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Incorporation of different roughage sources in growing sheep rations 1: Nutritional impact on growth performance, drinking water, economic efficiency and some blood parameters

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Twenty eight growing Barki male lambs aged 6 months with an initial live body weight 24.05±0.25 kg approximately were randomly assigned to four experimental groups (seven lambs in each treatment) and used to investigate the influence of replacing Berseem hay (BH) that considered the main roughage source in sheep feeding by alternative sources of roughage (field crop residues) such as pea straw (PS), chick pea straw (CPS) or lentil straw (LS). Group feeding trial lasted for 120 days and lambs were received one of the four tested experimental rations; first*1st* ration contained 30% BH and considered as control (R_1), second*2nd* ration contained 30% PS (R_2); third*3th* ration contained 30% CPS (R_3) and fourth*4th* ration contained 30% LS (R_4). The results showed that BH was superior in their content of CP (12.15%) and NFE (50.72%); meanwhile both PS and CPS were contained moderate value of CP (11.86 and 11.56%) and NFE (46.84 and 48.36%), meanwhile LS recoded the lowest value of both CP (9%) and NFE (45.95%). All experimental ration were almost iso-caloric and iso-nitrogenous. Inclusion different unconventional sources of roughage as alternative for berseem hay had no significant ($P>0.05$) effect on their total body weight gain (TBWG), average daily gain (ADG) and metabolic body weight ($kgW^{0.75}$). Moreover, R_2 that contained 30% pea straw insignificantly increased their BWG, ADG and metabolic body weight ($kgW^{0.75}$) in comparison with the other groups. Replacing BH by CPS or LS caused significant decreasing ($P<0.05$) in dry matter intake (DMI), crude protein intake (CPI), gross energy intake (GEI) and digestible energy intake (DEI). Meanwhile inclusion PS or LS were insignificantly decreased the same parameter mentioned above. Dietary treatments includes PS, CPS or LS were in significant improved their feed conversion compared to BH. Drinking water that expressed as ml/h/day; ml/ $kgw^{0.75}$ and L/100 kg live body weight was significantly ($P<0.05$) decreased. Daily profit above feeding cost and relative economical efficiency were improved by 16.33%, 3.30% and 10.70% when sheep fed PS or CPS or LS, respectively in comparison with that fed ration contained BH. In addition to, feed cost LE/ kg gain was improved by 16.51%, 13.44% and 17.03% for PS or CPS or LS, respectively compared to BH. Except for hemoglobin content dietary treatments had no significant effect on the other blood parameters determined. It could be concluded that, pea straw, chick pea straw and lentil straw considered good alternative for berseem hay in sheep ration realized depressing in ration costing without causing any adverse effect on their performance and blood parameters evaluated.

Keywords: Roughage sources, performance, water intake, economic efficiency, blood parameters.

INTRODUCTION

The scarcity of feed resources with the continuously increasing cost of usual animal feeds urgently demands searching some alternate feeds for ruminants (Mudgal et al., 2018). Also, Abo Omar (1998) noted that feeding costs make up for more than 70% of total production costs in any livestock operation. Therefore, it is essential to incorporate local raw and cheap materials in animal feeds, agricultural and industrial by-products in animal rations (Shqueir and Qwasmi, 1994).

In the present era of the fast-growing human population, ruminant species occupy an important niche in modern agriculture because of their unique ability to digest certain feedstuffs, especially roughages, efficiently. In future, the direct demands for grain by human beings will make efficient utilization of roughages increasingly important (Visser, 2005). Simultaneously, increasing demands for high-quality animal protein in the world show greater potential for development of sheep and goat production, whereas decreasing community grazing land and increasing cropping intensity have created a serious gap between demand and supply of concentrate feeds and fodder, which has made livestock feeding increasingly dependent on alternate feed resources. Effective utilization of available feed resources is the key to economical livestock rearing (Lardy et al., 2015; Beigh et al., 2017).

In such circumstances, the extensive use of crop residues in livestock feeding seems to be indispensable to meet the nutritional needs of livestock; however, the major constraint in the utilization of these crop residues is high cellulosic contents and poor nutritive value that even cannot support the maintenance nutrient requirement of the animals. Hence, efforts are being directed toward assisting the animals to utilize these low-grade feedstuffs more efficiently as effective utilization of available feed resources is the key to enhance livestock productivity economically. Efficient utilization of crop residues available locally in appreciable quantum seems to be accomplished by the application of feed technology to maximize advantage from feeds in animal system (Afzal et al., 2009; Beigh et al., 2017).

It is useful to convert vast renewable resources from plant by-products and crop residues into food edible for humans. With recycling of these by-products, humanly inedible nutrients in them are utilized by animal which converting them into high-quality foods for human consumption and do not become a waste-disposal problem and reducing costs and imports of animal feedstuffs (Elkholy et al., 2009a; Omer et al., 2012a and 2012b). In addition to recycling of plants by-products or crop residues to be used as animal feed help food processor to save money and also decrease the environmental pollution (Elkholy et al., 2009b).

One of the important limiting factors for animal production in Egypt is the availability of feedstuffs. Locally produced feeds are not sufficient to cover the nutritional requirements of livestock (Abou-Akkada, 1988). In addition to in Egypt, the total area planted by clover hay reached about 2 million feddans (EMA, 2003). Recently, according to the national policy, the berseem area was decreased to increase the wheat area. Using non-traditional feed in animal feeding led to some advantages such as participates in solving the problem of feed shortage, decrease the cost of feeding and alleviate the pollution problems (Abdel-Magid et al., 2008).

Also, the agricultural policy in Egypt aimed to increase the area cultivated by strategically crops on behalf of that cultivated by berseem. At the same time, several crops such as chick pea, pea, peanut, beans, kidney beans, linseed, lentil and others are cultivated in the newly reclaimed lands. So, significant amounts of the straws of these crops are produced annually as residues, about 25 thousand tons from chick pea straw (EMA, 2003) and 13 thousand tons from pea straw (AIEG, 2005).

Several studies have investigated the effects of roughage source and/or level on DMI and performance by feedlot cattle fed high-concentrate diets, literature data make it clear that roughage source and level can have substantial effects on DMI by cattle fed concentrate rations (Defoor et al., 2002; Galyean and Defoor, 2003) and El-Bedawy et al., (2004a & 2004b); Abdel-Magid et al., (2008); Khorshed (2008) with sheep. The effect on dry matter intake of adding a concentrate supplement to forage depends on the digestibility of the forage. Concentrate added to forage of low digestibility tends to be consumed in addition to the forage, but when added to forage of high digestibility it tends to replace the forage (McDonald et al., 1995).

Roughage play a major role as feed for ruminants, also, seasonal patterns affect the availability and quality of the roughages, particularly during the dry season (Wanapat, 1999).

It is evident from the literature that forage or roughage alone can not supply sufficient energy especially for high producing animals, therefore concentrate supplementation is always needed for maximizing intake and consequently improving overall performance of ruminant animal (Morita et al., 1996).

Lentil ranks the 5th among most important pulses in the world and is extremely important for diets of Near East and Indian (FAO, 2012). Its by-product lentil straw (LS, an unconventional feed) is a nutrient-dense feed stuff, due to its leguminous nature, LS has better ruminal degradation with whole tract digestibility as compared to routinely used cereal straws (Lopez et al., 2005; Singh et al., 2011; Lardy et al., 2015) and successful use of LS in the ration of large ruminants and sheep (Abbeddou et al., 2011a; Lardy et al., 2015) without having any side effect on the quality of animal products (Abbeddou et al., 2011b), which suggests its high acceptability and digestibility in livestock ration.

So, the main objective of this study was carried out to evaluate the impact of incorporation unconventional sources of roughages (field crop residues) such as (pea straw, chick pea straw or lentil straw) instead of berseem hay in sheep rations formulation on their performance, water consumption, economic efficiency and some of blood parameters.

MATERIALS AND METHODS

This study was carried out in co-operation work among Animal Production Department, National Research Centre, 33 El-Bohouth Street, P.O: 12622, Dokki, Giza, Egypt and Regional Center for Food and Feed, Agriculture Research Center, Ministry of Agriculture, Giza, Egypt.

The present work aimed to investigate the impact of incorporation different roughage sources as alternative source of Berseem hay (BH) in growing sheep rations on their growth performance, drinking water intake and economic efficiency.

Animals and feeds

Twenty eight growing Barki male lambs aged 6 months with an initial live body weight 24.05±0.25 kg approximately were used to investigate the influence of replacing Berseem hay (BH) that considered the good quality roughage source in sheep feeding by alternative sources of roughage (field crop residues) such as Pea straw (PS), Chick pea straw (CPS) or Lentil straw (LS).

The animals were randomly assigned to four experimental groups (seven lambs in each treatment).

Experimental animals were housed in semi-open pens and fed as group feeding for 120 days, the experimental rations were offered in form of complete feed mixture that formulated to cover the requirements of growing sheep according to the NRC (1985).

Lambs were received one of the experimental rations that assigned as follows:

- First*1st* experimental ration contained 30% Berseem hay and considered as control (R_1).
- Second*2nd* experimental ration contained 30% pea straw (R_2).
- Third*3th* experimental ration contained 30% chick pea straw (R_3).
- Fourth*4th* experimental ration contained 30% lentil straw (R_4).

Daily amounts of the experimental rations were adjusted every 2 weeks according to body weight changes. Rations were offered twice daily in two equal portions at 800 and 1400 hours, while feed residues were daily collected, sun dried and weekly weighed.

Fresh water was freely available at all times in plastic containers. Individual body weight change was recorded weekly before receiving the morning ration.

Chemical analysis (%) of ingredients and the experimental rations are presented in Tables (1 and 2).

Analytical procedures

Chemical analysis of ingredients and experimental ration samples were analyzed according to AOAC (2005) methods.

Blood samples were collected at the end of feeding trial from 12 animals (Three animals from each group) 3 hours post feeding from the left jugular vein in heparinized test tubes and centrifuged at 5.000 rpm for 15 minutes. Plasma was kept frozen at -20 C for subsequent analysis of glucose, hemoglobin were evaluated according to the method described by Weiss and Wardrop (210), 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); urea according to Patton and Crouch (1977); plasma glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) activities were determined as described by Reitman and Frankel (1957) and Harold (1975); while globulin was calculated by difference between total protein and albumin. Albumin: globulin ratio (A: G ratio) was also calculated.

Calculations

Gross energy (Kcal/ Kg DM) calculated according to Blaxter (1968). Each g CP= 5.65 Kcal, g EE= 9.40 Kcal and g (CF & NFE) = 4.15 Kcal.
Digestible energy (DE) was calculated according to NRC (1977) by applying the following equation: DE (kcal/ kg DM) = GE x 0.76.
Non fibrous carbohydrates (NFC) were calculated according to Calsamiglia *et al.* (1995) using the following equation: NFC = 100 – {CP + EE + Ash + NDF}.

Economic evaluation

Calculation of economical efficiency of the experimental rations that used in the present work depended on both local market price of ingredients and price of sheep live body weight.
Economic evaluation was calculated as follows:
The cost for 1-kg gain = total cost (Egyptian pound (LE)) of feed intake/ total gain (kilogram).

Statistical analysis

Data collected of (initial and final live body weight, total body weight gain, Average daily gain, feed and water intake, feed conversion) 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:
$Y_{ij} = \mu + T_i + e_{ij}$ where:
Y_{ij} = observation.
μ = overall mean.
T_i = effect of experimental rations for i = 1-4, 1 = (R_1 contained 30% berseem hay and considered as control), 2 = (R_2 contained 30% of pea straw), 3 = (R_3 contained 30% Chick pea straw) and 4 = (R_4 contained 30% lentil straw).

e_{ij} = the experimental error.

Table: 1. Chemical analysis of feed ingredients used in ration formulation.

Item	Ingredients							
	BH	**PS**	**CPS**	**LS**	**YC**	**WB**	**SBM**	**UDCSM**
Moisture	8.75	7.18	8.64	8.20	7.77	8.74	5.71	10.64
Chemical analysis on DM basis								
OM	91.87	89.64	92.60	89.79	97.60	94.94	93.60	92.60
CP	12.15	11.86	11.56	9.00	9.45	14.16	43.36	26.83
CF	26.50	28.50	30.62	32.91	1.52	10.22	4.26	26.52
EE	2.50	2.44	2.06	1.93	3.66	3.15	1.03	5.26
NFE	50.72	46.84	48.36	45.95	82.97	67.41	44.95	33.99
Ash	8.13	10.36	7.40	10.21	2.40	5.06	6.40	7.40
GE (kcal/ kg DM)	4126	4026	4124	3963	4384	4318	4589	4522
DE kcal/ kg DM)	3136	3060	3134	3012	3332	3282	3488	3437
NFC	26.97	23.21	24.92	25.64	50.24	35.27	12.82	10.39

BH: Berseem hay. PS: Pea straw. CPS: Chick pea straw.
LS: Lentil straw. YC: Yellow corn. WB: wheat bran.
SBM: Soybean meal. UDCSM: un-decorticated cotton seed meal.
OM: Organic matter. CP: Crude protein. CF: Crude fiber.
EE: Ether extract. NFE: Nitrogen free extract
GE: Gross energy. DE: Digestible energy. NFC: Non fibrous carbohydrates.
Gross energy (Kcal/ Kg DM) calculated according to Blaxter (1968).
Where each g CP= 5.65 Kcal, g EE= 9.40 Kcal and g (CF & NFE) = 4.15 Kcal.
DE (kcal/ kg DM) = GE x 0.76 (NRC 1977).
NFC = 100 – {CP + EE + Ash + NDF} according to Calsamiglia et al., (1995)

Table: 2. Composition and chemical analysis of the experimental rations.

Item	Experimental rations				Price of one kg (LE)
	(R_1)	(R_2)	(R_3)	(R_4)	
Composition (%)					
Yellow corn	30.00	30.00	30.00	30.00	3.750
Wheat bran	15.00	15.00	15.00	15.00	3.500
Soybean meal	10.00	10.00	10.00	10.00	7.500
UDCSM	12.00	12.00	12.00	12.00	5.500
Berseem hay (BH)	30.00	-	-	-	3.000
Pea straw (BS)	-	30.00	-	-	1.500
Chick pea straw (CPS)	-	-	30.00	-	1.400
Lentil straw (LS)	-	-	-	30.00	1.300
Limestone	1.20	1.20	1.20	1.20	0.250
Sodium chloride	1.00	1.00	1.00	1.00	1.000
Vitamin & mineral mixture[1]	0.80	0.80	0.80	0.80	15.000
Price of Ton (LE)	4093	3643	3613	3583	-
chemical analysis					
Moisture	8.20	7.73	8.17	8.00	-
Chemical analysis on DM basis					
Organic matter (OM)	92.35	91.68	92.57	91.65	-
Crude protein (CP)	16.17	16.08	16.00	16.00	-
Crude fiber (CE)	13.85	14.15	14.79	15.52	-
Ether extract (EE)	3.05	3.03	2.92	2.82	-
Nitrogen free extract (NFE)	59.28	58.42	58.86	57.31	-
Ash	7.65	8.32	7.43	8.35	-
Gross energy (kcal/ kg DM)	4235	4205	4235	4192	-
Digestible energy (kcal/ kg DM)	3219	3196	3219	3186	-
Non fibrous carbohydrates (NFC)	35.44	34.24	34.74	35.13	-

[1]Vitamin & Mineral mixture: Each kilogram of Vit. & 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, 0.33g Vit. B_6, 8.33 g Vit.B_5, 1.7 mg Vit. $B1_2$, 3.33 g Pantothenic acid, 33 mg Biotin, 0.83g 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.
UDCSM: Un-decorticated cotton seed meal.
Gross energy (Kcal/ Kg DM) calculated according to Blaxter (1968), where each g CP= 5.65 Kcal, g EE= 9.40 Kcal and g (CF & NFE) = 4.15 Kcal.
DE (kcal/ kg DM) = GE x 0.76 (NRC 1977).
R_1: first^{1st} experimental ration contained 30% Berseem hay.
R_2: second^{2nd} experimental ration contained 30% pea straw.
R_3: third^{3th} experimental ration contained 30% chick pea straw.
R_4: fourth^{4th} experimental ration contained 30% Lentil straw.

RESULTS AND DISCUSSION

Data of Table (1) cleared that BH was superior in their content of CP (12.15%) and NFE (50.72%); meanwhile both PS and CPS were contained moderate value of CP (11.86 and 11.56%) and NFE (46.84 and 48.36%) for PS and CPS, respectively, but LS recoded the lowest value of both CP (9%) and NFE (45.95%) comparing to the other sources of roughages mentioned above. On the other hand, LS recorded the highest value of CF (32.91%) followed by CPS (30.625 CF) and PS (28.50% CF). The values of gross energy (GE) ranged from 3963 to 4126 kcal/ kg DM; meanwhile digestible energy (DE) contents varied from 3012 to 3136 kcal/ kg DM, in addition to Non fibrous carbohydrates (NFC) ranged from 23.21 to 26.97% among the four sources of roughage. These values are generally within the published range of many authors (Awadalla et al., 1997; Tawila 1999; Bedawy et al., 2004a & 2004b; Abdel-Magid, 2005; Abdel-Magid et al., 2008; Abbeddou et al., 2011a; Aghajanzadeh-Golshani et al., 2012; Omer et al., 2012a & 2012b; Omer and Badr 2013; Mudgal et al., 2018).

In general, the chemical analysis of any feedstuff still the preliminary indicator on the possibility of using such material in feeding live stocks, but the final evaluation can't obtain without more information through digestibility trials and determining the feeding values of this feedstuff.

Composition and chemical analysis of the experimental rations are presented in Table (2) showed that all experimental ration were formulated to met the requirements of growing sheep, in addition, rations seams to be almost iso-caloric (gross energy ranged from 4192 to 4235 kcal/ kg DM); (digestible energy contents varied from 3186 to 3219 kcal/ kg DM) and iso-nitrogenous (CP ranged from 16.00 to 16.17%). On the other hand, crude fiber (CF) contents were slightly differ resulting change source roughage used as alternative source of Berseem hay (BH), these related to differ content of CF in the tested roughage sources used (CF ranged from 13.85 to 15.52%). Ether extract (EE) contents ranged from (2.82 to 3.05%), meanwhile, values of non fibrous carbohydrates (NFC) ranged from 34.24 to 35.44% among the different four experimental rations.

Productive performance of the experimental groups

Live bloody weight

Incorporation different unconventional sources of roughage as alternative for berseem hay had no significant (P>0.05) effect on their total body weight gain (TBWG), average daily gain (ADG) and metabolic body weight ($kgW^{0.75}$). Moreover, R_2 that contained 30% pea straw insignificantly increased their BWG, ADG and metabolic body weight ($kgW^{0.75}$) in comparison with the other groups (Table 3).

These results in harmony with those obtained by Abdel-Magid et al., (2008) who noted that during the growing period, sheep fed 35% pea straw containing diet group recorded the highest values of body weight gains (BWG) and average daily gain (ADG) followed by those of the control (35% Berseem hay (BH), while the lowest value was recorded for those fed 35% Chick pea straw (CPS) diet. Forster et al., (1988) recorded that lambs given 30% ground maize and 70% chopped forage of 0, 25, 50, 75 or 100% pea hay with Lucerne showed no significant differences in daily weight gains.

Feed intake

Data of Table (3) cleared that replacing BH (R_1) by CPS (R_3) or LS (R_4) caused significant decreasing (P<0.05) in dry matter intake (DMI), crude protein intake (CPI), gross energy intake (GEI) and digestible energy intake (DEI). Meanwhile inclusion PS (R_2) as a replacement for BH (R_1) or LS (R_4) was insignificantly decreased the same parameters mentioned above. On the other hand, non fibrous carbohydrates intake (NFCI) was significantly (P<0.05) decreased in (R_2, R_3 and R_4) comparing to BH containing ration (R_1). These results in agreement with those reported by El-Basiony (1992) who observed that calves fed berseem hay consumed less (P<0.05) DM.

Also, our results in agreement with those found by Abdel-Magid et al., (2008) who observed that Rahmani lambs fed berseem hay consumed less (P<0.05) DM compared to pea straw. On the other hand, the present results disagreement with those found by Omer et al., (2012b) who noted that inclusion peanut vein hay (PVH); beans straw (BS); kidney beans straw (KBS) or linseed straw (LS) in sheep diet significantly increased (P<0.05) feed consumption as DM or CP intakes in comparison with the BH containing diet. In addition to, Pathirana and Ørskov (1995) recorded an increasing in nutrient intake as a result of increases of forage legumes as supplements to low quality basal diets. Bartle et al., (1994) fed alfalfa and cottonseed hulls at 10, 20, or 30% of the dietary DM to finishing beef cattle; they found that within each roughage level, DMI was decreased compared to control diet. Guthrie et al., (1996) fed heifers diets with alfalfa, cottonseed hulls, and sorghum Sudan grass hay at either 7.5 or 15% of DM in whole shelled corn-based diets. They noted that DMI was greater by heifers fed the cottonseed hull and sorghum Sudan grass hay diets than by those fed alfalfa. On the other hand, Gad Alla (1997); Mohamed (1999); El-Adawy and Borhami (2001); Tag El-Din et al., (2002); Abdel-Magid (2005); Omer et al., (2011) and Omer and Badr (2013) noted that, replacing berseem hay by carrot-tops, strawberry byproducts, peanut hay, kidney beans or pea straws significantly improved the growth performance of growing rabbits.

Feed conversion

Data of Table (3) showed that feed conversion that expressed as g. intake / g. gain of dry matter or crude protein for rations contained 30% of PS or CPS or LS (R_2, R_3 and R_4) were in significant improved compared to BH (R_1). However, feed conversion that expressed as g. intake /g. gain of NFC for ration contained 30% PS (R_2) was significantly (P<0.05) improved in comparison with the BH (R_1) containing ration.

Table: 3. Productive performance of the experimental groups.

Item	Experimental rations				SEM
	(R_1)	(R_2)	(R_3)	(R_4)	
Live body weight, g					
Lambs number	7	7	7	7	-
Initial weight (kg)	24.100	23.900	24.200	24.000	0.25
Final weight (FW, kg)	46.400	47.000	45.850	45.900	0.20
Total body weight gain (TBWG, kg)	22.300	23.100	21.650	21.900	0.26
Experimental duration period	120 days				
Average daily gain (ADG, g/day)	186	193	180	183	2.11
Average body weight, kg*	35.250	35.450	35.025	34.950	0.20
Metabolic body weight ($kgW^{0.75}$)	17.98	18.26	17.66	17.56	0.27
Feed intake					
Dry matter intake as					
g/h/day	1058^{a}	1035^{ab}	1005^{bc}	989^{c}	7.39
$g/kgW^{0.75}$	58.84	56.68	56.91	56.32	5.30
Kg/ 100 kg live body weight	3.001^{a}	2.920^{b}	2.869^{c}	2.830^{d}	0.01
Crude protein intake as					
g/h/day	171^{a}	166^{ab}	161^{bc}	158^{c}	1.28
$g/kgW^{0.75}$	9.51	9.09	9.12	9.00	0.09
g/ 100 kg live body weight	485^{a}	468^{b}	460^{c}	452^{d}	2.45
Non fibrous carbohydrates intake as					
g/h/day	375^{a}	354^{b}	349^{b}	347^{b}	2.82
$g/kgW^{0.75}$	20.86^{a}	19.39^{b}	19.76^{ab}	19.76^{ab}	0.21
Kg/ 100 kg live body weight	1.064^{a}	0.999^{b}	0.996^{b}	0.993^{b}	0.01
Gross energy intake as					
kcal/h/day	4481^{a}	4352^{ab}	4256^{bc}	4146^{c}	32.76
$kcal/kgW^{0.75}$	249	238	241	236	2.68
Mcal/ 100 kg live body weight	12.712^{a}	12.276^{b}	12.151^{c}	11.863^{d}	0.06
Digestible energy intake as					
kcal/h/day	3406^{a}	3308^{ab}	3235^{bc}	3151^{c}	24.92
$kcal/kgW^{0.75}$	189	181	183	179	1.66
Mcal/ 100 kg live body weight	9.662^{a}	9.331^{b}	9.236^{c}	9.016^{d}	0.05
Feed conversion expressed as g. intake / g. gain of					
Dry matter	5.688	5.363	5.583	5.404	0.07
Crude protein	0.919	0.860	0.894	0.863	0.01
Non fibrous carbohydrates	2.016^{b}	1.834^{a}	1.939^{ab}	1.896^{ab}	0.03
Feed conversion expressed as kcal intake / g. gain of					
Gross energy	24.09	22.55	23.64	22.66	0.31
Digestible energy	18.31	17.14	17.97	17.22	0.24

a, b c and d: Means in the same row having different superscripts differ significantly ($P<0.05$).
SEM: Standard error of mean.
* Average body weight, kg = initial weight + final weight / 2.
R_1: first^{1st} experimental ration contained 30% Berseem hay.
R_2: second^{2nd} experimental ration contained 30% pea straw.
R_3: third^{3th} experimental ration contained 30% chick pea straw.
R_4: fourth^{4th} experimental ration contained 30% Lentil straw.

Also, feed conversion that expressed as kcal intake/ g. gain of gross energy or digestible energy in significantly improved. These results in agreement with those obtained by Abdel-Magid et al., (2008) who reported that incorporation 35% of pea straw in sheep ration insignificantly improved their feed conversion that expressed as kg DM intake/ kg gain (4.69) comparing to sheep received ration containing 35% berseem hay (4.78). Also, results in agreement with those found by Gad Alla (1997) who stated that feed conversion was improved by incorporation of sun dried crops and vegetable residues up to 50 or 75%. In addition to, the present results in agreement with those found by Abdel-Magid (2005) and El-Medany et al., (2008) and Omer et al., (2011)and Omer and Badr

(2013) who replaced berseem hay with pea, chick pea or kidney beans straws; dried carrot processing waste or strawberry by-products, in growing rabbit diets.

Drinking water by the experimental groups

As presented in Table (4) inclusion different tested of roughage sources such as (PS, CPS or LS) in sheep ration as alternative for BH significantly ($P<0.05$) decreased drinking water that expressed as ml/h/day; ml/ $kgw^{0.75}$ and L/ 100 kg live body weight. Meanwhile, incorporation LS only as replacing for BH significantly ($P<0.05$) decrease drinking water that expressed as L/ kg dry matter intake (3.438 vs. 3.592) for LS and BH containing rations, respectively. On the other hand, replacing PS or CPS for BH had no significant effect.

These results in agreement with those obtained by Omer et al., (2012b) who noticed that feeding sheep on ration contained 50% linseed straw significantly decreased their drinking water compared to sheep fed ration contained 50% Berseem hay. Mean while, they noted that feeding sheep on ration contained 50% beans straw significantly ($P<0.05$) increased drinking water, however, feeding sheep on ration contained 50% peanut vein hay or kidney beans straw in significantly increased drinking water in comparison with that received 50% Berseem hay containing diet. In addition to Mohamed (2007) noted that incorporation 15% bean straw plus 15% pea straw and 15% chick pea straw in growing Maghraby camels to replace groundnut hay that incorporated at 40% in control ration in significantly increased their evaluated drinking water.

Because DMI and water intake are positively associated (NRC, 1996), the increased DMI noted with higher dietary concentrations of NDF from roughage could be linked to a positive effect on acid load simply by an associated increase in water intake and dilution of acid. Incomplete mixing of water with ruminal contents (Allen, 1997) would tend to lessen the effects of greater water intake. In addition, increased water intake might merely shift site of acid absorption (i.e., rumen vs. intestines) and thereby not greatly alter total metabolic acid load; however, the temporal pattern of acid absorption would perhaps be altered so as to spread the metabolic acid load more evenly over time (Galyean and Defoor, 2003)

Table: 4. Drinking water by the experimental groups.

Item	Experimental rations				SEM
	(R_1)	(R_2)	(R_3)	(R_4)	
Initial weight (kg)	24.100	23.900	24.200	24.000	0.25
Final weight (kg)	46.400	47.000	45.850	45.900	0.20
Average body weight, kg*	35.250	35.450	35.025	34.950	0.20
Metabolic body weight ($kgW^{0.75}$)	17.98	18.26	17.66	17.56	0.27
Dry matter intake, g	1058^{a}	1035^{ab}	1005^{bc}	989^{c}	7.39
Drinking water					
ml/h/day	3800^{a}	3650^{b}	3550^{b}	3400^{c}	41.03
ml/ $kgw^{0.75}$	211^{a}	200^{b}	201^{b}	194^{b}	2.12
L/ 100 kg live body weight	10.780^{a}	10.296^{b}	10.136^{b}	9.728^{c}	0.11
L/ kg dry matter intake	3.592^{a}	3.527^{a}	3.532^{a}	3.438^{b}	0.02

a, b c and d: Means in the same row having different superscripts differ significantly ($P<0.05$).
SEM: Standard error of mean.
* Average body weight, kg = initial weight + final weight/ 2.
R_1: first^{1st} experimental ration contained 30% Berseem hay.
R_2: second^{2nd} experimental ration contained 30% pea straw.
R_3: third^{3th} experimental ration contained 30% chick pea straw.
R_4: fourth^{4th} experimental ration contained 30% Lentil straw.
Insensible water losses, ml = Total water intake -Total water losses.

Economic evaluation

By-products to replacement of berseem hay contributed in lowering the feeding cost and hence increasing the economic efficiency. Also, our results in agreement with those obtained by Mohamed (2007) who reported that feeding growing Maghraby camels ration that contained 15% bean straw plus 15% pea straw and 15% chick pea straw to replace groundnut hay that acts about 40% of control ration realized improving in their relative economic Economic efficiency was represented by daily profit over feed cost. The costs were based on average values of year 2019 for feeds and live body weight. Feeding costs and profit above feeding costs are shown in Table (5). The results cleared that replacing berseem hay (BH) by other sources of roughage such as Pea straw (PS), Chick pea straw (CPS) or Lentil straw (LS) in sheep ration occurred decreasing in daily feeding coast. The corresponding values were 13.39%, 16.23% and 18.37% for sheep fed rations contained 30% of PS, CPS and LS, respectively comparing to sheep received 30% BH. Meanwhile, daily profit above feeding cost and relative economic efficiency were improved by 16.33%, 3.30% and 10.70% when sheep fed PS or CPS or LS, respectively in comparison with that fed ration contained BH. On the other hand, feed cost LE/ kg gain was improved by 16.51%, 13.44% and 17.03% for sheep fed ration contained 30% PS or CPS or LS, respectively compared to that fed ration contained BH. The relative low price of PS, CPS or LS as compared with that BH made using this by-product in sheep rations a feasible and a promising feed.

The present results in agreement with those obtained by Omer and Badr (2013) who reported that replacement berseem hay (BH) by pea straw (PS) at 25 , 50, 75 and 100% of BH in rabbit rations improved their net revenue by 15.3, 36.7, 19.7 and 28.7% for rations mentioned above, respectively in comparison with that fed ration contained BH only (control). They also, noted that relative economic efficiency was improved by 15.8, 39.5, 23.7 and 34.2%, respectively, for the same tested diets compared to the control diet. Also, our results in agreement with those found by Abdel-Magid (2005); Abou Sekken et al., (2008); El-Medany et al., (2008) and Omer et al., (2011). They recorded that inclusion pea, chick pea or kidney beans straws; peanut hay; fennel and marjoram waste; dried carrot processing waste or strawberry efficiency and depressed their feed cost / kg gain.

Table: 5. Economic evaluation of the experimental groups.

Item	Experimental rations			
	(R_1)	(R_2)	(R_3)	(R_4)
Daily feed intake (fresh, kg)	1.153	1.122	1.094	1.075
Value of 1-kg feed (LE)	4.093	3.643	3.613	3.583
Daily feeding cost (LE) [a]	4.719	4.087	3.953	3.852
Average daily gain (kg)	0.186	0.193	0.180	0.183
Value of daily gain (LE) [b]	11.16	11.58	10.80	10.98
Daily profit above feeding cost (LE)	6.441	7.493	6.847	7.128
Relative economical efficiency [c]	100	116.3	106.3	110.7
Feed cost (LE/ kg gain)	25.37	21.18	21.96	21.05

R_1: first*1st* experimental ration contained 30% Berseem hay.
R_2: second*2nd* experimental ration contained 30% pea straw.
R_3: third*3th* experimental ration contained 30% chick pea straw.
R_4: fourth*4th* experimental ration contained 30% Lentil straw.
LE = Egyptian pound equals 0.06 American dollars ($) approximately.
[a]: based on price of 2019.
[b]: Value of 1-kg live body weight equals 60 LE (2019).
[C]: Assuming that the relative economic efficiency of control ration (R_1) equals 100.

Blood parameters of the experimental groups

As shown in Table (6) the results obtained cleared that, except for hemoglobin content dietary treatments had no significant effect on blood parameters that includes glucose, total protein, albumin, globulin, albumin: globulin ratio, cholesterol, triglycerides, total lipids, GPT, GOT, urea and alkaline phosphatase.

These results in harmony with those noted by Omer et al., (2012a) who reported that replacement 33 or 66 or 100% of clover hay by biologically treated corn stalks had no significant effect on blood plasma contents. Also, our data in agreement with those obtained by Omer and Badr (2013) who observed that replaced 25% of Berseem hay by pea straw in rabbit rations had no significant effect on total protein, albumin, globulin, albumin: globulin ratio, total cholesterol, alkaline phosphatase, AST and ALT. Also, the present results in agreement with those recoded by Abdel-Magid (1997); Gad Alla (1997); Mohamed (1999); Tag El-Din et al., (2002); Abdel-Magid (2005); Abou Sekken et al., (2008) and El-Medany et al., (2008) with rabbits.

Table: 6. Blood parameters of the experimental groups.

Item	Experimental rations				SEM
	(R_1)	(R_2)	(R_3)	(R_4)	
Glucose (mg/dl)	66.44	65.24	66.02	65.98	0.38
Hemoglobin (g/dl)	12.03^{ab}	11.96^{b}	12.15^{a}	12.06^{ab}	0.03
Total protein (g/ dl)	6.16	6.12	6.17	6.13	0.02
Albumin (g/ dl)	3.40	3.34	3.38	3.37	0.06
Globulin (g/ dl)	2.76	2.78	2.79	2.76	0.06
Albumin: globulin ratio	1.23	1.20	1.21	1.22	0.04
Lipiids paaraameters					
Cholesterol (mg/dl)	57.11	56.92	57.08	57.16	0.09
Triglycerides (mg/dl)	29.32	28.96	29.12	29.18	0.09
Total lipids (mg/dl)	356	352	360	354	2.58
Liver function					
GPT (U/l)	32.18	32.20	32.16	32.22	0.10
GOT (U/l)	21.26	21.18	21.20	21.24	0.06
Kidney function					
Urea (mg/dl)	20.16	20.14	20.18	20.15	0.02
Alkaline phosphatase (U/l)	64.31	64.65	64.52	64.61	0.17

a and b: Means in the same row having different superscripts differ significantly ($P<0.05$).
SEM: Standard error of mean.
R_1: first^{1st} experimental ration contained 30% Berseem hay.
R_2: second^{2nd} experimental ration contained 30% pea straw.
R_3: third^{3th} experimental ration contained 30% chick pea straw.
R_4: fourth^{4th} experimental ration contained 30% Lentil straw.

CONCLUSION

From the data obtained, during carrying out for this work and under the same condition for this study, it could be concluded that, pea straw, chick pea straw and lentil straw as unconventional source of roughage considered good alternative for berseem hay in sheep ration resulting depressing in ration costing. Also, it could be successfully used as instead of Berseem hay without causing any adverse effect on their performance and blood constituents.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Hamed A.A.Omer cooporation in designed and performleed the experiments, alculated the data, statistical analysis, wrote the manuscript and reveision the MS during the steps of designed and performleed the experiments and following the publication of the MS.

Ahmed, A.A.M cooperation in designed and performleed the experiments and following the field work.

All authors read and approved the final version.

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