica officinalis* may reduces cholesterol synthesis by inhibiting HMG Co-A reductase activity. Another hypothesis is that the possible polyphenolic compounds of Emblica officinalis might have interfered and counteracted lipid peroxidation. Other studies support these results, **Santhi, et al. (2013)** suggested that feeding on one medium sized of Amla (35g) for a period of 6 months was accompanied by a significant drop in the HbA1c, FBS, and Lipid profile values in 30 diabetic patients, while **Pallavi, et al. (2017)** found that Supplementation of extract *Emblica officinalis* EEO (100 mg/kg/bw) in feed rich with high fat content (30%) resulted in improvement of both lipid and glycemic profiles.

Table (3): Effect of Cinnamon and Amla on serum cholesterol and triglycerides of hyperlipidemic rats.

Parameters Groups		Serum total cholesterol (mg/dl)	Serum triglycerides (mg/dl)
Control (-)		84.28±6.19^{d}	70.27±3.7^{d}
Control (+)		174.29±2.5^{a}	126.41±3.62^{a}
Cinnamon	1%	148.02±5.81^{b}	125.39±3.96^{a}
	1.5%	155.91±4.77^{b}	119.03±2.7^{b}
Amla	1%	148.45±5.33^{b}	109.96±1.79^{c}
	1.5%	132.28±4.77^{c}	115.70±3.30^{bc}

Results of table (4) showed that, serum HDL, LDL-C cholesterol and VLDL for healthy rats group (control negative) was (43.99±6.67- 26.24±5.33 and14.05±0.75), respectively. While, serum HDL, LDL - cholesterol, and VLDL for untreated hyperlipidemic group (control positive) was (30.44±2.05- 118.57±14.90 and 25.28±0.72) respectively.

Current work, rats feeds on diet rich with fat content resulted in elevation in serum LDL-cholesterol, and VLDL at the same time as decrease in HDL- cholesterol in the serum. Treatment hyperlipidmic groups with two levels of cinnamon and amla led to significant drop in serum LDL-cholesterol, and VLDL, whereas increase in serum HDL- cholesterol as versus control group (untreated group).

Serum LDL and VLDL were decrease for hyperlipidmic group that treated with two levels of cinnamon and amla, while the lowest serum LDL was recorded for group treated with 1.5% of amla and 1% of cinnamon while the lowest serum VLDL was recorded for group treated with 1% of amla and 1.5% of cinnamon. In this study the best result in serum HDL-c was recorded for hyperlipidmic group that treated with1.5% cinnamon followed by 1.5% amla.

Previous studies on human beings revealed that cinnamon can inhibit lipid peroxidation and elevate total antioxidant potency in healthy individuals **(Hasani-Ranjbar el al., 2009).** Also, **Ranjbar et al. (2006)** In a cross-sectional study found that cinnamon could augment total antioxidant capability and reduce lipid peroxidation in normal individuals. In addition, **Khan et al. (2004)** demonstrated that giving of 1, 3, or 6 g of cinnamon daily decreased serum LDL cholesterol, glucose, cholesterol and total triglyceride in diabetic type 2 patients and proposed that the addition of cinnamon in the meals of diabetic type 2 peoples will decrease risk factors accompanied with diabetes and CVD illness.

Amla extract is responsible for suppressing synthesis of cholesterol via inhibiting hydroxy-3-methylglutaryl-Coenzyme A reductase action and increasing HDL (high-density lipoprotein) concentration to augment reverse cholesterol transport **(Anatony et al., 2008)**. A new study showed that supplementation *Emblica officinalis* to high fat diet (HFD) fed rats led to significant changes in lipid profile by redistribution of lipoproteins possibly through its bioactive compounds like flavonoids which are capable to prevent LDL oxidation **(Patel, et al 2013).**

Jeevangi et al. (2013) reported that taking of 540mg/kg b.wt. of the amla powder for experimental animals already fed on ration of high fat content, resulted in a significant drop in all studied parameters and induced hypolipidemic and antihyperlipidemic effects with a significant elevation in the serum HDL.

similar findings were reported in a study by **Walia and Mathur (2017)** observed that 30gm of amla powder supplementation per day for a period of 40 days the mean values for BMI and triglyceride, total cholesterol, LDL-C & VLDL-C levels were decreased as well as a significant increase in HDL levels in 30 subjects suffering from hyperlipidimia.

Table (4): Effect of Cinnamon and Amla on serum lipoproteins of hyperlipidemic rats.

Parameters Groups		HDL- cholesterol mg\dl	LDL– cholesterol mg\dl	VLDL mg\dl
Control (-)		43.99±6.67^{b}	26.24±5.33^{e}	14.05±0.75^{d}
Control (+)		30.44±2.05^{a}	118.57±14.90^{a}	25.28±0.72^{a}
Cinnamon	1%	45.74±7.12^{b}	77.19±12.71^{c}	25.07±0.79^{a}
	1.5%	50.65±10.10^{b}	81.44±8.27^{b}	23.80±0.91^{b}
Amla	1%	43.33±5.67^{b}	83.11±6.19^{b}	21.99±0.64^{c}
	1.5%	47.59±5.71^{b}	61.54±3.30^{d}	23.14±0.66^{bc}

Results of table (5) showed that, serum AST and ALT for healthy rats group (control negative) was (150.83±2.48 and 35.66±2.8) respectively. While, serum AST and ALT for untreated hyperlipidemic group (control positive) was (252.66±4.08 and 63.16±16) respectively. The average value of serum AST and ALT elevated significantly in hyperlipidemic group (contain high fat content in the diet) versus healthy control group (252.66±4.08 and 63.16±16) vs (150.83±2.48 and 35.66±2.8) respectively.

Feeding hyperlipidmic groups on two levels of cinnamon and amla induced significant drop in liver enzymes versus control +ve group (untreated group). The lowest results in serum AST and ALT were recorded for groups treated with 1% of amla followed by 1.5% of cinnamon.

Askariet et al., (2014) suggested that taking 1500 mg cinnamon daily may be effective in improving NAFLD (Nonalcoholic fatty liver disease characteristics) by decreasing ALT (alanine aminotransferase) and AST (aspartate aminotransferase). A new study showed that combination of ginger and cinnamon could decrease concentration of triglyceride (TG), total cholesterol (TC), very LDL cholesterol + LDL cholesterol (VLDL-C + LDL-C) and increase (HDL-C) in plasma. In addition ginger and cinnamon mixture decrease levels of AST and ALT enzymes but the level of total protein and albumin in plasma was unchanged **(Salah and Reham, 2016).**

Generally, the the serum glutamic pyruvic transaminase (SGPT) and serum glutamic oxaloacetic transaminase (SGOT) are definitive indicators of liver parenchymal injury. **Bheemshetty, et al. (2015)** reported significant decrease on SGOT and SGPT levels in mice treated with amla as compared to control. In maybe due to *Embilica Officinalis* (amla) contains many liver tonic which can be used against acute viral hepatitis and other liver disorders **(Rehaily, et al., 2002).**

In support of present findings, oral administration of *Emblica officinalis* (200mg/kg b.wt.) recovers all these alterations at their standard physiological level which is an indication of remedial effect of E. officinalis on SO2 induced hepatotoxicity **(Madhuri and Asha, 2016).** On another hand the extract of *Phyllanthus emblica Linn* was found to be enhance liver function by normalizing the activity of liver-specific enzyme alanine transaminase (ALT) **(Shamim et al., 2009).**

Table (5):- Effect of cinnamon and amla on serum liver enzymes of hyperlipidemic rats.

Parameters Groups		AST U/L	ALT U/L
Control (-)		150.83±2.48^{a}	35.66±2.8^{a}
Control (+)		252.66±4.08^{d}	63.16±16^{c}
Cinnamon	1%	201.66±25.37^{c}	56.66±3.88^{b}
	1.5%	177.0±24.85^{b}	50.66±4.08^{b}
Amla	1%	172.5±18.38^{b}	48.66±2.42^{b}
	1.5%	179.66±50^{b}	70.0±4.33^{c}

4. Conclusion

In conclusion, all dried plants used effectively reduced serum triglyceride, total cholesterol and

lipoproteins levels as the experimental period progressed. However, additional researches are required to recognize active constituents in the polyphenol-rich fraction of *Emblica* and *Cinnamon* and to explain the mode of the protective action against the metabolic syndrome.

References

1. Albers N, Benderson V, and Warnick G, (1983):- "Enzymatic determination of high density lipoprotein cholesterol". *Selected. Methods. clin. Chem. 10: 91-99.*
2. Allain C, Poon L, and Chan C, (1974):- Enzymatic determination of total serum cholesterol. *Clin. Chem., 20:470 – 475.*
3. Amit G, Vandana S, and Sidharth M, (2011):- Hyperlipidemia: An Updated Review. *Inter J of Biopharma & Toxicol Res; 1:81-89.*
4. Anderson R, Broadhurst C, Polanski M, Schmidt W, Khan A, Flanagan V, Schoene N, and Graves D, (2004): Isolation and characterization of polyphenol type-A polymers from Cinnamon with insulin-like biological activity. *J. Agric. Food Chem., 14;52(1):65-70.*
5. Antony B, Benny M, and Kaimal T, (2008):- A pilot clinical study to evaluate the effect ofemblica officinalis extract on markers of systemic inflammation and dyslipidemia. *Ind J Clin Bioch. 23(4) 378-381.*
6. *A.O.A.C. (1975):*- Official methods of analysis of association of official agricultural chemiste, Washington, D.C.
7. A.O.A.C (1990):- Official methods of the association of official analytical chemists is Th Ed-published by the association of official analytical chemists virgenia USA.
8. Askari F, Rashidkhani B, and Hekmatdoost A, (2014):- Cinnamon may have therapeutic benefits on lipid profile, liver enzymes, insulin resistance, and high-sensitivity C-reactive protein in nonalcoholic fatty liver disease patients. *Nutrition Research Volume 34, Issue 2 Pages 143-148.*
9. Bhatt B, Dube J, Dedousis N, Reider J, and O'Doherty R, (2006): Diet-induced obesity and acute hyperlipidemia reduce IκBα levels in rat skeletal muscle in a fiber-type dependent manner. *American Journal of Physiology - Regulatory, Integrative and Comparative Physiology. 290 (1):R233-R240.*
10. Bheemshetty S, Shankreppa D, and Potekar R, (2015):- Effect of Ethanolic Extract of *Emblica Officinalis* (*Amla*) on Pathophysiology of Liver in Hyperlipidemic Albino Wister Rats. *International Journal of Pharma and Bio Sciences July; 6(3): (B) 362 - 372.*
11. *Chapman D, Castilla R, and Campbell J, (1959):*- "Evaluation of protein in food. A method for the deter-mination of protein and food efficiency ratio". *J. Biochem. Physical; 37: 679-686.*
12. *Couturier K, Batandier C, Awada M, Hininger-Favier I, Canini F, Anderson R, Leverve X, and Roussel A, (2010).* Cinnamon improves insulin sensitivity and alters the body composition in an animal model of the metabolic syndrome. *Arch. Biochem. Biophys., 501(1):158-1561.*
13. Dugoua J, Seely D, Perri D, Cooley K, Forellin T, Mills E, and Koren G, (2007): From type 2 diabetes to antioxidant activity: a systematic review of the safety and efficacy of common and cassia Cinnamon bark. *n. J. Physiol. Phanvacol., 85:837-847.*
14. Fassati P, and Prencipe L, (1982): Determination of serum triglycerides. *Clin.Chem.*
15. Friedewald W, Leve R, and Fredrickson D, (1972): Estimation of concentration of low density lipoproteins separated by three different methods. *Clin. Chem. 28:2077.*
16. Ginghina C, Bejan I, and Ceck C, (2011):-Modern risk stratification in coronary heart disease. *J.Med. Life.* 4(4): 377-86.
17. Hasani-Ranjbar S, Larijani B, and Abdollahi M, (2009):- A systematic review of the potential herbal sources of future drugs effective in oxidant-related diseases. *Inflamm Allergy Drug Targets; 8(1):2–10.*
18. Jeevangi S, Manjunath S, and Sakhare P, (2013):- A Study of Anti-Hyperlipidemia, Hypolipedimic and Anti-Atherogenic Activity of Fruit of Emblica Officinalis (Amla) in High Fat Fed Albino Rats. *International Journal of Medical Research & Health Sciences; 2(1):70-77.*
19. Jha N, (2007):- Emblica officnalis. *Indian gooseberry. Amla. Phytopharm; 8:3-25.*
20. Jorgensen T, Capewell S, Prescott E, Allender S, Sans S, and Zdrojewski T, (2013):- Population-level changes to promote cardiovascular health. *Eur. J. Prev. Cardiol*., 20(3):409-21.
21. Kannappan S, Jayaraman T, Rajasekar R, Ravichandran M, and Anuradha C, (*2006):*- Cinnamon bark extract improves glucose metabolism and lipid profile in the fructose-fed rat. *Singapore Med J., 47: 858-863.*
22. Khan A, Flanagan V, Schoene N, and Graves D, (2004): Isolation and characterization of polyphenol type -A polymers from Cinnamon with insulin-like biological activity. *J. Agric. Food Chem.; 52 (1):65 – 70.*
23. Khan K, (2009): Role of *Emblica Officinalis* in medicine. A review Botany *Research International 2(4) 218-228.*
24. Khan R, Khan Z, and Shah S, (2010):-Cinnamon May Reduce Glucose, Lipid and Cholesterol Level in Type 2 Diabetic Individuals. *Pakistan Journal of Nutrition 9 (5): 430-433.*
25. Kishor M W, Brocks D R, Lee S D, Sachs-Barrable K, and Sheila J, (2008): Impact of lipoproteins on the biological activity and disposition of

hydrophobic drugs: implications for drug discovery. *Nature Reviews Drug Discovery 7, 84-99.*

26. Krishnaveni M, and Mirunalini S, (2010): Therapeutic potential of ("Amla" *Phyllanthus emblica*) the ayurvedic wonder. *Journal of Basic and Clinical Physiology and Pharmacology, 21 (1): 93 – 105.*
27. Madhuri Y, and Asha A, (2016):- Effect of *Emblica Officinalis* against So2 Induced Hepatotoxicity In Wistar Rats International. *Journal of Pharma and Bio Sciences Oct; 7(4): (B) 130 – 136.*
28. Margaret W, (2011): Vitamins and minerals of cinnamon, USDA food nutrient- Database: 380 – 3.
29. Norma E, (2005):-Atherosclerosis-An Inflammatory Process. *J Insur Med;37:72-75.*
30. Pallavi S, Bheemshetty S, Manjunatha R, and Kusal K, (2017):- Effect of Ethanolic Extract of *Emblica officinalis* (Amla) on Glucose Homeostasis in Rats Fed with High Fat Diet. *Journal of Krishna Institute of Medical Sciences University Vol. 6, No. 3, July-September.*
31. Pasupuleti V R, and Siew H G, (2014):- Review Article Cinnamon: *A Multifaceted Medicinal Plant Hindawi Publishing Corporation Evidence-Based Complementary and Alternative Medicine Volume, Article ID 642942, 12 pages.*
32. Patel S, Goyal R, Shah R, Tirgar P, and Jadav P, (2013):- Experimental study on effect of hydroalcoholic extract of Emblica officinalis fruits on glucose homeostasis and metabolic parameters. *Ayu; 34(4):440-44.*
33. Picchi M, Mattos A, Barbosa M, and Duarte C, (2011):- A high-fat diet as a model of fatty liver disease in rats. *Acta Cir Bras; 26(2): 25-30.*
34. Qin B, Nagasaki M, Ren M, Bajotto G, Oshida Y, and Sato Y, (2003):- Cinnamon extract (t radit ional herb) potentiates in vivo insulin-regulated glucose ut ilizat ion via enhanced insulin signaling in rats. *Diabetes Res Clin Pract.,62:139–148.*
35. Ranjbar A, Ghasmeinezhad S, Zamani H, Malekirad A, Baiaty A, Mohammadirad A, and Abdollahi M, (2006):- Antioxidative stress potential of Cinnamomumzeylanicum in humans: a comparative cross-sectional clinical study. *Therapy; 3(1):113–117.*
36. Reeves P, Nielsen F, and Fahey G, (1993): AIN-93 purified diets for laboratory rodents: final report of the American Institute of Nutrition ad hoc writing committee on the reformulation of the AIN-76A rodent diet. *J. Nutr. 123:1939–1951.*
37. Rehaily AJAI, Howiriny TAAl, and Sohaibani MOAI, (2002):- Gastro protective role of (Amla) Emblica-officinalis on in vivo test models in rats. *Phytomedicine, 9:515–22.*
38. Salah M, and Reham A, (2016):- Effect of Combined Administration of Ginger and Cinnamon on High Fat Diet induced Hyperlipidemia in Rats. *Journal of pharmaceutical, Chemical and Biological Sciences; 3(4): 561-572.*
39. Santhi K.V., Jalaja, D, and Sivannarayana G, (2013):-Effect of Amla, an approach towards the control of Diabetes mellitus. *Int. J. Curr. Microbiol. App.Sci 2(9): 103-108.*
40. S.A.S (1985):"Vsers guide statistic" Cary, Nc: S.A.S. Institute.
41. *Schermer S, (1967):* The blood morphology of laboratory animals. *Long Mans, Printed in Great Britain, Green and Co. LTD PP. 350.*
42. Shamim A, Qureshi I, Warda A, and Viqar S, (2009): The Effect of Phyllantus Emblica linn on type - II diabetes, triglycerides and liver - specific enzyme. *Pakistan J. of Nutrition 8 (2): 125-128, ISSN 1680-5194.*
43. Soheir N, Amal M, and Hessa M, (2010):- Anti-diabetic effect ofcinnamon powder and cinnamon aqueous extract on serum glucose of rats. *International Journal of Food, Nutrition and Public Health; 3(2): 183--197.*
44. Sonia R, Halima B, Zaida R, Ferdous A, and Jalaluddin I, (2013):- Effect of Cinnamon (Cinnamomum cassia) as a Lipid Lowering Agent on Hypercholesterolemic Rats. *Journal of Enam Medical College Vol 3 No 2 July.*
45. Vafa M, Mohammadi F, Shidfar F, Sormaghi M S, Heidari I, Golestan B, and Amiri F, (2012):-Effects of cinnamon consumption on glycemic status, lipid profile and body composition in type 2 diabetic patients. *Int J Prev Med.;3(8):531–536.*
46. Walia K, Boolchandani R, Dhand S, and Antony B, (2015):-Improving glycemic & lipidemic profile with amla powder (Emblica officinalis) supplementation in adults with type 2 diabetes mellitus. *IJBAMS; 5(2):251-58.*
47. Walia K, and Mathur R, (2017):- Impact of amla (emblica officinalis) powder supplementation on lipid profile and body mass index in hyperlipidemic obese adults. *Kaav International Journal of Arts, Humanities & Social Sciences.Vol-4/Iss-2/A56 Page No-329-334.*

10/31/2018