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PHYSIOLOGICAL RESPONSES OF GROWING CALIFORNIA RABBITS TO GUAVA BY-PRODUCTS SUPPLEMENTATION

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ABSTRACT

A total of 50 California male rabbits at 6 weeks of age were used in this study. They were randomly classified into five groups, 10 rabbits each. The 1st group, was fed on the basal diet, and considered as the control group, while the other groups [2nd, 3rd, 4th, and 5th] were the treatment groups, which were fed on the basal diet supplemented with different levels of guava by-product meal (GU) 10,20,30 and 30% +1.0gm/kg/diet of kemzyme respectively as replacement of colver hay, Daily weight gain, feed consumption, and feed conversion ratio were calculated. At the end of experiment (14 weeks), four males from each group were individually weighed and slaughtered. Plasma samples were collected and stored frozen at-20°C until biochemical analysis for plasma total protein and lipids fractions, plasma minerals (Ca, P, Fe); plasma enzymes (ALT, AST); glucose level, Hemoglobin and hematocrit values as well as thyroid's hormones concentration. Growth performance and carcass traits were also evaluated. Results obtained could be summarized as follow:

1- Body weight, feed consumption, and feed conversion ratio were not significantly affected by GU supplementation. However, feed conversion was improved in animals that fed guava plus enzyme supplementation, (-4.7: -8.4%).
2- Liver percentage was significantly affected especially in rabbits that fed on 30% GU plus enzyme (36.6%) than the other groups, but kidney, heart, small and Large intestine, and cecum were not significantly affected.
3- Plasma glucose, Ca, phosphorus, total protein and globulin were not significantly affected, however plasma albumin level was increased significantly for rabbits that fed guava and enzyme than control.
4- Fe level was slightly increased especially in rabbits fed 30% GU than that of the control.
5- Cholesterol and total lipids were decreased in rabbits that fed on 20 and 30% GU than the other groups.
6- Thyroid hormones (T_3, T_4) concentrations, N/L ratio, Hemoglobin, and Hematocrit (PVC) were not significantly affected by treatments as compared to the control.
7- ALT activity was not significantly affected, but AST activity decreased in rabbits that fed 30% GU as compared with the control, (-44.9%).
8- Total unsaturated fatty acids increased significantly especially in rabbits that fed 20% and 30% plus enzyme than the other groups.
9- Economical efficiency, performance index as well as production efficiency factor percentages were significantly higher in rabbits fed on GU especially those fed 20 and 30%.

From the achieved results the use of guava by-product as a new inexpensive, safe and available natural waste is recommended product to replace the same percentages of clover hay, in rabbit's diets.

INTRODUCTION

Natural antioxidants, particularly in fruits and vegetables have been of increasing interest to both consumers and scientists such as epidemiologists, food scientists, chemists and plant scientists. It has been suggested that antioxidants may protect bimolecules from oxidative damage and therefore be associated with reduced risks of cardiovascular disease and certain types of cancer. Guava showed the highest antioxidant activities in thiobarbituric acid assay, (Huang *et al.,* 2004). Also, the extracts leaves of GU may be used as a medicine of promising natural agents to treat gastrointestinal and respiratory disturbances. At present, the legislation of the European Union (EU) forbids the use of meat wastes to feed farm animals, but only allows the use of agricultural by-products containing the minimum microbial and toxic contents produce an cheap and safe rations, which reduce the costs of animal products, (Garcia *et al,* 2005), and Westendrof 2000).

Fruits with therapeutic properties may be used as antidiarrheal, medicament because of the presence of lectins which may be the bioactive components that can interfere with bacterial adhesion, since, the inclusion of fruits by-products having high fiber contents in the rabbits diet can decrease this problem that face rabbit's industry (Coutino-Rodrigue, *et al,* 2001).

On the other hand, it is worth to mention that Guava is a rich source of vit. C, more than the fresh orange juice, and a fair source of vit. A, Ca, phosphorus, Pantothenic acid, riboflavin, thiamin and niacin, pectin, and total free phenol content which ranged from 0.21-1.40% and was reported to play an antioxidant role. (El-Mansy, *et al.,* 2003).

The Agricultural by-products as natural additives, can play an important role in the metabolic processes and to be more effective either by counteracting some growth depressant factors in the digestive system, and modifying the hormonal balance or by improving the feed quality and consequently the animal consumption.

The use of enzymes mixtures in animal diets in as attempt to improve digestion and absorption of the nutrients. The addition of enzymes mixture in broiler diets to improved the energy utilization, nutri ents digestibility, feed efficiency and the growth rate (Ali, 1999).

Studies on using different wastes in animal feeding are still limited. Therefore, the use of the underutilized wastes of marketing residues has to be taken in consideration as alternatives to clover hay, grains as well as cereal by-products for decreasing the costs of animal feeding and consequently reducing the costs of animal feeding products and improving their net revenue. The present study aimed to investigate the effect of substituting clover hay by dried guava marketing residues on the physiological responses with some productive and carcass traits in California growing rabbits.

MATERIALS AND METHODS

Experimental Animals and Management:

A total of 50 California male rabbits at 6 weeks of age were used in this study. They were randomly classified into five groups, (10 rabbits each) and having nearly similar initial average body weight. Five experimental diets were formulated to be nearly isonitrogenous and isocaloric and covering the requirements of growing rabbits according to NRC (1977).

Table (1): Composition and Calculated Analysis of the Experimental Diets.

Ingredient %	1 Control	2 10%	3 20%	4 30%
Wheat bran	23	24.2	28.5	31
Clover hay	30	20	10	-
Yellow corn	11	11	5	5.5
Soybean meal [44%CP]	16.2	16.6	16	16.5
Barley	5	5	11	10
Wheat straw	7	6	2.5	-
Vegetable oil	1.9	1	0.5	-
Guava by-product	-	10	20	30
DL-Methionine	0.2	0.2	0.2	0.2
Molasses	3	3	3	3
Limestone	0.4	0.7	1.2	1.5
Dicalcium phosphate	1.5	1.5	1.3	1.5
Rabbit premix*	0.3	0.3	0.3	0.3
Salt (Nacl)	0.5	0.5	0.5	0.5
Total	100	100	100	100
Calculated analysis				
DE	2554	2550	2555	2585
CP%	16.07	16.04	16	16.09
CF%	16.22	16.66	16.56	16.47
Ca	1.02	1.0	1.0	1.3
P (av.p)	0.70	0.70	0.69	0.71
Lysine %	0.91	0.85	0.79	0.74
SAA "sulfer amino acids	0.73	0.70	0.68	0.67

*** One Kilogram of premix provides = 2000,000 IU vit. A, 150.000 IU vit. D, 8.33g vit. E, 0.33g vit. K, 0.33g vit. B1, 1.0g vit B2, 0.33g vit. B6, 8.33g vit B5, 1.7mg vit. B12, 3.33g pantothenic acid, 33mg Biotin, 0.83g folic acid, 200g choline chloride, 11.7g Zn, 12.5g I, 16.6mg SE, 16.6mg Co, 66.7g Mg, and 5g Mn.**

The composition and chemical analysis of the experimental diets are shown in Table (1), The fifth diet contained the same level of Guava marketing by – product as in the 4th diet, in addition to preparation (Kemzyme), one gram gram kemzyme/kg diet.

All rabbits were kept under the same managerial and hygienic environmental conditions. They were individually weighed at the beginning of the experiment, and then at weekly intervals until the end of the experiment. Daily weight gain, feed consumption, and feed conversion ratio were calculated.

Blood sampling and chemical analysis of blood parameters:

At the end of the experiment (14 weeks), four males from each group were randomly chosen, individually weighed and slaughtered. Blood samples were collected in heparinized tubes, while a drop of blood from each sample was used to make smears for the differential leucocytes counts. Differential counts of 100 leucocytes were made using glass slides stained with Wright's stain, and Neutrophils to lymphocytes ratio (N/L ratio) was calculated. Also, hematocrit (Ht%) was determined, using heparinized capillary tubes and microhematocrit centrifuge. The hematocrit figures were recorded after spinning microhematocrit tubes for 15 min, according to Hunsaker (1969). Blood samples were then centrifuged at 4000 rpm for 20 min and the plasma samples were decanted and stored at -20°C until biochemical analysis. The concentrations of plasma glucose, total protein, albumin, cholesterol, total lipids, Ca, P, Fe, thyroid hormones (T3, T4), aspartate amino transferase (AST), and alanine amino transferase (ALT) were determined using commercial kits (Diamond Diagnostic), where the biochemical analysis of plasma blood samples were done according to the maufacturers recommendated; Henry, (1974), Plasma total protein (g/dL) Doumas, *et al.* (1971), albumin (g/dl) Knight *et al* (1972) total lipids (g/L) Richmond (1973). cholesterol (mg/dl) Trinder (1969), Glucose (mg/dl) Conn (1988), Fe (ppm) Tietz (1990) hemoglobin (g/dl) Radwan (1979) plasma free fatty. In addition, the activities of some enzymes such as alanine transaminase (ALT) (Ec:2.6.1.2) (U/L) and aspartate transminase (AST) (Ec: 2.6.1.1)(U/L) were calorimeterically determined by using commercial kits according to Reitman and Frankel (1957).

The radioimmunoassay (RIA) method was used to determine the triiodothyronine (T_3) and thyroxin (T_4). Plasma T_3 and T_4 (ng/ml) were determined by (gamma coat ^{125}I RIA kits, [Clinical Assay Cambridge, medical diagnostics, Boston, MA] as reported by Akiba, *et al.* (1982). All rabbits were slaughtered by severing the jugular vein till the bleeding was completed.

Carcass measurments:

The heart, liver, kidney, and mesenteric fat. Small intestine, large intestine and cecum were weighed and lengths were recorded for small, large intestine and cecum. The relative weight of heart, liver, and kidney were determined to live body weight and intestine thickness was determined by the formula desribed by Stutz *et al.* (1983) as small intestine weight (g) /small intestine length (cm).

Economic efficiency (EE):

The EE was calculated according to the following equation:

EE = A-B/ B× 100

Where A is price cost of the obtained gain (LE per kg), and B is the feeding cost of this gain.

The performance index (PI) was calculated according to the equation described by North (1981) as follows:

PI = live body weight (kg) /feed conversion × 100

The production efficiency factor (PEF) was caculated according to the formula described by Emmert (2000).

Statistical analysis:

Data were analyzed by analysis of variance using the general linear Model Procedure of SAS (SAS Institute, 2004). Differences among groups means were determined with Duncan's multiple range test (Duncan, 1955).

RESULTS AND DICUSSION

1- Growth performance:

As shown in Table (2), body weight was not significantly affected by guava supplemented levels of 10, and 20% however, there was a significant increase in body weight of rabbits that fed 30% (GU) or 30% (GU) plus kemzyme than the control group, (0.76, 6.6% resp.).

Table (2): Effect of guava by-product on body weight and weight gain.

Body weight(g)	Groups				
	G1 (control)	G_2 (10%)	G_3 (20%)	G_4 (30%)	G_5 (30%+E)
W6	803.33±89.08^{a}	800±46.46^{a}	804.17±37.48^{a}	801.67±45.12^{a}	800.17±31.99^{a}
W8	1072.50±79.15^{b}	1120.83±16.60^{b}	1133.33±30.32^{ab}	1199.17±26.82^{a}	1193.33±72.66^{a}
W10	1417.00±99.17^{b}	1485.33±11.85^{a}	1469.67±16.41^{a}	1464.33±51.39^{a}	1483.83±10.93^{a}
W12	1816.33±128.85^{c}	1881.0±14.64^{ab}	1850.33±23.25^{cb}	1816.12±53.05^{c}	1882.50±47.27^{a}
W14	2060.0±65.29^{b}	2115.83±48.40^{a}	2145.0±37.50^{a}	2075.6±57.79^{b}	2195.88±38.74^{a}
Weight gain (g)					
6-8wk	269.12±14.50^{a}	320.72±25.16^{a}	329.05±17.45^{a}	397.38±24.93^{a}	393.04±32.15^{a}
8-10wk	344.41±22.41^{b}	364.50±31.80^{b}	336.14±24.61^{ab}	265.10±18.75^{a}	290.46±21.65^{a}
10-12wk	399.15±18.60^{ab}	395.46±20.54^{a}	380.45±34.15^{a}	351.52±28.20^{a}	398.67±31.66^{a}
12-14wk	243.55±20.40^{b}	234.80±30.12^{b}	294.44±23.85^{a}	259.31±25.16^{ab}	313.18±16.82^{a}
6-14wk	1256.31±84.45^{b}	1315.70±65.84^{a}	1340.65±91.42^{a}	1273.75±68.80^{b}	1395.50±48.35^{a}

a,b,c: Means in the same row with the same letters are not significantly different. $P \leq 0.05$

Also, feed consumption and feed conversion Table (3) were not significantly ($P<0.05$) affected by adding guava by-product although, the rabbits fed diets contained guava by-product consumed less feed during experiment than those fed the control diet (-0.08 : -3.7%). On the other hand, the feed conversion improved due to adding guava by-product and kemzyme to diet as compared to the control, (-4.7, -8.4%).These results are in agreement with those achieved by Abo-El-Ezz (2000), Rao *et al*, (2004), and Sunagawa *et al*, (2004). Who reported that guava by-product had no significant effect on the growth performances.

Table (3): Effect of guava by-product on feed consumption and feed conversion.

Body weight (g)	Groups				
	G_1 (control)	G_2 (10%)	G_3 (20%)	G_4 (30%)	G_5 (30%+E)
Feed consumption (g)					
6-8wk	980±37.75^{a}	968.33±25.22^{a}	1036.67±10.93^{a}	1056.48±87.62^{a}	1063.13±23.33^{a}
8-10wk	1265±29.30^{a}	1253.38±17.40^{a}	1246.68 ±24.04^{a}	1236.86±63.60^{a}	1350.2±31.22^{a}
10-12wk	1453.33±14.24^{a}	1425.0±32.53^{a}	1450.0±40.93^{a}	1376.60±29.63^{a}	1471.52±20.88^{a}
12-14wk	1635±59.65^{a}	1491.67±36.32^{b}	1596.62±29.06^{ab}	1533.18±20.88^{ab}	1613.30±30.85^{ab}
6-14wk	5333.32±120.81^{a}	5138.38±94.76^{b}	5329.25±134.55^{a}	5203.12±110.60^{b}	5498.02±118.46^{a}
Feed conversion ratio%					
6-8wk	3.61±0.28^{a}	3.02±0.33^{a}	3.15±0.11^{a}	2.66±0.35^{a}	2.70±0.52^{a}
8-10wk	3.66±0.53^{a}	3.44±0.08^{a}	3.71±0.22^{a}	4.66±0.32^{a}	4.64±1.14^{a}
10-12wk	3.65±0.29^{bc}	3.60±0.42^{a}	3.81±0.20^{bc}	3.91±0.20^{b}	3.68±0.23^{c}
12-14wk	6.68±2.90^{a}	6.35±0.62^{a}	5.42±0.43^{a}	5.90±0.82^{a}	5.15±1.34^{a}
6-14wk	4.27±0.58^{c}	3.91±0.27^{a}	3.98±0.11^{ab}	4.07±0.13^{b}	3.94±0.12^{a}

a,b,c: Means in the same row with the same letters are not significantly different. $P \leq 0.05$

The achieved improvement in the growth performance of the California growing rabbits fed GU by-product for only two months in the present study was limited. It could be claimed and expected that feeding growing and adult rabbits on diets containg GU by-product for longer times can remarkably improve their production performance.

2- Carcass traits and digestive tract measurement :

Table 4 show the effect of adding guava by-product and enzyme on the relative weights of liver, heart, and kidney. The weights and lengths of small and large intestine and the cecum are presented in Table (5). The results in Table (4) revealed that the relative weight of liver increased significantly, especially in group five, in which rabbits that fed 30% GU by-product plus kemzyme than those in other groups, (36.6%). Regarding the heart and kidney percentages were not significantly affected (P<0.05). The obtained results disagreement with the finding of Roy *et al* (2006) who found that the higher dose of guava extract (500mg/kg) prevented the increase in liver weight as compared to control group, while the lower dose was found to be ineffective.

Table (4): Effect of guava by-product on carcass traits.

Carcass traits / Groups	Live body weight	Hot carcass wt.	Liver%	Heart%	Kidney %
1	2030±88.88^{a}	1340.37±30.99^{a}	2.27±0.37^{b}	0.31±0.19^{ab}	0.63±0.60^{a}
2	2100±54.85^{a}	1311.17±20.98^{a}	2.60±0.27^{ab}	0.28±0.18^{ab}	0.69±0.55^{a}
3	2125±39.69^{a}	1348.70±51.17^{a}	2.70±0.98^{ab}	0.34±0.20^{ab}	0.64±0.58^{a}
4	2050±51.32^{a}	1288.83±39.63^{a}	2.62±0.32^{b}	0.28±0.17^{b}	0.76±0.60^{a}
5	2150±52.04^{a}	1340.83±37.99^{a}	3.10±0.89^{a}	0.34±0.19^{a}	0.71±0.67^{a}

a, b: Means in the same column with the same letters are not significantly different. P≤0.05.

Table (5): Effect of guava by-product on small, large intestine, and cecum weight and length.

Carcass traits / Groups	Small intestine wt (g),	Small intestine length (cm)	Large intestine Wt. (g)	Large intestine length (cm)	Cecum Wt. (g)	Cecum length (cm)	Small intestine thickness
1	50.07±3.42^{b}	262±4.16^{ab}	32.33±2.49^{b}	97.33±4.06^{a}	112.23±8.74^{a}	49±1.73^{a}	0.19±0.21^{a}
2	73.43±12.14^{a}	285±18.93^{ab}	36.50±2.97^{ab}	106±4.51^{a}	114.67±2.03^{a}	51.33±1.86^{a}	0.26±0.35^{a}
3	63.37±1.99^{ab}	249 ±22.68^{ab}	43.67±0.62^{a}	113.33±3.53^{a}	142.57±10.17^{a}	51.67±1.86^{a}	0.25±0.31^{a}
4	62.27±5.69^{ab}	229.33±17.61^{b}	46.70±5.37^{a}	105.67±2.19^{a}	147.53±20.48^{a}	50.67±2.96^{a}	0.27±0.30^{a}
5	59.80±5.09^{ab}	321.67±33.83^{a}	40.33±2.40^{ab}	111.33±9.68^{a}	143.47±15.04^{a}	51±0.58^{a}	0.19±0.20^{a}

a, b: Means in the same column with the same letters are not significantly different. P≤0.05.

Also, these results agreed with those of Abo-El-Azz (2000), who reported that the carcass weight percentage was increased significantly affected by the different levels ranging from 15-40% of substituting vegetable market waste instead of clover hay in growing New Zealand white rabbit diets, besides Rao, *et al* (2004) concluded that guava didn't significantly affect the carcass characteristics in pigs. In general Oh-WK *et al,* (2005) reported that the guava plant possesses a good hepatoproctive activity. Also the small and large intensines and the cecum weights and lengths were not significantly affected by adding guava and kemzyme, but the intestinal thickness showed a significant effect and kemzyme supplementation improved the feed digestibility and its utilization.

The thickness of intestine wall is considered as a good indicator for a number of microbial populations in intestinal lumen. The presence of undesirable bacteria may induce a chronic inflammation resulting in a thickening of the intestinal wall (krinke and Janroz, 1996). From these results, it could be concluded that the GU and the used kemzyme had no adverse effect on the intestinal lumen. Also, guava could be considered as the only natural agent showing significant inhibitory activities against the growth of two isolates of *Salmonella, Shigella* spp. and two isolates of the enteropathogenic Esherichia coli, Lin et al, (2002), Similarly guava is a source of lectin that can be explored to prevent adhension of E. coli to epithelial intestinal cells Coutino *et al* (2001).

3- Physiological and biochemical parameters of blood plasma

Data in Table (6) illustrated that blood glucose, Ca and Phosphorus concentrations were increased by the GU and enzyme supplementation, but the increases were not significant. Yakugaku *et al* (2004) stated that GU may have play inhibitory effects on intestinal the digestion and absorption of sugar, since it could be used as a source for diabetes- controlling. Also, Obatomi *et al* (1994) reported that guava significantly decreased the serum glucose levels in the non-diabetic and diabetic rats. This result is in agreement also with the findings of Rai *et al* (2007) and Mukhtar *et al* (2004), who noted that water extract of guava showed antihyperglycaemic activity and enhanced glucose tolerance in normal glucose loaded rats.

Table (6): Effect of guava by-product on blood parameters.

Blood parameters	Groups				
	G_1 (control)	G_2 (10%)	G_3 (20%)	G_4 (30%)	G_5 (30%+E)
Glucose mg/dL	89.07 ± 6.77^{a}	96.98 ± 10.05^{a}	87.50 ± 4.02^{a}	99.38 ± 12.97^{a}	88.44 ± 3.43^{a}
Calcium mg/dl	20.38 ± 6.43^{a}	21.62 ± 6.76^{a}	20.95 ± 2.10^{a}	17.38 ± 1.06^{a}	22.79 ± 3.11^{a}
Phosphorus mg/dL	5.49 ± 2.23^{a}	7.82±2.59a	9.04 ± 0.64^{a}	13.4 ± 4.65^{a}	14.18 ± 2.21^{a}
Total protein g/dL	5.73 ± 0.14^{a}	6.49 ± 2.20^{a}	6.44 ± 0.62^{a}	7.30 ± 0.73^{a}	6.74 ± 0.41^{a}
Albumin g/dL	3.12 ± 0.08^{a}	3.42 ± 0.64^{a}	4.47 ± 0.28^{a}	3.53 ± 0.84^{a}	5.20 ± 0.76^{a}
Globulin g/dl	2.61 ± 0.14^{a}	3.08 ± 1.82^{a}	1.98 ± 0.86^{a}	3.77 ± 0.58^{a}	1.54 ± 0.69^{a}
A/G ratio	1.20 ± 0.09^{a}	1.11 ± 0.08^{b}	2.26 ± 0.05^{ab}	0.94 ± 0.01^{b}	3.38 ± 0.07^{a}
Cholesterol mg/dl	39.15 ± 6.81^{a}	44.65 ± 9.14^{a}	23.85 ± 5.50^{a}	20.18 ± 6.95^{a}	45.87 ± 14.83^{a}
Total lipid g/dl	2.65 ± 0.44^{a}	2.89 ± 0.14^{a}	2.40 ± 0.12^{a}	2.54 ± 0.55^{a}	2.72 ± 0.53^{a}
Iron ppm	54.50 ± 11.50^{a}	54 ± 8.0^{a}	46 ± 10^{a}	75 ± 2^{a}	51.50 ± 5.5^{a}
T_3 ng/ml	1.55 ± 0.13^{ab}	1.72 ± 0.03^{b}	1.69 ± 0.05^{b}	1.56 ± 0.56^{ab}	2.74 ± 0.15^{a}
T_4 ng/ml	8.27 ± 0.68^{a}	12.39 ± 1.65^{b}	15.67 ± 1.50^{ab}	14.38 ± 2.56^{ab}	17.93 ± 1.63^{a}
T_3/T_4 ratio%	18.47 ± 0.17^{ab}	13.88 ± 0.18^{b}	10.78 ± 0.20^{a}	10.84 ± 0.25^{b}	15.28 ± 0.23^{b}
N/L ratio %	0.48 ± 0.14^{a}	0.45 ± 0.03^{a}	0.58 ± 0.36^{a}	0.45 ± 0.02^{a}	0.43 ± 0.05^{a}
Hemoglobin mg/dL	10.88 ± 0.72^{a}	10.6 ± 0.41^{a}	11.0 ± 0.62^{a}	9.7 ± 0.15^{a}	11.9 ± 1.80^{a}
Hematocrit %	44.7 ± 0.12^{a}	40.8 ± 0.68^{a}	44.5 ± 0.08^{a}	38.3 ± 0.63^{a}	39.2 ± 0.22^{a}
ALT μ/L	5.46 ± 0.42^{a}	3.82 ± 0.98^{a}	4.01 ± 0.27^{a}	4.32 ± 0.60^{a}	5.65 ± 0.52^{a}
AST μ/L	14.58 ± 2.06^{a}	13.72 ± 1.35^{a}	13.03 ± 1.19^{ab}	8.04 ± 0.62^{b}	13.20 ± 2.24^{ab}

a,b; Means in the same row with the same letters are not significantly different $P\leq0.05$.

The obtained results (Table 6) showed also that the plasma total protein and globulin were not significantly different than those of the control, but albumin level was increased in rabbits fed GU and the kemzyme than that of the control. While the A/G ratios were decreased. This low A/G ratio was found to be an indicator for immune system function Marsh and Scanes (1994). Therefore, the addition of guava products and by-products may enhance immunity in rabbits. Also, the Fe concentration in the plasma increased remarkably especially in rabbits fed 30% GU than that of control group, but the differences were not significant. These results are in agreement with the findings of Ballot *et al* (1987), who reported that guava markedly increased Fe absorption.They added that a close correlation between Fe absorption and ascorbic acid content of guava. The presence of guava by-product in the diet would be expected to increase Fe absorption markedly from diets of low Fe availability. Swarnalatha and Yegammai (2006) found that serum iron level was significantly increased when girls received 32 gm raw guava and this was accompanied by an improvement in mean hemoglobin level, packed cell volume mean, corpuscular volume and mean corpuscular Hb concentration. From the same Table (6), cholesterol and total lipids in plasma decreased especially in rabbits which were fed on 20 and 30% guava by-product than the corresponding levels in the other groups, but these differences were not significant. Singh *et al* (1993) and Binita and Asha (1998). Found that this hypolipaemic activity of guava is mainly due to the lower rate of absorption, higher rate of degradation and elimination of lipids, which could be responsible for the decreased concentration of cholesterol and activities of lipoprotein lipase in adipose tissue. The obtained results which indicated that heart weight was significantly increased following guava feeding. Similar results were also found by Wang, *et al* (2005), which revealed that Guava reduced blood lipids with a decrease in HDL and cholesterol.This may be due to its higher potassium and soluble fibre content, respectively.

Concerning plasma T_3 and T_4 hormones; hematocrit (Ht); N/L ratio, and Hemoglobin levels no significant differences were detected between the groups as compared with the control. Moreover, ALT activity was not significantly different, but AST activity decreased in rabbits fed 30% GU as compared with the control ones, (- 44.9%). These results are in close agreement with the findings of Roy *et al,* (2006), they revealed that guava (250-500mg/Kg) significantly reduced the elevated serum levels of AST and ALT.

Saturated and unsaturated fatty acids were also affected by GU and the kemzyme supplementation to rabbit's diet as shown in Table (7). Total unsaturated fatty acids increased significantly especially in G_3 and G_5 treatments and the ratio of saturated to unsaturated decreased significantly. Also in the same treatments, means of saturated fatty acids can be modified to unsaturated ones, but this mechanism is not completely understood until now, and may be explained through the modification of the saturated fatty acids to form monounsaturated and polyunsaturated fatty acids. These results are in close agreement with those obtained by Singh *et al.* (1992), who reported that guava significantly decreased saturated fatty acid and total fat concomitant with a significant decrease in serum total cholesterol and triglycerides. Therefore, the consumption of guava could result in improved antioxidant status and lipid profile. Thus it could reduce the risk of diseases caused by free radical activities and high cholesterol in blood as reported by Zardia (2006). Also guava displayed the ability to delay LDL oxidation and to prevent $_{ox}$LDL cytotoxicity, which may be considered antiatherogenic, Owen *et al* (2007).

Table (7): Effect of guava by-product on plasma fatty acids profile.

Fatty acids	Groups				
	1	2	3	4	5
Myristic $C_{14:0}$	1.101	2	1.52	1.33	1.38
Myrestoleic $C_{14:1}$	-	-	0.29	-	0.29
Palmitic $C_{16:0}$	29.62	24.52	20.30	31.52	19.53
Palmitoleic $C_{16:1}$	7.47	3.96	10.73	11.99	10.79
Heptadicanoic $C_{17:0}$	1.76	2.25	0.92	0.96	0.42
Stearic $C_{18:0}$	12.38	10.01	11.31	11.12	11.16
Oleic $C_{18:1}$	41.72	40.43	32.27	33.32	41.95
Linoleic $C_{18:2}$	6.12	15.01	21.34	8.87	13.07
Linolenic $C_{18:3}$	0.55	2.84	0.82	0.70	0.86
Arachidic $C_{20:0}$	0.37	-	0.62	0.45	0.60
Total saturated %	$44.16+0.28^{a}$	37.77 ± 0.20^{a}	34.69 ± 0.21^{a}	45.14 ± 0.27^{a}	33.06 ± 0.22^{a}
Total unsaturated%	50.84 ± 1.22^{b}	62.23 ± 1.02^{a}	67.81 ± 1.01^{a}	54.86 ± 1.20^{b}	66.94 ± 1.0^{a}
Sat./unsat. ratio%	86.86 ± 0.99^{a}	60.69 ± 0.98^{ab}	51.16 ± 0.89^{b}	82.28 ± 0.90^{a}	49.39 ± 0.88^{b}

a,b; Means in the same row with the same letters are not significantly different P≤0.05.

Economical evaluation:

In terms of economical evaluation data in Table (8) showed that rabbits fed on GU achieved the highest economical and production efficiency factors (PEF) compared to the control. On the other hand, the economical efficiency, performance index and production efficiency factor percentages were significantly higher in rabbits fed GU especially 20 and 30%. This could be due to reducing the amount of feed intake required to produce one productive unit of associated with the addition of guava by-product.

Table (8): Economic efficiency, relative economic efficiency and performance index as affected by guava by-product supplementation.

Parameters	Groups				
	G_1 (control)	G_2 (10%)	G_3 (20%)	G_4 (30%)	G_5 (30%+E)
Feed cost /kg (LE)	11.02	8.68	8.28	7.99	9.64
Total return	18.87	19.74	20.11	19.11	20.94
Net return	7.84	11.06	11.83	11.12	11.30
Economic efficiency (EE%)	41.56	56.02	58.82	58.19	53.98
Relative economic efficiency (REE)	100	134.79	141.53	140.01	129.88
Performance Index (PI)	25.83	32.82	33.19	29.16	29.83

From the achieved results it is highly recommended to add Guava by-products to the rabbit's diets as a new inexpensive, safe and as available natural agricultural waste materials especially in the a treatment for gastrointestinal diseases in rabbits. Also, it could be considered as antioxidant which independently inhibits free radical generation and lipid peroxidation that may prevent atherosclerosis and endothelial cell damage and alter the membrane structures involved in the ion transport into cells. (Abreu *et al*, 2006).

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بعض الاستجابات الفسيولوجية لإضافة مخلفات تصنيع الجوافة في الأرانب النامية

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استخدم في هذه الدراسة عدد ٥٠ أرنب ذكر عمر ٦ أسابيع حيث قسمت إلى خمسة مجاميع : غذيت المجموعة الأولى (الكنترول) على عليقة عادية بينما غذيت باقي المعاملات على العليقة الأساسية مضافاً إليها نسب مختلفة من مخلفات مصانع الجوافة وهي ١٠ و٢٠ و٣٠ و٣٠% + مستحضر إنزيمي (kemzyme) بمعدل ١ جرام لكل كيلو جرام من العليقة وذلك في المجاميع الثانية والثالثة والرابعة والخامسة على التوالي. وقد تم حساب وزن الجسم ، معدل استهلاك الغذاء ، معدل التحويل الغذائي وفي نهاية التجربة (١٤ أسبوع) تم ذبح أربعة ذكور من كل معاملة حيث أخذت البلازما لإجراء التحاليل المختلفة بالدم وكذلك بعض مقاييس الذبيحة .

وكانت أهم النتائج كما يلي: :-

١- لم يتأثر وزن الجسم – معدل استهلاك الغذاء ومعدل التحويل الغذائي بإضافة مستويات مختلفة من الجوافة وأن كان حدث بعض التحسن في معدل التحويل الغذائي .
٢- تأثر الوزن النسبي للكبد بإضافة الجوافة إلى العليقة بينما لم تتأثر أوزان الكلى والقلب والأمعاء الغليظة والرفيعة والأعور.
٣- لم يتأثر مستوى الجلكوز ، الكالسيوم ، الفوسفور ، البروتين الكلي والجلوبيولين في البلازما بأضافة الجوافة.
٤- إرداد مستوى الألبيومين في البلازما في الأرانب التي غذيت على الجوافة عند مقارنتها بمجموعة المقارنة.
٥- إزداد مستوى الحديد في البلازما خاصة في الأرانب التي غذيت على مستوى ٣٠% من مخلفات الجوافة وأن كانت الزيادة غير معنوية.
٦- أنخفض مستوى كلا من الكولستيرول والليبيدات الكلية في البلازما خاصة في الأرانب التي غذيت على ٢٠ ، ٣٠% من مخلفات الجوافة بالمقارنة بالمجاميع الأخرى.
٧- لم يتأثر مستوى هرمونات الدرقية T_3 & T_4 ونسبة كرات الدم المتعادلة إلى اليمفاوية (N/L) والهيموجلوبين وحجم المكونات الخلوية بإضافة الجوافة للعلائق.
٨- لم يتأثر نشاط أنزيم ALT بإضافة الجوافة ، ولكن نشاط أنزيم AST قد أنخفض خاصة في الأرانب المغذاه على ٣٠% عند المقارنة بمجموعة الكنترول .
٩- إزداد مستوى الأحماض الدهنية غير المشبعة في الأرانب المغذاه على ٢٠% ، ٣٠% + الأنزيم مقارنة بالمجاميع الأخرى .
١٠- كان أعلى عائد اقتصادى للمجموعة التي غذيت على علائق أحتوت على ٢٠% أو ٣٠% من مخلفات تصنيع الجوافة.

لذا توصي الدراسة بإمكانية إضافة مخلفات الجوافة إلى علائق الأرانب كمصدر طبيعي رخيص بديلاً عن الدريس (لأرتفاع ثمنه) كما أن استخدام مخلفات الجوافة يعتبر وسيلة آمنة للتخلص من أحد مخلفات التصنيع الزراعي. ولقد أوضحت نتائج البحث أن استخدام الجوافة ليس له أي تأثيرات فسيولوجية ضارة على الأرانب سواءً على الهرمونات والأنزيمات و كذلك على قياسات الدم المختلفة.