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Nutritive Value and Hypolipidemic Effects of Mulberry Leaves Powder

KEYWORDS: Mulberry-leaves . Total phenolic compounds . Growth-parameters .Hypolipidemic-effect .Serum lipids.

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ABSTRACT *The present work was carried out to evaluate nutritive value of mulberry (Morusalba) leaves powder. Chemical analyses revealed that dry matter (DM) was 6.81%, crude protein 27.14%, ash content 15.68%, fibers content 26.47%, crude fat 1.93% and 28.78% for carbohydrates. The caloric values were calculated as 241.05 Kcal./100g. Among minerals, calcium content was 1493.22, iron 27.06 and 2.18 mg/100g for zinc. Magnesium, phosphorus, sodium and potassium content were 533.24, 370.91, 58.62 and 1239.07 mg/100 gm, respectively. Concentrations of total phenolic compounds, tannins, alkaloids and saponin were within safe range. For growth parameters, weight gain improved in cholesterolemic rats fed on mulberry leaves powder (16.62gm) as compared topositive control group (12.09gm). Highest food conversion rate (FCR) was found in positive control group (0.84) thencholesterolemic rats (0.65) whereas the lowest FCR was for negative control group (0.41). These results indicated that specific growth rate (SGR) values of rat groups were significantly high related with final weight. Effects of mulberry leaves powder on serum lipid profile were studied. Oral administration of mulberry leaves powder of 25% for three and six weeks produces significant (P<0.001) reduction of serum total cholesterol (from 99.07 to 81.29 mg/dl), triacylglyceride (from 91.01 to 83.62 mg/dl) and LDL-cholesterol (from 43.76 to 12.92 mg/dl) in hypercholesteremic group. This administration also led to increase of HDL-cholesterol (from 37.11 to 51.63 mg/dl). The present study suggests that mulberry leaves powder would be considered as effective agent to improve growth rate and to lower lipid in cholesterolemic rats.*

Introduction

Hyperlipidemia is the current medical as well as social problem, as it leads to increase morbidity and mortality. The major risk factors of hyperlipidemia are associated with atherosclerosis which predisposes ischemic heart disease and cerebrovascular disease **(Brown and Goldstein 1986).**In the present century modern medicine draws its nourishment from the rich legacy of traditional medicine. Mulberry(*Morusindica L.* cv. Anantha) is one of the oldest medicinal plants, dating back to Hippocrates and ancient Egyptian times,Mulberry leaves, bark, and branches have long been used in Chinese medicine for healing of various health-related problems. Leaves of mulberry species have been widely consumed in Korea, Japan, and Chile.**(Jensen 1992 andEnkhmaaet al.2005).** The leaves of mulberry are nutritious, palatable, nontoxic and also enriched with different active principles**(Andallu and Vardacharyulu2009).**Mulberry leaves, rich in protein, fibers, minerals and vitamins C, contain trigonelline bases, glycoproteins Moran A, which have been found to possess antidiabetic effect **(Andallu and Vardacharyulu 2003).**

Dietary mulberry showed hypoglycemic andhypolipidemic effects in certain animal models **(El-Beshbishyet al2006).** Mulberry leaves have also been found to be rich sources of other protective nutrients such as zinc and ascorbic acid **(Gopalanet al. 1999).**

Studies have also shown that young mulberry leaves taken from the top part of the branches in summer contained the highest amount of DNJ (1-deoxynojirimycin), After optimization of the harvesting and drying processes for young mulberry leaves (*Morus alba L.* var. Shin ichinose), DNJ-enriched powder (1.5%) was produced **(Kimura et al. 2007).** A compound shown to inhibit the action of the glucosidase enzyme that controls the digestion of carbohydrates, because it promotes better blood glucose control and weight management also reduce serum lipids in experimental animals**(lee Zhong 2006 and Stephen 2007).**

The objectives of the present investigation were to evaluate the nutritive value of mulberry (Morusalba) leaves powder, minerals content, to estimate the concentration of total phenolics, tannins, alkaloidsmsaponin and to demonstrate the effect of mulberry leaves powder on lipid profile parameters in hyper-lipidemic rats.

Materials and Method

Mulberry leaves *(Morusalba)*were obtained from Sewa, MarsaMatroh, Egypt.

Preparation of mulberry leaves powder

The collected leaves were separated from the trees and cleaned thoroughly by washing. Then clean leaves were dried in an oven air at 40 – 60 °C for 72 hours**(Al-Sadek 2011),** dried mulberry leaves were grounded in an electric mill and sieved in 100 mesh to produce a fine powder. Samples were kept in polyethylene bags at 4 °C until used and analyzed in triplicate.

Basal diet

Rat groups fed a basal diet consists of fat (10%) ascorn oil, sucrose (10%), salt mixture (4%), vitamin mixture (1%), choline chloride (0.2%) and cholesterol powder (1.5%) were obtained from Morgan Co. Cairo, Egypt, neutral casein 16.28 gm (protein content 12%) and corn starch up to 100 gm**(Campbll 1963).**

Chemical composition of mulberry leaves powder

Moisture, fat, ash and total nitrogen contents were determined according to the methods described in**A.O.A.C (2000).**The crude fibers content were determined following the method given by**Pearson (1971).**

Total carbohydrates content were calculated by difference**(James 1995)** as follows :

% soluble carbohydrates =100 – (% crude protein + % crude fat + % crude fibers + % total ash) on dry weight.

Caloric values of mulberry leaves powder

Energy values of mulberry leaves powder were calculated from proteins, lipids and carbohydrates. Total energy values

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were calculated by multiplying the protein and carbohydrate by 4.0 and fat by 9.0, according to **Dougherty et al. (1988).**

Minerals Analysis
About 0.2 gm of each ground sample was digested using the procedure suggested by **Jackson (1958).** The digested solution was used for the determination of calcium (Ca), potassium (K), sodium (Na), zinc (Z), iron (Fe) and phosphorus (P).

Iron and zinc contents were determined directly in the diluted digested solution using the atomic absorption spectrophotometer. Potassium and sodium were determined using flame photometer according to the methods described in **A.O.A.C. (1980).**

Phosphorus content was determined spectrophotometericaly at 700 nm wavelength according to Molybdenum Blue Method using stannous chloride reductionas described by **Allen (1974).** Calcium was titrated using EDTA 0.01 N as a colorimetric methods as described by **Allen (1974).**

Determination of total phenolics
Total phenolics were determined using Folin-Ciocalteu reagent methods as described by **Ainsworth and Gillespie (2007).** All samples were extracted in methanol. In 100mL of each sample 200µL of F-C reagent was added and vortex thoroughly 800µL of 700 mM into each sample and incubated at room temperature for 2 h. 200µL of sample was transferred to a clear 96-well plate and absorbance of each well was measured at 765nm. The amount of total phenolics was calculated using a calibration curve (R2: 99.27) for gallic acid. The results were expressed as gallic acid equivalent per dry matter **(Ainsworth and Gillespie 2007)**.

Tannins were determined by vanillin hydrochloride method. One gram of the ground mulberry leaves powder was extracted in 50 mL of methanol, mix occasionally and after 24 h centrifuge at 12000xg and supernatant was collected. One mL of supernatant was added to 5 mL vililin hydrochloride reagent and mixed incubated at room temperature and the absorbance at 500 nm on microquant spectrophotometer was then noted (BioTech, USA). The calibration curve catechin was used as standard for the calculation of tannins **(Thimmaiah 2004).**

Saponin was estimated by the method reported by **Siddiqui and Ali (1997).** For the determination of alkaloids, 5 g of mulberry powder was accurately weighed. It was made into a paste with 5% sodium carbonate solution, which was then transferred into a flask and 75 mL of chloroform added, and refluxed for 15 min. After being filtered and cooled,filtrate was transferred to a separator, 40 mL of 5% sodium carbonate solution was added, and agitated gently for 7 min. Chloroform layer was taken off and reduced to the volume of about 10 ml by distillation, 40ml of 1% suphuric acid was added, and extracted with two 20 mL volume of chloroform. Separating funnel separated aqueous phase. It was made alkaline with ammonium hydroxide, and extracted with 10 mL portions of chloroform. Chloroform layers were combined, and washed with 5 mL of water. The total volume of fraction obtained was reduced to 5 mL by distillation. Chloroform was transferred to a crystallizing dish and the remainder of chloroform was removed through evaporation in a vacuumhood. Two mL of absolute alcohol was added to residue, evaporated to dryness at100°C and solid residue obtained was:

$$\text{Crude alkaloid} = \frac{\text{Weight of alkaloids obtained}}{\text{Total weight of sample}}$$

Total phenolic and tannin content were expressed as gallic acid equivalents through the calibration curve of gallic acid (Sigma, USA) with the concentration range of 0-100 mg/mL.

Biological evaluation
This experiment was carried out at laboratory of microbiology and physiology at Home Economics Dept., Faculty of Specific Education, Kafr El-Sheikh Univ. under normal healthy conditions for forty two days.

Animals
White male albino rats Sprague Dawely (12 rats) weighting (160-170gm), two month old were employed in this study. Rats were obtained from experimental animal house of Food Technology Research Institute, Agric. Res. Center, Giza, Egypt.

Upon arrival, they were randomly assigned to (3 groups) four rats each. Each animal was individually housed in a wire bottomed, stainless steel cage under the normal condition. The animals were weighted every week except during the first week, which weighted every day.

The experimental animals fed on basal diet for one week to acclimate them to our facility and basal diet. After acclimation, rats were fed on different diets as shown:

G1: Negative control (normal rats), fed on basal diet.
G2: Positive control (hypercholesteremic), fed on basal diet.
G3: Hypercholesteremic rats fed on 25% dry mulberry leaves powder mixed with basal diet.

Rats were divided into three groups: one group received only their usual basal diet (negative control), another group received cholesterolemic basal diet and the third group received 25% mulberry leaves powder mixed with the standard diet (experimental group). Rats were left to come after overnight fasting **(Andallu and Vardacharyulu 2001).**

Blood samples were collected in early morning. The control group on the day No. 1, blood samples were taken three times (on day No. 1, on day No. 21 and day No. 42) for the study of serum lipid levels. Cholesterolemic group was left to swallow 25% of mulberry leaves powder. All the parameters of lipid profile i.e. serum total cholesterol,triacylglyceride, HDL-cholesterol, LDL-cholesterol, andvLDL-cholesterolwere done.

All values expressed as mean in mg/dl ± SEM (standard error of mean). Statistical significance of difference between the base line serum level i.e. control (day No. 1) serum level and after 3 weeks (day No. 21) of treatment serum level and again base line serum level i.e. control (day No. 1) serum level and after 6 weeks (day No. 42) of treatment serumlevel was performed. The 'p' values of 0.05 or less were regarded as significant.

Induction of cholesterol
Normal rats fed a social diet for inducing hypercholesterolemia, the diet was prepared from fine ingredients per 100 gm according to **Rashwan (1998)**.

Blood sampling
In all mentioned groups, blood samples were taken from rats three times (on day No. 1, 21 and 42), the blood samples were collected after 12 hours fasting. At the end of experiment, rats weighed and scarified with a knife, blood of rats put into dry clean centrifuge tubes and left to clot.

The blood was centrifuged for 10 minutes at 3500 rpm to separate. The serum carefully aspirated, transferred into clean quite plastic tubes and keptfrozen at -18 ° C until biochemical analysis **(El-Khamissy 2005).**

Growth parameter analysis
Body weight and feed intake were measured every two days during six weeks test period, the amount of diet ingested was the difference between the weight of feed that rested in the feed bin (Da) and the amount placed one day before (D). These data were then used to calculate feed intake according to the following formula reported by **Ennouriet al. (2006).**

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Feed intake (g) =

$$= \frac{D-Da}{1} / 1$$

Where the number 1 correspond to the number of animals in the each cage.

From the experimental obtained data specific growth rate (SGR), food conversion ratio (FCR), body weight gain percentage (BWG), protein efficiency ratio (PER) and survival (%) were calculated as follows:

SGR = (ln W2 – ln W1/ T) ×100.
FCR = food fed / live weight gain.
BWG (%) = [(W2 - W1) / W1] × 100.
FER = Weight gained (g) / Feed offered (g).
PER = live weight gain (g) / protein fed (g).
Survival (%) = R2 / R1 ×100.

Where: W2 = final weight, W1 = initial weight and T = time (days) between lnW2 and lnW1. R1 = number of rats at the end of experiment, R2 = number of rats at the beginning of experiment **(Ogunjiet al 2011).**

Determination of total cholesterol, HDL cholesterol and triglycerides
The concentration of total cholesterol, high density lipoprotein cholesterol (HDL-c) and triglycerides in the serum were determined without extraction using enzymatic colorimetric methods with commercially available kit#276-64909 ,high density lipoprotein kit#278-67409 and triglyceride, kit#274-69807; Osaka, Japan. **Kim and Shin (1998)** procedures were employed to perform the previous mentioned determinations.

Determination of low-density lipoprotein cholesterol (LDL-c)
Low density lipoprotein cholesterol (LDL-c) concentration was calculated as the difference between total cholesterol and (HDL-c) according to the method of **Skottovaet al. (1998).**

LDL and vLDL-c were carried out by the following equations:
vLDL-c (mg/ld) = (triglyceride / 5).
LDL-c (mg/ld) =Total cholesterol– (vLDL-c +HDL-c).
Lopez-virellaet al. (1977).

Statistically analysis
Data of growth parameters and serum lipid profile were subjected to analysis of variancefollowed by Duncan's multiple range tests according to **(Steel and Torrie 1980).**

Results and Discussion
Gross chemical composition and caloric values of mulberry leaves powder
Mulberry leaves powder contained high level of crude protein (27.14), total ash (15.68%), fibers (26.47%) and carbohydrates (28.78%) while fat content was recorded at low percentage (1.93%) and energy was calculated according to nutrient sources as 241.05 Kcal./100 gm, agree with**Srivastava et al. (2006), Liu et al. (2010) and Iqbal et al. (2012).** It is clear from these results that mulberry leaves are rich in proteins and fibers **(Andallu and Vardacharyulu 2003).**

Table (1):Gross chemical composition and caloric values of mulberry leaves powder (gm/100gm).

Chemical composition of mulberry leaves powder %						**Caloric values**
Moisture*	Protein*	Fat*	Ash*	Fibers*	Carbohydrates	
6.81	27.14	1.93	15.68	26.47	28.78	241.05

*** All values are means of triplicate, (on dry weight).**

Minerals content of mulberry leaves powder
As shown in Table (2), minerals content of mulberry leaves powder were found in high levels as was previously reported by **Andallu and Vardacharyulu (2003) and Jane and Dacayanan (2012).** Calcium content was recorded the higher level than all minerals which recorded 1493.22 mg/100 g, while iron and zinc were found in low levels which recorded 27.06 and 2.18 mg/100g respectively, and these also agreed with those reported by**Srivastava et al. (2006).** Magnesium, phosphorus, sodium and potassium contents were 533.24, 370.91, 58.62 and 1239.07, respectively. It was noticed that mulberry leaves are rich in minerals as reported by **Andallu and Vardacharyulu (2003).**

Table (2): Minerals content of mulberry leaves powder (mg/100 gm)*

Minerals content of mulberry leaves powder (mg/100gm)						
Ca	Fe	Zn	Mg	P	Na	K
1493.22	27.06	2.18	533.24	370.91	58.62	1239.07

All values are means of triplicate, on dry weight.

Determination of total phenolics
Total phenolics concentration was 0.98% in mulberry leaves powder as shown in table (3). Concentration of tannins was within safe range 1.19% in agreement with **Cheemai et al. (2011)**. Tannins bind to proteins in the mouth reducing the palatability of the feed and subsequently decrease feed intake. Tannins have ability to bind and inhibit the digestive enzyme activities and affect the microbial and enzyme activities **(Makkar et al. 1989).** Whereas, lower concentration of tannins can improve nutrition for by reducing protein degradation in the rumen and increasing the flow of amino acids to the intestine **(McNabb et al. 1996).**

Table (3): Total phenolic compounds of mulberry leaves powder.

Items	Total phenolics	Tannins	Alkaloids	Saponin
%	0.98	1.19	Nil	Nil

Expressed as mg gallic acid equivalent/mg dry weight.

Biological experimental
Growth parametersof cholesterolemic rats fed on mulberry leaves powder.
From Table (4), it is clear that weight of all groups increase in the end of experiment comparing with initial weight. There was changing in feed intake of cholesterolemic rats to negative and positive groups from 17.32 to 19.83 g daily. In consistence with **Al-Sadek (2011),** cholesterolemia did not cause any significant decrease in the feed intake after six weeks when compared with the normal rats (19.83 g/day), **(Al-Sadek 2011).**

Table (4):Growth parameters ofalbino rats fed on mulberry leaves powder.

Rat groups Growth parameters	Negative control	Positive control	Cholesteremic rats
Initial weight (g)	163.25c ± 0.01	169.14 a ± 1.00	165.88 b ± 0.09
Final weight (g)	211.07a ± 1.07	189.59 c ± 1.60	193.46 b ± 1.03
Feed intake (g)	19.83a ± 0.80	17.32 b ± 0.05	18.05 b ± 0.05

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Specific growth rate (SGR %)	113.85 a ± 1.00	48.69 c ± 0.03	65.66 b ± 1.04
Food conversion ratio (FCR)	0.41 c ± 0.05	0.84a ± 0.01	0.65 b ± 0.02
Percentage body weight gain (BWG %)	29.29 a ± 0.09	12.09 c ± 1.5	16.62 b ± 0.02
Feed efficiency ratio (FER)	2.39a ± 1.01	1.02b ± 0.07	1.37ab ± 0.01
Protein efficiency ratio (PER)	1.74 a ± 0.05	1.52 b ± 0.01	1.16 c ± 0.02
Survival (%)	100	100	100

Hypocholesteremia rats affected directly on a gain weight and consequently on feed and protein efficiency ratio that also due to treated cholesterolemic group with mulberry leaves powder rich withfibers. For the fact, food consumption was unchanged, but the gain of body weight was decrease relative to control (+). Since insignificant changes in food consumption was not parallel to the growth of rats agree with **Ennouriet al. (2006).**

It may be concluded that all treatments affected positively the BWG% comparing with control positive group.

Cholesterolemic rats showed high BWG (16.62) comparing with Control (+) which was the lowest BWG (12.09).It is worthy mentioning that the treated group with plant sources such as seeds and leaves rich with fibers resulted in pronoun observed increasing of feed efficiency ratio (1.37) comparing with control positive group (1.02)**(Pathaket al. 2000).**

The weight gain improved in cholesterolemic rats fed on mulberry leaves powder (16.62) comparing with control (+) group (12.09) with being singnificant different between them and control (-) group which recorded the highest BWG (29.29). The same was for specific growth rate, where SGR of rat groups improved as (65.66) in cholesterolemic rats fed on mulberry leaves powder comparing with control (+) group (48.69) as shown in fig (1).

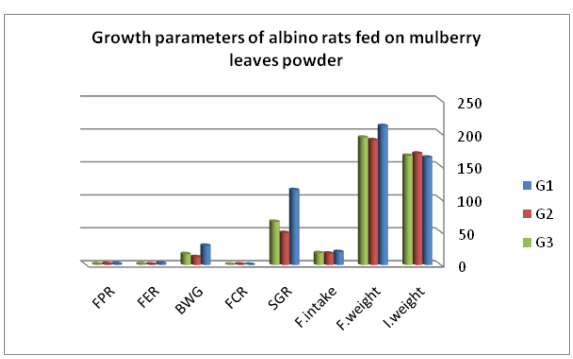

Fig (1) : Growth parameters of albino rats fed on mulberry leaves powder.

The highest FCR was control (+) group as (0.84) followed by cholesterolemic rats as (0.65) comparing with the best lowest FCR for control (-) group as (0.41). These various percentages of FCR were significantly different, low FCR values indicate an improved feed outcome **(De Silva and Anderson1995).**

Specific growth rate (SGR) was ranging from 48.69 for positive control to 113.85 for negative control with being rats group fed on mulberry leaves powder in the middle stage as 65.66. The growth data indicated that SGR values of ratsgroup were significantly high related with final weight**(Başçınaret al. 2007).**

Growth performance was best when cholesterolemic rats were fed on mulberry leaves powder. It was noticed also that survival ratio was 100 % in all rat groups throw the time of experiment and that means number of rats at the end of experiment was the same number of rats at the beginning of experiment (**Ogunjiet al. 2011).**

Effect on serum lipid.

The present study has been undertaken to demonstrate the effect of mulberry leaves powder on lipid profile parameters in hyper-lipidemic rats. The mean serum total cholesterol, HDL-cholesterol, triacylglyceride, LDL-cholesterol and vLDL-cholesterol levels of rats groups in the first day, after 3 weeks (day 21) and after 6 weeks (day 42) was compared with serum total cholesterol, HDL-cholesterol, triacylglyceride, LDL-cholesterol and vLDL-cholesterol levels of experimental groups. The results are shown in Table (5).

Significant changes were observed in all the parameters of lipid profile in rat groups throw out day No. 1, day No. 21 and day No. 42. In the first day, the highest triglycride, HDL-cholesterol and vLDL- cholesterol contents were observed for control (-) rats group as (92.66, 39.18 and 18.53 mg/dl, respectively, while the highest T-cholesterol and LDL- cholesterol contents recorded for control (+) rats group as 101.56 mg/dl and 46.44 mg/dl with being no significant changes between control (-), control (+) and cholesterolemic rats groups in vLDL-cholesterol content ranged from 18.08 to 18.53 gm/dl as shown in fig (2), agree with **Chen J, Lix (2007).**

Table (5): Serum lipid profile in cholesterolemic rats fed on mulberry leaves powder.

Day	Serum lipid profile	Rat groups		
		G1	G2	G3
1 a	Total cholesterol (mg/dl)	98.33 ± 1.04 C	101.56 ± 0.80 A	99.07 ± 1.01 B
	HDL-cholesterol (mg/dl)	39.18 ± 0.73 A	37.04 ± 1.00 B	37.11 ± 0.05 B
	VLDL- cholesterol (mg/dl)	18.53 ± 1.01	18.08 ±1.07	18.20 ±1.35
	LDL-cholesterol (mg/dl)	40.62 ± 1.91 C	46.44 ± 0.70 A	43.76 ± 2.03 B
	Triacylglyceride (mg/dl)	92.66 ± 0.98 A	90.41 ± 0.62 C	91.01 ± 1.08 B
21 b	Total cholesterol (mg/dl)	103.98 ± 0.09 B	128.69 ± 1.36 A	93.13 ± 1.22 C
	HDL-cholesterol (mg/dl)	42.34 ± 1.78 B	32.55 ± 0.01 C	46.49 ± 0.96 A
	VLDL- cholesterol (mg/dl)	19.93 ± 1.02 B	22.31 ± 0.59 A	17.05 ± 1.38 C
	LDL-cholesterol (mg/dl)	42.01 ± 0.06 B	73.78 ± 0.49 A	29.59 ± 1.55 C
	Triacylglyceride (mg/dl)	98.15 ± 2.18 B	111.58 ± 0.97 A	85.29 ± 1.46 C
42 c	Total cholesterol (mg/dl)	101.71 ± 1.08 B	156.05 ± 0.56 A	81.29 ± 0.37 C
	HDL-cholesterol (mg/dl)	40.09 ± 0.02 B	26.21 ± 0.68 C	51.63 ± 1.00 A
	VLDL- cholesterol (mg/dl)	19.69 ± 2.05 B	26.99 ± 0.01 A	16.72 ± 1.45 C
	LDL-cholesterol (mg/dl)	41.93 ± 1.18 B	102.85 ± 1.00 A	12.92 ± 2.04 C
	Triacylglyceride (mg/dl)	98.46 ± 1.29 B	134.97 ± 0.99 A	83.62 ± 1.03 C

- A, B and C: comparison of means of serum lipid profile parameters and rat groups.

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- a, b and c: comparison of means of rat groups by days.
- Values followed by the same letter in row are not significantly different at $p < 0.01$.
- Mean by parameter in the same raw with different letters are significantly different (a, b and c), $P< 0.05$.
- Different letters on same column represent statistically significant ($P<0.05$) difference between means.

Generally, after three weeks ofcholesterlemiainfiction, control (+) rats group recorded the highest total cholesterol, triglyceride, vLDL-cholesterol and LDL-cholesterol contents as 128.69, 111.58, 22.31 and 73.78 mg/dl, respectively, following by control (-) rats group as 103.98, 98.15, 19.93 and 42.01 mg/dl, respectively as shown in fig (3).

It was noticed that lipid profile parameters levels were clearly decreased after 21 days in cholesterolemic rats group fed on mulberry leaves powder compared with control (+) and control (-) groups except for HDL-cholesterol where was the best highest content 46.49 gm/dl in cholesterolemic rats group fed on mulberry leaves powder following by control (-) rats group 42.34 mg/dl. The results were agree with **Chen J, Lix (2007).**

Extending feeding to six weeks on investigated diet which contained mulberry leaves powder caused a continuous decrease inserum total cholesterol as 81.29 mg/dl, serum triglyceride level as 83.62 mg/dl, serum vLDL-cholesterol level as 16.72 mg/dl and 12.92 mg/dl as most lowest LDL-cholesterol content in hyperlipidemic rats. A significant increase in HDL-cholesterol was only noted in the mulberry treated group after 42 days as 51.63 mg/dl as shown in fig (4), which agree with**Al-Sadek(2011).**

Mulberry leaves affected lipid profile in normal rats also indicating hypolipidemic effect as a result of the synergistic action of bioactive compounds **(Andallu and Vardacharyulu, 2009).**

From the results it is worthly mentioning that mulberry leaves powder exhibits significant hypolipideic effect in hyperlipidemicrats by making significant reduction in unlikely lipid profile and improving likely lipid profile contents. Synthetic statins has some adverse effects and costly. In the light of these comparative findings, it can be stated that mulberry leaves powder may be useful in hyperlipidemicstatesnts with hyperten-sion, atherosclerosis, ischemic heart diseases etc.

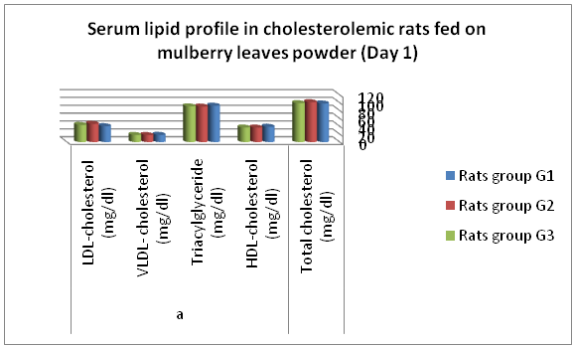

Fig (2) : Serum lipid profile in cholesterolemic rats fed on mulberry leaves powder (Day 1).

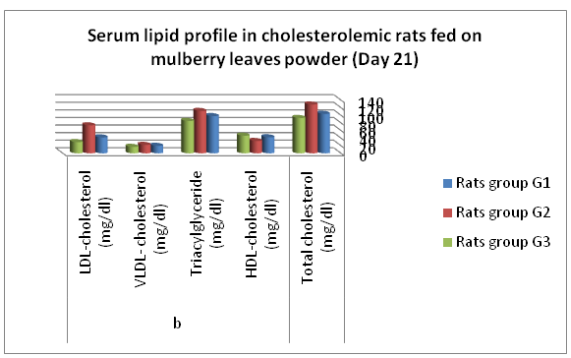

Fig (3) : Serum lipid profile in cholesterolemic rats fed on mulberry leaves powder (Day 21).

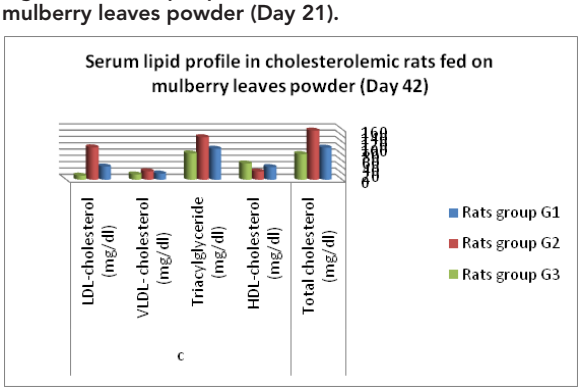

Fig (4) : Serum lipid profile in cholesterolemic rats fed on

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