

# Chemical and Biological Evaluation of Nutritional Characteristics of Egyptian Pecan

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## ABSTRACT

Two different cultivars of pecan, *Carya illinoensis*, grown in Egypt, namely: Desirable and Moneymaker were analyzed for their amino acids composition, chemical score, protein efficiency ratio (PER) and net protein ratio (NPR) as parameters for their protein quality. Moreover, total cholesterol (TC), cholesterol fractions and serum triglycerides of experimental rats fed on pecan were determined.

The concentration of arginine in pecan protein was found in high amount (166.94 and 147.20 mg/g protein for Desirable and Moneymaker, respectively) which offers health benefits. Lysine was the first limiting amino acid in both cultivars and the chemical score was 0.75 for Desirable and 0.66 for Moneymaker pecan cultivars. The protein quality of Desirable cultivar was higher than that of Moneymaker, meanwhile, they both had good protein quality where their Adj-PER and NPR were 2.30, 2.25 and 3.27, 3.25, for Desirable and Moneymaker cultivars, respectively, compared to 2.50 and 3.43 for casein diet as a reference protein. The blood serum analysis of the rat groups fed on pecan diet had lower levels of LDL-C, V.LDL-C and triglycerides, but had higher level of HDL-C than those fed on casein diet.

Our results show that the protein of pecan kernels (plant protein) is in good quality, especially for Desirable cultivar, and their fat may improve human serum lipid profile by lowering LDL-C and V.LDL-C and increasing HDL-C.

**Keywords:** Amino acids, Cholesterol fractions, Net protein ratio (NPR), Pecan, Protein efficiency ratio (PER).

## INTRODUCTION

Pecan (*Carya illinoensis*) belongs to the family *Juglandaceae*, which also includes other tree nuts such as walnuts (McHatton, 1957 and Rosengarten, 1984). It is successfully cultivated in subtropical zones. Pecan trees were known in Egypt in the last years of the 20<sup>th</sup> century, where it has been successfully grown in scattered areas.

Nuts and seeds have a wide range of uses, they tend to be either used as snack items or added as minor ingredient to savory and sweet dishes, moreover, they have wider applications in vegetarian diets as important sources of protein, unsaturated fatty acids, tocopherols and other nutrients (Gray, 2005).

Nuts may be source of health promoting compounds that elicit cardioprotective effects. In particular, nuts include plant protein, polyunsaturated fatty acids, dietary fibers, plant sterols phytochemicals and micronutrients like; tocopherols, copper, magnesium and folic acid (Kris-Etherton *et al.*, 2001 and Nijjar, *et al.* 2010). These components likely combine to reduce LDL-C beyond the effects of those predicted by equations based solely on fatty acid profiles (Van Horn, 2008). At present, nuts are classified as part of the USDA Food Guide pyramids Meat/Meat Alternate Group (Dreher *et al.*, 1996). In July 2003 the US Food and Drug Administration (FDA) approved a qualified health claim stating that consumption of 42 g per day of most tree nuts may reduce the risk of heart disease. Amino acid composition analyses indicated that lysine in pecan, brazil nut, cashew and walnut; sulfur amino acids in almond to be the first limiting amino acid as compared to human amino acids requirements (Venkatachalam and Sathe, 2006). There are little information about the nutritive value of pecan protein and its effect on human health. Therefore, this study was conducted to study the nutritive value of two Egyptian pecan cultivars by determining their amino acids composition, PER and NPR. Moreover, blood serum cholesterol and triglycerides were determined using animal feeding experiments.

## MATERIALS AND METHODS

### 1.1. Materials

Two cultivars of in shell pecan fruits namely: Desirable and Moneymaker were brought from Agriculture Ministry of Egypt. The fruits were shelled and the kernels were packed in polyethylene bags and stored at (-16 – -18°C) until required. The samples were prepared for chemical analysis by grinding the pecan kernels to pass through a 40 mesh sieve.

### 1.2. Analytical methods

Moisture, crude ether extract and crude protein were determined as described by the AOAC (2003). Amino acids composition was determined by the method of Duranti and Cerletti (1979) using Beckman amino acid analyzer Model 19 Cl. For the determination of Tryptophan the samples were subjected to alkaline

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hydrolysis for 20 hours using Ba(OH)<sub>2</sub>, then the samples were determined according to the AOAC (2003). The essential amino acid scores were calculated in the sample by dividing the amino acid contents by the values in the reference protein (FAO/WHO, 1991). The chemical score of the pecan was identified corresponded to the lowest value of these essential amino acid scores.

### 1.3. Biological methods

Three experimental diets, each containing one of the following materials as the sole source of protein namely: casein, Desirable pecan and Moneymaker pecan. The fourth experimental diet was non-protein diet. The composition of the basal diets is given in Table (1) and the constituents of the other diets were prepared to have the same composition according to the method of AOAC (2003), based on the chemical composition of pecan cultivars which was 9.15, 8.08% crude protein; 75.94, 74.84% crude ether extract; 1.61, 1.50% ash and 9.13, 10.78% total carbohydrates for Desirable and Moneymaker cultivars, respectively (El-Shimy *et al.*, 2011).

Protein efficiency ratio (PER), adjusted PER, net protein ratio (NPR), total cholesterol (TC), cholesterol fractions and triglycerides were determined as parameters to assess the biological value of pecan.

Male albino rats (21-23 days old) with average weight of 50±5 g, obtained from Economic Home Department Laboratory- Alexandria University- Egypt were used. The rats were divided into four groups of eight rats, and fed on the forementioned diets, water and food were *ad libitum* daily for four weeks. Uneaten and scattered foods were estimated daily and the rats were weighted twice a week. PER, adjusted PER and NPR were calculated according to AOAC (2003).

**Table 1. Composition of the basal diet\***

Ingredients	(%)
Corn starch	70
Protein	10
Cotton seed oil	10
Salt mixture**	5
Vitamin mixture***	1
Cellulose	4

\*AOAC (2003)

\*\*The composition of the salt mixture is (%): 54.3 calcium chloride, 2.5 magnesium carbonate, 1.500 magnesium sulphate, 6.8 sodium chloride, 11.0 potassium chloride, 21.0 potassium phosphate, 2.0 ferric phosphate, 0.008 potassium iodide, 0.035 manganese, 0.010 sodium fluoride, 0.017aluminum sulphate and 0.83 copper sulphate.

\*\*\*The composition of the vitamin mixture is (g): 0.3 thiamine HCl, 1.0 riboflavin, 0.2 pyrodoxin HCl, 6.0 calcium pantothenate, 20.0 nicotinic acid, 20.0 inositol, 60.0 p-amino benzoic acid, 0.2 biotin and 0.2 folic acid.

### 1.4. Blood serum analysis

A blood sample from each group was taken at the end of the experiment. Blood samples were placed into a dry clean glass tube with 0.2 ml heparin as anticoagulant and then left for 10 minutes at ambient temperature. The tubes were centrifuged at 8000 rpm for 10 minutes to separate the serum and the plasma. The clean supernatant serum was analyzed immediately.

The serum was used for determination of the triglycerides, the total cholesterol, the high density lipoprotein cholesterol (HDL-C), the low density lipoprotein cholesterol (LDL-C), and the very low density lipoprotein cholesterol (V.LDL-C) according to SYNCHRON LX system chemistry information manual (2000).

#### 1.4.1. Blood serum cholesterol fractions

300 µL of reactive reagent solution were added to 3.0 µL of the sample and the formed coloured compound was measured at 520 nm. The reactive reagent ingredients were described in Table (2). The high density lipoprotein cholesterol (HDL-C) was determined using the spectrophotometric method using unique detergent to solublize only the HDL particles. Amount of 280 µL reactive reagent solution was added to 3.0 µL of the sample and the formed coloured compound was measured at 560 nm. The low density lipoprotein cholesterol (LDL-C) was calculated from the difference between the total cholesterol and high density lipoprotein cholesterol (HDL-C). The reactive reagent ingredients were described in Table (2).

The very low density lipoprotein cholesterol (V.LDL-C) was calculated using the following equations:

$$\text{Triglycerides}$$

$$\text{V.LDL-C} = \frac{\text{Triglycerides}}{5}$$

#### 2.4.2. Blood serum triglycerides

The blood serum triglycerides level was determined using the spectrophotometric method, where 300 µL of reactive reagent solution were added to 3.0 µL of the sample and the formed coloured compound was measured at 520 nm. The reactive reagent ingredients were described in Table (2).

### 1.5. Statistical analysis

Statistical analysis was done by FACTOR and L.S.D. procedures available within the MSTAT-C software package (Version 1.2). Analysis of variance of different experiments was performed according to Steel and Torrie (1980).

**Table 2. Ingredients for blood serum profiles and triglycerides determination**

Reagent constituents	Concentration
<b>Blood serum cholesterol determination</b>	
4-Aminoantipyrine	0.26 mmol/L
Phenol	8.06 mmol/L
Cholesterol esterase ( <i>Candida Cylindracea</i> )	211 IU/L
Cholesterol oxidase ( <i>Brevibacterium Maris</i> )	216 IU/L
Horseradish peroxidase (HPO)	6667 IU/L
<b>Blood serum high density lipoprotein (HDL) determination</b>	
Cholesterol esterase ( <i>Candida Cylindracea</i> )	1250 IU/L
Cholesterol oxidase ( <i>Brevibacterium Maris</i> )	1600 IU/L
Horseradish peroxidase (HPO)	5000 IU/L
Polyanion	0.1 %
Detergent	1.0 %
<b>Blood serum triglycerides determination</b>	
Lipase	93 U/L
Adenosine triphosphate (ATP)	2.52 mmol/L
Glycerol Kinase (GK)	4.0 KIU/L
Glycerophosphate oxidase (GPO)	1.1 KIU/L
4-Aminoantipyrine	0.71 mmol/L
3,5 Dichloro-2-Hydroxybenzenesulfonic acid (DHBS)	1.54 mmol/L
Horseradish peroxidase (HPO)	9.0 KIU/L

## RESULTS AND DISCUSSION

### 1.6. Amino acids composition

Table (3) shows the amino acids composition as (mg/g protein) of pecan cultivars compared to FAO/WHO pattern for children. It is obvious that the major amino acids of pecan are glutamic acid followed by arginine for both cultivars Desirable and Moneymaker. The relatively high content of arginine in nuts may help in raising levels of endogenous nitric oxide, which promotes normal endothelial function and has effects to inhibit platelet aggregation, monocyte adherence, chemotaxis, and vascular smooth muscle proliferation (Loscalzo, 1995; Fraser, 1999 and De Lorgeril and Salen, 2004).

From the essential amino acids results (Table; 3), it can be seen that Desirable cultivar had significantly high content in most of the essential amino acids, and the total essential amino acids of Desirable cultivar are higher than that of Moneymaker cultivar. At the same time, both cultivars provided all the essential amino acids at higher concentration compared to the pattern of FAO/WHO for 2-5 years old children, except for lysine and threonine.

The essential amino acid scores of raw pecan kernels cultivars are presented in Table (4). The chemical score for Desirable cultivar (0.75) was higher than that of Moneymaker one (0.66). Lysine was the first limiting amino acid for both cultivars and threonine was the second one in Moneymaker only.

Venkatachalam (2004) found that lysine was the first limiting essential amino acids in the defatted flour of pecan. Threonine and tryptophan were the second and the third ones.

Moreover, Venkatachalam and Sathe (2006) reported that lysine in pecan, brazil nut, cashew and walnut, sulfur amino acids in almond, to be the first limiting amino acid as compared to human (2-5 years old) amino acids requirements.

### 1.7. Average weight gain, protein efficiency ratio (PER) and net protein ratio (NPR) of rats fed on casein and pecan diets

Average weight gain, protein efficiency ratio (PER) and net protein ratio (NPR) of rats fed on casein and pecan diets are given in Table (5).

The results indicate that the average weight gain for rats, which were fed on the casein and pecan cultivars diets were as follows in descending order: 35.30 g for casein, 32.11 g for Desirable cultivar and 31.25 g for Moneymaker cultivar. Moreover, when adjusted PER was calculated for the forementioned diets, it was found that, Desirable and Moneymaker pecan had slightly, but significantly, lower values, 2.30 and 2.25, respectively, than that of casein (2.50) as a reference protein. Meanwhile, net protein ratio (NPR) for pecan diets were 3.27 and 3.25 for Desirable and Moneymaker cultivars, respectively, which are not far from that of casein diet (3.43). The high growth of the rats which were fed on pecan diets can be confirmed by the results of Table (3), which showed that pecan protein had high amounts of essential amino acids. Estevez *et al.* (1995) studied the PER and NPR of walnut snack type bars and reported that walnut protein has good quality as compared to casein. So, it can be concluded that pecan protein, as plant protein, is considered a high quality protein, which gives it an advantage as a protein source for vegetarians and children.

### 1.8. Blood serum cholesterol picture and triglycerides

Table (6) shows the data of total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C), very low density lipoprotein cholesterol (VLDL-C), LDL: HDL and triglycerides (TG) in the serum of rats fed on casein and raw pecan Desirable and Moneymaker cultivars, for 4 weeks.

**Table 3. Amino acids composition of raw pecan cultivars proteins**

Amino acids composition (mg /g protein)	Cultivars		L.S.D	FAO/WHO pattern (1985)**
	Desirable	Moneymaker		
Crude protein	9.15 <sup>a</sup>	8.08 <sup>b</sup>	0.27	
<b>Essential Amino acids (E.A.A)</b>				
Isoleucine	47.05 <sup>a</sup>	41.55 <sup>b</sup>	0.41	28.00
Leucine	76.30 <sup>a</sup>	67.38 <sup>b</sup>	0.42	66.00
Lysine	43.42 <sup>a</sup>	38.34 <sup>b</sup>	0.49	58.00
Threonine	37.03 <sup>a</sup>	32.70 <sup>b</sup>	0.50	34.00
Valine	55.57 <sup>a</sup>	49.07 <sup>b</sup>	0.44	35.00
Tryptophan	19.98 <sup>a</sup>	17.64 <sup>b</sup>	0.50	11.00
Methionine	23.90 <sup>a</sup>	21.10 <sup>b</sup>	0.41	
Cystine	16.71 <sup>a</sup>	14.75 <sup>b</sup>	0.43	
Methionine + Cystine	40.61 <sup>a</sup>	35.85 <sup>b</sup>	0.48	25.00
Phenylalanine	63.19 <sup>a</sup>	55.80 <sup>b</sup>	0.53	
Tyrosine	43.79 <sup>a</sup>	38.67 <sup>b</sup>	0.66	
Phenylalanine + Tyrosine	106.98 <sup>a</sup>	94.47 <sup>b</sup>	0.67	63.00
Histidine	32.24 <sup>a</sup>	28.47 <sup>b</sup>	0.51	19.00
Total E.A.A	459.18 <sup>a</sup>	405.47 <sup>b</sup>	0.36	339.00
<b>Limiting Essential Amino acids (LEAA)</b>				
First	Lysine	Lysine		
Second	-	Threonine		
<b>Non Essential Amino acids (N.E.A.A)</b>				
Arginine	166.94 <sup>a</sup>	147.42 <sup>b</sup>	0.36	
Aspartic acid	102.67 <sup>a</sup>	90.67 <sup>b</sup>	0.40	
Glutamic acid	217.87 <sup>a</sup>	192.39 <sup>b</sup>	0.66	
Glycine	52.60 <sup>a</sup>	46.45 <sup>b</sup>	0.53	
Proline	50.25 <sup>a</sup>	44.37 <sup>b</sup>	0.66	
Serine	51.11 <sup>a</sup>	45.14 <sup>b</sup>	0.52	
Alanine	47.49 <sup>a</sup>	41.93 <sup>b</sup>	0.53	
Total N.E.A.A	688.93 <sup>a</sup>	608.37 <sup>b</sup>	0.57	

\*Means between columns sharing the same letters are not significantly different, using the revised L.S.D test at 0.05 level.

\*\* From FAO/WHO pattern (1985) for weaned (2-5 years) children.

**Table 4. Essential amino acid scores of pecan kernel cultivars**

Essential amino acids composition (mg/g protein)	Cultivars		FAO/WHO pattern (1985)**	Chemical score <sup>1</sup>	
	Desirable	Moneymaker		Desirable	Moneymaker
Isoleucine	47.05 <sup>a</sup>	41.55 <sup>b</sup>	28.00	1.68	1.48
Leucine	76.30 <sup>a</sup>	67.38 <sup>b</sup>	66.00	1.16	1.02
Lysine	43.42 <sup>a</sup>	38.34 <sup>b</sup>	58.00	0.75***	0.66***
Threonine	37.03 <sup>a</sup>	32.70 <sup>b</sup>	34.00	1.09	0.96
Valine	55.57 <sup>a</sup>	49.07 <sup>b</sup>	35.00	1.59	1.40
Tryptophan	19.98 <sup>a</sup>	17.64 <sup>b</sup>	11.00	1.82	1.60
Methionine + Cystine	40.61 <sup>a</sup>	35.85 <sup>b</sup>	25.00	1.62	1.43
Phenylalanine + Tyrosine	106.98 <sup>a</sup>	94.47 <sup>b</sup>	63.00	1.70	1.50
Histidine	32.24 <sup>a</sup>	28.47 <sup>b</sup>	19.00	1.70	1.50
Total E.A.A	459.18 <sup>a</sup>	405.47 <sup>b</sup>	339.00		

\*Means between columns sharing the same letters are not significantly different, using the revised L.S.D test at 0.05 level.

\*\* From FAO/WHO pattern (1985) for weaned (2-5 years) children.

\*\*\* The first limiting amino acids.

1- Essential amino acid scores calculated by dividing the essential amino acid amount (E.A.A) mg/g protein by the same value of E.A.A of the FAO/WHO pattern.

**Table 5. Weight gain, Food intake, and Protein intake of rats fed on casein and pecan diets**

Food Group	Average Weight gain (g) M±SD*	Average Food intake (g) M±SD	Average Protein intake (g) M±SD	PER <sup>1</sup> M±SD*	Adj-PER <sup>2</sup> M±SD	NPR <sup>3</sup> M±SD
Casein (Reference)	35.30 <sup>a**</sup> ±2.88	162.50 <sup>a**</sup> ±7.81	16.10 <sup>a</sup> ±0.76	2.20 <sup>a**</sup> ±0.13	2.50 <sup>a</sup> ±0.00	3.43 <sup>a</sup> ±0.21
Pecan (Raw) Desirable	32.11 <sup>b</sup> ±2.87	160.79 <sup>b</sup> ±7.80	15.92 <sup>b</sup> ±0.75	2.02 <sup>b</sup> ±0.12	2.30 <sup>b</sup> ±0.10	3.27 <sup>b</sup> ±0.21
Pecan (Raw) Moneymaker	31.25 <sup>c</sup> ±2.87	159.53 <sup>c</sup> ±7.82	15.79 <sup>c</sup> ±0.74	1.98 <sup>c</sup> ±0.12	2.25 <sup>c</sup> ±0.10	3.25 <sup>c</sup> ±0.21
L.S.D	0.266	0.640	0.124	0.056	0.018	0.017

\*M±SD = Mean ± Standard Deviation.

\*\*Means in the same column sharing the same letters are not significantly different, using the revised L.S.D test at 0.05 level.

$$1 - \text{PER} = \frac{\text{Weight gain}}{\text{Protein intake}}$$

$$2 - \text{Adj-PER} = \frac{\text{PER} \times 2}{\text{PER for reference} - \text{protein (casein)}}$$

$$3 - \text{NPR} = \frac{\text{Weight gain} + \text{weight loss}^{***}}{\text{Protein intake}}$$

\*\*\*Weight loss from the non protein group.

**Table 6. Blood serum total cholesterol (TC), cholesterol fractions and triglycerides (TG) (mmol/L) of rats fed on casein and pecan diets**

Food Group	Total Cholesterol (TC) M±SD*	HDL-C <sup>1</sup> M±SD	LDL-C <sup>2</sup> M±SD	V.LDL-C <sup>3</sup> M±SD	LDL:HDL Ratio M±SD	Triglycerides (TG) M±SD
Casein (Reference)	4.32 <sup>a**</sup> ±0.26	0.67 <sup>b</sup> ±0.34	3.11 <sup>a</sup> ±0.19	0.43 <sup>a</sup> ±0.21	4.64:1 <sup>a</sup> ±0.20	2.15 <sup>a</sup> ±0.53
Pecan (Raw) Desirable	2.71 <sup>b</sup> ±0.33	0.83 <sup>a</sup> ±0.44	1.66 <sup>b</sup> ±0.23	0.19 <sup>b</sup> ±0.25	2.00:1 <sup>b</sup> ±0.11	0.95 <sup>c</sup> ±0.50
Pecan (Raw) Moneymaker	2.76 <sup>b</sup> ±0.20	0.83 <sup>a</sup> ±0.33	1.77 <sup>b</sup> ±0.21	0.21 <sup>b</sup> ±0.26	2.13:1 <sup>b</sup> ±0.13	1.05 <sup>b</sup> ±0.43
L.S.D	0.079	0.018	0.111	0.056	0.785	0.096

\*M±SD = Mean ± Standard Deviation.

\*\*Means in the same column sharing the same letters are not significantly different, using the revised L.S.D test at 0.05 level.

1-HDL-C = High Density Lipoprotein Cholesterol.

2- LDL-C = Low Density Lipoprotein Cholesterol.

3- V.LDL-C = Very Low Density Lipoprotein Cholesterol.

The results indicated that there was a significant reduction in the level of the total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), very low density lipoprotein cholesterol (V.LDL-C), LDL: HDL and triglycerides (TG) in the blood serum of the rats fed on the Desirable and Moneymaker cultivars of raw pecan diets compared to those fed on casein diet.

Total cholesterol (TC) was 4.32 mmol/L for the rats fed on casein diet and was 2.71 and 2.76 mmol/L for the rats which were fed on raw pecan (Desirable and Moneymaker) diets, respectively. On the other hand, high density lipoprotein cholesterol (HDL-C) significantly increased from 0.67 mmol/L for the rats fed on casein diet to 0.83 and 0.83 mmol/L for those fed on raw pecan cultivars diets, respectively.

Meanwhile, low density lipoprotein cholesterol (LDL-C) and very low density lipoprotein cholesterol (V.LDL-C) were 3.11 and 0.43 mmol/L in the blood serum of the rats fed on casein diet, respectively, while

they were 1.66, 0.19 and 1.77, 0.21 mmol/L, for the rats fed on raw Desirable and Moneymaker diets, respectively.

Moerover, Nijjar *et al.* reported, in their review (2010), that nut kernels particular walnuts may improve human serum lipid profile by lowering low density lipoprotein cholesterol (LDL-C) and very low density lipoprotein cholesterol (V.LDL-C), because they are composed largely of polyunsaturated fatty acids, especially alpha-linolenic acid and linolenic acid. In addition to lowering serum cholesterol, pecan-enriched diets also increased high density lipoprotein cholesterol (HDL-C)

Nagaraju and Belur (2008) reported that rats which were fed on blended oils containing peanuts oil reduced the susceptibility of low density lipoprotein (LDL-C) cholesterol to oxidation, enhanced hepatic antioxidant enzymes and decreased lipid peroxidation in liver. Oxidized LDL-C plays an important role in

atherosclerosis. Furthermore, Aksoy *et al.* (2007) studied the effects of pistachio nuts intake on rats serum lipids oxidation. They reported that consumption of pistachio nuts as 20% of daily caloric intake increased the high density lipoprotein (HDL-C) cholesterol and the total cholesterol (TC) to HDL ratio, compared to those not taking pistachio nuts.

Moreover, when the ratio between LDL and HDL was calculated (Table; 6), it was found that LDL: HDL was 4.64:1 for casein and significantly decreased to 2.00:1 and 2.13:1 for Desirable and Moneymaker pecan cultivars diets, respectively.

Kinosian *et al.* (1995) showed that the changes in TC/HDL and LDL/HDL ratios were better predictors of coronary artery disease than the changes in LDL alone. Epidemiologic studies and studies in animals suggest that raising the levels of HDL cholesterol may retard the development of atherosclerosis. In humans, each increase in baseline HDL cholesterol by 1 mg/dl (0.03 mmol/L) is associated with 6% decrease in the risk of death from coronary disease or myocardial infection (Gordon *et al.*, 1986).

Triglycerides (TG) values were also presented in Table (6). It is clear that feeding the rats on pecan diets reduced the triglycerides (TG) content in their blood serum compared to those fed on casein diet. It was significantly reduced from 2.15 mmol/L for casein diet to 0.95 and 1.05 for raw pecan (Desirable and Moneymaker cultivars) diets, respectively. These results are in good agreement with Rajaram *et al.* (2001) who reported that pecan enriched diets lowered triacylglycerol (TAG) concentrations, leading to favourably altering the lipid profile.

### CONCLUSION

These results show that the protein of pecan kernels were of good quality, especially for Desirable cultivars. Also pecan lipid has a good effect on serum lipid profile by lowering LDL-C and V.LDL-C and increasing HDL-C.

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## الملخص العربي

### التقييم الكيماوي والحيوي للنحوص الغذائية للبيكان المصري

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كما تبين من نتائج تغذية فئران التجارب أن القيمة الغذائية لبروتينات كل من صنفَي البيكان تعتبر جيدة حيث كانت نسبة كل من Adj-PER و NPR هي: ٢,٣٠، ٢,٢٥ و ٣,٢٧، ٣,٢٥ في وجبات الفئران المغذاة على الـ Desirable والـ Moneymaker على التوالي مقارنة بـ ٢,٥٠، ٣,٤٣ لبروتينات الكازين كروتين مرجعي.

أيضا أوضحت نتائج تحليل دم الفئران أن الإجماع التي تم تغذيتها على وجبات من البيكان قد حدث لها انخفاض في كل من الليبوبروتين منخفض الكثافة LDL-C والليبوبروتين منخفض الكثافة جدا V.LDL-C وارتفاع في الليبوبروتين مرتفع الكثافة HDL-C مقارنة بالفئران المغذاه على وجبة الكازين. وفي ضوء نتائج هذه الدراسة يتضح أن البيكان مصدر غذائي جيد ومفيد صحيا للمستهلك وأن صنف الـ Desirable أفضل من صنف Moneymaker من وجهة النظر التغذوية.

تم دراسة صنفين من البيكان (*Carya illinoensis*) الذي يتم زراعته في مصر وهما Desirable، Moneymaker حيث تم التحليل الكمي للأحماض الأمينية ومنها تم حساب الـ Chemical score، كما تم حساب قيمة الـ PER والـ NPR كمقاييس لجودة البروتين باستخدام فئران التجارب. وأيضا تم تقدير الكولسترول الكلي (TC) والليبوبروتين مرتفع الكثافة HDL-C والليبوبروتين منخفض الكثافة LDL-C والليبوبروتين منخفض الكثافة جدا V.LDL-C والجليسريدات الثلاثية (TG) في دم الفئران.

وبينت النتائج أن الحامض الأميني الأرجنين يوجد بنسب مرتفعة تصل إلى ١٦٦,٩٤، ١٤٧,٢٠ ملجم/ جم بروتين لكل من صنفَي الـ Desirable والـ Moneymaker على التوالي، وهذا له فوائد صحية كبيرة. من ناحية أخرى وجد أن الحامض الأميني الـ Lysine هو الحامض الأميني الحدي في كل من الصنفين ولكن بنسبة ليست منخفضة (٠,٧٥) لصنف الـ Desirable و(٠,٦٦) لصنف الـ Moneymaker.