Evaluation of Corn Stalks Treated Biologically with *Aspergillus niger* as feed for growing rabbits

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Abstract: A total of sixty-four male New Zealand White (NZW) rabbits weaned at 5 weeks of age, were randomly divided into four groups (sixteen rabbits/group) according to their initial live body weight (850 gm approximately to evaluate the possibility of feeding rabbits on diets containing corn stalks treated biologically with *Aspergillus niger* (*A. Niger*); and their response to growth performance, slaugher and carcass characteristics, edible organs as well as different blood parameters.The rabbits of the first three groups were fed on rations contained corn stalks treated biologically with *A. niger*, with 10%, 20% or 30% respectively, whilst those of the fourth group were give ration without *A. niger* (0% e.g. the commercial diet). At the end of the experimental period, three rabbits from each treatment were selected and slaughtered to study the different carcass characteristics. Blood samples were taken during slaughtering process in heparinized test tubes and centrifuged at 3000 rpm for 15 minutes, the plasma were collected and preserved in a deep freezer at -20°C until time of the analysis. The different blood plasma chemical parameters were calorimetrically determined using the proper commercial kits, following the same steps as described by the manufactures. All the results were subjected to analysis of variance. The most important results obtained in the present investigation could be summarized in the following points; 1). It was observed that the different biological treatments did not affect the live body weight gains. On the other hand, feed consumption had been influenced significantly by the treatment differences. 2).The present study showed that introducing biological treated corn stalks at the rate of 10% of the concentrate feed mixture improves feed conversion of growing rabbits. 3). The data of slaughter weight (SW), carcass weight (CW), empty body weight (EBW) and dressing percentage (DP) were not significantly affected by the different biological treatments. 4). With the exceptions of testis, no significant effects were detected in absolute or relative weights of edible organs. On the other hand, marked differential effects due to the biological treatments had been noticed on weights and percentages of testis. However, upon the basis of the present results one may suggest that the biological treatments may have on important role on the testis. 5). Results of the statistical analysis revealed that weights and percentages of the different carcass cuts were not significantly affected by the biological treatments. 6). No significant effects were detected in blood constituents of the experimental rabbits due to the different biological treatments. Likewise, it was observed that the data of the present investigation lies within the normal levels. 7). It was concluded from the present study that the biological treatments used in the present experiment have no deleterious effects on the liver and kidneys functions since levels of blood chemical constituents were not significantly changed. 8).Finally upon the basis of the obtained results, it could be suggested that *A. niger* can be used safely and successfully to enrich poor quality roughages such as corn stalks. [Journal of American Science. 2010;6(10):355-363]. (ISSN: 1545-1003).

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1. Introduction

In many tropical and sub-tropical countries, there is a gap between available and required animal feeds. Moreover, the competition between humans and livestock on concentrates is very obvious. Therefore, improving the nutritive value of poor quality roughages e.g. stalks, straws and other fibrous agricultural by-products might be one solution for this problem.

However, at the present time, most of these low quality roughages are not only wasting natural resources, but also an important source of environmental pollution. Therefore, legal laws are already being taken in many countries in the world to forbidden and ban the burning of stalks, straws and stubbles from grasses, grains, fruits and other crops.

In summary, however, in many developing countries, animals suffer from shortages of feed that are continuously increasing in their costs. At the same time, many thousand tons of agricultural wastes and residues per year are produced from processing of fruits and vegetables.

However, in Egypt, there are about 22 million tons of plants by products produced annually. However, although rice straw and wheat straw are already being fully utilized by many farmers, either for feeding livestock or for bedding poultry farms, yet corn stalks is not being studied on large scale.

While, the problem of feeding stalks and other fibrous by-products to animals, which limits their use in animal ration can be summarized in the following statements: high crude fiber content; low protein content, low digestibility and poor feed palatability. Therefore, biological, chemical and physical treatments can be used.

Moreover, corn is considered as an important main summer field crop in Egypt and occupies a large area of available cultivated land. Therefore, corn stalks had been selected to be investigated as one of the most important low quality roughage used as an untraditional animal feeds to increase its protein content by the biological treatment. Likewise, the aim of the present investigation was to study influence of feeding biologically treated corn stalks on growth performance carcass traits and blood components of growing rabbits.

2. Material and Methods

The present experiment was carried out at the faculty of Agriculture, Banha University, Moshtohor. The chemical analysis and the microbiological studies of the present investigation were carried out at the laboratories of National Research Centre (NRC) and the medical service unit (MSU) of NRC, Dokki, Egypt.

The main objective of the present trial was to study effect of feeding biological treated corn stalks with *Aspergillus niger* on growth performance, feed conversion, carcass characteristics and blood plasma constituents of growing Newzealand white rabbits.

The biological treatments:

(a) *Aspergillus niger* enrichment**:**

A heap of 10 kgs. chopped corn stalks (CS) was treated with 400 ml. standard inoculums of *Aspergillus niger* and following additives were added to the treated corn stalks:

250gm. Molasses, 100gm. Urea, 100 gm. Super phosphate, 100 gm. Ammonium sulfate, 250 gm Sodium chloride, 50 gm. active dry yeast (*Saccharomyces cevervisiae*) and 20 liters water to keep the moisture content at about 66%. The composting heap was covered with polyethylene sheets and left for 14 days. The protein was analyzed.

(b) Inoculum preparation:

pure culture of *Aspergillus niger* preserved on potato dextrose agar (PDA) solution was employed for laboratory inoculum preparation as follows:

The culture was renewed on PDA medium, then incubated for 72 hrs. at 28°C $\pm$ 2. Ten ml. Sterilized water was used to crush fungal growth to be used as inoculum at 10% (v/w). 500 ml. of conical flasks each containing 25 gm sugar beet pulp (SBP) moistened at solid liquid ratio 1:2 with solution containing (g/L) urea, 2.0 Ammonium sulphates 2.0 potassium hydrogen phosphate, 2.0 magnesium sulphate, 0.05 and 50 gm. sugar cane molasses. The flasks were autoclaved at 121°C for 30 minutes. The cooled sterilized flasks was inoculated then incubated at room temperature 30°C $\pm$ 2 for 72 hrs.

(c) Propagation of fungal inoculum:

Five liters flasks capacity each containing 300 gm. sugar beet pulp (SBP) moistened at solid: liquid ratio 1:2 with the same above nutrient solution. The sterilized flasks were inoculated with fungal growth obtained from previous step at 10% (w/w), then incubated at room temperature 30°C $\pm$ 2 for 5 days.

(d) Scalling up the biological treatment:

The prepared corn stalks in all biological steps were moistened with nutrient solution at solid: liquid ratio 1:2 containing urea 1.5%, ammonium sulphate 1.0%, magnesium sulphate 0.05%, molasses 2.5% and active dry yeast ***S. cevervisiae*** F.25 0.01%. The following steps were applied:

1- Ten kg of prepared corn stalks was inoculated with above prepared inoculum at 10% (w/w) and incubated in polyethylene bags 75x120 cm on room temperature for 7 days.
2- The fermented corn stalk from the first step was mixed with 90 kg. moistened corn stalks, then left to ferment for ten days at room temperature.
3- Fermented corn stalk from the second step was well mixed with 400 kg. Prepared corn stalks and left to ferment for ten days at room temperature. The corn stalks treated was down up day after day to end of biological period.

The obtained product was air dried, preserved to analysis for using in feeding trials.

Manufacturing the pelleted feed:

The air dried compact have been transferred to the feed mill (the united company) for preparing the experimental pelled feed by substitution of berssem hay with corn stalks treated biological with *Aspergillus niger* at the rate of 33%, 66% from berseem hay, in addition to 100% (complete substitution of berseem hay with corn stalks).

Animals used:

Sixty four New Zealand white weaned rabbits of five weeks old were allocated into four equal groups of 16 rabbits in each with nearly similar initial weight. The animals were housed individually in galvanized wire hutches of rabbit batteries.

The rabbits were offered a commercial diet for about seven days before starting the trial. The experimental rations were offered ad.lib. twice daily at 9.00 a.m. and 3.00 pm. in addition to fresh water which was available all time. Residuals of feed were weighed daily and then subtracted from the offered amounts to obtain the actual accumulated feed consumed per week. The rabbits were individually weighed to the nearest five grams every week before morning meal during the experimental period.

Feeding treatments:

Four experimental diets of iso-nutritive value but differ in their components according to the purpose of the present study were formulated. The experimental diets were adjusted to cover the nutrient requirements of growing rabbits according to the NRC, (1977) recommendations. The experimental animals were fed on complete diets contained different amount of biologically treated corn stalks in combination with berseem hay.

The chemical analysis of the experimental diets:

The chemical analysis of the experimental diets were determined as described by Association of Official Analytical Chemists (AOAC, 1990).

The slaughter experiments and carcass characteristics:

At the end of the experimental period, three representative rabbits from each feeding group were randomly taken to study the different carcass characters. Those animals were fasted for approximately 12 hours before slaughtering and then individually weighed and slaughtered by severing the neck with a sharp knife according to the Islamic religion. Empty body weight (EBW) was obtained as stated in the following equation:

EBW = body weight (BW) – (full digestive tract – empty digestive tract)

The dressing percentage (DP) was calculated based on empty body weight (EBW); e.g. DP = CW/EBW. After skinning the carcass, the different edible organs (e.g. liver, kidneys, heart, spleen, lungs and testis) were separated and weighed. The weights and percentages of these edible organs relative to empty carcass weights (EBW) were calculated.

Chemical analysis of blood samples:

Blood samples were taken during slaughtering process in heparinized test tubes an centrifuged at 3000 rpm for 15 minutes, the plasma were collected and preserved in a deep freezer at -20°C until the time of analysis. Various blood plasma chemical parameters; e.g. GPT, GOT, alkaline phosphatase, uric acid, creatinine, total lipids and cholesterol were colorimetrically determined using commercial kits following the same steps as described by manufactures.

Statistical Analysis:

Data of all variables were statistically analyzed according to user's Guide SAS (1996). The model used was:

$Y_{ij} = \mu + T_i + E_{ij}$

Y_{ij} = the observation of ij

μ = The overall mean

T_i = The effect of i (treatments).

E_{ij} = the experimental random error.

Data of percentages were subjected to arc-sine transformation to approximate normal distribution before being analyzed. Variables having significant F-test were compared using Duncan's multiple range test (Duncan, 1955). All statements of statistical significance were based on probability ($P < 0.05$).

3. Results and Discussion

Effect of fungal treatments on chemical constituents of corn stalks.

The chemical analysis of untreated and treated corn stalks with *Aspergillus niger* and the chemical components of the experimental rations are presented in table (1), whilest the composition of the experimental rations (%) are presented in table (2), it is interested, to mote from the present results (table 1) that there is improving in both crude protein and nitrogen free extract percentages and decreasing in crude fiber content of biologically treated corn stalks. However, the most probable explanations of the increasing in protein content of biologically treated corn stalks may be due to the release of water soluble sugar from polysaccharides might have led to faster growth of fungus which in turn resulted in higher crude protein content or may be due to the release of addition of basal mineral media containing nitrogen salts as has been suggested by Grajek (1988) and Garcia *et al*., (1993).

On the other hand, it would be of interest, however, to note that the decreasing in crude fiber content of biological treated corn stalks in comparison with untreated ones may be due to the utilization of crude fiber by the fungi for their growth since fungi among the microorganisms which have capability in decomposing different agricultural by-products as had been suggested by Kim *et al*. (1985).

Effect of the biologically treated corn stalks on growth performance of the experimental animals:

Table (3) shows the influence of using different percentages of the biologically treated corn stalks on the growth performance of the experimental rabbits. It is interesting, however, to state that the initial live body weights of the rabbits ranged from 845.0 gm to 868.0 gm (± 24.01), the differences were non-significant. It is of special interest, however, to note that the biological treatments did not affect significantly the live body weight gains.

It is worth mentioning that, the disappearance of the significant effect may be due to the existence of great individual variations within treatment in the experiment. However, the demonstration of such variations, would require to use number of animals so large as to minimize the individual variations and experimental error.

Worthy of note is that, the daily body weight gains wee ranged between 14 gm/day to 16 gm/day ($\pm$ 0.59) as shown in table (3). The present results, however, are compatible with those of El-Adawy *et al*. (2001), El Sayaad *et al*. (2009), El Shahat *et al*. (2006) and Khayyal *et al*. (2009) using the same breed (e.g. Newzealand white rabbits).

On the other hand, results of the present work are somewhat lower than those stated by El Sayaad *et al*. (1996) and Soliman *et al*. (2000). However, differences in managements, ages of animals, feeding treatments and other environmental conditions may be account for the lower data obtained in the present experiment.

It would be of interest, however, to observe that feed intake had been influenced significantly ($P \leq 0.05$) by the different percentages of the biologically treated corn stalks (Table 3). The present results however, revealed that the rabbits raised under treatment two consumed the least amount of rations. However, the most probable explanation for this observation is that the partly replacement of 20% berseem hay by treated corn stalks with (*A. niger*) may depress appetite of rabbits.

On the other hand, the animals reared on untreated biologically diet (treatment four) consumed the greatest amount of ration. Based upon the present results, however, one may suggest that the untreated biologically diet may be more palatable to rabbits then the other ones and increase the appetite of animals.

Results of feed conversion (Table 3) revealed that the animals reared under treatment one were the best, whilst those raised on the untreated diet were the poorest. However, upon the basis of the present finding, it is comprehensible to suggest that he biological treatment may improve feed conversion efficiency.

Effects of the biological treatments on same carcass aspects.

(i) Effect on slaughter weight carcass weight, empty body weight and dressing percentages.

The mean values of slaughter weight (SW), carcass weight (CW), empty body weight (EBW) and dressing percentages (DP) as affected by the different biologically treatments are shown in table (4).

Worthy of note is that mean values of slaughter and carcass characteristics were not affected by the different biological treatments. Based upon the present results, however, one may suggest that differences in crude fiber content of the experimental rations did not show any significant effect on these slaughter and carcass traits.

However, the present suggestion is in accordance generally with those of Anber (1986), Khashaba (1988), Soliman *et al*. (2000) andEl Shahat, *et al*. (2006) who noticed that differences in crude fiber levels did not show any significant effect on those slaughter and carcass characters of rabbits.

The present results, however, elucidate also that carcass weight were increased in the groups exhibiting heavier slaughter weights. However, empty body weight is considered to be valuable character in comparing animals of different treatments because variations in gut "fill" are eliminated. However, the value of excluding gut "fill" lies in the fact that, not only does it vary, with the environment, feeding treatments, etc, but it also represents an increasing proportion of the live body weight as an animal gets older and heavier.

It would be of interest, however, to state that the dressing percentage is a factor of obvious important in evaluating the product from animal production experiments. However, the weights of the contents of the digestive tract which termed the "fill" is generally an uncontrolled variable and introduces an unknown error in the individual case, as had been mentioned previously. However, it is possible to obtain dressing percentage which involves no error from "fill". This is done by calculating carcass weight (CW) as a percentage of empty body weight (EBW). There is much in favour of this method for determing dressing percentage. Therefore, in the present investigation the dressing percentage (DP) is determined by this method, e.g. carcass weight (CW) as a percentage of empty body weight.

It is of special interest, however, to state that the dressing percentage is of considerable importance, since it determines to much extent the output of edible tissues from an animal.

The present results showed clearly that the mean values of the dressing percent aged ranged from 51.57 to 61.23 with no significant differences among the different treatments. The present data, however, are compatible generally with those of Ayyat *et al*. (2003), Radwan (2002), Purnima *et al*., (2003), El Shehat *et al*. (2006) and Khayyal *et al*. (2009). On the other hand, the present values of the dressing percentages are somewhat higher than the reported by Ghazalah and El Shahat (1994), who reported ranges between 40.6% to 47.7% for rabbits. However, it is worth to state that their values were calculated relative to slaughter weight and this explains the depression of their data compared to the obtained results of the present investigation.

(ii) Effects on edible organs of carcasses:

Mean values of weights and percentages of edible organs relative to empty body weight (EBW) as affected by the different biological treatments are presented in Table (5).

It is worth noting that with the exception of weight and percentages of testis, the results revealed that no significant effects (P>0.05) were detected in absolute or relative weights of edible organs of rabbit carcass due to the different biological treatments used in the present investigation.

The pattern of the present results are compatible generally with those of Abdel Razik (1996), Soliman *et al*. (2000), El Shahat *et al*. (2006) and Abdel-Azeem and El-Bordeny (2007) in showing that absolute and relative weights of edible organs of rabbits carcasses were not affected by different dietary treatments. However, until quite recently no detailed studies had been made on the influence of different biological treatments on carcass characteristics of growing animals. In the future, attention should be directed to this new scientific field. However, it seems that further experimental works are required before definite conclusion can be stated. Finally, based upon the results of the significant effects of different feeding treatments on weights and percentages of tests; one may suggest that the biological treatments may have an important role on tests. The mean weights and percentages of the different carcass cuts as affected by the feeding treatments are presented in table (6). Duncan's multiple range test is shown in the same table.

It is worth noting, however, that the different carcass cuts were not affected by the biological treatments. However, the most interesting features of the results at hand, is that the hind legs had the biggest proportion (34.05 – 36.02) of the carcass, followed by the boin cuts (24.70-27.03) then the thoracic cage (20.85-23.25), while the fore legs cuts had the smallest proportion (15.98-17.30).

In this context, it should be draw the attention to the fact that, the parts of the carcass containing the thickest muscular cuts such as the hind legs and the loin should make up high proportion of the carcass, whilst the fore legs and thoracic cage should be relatively low.

It is worthy noting, however, to state that the high priced carcass cuts; e.g. the loin and the hind legs are more desirable by the consumers, representing nearly 59%-62% of the whole carcass weight. The present results, however, are in agreement generally with those of Radwan (2002) Pournima *et al*. (2003) and El Shahat *et al*., (2006).

Effects on the chemical analysis of blood plasma parameter:

The mean values of the chemical analysis of blood plasma parameters of the experimental animals as affected by the biological treatments are presented in table (7).

The statistical analysis, however, revealed that the mean values of the different blood parameters were not affected significantly by the biological treatments. Based upon the present results, however, one may suggest that the different biological treatments used in the present investigation may not affect the blood plasma components of rabbits. Likewise, upon the basis of the present data, one may conclude that biological treatments used in present study may have no deleterious effects on liver and kidneys functions since levels of blood chemical analysis values were not significantly changed.

The present data, however, are generally compatible with those reported by Chiericato *et al.* (1985) El-Gaafary *et al.* (1992), Tawfeek, *et al.* (1994), Hillyer and Quesenberry (1994), Mouse and Abdel Sammea (2002) Morad (2005) and Abdel-Azeem and El-Bordeny (2007). On the other hand, the present results, however, are same, what lower, then those observed by Soliman *et al.* (2000). However, the differences in feeding treatments, management and other environmental factors may account for the differences observed between the two experiments.

However, the amount of knowledge relating to the effect of biological treatments on blood chemical analysis of rabbits is very scanty. However, in the future further investigations in this very open field of scientific work are required to supply such important additional knowledge's.

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Table (1): Chemical analysis of untreated, treated corn stalks and complete rabbit diets.

Item	Chemical constituents on DM besis						
	DM	OM	CP	Ash	CF	EE	NFE
Corn stalks	93.76	89.51	4.61	10.53	44.51	3.45	36.79
Biologically treated corn stalks (B.T.C.S.)	89.60	81.40	15.07	17.55	24.75	0.72	42.95
Complete animal diets							
	DM	OM	CP	Ash	CF	EF	NFE
Ti (10% B.T.C.S.)	92.05	89.75	14.30	10.25	18.54	1.60	54.28
T2 (20% B.T.C.S.)	92.73	89.30	14.71	10.75	18.35	1.87	53.53
T3 (30% B.T.C.S.)	92.30	88.91	14.65	11.30	18.62	1.06	51.75
T4 (Control, 0% B.T.C.S.)	92.68	89.01	14.79	11.21	18.03	1.71	50.97

DM: dry matter O.M. Organic matter
CP: Crude protein C.F.: Crude fiber
EE: ether extract NFE: Nitrogen free extract
B.T.C.S. = Biologically treated corn stalks.

Table (2): Ingredients constituents of the experimental diets (%).

Ingredients %	Experimental rations %			
	T_1 (10%)	T_2 (20%)	T_3 (30%)	Control
Yellow corn	18.00	18.00	18.00	18.00
Barley	7.4	7.4	7.4	7.4
Berseem hay	20.00	10.00	0.00	30.00
Treated corn stalks	10.00	20.00	30.00	0.00
Soybean meal	12.00	12.00	12.00	12.00
Wheat bran	20.00	20.00	20.00	20.00
Sun flower meal	7.00	7.00	7.00	7.00
Sodium chloride	0.30	0.30	0.30	0.30
Lime stone	2.00	2.00	2.00	2.00
Vitamins and minerals(*)	0.20	0.20	0.20	0.20
Molasses	3.10	3.10	3.10	3.10
Total	100.00	100.00	100.00	100.00

* Kg. of Vitamines and minerals premix contained Vit. A2000000. IU; Vit. D_3 150000 IU; Vit. E 8.33g; Vit. B_1 0.33g; Vit. B_2 1.00g; Vit B_4 0.33; Vit. B_6 8.33g; Vit. B_{12} 1.70 mg; Panto thenic acid 3.33g; Biotine 33mg; Mg 66.70g. Folic acid 0.83g; Choline chloride 200g; Zn 11.70 g., Fe 12.50g; Cu 0.50 g; Se 16.60 mg and Mn 5.00g.

Table (3) Influence of treated corn stalks on growth performance, feed consumption and feed conversion of the experimental animals.

Items	Experimental rations %					
	T1 (10%)	T2 (20%)	T3 (30%)	T4 (Control)	+ S.E.	Significances
Initial weight (gm).	868	851	845	857	24.01	N.S.
Mean weights at the end of the experiment (gm.)	2212	2027	2015	2201	29.05	N.S.
Total body weight gains (gm.)	1344	1176	1260	1344	25.10	N.S.
Daily body weight gain (gm.)	16.00	14.00	15.00	16.00	0.59	N.S.
Daily feed intake (gm.)	89.60a	82.88a	97.50b	108.00b	2.27	*P
Feed conversion (feed intake/BWgain)	5.60a	5.92ab	6.50b	6.75b	0.12	*P

Means within the same row with different superscripts are significantly different.
NS = not significant * P = significant at ($P < 0.05$).

Table (4) Mean values of slaughter and carcass characteristics of the experimental animals as influenced by feeding different levels of biologically treated corn stalks.

Experimental groups / Characters	T_1 (10%)	T_2 (20%)	T_3 (30%)	T_4 (Control)	± S.E.	Significances
Slaughter Wt. (gm)	2201	2011	1880	2180	68	N.S.
Carcass Wt. (gm)	1150	981	935	1210	40	N.S.
EBW (gm)	1962	1828	1813	1976	57	N.S.
DP	58.61	53.67	51.57	61.23	0.65	N.S.

EBW: Empty body weight. DP: dressing percentage. NS: non-significant.

Table (5) Weights and percentages of edible organs relative to empty body weight (EBW) as affected by different feeding treatments.

Experimental groups / Characters	T_1 (10%)	T_2 (20%)	T_3 (30%)	T_4 (Control)	± S.E.	Significances
EBW (gm.)	1962	1828	1813	1976	57	N.S.
Lungs weight (gm.)	12.82	12.33	12.15	12.91	0.73	N.S.
Lungs/EBW (%)	0.56	0.67	0.67	0.65	0.01	N.S.
Heart Weight (gm.)	6.83	5.75	5.59	7.01	0.35	N.S.
Heart/EBW (%)	0.35	0.31	0.31	0.35	0.02	N.S.
Spleen Weight (gm.)	5.75	6.03	5.45	6.50	0.57	N.S.
Spleen/EBW (%)	0.29	0.33	0.30	0.33	0.02	N.S.
Kidneys Wt. (gm.)	17.34	15.57	13.75	18.22	0.98	N.S.
Kidneys/EBW (%)	0.88	0.85	0.75	0.92	0.03	N.S.
Liver weight (gm.)	46.12	45.50	42.33	47.25	3.75	N.S.
Liver/EBW (%)	2.35	2.49	2.33	2.39	0.10	N.S.
Testis weight (gm)	9.14^{a}	8.12^{b}	7.50^{b}	10.95^{a}	0.65	*P
Testis/EBW (%)	0.47^{a}	0.44^{b}	0.41^{b}	0.55^{a}	0.05	*P

a and b: Means in the same row having different superscripts differ significantly (P<0.05).
NS: not significant *P: significant at 5% level.

Table (6): Mean weights and percentages of carcass cuts as affected by the different levels of biologically treated corn stalks.

Treatments / Carcass cuts	T_1 (10%)	T_2 (20%)	T_3 (30%)	T_4 (Control)	± S.E.	Significances
Carcass Wt. (gm.)	1150	981	935	1210	40	N.S.
Thoracic cage						
Weight (gm.)	239.78^{b}	228.08^{a}	211.78^{a}	268.62^{c}	8.7	N.S.
%	20.85	23.25	22.65	22.20	0.25	N.S.
Loin:						
Weight (gm.)	310.85^{a}	242.31^{b}	243.18^{b}	312.18^{a}	12.50	N.S.

%	27.03	24.70	26.00	25.80	0.75	N.S.
Fore-legs:						
Weight (gm.)	196.65[a]	164.32[b]	161.76[b]	193.36[a]	4.50	N.S.
%	17.10	16.75	17.30	15.98	0.65	N.S.
Hind legs:						
Weight (gm.)	402.73[a]	346.29[b]	318.37[b]	435.84[a]	21.70	N.S.
%	35.02	35.30	34.05	36.02	0.83	N.S.

a,b and c: means in the same row having different superscripts significantly differ at (P < 0.05).
SE: standard errors. NS: non-significant

Table (7): Blood plasma components of the experimental rabbits as affected by the different feeding treatments.

Treatments / Blood plasma Constituents	T_1 (10%)	T_2 (20%)	T_3 (30%)	T_4 (Control)	± S.E.	Significances
Liver function						
GPT (U/L)	68.95	73.85	79.50	65.93	7.75	N.S.
GOT (U/L)	133.27	110.95	142.53	99.97	9.30	N.S.
Alkaline phosphatase (IU/L).	68.55	65.73	60.95	70.12	3.95	N.S.
Kidneys Function						
Urea-N (mg/dl.)	46.93	51.67	55.75	62.10	4.51	N.S.
Creatinine (mg/dl.)	1.37	1.51	1.03	1.42	0.05	N.S.
Uric acid (mg./dl.)	0.53	0.65	0.43	0.76	0.08	N.S.
Fat Fractions						
Total lipids (mg/dl).	70.35[c]	63.57[a]	61.95[a]	65.00[b]	2.93	N.S.
Total cholesterol (mg/dl.)	69.45[a]	73.56[b]	65.91[a]	81.05[c]	3.70	N.S.

a,b, and c: Means in the same row having different superscripts differ significantly at P< 0.05. NS: Non significant.

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