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Effect of Using Guava By-Products with or without Enzyme Supplementations on Growing Rabbit's Performance

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Abstract

THIS study aimed to evaluate the effect of using guava by-products without or with multi-enzyme supplementations as an alternative feed source on the growth performance, nutrient digestibility, carcass characteristics and some blood parameters. Ninety-weaned male rabbits were divided into six treatments. Two different levels of guava (%5 and %10) in addition to control diet (0%) supplemented with or without commercial enzyme at level of 1 g/kg diet were used in (3*2) factorial design. Results showed significantly increases in the body weight gain, total feed intake, performance index and better feed conversion ratio for enzyme supplemented group. Rabbits fed higher level of guava (10%) recorded the worst values than those of other experimental levels (0% and 5%). all groups fed on either lower or higher level of guava by-product with enzyme supplementation were better than control group in all performance parameters. Nutritive values and digestibility of all nutrients improved significantly in rabbits fed diets either has low level of guava or enzymes supplementation. Growing rabbits fed guava by-products supplemented with or without enzyme had no deleterious impact on liver and kidney functions. Urea, protein metabolites and lipid profile decreased significantly for all experimental treatments than control groups. Rabbits fed guava either with or without enzyme recorded higher value of glucose. Blood antioxidants parameters of all experimental treatments were higher, than control groups. Rabbits fed on all levels of guava by-product with enzyme or at level of 5% without enzyme recorded the highest values of economical and relative efficiency.

Keywords: Guava by-product, Enzymes, rabbit’s performance, digestibility, blood parameters.

Introduction

The rabbit industry faces a critical challenge: developing cost-effective, sustainable diets amid rising feed costs and scarcity driven by climate change and resource competition. A promising solution lies in utilizing locally available, non-conventional resources, such as recycled fruit and vegetable by-product. This approach not only enhances feed affordability and security but also supports environmental sustainability and reduces food waste, aligning production with ecological and economic goals [1-2]. Guava by-product (GU), primarily composed of by-product (approx. 94%) and skins (6%), is a rich source of fibrous components like stone cells. Its nutritional profile is characterized by high fiber (61.4%), along with significant fat (16.0%) and protein (7.6%) content, and a small ash component (0.93%) [3-4-5]. the high fiber content of guava by-product (GU) makes it a suitable candidate for incorporation into rabbit diets. Rabbits are hind-gut fermenters with a higher dietary fiber requirement than most poultry and simple-stomached animals, and they can effectively retain and digest small fiber particles [6]. This potential application is further supported by extensive research on the nutritional value and biological activity of various guava components, including its peel, flesh, and leaves [7-8-9]. Few experiments have been conducted on the use of guava by-product as a feed ingredient in rabbit nutrition.

Several studies have shown that the use of prebiotics and organic acids supplementation to the diet could support digestion and/or metabolism by animals through their action on intestinal microflora. Thus, the objective of the present study was to

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evaluate the effect of using different levels of guava by-product (5 or 10%) with or without enzyme supplementation on the rabbit performance, digestibility, carcass yield, blood serum parameters and economic efficiency of growing rabbits.

Material and Methods

Guava by-product collection

Guava by-product samples were collected from the Vitrac® food processing facility in Qalyubia, Egypt. The collected by-product was subsequently sun dried, mechanically crushed in a disc crusher, and thoroughly homogenized preparing to chemical analysis (Table 1). The processed material was stored under well-ventilated conditions pending its incorporation into experimental diets (Table 2).

Experimental designs and animals

This study was conducted at the Animal Production Research Institute., to evaluate the effect of different levels of guava by-products with or without multi-enzyme supplementations as an alternative feed source on the growth performance, nutrient digestibility, carcass characteristics and blood biochemical parameters. A total number of ninety newly weaned male New Zealand White rabbits at 35-days of age with an initial live body weight 543.88 ± 53.86 g were used in this experiment. The rabbits were randomly distributed into six treatment groups (n=15 per group), each comprising five replicates of three animals. The dietary treatments were formulated as follows: a basal diet without additives served as the negative control, a basal diet supplemented with 1 g/kg multi-enzyme served as the positive control, and two additional diets incorporating 5% or 10% guava by-product (5% GU and 10% GU), both without enzyme supplementation. While the other two diets contained the same levels of guava by-product supplemented with multi enzymes [(Nutri Kem Extend dry, Kemin Europa N.V. Belgium) contained from Endo-13(4)-beta-glucanase (beta-glucanase) (Aspergillus aculeatus), Endo-1,4-beta-glucanase (Trichoderma longibrachiatum), Alpha-amylase (Bacillus amyloliquefaciens), Bacillolysin (protease) (Bacillus amyloliquefaciens). Endo-1.4-beta-xylanase (xylanase) (Trichoderma viride)] at level of 1g/kg diet (GU 5% ENZ and GU 10% ENZ).

Growth Performance

Final body weight (FBW) was determined from weekly measurements, while feed intake (FI) was recorded daily. From these data, total gain (TG) and feed conversion ratio (FCR, g feed/g gain) were calculated.

Digestibility Trial

A digestibility trial was performed in the experiment's final week to assess apparent nutrient digestibility, following the methodology of [10]. For this five-day trial, five rabbits per treatment were randomly allocated to individual metabolic cages. We recorded daily feed intake and collected feces throughout the collection period. The fecal samples were then weighed, homogenized by thorough mixing, and archived at -20°C. Subsequent laboratory analysis of the feed and fecal composites for OM, DM, CP, and CF was conducted in accordance with standard [11]. protocols. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analysed sequentially using an ANKOM fiber analyser, following the methods of [12]. In contrast, nitrogen-free extract (NFE) was calculated by difference. Digestible energy (DE) was estimated using the equation from [13]. DE (kcal/kg diet) = 5.28 DCP + 9.51 DEE + 4.2 (DCF + DNFE), where DCP is digestible crude protein, DEE is digestible ether extract, DCF is digestible crude fiber, and DNFE is digestible nitrogen-free extract.

Carcass Characteristics

A subset of five rabbits per group was randomly selected, subjected to a 12-hour fast, and then weighed prior to slaughter. Post-slaughter, the non-edible components (viscera, tail, and pelt) were removed. The hot carcass and edible giblets including the heart, liver, spleen, lungs, and kidneys were subsequently weighed. The dressing percentage was derived from the ratio of the hot carcass weight to the pre-slaughter live weight. Similarly, giblet yield was calculated as a proportion of live body weight.

Blood parameters

Immediately after slaughter, blood samples were drawn from each rabbit into heparinized sterile tubes. The samples from all three animals per group were then centrifuged to isolate plasma, which was subsequently stored at -20°C until the analysis of blood parameters could be performed. Plasma was used for the determination of the total protein, total albumin, globulin, Creatinine, plasma glucose, Plasma aspartate aminotransferase (AST) and alanine aminotransferase (ALT), total cholesterol and uric acid. All biochemical blood constituents were determined using a spectrophotometer (Spectronic 21 DUSA) and commercial diagnostic kits (Combination, Pasteur Lap.). Total antioxidant capacity (TAC), superoxide dismutase (SOD) activity, glutathione peroxidase (GPX) activity, glutathione (GSH) activity and Glutathione reductase (GR) were determined according to [14-15-16-17]. respectively.

Economic evaluation

Economic efficiency (EE), the economic efficiency of experimental diets was calculated as the ratio between net revenue and cost of feed consumed according to [18].

Statistical analysis

Statistical analyses of results were analysed using the General Linear Models procedure by using [19]. software with the following fixed model: $Y_{ijk}=\mu+L_i+Z_J+(LZ)_{ij}+e_{ijk}$

Where: Y_i = the observation, μ = Overall mean, e_i= Random error. L= Effect of Level

Z = Effect of Enzyme Supplementation, LZ = Interaction between Level and enzyme supplementation. Treatment means indicating significant differences ($P<0.01$ and $P<0.05$) were tested using Duncan's multiple range test [20].

Results and Discussion

Growth Performance

Data of growth performance of male rabbits fed guava by-product supplemented with or without an enzyme is summarized in Table 3. The main effects of enzyme addition and level of substitution (guava levels) significantly affected FBW, BWG, FCR and PI during the overall experimental period. Enzymes supplementation groups showed significant ($p<0.01$) improvement for growth performance parameters. From this study, it is noted that there is an inverse relationship between the increase in guava level and the growth rates of rabbits. The higher the guava concentration in the feed, the lower the growth rates of rabbits. Rabbits fed in 0% guava (control) recorded significant improvement in growth parameters, followed by those fed on either 5% guava or 10%. Interaction effects showed significant increases in the FBW, BWG and PI for (GU 0% ENZ) group, followed by (GU 5% ENZ) group. Referring to TFI (GU 0% ENZ) group recorded significantly ($p<0.01$) higher value, followed by (GU 0% free) and (GU 5% ENZ) and finally the other experimental groups. [21]. found that FI decreased as the dietary crude fiber levels increased. In addition, supplementing rabbit diets with GU 0% ENZ and GU 5% ENZ resulted in a linear improvement in FCR ($p<0.01$). The values of the FCR were recorded by the (GU 0% ENZ) and (GU 5% ENZ) groups, and no significant difference between them. [22]. reported that~~,~~ birds fed the diet containing 5% guava by-product had significantly lower values of FI and the best FCR values (highest PI) during the total experimental period. [23]. reported that inclusion of Guava by-product in the diet improved the performance of broiler chickens. The synergistic effect of ethanol extract (EE) and crude fiber (CF) in guava by-product (GU) enhances nutrient absorption by increasing retention time in the gut. This improves growth performance and reduces feed intake (FI) in broilers. Research shows that diets incorporating moderate levels (5-10%) of properly balanced guava by-product can maintain optimal growth performance [24-25].

Nutrient Digestibility

The digestibility coefficient of nutrients of growing rabbits fed guava supplemented with or without enzyme is summarized in Tables 4 and 5. Enzyme supplementation groups recorded significantly ($p<0.01$) better digestibility coefficient for all nutrients than those without enzyme supplementation. Also, nutrients digestibility decreased significantly ($p<0.01$) as levels of guava increased. Concerning the interaction effect, digestibility coefficient of DM, OM and CP, also cell wall constituents (NDF&ADF) and nutritive values (TDN&DCP) improved significantly ($p<0.001$) in rabbits fed (GU 0% ENZ) followed by GU 0% free and GU 5% ENZ. There were significant differences among them. The digestibility coefficient of CF and NFE had the same trend, but there was no significant difference between (GU 0% free and GU 5% ENZ). The GU 5% ENZ group had the highest significant ($p<0.01$) value of the digestibility coefficient of EE compared with those in other groups. The GU 0% ENZ and GU 0% free groups exhibited the highest ADL digestibility, followed by GU 5% ENZ, but there was no significant difference among them. The digestibility coefficients observed in the present study differed from the findings of [26]. Their research indicated that the inclusion of 20% GU in a rabbit's diet enhanced the digestibility of both NDF and ADF over the control group. The digestibility of guava residue in animals is reduced due to its high by-product content, which contains significant amounts of acid detergent fiber (ADF) and lignin [27]. Lignin is an indigestible substance that forms a physical barrier around feed, preventing microbial enzymes from breaking it down and leading to a lower digestibility coefficient [28].

Blood biochemical parameters

The finding in Table 6 and 7, clearly shows that enzyme supplementation groups recorded significantly ($p<0.01$) higher concentration values for glucose (GU), total protein (TP), albumin (AB) and AG ratio than those of without enzyme supplementation. Also, blood protein concentration (TP, AB, GB, AG), lipid profile parameters (TG, TC, HDL, LDL) and urea concentration decreased significantly ($p<0.01$) as guava levels increased, on the other hand, glucose concentration increased significantly ($p<0.01$) as guava levels increased. Concerning the interaction effect, growing rabbits fed guava by-product supplemented with or without enzyme had no deleterious impact on liver and kidney functions as indicated by AST and ALT concentrations as well as creatinine. The urea concentration recorded significant ($p<0.021$) decreased value for rabbits fed guava by-product. We hypothesize that the elevated protein levels are a consequence of the high neutral detergent insoluble nitrogen (NDIN) content in guava by-product. This NDIN may serve as a source of available nitrogen for microbial fermentation, leading to increased microbial protein synthesis and subsequent intestinal absorption of amino acids [27].The results of this study corroborate previous research on the safety of dietary GU for ruminants. Our data are comparable to the findings of [29]. who concluded that incorporating up to 10% GU into goat rations did not detrimentally affect blood or serum biochemical indices. This is further supported by [30]. Who found no significant difference (P>0.05) in serum protein, albumin, and globulin values between control lambs and GU-fed lambs. The values observed in our experiment were within established normal ranges, which indicate that no antinutritional factors were present to hinder nutrient absorption in the small intestine. This, in turn, points to intact hepatocellular function, as serum protein and albumin levels are key indicators of hepatic health.

Growing rabbits fed guava by-product supplemented with or without enzyme had significantly (p<0.001) increased value of glucose concetration compared with the other experimental groups. In contrast, [30] Observed that blood glucose levels increased insignificantly (P>0.05) with higher levels of GU in the diet. This minimal response may be attributed to the presence of soluble carbohydrates and other digestible nutrients, which are known to elevate blood glucose [31]. Triglyceride concentration was significantly (p <0.001) decreased in growing rabbits fed guava by-product supplemented with or without enzyme compared to the control groups. Total cholesterol, HDL and LDL had a similar trend of triglyceride concentration. According to [30]. The experimental groups fed GU exhibited a non-significant decrease (P>0.05) in total serum cholesterol concentration. The authors proposed that this effect is likely due to the high vitamin C content in GU, which acts as a free radical scavenger in the bloodstream, there by potentially lowering cholesterol.

Blood antioxidant status parameters

In Table 8, enzyme supplementation groups recorded significantly (p <0.01) higher concentration values for TAC, SOD, CAT, GPX, GR and TBARS than those without enzyme supplementation. The same parameters had increased significantly (p <0.01) as levels of guava increased except for TBARS, which increased in the opposite direction. Regarding the interaction effect, the TAC, SOD, CAT, GPX and GR of rabbits given guava by-product supplemented with or without enzyme had much higher (p <0.003, 0.038, 0.001, 0.009 and 0,046), respectively, than the control groups. The TBARS of all treatments was significantly lower (p <0.011) than the control group. [32]. Showed that, there was a quadratic effect of supplementation of guava by-product on the TBARS value of the thigh meat, that is, with increasing inclusion of by-product, the TBARS value was reduced to 0.72%, indicating greater lipid stability of thigh meat in the inclusion value. [32]. Reported that guava undergoes processing for the production of juices, jams, pulps, and extracts. This fruit have skins and by-product, natural sources of antioxidants, The guava industry produces a solid by-product called "decanter" during the juice extraction process. This antioxidant-rich material is a viable supplement for animal diets. According to [32]. incorporating guava by-product into broiler feed at an early stage serves as an effective natural antioxidant. It improves thigh meat quality without negatively impacting the birds' productive performance.

Carcass traits

The results of the carcass traits are shown in Table 9 and 10. As mentioned above enzyme supplementation groups recorded significantly (p <0.01) better growth parameters. As the guava level increased, growth rates decreased, the same trend was observed with slaughter weight and dressing percentage. On the other hand, the percentage of organs (liver, lungs, giblets and edible parts) and abdominal fat % were higher for the free enzyme group (p <0.001). Also, the same organs were significantly lower as the level of guava decreased. The interaction effect showed that the slaughter weight as well as the dressing percentage exhibited a significant (p <0.003and 0.001) increase in rabbits fed GU 0% ENZ, followed by GU 5% ENZ and finally GU 0% free compared with the other experimental groups. In this respect [24]. found that inclusion of GU in broiler diets has been shown to increase the carcass yields. [30]. indicated that the use of about 20% of GU in diets has an insignificant effect on the carcass quality. Incorporation of GU in rabbit diets had a slight impact on their carcass quality [26]. The proportion of lungs and heart had not significantly (p=0.166 and 0.423, respectively) among the treatment groups. The proportion of kidneys and liver had significantly (p<0.038 and 0.006) different among the treatment groups. Rabbits of the GU10% free group had a higher proportion of kidneys and liver than the other experimental groups. The supplemented groups caused a quadratic decrease (p < 0.004) in proportion of the abdominal fat compared with the control group. The GU 0% ENZ and GU 5% ENZ had lower values of giblets proportion (p <0.012) than the other experimental groups. [33] showed that guava by-products have significantly less abdominal fat than other dietary levels or the control. On the other hand, [24]. found that~~,~~ the use of GU at level 12% resulted in a linearly significant effect on the thigh yield, absolute weight of gizzard and abdominal fat, which increased with each 1% of addition to the diet. Total edible parts significantly (p <0.001) increased with GU 0% ENZ, followed by GU 5% ENZ, and GU 0% free groups compared with the other groups.

Economic efficiency

The group of rabbits fed GU 5% ENZ recorded lower values of average total feed intake (7937 g) and total feed cost (140.05 LE) than those of +ve control group (GU 0% ENZ), which recorded (8183 and 148.11 LE) respectively table 11. Average revenue of total gain, net feed revenue (LE), economic and relative efficiency values, improved in rabbits fed GU 0% ENZ and GU 5% ENZ as compared with those fed the control (-ve control) and other experimental diets. GU 5% ENZ recorded higher values of economic feed efficiency % (75.47) and relative efficiency values (210.17) than the experimental groups except GU 0% ENZ group, which recorded the nearest values (76.22 and 211.50, respectively). This improvement **is** based on the higher body weight and better feed conversion ratio. The use of different levels of GU in the feed for rabbits or inclusion in their diets has been found to decrease the feed costs.

According to studies by [33-24]. the use of unconventional feed ingredients decreases overall production costs and improves profitability, a finding supported by later work from [26].

Conclusion

The findings suggest that guava by-product is a viable alternative feed for growing rabbits at levels up to 5%, maintaining both productive performance and economic efficiency. Using of enzymes improve the utilization of guava by-product to further decrease production costs.

Acknowledgments

This study was conducted at the Nubaria Experimental Station, Animal Production Research Institute, Agriculture Research Center. All experimental procedures were performed in accordance with the Animal Production Research Institute's Standards for the Care and Use of Animals (Protocol No. 02 02 02 37 in 20/5/2024).

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Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

This study follows the ethics guidelines of the Animal Production Research Institute, Agriculture Research Centre, Giza, Egypt. (ethics approval number, 02 02 02 37 in 20 /5/2024).

TABLE 1. Chemical composition and amino acid content of Guava by-product on dry matter basis

Amino acid%	Guava by-product	Chemical composition	Guava by-product
Methionine	3.61	DM	92.87
Leucine	6.93	OM	98.07
Valine	6.01	CP	9.41
Lysine	1.22	CF	59.36
Tyrosine	5.01	EE	11.39
Isoleucine	5.66	NFE	17.91
Histidine	2.01	Ash	1.93
Phenylalanine	3.43	NDF	79.88
Cysteine	1.49	ADF	45.63
Threonine	3.58	ADL	13.07
Arginine	10.59	Cellulose	34.25
Proline	4.21	Hemicellulose	32.56
Alanine	8.33	DE, Kcal/kg	2039
Glutamic acid	17.88		
Glycine	6.03		
Serine	6.2		
Aspartic acid	3.78		

TABLE 2. Ingredients and chemical composition of the experimental diets

Ingredients%	Control	5 % Guava	10% Guava
Berseem hay	32.1	26.1	21.1
Barley grain	21.9	18.9	16.5
Yellow corn	7.1	7.1	9.6
Wheat bran	17.5	19.5	18.5
Soybean meal	14.4	15.4	15.3
Guava by-prod	0	5	10
Molasses	3.6	4.6	5.6
Di Ca phos	1.4	1.4	1.4
Limestone	1.1	1.1	1.1
Salt	0.5	0.5	0.5
Premix	0.3	0.3	0.3
Methionine	0.1	0.1	0.1

Chemical composition of diet (g/100g DM)			
DM	89.36	90.45	90.12
OM	92.86	92.61	92.34
CP	15.36	15.39	15.43
CF	13.98	15.53	16.98
EE	3.24	3.54	3.77
NFE	60.28	58.15	56.16
Ash	7.14	7.39	7.66
NDF	35.05	37.87	38.51
ADF	21.63	22.77	23.06
ADL	4.76	5.65	5.89
DE, Kcal/kg	2766	2679	2593

TABLE 3. Effects of enzyme supplementation, guava levels and their interaction on rabbit performance

Treatments	Final body weight (g)	Body weight gain (g)	Total feed intake (g)	Feed conversion ratio	Performance index*
			Enzyme supplementation effect		
Enz free	2107 ^{b}	1564 ^{b}	7794 ^{b}	5.015 ^{a}	42.42 ^{b}
Enz supp	2527 ^{a}	1983 ^{a}	7981 ^{a}	4.064 ^{b}	63.14 ^{a}
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01
			Guava levels effect		
Gu 0%	2461 ^{a}	1916 ^{a}	8132 ^{a}	4.327 ^{b}	58.79 ^{a}
Gu 5%	2405 ^{b}	1863 ^{b}	7869 ^{b}	4.276 ^{b}	57.41 ^{a}
Gu 10%	2089 ^{c}	1547 ^{c}	7649 ^{c}	4.998 ^{a}	42.51 ^{b}
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01
			Interaction effect		
Gu 0% free	2184 ^{d}	1639 ^{d}	8077^{b}	4.932 ^{b}	44.43 ^{d}
Gu 5% free	2202 ^{cd}	1661 ^{cd}	7798 ^{d}	4.707 ^{c}	46.99 ^{c}
Gu 10% free	1905 ^{e}	1363 ^{e}	7460 ^{e}	5.473 ^{a}	34.84 ^{e}
Gu 0% ENZ	2719 ^{a}	2175 ^{a}	8183 ^{a}	3.762 ^{d}	72.26 ^{a}
Gu 5% ENZ	2595 ^{b}	2051 ^{b}	7937 ^{c}	3.874 ^{d}	67.41 ^{b}
Gu 10% ENZ	2247 ^{c}	1704 ^{c}	7811 ^{d}	4.591 ^{c}	49.08 ^{c}
Pooled SE ±	30.35	30.22	25.02	0.066	1.47
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01

^{a,e} Means in the same Column having different superscript differ significantly.
* Performance index % = final live body weight (Kg) /feed conversion*100, Calculated according to [34].

TABLE 4. Digestibility coefficients% of nutrient of male rabbits fed guava by-product supplemented with or without enzyme

Treatments	DM	OM	CP	CF	EE	NFE
			Enzyme supplementation effect			
Enz free	61.16^{b}	62.08^{b}	66.56^{b}	46.64^{b}	84.29^{b}	63.56^{b}
Enz sup	66.76^{a}	67.43^{a}	70.98^{a}	55.31^{a}	86.13^{a}	68.66^{a}
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01
			Guava levels effect			
Gu 0%	69.79^{a}	70.46^{a}	78.43^{a}	57.08^{a}	84.58^{b}	70.78^{a}
Gu 5%	62.47^{b}	63.32^{b}	66.09^{b}	50.72^{b}	85.96^{a}	64.66^{b}
Gu 10%	59.63^{c}	60.50^{c}	61.81^{c}	45.14^{c}	85.11^{b}	62.89^{b}
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01
			Interaction effect			
Gu 0% free	67.47^{b}	68.21^{b}	76.90^{b}	54.71^{b}	85.30^{c}	68.20^{b}
Gu 5% free	59.82^{e}	60.84^{e}	64.16^{d}	46.34^{d}	84.22^{d}	62.36^{c}
Gu 10% free	56.20^{f}	57.20^{f}	58.62^{e}	38.88^{e}	83.55^{e}	60.11^{c}
Gu 0% ENZ	72.11^{a}	72.71^{a}	79.95^{a}	59.45^{a}	83.86^{ed}	73.36^{a}
Gu 5% ENZ	65.12^{c}	65.80^{c}	68.02^{c}	55.10^{b}	87.70^{a}	66.96^{b}
Gu 10% ENZ	63.05^{d}	63.80^{d}	64.99^{d}	51.40^{c}	86.86^{b}	65.67^{b}
Pooled SE	1.26	1.23	1.81	1.65	0.40	1.07
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01

^{a,e} Means in the same Column having different superscript differ significantly. DM=Dry Matter, OM= Organic Matter, CP=Crude Protein, CF= Crude Fiber, EE= Ether Extract, NFE=Nitrogen Free Extract

TABLE 5. Digestibility coefficients % of cell wall constituents of male rabbits fed guava by-product supplemented with or without enzyme.

Treatments	NDF	ADF	ADL	TDN	DCP
Enzyme supplementation effect					
Enz free	48.94^{b}	38.34^{b}	32.42^{b}	61.17^{b}	10.23^{b}
Enz sup	52.77^{a}	41.58^{a}	35.52^{a}	65.92^{a}	10.91^{a}
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01
Guava levels effect					
Gu 0%	55.49a	51.15a	40.53a	68.32a	12.03a
Gu 5%	50.07b	36.26b	32.46b	62.48b	10.20b
Gu 10%	47.02c	32.48c	28.92c	59.83c	9.50c
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01
Interaction effect					
Gu 0% free	53.64b	49.86b	39.87a	66.79b	11.81b
Gu 5% free	48.58d	34.78d	30.77c	60.07e	9.90d
Gu 10% free	44.60e	30.37e	26.63d	56.64f	8.99e
Gu 0% ENZ	57.33a	52.44a	41.18a	69.85a	12.24a
Gu 5% ENZ	51.55c	37.73c	34.16b	64.90c	10.49c
Gu 10% ENZ	49.44d	34.58d	31.21c	63.02d	10.01d
Pooled SE	0.99	2.00	1.26	1.07	0.27
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01

a, e Means in the same Column having different superscript differ significantly.
NDF= neutral detergent fiber, ADF= acid detergent fiber, ADL=acid detergent lignin.
TDN=Total Digestible Nutrients DCP= digestible crude protein

TABLE 6. Blood biochemical parameters of male rabbits fed guava by-product supplemented **with or without enzyme**

treatments	GU gm/dl	TP g/dl	AB g/dl	GB g/dl	AG %	URA mg/dl	CRE Mg/dl
Enzyme supplementation effect							
Enz free	87.59^{b}	6.32^{b}	3.31^{b}	3.01	1.09^{b}	37.97	0.80
Enz supp	89.78^{a}	6.69^{a}	3.63^{a}	3.06	1.18^{a}	37.92	0.81
P value	<.0.01	<.0.01	<.0.01	0.15	<.0.01	0.80	0.39
Guava levels effect							
Gu 0%	85.32^{c}	7.35^{a}	4.13^{a}	3.22^{a}	1.29^{a}	38.69^{a}	0.80
Gu 5%	89.43^{b}	6.45^{b}	3.36^{b}	3.09^{b}	1.09^{b}	37.86^{b}	0.80
Gu 10%	91.30^{a}	5.72^{c}	2.92^{c}	2.79^{c}	1.05^{b}	37.29^{b}	0.81
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01	0.67
Interaction effect							
Gu 0% free	83.25^{d}	7.06^{b}	3.87^{b}	3.19^{ab}	1.22^{b}	38.67^{a}	0.80
Gu 5% free	88.52^{bc}	6.34^{c}	3.25^{cd}	3.09^{b}	1.05^{c}	37.92^{ab}	0.79
Gu 10free	91.01^{ab}	5.56^{e}	2.80^{e}	2.76^{c}	1.01^{c}	37.34^{b}	0.81
Gu 0% ENZ	87.39^{c}	7.63^{a}	4.38^{a}	3.25^{a}	1.35^{a}	38.71^{a}	0.80
Gu 5% ENZ	90.35^{ab}	6.56^{c}	3.47^{c}	3.09^{b}	1.12^{bc}	37.81^{ab}	0.81
Gu10%ENZ	91.60^{a}	5.87^{d}	3.05^{de}	2.83^{c}	1.08^{c}	37.23^{b}	0.81
Pooled SE	0.74	0.17	0.13	0.04	0.03	0.17	0.01
P value	<.0.01	<.0.01	<.0.12	<.0.01	<.0.16	<.0.21	0.86

a, e Means in the same Column having different superscript differ significantly.
GU=glucose TP= total protein AB= albumin GB= Globulin AG= A/G ratio CRE= Creatinine

TABLE 7. Blood biochemical parameters of rabbits fed guava by-product supplemented with or without enzyme

treatments	TG Mg/dl	TC Mg/dl	HDL Mg/dl	LDL Mg/dl	AST U/DL	ALT U/DL
			Enzyme supplementation effect			
Enz free	99.4	114.65	48.77	45.94	31.39	20.80
Enz supp	99.4	113.59	48.29	45.49	31.85	21.37
P value	0.62	0.49	0.20	0.72	0.49	0.52
			Guava levels effect			
Gu 0%	114.6[a]	136.3[a]	51.34[a]	62.09[a]	31.68	20.69
Gu 5%	93.29[b]	107.3[b]	47.91[b]	40.75[b]	31.28	21.38
Gu 10%	90.08[b]	98.69[c]	46.35[c]	34.32[c]	31.91	21.18
P value	<.0.01	<.0.01	<.0.01	<.0.01	0.78	0.80
			Interaction effect			
Gu 0% free	114.9[a]	137.4[a]	51.56[a]	62.93[a]	31.83	20.89
Gu 5% free	93.40[b]	107.6[b]	48.21[b]	40.73[b]	31.11	20.27
Gu 10free	90.55[b]	98.85[c]	46.55[cd]	34.19[c]	31.23	21.23
Gu 0% ENZ	114.3[a]	135.2[a]	51.12[a]	61.25[a]	31.53	20.49
Gu 5% ENZ	93.18[b]	107.0[b]	47.60[bc]	40.78[b]	31.45	22.48
Gu10%ENZ	89.61[b]	98.53[c]	46.16[d]	34.44[c]	32.58	21.12
Pooled SE	2.73	3.96	0.53	2.93	0.29	0.40
P value	<.0.01	<.0.01	<.0.02	<.0.04	0.80	0.74

[a,] eMeansin the same Column having different superscript differ significantly
TG=Triglycerides TC=Total Cholesterol, HDL=High Density Lipoprotein LDL= Low Density Lipoprotein, AST=Aspartic Transaminase, ALT=Alanine Transaminase

TABLE 8. Blood antioxidant status of male rabbits fed guava by-product supplemented with or without enzyme

treatments	TAC u/ml	SOD u/ml	CAT u/ml	GPX u/ml	GR u/ml	TBARS u/ml
			Enzyme supplementation effect			
Enz free	2.14[b]	50.54[b]	10.24[b]	6.93[b]	11.68[b]	24.82[a]
Enz supp	2.55[a]	54.97[a]	11.06[a]	7.22[a]	11.96[a]	23.37[b]
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01
			Guava levels effect			
Gu 0%	1.51[c]	40.34[c]	8.66[c]	5..87[c]	10.69[c]	28.47[a]
Gu 5%	2.66[b]	57.22[b]	10.72[b]	7.41[b]	11.93[b]	22.74[b]
Gu 10%	2.86[a]	60.71[a]	12.57[a]	7.95[a]	12.85[a]	21.08[c]
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01
			Interaction effect			
Gu 0% free	1.06[d]	36.29[d]	8.35[d]	5.7[e]	10.39[d]	29.41[a]
Gu 5% free	2.59[b]	56.22[b]	10.41[c]	7.26[c]	11.86[b]	23.34[c]
Gu 10free	2.79[ab]	59.13[ab]	11.98[b]	7.85[a]	12.79[a]	21.70[d]
Gu 0% ENZ	1.97[c]	44.40[c]	8.98[d]	6.04[d]	10.99[c]	27.52[b]
Gu 5% ENZ	2.74[ab]	58.22[b]	11.04[c]	7.57[b]	11.99[b]	22.14[d]
Gu 10ENZ	2.94[a]	62.29[a]	13.17[a]	8.04[a]	12.91[a]	20.46[e]
Pooled SE	0.16	2.28	0.41	0.22	0.22	0.80
P value	<.0.01	0.038	<.0.01	<.0.01	0.046	0.011

[a,] e Means in the same Column having different superscript differ significantly.
TAC= Total antioxidant capacity. SOD= Superoxide dismutase activity CAT=Catalase GPR= Glutathione peroxidase GR= Glutathione reductase TBARS= Thio barbituric acid reactive substances

TABLE 9. Carcass characteristics of male rabbits fed guava by-product supplemented with or without enzyme

Treatments	Live body weight (g)	Slaughter weight (g)	Carcass (%)	Abdominal fat%	EDP
		Enzyme supplementation effect			
Enz free	2171.11^{b}	1270.09^{b}	58.32^{b}	3.17^{a}	62.76^{b}
Enz supp	2478.33^{a}	1511.12^{a}	60.74^{a}	2.73^{b}	65.02^{a}
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01
		Guava levels effect			
Gu 0%	2487.50^{a}	1557.38^{a}	62.48^{a}	2.57^{c}	66.71^{a}
Gu 5%	2379.17^{b}	1444.78^{b}	60.69^{b}	2.99^{b}	64.99^{b}
Gu 10%	2107.50^{c}	1169.65^{c}	55.43^{c}	3.29^{a}	59.97^{c}
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01
		Interaction effect			
Gu 0% free	2275.00^{c}	1385.83^{c}	60.91^{bc}	2.66^{d}	65.15^{b}
Gu 5% free	2260.00^{c}	1353.92^{c}	59.91^{c}	3.24^{b}	64.32^{b}
Gu 10free	1978.33^{d}	1070.52^{e}	54.13^{e}	3.61^{a}	58.81^{d}
Gu 0% ENZ	2700.00^{a}	1728.92^{a}	64.04^{a}	2.47^{e}	68.26^{a}
Gu 5% ENZ	2498.33^{b}	1535.65^{b}	61.46^{b}	2.74^{d}	65.67^{b}
Gu10%ENZ	2236.67^{c}	1268.79^{d}	56.73^{d}	2.97^{c}	61.14^{c}
Pooled SE	55.038	50.190	0.804	0.094	0.769
P value	<.0.01	<.0.01	<.0.01	<.0.01	<.0.01

$^{a, e}$ Means in the same Column having different superscript differ significantly.

TABLE 10. Carcass characteristics of male rabbits fed guava by-product supplemented with or without enzyme

Treatments	Kidney%	Liver%	Lung%	Heart%	Giblets%
		Enzyme supplementation effect			
Enz free	0.86	3.14^{a}	0.61^{a}	0.44	4.44^{a}
Enz supp	0.85	2.99^{b}	0.54^{b}	0.45	4.28^{b}
P value	0.23	<.0.01	<.0.01	0.81	<.0.01
		Guava levels effect			
Gu 0%	0.84	2.95^{c}	0.56^{b}	0.44	4.23^{b}
Gu 5%	0.85	3.01^{b}	0.58^{ab}	0.45	4.31^{b}
Gu 10%	0.87	3.24^{a}	0.60^{a}	0.44	4.55^{a}
P value	0.06	<.0.01	0.045	0.39	<.0.01
		Interaction effect			
Gu 0% free	0.85^{b}	2.96^{c}	0.58	0.43	4.23^{c}
Gu 5% free	0.84^{b}	3.11^{b}	0.63	0.46	4.41^{b}
Gu 10free	0.90^{a}	3.35^{a}	0.63	0.44	4.69^{a}
Gu 0% ENZ	0.85^{b}	2.93^{c}	0.5^{b}	0.45	4.22^{c}
Gu 5% ENZ	0.86^{b}	2.91^{c}	0.53	0.45	4.21^{c}
Gu10%ENZ	0.85^{b}	3.13^{b}	0.56	0.44	4.42^{b}
Pooled SE	0.006	0.038	0.011	0.004	0.043
P value	0.038	<.0.01	0.17	0.42	0.012

$^{a, e}$ Means in the same Column having different superscript differ significantly.

TABLE 11. Economic efficiency of male rabbits fed guava by-product treated with or without enzyme

	Treatments					
	Control		5 % Guava by-product		10 % Guava by-product	
Enzyme	-ve	+ve	-ve	+ve	-ve	+ve
Total feed intake(g)	8077	8183	7798	7937	7460	7811
Total gain g	1639	2175	1661	2051	1363	1704
Total feed cost (LE)	144.58	148.11	136.04	140.05	128.87	136.50
Revenue of total gain	196.68	261.00	199.32	246.12	163.56	204.48
Net feed revenue (LE)	52.10	112.89	63.28	106.07	34.69	67.98
Economic feed efficiency %	36.04	76.22	46.52	75.47	26.92	49.80
Relative Economic efficiency	100	211.50	129.09	210.17	74.69	138.20

Market price for 1-ton diets of –ve control was 17900 LE/ ton, +ve control was 18100 LE/ ton, –ve 5% guava by-product was 17445 LE/ ton, +ve 5% guava by-product was 17645 LE/ ton, –ve 10% guava by-product was 17275 LE/ ton, +ve 10% guava by-product was 17475 LE/ ton 1 KG multi-enzyme was 200LE, the price of 1kg live rabbits was 120 LE. Revenue of total gain (LE) = price of 1 Kg live body weight × total gain.Net feed revenue (LE) = revenue of total gain - total feed cost. Economic feed efficiency% =(Net feed revenue/ total feed cost) ×100

References

1. Bakshi, M.P.S., Wadhwa, M. and Makkar, H. P. S. Waste to worth: Vegetable wastes as animal feed. *CAB Rev.*, **11**, 1–26(2016).

2. Shurson, C. Gerald What a waste - can we improve sustainability of food animal production system by recycling food waste streams into animal feed in an Era of heath climate and Economic crises? *Journal of Sustainability*, **12** (17),7071(2020).

3. Khalifa, I. A. E. (2014). Utilization of some agriculture residues in food processing.M.Sc. Thesis, Faculty of Agric., Benha University.

4. Bernardino Nicanor, A., Ortiz Moreno A, Martinez Ayala, A. L., and Davila ortiz G. Guava seed protein isolate. Functional and nutritional characterization. *Journal of Food Biochemistry,* **25**, 77-90(2001).

5. Denny, C., Melo, P. S., Franchin, M., Massarioli, A. P., Bergamaschi, K. B., de Alencar, S. M. and Rosalen, P. Guava pomace: a new source of anti-inflammatory and analgesic bioactives. *BMC Complement Altern. Med.*, **13**, 235-242 (2013). . https://doi.org/10.1186/1472-6882-13-235.

6. EL-Manylawi, M. A. F. Response of growing New Zealand white rabbit to dietary date stone meal with or without commercial enzyme supplementation. *First International Scientific Conference for the Development of Date Palm and Dates sector in the Arab World.,* 899-908 (2011).

7. Gutiérrez, R.M.P., Mitchell, S. and Solis, R.V. *Psidium guajava*: A Review of Its Traditional Uses, Phytochemistry and Pharmacology. *Journal of Ethnopharmacology*, **117**, 1-27 (2008).

8. Labibah, B. A. Antioxidant activity of the peels of guava, papaya and pine apple. Final year project submitted in partial fulfilment of the requirements for the degree of Bachelor of Science (Chemistry) in the *Faculty of Applied Sciences Universiti Teknologi MARA.* (2009).

9. Sanda, K. A., Grema, H. A., Geidam, M. A. and Bukar-Kolo, Y. M. Pharmacological aspects of Psidium guajava. . *International Journal of Pharmacology*, **7**, 316-324 (2011).

10. Perez, J., Lebas, F., Parigi-Bini, R., Cossu, M., Carazzolo, A., Villamide, M. European reference method for in vivo determination of diet digestibility in rabbits. *World Rabbit Sci*., **3**, 41–43 (1995).

11. Association of Official Analytical Chemists, A.O.A.C. Official Methods of Analysis, **19th ed.**, *Arlington, V.A., USA.* (2005)

12. Van Soest, P.J., Robertson, J.B., Lewis, B.A. Methods for Dietary Fiber, Neutral Detergent Fiber, and Nonstarch Polysaccharides in Relation to Animal Nutrition. *J. Dairy Sci*., **74**, 3583–3597(1991). [CrossRef] [PubMed]

13. Noblet, J. Digestive and Metabolic Utilization of Feed Energy in Swine: Application to Energy Evaluation Systems. *J. Appl. Anim. Res*., **17**, 113–132 (2000).

14. Koracevic, D. Koracevic, G. Djordjevic, V. Andrejevic, S. and Cosic, V. Method for the measurement of antioxidant activity in human fluids. *J. Clin. Pathol*., **54**, 356-361 (2001).

15. Misra, H. P. and Fridovich, I. The role of superoxide anion in the autoxidation of epinephrine and a simple assay for superoxide dismutase. *Journal. Biol. Chem*., **247**, 3170–3175 (1972).

16. Paglia, D. E. and Valentine, W. N. Studies on the quantitative and qualitative characterization of erythrocyte glutathione peroxidase. The *Journal of Laboratory and Clinical Medicine,* **70** (1),158-169 (1967).

17. Ellman, G. L. Tissue sulfhydryl groups. *Arch. Biochem Biophys.*, **82**, 70-77 (1959).

18. Soliman, A. Z., El-Manylawi. M. F., Fatma G. A, Fatma T. F. A. Reproductive performance of New Zealand white rabbit does fed on diets containing corn distiller’s dried grains with soluble. *3rd Mediterranean Poultry Summit and 6th International Poultry Conference, 26 -29 March, Alexandria, Egypt*. (2012).

19. SAS Institute Inc. SAS-User’s Guide: Statistics. SAS Instute Inc., Cary, NC., USA (2006).

20. Duncan, D.B. Multiple ranges and multiple F-test. *Biometric.*, **11**,1(1955).

21. Abdel-Azeem, F. A. Studies on the effect of different crude fibre levels on laying Japanese quail (Coturnix Japonica). *Egypt. Poult. Sci. J*., **25**, 241- 257(2005).

22. Emam, R. M. S., Abused A. M. F, Abdel Wahed H. M., Ragab M. S, Effect of using Guava and olive waste with or without enzyme addition in the diets on growing Japanese quail. *Fayoum Journal of Agricultural Research and Development* (*Fjard*), **37**, (2), 310-334(2023).

23. Bikrisima, S. H. L., Mahfudz L. D. and Suthama.N. Production capacity of broiler chickens fed red guava fruit meal as source of natural antioxidant. *Egyptian J. Nutrition and Feeds,* **19** (3), 461-472 (2016). *http://repository.unhas.ac.id/handle/123456789/12617*

24. Lira, R. C. Rabello. C. B. V. Ferreira, P. V. Lana, G. R. Q. Ludke. J. V. and Dutra, W. M. Inclusion of guava wastes in feed for broiler chickens. *Rev. Bras. Zootecn.*, **38** (12), 2401-2409.(2009).

25. Aditya, H., Mahfuds L. D., Ismadi, V. D. Y. B. Effect of red guava fruit meal in diet on broiler fat content. *Anim. Agric. J.,* **2** (2), 41-48(2013).

26. Kamel, E. R., Abdel-Fattah, F, El-Qaliouby, H. S. and Mahmoud, E. A. A., Response of New Zealand rabbits to diet containing guava waste (*PsidiumGuaijava L.*): 1. Effect on growth performance, diet digestibility and economic efficiency. *Alexandria Journal of Veterinary Sciences,* July. **50** (1), 24-35. (2016)

27. Braga, A. P., Amâncio, A.V.A.F., Gonçalves, J.S., Assis, L.S.L.C., Souza C.M.S., Maia I.S.A.S. and Gerra, D.G.F., Ruminal degradability of agro-industrial fruit residues. Semina: *Ciências Agrárias, Londrina*, **37** (1), 279-292 (2016).

28. Oliveira, E.R., Monção F.P., Góes R.H.T.B., Gabriel A.M.A., Moura L.V., Lempp B., Graciano, D.E., and Tachetto, A.T.C. Degradabilidade ruminal da fibra em detergente neutro de gramíneas Cynodon spp. em quatro idades de rebrota. *Ruminant nutrition. Acta Sci., Anim. Sci.*, **36**(2), 22469(2014). https://doi.org/10.4025/actascianimsci.v36i2.22469

29. Oliveira, E.R., Monção F.P., Góes R.H.T.B., Gabriel A.M.A., Moura L.V., Lempp B., Graciano, D.E., and Tachetto, A.T.C. Degradação ruminal da fibra em detergente neutro de gramínea do gênero Cynodon spp. emquatroidades de corte. *Revista Agrarian, Dourados*, **6**,(20),205-214 (2013).

30. Ibrahim, O. A., Hyacinth A. A., Terzungwe, A. and Danie, O.L. Growth performance, hematological and serum biochemical profiles of West African Dwarf goats fed dietary guava leaf meal. *International Journal of Agriculture and Biosciences.* **5** (4), 188-191(2016).

31. Hassan, T. M. M., Abdel-Fattah, F. A. I., Farid A. S. and Kamel E. R. Effect of feeding guava waste on growth performance, diet digestibility, carcass characteristics and production profitability of Ossimi lambs. *Egypt. J. Nutr. Feed,* **19** (3),461-472. (2016).

32. Abdollahzadeh, F, Pirmohammadi, R., Farhoomand, P., Fatehi, F. and Pazhoh, F. F., The Effect of Ensiled Mixed Tomato and Apple Pomace on Holstein Dairy Cow, *Italian Journal of Animal Science,* **9**, 2(2010). https://doi.org/10.4081/ijas-2010.e41

33. Oliveira, M. D,.Carvalho Mello, H. H., Stringhini J.H., Mascarenhas A. g., Arnhold E., da Conceição E. C., da Silva Martins, J. M., Silva Júnior, A.J, Antioxidant effect of the guava by-product in the diet of broilers in the starter phase R. *Brazilian Journal of Animal Science*, R. *Bras. Zootec*, 47, e20160290. (2018).

34. El-Deek, A. A., Asar, M. A,. Hamdy, S. M,. and Abdalla, A. A,. Utilization of guava by- products in broiler finisher diets. *Egypt. Poult. Sci.*, **29**, 53-75 (2009).

35. North, M. O,. Commercial Chicken Production. Manual 2nd ed., *ANI publishing Company ING, USA.* 889-891(1981).

تأثير إستخدام منتجات الجوافة الثانوية مع أو بدون إضافه إنزيمية على أداء الأرانب النامية

أنوار السيد بخيت على[1]، فتحى عبد العظيم محمد[2] ، امل محمد عبد المجيد فايد[1] ، هانى على ثابت[2] و محمد إبراهيم عبد الله شراب[2]

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الملخص

تهدف هذه الدراسة إلى تقييم تأثير استخدام منتجات الجوافة الثانوية بدون أو بإضافة الإنزيمات على أداء النمو وهضم العناصر الغذائية وخصائص الذبيحة وبعض معايير الدم. تم تقسيم تسعين أرنبًا ذكرًا مفطومًا إلى ست معاملات. تم استخدام مستويين مختلفين من الجوافة (5٪ و 10٪) بالإضافة إلى مجموعة المقارنه (0٪) بدون أو بإضافة مخلوط إنزيمات بمستوى 1 جم / كجم في تصميم ذو اتجاهين (3*2). أظهرت النتائج زيادة معنويه في زيادة وزن الجسم وإجمالي الغذاء المأكول ودليل الأداء والكفاءه التحويليه الأفضل للمجموعات المضاف الإنزيم. سجلت الأرانب التي تغذت على مستوى أعلى من منتجات الجوافة الثانويه (10٪) أسوأ القيم من تلك التى في المستويات التجريبية الأخرى (0٪ و 5٪). كانت جميع المجموعات التي تغذت على مستوى أقل أو أعلى من منتجات الجوافة الثانوية مع الإنزيم أفضل من مجموعة المقارنه في جميع معايير الأداء. تحسنت القيم الغذائية وهضم جميع العناصر الغذائية بشكل ملحوظ في الأرانب التي تغذت على أنظمة غذائية تحتوي إما على مستوى منخفض من الجوافة أو الإنزيمات. لم تظهر الأرانب النامية التي تغذت على الجوافة المُضاف إليها إنزيم أو بدونه أي تأثير ضار على وظائف الكبد والكلى. إنخفضت اليوريا وقياسات بروتين الدم ومستوى الدهون بشكل ملحوظ في جميع المعاملات التجريبية مقارنةً بمجموعات المقارنه. سجّلت الأرانب التي تغذت على الجوافة سواءً مع الإنزيم أو بدونه قيم أعلى للجلوكوز فى الدم. كانت معايير مضادات الأكسدة في الدم لجميع المعاملات التجريبية أعلى من مجموعات المقارنه. أما الأرانب التي تغذت على جميع مستويات مُنتجات الجوافة الثانوية مع الإنزيم أو بتركيز 5% بدون إنزيم فقد سجّلت أعلى قيم للكفاءة الاقتصادية .

الكلمات الدالة: مخلفات الجوافة، الأداء الإنتاجي، الهضم، معاملات الدم، مضادات الأكسدة، الأرانب النامية.