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Response of Growing Male Barki Sheep to Feeding on Rations Containing Gradual Levels of Soybean Straw That Used as Replacement of Concentrate Feed Mixture

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Abstract: One of the very 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. So, our team work aimed to search for using non-traditional feed led to decrease the cost of feeding and alleviate the pollution problem. While, feeding is the main cost of animal production, protein is an essential key ingredient of animal feed and it is necessary for mass sheep growth performance. Concentrate feed mixture (CFM) that used in sheep feeding composed of ingredients highly in their costing such as soybean meal, yellow corn, wheat bran….etc. So, the team work aimed to incorporated the soy bean straw (SBS) to replace a gradually portions of CFM to investigate its impacts on sheep response, digestibility, nitrogen balance, ruminal fermentation and blood constituents. To realize this objective a total numbers of fifteen growing male Barki lambs aged 5-6 months with an average weights (26.400 ± 0.538 kg) were randomly distributed into three equal groups each contains 5 lambs that housed in semi-open pens as group feeding for 74 days to investigate the influence of inclusion soybean straw (SBS) at 30, 40 and 50% meanwhile, concentrate feed mixture (CFM) used at 70, 60 and 50% to produce three experimental rations different in their concentrate: roughage (C: R) ratios as follows R_1 composed of (70: 30), R_2 composed (60: 40) and R_3 composed (50: 50), respectively on their growth performance, digestion coefficients, nitrogen balance, ruminal fermentation and some blood parameters. The results showed that concentrate feed mixture (CFM) was superior in their contents of organic matter (OM), crude protein (CP), ether extract (EE), nitrogen free extrct (NFE), hemicellulose, cell soluble-NDF, gross energy (GE), digestible energy (DE) total digestible nutrient (TDN) and digestible crude protein (DCP) in comparing to soybean straw (SBS). Meanwhile, SBS was suprior in their contents of crude fiber (CF), ash, neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) and cellulose in comparison with CFM. Experimental rations were different in their contents of CP (not iso-nitrogenous), but, it seem to be iso-caloric. Incorporation SBS at different levels in significantly (P>0.05) increased final weight (FW), total body weight gain (TBWG) and average daily gain (ADG). Concentrate feed mixture (CFM) intake significantly (P<0.05) decreased, meanwhile, soy bean straw (SBS) intake significantly (P<0.05) increased. Total dry matter intake in significantly (P>0.05) increased. In addition to, feed conversion values were improved. Sheep received (R_3) that contained the high level (50%) of SBS recorded the highest nutrient digestibility values of DM, OM, CF, EE, NDF, ADF, hemicellulose and cellulose comparing to the others group sheep that fed rations containing 30 or 40 % SBS (R_1 and R_2, respectively). All groups were positive in their nitrogen balance (NB), values of nitrogen retention (NR) as % of nitrogen intake or digested nitrogen were significantly improved in R_2 and R_3 in comparison with R_1. Increasing SBS in the ration significantly (P<0.05) increased ruminal pH, ammonia nitrogen (NH_3-N) and total volatile fatty acids (TVFA"s) concentrations. Ruminal total nitrogen (TN) and ruminal non protein nitrogen (NPN) were significantly (P<0.05) increased with increasing SBS in the rations. Increasing level of SBS realized insignificantly (P>0.05) increasing values of glucose, white blood cell (WBC) count, total protein

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and albumin: globulin ratio. Meanwhile, in significantly (P>0.05) decreasing was recorded for globulin, total cholesterol, total lipids, triglycerides, GOT, urea and alkaline phosphatase. It can be mentioned that soybean straw can be successful used if sheep feeding up to 50% with decreasing the concentrate feed mixture from 70% to 50% without occurring any adverse effect their growth performance, digestibility coefficients, nitrogen balance and ruminal fermentation and blood constituents.

Key words: Soybean straw · Sheep · Performance · Digestion coefficients · Nitrogen balance · Ruminal fermentation · Some blood parameters

INTRODUCTION

Soybean straw, the residual part, has the potential to serve an inexpensive feedstock for the production of fermentable sugars, instead of food sources, such as corn, sugar cane and other food stocks, for the production of bioethanol or other biorefinery products [1, 2]. Among various biomass sources, crop residues such as rice, wheat, barley straw and corn stover have gained considerable interest and several studies have already been reported based on these feed stocks [3-5]. However, soybean straw, like other lignocellulosic biomaterials, consists of a rigid cellulose structure of strongly cross-linked amorphous hemicellulose and lignin Soybean straw contains a relatively low level of hemicellulose and lignin per gram biomass, compared with other lignocellulosic biomasses. Thus, pretreatment is needed to increase the cellulose content and to decrease the hemicellulose and lignin contents in the biomass. The pretreatment processes should enhance the proportion of cellulose in soybean straw [6-10].

Soybean straw is considered as a roughage but with a better nutritional value than rice straw. It is suitable for cattle both as fresh and ensiled material. The most practical ways of utilizing soybean straw in dairy cattle feeding systems are as a roughage source supplemented with protein sources or concentrate feeds, or as supplemental roughage. To improve the nutritive value of soybean straw and pods, treating it chemically with urea and spraying it with a urea/molasses solution have been suggested, The nutritive value of soybean straw is relatively poor with a protein content ranging from 4 to 12% DM and very high fiber contents (NDF about 80% DM). However, like other legume straws, it is a better roughage than most cereal straws [11].

Furthermore, the utilization of soybean straw could offer several advantages for the sustainable development based on the biomass utilization. Sugar crops or alternative lignocellulosic biomass plants consumed nutrients in the soil leading to decreased nutrients levels as noted by [12, 13]. On the other hand, a legume plant soybean with symbiotic bacteria Rhizobia in the nodules of its root systems can fix nitrogen into ammonia and ammonium leading to nitrogen enrichment in the soil, including CO_2 fixation by photosynthesis. Considering the sustainability, the residual biomass from the soybean is a potential resource for production of fermentable sugar [12, 13].

The nutritive value of soybean straw is higher than rice straw but lower than pod husk [14].

The blood biochemical profiles are considered important in evaluating the health status of animals. The estimates of biochemical constituents are the prerequisites to diagnose several pathophysiological and metabolic disorders in cattle [15].

When growing Ossimi lambs fed on soybean straw as a main roughage source that offered *ad lib*, noticed no significant differences in feed intakes of soybean straw were found among different groups as found by [16].

Examination of rumen parameters gives rapid diagnostic test for monitoring the function of the rumen as well as the nutritional health of the animals. Ruminal pH reflects the rumen acidosis condition, while, ruminal total volatile fatty acids as indicator of ruminal fermentation pattern and energy release in animal body. Rumen ciliate protozoa play diverse and important roles in ruminal metabolism of nutrients [17].

So, this work aimed to investigate the impact of inclusion soybean straw at different levels in sheep ration with decrease the quantity of concentrate feed mixture on their productive performance, nutrient digestibility coefficients, nutritive values, ruminal fluid parameters and some of blood parameters.

MATERIALS AND METHODS

This work was carried out in co-operation work among Animal Production Department, National Research Centre, 33 El-Bohouth Street, P.O: 12622, Dokki, Cairo, Egypt and Field Crops Research Department, National Research Centre, 33 El-Bohouth Street, P.O: 12622, Dokki, Cairo, Egypt.

The field work was carried out at El-Nubaria Experimental and Production Station, Sheep Research Unit, El-Imam Malik Village, Behira Governorate.

The present work aimed to investigate the impact of incorporate soybean straw (produced from an experiment of soybean cultivated by added the hydrogel to the soil at rate of 4 g/m^2) at different levels with decreasing the percentages of concentrate feed mixture in sheep ration to decrease their feed costing and to study its influence on their productive performance, water intake and economic efficiency.

Animals and Feeds: A total numbers of Fifteen growing male Barki lambs aged 5-6 months with an average weights (26.400±0.358 kg) were randomly distributed into three equal groups each contain 5 lambs to investigate the impact of inclusion soybean straw (SBS) at different levels 30, 40 and 50%, meanwhile concentrate feed mixture were incorporated at 70, 60 and 50%. That considered as concentrate: roughage ratio as (70: 30), (60: 40) and (50: 50) for R_1, R_2 and R_3, respectively on live weight, average daily gain (ADG), feed conversion, feed and water intakes and economic evaluation.

Experimental animals were housed in semi-open pens and fed as group feeding for 74 days and the experimental rations were offered as 4% of live body weight that cover the requirements of total digestible nutrients and protein for growing sheep.

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

- R_1: 1st experimental ration that composed of 70% concentrate feed mixture (CFM) plus 30% soy bean straw (SBS) and assigned as control.
- R_2: 2nd experimental ration that composed of 60% CFM plus 40 % SBS.
- R_3: 3rd experimental ration that composed of 50% CFM plus 50 % SBS.

Daily amounts of three different experimental rations were adjusted every 2 weeks according to body weight changes and it 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 always freely available in plastic containers. Individual body weight change was recorded weekly before receiving the morning ration.

Chemical analysis (%) of soybean straw (SBS) and concentrate feed mixture (CFM) are presented in (Table 1). Meanwhile, composition and chemical analysis (%) of experimental rations are illustrated in (Table 2).

Digestibility Trials: At the end of feeding trial, twenty digestibility trials were carried out using four animals from each group and housed in individual metabolic cages. Cages allowed catching feces separately from the urine which was collected in attached glass containers containing 50 ml sulphoric acid 10%. Different tested rations (complete fee mixture) were offered at 8.00 a.m. and water was available all times. The digestibility trial consisted of 7 days as a preliminary period followed by 5 days for feces and urine collection. During the collection period, feces and urine were quantitatively collected from each animal once a day at 7.00 a.m. before feeding. Actual quantity of feed intake and water consumption were recorded. A sample of 10% of the collected feces from each animal was sprayed with 10% sulphoric acid and 10% formaldehyde solutions and dried at 60°C for 48 hrs. Samples were mixed and stored for chemical analysis. Composite samples of feeds and feces were finely ground prior to analysis. Also 10% of the daily collected urine from each animal was preserved for nitrogen determination. The nutritive values expressed as the total digestible nutrient (TDN) and digestible crude protein (DCP) of the experimental rations was calculated by classical method that described by [18].

Rumen Fluid Parameters: Rumen fluid samples were collected from four animals at the end of the digestibility trials at 4 hrs post feeding via stomach tube and strained through four layers of cheesecloth. Samples were separated into two portions, the first portion was used for immediate determination of ruminal pH and ammonia nitrogen (NH_3-N) concentration, while the second portion was stored at-20°C after adding a few drops of toluene and a thin layer of paraffin oil till analyzed for volatile fatty acid's (TVFA's).

Blood Parameters: Blood samples were collected at the end of digestibility trials from 20 animals (four animals from each group) at 4 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.

Analytical Procedures: Chemical analysis of the experimental ration samples were analyzed according to AOAC [19] methods. Ruminal pH was immediately determined using a digital pH meter.

Ruminal ammonia nitrogen (NH_3-N) concentrations were determined applying NH_3 diffusion technique using Kjeldahle distillation method according to AOAC [19]. Meanwhile, ruminal total volatile fatty acids (TVF'A) concentrations were determined by steam distillation according to [20]. Molar proportion of volatile fatty acids were determined according to [21].

Blood samples were analyzed using commercial diagnostic kits from Biomerieux, France and Quimica Clinica Aplicada (QCA), Amposta, Spain, were used for assay of serum biochemical parameters. Glucose red blood cell count (RBCs) and white blood cell count. of collected blood samples were described by [22]; hemoglobin as described by [23]; plasma total protein was determined according to [24]; albumin was determined according to [25]; triglycerides were determined according to [26]; total lipids were determined according to [27]; total cholesterol was determined according to [28]; alkaline phosphates activity was measured according to method described by [29]; urea according to [30]; creatinine according to [31]; plasma glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) activities were determined as described by [32]; while globulin was calculated by difference between total protein and albumin. Albumin: globulin ratio (A: G ratio) was also calculated.

Cell wall constituents includes neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to [33]. Meanwhile, hemicellulose and cellulose content were calculated by difference using the following equations:

Hemicellulose = NDF - ADF. Meanwhile, Cellulose =ADF - ADL

Calculations: Non-fibrous carbohydrates (NFC) were calculated according to [34] using the following equation: NFC = 100 - {CP + EE + Ash + NDF}.

Gross energy (kcal/ kg DM) was calculated according to [35] using the following values 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 [36] by applying the following equation: DE (kcal/ kg DM) = GE × 0.76.

Total digestible nutrient (TDN) was calculated according to [36] by applying the following equation: TDN % = DE / 44.3.

Digestible crude protein (DCP): calculated according to [36] by applying the following equation: Digestible crude protein (%) = 0.85 X_1 – 2.5. Where X1= Crude protein % on DM basis.

Statistical Analysis: Data collected of sheep performance includes (live weight, average daily gain, daily dry matter intake and feed conversion); digestion coefficients; cell wall digestibility coefficients; nutritive values; nitrogen balance; ruminal fluid parameters and blood constituents were subjected to statistical analysis as one-way analysis of variance according to [37]. Meanwhile, Duncan's Multiple Range Test [38] 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 different experimental rations for i = 1-3, 1 = R_1: 1st experimental ration that composed of 70% concentrate feed mixture (CFM) plus 30% soy bean straw (SBS) and assigned as control., 2 = R_2: 2nd experimental ration that composed of 60% CFM plus 40 % SBS and 3 = R_3: 3rd experimental ration that composed of 50% CFM plus 50 % SBS. e_{ij} = the experimental error.

RESULTS AND DISCUSSION

Chemical Analysis, Cell Wall Constituent and Nutritive Values of Soybean Straw (SBS) and Concentrate Feed Mixture (CFM): Data illustrated in (Table 1) showed that values of organic matter (OM), crude protein (CP), ether extract (EE), nitrogen free extrct (NFE), hemicellulose, cell soluble-NDF, gross energy (GE), digestible energy (DE) total digestible nutrient (TDN) and digestible crude protein (DCP) were higher for concentrate feed mixture (CFM) in comparison with soybean straw (SBS). Meanwhile, values of crude fiber (CF), ash, neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) and cellulose were higer in SBS comparing to CFM. These results in agreement with those noted by [39-46 and 16] who noted that values recorded for chemical analysis of SBS were ranged from 85.1 to 96.0 % for DM; ranged from 3.0 to 12.6% for CP; ranged from 38.1 to 51.4% for CF; ranged from 76.2 to 83.2% for NDF; ranged from 40.2 to 68.8% for ADF; ranged from 7.5 to 16.4% for ADL (lignin); ranged from 0.80 to 1.7% for EE; ranged from 3.1 to 13.8 % for ash contents, respectively. Also, Soybean straw contains about 25 to 44.2% of cellulose; 5.9 to 22.6 of hemicellulose; 5 to 21.7% of lignin and 2 to 10.6% of ash as noted by [6-10, 13].

Table 1: Chemical analysis, cell wall constituent and nutritive values of feed soybean straw (SBS) and concentrate feed mixture (CFM)

Item	SBS	CFM*
Moisture	9.54	8.01
Chemical analysis on DM basis (%)		
Organic matter (OM)	91.30	95.06
Crude protein (CP)	4.44	16.99
Crude fiber (CF)	42.17	4.71
Ether extract (EE)	1.29	2.91
Nitrogen free extrct (NFE)	43.40	70.45
Ash	8.70	4.94
Cell wall constituents (%)		
Neutral detergent fiber (NDF)	56.63	32.02
Acid detergent fiber (ADF)	47.89	13.73
Acid detergent lignin (ADL)	8.67	2.32
Hemicellulose[1]	8.74	18.29
Cellulose[2]	39.22	11.41
Cell soluble-NDF[3]	43.37	67.98
Non fiber carbohydrates (NFC)[4]	28.94	43.13
Nutritive values		
Gross energy (GE), kcal/ kg DM	3923.00	4353.00
Digestible energy (DE) kcal/ kg DM	29.81	3308.00
Total digestible nutrient (TDN)	67.29	74.67
Digestible crude protein (DCP)	1.27	11.94

*CFM: Concentrate feed mixture composed of 60% yellow corn, 20% soybean meal, 19% wheat bran, 0.20% lime stone, 0.30% sodium chloride, 0.20% anti toxic and 0.30% vitamin and mineral mixture.
SBS: Soybean straw
CFM: Concentrate feed mixture.
[1]Hemicellulos = NDF – ADF.
Cellulose = ADF – ADL.
[3]Cell soluble-NDF = 100 – NDF. [4]NFC = 100 – {CP + EE + Ash + NDF}.

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

	Experimental rations		
Item	R_1	R_2	R_3
Composition of experimental rations	70 % CFM + 30% SBS	60 % CFM + 40% SBS	50 % CFM + 50% SBS
Calculated of chemical analysis (%)			
Moisture	8.47	8.63	8.78
Chemical analysis on DM basis (%)			
Organic matter (OM)	92.43	93.56	93.18
Crude protein (CP)	13.22	11.95	10.70
Crude fiber (CF)	15.95	19.70	23.45
Ether extract (EE)	2.45	2.27	2.11
Nitrogen free extrct (NFE)	60.81	59.64	56.92
Ash	7.57	6.44	6.82
Cell wall constituents (%)			
Neutral detergent fiber (NDF)	39.40	41.87	44.33
Acid detergent fiber (ADF)	23.98	27.40	30.82
Acid detergent lignin (ADL)	4.22	4.86	5.49
Hemicellulose[1]	15.42	14.47	13.51
Cellulose[2]	19.76	22.54	25.33

CFM: Concentrate feed mixture. SBS: Soybean straw.
R_1: 1st experimental ration assigned as control and it contained 70% CFM plus 30% SBS.
R_2: 2nd experimental contained 60% CFM plus 40% SBS.
R_3: 3rd experimental ration contained 50% CFM plus 50% SBS.
[1]Hemicellulos = NDF – ADF.
[2]Cellulose = ADF – ADL.

Composition and Chemical Analysis of the Different Experimental Rations: Data presented in (Table 2) cleared that the experimental rations were different in their contents of CP (not iso-nitrogenous) where CP varied from 10.70 to 13.22% among three experimental ration. But, it seem to be iso-caloric where EE contents ranged from 2.11 to 2.45%. Also, it was noticed that with increasing the percentages of soybean straw (SBS) in sheep rations occurred gradually decreasing in CP, EE, NFE, ash, hemicellulose, cell soluble-NDF and DCP% contents of experimental ratios. Meanwhile, values of CF, NDF, ADF, ADL and cellulose were increased. Moreover, values of NFC, GE DE and TDN were near in the three testes rations. The corresponding values of CP, CF and EE were (13.22, 15.95 and 2.45%); (11.95, 19.70 and 2.27%) and (10.70, 23.45 and 2.11%) for R_1, R_2 and R3, respectively. This variation in chemical analysis of the experimental ration related to the different percentage levels of both CFM and SBS that used in formulation the experimental rations.

Productive Performance of the Experimental Groups: Results of (Table 3) cleared that that inclusion SBS at different levels in significantly (P>0.05) increased final weight (FW), total body weight gain (TBWG) and average daily gain (ADG). Dietary treatments significantly (P<0.05) decreased concentrate feed mixture (CFM) intake, meanwhile, soy bean straw (SBS) significantly (P<0.05) increased in R_2 and R_3 comparing to R_1. On the other hand total dry matter intake in significantly (P>0.05) increased. The corresponding values of total dry matter intake were 998, 1096 and 1067 g for R_1, R_2 and R_3, respectively. Values o f feed conversion expressed as (g. intake / g. gain) of dry matter were improved with R_3 that composed of (50% CFM and 50% SBS) compared to R_1 that composed of (70% CFM plus 30% SBS), Furthermore R_3 recorded the best feed conversion followed by R_2 comparing to R_1.

These results in harmony with those recorded by [47] who noted that when soybean straw incorporated in H.F. X Deoni cross bred interse calves at 50 or 100% of roughage caused insignificantly (P>0.05) increasing in their final weight, total body weight gain and average daily gain, meanwhile, feed intake was increased with increasing the level of SBS but concentrate was decreased. In India, soybean straw fed *ad libitum* with a concentrate to growing kids led to a higher forage intake and lower concentrate intake compared to sorghum stover [48]. In Nigeria, soybean straw included at up to 30% of the DM, replacing maize mill waste, in the diets of growing goats significantly increased DM intake (516 *vs*. 465 g/d) and daily weight gain (57.8 *vs*. 34.7 g/d) as noted by [49]. In the USA, soybean straw given without a supplement to weaned beef cattle heifers did not maintain their weight, but when supplemented with maize grain there was a small weight gain of 110 g/das recorded by [50]. In India, Murrah buffaloes heifers fed soybean straw *ad libitum* as the sole diet had a daily weight gain of 316 g/d, but supplementation was recommended for better performance [51]. Soybean straw fed to growing calves replaced 50% or 100% of sorghum straw in diets with concentrates, supporting the same growth performance [43]. In India, a complete diet comprised of 60% soybean straw and 40% concentrate maintained the body weight of 26 kg adult goats [52]. The same diet allowed a daily weight gain of 48.6 g/d in growing kids [52]. Furthermore, feeding growing Ossimi lambs on soybean straw as a main source of roughage *ad lib*, they showed no significant differences in feed intakes of soybean straw among different groups as noted by [16].

Nutrients & Cell Wall Digestibility Coefficients and Nutritive Values of the Experimental Rations: Data of (Table 4) showed that incorporation soybean straw (SBS) at high level 50% (R_3) recorded the highest nutrient digestibility values of DM, OM, CF, EE, NDF, ADF, hemicellulose and cellulose comparing to the others group sheep that fed rations containing 30 or 40 % SBS (R_1 and R_2, respectively). Meanwhile R_3 recorded the lowest values CP, NFE digestibility and TDN & DCP as a nutritive values determined. On the other hand, R_2 that contained the medium level of SBS (40%) recorded the medium values of nutrient digestibility and nutritive value comparing to R_1 and R_3.

These results in agreement with those obtained by [47] who carried out an experiment that designed to improve the utilization of soybean straw by simple physical mixing jowar straw with soybean straw using Nine H.F. X Deoni cross bred interse calves of 6 to 12 months of age that designed as three groups. First 1^{st} composed of jowar straw *ad lib* plus concentrate and considered as control (T_0); meanwhile, the (T_1) received jowar straw 50% and soybean straw 50% plus concentrate, but (T_2) received 100% soybean straw plus concentrate as per requirement. They reported that the dietary treatment had no (P>0.05) significant effect on different nutrient digestibility coefficients includes (DM, CP, CF, EE and NFE digestibility. Also they mentioned that digestibility of dry matter in T_1 (56.77%) was significantly superior over treatment T_0 (55.75%) and T_2 (55.35%). The digestibility of CP, CF, EE and NFE under

Table 3: Productive performance of the experimental groups

Item	Experimental rations R_1	R_2	R_3	SEM
Initial weight (kg)	26.300	26.200	26.400	0.358
Final weight (FW, kg)	38.000	40.000	41.000	0.739
Total body weight gain (TBWG, kg)	11.700	13.800	14.600	0.629
Experimental duration period		74 days		
Average daily gain (ADG, g/day)	158.11	186.49	197.30	8.467
Feed intake				
Concentrate feed mixture (CFM), g	781^a	689^b	597^c	26.983
Soy bean straw (SBS), g	217^b	407^a	470^a	41.744
Total dry matter intake (DMI)	998	1096	1067	22.55
Feed conversion g DMI. intake / g. gain	6.312^b	5.877^{ab}	5.408^a	0.160

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).
SEM: Standard error of mean.
R_1: 1st experimental ration assigned as control and it contained 70% CFM plus 30% SBS.
R_2: 2nd experimental contained 60% CFM plus 40% SBS.
R_3: 3rd experimental ration contained 50% CFM plus 50% SBS.

Table 4: Nutrients & cell wall digestibility coefficients and nutritive values of the experimental rations

Item	Experimental rations R_1	R_2	R_3	SEM
Nutrient digestibility (%) of				
Dry matter (DM)	73.36^b	74.11^{ab}	74.44^a	0.70
Organic matter (OM)	76.03^b	76.31^b	76.85^a	0.42
Crude protein (CP)	66.12^a	64.10^b	61.68^c	1.91
Crude fiber (CF)	85.12^c	86.92^b	88.51^a	1.47
Ether extract (EE)	78.13^c	81.41^b	83.16^a	2.20
Nitrogen-free extract (NFE)	73.66^a	71.76^b	69.71^c	1.75
Cell wall constituents digestibility of				
Neutral detergent fiber (NDF)	63.12^c	66.19^b	69.80^a	2.89
Acid detergent fiber (ADF)	41.16^c	42.32^b	44.51^a	1.48
Hemicellulose	69.50^c	72.13^b	74.12^a	2.00
Cellulose	78.36^a	80.13^b	80.13^a	2.11
Nutritive values (%)				
Total digestible nutrient (TDN)	71.42^a	71.74^a	70.99^b	0.40
Digestible crude protein (DCP)	8.74^a	7.66^b	6.60^c	0.93

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).
SEM: Standard error of mean.
R_1: 1st experimental ration assigned as control and it contained 70% CFM plus 30% SBS.
R_2: 2nd experimental contained 60% CFM plus 40% SBS.
R3: 3rd experimental ration contained 50% CFM plus 50% SBS.

treatment T_0, T_1 and T_2 were 55.77, 57.77 and 56.00, 52.18, 52.61 and 51.64, 53.15, 56.00 and 54.71 and 56.62, 56.70 and 56.76 per cent, respectively. Also, Similar type of findings was reported by [53, 54]. In the USA, soybean straw treated with various alkalis had a higher *in vitro* DM and OM digestibility. Alkali-treated soybean straw fed alone to heifers and steers (202 kg) for 141 days allowed the same daily weight gain as fescue hay [55, 56]. Also, the present results in harmony with those found by [57] who carried out an experiment using three groups of goat kids received diets with different concentrate: roughage ratio (90:10); (80:20) and (70:30) for R_1, R_2 and R_3, respectively to study its effects on nutrient digestibility coefficients. They noted that kids in T_2 and T_3 groups that containing 20 or 30% roughage recorded significantly (P<0.01) higher of apparent digestibility coefficient values of DM, OM, EE, CP, CF and NFE than those recorded for kids fed 10% roughage (T_1 group). Also, they noted that T_3 (30% roughage) had the highest values for CP, EE and NFE. In addition to as for fiber fraction digestibility coefficient it seems that T_3 had the highest value of NDF, ADF, cellulose and hemicellulose followed by T_2 while the lowest values were for T_1. In general, it is accepted that adding concentrate to ruminant diets increases DM and OM digestibility [58, 59]. Also, the increase value of digestibility coefficient for CF and it's fraction for sheep with increasing the level of roughage in the rations from (30 to 40 or 50%) may be related to the increased ruminal pH value and/or the increase in ruminal ciliate protozoa numbers and the improvement in rumen fermentations as described by [57]. On the other hand, in a study carried out by [60] they noted that the decrease in ruminal fiber digestion is believed to be caused by the inhibited growth of cellulolytic bacteria when ruminal pH decreases below 6.2. Similar results were obtained by [61] who reported that ruminal OM digestibility was increased while digestibility of NDF and ADF were decreased by increasing the proportion of concentrate in sheep diets. Moreover, [62] fed Sixteen buffalo calves aged about 18-20 months on diets composed of four concentrate: roughage (C: R) ratios (80: 20), (75: 25), (60:40) and (55: 45) to investigate the impact of C: R ratio on their nutrient digestibility and nutritive value. They revealed that increasing in the proportion of concentrate in the diet significantly (P<0.05) increased the digestibility of dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen free extract (NFE) and the total digestible nutrients (TDN).

Nitrogen Utilization by the Experimental Groups: Data of (Table 5) mentioned that nitrogen intake was significantly (P<0.05) decreased with increasing the level of soybean (SBS) increasing from 30 to 40 and 50% in the rations. This may be related to decreasing the CP content in SBS. Fecal nitrogen (FN), urinary nitrogen (UN) and total nitrogen extraction (TNE) were significantly (P<0.05) decreased with increasing the level of SBS in the rations. All values of nitrogen retention (NR) among the three tested groups fed R_1, R_2 or R_3 were positive in their NB, but it was improved with R_2 and R_3 that contained 40 and 50% SBS comparing to R_1 that contained 30% SBS. Values of nitrogen retention as % of nitrogen intake (NR, % of NI) or NR, % of digested nitrogen (DN) were significantly improved in R_2 and R_3 in comparison with R_1. the best values of NR, NR, % of NI and NR, % of DN were recorded by group lambs fed R_2 that received ration containing 40% SBS. These results in agreement with those obtained by [57] who noted that increasing roughage level from 10 to 20 and 30% in goat kids rations improved their nitrogen balance (NB) or nitrogen retention (NR). Goat kids fed rations composed of concentrate: roughage ratio at (70:30) or (80: 20) improved both (NR, % of NI or NR, % of DN) in comparison with that received ration composed of (90: 10). Furthermore [63] noted that nitrogen (NB) balance of goats fed diet with high concentrates showed highest N balance. These results indicate that an increase in concentrate supplementation showed significantly higher NB. In addition to [64] mentioned that N (g/g of N intake) was retained in goats fed high concentrate diets when the concentrate level increased (P>0.05). On the other hand [61] reported that fecal or urine nitrogen excretion and nitrogen retention were not affected by concentrate: roughage ratio.

Ruminal Fluid Parameters of the Experimental Groups: Results illustrated in (Table 6) revealed that increasing level of soybean straw (SBS) in sheep ration from 30 to 40 or 50% significantly (P<0.05) increased ruminal pH, ammonia nitrogen (NH_3-N) and total volatile fatty acids (TVFA"s) concentrations.

Values of molar proportion of volatile fatty acids were significantly (P<0.05) affected by increasing the levels of SBS incorporation in sheep rations. values of acetic, butyric acids % and acetic: propionic acids ratio were significantly (P<0.05) increased with increasing the level of SBS inclusion in the rations from 30% (R_1) to 40 or 50% (R_2 and R_3). Meanwhile, propionic, iso-butyric and valeric acids % were significantly (P<0.05) decreased. On the other hand, values of iso-valeric acid % were insignificantly (P>0.5) decreased.

Values of ruminal total nitrogen (TN) and ruminal non protein nitrogen (NPN) were significantly (P<0.05) increased when SBS increased from 30% (R_1) to 40 and 50% (R_2 and R_3). Meanwhile, values of ruminal true protein nitrogen (TPN) were insignificantly (P>0.05) increased. The impacts of concentrate: Roughage (C: R) ratios on rumen fermentations in ruminants have been investigated widely, but the results were inconsistent. Several possible explanations exist for this difference. Firstly, it might be due to the rumen ecosystem being able to adapt the appropriate changes of C: R ratios [57]. In addition, feeding the lower R: C ratios (40: 60 and 50: 50) rations might have near a similar degradation rate between protein and carbohydrate, which then increased the growth yield of ruminal bacteria compared with the higher R: C ratios (60:40 and 70:30) diets had no difference of NH_3-N and total VFA's concentrations in the rumen [65]. The present results in agreement with those obtained by [57] who noted that increase roughage from 10% (R_1) to 20% (R_2) and 30% (R_3) in goat sheep rations caused significant (P<0.01) difference among treatments in ruminal pH values; the highest (P<0.01) pH value was

Table 5: Nitrogen utilization by the experimental groups

Item	Experimental rations			SEM
	R_1	R_2	R_3	
Nitrogen intake (NI)	21.11[a]	20.96[a]	18.27[b]	0.426
Fecal nitrogen (FN)	4.22[a]	3.86[b]	3.62[c]	0.078
Digested nitrogen (DN)	16.89[a]	17.10[a]	14.65[b]	0.365
Urinary nitrogen (UN)	6.93[a]	5.54[b]	4.90[c]	0.258
Total nitrogen extraction (TNE)	11.15[a]	9.40[b]	8.52[c]	0.334
Nitrogen retention (NR)	9.96[b]	11.56[a]	9.75[b]	0.277
NR, % of NI	47.18_c	55.15[a]	53.37[b]	1.070
NR, % of DN	58.97[b]	67.60[a]	66.55[a]	1.196

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).
SEM: Standard error of mean.
R_1: 1st experimental ration assigned as control and it contained 70% CFM plus 30% SBS.
R_2: 2nd experimental contained 60% CFM plus 40% SBS.
R_3: 3rd experimental ration contained 50% CFM plus 50% SBS.

Table 6: Ruminal fluid parameters of the experimental groups

Item	Experimental rations			SEM
	R_1	R_2	R_3	
pH	6.42[b]	6.63[b]	6.95[a]	0.258
Ammonia nitrogen (NH_3-N), mg/dl	21.16[c]	22.43[b]	23.36[a]	1.004
Total volatile fatty acids (TVFA's), (meq/dl)	8.31[b]	8.79[a]	8.93[a]	0.302
Molar proportion of volatile fatty acids				
Acetic acid %	59.53[c]	60.36[b]	62.04[a]	1.127
Propionic acid %	24.16[a]	23.44[b]	21.92[c]	0.987
Butyric acid %	11.02[c]	11.25[b]	11.49[a]	0.226
Iso-Butyric acid %	1.39[a]	1.28[b]	1.22[c]	0.076
Valeric acid %	2.53[a]	2.42[b]	2.35[c]	0.084
Iso-Valeric acid %	1.37	1.25	0.98	0.502
Acetic acid: Propionic acid ratio	2.46[b]	2.58[a]	2.83[a]	0.161
Ruminal nitrogen fractions (mg/ 100 ml)				
Total nitrogen (TN)	42.36[b]	43.62[a]	44.18[a]	0.997
Non protein nitrogen (NPN)	22.25[b]	23.39[a]	24.14[a]	0.992
True protein nitrogen (TPN)	20.11	20.23	20.04	0.420

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).
SEM: Standard error of mean.
R_1: 1st experimental ration assigned as control and it contained 70% CFM plus 30% SBS.
R_2: 2nd experimental contained 60% CFM plus 40% SBS.
R_3: 3rd experimental ration contained 50% CFM plus 50% SBS.

recorded by T_3 followed by T_2 then T_1. Also, they noticed that three treatments had the previous trend in TVFA's concentration (ml equiv/100 ml RL) as T_3 that contained 30% roughage was the highest one ($P \leq 0.01$) while T_1 that contained 10% roughage was the lowest one. Furthermore, they noted that negative relationship between pH value and TVFA's concentration for each ration. The rumen pH in general decreased with increasing the TVFA's concentration in lambs rumen. Variation in rumen pH might be responsible for the changes in other ruminal metabolites. He also, noted that the changes in the rumen pH affected microorganisms activates and consequently the mutability concentrations. On the other hand, Total VFA's concentration in the rumen of sheep in our study were within the range previously reported for sheep and goats fed diets differ in concentrate :roughage ratio as noted by [57, 58, 64-66]. For ruminal NH_3-N concentration and ruminal nitrogen fraction in agreement with those found by [57] who noted that increasing roughage from 10 (R_1) to 20 (R_2) and 30 (R_3) in goat sheep rations and occurred significantly (P<0.01) difference among treatments in ruminal ammonia nitrogen, non-protein nitrogen, total nitrogen and true protein concentrations (mg/100 ml RL), in addition to, T_3 that contained the high level of roughage 30% had the highest (P<0.01) values followed by T_2 that contained the medium level of roughage 20% and T_1 that contained the lowest level of roughage 10%, respectively.

Table 7: Blood parameters of the experimental groups

Item	Experimental rations			
	R_1	R_2	R_3	SEM
Glucose (mg/dl)	70.12	70.36	70.81	0.192
Hemoglobin (g/dl)	12.36^{b}	12.43^{ab}	12.52^{a}	0.029
Red blood cell (RBC) count (n x10^6/µl)	3.88^{b}	3.92^{ab}	3.96^{a}	0.016
White blood cell (WBC) count (n x10^3/µl)	4.12	4.14	4.16	0.017
Total protein (g/ dl)	6.42	6.46	6.49	0.033
Albumin (g/ dl)	3.22^{b}	3.28^{ab}	3.32^{a}	0.017
Globulin (g/ dl)	3.20	3.18	3.17	0.034
Albumin: globulin ratio	1.01	1.03	1.05	0.013
Lipids parameters				
Total cholesterol (mg/dl)	108.00	107.00	105.00	0.856
Total lipids (mg/dl)	364.00	359.00	355.00	2.189
Triglycerides (mg/dl)	11.96	11.92	11.88	0.020
Liver functions				
GPT (U/I)	38.82^{a}	38.45^{ab}	38.32^{b}	0.100
GOT (U/I)	21.43	21.32	21.19	0.060
Kidney functions				
Urea (mg/dl)	18.40	18.32	18.26	0.100
Createnin (mg/dl)	1.09^{a}	1.04^{ab}	0.99^{b}	0.016
Alkaline phosphatase (U/I)	62.90	62.65	62.46	0.114

a and b: Means in the same row having different superscripts differ significantly (P<0.05).

SEM: Standard error of mean. Glutamic oxaloacetic transaminase. GPT: Glutamic pyruvic transaminase..

R_1: 1st experimental ration assigned as control and it contained 70% CFM plus 30% SBS.

R_2: 2nd experimental contained 60% CFM plus 40% SBS.

R_3: 3rd experimental ration contained 50% CFM plus 50% SBS

They also, noted that the higher values of non-protein nitrogen, total nitrogen and true protein concentrations for T_3 may be related to high CP digestibility as it is involved in ruminal NH_3-N concentration. Also, the present results of rumen parameters are in agreement with those recorded by [64] who found that the pH response over time was greater decreases in pH after feeding in goats receiving diets containing different rough to concentrate ratio. Also, they noted that the expected increase in TVFA"s concentration with high level of concentrate and hence more digestible OM, was not observed (P<0.12), they also, cleared that the ruminal NH_3-N concentration varied (P<0.001) being greater for high- concentrate than low-concentrate diets. On the other hand, Chen *et al*. [67] fed goats treatments contained four forage to concentrate ratios (on dry matter basis): 70:30 (Group A), (60:40 (Group B), 50:50 (Group C) and 40:60 (Group D). They found that the ruminal pH value was decreased (P<0.05) in goats fed the groups C and D diets compared with those fed the A and B diets, although, The concentrations of ruminal NH_3-N and TVFA"s were not affected (P>0.05) by dietary treatments. Also [68, 64] observed no effect of concentrate content on total volatile fatty acids (TVFA's) concentration in the rumen of goats fed different roughage levels. Furthermore [62] noted that feeding buffalo calves on diets composed of concentrate: roughage (C: R) ratios at (80: 20), (75: 25), (60:40) or (55: 45) to investigate the impact of C: R ratio on ruminal fermentation. They recorded that a linearly increasing in both ruminal volatile fatty acids (VFA) and ammonia nitrogen concentrations with increasing the dietary concentrate portion (60, 75 and 80), however the rumen pH were decreased (P<0.01) with increasing the concentrate level in the diet.

Blood Parameters of the Experimental Groups: Data of blood parameters that illustrated in (Table 7) showed that increasing the level of incorporation of soybean straw (SBS) from 30% (R_1) to 40% (R_2) or 50% (R_3) in sheep rations insignificantly (P>0.05) increased values of glucose, white blood cell (WBC) count, total protein and albumin: globulin ratio. Meanwhile, in significantly (P>0.05) decreasing was recorded for globulin, total cholesterol, total lipids, triglycerides, GOT, urea and alkaline phosphatase. Sheep that received ration containing 50% SBS (R_3) significantly (P<0.05) increased values of hemoglobin, red blood cell (RBC) count, albumin, but it significantly (P<0.05) decreased values of GPT and greatening in comparison with that fed ration containing 30% SBS (R_1). The present results near from the results that obtained by [62] who fed buffalo calves on diets composed of concentrate: roughage (C: R) ratios at (80: 20), (75: 25), (60:40) or (55: 45) to investigate the influence of C: R ratio on blood constituent. They noted that increasing the proportion of concentrate from 55 % to 80 % in the diets increased blood glucose, total protein and globulin concentration in buffalo calves.

The increase in plasma glucose concentration reflects higher hepatic glucogenesis as mentioned by [69], associated with the higher propionate proportion. This result support the previous report of [67-72] who revealed that the high concentrate diet probably improved energy balance, protein synthesis and humoral immunity of the animal. Blood urea nitrogen (BUN) was not affected (P>0.05) by different concentrate to roughage ratio in this study. The urea N produced from protein and amino acid catabolism in the body. That implies decreasing protein utilization, increasing blood urea N content [73]. Experimental diets with different C: R ratios failed to induce any impact on liver enzymes (ALT and AST).

CONCLUSION

From the results obtained and under the same condition available through out carrying of this work it can be mentioned that increasing roughage ratio in sheep rations from 30 to 40 or 50 % that resulting in producing rations containing (70: 30) or (60: 40) and (50: 50) % of concentrate: roughage ratio and it realized an improvement in their growth performance, nutrient digestibility coefficients, nitrogen balance and enhances fermentation of rumen parameters such that it had improved ruminal pH, increased ruminal total volatile fatty acids, ammonia nitrogen, non-protein nitrogen, total nitrogen and true protein nitrogen concentration without occurring any adverse effects on their blood constituents. So it can be increasing the percentages of soybean straw in sheep rations up to 50% plus 50% of concentrate feed mixture.

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