



Effect of Graded Supplementation Levels of Golden Chain Tree (*Cassia Fistula L.*) Leaves on Feed Intake, Nutrients Digestibility and Plasma Lipids Profile in Growing Rabbits

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Abstract: The aim of the trial was to explore the effects of graded supplementation levels of Golden Chain Tree Indian Laburnum (*Cassia fistula L.*) leaves on feed intake, nutrients digestibility and plasma lipids profile in growing rabbits. A total number of sixteen male rabbits of Mini Rex Breed at weaning age of 35±5 days having body weight range from 1060-1185 g were divided into total four groups and each group consisted of four rabbits. The *Cassia fistula* leaves were supplemented for ten days with the level of 0% (C), 10% (N), 20% (O) and 30% (P) to formulate four diets for the present study. Results showed that the dry matter digestibility (DMD) was significantly increased (P<0.05) in the N and O group that was being offered 10% and 20% *Cassia fistula L.* leaves. Regarding plasma lipid profile, the low density lipoprotein (LDL) and the triglyceride (TG) values decreased significantly (P<0.05) in all treatment groups as compared to the control group (C), while the HDL (high density lipoprotein) was increased significantly (P<0.05) in all treatment groups as compared to the C group. In group O, that was fed 20% of the *Cassia fistula* leaves, an efficient feed conversion ratio (FCR) was observed over control. *Cassia fistula* leaves at dosage level of 20% could be suggested because it improved the nutritive values of the experimental ration, nutrients digestibility coefficients and plasma lipid profile in rabbits.

Keywords: *Cassia fistula*, Feed intake, Lipid profile, Nutrient digestibility, Rabbits.

Büyüme Dönemindeki Tavşan Rasyonlarına Farklı Oranlarda Altın Zincir Ağacı (*Cassia Fistula L.*) Yaprakları İlavesinin Yem Tüketimi, Besin Maddesi Sindirilebilirliği ve Plazma Lipit Profili Üzerine Etkilerinin Araştırılması

Öz: Bu araştırma, rasyonlarına farklı düzeylerde (%0, 10, 20 ve 30) altın zincir ağacı=Indian laburnum yaprakları ilave edilen büyüme dönemindeki tavşanlarda yem tüketimi, besin maddeleri sindirilebilirliği ve plazma lipidleri üzerindeki etkilerinin belirlenmesi amacıyla gerçekleştirilmiştir. Bu amaçla denemede, canlı ağırlığı 1060-1185 g olan 35 ± 5 günlük süttan kesilmiş toplam 16 adet Mini Rex cinsi erkek tavşan herbirinde 4 adet olmak üzere dört gruba ayrılmıştır. *Cassia fistula* yaprakları rasyonlara %0 (K), %10 (N), %20 (O) ve %30 (P) düzeylerinde on gün boyunca ilave edilmiştir. Elde edilen sonuçlara göre, N ve O gruplarının kuru madde sindirilebilirliği Kontrol (K) ve P grubuna göre anlamlı derecede farklı iken (P<0.05), K ve P grubu değerleri arasında fark bulunmamıştır. Plazma lipit profili ile ilgili olarak, düşük yoğunluklu lipoprotein (LDL) ve trigliserit (TG) değerleri, tüm deneme gruplarında kontrol grubuna (C) kıyasla önemli ölçüde azalırken (P <0.05), yüksek yoğunluklu lipoprotein (HDL) tüm deneme gruplarında C grubuna göre anlamlı derecede (P <0.05) yüksek bulunmuştur. Diğer deneme grupları ve kontrol grubuna kıyasla grup O'da daha iyi yemden yararlanma oranı (YYO) tesbit edilmiştir. Büyüme dönemindeki tavşan rasyonlarına, %20 oranına kadar altın zincir ağacı yaprakları ilavesinin yem tüketimi, besin maddesi sindirilebilirliği ve plazma lipid profilini olumlu yönde etkilediği sonucuna varılmıştır. *Cassia fistula* yaprakları, %20 dozaj seviyesinde önerilebilir, çünkü bu düzey, rasyonların besin maddesi değerlerini, sindirilebilirlik katsayılarını ve tavşanlarda plazma lipid profilini geliştirdiği söylenebilir.

Anahtar Kelimeler: *Cassia fistula*, Lipit profili, Sindirilebilirlik, Tavşan, Yem tüketimi.

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INTRODUCTION

With the passage of time, meat requirement has increased. For health maintenance, nutrition in terms of macro and micro-nutrients play a major role in livestock production (1). Pakistan is an agriculture country and livestock is the most important sector of our country. It contributed to agriculture sector about 55.9% while it contributed 11.8% to the national Gross Domestic Product (GDP) (2). To cope with the shortage of animal protein availability, it is necessary to enhance the growth of small livestock with minimum cost. Livestock plays a vital role in developed countries in terms of food, financial and social aspect (3). The major components of meat are lipids and protein. The rabbit meat contains much protein and the presence of high level of essential amino-acids is a characteristic point. The rabbit meat is lack in uric acid but purines are present in small amount. Rabbit meat has lower cholesterol level then the red meat because fat contents are less in rabbit meat ranging from 0.6-14.4% with 6.8% of average value (4). The rabbits are prone to coccidiosis because during coprophagia rabbits consume their feces directly from anus, (5). Rabbit are herbivorous so their feed mostly consisted of dietary fibers (6). To make the rabbit meat more profitable the animal nutritionists are constantly trying to introduce alternative and inexpensive feed resources. *Cassia fistula* has a therapeutic use because it contains a lot of phenols e.g.: Flavonoids and anthraquinone with proanthocyanidine and due to the presence of these compounds. It is antioxidant and responsible for pharmacological actions. The reproductive parts i.e. pods are higher in antioxidant activity than the non-vegetative part (7). Antifungal and antibacterial activity of *Cassia fistula* extract is introduced (8). The active constituent that could be extracted from *Cassia fistula* plant consists of bioflavonoids and proanthocyanidins. Besides these phenolic and their

derivatives, alkaloids like diterpene and triterpenes are also present (9). The dried leaves of *Cassia fistula* Linn belong to the *leguminosae* family. It is used for minimizing the chance of unfavorable effects and to loosen up the intestine (10) due to effect of metabolism concerning energy creation (11).

Nowadays, plant based drugs are used as substitute to synthetic drugs and there is a good scope for using herbal medicines possessing antioxidant and anti hyperlipidaemic property with enough protection and effectiveness. Hence, the present experiment was performed to evaluate the nutritional outcome of *Cassia fistula* leaves in the growth and performance in rabbits fed with different supplemented levels in the ration.

MATERIALS and METHODS

The current study was performed at Department of Poultry Science, University of Agriculture, and Peshawar Pakistan after the approval of the Local Ethics Committee under approval No: Agri-546 on 10-04-2017.

Plant Material and Analyses

The fresh bark of the *Cassia fistula* was collected from Peshawar District, Khyber Pukhtoon Khwa (KPK) province, Pakistan in the month of July to August and the plant was identified and authenticated by the Research Officer (Botany), Central Research Institute, (Ministry of Health and Family welfare, Govt of Pakistan).

A compound sample from basal feed was taken and the DMI, OMI, CPI, EEI NFEI, AshI, dry matter digestibility was analyzed in the Animal Nutrition laboratory of the faculty of Veterinary Medicine, AKU according to manual laboratory analyses methods as explained by Soest et al (12). The feed

sample was grinded by the grinder (Retsch ZM 200, Germany).

Phenols Composition of Cassia fistula Linn

Cassia fistula Linn contains bioactive flavone glycoside 5,3',4'-tri-hydroxy-6-methoxy-7-O-alpha-L-rhamnopyranosyl-(1-->2)-O-beta-D-galactopyranoside,5-(2hydroxyphenoxy-methyl) furfural,(2'S)-7-hydroxy-5-hydroxymethyl-2 (2'hydroxypropyl) chromone, benzyl2-hydroxy-3,6-dimethoxybenzoate, benzyl2beta-O-D-glucopyranosyl 3,6dimethoxybenzoate,5hydroxymethylfurfural,(2'S)-7-hydroxy-2-(2'-hydroxypropyl)-5 methylchromone, and two oxyanthra quinones, chrysophanol and chrysophanein.

Animal and Management

The experiments of the present study were carried out at Poultry Science Department, and chemical analysis was carried out in the laboratories

of Department of Animal Nutrition Faculty of Animal Husbandry and Veterinary Sciences, The University of Agriculture, Peshawar. Four experimental rations were formulated containing different levels of Cassia fistula Linn leaves to determine its effect on the growth performance of growing rabbits as shown in Table 1. A total of sixteen male rabbits of Mini Rex Breed weaning age 35±5 days having body weight range from 1060-1185 g were selected at randomly to four treatments, with each treatment diets for four rabbits. Before the experiment started clean the cages and the other equipment's such as buckets, feeders and drinkers. Ration ingredients of the groups are presented in Table 1, chemical composition of the Cassia fistula leaves was shown in Table 2 and chemical composition of the experimental diets was given in Table 3.

Table 1: Formulation of the experimental diets.

Tablo 1: Deneysel Diyetlerin formülasyonu.

Ingredients	Cassia fistula 0%	Cassia fistula 10%	Cassia fistula 20%	Cassia fistula 30%
Cassia fistula	0.00	10.00	20.00	30.00
Berseem hay	30.00	20.00	10.00	0.00
MSC	16.00	14.00	12.00	10.00
Sun Flower meal	16.00	14.00	12.00	10.00
Molasses	8.00	8.00	8.00	8.00
Wheat Bran	14.00	14.00	14.00	14.00
Corn grain	14.00	18.00	22.00	26.00
Salt	1.00	1.00	1.00	1.00
Mineral Mix	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00

Table 2. Chemical composition of Cassia fistula leaves (% DM basis).

Tablo 2. Cassia fistül yapraklarının kimyasal bileşimi (% KM temelinde).

Dry Matter (as fed)	Crude protein	Crude fiber	Ether extract	Organic Matter	NDF	ADF	Lignin	Ash	Calcium (g/kg)	Phosphorus (g/kg)
41.3	18.7	25.8	7.6	89.7	35.4	23.1	6.3	10.3	32.7	3.3

Feeds and Feeding

Each animal of the four groups were supplied 200 g of pelleted diet each day. The group C was fed experimental ration containing 0% Cassia fistula Linn

leaves, group N was offered 10% Cassia fistula Linn leaves, group O with 20% Cassia fistula Linn leaves and P with 30% Cassia fistula Linn leaves respectively.

Table 3. Chemical composition of the experimental diet.**Table 3.** Deneysel diyetlerin kimyasal kompozisyonu.

Ingredients	DM %	CP %	OM %	EE %	Ash %	NFE %	TDN %
C.F 0%	88.2	16.6	78.8	15.8	9.49	25.7	55.2
C.F 10%	90.1	16.2	80.3	14.7	9.89	27.8	59.8
C.F 20%	89.6	15.9	79.2	12.3	10.3	29.0	61.0
C.F 30%	90.5	15.8	80.0	11.3	10.2	29.2	56.1

Diet and Serum Analysis

The diet composition was determined in the science and experimental research laboratory of Agricultural University Peshawar Pakistan.

Serum samples was analyzed for LDL, HDL, TG and TC values level by the totally automatic ELISA Machine (Chemwell 2910, Awareness Tech. Inc®, ABD)

Statistical Analysis

In the MS excel, the data was composed and was tested statistically through SPSS program window.16 versions. Complete randomized design was used for the comparison of mean values of different studied variables. To find out the significant differences between the effects of the experimental diets the least significance different test was used.

Table 4. Effect of Cassia fistula leaves on daily feed intake in growing rabbits (Mean ±SE).**Table 4.** Cassia fistül yapraklarının, büyüyen tavşanlarda günlük yem alımına etkisi (Ortalama ± SE).

Feed intake(g/day)		Ration			
		C C.F- 0%	N C.F-10%	O C.F-20%	P C.F- 30%
DMI	Mean	107.2 ^a	96.2 ^b	68.1 ^c	69.6 ^c
	SE	±1.44	±1.42	±1.06	±0.85
OMI	Mean	84.5 ^a	77.3 ^b	55.1 ^c	56.3 ^c
	SE	±1.13	±1.14	±1.52	±0.81
CPI	Mean	17.9 ^a	15.6 ^b	11.8 ^c	11.7 ^c
	SE	±0.24	±0.23	±0.0.68	±0.48
EEI	Mean	16.9 ^a	14.1 ^b	8.3 ^c	8.4 ^c
	SE	±0.22	±0.21	±0.13	±0.17
NFEI	Mean	27.6 ^a	26.8 ^a	20.2 ^b	20.2 ^b
	SE	±0.37	±0.39	±0.52	±0.81
Ash I	Mean	10.1 ^a	9.50 ^d	7.18 ^b	7.31 ^b
	SE	±0.13	±0.14	±0.16	±0.34

The results showed that the group of rabbits feeding the diet supplemented with Cassia fistula leaves showed decreased in daily feed intake in gram per rabbit per day as compared with the control group of rabbits receiving basal diet. The data revealed that the experimental ration supplemented with Cassia fistula leaves did not affect the appetite of the growing rabbits as well as nutrients intake for long period of consumption. Similar results were also found by Rampogal et al (13) and Preeti (14). The intake of dry matter and organic matter were decreased appropriately by adding gradual level to Cassia fistula leaves in the experimental diets.

The reason of decreased intake in growing rabbits was due to coarseness of experimental diet. Supplementation of Cassia fistula leaves that acts as physical barrier to intake of feed or it may be due to occurrence of change in satiety control center in the hypothalamus which under this study was considered (15). The data in the table 4 revealed that the intake of total dry matter of the experimental diet supplemented Cassia fistula

leaves decreased the daily feed intake as dry matter (g/rabbit/day), crude protein (g/r/d) and organic matter (g/r/d). Its reason was that Cassia fistula leaves had no effect on the palatability on the experimental diet of rabbits. The decrease in the daily feed intake in growing rabbits was due to supplementation of Cassia fistula leaves in the diet of rabbits that increases the digestibility of the nutrients of the ration and also increases the metabolism of the experimental ration that reduces in the daily feed intake of growing rabbits (16).

In Vivo Nutrients Digestibility

In the Table 5 the digestibility coefficient for feed nutrients in rabbits is presented. The result showed that the digestibility of dry matter of diets C, N and O were significantly difference ($P < 0.05$) while the ration C and P were non-significant. The finding of the present study revealed that Cassia fistula leaves was moderate quality of legume that could supply enough nutrients to rabbits above maintenance or under physiological conditions of greater nutrients demands.

Table 5. In vivo nutrients digestibility used in the experimental rations (Mean \pm SE).

Table 5. Deney rasyonlarında kullanılan besinlerin in vivo besinlerin sindirilebilirliği (Ortalama \pm SE).

Parameter		Ration			
		C C.F- 0%	N C.F-10%	O C.F-20%	P C.F-30%
Dry matter digestibility	Mean	54.8 ^c	64.3 ^b	75.8 ^a	52.7 ^c
	SE	± 2.78	± 2.05	± 1.49	± 3.27
Organic matter digestibility	Mean	54.3 ^c	62.1 ^b	72.5 ^a	58.0 ^{bc}
	SE	± 2.87	± 1.46	± 1.94	± 2.71
Crude protein digestibility	Mean	57.1 ^c	64.9 ^b	76.9 ^a	62.9 ^{bc}
	SE	± 2.58	± 2.08	± 1.77	± 1.67
Ether extract digestibility	Mean	66.0 ^c	73.4 ^b	81.6 ^a	71.7 ^{bc}
	SE	± 2.70	± 1.60	± 1.48	± 1.66
Nitrogen free extract digestibility	Mean	45.8 ^b	51.2 ^b	59.7 ^a	46.7 ^b
	SE	± 2.08	± 2.43	± 2.39	± 1.73
Ash digestibility	Mean	46.6 ^c	55.3 ^b	66.5 ^a	49.0 ^{bc}
	SE	± 2.58	± 2.38	± 2.13	± 2.61

Diet composition had affected the digestibility of dry matter and organic matter that resulted in significant differences ($P < 0.05$) among the experimental rations for these variables of dry

matter, organic matter and crude proteins. The Cassia fistula leaves present in the experimental ration decreases the interference of the tight junction of the epithelial cells of colon for the

nutrients and ultimately increases the passage of nutrients across the tight junction between the epithelial cells of colon in rabbits (17).

Our result is according to Vanderperren et al (18) where they described that the digestibility coefficient of dry matter, organic matter, and other nutrients contents were observed maximum in the rabbits feeding on diet supplemented with optimum level of Cassia fistula leaves because in large intestine the gut bacteria converts it into active metabolites known as rheinanthrone, that increases the colonic motility and secretion of intestinal fluid. Due to antioxidant activities of these plants, the function of liver is increased that enhanced the secretion of digestive enzymes and ultimately increased the function of digestive system in growing rabbits which was accordance with the results obtained by Hernandez et al (19).

The digestibility coefficient was observed maximum in the group of rabbits receiving

experimental ration C supplemented 20% of Cassia fistula leaves because it provides optimum level of crude fiber in the experimental ration. High level of Cassia fistula leaves supplementation in rabbit's ration increases the crude fiber level above normal that effect the bacteriostatic activity in the caecum of the growing rabbits. Therefore, it reduces the process of microbial protein synthesis and fermentation in caecum that results in decreased caecum microbial population (15,20).

Plasma Lipid Profile

Results showed mean values of triglyceride cholesterol of rabbits receiving experimental ration C, N, O and P were found significant different ($P < 0.05$) among the rabbits group of the experiment (in Table 6). The triglyceride cholesterol mean value was maximum (124.7 mg/dl) for rabbits receiving ration C but was observed minimum (111.6 mg/dl) in rabbits feeding ration P.

Table 6. Effect of supplemented Cassia fistula leaves on plasma lipid profile in growing rabbits (Mean \pm SE).

Table 6. Rasyona ilave edilen Cassia fistula yapraklarının büyüyen tavşanlarda plazma lipid profili üzerindeki etkisi (Ortalama \pm SE).

Parameter		Rations			
		C C.F- 0%	N C.F-10%	O C.F-20%	P C.F- 30%
Total cholesterol (mg/dl)	Mean	76.7 ^a	69.0 ^b	63.3 ^c	60.4 ^d
	SE	± 1.06	± 1.10	± 1.51	± 1.73
LDL Cholesterol (mg/dl)	Mean	35.7 ^a	30.9 ^b	26.3 ^c	21.6 ^d
	SE	± 0.68	± 0.88	± 1.14	± 1.70
HDL Cholesterol (mg/dl)	Mean	34.7 ^d	37.0 ^c	41.0 ^b	45.1 ^a
	SE	± 0.64	± 0.42	± 0.79	± 0.79
TG (mg/dl)	Mean	124.7 ^a	119.1 ^b	114.0 ^c	111.6 ^d
	SE	± 0.95	± 1.16	± 1.35	± 1.41

LDL: Low density lipoprotein, HDL: High Density lipoprotein, TG: Triglyceride

The results showed that supplement feed gradually decreased the total cholesterol, LDL and TG but it increases the HDL and the result of the present study reported by Lim et al (21).

HDL cholesterol concerned in the cholesterol transport from the side-line tissue to the liver and therefore decreases the chance of excess cholesterol storage in the different tissues of the body and the chances of atherosclerosis occurrence.

The LDL lowering effect may be due the increased in metabolism of LDL or may be due to the decreased LDL synthesis from liver (22). The decreased in Triglyceride was due to the activity of lipoprotein lipase enzyme or may be due to an increased in metabolism of LDL (23).

Liver has a vital role in the metabolism of lipid but if large amount of lipid produced in the blood occur due to an imbalance between lipid formation,

lipid degradation and excretion than excessive amount of lipid accumulate within the cells of liver called hepatocytes that cause fatty liver and hepatic steatosis. It is also known as hypercholesterolemia or dyslipidemia patients (24). The use of Cassia fistula plant leaves in the diet of rabbits reduces the chances of toxicity occur due to high fat diet. Study showed that Cassis fistula plant leaves acts as an antioxidant activity that can give protection to the liver of growing rabbits (25).

In present study it is stated that the presence of methanol in the Cassia fistula leaves have an antioxidant characteristics that showed free radical scavenging property and give protection to the rabbit liver from toxicant (26, 27). Supplementation of the experimental diets with Cassis fistula leaves containing methanol under investigation causes the reduction of Triglyceride, Total cholesterol and LDL and the increase in the HDL level. Hence, Cassia fistula leaves have a strong hypotriglyceridemia and hypocholesterolemia effects. These finding seems to be in accordance with another study results (21,26,28,29). The Cassia fistula plant have many products which cause reduction in the cholesterol and phospholipids level by interfering in the absorption of dietary fat and also increased the excretion of endogenous cholesterol (30).

The addition of Cassia fistula leaves in the rabbit ration decreases the lipid per oxidation indicator in the tissue of the body. The propagation of lipid per oxidation chain is prohibited by the poly

phenol content of Cassia fistula leaves by reacting with peroxy radicals. The leaves of the Cassia fistula have antioxidant characteristics due to the presence of phenol content (31). It also gives protection to the antioxidant activity in the living cells that suffer from oxidative stress started by free radicals and hyperlipidemia. Moreover, in one study Hesperidin supplementation improved immun response, antioxidant capacity, HDL percentage of total blood cholesterol pool and growth parameter in human and animal models (32,33).

Body Weight Gain and FCR

The current study showed that body weight gain g/day/rabbit mean values receiving rations C, N and O were significantly different ($P < 0.05$). However, body daily weight gain in g/day/rabbit was statistically non-significant in groups of rabbits receiving diet C and P. Highest daily body weight gain g/day/rabbit was observed in experimental rabbits receiving the diet O supplemented with 20% Cassia fistula leaves. While lowest body weight gain in g/day/rabbit was found in rabbits feeding ration containing 0% Cassia fistula leaves.

The results of feed conversion ratio were presented in Table 7. The overall FCR of the rabbits supplemented graded level of Cassia fistula leaves in their diets was better from the basal diets feeding 0% Cassia fistula leaves.

Table 7. Body weight gain estimation in growing rabbits by difference method (Mean \pm SE).

Tablo 7. Büyüyen tavşanlarda canlı ağırlık artışının fark yöntemiyle tahmini (Ortalama \pm SE).

1 Items		Rations			
		C C.F- 0%	N C.F-10%	O C.F-20%	P C.F-30%
Initial weight (g)	Mean	1322.5 ^b	1336.3 ^{ab}	1339.8 ^{ab}	1356.0 ^a
	SE	± 11.0	± 8.26	± 5.17	± 4.30
Final weight (g)	Mean	1514.2 ^c	1547.8 ^b	1579.4 ^a	1526.0 ^c
	SE	± 4.69	± 3.62	± 3.80	± 3.53
Difference(g)	Mean	191.7 ^c	211.5 ^b	239.6 ^a	169.9 ^d
	SE	± 7.41	± 6.24	± 3.90	± 7.26
Body weight gain (g/day)	Mean	3.05 ^c	3.52 ^b	3.99 ^a	3.19 ^c
	SE	± 0.12	± 0.10	± 0.06	± 0.11
FCR	Mean	6.36 ^a	5.50 ^b	4.19 ^c	5.43 ^b
	SE	± 0.25	± 0.15	± 0.13	± 0.19

FCR: Feed Conversion Ratio

It was also proving from the study that average daily body weight gain was similar among the rabbit's groups feeding on control diet consisting of 0% Cassia fistula leaves and the diet D containing 30% Cassia fistula leaves (20).

The addition of Cassia fistula leaves in the experimental ration as a supplement improved the

feed conversion ratio (g intake/g wt gain) of dry matter, organic matter, crude protein and total digestible nutrients because the Cassia fistula decreases the interference of the tight junction between the colonic epithelial cells and ultimately increases the passage of nutrients through these colonic epithelial junctions (17).

Table 8. Effect of different level of Cassia fistula leaves on profitability parameters (Mean± SE).

Tablo 8. Farklı Cassia fistül yapraklarının karlılık parametreleri üzerindeki etkisi (Ortalama ± SE).

Parameter		Rations			
		C C.F 0%	N C.F 10 %	O C.F 20%	P C.F 30%
Total wt. gain (g)	Mean	191.7 ^c	211.5 ^b	239.6 ^a	183.3 ^c
	SE	±7.41	±6.24	±3.90	± 6.72
Feed cost/rabbit	Mean	34.7 ^a	33.9 ^a	17.9 ^b	12.9 ^c
	SE	±0.87	±0.86	± 0.19	±0.20
Total sale	Mean	47.9 ^c	52.8 ^b	59.9 ^a	45.8 ^d
	SE	±2.80	±2.64	±1.27	±1.70
Profit	Mean	13.1 ^d	18.9 ^c	42.0 ^a	32.9 ^b
	SE	±1.92	± 1.78	± 1.07	±1.49

Total weight gain, profit and total sale increase in O group as compared to other groups however, feed cost decrease in P groups as compared with others groups (in Table 8).

As a conclusion, Cassia fistula leaves used as feed additives (20%) of the diets improved the nutritive values of the experimental ration and nutrients digestibility coefficients in rabbits. In addition, such feed additives affected the plasma lipid profile of the growing rabbits by decreasing total cholesterol, LDL and triglycerides but increasing HDL. The Cassia fistula leaves that contain Anthraquinone and polyphenols may decrease the cholesterol and triglycerides and also stimulate the activity of enzymes of lipid metabolism. The supplemented feed with 20% Cassia fistula leaves has lower value of feed cost per kg live body weight and highest value of relative economic competence.

Conflict of interest

The authors declare that they have no conflict of interest.

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