Journal of Home Economics
Volume 30, Number (1), 2020
http://homeEcon.menofia.edu.eg

Journal of Home Economics
ISSN 1110-2578

Effect of coconut fruits and their milk on biological and biochemical changes of hypercholesterolemic rats

Yousif Elhassaneen, Amal Nasef and Altaf Abo-Khazima

Nitration and food science Department, Faculty of Home Economics, Menoufia University, Shebin El-Kom, Egypt

Abstract: This study was conducted to find out the effect of coconut fruits and their milk on biological and biochemical changes of hypercholesterolemic rats. Therefore, Thirty-six male albino rats, weighing 140-150g, were used. They were divided into two main groups. The first main group (6 rats) was used as a negative control group,which were fed the basal diet. The second main group (30 rats) was fed a basal diet supplemented with powdered cholesterol and a ahigh- fat diet (10% animal lipid) to induce hypercholesterolemia and were divided into five equal subgroups. One group was placed as a positive control group who were continuously fed the basic diet. The rest four groups were fed the basic diet with coconut fruits at a concentration of 2.5 and 5% and coconut milk at levels of 250 and 500 ml per kg of feed for 28 days. The data obtained indicated that both coconut powder and coconut milk resulted in a significant decrease ($P \leq 0.05$) in serum TC, TG, LDL and VLDL with increased HDL. Both coconut powder and coconut milk also improve liver and kidney function. These data confirmed the hypothesis that both coconut powder and coconut milk contain several bioactive compounds capable of mitigating the harmful effects of high cholesterol and inhibiting high blood cholesterol in rats. Therefore, we recommend using such fruits in moderate quantities in our daily diets to benefit from its health benefits.

Keywords: hypercholesterolemic rats, liver functions, kidney functions, serum lipid profile.

Introduction

Cholesterol is a waxy steroid metabolite found in the cell membranes and transported in the blood plasma of all animals **(Leah, 2009).** It is biosynthesized by all animal cells and is an essential structural component of animal cell membranes. Cholesterol is one of three major classes of lipids which all animal cells use to construct their membranes. It is transported in the blood plasma within protein particles (lipoproteins). Lipoproteins are classified by their density very low density lipoprotein (VLDL), intermediate density lipoprotein (IDL), low density lipoprotein (LDL) and high density lipoprotein (HDL) (**Biggerstaff and Wooten, 2004).**

Hypercholesterolaemia became the most frequently encountered medical problem worldwide. Among its causes are the bad dietary habits and increased dependence on fast food. **(Bipasha and Goon, 2014).** Hyperlipidemia is a common predicament in society due to change of lifestyle and food practice. Besides medication, diet also plays an important role in the management of lipid and lipoprotein concentrations in blood. Previous studies have shown that the uncontrolled consumption of high fat diet also leads to insulin resistance (IR) because the saturated fatty acids (SFA) interfere with the action of insulin **(Park *et al*., 2011).** Causes of hyperlipidemia could be included a diet rich in saturated fat and cholesterol increases blood cholesterol and triglyceride levels, Other disorders as obesity, diabetes mellitus and hypothyroidism increase the risk of hyperlipidemia, obesity, several drugs such as corticosteroids, estrogen and betablockers (**Gupta *et al* ., 2016).**

Coconut (Cocos nucifera) belonging to the Arecaceae family holds quite an importance in the Indian traditional medicinal system. C. nucifera inflorescence (CnI) has been reported in literature to be useful in treatment of diarrhoea, dysentery, diabetes, and dyspepsia (**Rengjith *et al*., 2013**). Coconut meat is the white flesh found inside the hard, brown outer shell of the coconut. it is rich in several important minerals, especially manganese and copper. While manganese supports enzyme function and fat metabolism, copper assists bone formation and heart health. **(Li and Yang, 2018)**. Coconut milk is the liquid that is extracted from the grated coconut white meat which is rich in saturated fats and it widely consumed in parts of Asia and South America. They are widely cultivated in the tropical climates as mentioned above and are exported as canned products to North America and Europe **(Tinchan *et al*., 2015).**

The functionality of coconut flour in terms of prevention for risk of chronic diseases, e.g. diabetes mellitus, cardiovascular diseases (CVD) and colon cancer, which, revealed increase production of coconut and coconut flour. The production of coconut flour is very economical because it can be produced in a small or large scale. The raw material is obtained from the by-product (waste) of the coconut milk industry and the process and equipment used in its production is simple and cheap. Coconut flour as a good source of dietary fiber can be added to bakery products, recipes and other food products for good health **(Trinidad *et al.*, 2006).** Also, **Salil and Rajamohan (2001)** studied the effect of coconut protein in rats fed high fat cholesterol containing diet on the metabolism of lipids and lipid peroxides. The results showed that Feeding coconut protein results in decreased levels of Malondialdehyde in the heart and increased activity of Superoxide dismutase and Catalase. supplementation of coconut protein causes increased excretion of urinary nitrate which implies higher rate of conversion of arginine into nitric oxide. In the present study, the arginine supplemented group and the coconut protein fed group produced similar effects. These studies clearly demonstrate that coconut protein is able to reduce hyperlipidemia and peroxidative effect induced by high fat cholesterol containing diet. Furthermore, **Kasai *et al.*, (2003**) reported hypercholesterolemic effect of coconut oil. This difference could be due to addition of coconut oil to cafeteria diet in the present study, whereas in other studies, coconut oil was administrated with standard rat chow. The oil is obtained of coconut kernel and it is a natural functional food rich in medium-chain triglycerides (MCTs), mainly the saturated fatty acids with approximately 50% of the lauric acid. The lauric acid has potential virucidal and bactericidal actions **(Liau *et al.*, 2011).** Further studies revealed that one of the factors responsible for the cholesterol lowering action is coconut kernel protein. Studies from this laborator/and elsewhere suggest that lysine/arginine ratio of a protein influences its effect on cholesterol metabolism. Animal protein with higher lysine/arginine ratio were hypercholesterolemic while many plant proteins with their lower lysine/arginine ratio had hypocholesterolemic effect **(Harding *et al.*, 2009).** Also, **Feng *et al.*, (2012)** found that coconut milk and coconut meat contain dietary phosphorous that prevents oxidative damage and increases the activity of antioxidant enzymes in the intestine and hepatic pancreas of young. Finally, **Khaw**

***et al.*, (2018) and Rachel, (2017)** indicated that coconut meat contains coconut oil, which may boost HDL (good) cholesterol and reduce LDL (bad) cholesterol. Improvements in these markers may reduce your risk of heart disease. Therefore, the present study aimed to investigate the effect of coconut fruits and their milk on biological and biochemical changes of hypercholesterolemic rats.

Materials and Methods

Materials

Coconut *(Cocos nucifera*, L.) fruits and their milk, was obtained from local market of Shebin El-kom. Coconut was ground into fine powder by using electric grinder (Toshiba ElAraby, Benha, Egypt) and kept in dark, stoppered glass bottles in a cool and dry location until using. Coconut milk is the liquid obtained by pressing of grated coconut meat resulting in rich white liquids and kept in dark, stoppered glass bottles in a cool and dry place until using. The coconut powder and coconut milk were kept in a cool, dry and dark place to reduce the oxidation of their contents.

Rats and diets

Male albino rats, weighing 140-150 g per each, were purchased from the Institute of Medical Insect Research, Doki, Cairo, Cholesterol obtained from El-Gomhoria Company Fof Trading Chemicals, Drugs and Medical Instruments, Cairo, Egypt. Basal diet constituents were obtained from Technogene Chemical Co., Dokki, Egypt.

Experimental design

Thirty-six male albino rats were housed in healthy condition (21-23ºC) and fed on basal diet for one week before starting the experiment for acclimatization, after this, rats were divided into two main groups, the first group (6 rats) fed on basal diet as a negative control (ve-) and the other main group (30 rats) was fed on cholesterol powder and high fat diet (10% animal lipid) for 3 weeks to induce hypercholesterolemia, then classified into 6 groups as follows: group (1), rats will feed on basal diet as a control negative (ve-); group (2), injected by obesity was induces in normal healthy male albino rats by fed on cholesterol powder and high fat diet (10% animal lipid) supplemented in the basal diet and used as a positive control group (ve+); group (3), a group infected cholesterolemic and is fed on coconut fruit as powder dose of 2.5% of diet; group (4), a group infected cholesterolemic and is fed on coconut fruit dose of 5% of diet; group (5), a group infected with cholesterolemic

and is fed on coconut milk at a dose of 250 mg / kg of diet; and group (6), a group infected with cholesterolemic and is fed on coconut milk at a dose of 500 mg / kg of diet.

At the end of the experimental (4 weeks), rats were fasted for 12-h then scarified. Blood samples were collected from the portal vein into dry clean centrifuge tubes for serum separation. Blood samples centrifugedfor 10 minutes at 3000 rpm to separate the serum according to **Drury and Wallington (1980).**

Serum lipid profile assay

Cholesterol, TG, HDL-c, LDL-c and VLDL-c were determined according to **Allain *et al*., (1974), Lopez (1977), Fossati and Prencipe (1982)** and **Lee and Nieman (1996),** respectively. Low density lipoprotein cholesterol and very low density lipoprotein cholesterol calculated according to the following equation: LDL-Cholesterol = Total cholesterol-(HDL-c + TG/5 (VLDL-c – HDL.

Liver functions assay

Alanine Transaminase (ALT), Aspartate Transaminase (AST)and alkaline phosphatase (ALP) were determined according to the methods described by **Bergmeyer and Harder (1986), Kachmar and Moss (1976)** and **Varley *et al*., (1980)** respectively.

Kidney functions assay

Urea, Creatinine and Uric acid were determined according to the methods of **Patton and Crouch (1977)**, **Henry (1974),** and **Schultz (1984)** respectively.

Statistical Analysis

Data were expressed as mean ± standard deviation. In order to compare the groups. Analysis of Variance (ANOVA) test was used. Different values at some column ($P \leq 0.05$) were considered to be statistically significant according to SAS (2006).

Results and Discussion

Effect of coconut fruits and coconut milk on body weight gain (BWG) (g|day/rat), feed intake (FI) (g/d) and feed efficiency ratio(FER) (%) of hypercholesterolemic rats

The mean value of body weight gain (g|day/rat), feed intake (FI) (g/d) and feed efficiency ratio (FER) (%) of hypercholesterolemic rats fed on various diets are recorded in Table (1). Rats fed on high cholesterol diet (control +ve) had a significant increase in concentration of BWG, FI and FER which recorded 51 ± 11.76, 15.29 ± .31 and .024

± .005 mg/dl, respectively compared to control (–ve) group which recorded 31 ± 3.80, 12.58 ± .71 and .011 ± .007 mg/dl, respectively. Rats fed on high cholesterol diets supplemented with coconut powder 2.5% - 5% and coconut milk 250 -500 ml had significant decreases in concentration of BWG, FI and FER. As compared to the positive control group. Best treatment for BWG, FI and FER seems to be that of coconut milk 500 ml respectively. Our results are in agreement the results obtained by **St-Onge *et al*., (2002)** mentioned that coconut oil is an oil extracted from coconut meat that works on Reduction of body weight, food intake and feeding efficiency ratio in hyperlipidemic mice. Also **Mini and Rajamohan, (2004)** reported that the coconut improves digestion and absorption of other nutrients such as; vitamins, minerals, amino acids. It prevents obesity, overweight problem by increasing metabolic rate, regulates thyroid function, boosts energy and fights fatigue. **Bawalan and Chapman , (2006)** found that coconut is used in the treatment of mal-absorption of fat such as cystic fibrosis and enteritis. Furthermore, **Zheng *et al* ., (2018)** showed that coconut milk is rich in B vitamins are enzyme cofactors that play an important role in energy metabolism and reducing excess weight (BW),food intakes (FI) and feed efficiency ratio by improving enzyme activities associated with energy metabolism in mice fed a high-fat diet. In similar studies, **Naruta and Buko, (2001)** reported that the coconut milk contains pantothenic acid, as pantothenic acid derivatives help obese mice reduce food intake and moderate body weight. Also, **McCarty and DiNicolantonio ,(2016)** suggested that the MCTs in this fruit may promote feelings of fullness, calorie burning, and fat burning, all of which may support weight loss. Additionally, **Rial *et al*., (2016)** indicated that coconut milk and coconut meat contain medium chain triglycerides (MCTs). Some studies indicate that MCTs reduce body weight, body composition and metabolism.

Table (1): Effect of coconut fruits and coconut milk on body weight gain (BWG) (g/d), feed intake (FI) (g/d) and feed efficiency ratio(FER) (%) of hypercholesterolemic rats

Groups	BWG	% of change	(FI)	% of change	(FER)	% of change
Group (1): Control (-)	31 [b] ± 3.80	-39.21	12.58 [d] ± 0.71	-17.7	.011 [c] ± .007	-54.2
Group (2): Control (+)	51 [a] ± 11.76	--------	15.29 [a] ± 0.31	-------	.024 [a] ± .005	-------
Group (3): Coconut powder 2.5%	38.20 [b] ± 7.46	-25.09	15.06 [a] ± .10	-1.50	.020 [ab] ± .001	-16.7
Group (4): Coconut Powder 5%	34.40 [b] ± 9.91	-32.54	14.30 [b] ± .35	-6.47	.016 [bc] ± .005	-50
Group (5): Coconut milk 250 ML	32.80 [b] ± 2.77	-35.69	13.36 [c] ± .29	-12.6	.020 [ab] ± .002	-16.7
Group (6): Coconut milk 500 ML	31.60 [b] ± 11.01	-38.04	13.24 [c] ± .29	-13.4	.016 [bc] ± .005	-50

Means in the same column with different letters are significantly different at $P \leq 0.05$.

Effect of coconut fruits and their milk on relative organs weight (%) of hypercholesterolemic rats

The mean value of liver weight (g) and heart weight (g) of hypercholesterolemic rats fed on various diets are recorded in Table (2). Rats fed on high cholesterol diet (control +ve) had a significant increase in concentration of liver weight and heart weight which recorded 4.38 ± .13 and .72 ± .08 , respectively compared to control (–ve) group which recorded 4.08 ± .08 and .54 ± .05. Rats fed on high cholesterol diets supplemented with coconut powder 2.5% - 5% and coconut milk 250 - 500 ml had significant decreases in concentration of liver weight and heart weight. As compared to the positive control group. The best treatment was observed for group 6 (coconut Milk (500ml).

Table (2): Effect of coconut fruits and coconut milk on relative organs weight (%) of hypercholesterolemic rats

Groups	Liver (g)	% of change	Heart (g)	% of change
Group (1): Control (-)	4.08 b ± .08	-6.85	.54 b ± .05	-25
Group (2): Control (+)	4.38 a ± .13	--------	.72 a ± .08	-------
Group (3): Coconut powder 2.5%	4.32 a ± .08	-1.37	.56 b ± .05	-22.22
Group (4): Coconut Powder 5%	4.24 ab ± .20	-3.19	.60 b ± .07	-16.66
Group (5): Coconut milk 250 ML	4.22 ab ± .04	-3.65	.62 ab ± .08	-13.88
Group (6): Coconut milk 500 ML	4.14 b ± .08	-5.47	.62 ab ± .08	-13.88

Means in the same column with different letters are significantly different at $P \leq 0.05$.

Effect of coconut fruits and coconut milk on liver enzymes Alanine Transaminase (ALT) (U/L), Aspartate Transaminase (AST) (U/L) and Alkaline Phosphatase (ALP) (U/L) of hypercholesterolemic rats

The mean value of serum Alanine Transaminase ALT(U/L), Aspartate Transaminase (AST) and Alkaline Phosphatase (ALP) (U/L) of hypercholesterolemic rats fed on various diets were tabulated in Table (3). Rats fed on high cholesterol diet (control +ve) had a significant increase in concentration of ALT, AST and ALP which recorded 45 ± 16.56, 173 ± 33.67 and 133.68 ± 10.03 , respectively compared to control (–ve) group which recorded 26 ± 4.41, 81 ± 11.20 and 93.68 ± 3.26. Rats fed on high cholesterol

Table (3): Effect of coconut fruits and coconut milk on liver enzymes Alanine Transaminase (ALT), Aspartate Transaminase (AST) and Alkaline Phosphatase (ALP) (U/L) of hypercholesterolemic rats

Groups	ALT(U/L)	% of change	AST(U/L)	% of change	ALP(U/L)	% of change
Group (1): Control (-)	26 [c] ± 4.41	-42.22	81 [d] ± 11.20	-53.17	93.68 [b] ± 3.26	-29.92
Group (2): Control (+)	45 [a] ± 16.56	--------	173 [a] ± 33.67	-------	133.68 [a] ± 10.03	-------
Group (3): Coconut powder 2.5%	39.32 [ab] ± 7.11	-12.62	161 [ab] ± 10.19	-6.93	123.68 [a] ± 2.94	-7.48
Group (4): Coconut Powder 5%	33.32 [bc] ± 2.16	-25.95	138.32 [bc] ± 9.90	-20.04	100.68 [b] ± 20.27	-24.68
Group (5): Coconut milk 250 ML	29.42 [bc] ± 2.48	-34.62	127.10 [c] ± 22.49	-26.53	98 [b] ± 7.48	-26.69
Group (6): Coconut milk 500 ML	29.68 [bc] ± 3.62	-34.04	101.68 [d] ± 12.45	-41.22	97 [b] ± 11.64	-27.43

Means in the same column with different letters are significantly different at $P \leq 0.05$.

diets supplemented with coconut powder 2.5% - 5% and coconut milk 250 -500 ml had significant decreases in concentration of ALT, AST and ALP As compared to the positive control group. Our results are in agreement the results obtained by **Rocha *et al* ., (2019)** who reported that coconut meat contains coconut oil, which may decrease the liver activities, serum levels of alanine amino transferase (ALT), Aspartate amino transferase (AST) and alkaline phospahtase (ALP). Also **DebMandal and Mandal, (2011**) found that medium chain triglycerides and fatty acids help in preventing liver diseases as substances are easily converted into energy when they reach the liver,

thus reducing work load on the liver and also preventing accumulation of fat. Furthermore, **Indra *et al*., (2015)** showed that Coconut milk have a better effect on the improvement of nutritional status in patients with liver cirrhosis, What does it contain from high levels of potassium, magnesium, iron, and zinc, with a good amount of vitamin E and C. Regarding the hyaluronic acid and other acids **Chen *et al*., (2018)** indicated that Coconut milk and meat contain a high percentage of manganese, as it helps the body to benefit from a number of vitamins, such as choline, thiamine, and vitamins C and E, and ensures normal liver function and activation of many enzymes in the metabolism process.

Effect of coconut fruits and coconut milk on albumin (ALB) (g/dl) and total protein (TP) (g/dl) of hypercholesterolemic rats

Data in Table (4) indicated that the mean value of ALB **(g/dl)** and T.P **(g/dl)** of hypercholestrolemic rats fed on various diets. Rats fed on high cholesterol diet (control +ve) had a significant increase in concentration of ALB and T.P which recorded 3.70 ± .12 and 7 ± .14 03 , respectively compared to control (–ve) group which recorded 3.40 ± .001 and 6.62 ± .04. Rats fed on high cholesterol diets supplemented with coconut powder 2.5% - 5% and coconut milk 250 -500 ml had significant decreases in concentration of ALB and T.P. As compared to the positive control group. The best treatment was observed for group 6 (coconut Milk (500ml). Our results are in agreement the results obtained by **Olaleye *et al* ., (2010) and Kwon *et al* ., (1996)** reported that the coconut decreased albumin and total protein in rats. Also **Indra *et al* ., (2015)** showed that Coconut milk have a better effect on the improvement of nutritional status in patients with liver cirrhosis, What does it contain from high levels of potassium, magnesium, iron, and zinc, with a good amount of vitamin E and C. Regarding the hyaluronic acid and other acids. **Otuechere *et al*., (2013)** showed that coconut meat contains coconut oil, which protects against liver damage in albino rats challenged with the anti-folate combination, trimethoprimsulfamethoxazole.

Table (4): Effect of coconut fruits and coconut milk on albumin (ALB) and total protein (T.P) (g/dl) of hypercholesterolemic rats

Groups	ALB (g/dl)	% of change	T.P (g/dl)	% of change
Group (1): Control (-)	3.40 [b] ± .001	-8.10	6.62 [b] ± ,04	-5.42
Group (2): Control (+)	3.70 [a] ± .12	--------	7 [a] ± .14	-------
Group (3): Coconut powder 2.5%	3.68 [a] ± .10	-0.54	6.98 [a] ± .08	-.28
Group (4): Coconut Powder 5%	3.52 [b] ± .22	-4.86	6.88 [a] ± .21	-1.71
Group (5): Coconut milk 250 ML	3.48 [b] ± .08	-5.94	6.80 [ab] ± .12	-2.85
Group (6): Coconut milk 500 ML	3.42 [b] ± .04	-7.56	6.62 [b] ± .21	-5.42

Means in the same column with different letters are significantly different at $P \leq 0.05$.

Effect of coconut fruits and coconut milk on serum lipid profile of hypercholesterolemic rats

Data in Table (5) indicated that the mean value of T.C (mg/dl), T.G. (mg/dl), LDL-c (mg/dl), and VLDL-c (mg/dl) of hypercholestrolemic rats fed on various diets. Rats fed on high cholesterol diet (control +ve) had a significant increase in concentration of T.C, T.G, LDL-c and VLDL-c which recorded 106.68 ± 5.49, 191.60 ± 26.98, 25 ± 2.12, 42.84 ± 3.53 and 36.32 ± 6.98 , respectively compared to control (–ve) group which recorded 74.68 ± 5.35, 99.32 ± 21.92, 31 ± 3.24, 24.25 ± 4. 28, 21.45 ± 2.62 ± .04. Rats fed on high cholesterol diets with coconut powder 2.5% - 5% and coconut milk 250 -

500 ml had significant decreases in concentration of T.C, T.G, LDL-c and VLDL-c. the mean value of serum (H.D.L.c) (mg\dl) of hypercholesterolemic rats fed on different diets. It could be observed that the mean value of (HDLc) of control (+) group was lower than control (-)group, being 25 ± 2.12 and 31 ± 3.24 respectively, showing significant difference with percent of increase +24 % of control (-) group as compared to control (+)group. Our results are in agreement with the results obtained by **Scheurig *et al*.,(2007)** they indicated that coconut milk contained panthen, which helped lower the bad (bad) LDL cholesterol and raise HDL (the good) cholesterol. In some open studies, pantothense appears to lower cholesterol and triglyceride levels in people with high cholesterol. In similar studies, **Nevin and Rajamohan , (2007)** they reported that The virgin coconut oil reduced, total cholesterol, triglycerides, very low density lipoprotein cholesterol(VLDL -C) and low density lipoprotein cholesterol (LDL-C) but increased high density lipoprotein cholesterol (HDL-C). Also, **Intahphuak *et al* ., (2010)** reported that liver disease lead to increased serum lipids, impaired lipoprotein synthesis, and fat maldigestion& malabsorption. Furthermore, **Trinidad *et al*., (2004)** reported that coconut flakes reduced serum total and LDL cholesterol and serum triglycerides. **Ekanayaka *et al*.,(2013)** indicated that the serum LDL - VLDL levels decreased while the HDL levels increased in healthy subjects on a diet containing coconut milk. At the same time, **Mini and Rajamohan, (2004)** showed that coconut improves digestion and absorption of other nutrients such as; vitamins, minerals, amino acids. It prevents obesity, overweight problem by increasing metabolic rate, regulates thyroid function, boosts energy and fights fatigue.

Table (5): Effect of coconut fruits and coconut milk on serum lipid profile of hypercholesterolemic rats

Groups	TC(mg/dl)	% of change	TG(mg/dl)	% of change	HDL-C(mg/dl)	% of change	LDL-C(mg/dl)	% of change	VLDL-C(mg/dl)	% of change
Group (1): Control (-)	74.68 ^{c} ± 5.35	-29.99	99.32 ^{c} ± 21.92	-48.16	31 ^{a} ± 3.24	24	24.25 ^{c} ± 4.28	-43.39	21.45 ^{d} ± 2.62	-40.94
Group (2): Control (+)	106.68 ^{a} ± 5.49	--------	191.60 ^{a} ± 26.98	-------	25 ^{b} ± 2.12	-------	42.84 ^{a} ± 3.53	-------	36.32 ^{a} ± 6.98	-------
Group (3): Coconut powder 2.5%	87.68 ^{b} ± 10.25	-17.81	136.60 ^{b} ± 19.23	-28.70	26 ^{b} ± 1.41	4	35.80 ^{b} ± 6.70	-16.43	32.45 ^{b} ± 5.22	-10.65
Group (4): Coconut Powder 5%	79.40 ^{bc} ± 9.54	-25.57	145.68 ^{b} ± 20.61	-23.96	26 ^{b} ± 1.22	4	29.14 ^{bc} ± 4.29	-31.97	29.12 ^{bc} ± 4.12	-19.82
Group (5): Coconut milk 250 ML	79 ^{bc} ± 6.04	-25.95	142 ^{b} ± 14.07	-25.88	26.32 ^{b} ± 1.63	5.28	26.70 ^{c} ± 6.37	-37.67	28.40 ^{bc} ± 2.81	-21.80
Group (6): Coconut milk 500 ML	78 ^{bc} ± 7.44	-26.88	117.68 ^{bc} ± 16.12	-38.58	26.32 ^{b} ± 2.48	5.28	27.25 ^{c} ± 6.006	-36.39	23.52 ^{cd} ± 3.22	-35.24

Means in the same column with different letters are significantly different at $P \leq 0.05$.

On the other side, **Bawalan and Chapman, (2006)** reported that coconut is used in the treatment of mal-absorption of fat such as cystic fibrosis and enteritis. Also, **Fernando *et al.*, (2015)** reported that coconut is classified as a highly nutritious 'functional food'. It is rich in dietary fiber, vitamins and minerals; however, notably, evidence is mounting to support the concept that coconut may be beneficial in the treatment of obesity, dyslipidaemia and elevated LDL. Furthermore, **Amarasiri and Dissanayake, (2006)** found that coconut milk is naturally rich in a component called lauric acid. This component is an effective barrier against many viruses and infections, as it has anti-viral and anti-fungal properties. It has been found to help balance cholesterol in the bloodstream, by raising levels of good cholesterol and lowering levels of bad cholesterol. Finally, **Khaw *et al.*, (2018) and Rachel, (2017)** indicated that coconut meat contains coconut oil, which may boost HDL (good) cholesterol and reduce LDL (bad) cholesterol. Improvements in these markers may reduce your risk of heart disease.

Effect of coconut fruits and coconut milk on glucose levels (mg/dl) of hypercholesterolemic rats

The mean value of serum glucose (mg/dl) of hypercholesterolemic rats fed on various diets were tabulated in Table (6). It could be noticed that the mean value of glucose of control (+) group was higher than control (-) group, being 173 ± 33.67 & 82 ± 12.18 respectively, showing significant difference and percent of decrease -52.60 % as compared to control (+) group. All hypercholesterolemic rats fed on different diets revealed significant decreases in mean values as compared to control (+) group. The percent of decreases were from-6.93 to -41.27 % for groups 3 to group 6. The better treatment was observer for group 6 (coconut milk 500ml). Our results are in agreement with the results obtained by **Vijayakumar *et al* ., (2018),** they found that coconut diet helps reduce blood glucose levels and body weight in normal healthy individuals. Also **Lima *et al*., (2015)** showed that the coconut kernel protein has potent anti-diabetic activity through reversal of glycogen levels, activities of carbohydrate metabolizing enzymes and the pancreatic damage to the normal levels due to its effect on pancreatic β-cell regeneration by means of argini. Furthermore, **Talaei *et al*., (2018)** reported that Coconut milk contains almost the same nutrients as the coconut flesh. So considering this fact, fresh coconut milk (pressed from coconut meat) is rich in fiber. Dietary fibers specially the soluble ones helps to slow down the absorption of sugar and help in keeping the blood sugar levels under control. it's a rich source of calcium, vitamin-D, potassium, and may even help prevent type 2 diabetes.

In similar studies, **Lee *et al*., (2013)** reported that Both coconut milk and meat are high in manganese, which plays a role in regulating blood sugar. Manganese is highly concentrated in the pancreas. It participates in the production of insulin, which removes sugar from the blood. Thus, manganese might contribute to the correct secretion of insulin and help stabilize blood sugar. Also, **Weickert and Pfeiffer, (2018)** showed that the high fiber content of coconut meat can also help slow digestion and improve insulin resistance, which can help regulate blood sugar levels as well. Furthermore, **Effiong *et al* ., (2010)** showed that coconut meat contains Coconut oil, which supplies energy to cells because it is easily absorbed without the need of pancreatic enzymes. It has been shown to improve insulin secretion and utilization of blood glucose due to the presence of capric and lauric acids.

Table (6): Effect of coconut fruits and coconut milk on glucose levels (mg/dl) of hypercholesterolemic rats

Groups	Glucose(mg/dl)	% of change
Group (1): Control (-)	82 ^{d} ± 12.18	-52.60
Group (2): Control (+)	173 ^{a}± 33.67	--------
Group (3):Coconut powder 2.5%	161 ^{ab}±10.19	-6.93
Group (4): Coconut Powder 5%	138.3 ^{bc}±9.90	-20.05
Group (5): Coconut milk 250 ML	127.1 ^{c}±22.4	-26.53
Group (6): Coconut milk 500 ML	101.6 ^{d}±12.4	-41.27

Means in the same column with different letters are significantly different at $P \leq 0.05$.

Effect of coconut fruits and coconut milk on kidney functions of hypercholesterolemic rats

The mean value of serum creatinine (mg/dl), urea (mg/dl) and uric acid (mg/dl) of hypercholesterolemic rats fed on various diets were illustrated in Table (7). Rats fed on high cholesterol diet (control +ve) had a significant increased in concentration of Serum Creatinine, Serum Urea and Serum Uric acid which recorded .78 ± .04, 3.62 ± .78 and 36.58 ± 6.16 , respectively compared to control (–ve) group which recorded .68 ± .04, 1.08 ± .14 and 27.42 ± 1.60. Rats fed on high cholesterol diets with coconut powder 2.5% - 5% and coconut milk 250 - 500 ml had significant decreases in concentration of serum creatinine, urea and uric acid as compared to the positive control group. Our results are in agreement the results obtained by **Srivastava *et al* ., (2016)** reported that coconut meat contains coconut oil, which reduces levels of urea and creatine .It is known, VCO contains antioxidants including tocotrienol, flavonoids and some polyphenol compounds. With the presence of these antioxidants, **Xu *et al* ., (2014)** showed that the dietary fiber in coconut pulp reduces urea and serum creatinine for patients with chronic kidney disease.. **el-shemy , (2018)** showed that Coconut is effective in alleviation hyperglycemia, hyperlipidemia, renal and hepatic dysfunctions.

Table (7): Effect of coconut fruits and coconut milk on kidney function of hypercholesterolemic rats

Groups	Creatinine (mg/dl)	% of change	Uric acid(mg/dl)	% of change	Urea(mg/dl)	% of change
Group (1): Control (-)	.68 [b] ± .04	-12.82	1.08 [c] ± .14	-70.16	27.42 [c] ± 1.60	-25.04
Group (2): Control(+)	.78 [a] ± .04	--------	3.62 [a] ± .78	-------	36.58 [a] ± 6.16	-------
Group (3): Coconut powder 2.5%	.70 [b] ± .001	-10.25	2.68 [b] ± .08	-25.96	32.82 [ab] ± 3.001	-10.27
Group (4): Coconut Powder 5%	.70 [b] ± .07	-10.25	2.38 [bc] ± .41	-34.25	31.20 [bc] ± 4.71	-14.70
Group (5): Coconut milk 250 ML	.70 [b] ± .002	-10.25	2.28 [bc] ± .20	-37.01	29.80 [bc] ± 1.51	-18.53
Group (6): Coconut milk 500 ML	.68 [b] ± .04	-12.82	2.03 [bc] ± .65	-43.92	29.70 [bc] ± .53	-18.80

Means in the same column with different letters are significantly different at $P \leq 0.05$.

In conclusion, our data confirmed the hypothesis that both coconut powder and its milk contain several bioactive compounds capable of mitigating the harmful effects of high cholesterol and inhibiting hypercholesterolemia in rat. Therefore, we recommended the using of coconut fruits and/or their milk in moderate amounts in our daily diets to take the advantages of their health benefits.

References

Amarasiri, W.A., Dissanayake, A.S. (2006): Coconut fats. Ceylon Medical Journal 51 (2), 47-51.

Allain, C.C.; Poon, L.S.; Chan, C.S.; Richmon, W. and Fu, P.C.(1974): Enzymatic determination of total serum cholesterol. Clin. Chem., 20:470-475.

Bawalan, D.D. and Chapman, K.R. (2006): Virgin Coconut Oil Production Manual for Micro- and Village-Scale Processing. Bangkok: FAO Regional Office. 112 p.

Bergmeyer, H. and Harder,M.(1986): A colorimetric method Of the determination of serum glutamic oxaloacetic and glutamic pyruvic transaminase . Clin. Biochem., 24:28-34.

Binnert, C.; **Pachiaudi**, C.; **Beylot, M. and Hans**, D. (1998): **Influence of human obesity on the metabolic fate of dietary long and medium chain triacyglycerols.** American Journal of Clinical Nutrition 67(4):595-601

Biggerstaff, K. D. and Wooten, J. S. (2004): Understanding lipoproteins as transporters of cholesterol and other lipids. National Institutes Of Health. 28 (1-4):105-6.

Bipasha, M.s. and Goon, S. (2014): Fast food preferences and food habits among students of private universities in Bangladesh. South East Asia Journal of Public Health, 3(1)

Chen, P.; Bornhorst, J. and Aschner, M. (2018): Manganese metabolism in humans**.** Front Biosci (Landmark Ed)., 1;23:1655-1679.

DebManda,M. and Mandal,S. (2011): Coconut (Cocos nucifera L.: Arecaceae): In health promotion and disease prevention. Asian Pacific Journal of Tropical Medicine. 4(3): 241-247.

Drury, R.A. and Wallington,E.A. (1980): Carlton's Histological Technique. 5th Ed. Oxford University.

Effiong, G.S.; Ebong, P.E, Eyong, E.U.; Uwah, A.G. and Ekong, U.E. (2010): Amelioration of chloramphenicol induced toxicity in rats by coconut water. J Appl Sc Res. 6 (4) . 331-335.

Ekanayaka, R.A.I.; Ekanayaka, N.K.; Perera, B. and De Silva, P.G.S.M. (2013): Impact of a Traditional Dietary Supplement with Coconut Milk and Soya Milk on the Lipid Profile in Normal Free Living Subjects. J Nutr Metab.2013: 481068

El-Shemy, M.A.(2018): Antidiabetic and Anti-hyperlipidemic Effects of Virgin Coconut Oil in Rats. J. Vet. Sci, 49(2): 111-117.

Feng,l .; xie, B.N.; Liu,Y.; Kuang,Y.S.; Tang,L.; Jiang,J.; Hu,K.; Jiang,D.W.; Li,H.S and Zhou,Q.X. (2012): Dietry phosphorus

prevents oxidative damage and increase antioxidant enzyme activities in intestine and hepatopancreas of juvenile jian carp. 19(3) .

Fernando,W.M.A.D.B.; Martins,I.J.; Goozee,K.G.; Brennan,.; Jayasena,V. and Martins,R.N. (2015): The role of dietary coconut for the prevention and treatment of Alzheimer's disease: potential mechanisms of action. Br J Nutr, 14;114(1):1-14.

Fossati, P. and Prencipe, L. (1982): Triglyceride enzymatic colorimetric method. J . of Clin. Chem., (28):20077-2080.

Gupta, R.; Mohan , I. and Narula, J. (2016): Trends in coronary heart disease epidemomiology in India. Ann Global Health. 82:307-15.

Harding,S.V.; Lopez,S.V.; Rideout,T.C.; Matthan,N.R.; Ausman,L.M.; Lichtenstein,A.H.and Jones,P.J. (2009): Variation of dietary lysine:arginine ratio does not affect cholesterol biosynthesis in hypercholesterolemicindividuals.J.FASEB. https://doi.org/10.1096/fasebj.23.1_supplement.722.12

Henry, J.B. (1974): Clinical Diagnosis and Management by Laboratory Methods. 20th Edition. Philadelphia: W. B. Saunders.

Indra, S.; Gani, R.A.; Syam, A.F. and Shatri, H. (2015): Effect of coconut milk supplementation to Nutritional status parameters in liver cirrhosis patients .

Intahphuak, S.; Khonsung, P. and Panthong, A. (2010): Anti-inflammatory, analgesic, and antipyretic activities of virgin coconut oil**.** Pharmaceutical Biology. 48(2):151.

Khaw, K.T.; Sharp, J.S.; Finikarides, L.; Afzal, I.; Lentjes, M.; Luben, R. and Forouhi, N.G. (2018): Randomised trial of coconut oil, olive oil or butter on blood lipids and other cardiovascular risk factors in healthy men and women**.** BMJ Open, ; 8(3): e020167.

Kachmar , J.F. and Moss, D.W. (1976). Enzymes, In: Fundamentals of Clinical (Edited by Tiez N). Philadelphia PA. W. B. Saunders Co. PP. 666-672.

KWON , K.S.; BAE, D.; PARK, K.H. and RHEE, K.C. (1996): AqueousExtraction and Membrane Techniques Improve Coconut Protein Concentrate Functionality. Journal of food science. Journal of Food Science. https://doi.org/10.1111/j.1365-2621.1996.tb12197.x

Lee, R. and Nieman, D.(1996): Nutritional Assesment . 2nd Ed. Mosby, Missouri , USA.

Leah, E. (2009): Cholesterol lipidomics gateway .Http:/www.lIpIdaps.org/ update /2009 /09050 /fulipidmaps.2009.3.html. Do1: 10.1038/ lipidomaps.2009.3.

Lee, S.H.; Jouihan, H.A.; Cooksey, R.C.; Jones, D.; Kim, H. J.; Winge, D.R. and McClain, D.A. (2013): Manganese supplementation

protects against diet-induced diabetes in wild type mice by enhancing insulin secretion. Endocrinolgy. 154(3):1029-38.

Liau, K.M.; Lee, Y.Y.; Chen, C.K. and Rasool, A.H. (2011): An open-label pilot study to assess the efficacy and safety of virgin coconut oil in reducing visceral adiposity. ISRN Pharmacol. 3 (15): 1-7.

Lima, E.B.; Sousa, C.N. Meneses, L.N.; Ximenes, N.C., Santos, J.M.; Vasconcelos, G.S., Lima, N.B.; Patrocinio, M.C.; Macedo, D. and Vasconcelos, S.M. (2015): Cocos nucifera (L.) (Arecaceae): a phytochemical and parmacolgical. J. Biological Research. 48(11): 953-964.

Li, L. and Yang, X. (2018): The Essential Element Manganese, Oxidative Stress, and Metabolic Diseases: Links and Interactions. Oxid Med Cell Longev. 2018: 7580707.

Lopez, M.F. (1977): HDL- Cholesterol colorimetric method. J. of Clin. Chem., 230- 282.

McCarty, M.F. and DiNicolantonio, J.J. (2016):
Lauric acid-rich medium-chain triglycerides can substitute for other oils in cooking applications and may have limited pathogenicity**.** Open Heart. 3(2): e000467.

Mini, S. and Rajamohan, T. (2004): Influence of coconut kernel protein on lipid metabolism in alcohol fed rats. Indian J Exp Biol. 42 (1). 53-57.

Mirzaei, F.; Khazaei , M.; Komaki, A.; Amiri, I. and Jalili, C. (2019):
The Effects of Virgin Coconut Oil on Prevention of Alzheimer's Disease, Journal of Natural Pharmaceutical Products. 14 (4).

Naruta , E. and Buko,V. (2001): Hypolipidemic effect of pantothenic acid derivatives in mice with hypothalamic obesity induced by aurothioglucose, Exp Toxicol Pathol.

Negm, S. (2019): Effect of Soybean, Virgin Coconut and Moringa oleifera Seed Oils on the Propylthiouracil Induced Hypothyroidism in Rats. Alexandria Science Exchange Journal 40(6):649-659.

Nevin KG, Rajamohan T. Influence of virgin coconut oil on blood coagulation factors, lipid levels and LDL oxidation incholesterol fed Sprague-Dawley rats. Eur e-J Clin Nutr Metabol 2007; e1-e8

Olaleye, T.M.; Akinmoladun, A.C. and Ogunboye, A. (2010): Antioxidant activity and hepatoprotective property of leaf extracts of Boerhavia diffusa Linn against acetaminophen-induced liver damage in rats. Food and chemical toxicology 48(8-9):2200-5

Otuechere, C.A.; Madarikan, G.; Simisola, T.; Bankole, O. and Osho, A. (2013): Virgin coconut oil protects against liver damage in albino

rats challenged with the anti-folate combination, trimethoprim-sulfamethoxazole . J. Basic Clin Physiol Pharmacol.1;25(2):249-53.

Patton. C.J. and Crouch, S.R. (1977): Enzymatic determination of urea. J. Anal. Chem., 49:464-469.

Park, S.; Kim, S. and Kang, S. (2011): Gastrodia elata Blume water extracts improve insulin resistance by decreasing body fat in diet-induced obese rats: Vanillin and 4-hydroxybenzaldehyde are the bioactive candidates. Eur. J. Nutr. 50: 107-118.

Rachel Hajar, M.D.(2017): Risk Factors for Coronary Artery Disease: Historical Perspectives, Heart Views. 18(3).

Renjith, R.S.; Chikku, A.M. and Rajamohan, T. (2013): Cytoprotective antihyperglycemic and phytochemical properties of Cocos nucifera, (L.) inflorescence. Asian Pac. J. Trop. Med. 6 (10): 804-810.

Rial, S.A.; Karelis, A.D.; Bergeron,K.F. and Mounier, C. (2016): Gut Microbiota and Metabolic Health: The Potential Beneficial Effects of a Medium Chain Triglyceride Diet in Obese Individuals. Nutrients. 12;8(5):281.

Rocha,V.; Alves, F. and Azevedo. C.(2019): Coconut oil action on the hepatic function of rats wister submitted to the diet hypercaloric, International Journal of Development Research. 9(4):27

SAS (2006): Statistical Analysis System, SAS User's Guide: Statistics. SAS Institute Inc.Editors, Cary, NC.

Salil, g. and Rajamohan, t.(2001): Hypolipidemic and antiperoxidative effect of coconut protein in hypercholesterolemic rats.j. Biology. 32553496.

Scheurig, A.C.; Thorand, B.; Fischer, B.; Heier, M. and Koenig, W. (2007): Association between the intake of vitamins and trace elements from supplements and C-reactive protein: results of the MONICA/KORA Augsburg study. Eur J Clin Nutr.

Schultz, A. (1984): Uric Kaplan A. Clin Chem ., Mosby Co. St. Louis Toronto . Princeton ; 1261 – 1266 and 418.

Srivastava ,Y.; Semwal, A.D. and Majumdar A. (2016): Quantitative and qualitative analysis of bioactive components present in virgincoconut oil. Cogent Food & Agriculture.; 2(1):1164929.

St-Onge, M.P. and Jones, P.J. (2002): Physiological effects of medium-chain triglycerides: potential agents in the prevention of obesity. J. Nutr., 132(3): 329-332.

Talaei, M.; Pan, A.; Yuan, J.M. and Koh,W.P. (2018): **Dairy intake and risk of type 2 diabetes,** Clin Nutr., 37(2):712-718.

Tinchan, P.; Lorjaroenphon, Y.; Cadwallader, K.R. and Chaiseri, S. (2015): Changes in the profile of volatiles of canned coconut milk during storage. J Food Sci. 80:C49–C54.

Travis, A.J and Kopf, G.S. (2002): The role of cholesterol efflux in regulating the fertilization potential of mammalian spermatozoa. J Clin Invest. 110(6):731-6.

Trinidad, P.T.; Aida C.M.; Divinagracia, H.V.; Anacleta, S. L.; Faridah, C. A.; Joan, C.C.; Rosario, R.E.; Dina, B.M. Angelica, S.M.; and Modesto, T.C. (2006): Dietary fiber from coconut flour: A functional food, Innovative Food Science and Emerging Technologies 7: 309-317.

Trinidad, T.; Mallillin, A.; Loyola, A.S. and Valdez, D.H. (2004): The Cholesterol-Lowering Effect of Coconut Flakes in Humans with Moderately **Raised Serum Cholesterol.** Journal of Medicinal Food. 7(2):136-40.

Varley, H.; Gewenlock, A. and Bell, M. (1980): Practical Clinical Biochemistry, Vol. 1, 5th Ed. London; Williams Heinemen Medical books, Ltd. pp. 741:897.

Vijayakumar, V.; Shankar, N.R.; Mavathur, R.; Mooventhan, A.; Anju, S. and Manjunath, N.K. (2018): Diet enriched with fresh coconut decreases blood glucose levels and body weight in normal adults, J Complement Integr Med., 20;15(3) :/j/jcim. 2018.15.issue-3/jcim-2017-0097/jcim-2017-0097.xml.

Weickert, M.O. and Pfeiffer, A.F.H. (2018): Impact of Dietary Fiber Consumption on Insulin Resistance and the Prevention of Type 2 Diabetes. J. Nutr. 1;148(1):7-12

Xu, H.; Huang, X.; Risérus, U.; Krishnamurthy, V.M.; Cederholm, T.; Ärnlöv,J.; Lindholm, B.; Sjögren, P. and Carrero, J.J. (2014): Dietary Fiber, Kidney Function, Inflammation, and Mortality Risk**.** Clin J Am Soc Nephrol. 5; 9(12): 2104–2110

Zheng, Y.; Ma, A.G.; Zheng, M.C.; Wang, O.Z.; Liang, H.; Han, X.X. and Schouten, E.G. (2018): B Vitamins Can Reduce Body Weight Gain by Increasing Metabolism-related Enzyme Activities in Rats Fed on a High-Fat Diet.53(5):393-8.

Journal of Home Economics, Volume 30, Number (1), 2020

تاثير ثمار ولبن جوز الهند على التغيرات البيولوجية والكيميائية للفئران المصابة بارتفاع الكوليسترول

يوسف عبد العزيز الحسانين، أمل ناصف ذكى، ألطاف عصام محمد على أبوخزيمه

قسم التغذية وعلوم الأطعمة ، كلية الاقتصاد المنزلي، جامعة المنوفية، شبين الكوم ، مصر

أجريت هذه الدراسة لمعرفة تأثير ثمار ولبن جوز الهند على التغيرات البيولوجية والكيميائية والهستويولوجية للفئران المصابة بارتفاع الكوليسترول. لذلك تم استخدام ستة وثلاثين ذكور فئران ألبينو والتي تزن 140-150 جم حيث تم تقسيمها إلى مجموعتين رئيسيتين. المجموعة الأولى الرئيسية (6 فئران) استخدمت كمجموعة ضابطة سالبة والتي تغذت على النظام الغذائي الأساسي. وتم تغذية المجموعة الرئيسية الثانية (30 جرذاً) على نظام غذائي أساسي مكمل بمسحوق الكولسترول ونظام غذائي عالي الدهون (10٪ دهون حيوانية) للحث على فرط كوليسترول الدم وتم تقسيمها إلى خمس مجموعات فرعية متساوية. تم وضع مجموعة واحدة كمجموعة ضابطة موجبة والتي تغذت باستمرار على النظام الغذائي الأساسي. وتم إطعام المجموعات الأربع المتبقية على النظام الغذائي الأساسي المضاف إليه ثمار جوز الهند بتركيز 2.5 و 5٪ وحليب جوز الهند بمستويات 250 و 500 مل لكل كيلوجرام من العلف لمدة 28 يومًا. ولقد أشارت النتائج التي تم الحصول عليها إلى أن كلا من مسحوق جوز الهند وحليبها قد أدى إلى انخفاض معنوي ($P\leq0.05$) في مصل TC و TG و LDL و VLDL مع زيادة HDL . وان كل من مسحوق جوز الهند وحليبها يحسن أيضا من وظائف الكبد والكلى. أكدت هذه البيانات الفرضية القائلة بأن كلا من مسحوق جوز الهند وحليبها يحتويان على العديد من المركبات النشطة بيولوجيًا القادرة على التخفيف من الآثار الضارة لارتفاع الكوليسترول وتثبيط ارتفاع الكولسترول في الدم لدى الجرذان. لذلك توصى الدراسة باستخدام مثل هذه الفاكهة بكميات معتدلة في وجباتنا الغذائية اليومية للاستفادة من فوائدها الصحية.

الكلمات المفتاحية: الفئران المصابة بارتفاع الكوليسترول ، وظائف الكبد ، وظائف الكلى ، صورة دهون الدم.