Bulletin of the National Research Centre

RESEARCH Open Access

Incorporation field crop residues in rabbit rations

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Abstract

Background: In Egypt, the area of Berseem was decreased and wheat area increased which lead to high price of rabbit rations. Using non-traditional feed led to decrease the cost of feeding. The main objective of this study is to replace 50% of Berseem hay (BH) of rabbit rations by agriculture by-products such as Mung bean husks (MBH), soybean vein hay (SBVH), or peanut vein hay (PVH).

Method: Twenty-four New Zealand White (NZW) rabbits aged 5–6 weeks (584 ± 25 g) were randomly divided into four equal experimental groups. Feeding trial lasted 70 days.

Results: Except for organic matter (OM) digestibility, treatments had no effect on all other nutrient digestibilites that includes dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), and nitrogen free extract (NFE) and nutritive values {total digestible nutrient (TDN) and digestible crude protein (DCP)}. Instead, 50% of BH by the other alternative source of agriculture by-products had no effect on all carcass parameters measured. However, dressing percentages was improved. Treatments had no effect on albumin, total lipids, triglycerides, total cholesterol, low-density lipoprotein (LDL), glutamic oxaloacetic transaminase (GOT), creatinine, and alkaline phosphatase.

Conclusion: It can be instead 50% of hay used in rabbit rations with alternative sources of roughage, such as Mung bean husks, soybean vein hay, or peanut vein hay, without any adverse effect on their performance, digestion, carcass characteristics, and blood constituents.

Keywords: Berseem hay, Agriculture by-products, Carcass characteristics, Blood constituents

Background

One of the very important limiting factors for animal production in Egypt is the availability of feed stuffs. Locally produced feeds are not sufficient to cover the nutritional requirements of livestock (Abou-Akkada 1988).

In Egypt, the total area planted by clover hay reached about two million feddans (EMA 2003); recently according to the national policy, the area of Berseem was decreased and wheat area increased which lead to high price of rabbit rations (Abo EL-Maaty et al. 2014). Using non-traditional feed led to decrease the cost of feeding and alleviate the pollution problems (Abdel-Magid Soha et al. 2008).

The volume of agriculture by-products reached 35 million tons annually, 23 million tons of which were plant wastes (7 million tons of them are used as fodders; 4 million tons were used as organic fertilizers; and the rest of wastes which 12 million tons were left without any use) as noted by Sadek Enath (2013).

Recently, some studies were designed to use some agricultural by-products in rabbit feeding, especially as alternatives to Berseem hay, which commonly represents about 30–40% of the complete pelleted diets of rabbits. Peanut and Mung beans and kidney beans are cultivated in the newly reclaimed lands. So, significant amounts of their straws and by-products of these crops are produced annually that may help in the solution of the shortage of animal feeding (Omer et al. 2012).

Rabbits have fast reproductive and growth rates and are excellent species in converting feed into body weight. They are both known to yield high-quality protein meat with low fat; rabbits have a small body size but can be raised on relatively small amounts of non-conventional

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feedstuffs Cheeke (1986). They can be produced on grain-free diets, mainly on forages and other type of agricultural by-products. The specific advantages of rabbits have been reviewed by Cheeke et al. (1987); some of these advantages make rabbits a suitable livestock species for meat production in the developing nations.

So, this work aimed to investigate the influence of replacing 50% of Berseem hay that is considered the main source of roughage in rabbit rations with untraditional sources of roughage (Mung bean husks, soybean vein hay, and peanut vein hay) on rabbit's performance, digestion coefficients, nutritive values, carcass characteristics, and blood constituents.

Methods

The present study was carried out at El-Nubaria Experimental and Production Station at El-Imam Malik Village.

Experimental animals and feeds

From September to November, 2017, 24 New Zealand White (NZW) rabbits aged 5–6 weeks with an average body weight of 584 ± 25 g were randomly divided into four equal experimental groups (6 rabbits in each treatment).

Rabbits were housed in galvanized wire cages (50 × 50 × 45 cm) and provided with stainless steel nipples for drinking and feeders allowing recording feed intake during the feeding trial that continued for 70 days.

All experimental group rabbits were kept under the same managerial conditions, and rations were offered pelleted with diameter 4 mm.

The experimental pelleted rations were formulated to cover the nutrient requirements for rabbits according to NRC (1977) as described in Tables 1 and 2. Rabbits received one of the fourth rations as follows:

The first one was considered as control (R_1). The second, third, and fourth experimental rations were formulated by replacing 50% of Berseem hay (BH) by alternative sources of roughage such as MBH, SBVH, and PVH, for R_2, R_3, and R_4, respectively. Rations were offered ad libitum.

Digestibility trials

At the end of the feeding trial, three rabbits from each treatment were used in a digestibility trial that carried out over a period of 7 days. Feces were daily collected quantitatively during the collection period before feeding at 8:30 a.m. Feed intake of experimental rations and weight of feces were also daily recorded. Representative samples of 10% of total fresh weight of feces were sprayed with solution of 10% sulfuric acid and 10% formaldehyde and oven dried at 60 °C for 48 h, and composite samples of dried feces were ground and stored for later chemical analysis. The nutritive values expressed TDN and DCP of experimental rations that were calculated using a classic method as described by Abou-Raya (1967).

Table 1 Composition of the experimental rations

Item	BH (R_1)	MBH (R_2)	SBVH (R_3)	PVH (R_4)
Yellow corn	150	130	150	150
Soybean meal	240	260	240	240
Wheat bran	170	170	170	170
Barley grain	180	180	180	180
Berseem hay	230	115	115	115
Mung bean husks	–	115	–	–
Soybean vein hay	–	–	115	–
Peanut vein hay	–	–	–	115
Di-calcium	12	12	12	12
Limestone	12	12	12	12
Sodium chloride	3	3	3	3
Vit. and Min. mixture[1]	2	2	2	2
D-L-Methionine	1	1	1	1

[1]Vit. and Min. mixture: each kilogram of Vit. and Min. mixture contains 2000.000 IU Vit. A, 150.000 IU Vita. D, 8.33 g Vit. E, 0.33 g Vit. K, 0.33 g Vit. B_1, 1.0 g Vit. B_2, 0.33 g Vit. B_6, 8.33 g Vit.B_5, 1.7 mg Vit. $B1_2$, 3.33 g pantothenic acid, 33 mg biotin, 0.83 g folic acid, 200 g choline chloride, 11.7 g Zn, 12.5 g Fe, 16.6 mg Se, 16.6 mg Co, 66.7 g Mg, and 5 g Mn
BH Berseem hay, *MBH* Mung bean husks, *SBVH* soybean vein hay, *PVH* peanut vein hay

Slaughter trials

Three representative rabbits from each treatment were randomly chosen to determine the carcass parameters according to Blasco et al. 1993. Rabbits were fasted for 12 h before slaughter, which was performed according to the Islamic rules. Animals were weighed just before slaughter, slaughter weight (SW) was recorded and as well as after complete bleeding.

Total edible offals (Giblets) which included heart, liver, kidneys, lungs, spleen, and testes were weighed.

Full and empty weights of digestive tract were recorded. Hot carcass which included head and giblets were weighed to calculate dressing percentages.

Blood sample collection and analytical procedures

Blood samples were collected from the slaughtered rabbits (three of each treatment) and centrifuged at 4000 r.p.m. for 20 min, for the preparation of blood plasma. Plasma kept frozen at − 18 °C for subsequent analysis. Plasma total protein was determined according to Armstrong and Carr (1964) and Witt and Trendelenburg (1982); albumin was determined according to Doumas et al. (1971) and Tietz (1986); triglycerides were determined according to Fossati and Principe (1982); total lipids were determined according to Postma and Stroes (1968)); total cholesterol was determined according to Allain et al. (1974) and Pisani et al. (1995); alkaline phosphates' activity was measured according to the method of Beliefield and Goldberg (1971); plasma

Table 2 Chemical analysis of the experimental rations

Item	BH (R_1)	MBH (R_2)	SBVH (R_3)	PVH (R_4)
Moisture	9.12	9.15	9.33	9.40
Chemical analysis (%) on DM basis				
OM	89.42	89.69	89.40	89.51
CP	20.89	20.79	20.69	20.74
CF	12.17	12.38	14.59	13.22
EE	2.77	2.45	2.77	2.84
NFE	53.59	54.07	51.35	52.71
Ash	10.58	10.31	10.60	10.49
Neutral detergent fiber NDF)	36.39	36.74	37.03	37.84
Gross energy (kcal/kg DM)	4170	4163	4166	4175
Digestible energy (Mcal/kg DM)	2.577	2.560	2.546	2.506
Non fibrous carbohydrates (NFC)	29.37	29.71	28.91	28.09

Gross energy (kcal/kg DM) was calculated (Blaxter 1968)
Digestible energy (M cal) was calculated (Cheeke 1987)
BH Berseem hay, *MBH* Mung bean husks, *SBVH* soybean vein hay, *PVH* peanut vein hay, *NFC* non-fibrous carbohydrates were calculated (Calsamiglia et al. 1995)

glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) activities were determined as described by Reitman and Frankel (1957) and Harold (1975); creatinine was estimated according to Husdan (1968)); high-density lipoprotein (HDL) was estimated according to Assmann (1979)**;** and low-density lipoprotein (LDL) was determined as method described by McNamara et al. (1990) using commercial kits. On the other hand, globulin and albumin to globulin ratio (A:G ratio) were calculated.

Chemical analyses of experimental rations and feces were analyzed according to AOAC (2005) methods. Meanwhile, neutral detergent fiber (NDF) was determined according to Goering and Van Soest (1970) and Van Soest et al. (1991).

Calculations

Gross energy (kcal/kg DM) was calculated according to Blaxter (1968). Each g CP = 5.65 Kcal, g EE = 9.40 kcal and g (CF and NFE) = 4.15 kcal.

Digestible energy (DE) was calculated according to Cheeke (1987) by applying the following equation: DE (Mcal/kg DM) = 4.36–0.049 × NDF.

Non-fibrous carbohydrates (NFC), calculated according to Calsamiglia et al. (1995) using the following equation: NFC = 100 − {CP + EE + Ash + NDF}.

Statistical analysis

Data collected of feed intake, live body weight; feed conversion, nutrient digestibility, blood constituents, and carcass data were subjected to statistical analysis as one-way analysis of variance according to SPSS (2008). Duncan's multiple range test (Duncan 1955) was used to separate means when the dietary treatment effect was significant according to the following model:

$$Yij = \mu + Ti + eij$$

where
Y_{ij} = observation
μ = overall mean
T_i = effect of experimental rations for i = 1–4, 1 = (control ration contained 23% BH), 2 = replacing 50% of BH with MBH
3 = replacing 50% of BH with SBVH and
4 = replacing 50% of BH in with PVH
e_{ij} = the experimental error.

Results

Chemical analysis

Experimental rations were almost iso-caloric (ranged from 4163 to 4175 kcal/kg DM) and also iso nitrogenous (ranged from 20.69 to 20.89% CP). Meanwhile, approximately, EE content was in the same range that ranged from 2.45 to 2.84% among the four experimental tested rations. On the other hand, CF content was varied from 12.17 to 14.59%; this is related to the differences in tested materials content of CF. Also, NDF content was slightly increased with instead 50% of BH in control ration by the three other tested materials used in ration formulation. Digestible energy contents were slightly decreased for tested rations compared to the control Table 2.

Nutrient digestibility and nutritive values

Data illustrated in Table 3 mentioned that, except OM digestibility, treatments had no significant effect on all other nutrient digestibilites and nutritive values. However, replacing 50% of Berseem hay in control ration with tested materials slightly improved both nutrient digestibility and nutritive values for experimental rations (R_2 recorded the best values) so it can be safely used as untraditional source of roughage or as instead of Berseem hay.

Growth performance

Replacing 50% of BH with MBH, SBVH, or PVH (Table 4) improved FW, TBWG, ADG, and feed conversion that expressed as (g DMI/g gain). However, no significant decrease occurred with daily dry matter intake.

Carcass characteristics

Dressing percentages

Treatments had no significant effect on all carcass parameters measured including SW, DT, EBW, giblets, DP, and carcass cuts (Table 5).

Table 3 Nutrient digestibility and nutritive values of the experimental rations

Item	BH (R_1)	MBH (R_2)	SBVH (R_3)	PVH (R_4)	SEM
Digestion coefficients (%)					
DM	88.16	89.21	89.14	88.32	0.50
OM	71.23^{b}	75.14^{a}	74.26^{a}	72.94^{ab}	0.58
CP	63.25	65.43	64.17	63.80	0.49
CF	56.11	58.12	57.29	56.33	0.41
EE	63.22	66.13	65.86	64.88	0.53
NFE	77.66	79.21	78.83	77.75	0.50
Nutritive values (%)					
TDN	65.60	67.27	66.22	65.81	0.39
DCP	13.21	13.60	13.28	13.23	0.10

a and b: means in the same row having different superscripts differ significantly ($P < 0.05$)
SEM standard error of mean, *BH* Berseem hay, *MBH* Mung bean husks, *SBVH* soybean vein hay, *PVH* peanut vein hay

External and internal offals

Treatments had no effect on both total external and internal offals (Table 6) that expressed as weight or % of slaughter weight.

Digestive tract weights and length

Treatments had no significant effect on the full and empty weight of the stomach, large intestine, and total digestive tract and the length of the stomach and small and large intestine. Also, present results mentioned that stomach length was slightly increased, while small intestine length decreased with replacing BH with (MBH, SBVH, or PVH). However, except R_2, the large intestine length was insignificantly decreased when rabbits received diets that were replaced by 50% of Berseem hay in control ration by SBVH or PVH (Table 7).

Table 4 Growth performance of the experimental groups

Item	BH (R_1)	MBH (R_2)	SBVH (R_3)	PVH (R_4)	SEM
Initial weight (g)	584	580	588	582	24.88
Final weight (FW, g)	2041	2321	2206	2186	70.50
Total body weight gain (TBWG, g)	1457	1741	1618	1604	73.10
Average daily gain (ADG, g/day)	20.81	24.87	23.11	22.91	1.04
Daily dry matter (DMI), g	119.1	114.4	109.5	112.3	4.20
Feed conversion (g DMI/g gain)	5.72	4.60	4.74	4.90	0.20

SEM standard error of mean, *BH* Berseem hay, *MBH* Mung bean husks, *SBVH* soybean vein hay, *PVH* peanut vein hay

Table 5 Dressing percentages and carcass cuts of the experimental groups

Item	BH (R_1)	MBH (R_2)	SBVH (R_3)	PVH (R_4)	SEM
Slaughter weight (SW), g	2451	2188	2353	2169	91.94
Digestive tract (DT)					
Full weight, g	420	331	376	326	18.65
Empty weight, g	166	162	151	181	6.44
Content weight, g	254^{a}	169^{ab}	225^{ab}	145^{b}	18.99
Empty body weight (EBW), g	2197	2019	2128	2024	80.08
Head weight, g	125	120	117	124	3.46
Edible offal's (giblets) weight, g	141	112	138	116	6.27
Carcass weight (CW_1)	1256	1165	1231	1145	54.61
Carcass weight (CW_2)	1381	1285	1348	1269	57.80
Carcass weight (CW_3)	1522	1397	1486	1385	63.38
Dressing percentages (DP)%					
DP^1	51.24	53.24	52.32	52.79	0.65
DP^2	56.34	58.73	57.29	58.51	0.62
DP^3	62.10	63.85	63.15	63.85	0.59
DP^4	57.17	57.70	57.84	56.57	0.59
DP^5	62.86	63.64	63.35	62.70	0.58
DP^6	69.28	69.19	69.83	68.43	0.63
Carcass cuts (g or % of CW_1)					
Fore limbs	410	448	392	376	20.99
	32.64^{b}	38.45^{a}	31.84^{b}	32.84^{b}	0.99
Loin	374	303	354	309	19.07
	29.78	26.01	28.76	26.99	0.67
Hind limbs	472	414	485	460	18.01
	37.58	35.54	39.40	40.17	0.82

a and b: means in the same row having different superscripts differ significantly ($P < 0.05$)
SEM standard error of mean, *BH* Berseem hay, *MBH* Mung bean husks, *SBVH* soybean vein hay, PVH peanut vein hay
EBW: Empty body weight = Slaughter weight − digestive tract content
CW_1: Carcass weight
CW_2: Carcass weight + head
CW_3: Carcass weight + head + edible offals included (liver, heart, kidneys, lungs, testes, and spleen)
DP_1: Dressing percentages calculated as (CW_1 / SW × 100)
DP_2: Dressing percentages calculated as (CW_2 / SW × 100)
DP_3: Dressing percentages calculated as (CW_3 + SW × 100)
DP_4: Dressing percentages calculated as (CW_1 / EBW × 100)
DP_5: Dressing percentages calculated as (CW_2 / EBW × 100)
DP_6: Dressing percentages calculated as (CW_3 + EBW × 100)

Blood parameters

Treatments had no effect on albumin, total lipids, triglycerides, total cholesterol, low-density lipoprotein, GOT, creatinine, and alkaline phosphatase (Table 8). Total protein and globulin (R_3) and HDL (R_2) increased ($P < 0.05$), while GPT (R_3) decreased ($P < 0.05$) compared to control.

Table 6 External and internal offal's (Giblets) of the experimental groups

Item	BH (R_1)	MBH (R_2)	SBVH (R_3)	PVH (R_4)	SEM
Slaughter weight (SW), g	2451	2188	2353	2169	91.94
External offal's (g or % of SW)					
Blood	49 2.00	54 2.47	52 2.21	57 2.63	2.39 0.12
Fur, legs, ears and tail	459 18.73	406 18.56	438 18.61	402 18.53	19.03 0.34
Total external offals	508 20.73	460 21.03	490 20.82	459 21.16	19.79 0.36
Edible offals (g or % of SW)					
Head	125 5.10^{bc}	120 5.48^{ab}	117 4.97^{c}	124 5.72^{a}	3.46 0.11
Internal offal's (giblets), (g or % of SW)					
Liver	84^{a} 3.43^{a}	58^{b} 2.65^{b}	82^{a} 3.48^{a}	62^{ab} 2.86^{b}	4.58 0.11
Heart	9 0.37	10 0.46	11 0.47	7 0.32	0.73 0.03
Kidneys	23 0.94^{ab}	22 1.01^{a}	19 0.81^{b}	20 0.92^{ab}	1.36 0.03
Lungs	16 0.65	12 0.55	14 0.59	15 0.69	0.78 0.03
Testes	9 0.37^{b}	10 0.46^{a}	10 0.42^{ab}	10 0.46^{a}	0.28 0.01
Spleen	1 0.04	1 0.05	1 0.04	1 0.05	0.00 0.02
Total internal offals (giblets)	141 5.75	112 5.12	138 5.86	116 5.35	6.27 0.10

a, b, and c: means in the same row having different superscripts differ significantly ($P < 0.05$)
SEM standard error of mean, *BH* Berseem hay, *MBH* Mung bean husks, *SBVH* soybean vein hay, *PVH* peanut vein hay

Table 7 Digestive tract weights and length of the experimental groups

Item	BH (R_1)	MBH (R_2)	SBVH (R_3)	PVH (R_4)	SEM
Slaughter weight (SW), g	2451	2188	2353	2169	91.94
Stomach (g or % of SW)					
Full	100 4.08	86 3.93	93 3.95	79 3.64	5.26 0.21
Empty	27 1.10	25 1.14	28 1.19	23 1.06	1.25 0.05
Content	73 2.98	61 2.79	65 2.76	56 2.58	5.34 0.22
Small intestine (g or % of SW)					
Full	119 4.86^{a}	83 3.79^{b}	86 3.65^{b}	100 4.61^{ab}	6.59 0.21
Empty	71^{ab} 2.90^{ab}	54^{b} 2.47^{b}	59^{b} 2.51^{b}	81^{a} 3.73^{a}	4.21 0.21
Content	48 1.96^{a}	29 1.32^{ab}	27 1.15^{ab}	19 0.88^{b}	5.56 0.18
Large intestine (g or % of SW)					
Full	201 8.20	162 7.40	197 8.37	147 6.78	10.62 0.41
Empty	68 2.77	82 3.75	64 2.72	78 3.60	4.59 0.26
Content	133^{a} 5.43^{ab}	80^{ab} 3.65^{ab}	133^{a} 5.65^{a}	69^{b} 3.18^{b}	11.96 0.47
Total digestive tract (g or % of SW)					
Full	420 17.13	331 15.13	376 15.98	326 15.03	18.65 0.62
Empty	166 6.77	162 7.40	151 6.42	181 8.34	6.44 0.39
Content	254^{a} 10.36^{a}	169^{ab} 7.73^{ab}	225^{ab} 9.56^{ab}	145^{b} 6.69^{b}	18.99 0.63
Digestive tract length, cm					
Stomach	17	20	18	18	0.87
Small intestine	360	341	350	354	11.91
Large intestine	90	91	69	79	5.08

a and b: means in the same row having different superscripts differ significantly ($P < 0.05$)
SEM standard error of mean, *BH* Berseem hay, *MBH* Mung bean husks, *SBVH* soybean vein hay, *PVH* peanut vein hay

Discussion

The main objective of this study was to investigate the influence of replacing 50% of BH of rabbit ration formulation by alternative sources of agriculture by-products such as MBH, SBVH, or PVH. The present results of Table 3 in agreement with those found by Asar et al. (2010) who noted that digestion coefficients of (DM, OM, CP, EE, and NFE), TDN and DCP were improved by replacing barley with alfalfa hay, Berseem hay, or dried Faba bean straw each at 25% as a fiber source for rabbits fed rations contained 30% corn-cob meal. On the other hand, Ghazalah and El-Shahat (1994) showed that inclusion of olive meal instead of barley increased OM digestibility. Also, Salwa et al. (2000), Falcão-e-Cunha et al. (2004), and Sarhan (2005) noticed that inclusion of agriculture by-products in rabbit rations improved EE digestibility. Also, Omer and Badr (2013) found that OM, CF, EE, and NFE digestibilities were significantly ($P < 0.05$) improved with replacement Berseem hay by pea straw in rations at different levels of replacement (0, 25, 75, and 100%). Also, feeding 30% pea pods hulls diet had better nutritive value compared to control (Sarhan 2005). Meanwhile, Myrie et al. (2008) showed that most feedstuffs contain anti-nutritional factors such as insoluble fibers, ligins, tannins and lectins, intake of these anti-nutritional factors reduced nutrient digestibility and increased endogenous protein losses, through increasing of intestinal mucus secretion.

Data concerning with performance Table 4 in harmony with those reported by Asar et al. (2010), Omer et al. (2011), and Omer and Badr (2013) concluded that inclusion dried faba bean straw, strawberry by-products, pea

Table 8 Blood parameters of the experimental groups

Item	BH (R_1)	MBH (R_2)	SBVH (R_3)	PVH (R_4)	SEM
Total protein (g/ dl)	5.81b[c]	5.68[c]	6.82[a]	6.76[ab]	0.20
Albumin (g/ dl)	4.14	3.71	3.68	4.67	0.20
Globulin (g/ dl)	1.67[b]	1.97[b]	3.14[a]	2.09[b]	0.21
Albumin: globulin ratio	2.48[a]	1.88[ab]	1.17[b]	2.23[ab]	0.21
Total lipids (mg/dl)	282	301	248	367	27.15
Triglycerides (mg/dl)	62.03	55.12	85.52	97.86	9.90
Total cholesterol (mg/dl)	49.79	51.35	47.49	53.74	1.16
HDL (mg/dl)	16.03[b]	18.96[a]	16.63[b]	17.35[ab]	0.44
LDL (mg/dl)	33.76	32.39	30.86	36.39	1.13
GPT (U/l)	77.53[a]	76.26[ab]	73.63[b]	75.11[ab]	0.61
GOT (U/l)	37.79	38.55	41.70	42.38	0.95
Creatinine (mg/dl)	0.98	1.04	0.75	0.97	0.06
Alkaline phosphatase (U/l)	73.26	59.16	77.12	70.87	3.45

a and b: means in the same row having different superscripts differ significantly ($P < 0.05$)
SEM standard error of mean, *BH* Berseem hay, *MBH* Mung bean husks, *SBVH* soybean vein hay, *PVH* peanut vein hay, *HDL* high-density lipoprotein, *LDL* low-density lipoprotein

straw, and corn-cob meal can be substituted for dried clover and barley in growing rabbit rations without any adverse effect on their performance.

Also the present results in agreement with those found by García et al. (1993) who showed that incorporation sugar beet pulp up to 15% did not effect on growth performance. On the other hand, Salwa et al. (2000) established that TBWG of rabbits fed dried watermelon by-product inclusion up to 12% as replacing for clover hay were not significantly different. In addition, Abo EL-Maaty et al. (2014) noted that rabbits fed rations replaced clover hay with cucumber (*Cucumis sativus* L.) vines straw up to 75% resulted in comparable growth performance compared to control. On the other hand, the present results in contrast direction with those noticed by Zeweil (1992) who noted that rabbits received 50% pea by-product in their diet recorded higher feed intake by 23% than those fed the control diet. Moreover, Amber et al. (2002) found that feed intake was significantly ($P < 0.001$) increased for rabbits fed Mung bean hay and rice straw compared with those received sugar beet pulp and sweet potato tops. Also, Galal et al. (2014) observed that rabbit received ration containing 40% strawberry vines by-product replaced from Berseem hay tended to significant ($P < 0.05$) higher feed intake. Meanwhile, Al-Shanti (2003) noted that insignificant differences in feed intake were noticed when rabbits fed 5 to 20% inclusion levels of either olive cake or olive pulp.

Results in Table 5 are in harmony with El-Adawy and Borhami (2001), El-Gendy et al. (2002), Abdel-Magid Soha (2005), El-Medany et al. (2008), and Omer et al. (2011) who reported that replacing clover hay by peanut hay, dried sugar beet tops, pea, chick pea, kidney beans straw, dried carrot processing waste, or strawberry by-products in rabbit diets had no significant in dressing percentages. On the other hand, Asar et al. (2010) noticed that rabbits that received diet which contained corn-cob meal with Berseem hay recorded the highest dressing percentage value that reached to 5.48% over the control. Also, Sarhan (2005) showed that dressing percentages of rabbits fed pea vines hay or pea pods hulls supplemented diets were higher than the control group. However, in contrast, Amber et al. (2002) observed that dressing percentage values were significantly lower for rabbits fed diets which contained sugar beet pulp, sweet potato tops, or Mung bean hay than those fed the control.

Data of external and internal offals (Table 6) in agreement with those reported by Zeweil (1992) and Asar et al. (2010) who observed that there were no significant differences found in the liver, heart, spleen, and kidney relative weights due to dietary inclusion of pea by-product, corn-cob meal, alfalfa hay, Berseem hay, or dried faba bean straw.

The length of the small intestine (Table 7) disagreement with those observed by Asar et al. (2010) who noted that a highly significant increase in the length of small intestine was recorded by rabbits fed diets of corn-cob meal plus Alfalfa hay.

Data of blood parameters (Table 8) in agreement with those obtained by Abdel-Magid Soha (1997), Gad Alla (1997), Mohamed (1999), El Sayed et al. (1999), Tag El-Din et al. (2002), Abdel-Magid Soha (2005), Abou Sekken et al. (2008), and El-Medany et al. (2008). Meanwhile, when BH was replaced by pea straw at different levels (0, 25, 50, and 100%), alkaline phosphatase increased ($P < 0.05$), total cholesterol decreased ($P < 0.05$), and total protein and globulin were increased in tested rations (Omer and Badr 2013).

Conclusion

From the previous study, agriculture by-products such as peanut vein hay, straws of kidney beans, barley, flax, pea, and others may help in the solution of the shortage of animal feeding (Omer et al. 2012; Omer and Badr 2013). Berseem hay that considered as the important source of roughage depending on using it in rabbit ration formulation can be replaced by 50% of different roughages such as soybean vein hay, peanut vein hay, and Mung bean husks without any adverse effect on their gain, digestion coefficients, carcass characteristics, and blood constituents.

Acknowledgements
This work was supported by scientific project section, National Research Centre (P11030122) under the title "Increasing productivity of some un-traditional crops and crop residues for animal feeding."

Funding
Project No. (P11030122) under the title "Increasing productivity of some un-traditional crops and crop residues for animal feeding." National Research Centre.

Availability of data and materials
"Not applicable" for that section.

Authors' contributions
HA-AAO cooperated in the plane of work, field work, chemical analysis, data calculations, statistical analyses of data, and writing of the MS and helped in the publication. MFE K provided experimental animals and facilities. SMA cooperated in the plane of work, field work, and revision of the MS and helped in the publication. SSA-M cooperated in the plane of work and field work and followed the publication with the journal (corresponding author). SIE-N cooperated in the blood sample analysis. BAB contributed in providing facilities. All authors read and approved the final manuscript.

Ethics approval and consent to participate
"Not applicable" for that section.

Consent for publication
"Not applicable" for that section.

Competing interests
The authors declare that they have no competing interests.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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Received: 3 September 2018 Accepted: 5 November 2018
Published online: 27 November 2018

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