El-Kady et al. Bulletin of the National Research Centre (2019) 43:77
https://doi.org/10.1186/s42269-019-0110-1

Bulletin of the National Research Centre

RESEARCH Open Access

Effect of feeding rabbits on fungal treated corn stalks on carcass characteristics and meat composition

Roshdy I. El-Kady, Ashraf A. A. Morad, Abdelmegid A. Abedo* and Ali A. El-Shahat

Abstract

Background: Corn stalk as low quality roughage is high in lignocellulytic materials and low in readily available carbohydrates and nitrogen as well as several minerals. Intake and utilization of it can be increase by applying some treatments; physical, chemical, and biological methods, biological method shows the most effective method. This study aimed to evaluate the effect of replacing clover hay (it is high quality roughage in Egypt and high price) by fungal treated corn stalks with *Trichoderma ressei* on carcass characteristics and meat analysis of rabbits. Forty-two weaned New Zealand white rabbits were divided to two groups. The first group (24 rabbits) was divided into 4 subgroups (6 each), and were fed diets contained 0% corn stalks (control), 33, 66, and 100% treated corn stalks with media only (without *Trichoderma ressei*). The second group (18 rabbits) was divided into 3 subgroups (6 each), and were fed diets contained 33, 66, and 100% fungal treated corn stalks with *Trichoderma ressei* as replaced of clover hay (11, 22, and 33% of whole), each group was divided into 3 replicates (2 each). At the end of the trial, 3 rabbits from each group were slaughtered to derermine carcass characteristics and chemical composition of meat.

Results: There were no significant differences in values of dressing percentages either between treatments or levels. Also, the interaction between treatments and levels were no significant. Feeding fungal treated corn stalks did not significant effect on dry matter (DM), crude protein (CP), and ether extract (EE), while significant($P < 0.05$) increased ash content compared with without *Trichoderma reesei*. And feeding 100% corn stalks recorded ($P < 0.05$) the highest value compared with levels 33 and 66%. The interaction between treatments and levels on CP, EE, and ash was significant, the results pointed that fed level of 66% treated corn stalks was significant ($P < 0.05$) increased CP content compared with 66% without *Trichoderma reesei*. Also fed level of 100% treated corn stalks was recorded ($P < 0.05$) the highest value of ash content compared with level of 66% treated CS and with levels of 33, 66, and 100% without *Trichoderma reesei,* respectively. While fed treated corn stalks at 66% significant ($P < 0.05$) decreased EE content compared with feeding level of 66% without *Trichoderma reesei*. But, there were no significant difference in DM content. It could be concluded that treated corn stalks with fungi could be used without any adverse effects and enhance carcass characteristics and chemical composition of rabbits meat.

Keywords: Fungal treatment, Carcass characteristics, Meat composition, Rabbits

* Correspondence: abedoaa@yahoo.com
Animal Production Department, National Research Centre, 33 El Bohouth St., Dokki, Giza P.O. 12622, Egypt

Background

In Egypt the farm animals suffer from shortage of feeds and, also, are continuously increasing in prices. However, annually many million tons of agricultural by-products are producing from fields and processing of vegetables and fruits. Annually, in Egypt about 25 million tons from agricultural by–products produced (MALR 2008). The nutritive value of agricultural by-products can be enhanced through their biological treatments. It was estimates that about 13.0 million tons of total digestible nutrients (TDN) are required per year in Egypt, while only 9.6 million tons are annually produced providing 75% of livestock energy requirements (AESI 2011).

Corn stalk as low quality roughage is high in lignocellulytic materials and low in readily available carbohydrates and nitrogen as well as several minerals. Also, its utilization is limited as a result of low feed intake by the animals and high transportation cost, being bulky (Rissanen et al. 1981 and Abedo 2011).

A great deal of research was carried out to increase use of this by–products and increasing its feeding value. Intake and utilization of such roughages can be increase by supplementation with some nutrients or by applying some treatments; physical, chemical, and biological methods (Rangnekar et al. 1982 and Cheeke 1987). Biological method shows the most effective method among the different methods (Deraz and Ismail 2001; Morad 2005 and Abd El-Hakim et al. 2006 and Abedo 2011).

Morad (2005) and Abd El-Hakim et al. (2006) stated that feeding biological treated corn stalks and rice straw did not significant effect on dressing percentage of rabbits, while El-Badawi et al. (2007) reported that feeding biological treated sugar beet pulp significant increased dressing percentage for rabbits.

Morad (2005), Abd El-Hakim et al. (2006), and El-Badawi et al. (2007) reported that chemical composition of rabbits meat was significant affected by feeding biological treated rice straw and sugar beet pulp. Hernandez et al. (2000) mentioned that rabbit can be contribute to solve the meat shortage in developing countries, because rabbits have rapid growth rate, high fertility, short gestation period, short generation intervals, high feed efficiency, early marketing age, high muscle bone ratio, also, its meat has high protein, low fat and cholesterol contents.

This study aimed to study effect of replacing clover hay (it is high quality roughage in Egypt and high price) by fungal treated corn stalks with *Trichoderma ressei* on carcass characteristics and meat composition for growing rabbits.

Materials and methods

Microorganisms

Trichoderma ressei was obtained from Agriculture Microbiology Department, National Research Centre, Dokki, Giza, Egypt.

Mycotoxin determination

Thin layer chromatography for determination of mycotoxin of treated material was applied according to the method described by AOAC (2000) and Fadel et al. (1992).

Fungal treatment

Three-day old slants cultures of *Trichoderma ressei* was crushed into conical flasks containing 20 ml sterilized water, the fungal spores suspension used as inoculant at 10% *V*/*W* to inoculate 25 g ground corn stalks moistened at 1:2 solid: liquid ratio in 500 ml capacity conical flasks with medium consists of 0.2% urea, 0.02% potassium di-hydrogen phosphate, 0.03% magnesium sulfate, and 4.0% sugarcane molasses, the inoculated flasks were incubated for 72 h. at 30 °C. The previous inoculate used to inoculate 500 g moistened corn stalks with the previous medium at 1 solid: 2 liquid at 10% *V*/*W* then packed in 50 × 100 cm polyethylene bags. The inoculated bags were incubated for 10 days at room temperature (30 ± 2 °C) according to Fadel et al. (1992).

One hundred and sixty kg chopped corn stalks equally divided to two heaps. The first heap moistened at 1 solid: 2 liquid with medium consists of (%); 1.5 ammonium sulphate, 2.5 urea, 1.0 supper phosphate, 0.5 magnesium sulphate, and 2.5 molasses, mixed well and then spread on plastic sheet without *Trichoderma reesei*. The second heap moistened with the same medium and inoculated with the above prepared inoculant of *Trichoderma reesei* at 10%, mixed well, then spread on plastic sheet. The two heaps shuffled upside down daily for 2 weeks (the proper fermentation period). At the end of fermentation period, the treated corn stalks was exposed to sun dry until its moisture reached to less than 10%, then packed and stored until use it to manufacturing the experimental pelleted diets.

Experimental diets

Dried treated corn stalks without and with *Trichoderma reesei* were used to formulate the experimental diets by replacing clover hay at 0, 33, 66 and 100% (0, 11, 22, and 33% of whole diet, respectively). 7 diets were formulated to be iso-caloric and iso-nitrogenous and to cover the nutrients requirements for growing rabbits according to NRC (1977) recommendation as presented in Table 1.

Animals and feeding trials

Forty-two weaned New-Zealand white rabbits, weighted 500 g ± 90 g and aged 6 weeks were randomly divided into two groups. The first group (24 rabbits) was divided into 4 subgroups (6 each), and were fed diets contained 0% corn stalks (control), 33, 66, and 100% treated corn stalks with media only (without *Trichoderma ressei*). The second group (18 rabbits) was divided into 3 subgroups (6 each),

Table 1 Formulation of the experimental diets

Component	0% (Control)	Diets					
		Without *T. ressei*			With *T. ressei*		
		33%	66%	100%	33%	66%	100%
Barley	14.46	2.00	1.50	1.50	2.00	1.50	1.50
Yellow corn	15.75	31.00	39.35	38.75	31.00	39.35	38.75
Wheat bran	16.50	11.00	0.60	0.60	11.00	4.25	5.25
Soybean meal	17.40	19.65	21.65	21.65	19.65	18.00	17.0
Clovr hay	33.00	22.00	11.00	–	22.00	11.00	–
Corn stalks	–	11.00	22.00	33.00	11.00	22.00	33.00
NaCl	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Calcium Di-phosphate	2.05	2.40	2.85	3.05	2.40	2.85	3.05
Lime stone	0.10	0.20	0.25	0.60	0.20	0.25	0.60
Premix *	0.30	0.30	0.30	0.30	0.30	0.30	0.30
L.Meth.	0.04	0.05	0.10	0.15	0.05	0.10	0.15
Calculated**							
Digestible energy, K cal/Kg	2513	2503	2495	2412	2518	2501	2425
Ca	1.08	1.04	1.01	1.03	0.970	0.92	0.96
P	0.80	0.80	0.79	0.80	0.82	0.79	0.83
Na	0.20	0.19	0.18	0.17	0.17	0.18	0.17
Lysine	0.89	0.85	0.80	0.74	0.85	0.71	0.63
Methionine	0.55	0.57	0.57	0.58	0.56	0.46	0.54

*Each kg contains; 2000 IU Vit. A, 0.33 g Vit. B_1, 1.09 Vit B_2, 150 IU Vit B_3, 8.33 g Vit E, 0.33 g Vit K, 3.33 g pantothemic acid, 30 g nicatonic acid, 2 g Vit B_6, 1.7 mg Vit. B_{12}, 0.039 folic acid, 33 mg biotin. 0.50 g Cu, 200 mg cholin chloride, 5.0 g Mn, 12.5 g Fe, 66.7 mg Mg, 1.33 mg Co, 16.6 mg Se, 11.9 Zn, 16.6 mg Iodine, and 10.0 g Antioxidant
**according to Cheeke (1987) using the following equation: DE = 4.36–0.0491 x NDF%

and were fed diets contained 33, 66, and 100% fungal treated corn stalks with *Trichoderma ressei* as replaced of clover hay (11, 22, and 33% of whole), each group was divided into 3 replicates (2 each). The experimental animals groups were fed the pervious experimental diets for 91 days. All animals were housed in metal battery cages (2 rabbits each) and kept under the same managerial and hygienic conditions.

Slaughter trials
At the end of feeding trial, animals were fasted for 12 h. Before sacrificing rabbits were individually weighted, and 3 rabbits from each group were randomly chosen, slaughtered by cutting the neck and jugular vein using sharp knife to determine carcass characteristics and meat analysis. The slaughtered weight was recorded after complete bleeding, then shinning off was done. The skin, viscera, lung, heart, liver, and kidneys were removed, then rest of the rabbit body was weighted to valuate the dressing percentage. Carcass cuts included fore part, middle part, hind part and head with neck were weighted. The cracass meat samples were taken from 9, 10 and 11*th* ribs, dried for 24 h. at 60 °C, and kept to determine the chemical composition.

Analytical methods
Colleced samples of the carcass meat was analyzed for determine dry matter (DM), crude protein (CP), ether extract (EE), and ash according to AOAC (2000).

Statistical analysis
Collected data of experiment were subjected to statistical analysis as two factors-factorial analysis of variance using SPSS (1997). And Duncan's multiple range test was used for separate means when the differences were significant according to Duncan (1955). And the statistical model was $Y_{ijk} = \mu + Ti + L_j + (TL)_{ij} + e_{ijk.}$

Where;Y_{ijk}: The observation, μ: mean, Ti: Treatment effect, L_j: Level effect, TL_{ij}: Interaction effect between treatments and levels, and e_{ijk}: Experimental error.

Results
Carcass characteristics
Values of slaughter weights (SW), empty body weight (EBW), carcass weight (CW_1), carcass weight + total edible offals (CW_2), edible offals (giblets), dressing percentages and carcass cuts are show in Table 2. And the interaction between treatments and levels show in Table 3. The results indicated that there were no significant differences in values of EBW, $CW_{1,}$ CW_2 and dressing percentages (1, 2,

Table 2 Effects of fungal treatments and replacing levels of corn stalks on carcass characteristics for growing rabbits

Item	Treatments		SEM	Levels				SEM
	Without *T. reesei*	With *T. reesei*		0%	33%	66%	100%	
Initial body wt., g*	571	553	20.73	566	572	568	542	20.71
Final body wt., g*	2060[b]	2254[a]	32.99	2079[bc]	2361[a]	2199[b]	1990[c]	32.99
Daily gain, g/day*	16.36[b]	18.69[a]	0.30	16.63[c]	19.66[a]	17.92[b]	15.91[d]	0.30
Slaughter wt. (SW), g	2321	2505	75.05	2348	2426	2348	2529	75.05
Empty body wt. (EBW), g	2098	2263	67.80	2122	2192	2122	2286	67.80
Carcass wt. (CW_1), g	1262	1353	37.92	1257	1337	1268	1369	37.92
Carcass wt. + total giblets (CW_2), g	1379	1482	41.59	1358	1460	1401	1504	41.59
Dressing percentages (DP), %								
DP1	54.56	54.10	0.54	53.67	55.17	54.09	54.38	0.54
DP2	60.38	59.87	0.60	59.39	61.06	59.87	60.19	0.60
DP3	65.94	65.57	0.58	64.12	66.71	66.16	66.03	0.58
Carcass cuts weight, g								
Fore part	385	416	14.05	383	397	399	424	14.05
Middle part	252	269	8.74	228[b]	279[a]	250[ab]	285[a]	8.74
Hind part	458	499	15.78	477	486	460	490	15.78
Head + Neck	168	168	4.24	168	175	158	169	4.24
Edible offals (giblets), g								
Kidneys	18.75	19.58	0.76	17.67	19.33	19.17	20.50	0.76
Liver	73.50[b]	85.17[a]	4.14	61.00[b]	78.00[ab]	92.33[a]	86.00[a]	4.14
Heart	8.83	9.08	0.66	7.00	8.83	9.00	11.00	0.66
Lungs	15.00	14.17	0.91	14.00	16.50	12.17	15.67	0.91
spleen	1.00	1.00	0.00	1.00	1.00	1.00	1.00	0.00
Total	117.1	129.0	5.43	100.7[b]	123.7[ab]	133.7[a]	134.2[a]	5.43

a and b: Means in the same row have different superscripts are differ significantly at $p < 0.05$. SEM: Standard error of the mean. $Dp_1 = CW_1$ / SW, $DP_2 = CW_1$/ EBW, $DP_3 = CW_2$ / EBW. *: El-Ayek et al. 2014

and 3) either between treatments or levels as show in Table 2. Also, the interaction between treatments and levels were no significant (Table 3). The treatments were not significant effect on carcass cuts (fore part, middle part, and hind part), while level of 66 and 100% corn stalks were significantly ($P < 0.05$) recorded higher middle part compared with control (Table 2). The interaction between treatments and levels on carcass cuts were no significant (Table 3). The results showed that feeding fungal treated corn stalks significant increased liver weight compared with without *Trichoderma ressei* and feeding levels of 66 and 100% ($P < 0.05$) increased liver weight and total edible offals compared with control (Table 2). The interaction show that feeding treated corn stalks at levels 66 and 100% ($P < 0.05$) increased liver weight compared with control as show in Table 3.

Meat composition

Table 4 shows the effect of treatments and levels on meat composition. The results indicated that fed fungal treated corn stalks did not significant effect on dry matter (DM), crude protein (CP), and ether extract (EE), while significant($P < 0.05$) increased ash content (2.64) compared with 2.17% for without *Trichoderma reesei* and feeding level of 100% corn stalks recorded ($P < 0.05$) the highest value compared with levels 33 and 66%. Effect of interaction between treatments and replacing levels show in Table 5, the results pointed that fed level of 66% treated corn stalks was significant ($P < 0.05$) increased CP content compared with 66% without *Trichoderma reesei*. Also fed level of 100% treated corn stalks was recorded (P < 0.05) the highest value of ash content (3.02) compared with 2.37% for level of 66% treated CS and 1.92, 1.94, and 2.18% for levels of 33, 66, and 100% without *Trichoderma reesei*, respectively. While fed treated corn stalks at 66% significant (P < 0.05) decreased EE content (32.04) compared with 39.16% with feeding level of 66% without *Trichoderma reesei*. But, there were no significant difference in DM content.

Discussion

Carcass characteristics

Results concerning carcass characteristics are shown in Table 2, it was evident that treated corn stalks with fungi

Table 3 Effect of interaction between fungal treatments and replacing levels of corn stalks on carcass characteristics for growing rabbits

Item	0%	Diets						SEM
		Without *T. reesei*			With *T. reesei*			
		33%	66%	100%	33%	66%	100%	
Initial body wt., g*	566	568	581	570	576	554	514	20.71
Final body wt., g*	2079^{c}	2207^{bc}	2055^{cd}	1900^{d}	2515^{a}	2344^{ab}	2080^{c}	32.99
Daily gain, g/day*	16.63^{d}	18.01^{c}	16.19^{e}	14.62^{f}	21.31^{a}	19.67^{b}	17.21^{d}	0.30
Slaughter weight (SW), g	2348	2302	2319	2316	2549	2377	2744	75.05
Empty body wt. (EBW), g	2122	2080	2096	2092	2304	2147	2479	67.80
Carcass wt. (CW_1), g	1257	1279	1222	1290	1394	1313	1448	37.92
Carcass wt. + total giblets (CW_2), g	1358	1400	1344	1415	1521	1459	1592	41.59
Dressing percentages (DP), %								
DP1	53.67	55.63	52.91	56.03	54.71	55.27	52.73	0.54
DP2	59.39	61.57	58.56	62.01	60.55	61.18	58.36	0.60
DP3	64.12	67.37	64.37	67.90	66.05	67.95	64.15	0.58
Carcass cuts weight, g								
Fore part	383	387	370	399	408	427	448	14.05
Middle part	228	266	243	272	291	258	298	8.74
Hind part	477	455	450	448	517	470	533	15.78
Head + Neck	168	172	159	171	178	159	169	4.24
Edible offals (giblets), g								
Kidneys	17.67	20.33	17.33	19.67	18.33	21.00	21.33	0.76
Liver	61.00^{b}	73.67^{ab}	82.67^{ab}	76.67^{ab}	88.33^{ab}	102.00^{a}	95.33^{a}	4.14
Heart	7.00	8.67	8.33	11.33	9.00	9.67	10.67	0.66
Lungs	14.00	17.00	12.67	16.33	16.00	11.67	15.00	0.91
spleen	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Total	100.7^{b}	120.7^{ab}	122.0^{ab}	125.0^{ab}	126.7^{ab}	145.3^{a}	143.3^{a}	5.43

a and b: Means in the same row have different superscripts are differ significantly at $P < 0.05$. SEM: Standard error of the mean. $Dp_1 = CW_1 / SW$, $DP_2 = CW_1 / EBW$, $DP_3 = CW_2 / EBW$, *: El-Ayek et al. 2014

improved EBW, CW1 and CW2 by about 7.9, 7.2 and 7.5% for treated corn stalks with fungi than that of without fungi, respectively, however on significant differences were detected may be due to the variations within groups and the relatively small number of observation.

From data concerning dressing percentages (DP %), DP1, DP2 and DP3 showed slight non-significant differences between treatments with and without fungi or between different levels of supplementation than un-supplemented diets. These results are in agreement with Nofal et al. (1995) who showed that the dressing percentage of slaughter rabbits at 14–16 weeks of age was 60.6, 60.1, and 60.8% for New Zealand, California and California x New Zealand rabbits, respectively. Moreover, Ahmed (1998) observed that using 5% wheat straw which treated with fungi *Trichoderma reesei* in rabbit ration gave the highest value of dressing percentages (60.28), while rabbit given 15% wheat straw gave the lowest value (50.04%). Also, El-Badawi et al. (2007)

Table 4 Effects of fungal treatments and replacing levels of corn stalks on chemical composition of rabbit meat

Component, %	Treatments		SEM	Levels of corn stalks				SEM
	Without *T. reesei*	With *T. reesei*		0%	33%	66%	100%	
Dry matter (DM)	39.31	39.41	0.99	35.92	40.08	40.90	40.54	0.99
Crude protein (CP)	61.02	62.02	0.70	61.10	62.20	62.25	60.52	0.70
Ether extract (EE)	36.81	35.34	0.67	36.24	35.58	35.60	36.88	0.67
Ash	2.17^{b}	2.64^{a}	0.09	2.66^{a}	2.22^{b}	2.15^{b}	2.60^{a}	0.09

a and b: Means in the same row have different superscripts are differ significantly at $P < 0.05$
SEM: Standard error of the mean

Table 5 Effect of interactions between treatments and levels of corn stalks on chemical composition of rabbit meat

Comp.	0%	Diets						SEM
		Without *T. reesei*			With *T. reesei*			
		33%	66%	100%	33%	66%	100%	
DM, %	35.92	40.31	41.00	40.02	39.85	40.80	41.06	0.99
CP, %	61.10^{ab}	62.92^{ab}	58.90^{b}	61.14^{ab}	61.47^{ab}	65.59^{a}	59.90^{ab}	0.70
EE, %	36.24^{ab}	35.16^{ab}	39.16^{a}	36.68^{ab}	36.01^{ab}	32.04^{b}	37.08^{ab}	0.67
Ash, %	2.66^{ab}	1.92^{c}	1.94^{c}	2.18^{bc}	2.52^{ab}	2.37^{bc}	3.02^{a}	0.09

a, b and c: Means in the same row have different superscripts are differ significantly at $P < 0.05$
SEM: Standard error of the mean

reported that the dressing percentage for rabbits fed diets contained 25 and 50% fungal treated sugar beet pulp (TSBP) (75.15 and 73.96) were not different compared with control (72.14), but it were significantly ($P < 0.05$) higher than (69.15 and 64.05%) for rabbits fed 25 and 50% untreated sugar beet pulp (USBP). These differences in dressing percentages may be due to the nature and type of materials of roughages (wheat straw, sugar beet pulp and corn stalks) which treated with fungi or to the differences of component diets, also to the experimental conditions of each experiment. These results are disagreement with Thayalim and Samanasinghe (2002) who found that addition effective microorganism (EM) to rabbit diets increased dressing percentages.

Concerning the effects of fungal treatment and replacing levels of corn stalks on carcass cuts weight are shown in Table 2, it was cleared that treated corn stalks with fungi improved Fore part, Middle part and Hind part by about 8.05, 6.74 and 8.95% for treated corn stalks with fungi than that of without fungi, respectively, however, no significant differences between treatments with or without treatment were detected in this respect. Replacing levels of clover hay by treated corn stalks at 33, 66 and 100% showed that 33, 66 and 100% levels improved Middle part of carcass cut weight significantly than that of control diet, however, no significant differences were detected with Fore part, Hind part or head + neck with different levels of supplement than that of control diet. These results cleared that increasing levels of treated corn stalks form 33, 66 to 100% were improved ($P < 0.05$) the excellent carcass cuts weight (Middle part) than that of control diet.

Concerning the effects of fungal treatment and replacing levels of corn stalks on edible offals (giblets) are shown in Table 2, it was cleared that treated corn stalks with fungi increased liver weight significantly than that of without treatment, however, no significant differences were observed in the rest of giblets. Replacing levels of clover hay by treated corn stalks at 33, 66 and 100% showed that 66 and 100% levels significantly increased liver and total giblets than that of control diet; no significant differences were detected in the rest of giblets, at different levels of supplement. These results are agreement with El-Badawi et al. (2007), they reported that the edible giblets percentage, especially liver, kidneys and heart were higher for rabbits fed TSBP diets, especially at 50% compared with rabbits fed 25% USBP and control diets.

The interaction between treatments and levels are shown in Table 3. The results indicated that there were no significant differences in values of EBW, CW1, CW2, dressing DP1, DP2, DP3 and carcass cuts weight between without or with fungi treatment. However, treated fungi at 66 or 100% showed significant increase in liver and total edibles offals (giblets) than that of control diet.

Meat composition

Table 4 showed that the effect of treatments and levels on meat composition evident that ash content of rabbits meat were significantly higher with treated corn stalks with fungi than that of without fungi. Ether extract (EE) content of meat was nearly similar and somewhat lower by about 4% with than without fungal treatment with non-significant differences detected between treatments. However, dry matter (DM) and crude protein (CP) contents of meat showed non-significant differences detected between treatments. Effect of replacing levels of treated corn stalks on chemical composition of rabbits meat showed that DM content of meat increased by 11.5, 13.8 and 12.8% with 33, 66 and 100% levels, respectively with non-significant differences observed between different levels and control treatments, may be due to the large variations within groups and the relatively small numbers of observations. Also, CP and EE contents of meat showed non-significant differences between treatments. However, ash content of meat showed significant differences between control and 100% than that of 33 and 66% levels of corn stalks.

The effect of interactions between treatments and levels of corn stalks on chemical composition of rabbits meat (Table 5), cleared that CP content significantly increased with 66% with fungi than that the same level without fungi, with the contrast with EE which significantly decreased with fungi than that of the sane level

(66% without fungi). Moreover, ash content showed significantly higher with 100% with fungi than 33 and 66% without fungi treatment. Non-significant differences detected between either with or without fungi on DM of rabbits meat. Cheeke (1986) reported that rabbit meat is high in protein and low in fat. Matusevivius et al. (2006) found that adding probiotic to rabbit rations did not have any influence on dry matter and ash.

In this connection, Zaza (2005) found that incorporation of either treated or non- treated apple pomace to rabbit diets led to significant reduction in the fat content of rabbits meat and insignificant differences ($p > 0.05$) were found among all treatments in crude protein content. El-Badawi et al. (2007) reported that chemical composition of lean meal showed higher content of DM, but less EE content for rabbits fed untreated SBP diets compared with control group. Rabbits fed treated SBP recorded higher ash content compared with those fed control and 25% USBP diets. CP content was not different between all groups.

Conclusion

From the previous results could be concluded that treated corn stalks with or without fungi could be successfully used to improve carcass cuts weight (Middle part) and total giblets with 33 to 100% than control diet. Treated corn stalks with fungi at 66% increased CP content, while decreased EE content of rabbits meat compared with without fungi. Ash content increased with 100% treated than 33 or 66% without fungi treatment. It worthy to note that treated corn stalks with fungi could be used without any adverse effects and enhance carcass characteristics and chemical composition of rabbits meat.

Abbreviations

AOAC: Association of Official Analytical Chemists; CP: Crude protein; CW_1: Carcass weight; CW_2: Carcass weight + total edible offals; DM: Dry matter; DP_1: Dressing percentage = CW_1 / SW; DP_2: Dressing percentage = CW_2 / EBW; DP_3: Dressing percentage = CW_2 + total edible offals / EBW; EBW: Empty body weight; EE: Ether extract; hr: Hour; MALR: Ministry of Agriculture and Land Reclamation; ml: Milliliter; NRC: National Research Council; SBP: Sugar beet pulp; SEM: Standard error of the mean; SPSS: Statistical Package for the Social Siemens; SW: Slaughter weight; T: *Trichoderma*; TSBP: Treated sugar beet pulp; USBP: Untreated sugar beet pulp

Acknowledgements

Not applicable.

Funding

This work was funded by the National Research Centre.

Availability of data and materials

The authors declare that all data and the materials are available.

Authors' contributions

RIE designed this work and wrote the manuscript, AAAM performed the farm trials and laboratory analysis, AAA participated in farm trials and wrote the manuscript, AAE designed this work. All authors read and approved the final manuscript.

Ethics approval and consent to participate

Did not done the ethics process for this work. All authors declare consent to participate.

Consent for publication

All authors declare that this manuscript is consent for publication.

Competing interests

The authors declare that they have no competing interests.

Publisher's Note

Received: 4 February 2019 Accepted: 3 April 2019
Published online: 10 May 2019

References

Abd El-Hakim AS, Shakweer IME, Azoz AA (2006) Effect of using different levels of biologically treated rice straw in growing rabbits diets on growth performance, nutrients digestibility and some physiologies parameters. Egypt J Rabbit Sci 16(2):191–209

Abedo AA (2011) Prospects of recycling field crop residues in animal feeding strategy. Animal Production Department, National Research Center, Giza, pp 7–8

Agricultural Economic and Statistics Institute (2011) Ministry of Agriculture, Agri., Economic, part 1. Pub., Agri. Res. Center, Egypt

Ahmed FG (1998) Improvement the nutritive value of some roughages used for rabbits feeding. M.Sc. Thesis, Fac Agric, Ain Shams Univ, Egypt

AOAC (2000) Association of official analytical chemists, 17th edn. Assoc. of Anal Chem, Arlington

Cheeke PR (1986) Potentials of rabbit production in tropical and subtropical agricultural systems. J Anim Sci 63:1581–1586

Cheeke PR (1987) Rabbit feeding and nutrition. Academic Press, INC, Orlando, p 367

Deraz TAA, Ismail H (2001) Cotton stalks treated with white-rot fungi for feeding sheep. Egypt J Nutr Feed 4(Special Issue):423–434

Duncan DB (1955) Multiple range and multiple F test. Biometrics 11:1

El-Ayek MY, El-Ayouty El-Sayd A, El-Shahat AA, El-Kady RI, Morad AAA (2014) Effect of some biological treatments for corn stalks on productive performance of New Zealand rabbits. Egypt J Nutr Feed 17(1):75–88

El-Badawi AY, Hassan AA, Abedo AA (2007) Growth performance of New-Zealand white rabbits fed diets containing different levels of untreated or fungal treated sugar beet pulp. In: The 58th EAAP meeting, August 26–29, 2007. Dublin, Ireland

Fadel M, Amara H, Murad HA, El-Shinawy HK (1992) Production of fungal protein from wheat straw by *Pencillium funculosium*. Egypt J Food Sci 20:1

Hernandez P, Pla M, Oliver MA, Blasco A (2000) Relationship between meat quality measurements in rabbits fed with three diets of different fat type and content. Meat Sci 55:379–384

MALR (2008) Ministry of agriculture and land reclamation part 1. Published by Agric Res Center, Ministry of Agriculture, Egypt

Matusevivius P, Asmenskaite L, Zilinskiene A, Gugolek A, Manfred O, Hartman A (2006) Effect of probiotic bioplus 2B® on performance growing rabbit. Veterinarija IR Zootechinika 36(58):54–59

Morad AAA (2005) Microbial and physiological studies for improving the nutritional value of untraditional animal feeds. M.Sc. Thesis Faculty of Agric, Al-Azhar, University, Egypt

Nofal RY, Toth S, Virag GY (1995) Carcass traits of purebred and crossbred rabbits. World Rabbit Sci 3(4):167–170

NRC (1977) National Research Council. Nutrient requirements of rabbits. National Academy of Sciences, Washington, DC

Rangnekar DV, Badve VC, Kharat ST, Sobole BN, Joshi AL (1982) Effect of high pressure steam treatment on chemical composition and *in vitro* digestibility of roughages. Anim Feed Sci Technol 7:61–70

Rissanen H, Kossila V, Kommeri M, Lampila M (1981) Ammonia treated straw in the feeding of dairy cows and growing cattle. Agric Environ 6:267–271

SPSS (1997) Statistical package for the social siemens, release 6. SPSS Inc., Chicago

Thayalim S, Samanasinghe K (2002) Influence of EM on the performance of the domestic rabbit (*oryctogu cuniculus*). In: 7th international conference on kyusei nature fanning, New Zealand, pp 7–8

Zaza GHM (2005) Effect of incorporation of biologically treated sugar beet pulp as non-conventional feedstuffs in the diets of growing rabbits. In: The 4th inter. conference on Rabbits production in hot climates, Sharm El-Sheikh, Egypt