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Effect of Whole Substitution of Protein Source by *Nigella sativa* Meal and Sesame Seed Meal in Ration on Performance of Growing Lambs and Calves

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Abstract: This study included two experiments to investigate the effect of whole substitution of soybean meal and cotton seed meal by *Nigella sativa* meal (NSM) and sesame seed meal (SSM) as sources of protein in growing Barki lambs and growing calves ration on growth performance, digestibility and economical study. Experiment I: Fourteen Barki lambs averaged 28.60 kg body weight; 4 months old were divided into 2 groups of 7 animals in each according to live weight in growth trial for 90 days. Animals were fed clover hay plus concentrate feed mixture (CFM). Experiment II: Twenty two male Friesian calves averaged 246 kg live body weight, 14 months old were divided into 2 groups of 11 animals in each according to live weight. Animals were fed wheat straw plus CFM for 120 days. Results of chemical composition indicated that *Nigella sativa* meal and sesame meal were rich in protein and fat 33.13%, 32.35 % and 12.72, 15.45, respectively. Results of experiment I showed insignificant differences between the experimental rations for DM, OM, CP, EE and NFE. Crude fiber (CF) recorded lower value of digestion coefficient with R2 (59.16%) compared with R1 (69.01%). No significant differences observed between two rations in final weight, total weight and average daily gain of growing lambs. The data of feed intake did not show any differences between rations, economical study explained a significant decrease in daily cost with R2 which contained NSM and SSM compared with R1 which contained commercial CFM. Results of experiment II indicated that digestibility values of DM, OM, CP and CF were similar between the two rations while EE and NFE were significant higher with R2 compared with R1. Nutritive values results as TDN and DCP showed significant increase in TDN with R2. There were insignificant differences in average daily gain (ADG) and final body weight (FBW) of the experimental animal fed two tested rations. But there is a slight increase in average daily gain and final weight by 125 g and 15 kg with animal group fed R2 compared with R1. Relative economic efficiency was increased by 57% with replacement NSM and SSM for cotton seed meal and soybean meal. Conclusively, *Nigella sativa* meal and sesame meal are good source of protein and may be used as sole source of protein in rations of growing lambs and bulls and therefore it can be used to improve profitability.

Key words: Growing Calves · Barki Lambs · Sesame Meal · Nigella Sativa Meal And Digestibility

INTRODUCTION

Conventional feed ingredients, such as soybean meal and cotton seed meal tend to increase the animal production costs due to either their being transported from other regions or being considered a commodity. Thus, the replacement of traditional feeds with alternatives has become a common practice in the attempt to lower production costs [1]. While, rations formulated from alternative feeds (by-products) must be efficient and economical, while offering the same performance obtained from conventional rations.

Among these by-products is the sesame seed meal (SSM). It is a by-product of sesame seed pressing. Sesame oil cake or meal is a relatively good source of crude protein (CP) which can replace part of basic ingredients in diets such as soybean and cotton seed meal. The chemical composition of SSM varies according

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to the method of processing mechanical or solvent extraction [2]. Ryu [3] reported that incorporation of SSM in calves rations had positive effects on its performance. Also, SSM improve performance of fattening lambs when fed at levels which ranged from 5% to 20% [4].

Also *Nigella sativa* meal (NSM) considered one of these un-conventional feeds of protein. *Nigella sativa* seed referred to as black cumin, as an important medical and primarily consumed as medical oil. Also, its meal after oil removal can be used as a protein source in animal ration. *Nigella sativa* meal contains most of the essential amino acids, with crude protein about 33% [5]. At the same time, Abdel-Magid *et al.* [6] investigated that *N. sativa* meal could be used to promote growth performance and improve feed conversion and importantly reducing feed costs and hence increased economic efficiency.

The objective of this study was to investigate the effect of whole substitution of soybean meal and cotton seed meal as traditional source of protein by *Nigella sativa* meal and sesame seed meal protein as un-conventional sources of protein in growing Barki lambs and growing calves ration on growth performance, digestibility and economical efficiency.

MATERIALS AND METHODS

Animals

Experiment I: Fourteen Barki lambs averaged 28.60 kg body weight; 4 months old were divided into 2 groups of 7 animals in each according to live weight in growth trial for 90 days. Animals were fed clover hay plus concentrate feed mixture (CFM) by 3% from live body weight (LBW).

Experiment II: Twenty two male Friesian calves averaged 246.90 kg live body weight, 14 months old were divided into 2 groups of 11 animals in each according to live weight. Animals were fed wheat straw plus concentrate feed mixture (CFM) by 1,2 % respectively from live body weight (LBW) for 120 days.

Rations and Feeding Procedures: The growing bulls calves were fed individually and the growing lambs were fed in groups. Concentrate feed mixtures (CFM) and roughages were offered twice daily and water was allowed freely all the day round. Orts were collected just before offering the next day's feed. Animals were weighed every two weeks before morning feeding after 17 h fasting period. Amount of feeds was adjusted according to body weight changes. Feed intake was recorded, daily body weight gain and feed efficiency (kg. feed/kg. gain) were calculated. Formulation of concentrate feed mixtures used in two experiments shown in Table 1.

Table 1: Formulation of the experimental concentrate feed mixtures (CFM)

Item	CFMC	CFMT
Yellow corn	47.5	50
Wheat bran	25	22.5
Soybean meal	10	----
Cottonseed meal	15	----
Sesame meal	----	12.5
Nigella sativa meal	----	12.5
Salt	0.6	0.6
Mineral mix*	0.5	0.5
Limestone	1.4	1.4

CFMC: concentrate feed mixture control and CFMT: concentrate feed mixtures treatment.*Mineral mix: 50g Zn, 50g Mn, 50g Fe, 10g Cu, 0.50g I, 0.10g Co and 0.20g Se plus $CaCo_3$ up to 2kg.

Digestion Trials: Nutrients digestibility were determined by the acid insoluble ash (AIA) technique as described by Van Keulen and Young [7], to determine the digestion coefficients and the nutritive values of the two experimental rations. During feeding trials, feces samples were collected for six successive days from each animal.

Chemical Analysis: Feeds and feces were carried out in triplicate using AOAC [8] methods to determine the concentrations of DM (Method no. 934.01), crude protein (CP; Method no. 2001.11), crude fiber (CF; Method no. 978.10), ash (Method no. 967.05) and ether extract (EE) was determined (Method no. 920.39).

Statistical Analysis: Data were analyzed using the general linear model procedure of SAS [9]. One way ANOVA procedure used to analyze the digestibility, feed intake, growth rate data following the next model; $y_{ij} = \mu + T_{ij} + E_{ij}$, were: μ is the overall mean of y_{ij}, T_{ij} is the treatment effect; the E_{ij} is the experimental error. The differences between means were separated according to Duncan's New Multiple Range Test [10].

RESULTS AND DISCUSSION

Results of chemical composition indicated that *Nigella sativa* meal and sesame seed meal were a rich source of protein and fat 33.13%, 32.35 % and 12.72, 15.45, respectively (Table 2). Concentrate feed mixture for treatment (CFMT) had a higher content of EE and NFE and a lower value of CF compared to CFMC as the traditional CFM. These results may be due to chemical composition of sesame meal and *Nigella sati*va meal.

Table 2: Chemical composition of tested ingredients and concentrate feed mixtures (CFM) in two experiments (on DM basis)

	Ingredients				CFM	
Item	WS	CH	NSM	SSM	CFMC	CFMT
DM	94.56	90.00	90.35	93.85	93.45	93.33
OM	83.52	91.07	91.57	89.80	90.98	91.69
Ash	16.48	8.93	8.45	10.20	9.02	8.31
CP	3.42	13.50	33.13	32.35	14.90	15.50
EE	1.71	2.87	12.72	15.45	4.47	7.48
CF	38.59	30.03	10.96	9.00	14.63	6.58
NFE	39.80	44.67	34.76	33.00	56.98	62.13

WS: wheat straw, CH: Clover hay, NSM: *Nigella sativa* meal, SSM: sesame seed meal, CFMC: concentrate feed mixture control and CFMT: concentrate feed mixture treatment.

Table 3: Effect of the experimental rations on nutrients digestibility and nutritive values (%) of lambs

	Experimental rations		
Item	R1	R2	P value
Chemical composition			
DM	92.30	92.23	----
OM	91.01	91.49	----
Ash	8.99	8.51	----
CP	14.43	14.85	----
EE	3.94	5.96	----
CF	19.76	14.32	----
NFE	52.88	56.36	----
Digestibility			
DM	78.07±0.76	79.15±2.92	0.739
OM	80.26±1.16	80.05±2.77	0.947
CP	74.05±0.97	77.51±3.17	0.355
EE	79.33 [a] ±2.42	64.98 [b] ±4.98	0.150
CF	69.01 [a] ±0.95	59.16 [b] ±3.79	0.021
NFE	71.31±0.53	67.12±3.70	0.325
Nutritive values			
TDN	70.19 [a] ±0.27	65.91 [b] ±0.16	0.0001
DCP	10.69±0.14	11.51±0.47	0.168

Means in the same row with different superscript are significantly different (P<0.05).

Similar trend indicated that NSM and SSM can be a good source of protein and energy which reported by Ayman Hejazi and Abo Omar [2], Abdel-Magid *et al*. [6], Awadalla [11] and El-Kady *et al*. [12].

Experiment I: (Growing lambs)

Chemical Composition of the Experimental Rations, Digestibility and Nutritive Values: Data of chemical analysis of experimental rations of experiment I in Table 3 indicated that R2 contained EE (5.96) and NFE (56.36%) more than R1 and lower value of CF (14.32%). These results might be due to chemical composition of CFM in R2 which contained NSM and SSM as a source of protein.

Results in Table 3 showed insignificant differences between the experimental rations for dry matter (DM), organic matter (OM), Crude protein (CP), ether extract (EE) and nitrogen free extract (NFE). Such results were mainly a reflection of the chemical composition and the proportion of the experimental ingredients especially the four protein sources in rations. In the same time, crude fiber (CF) recorded lower value of digestion coefficient with R2 (59.16%) compared with R1 (69.01%). This may be due to negative effect of higher content of EE in R2 on rumen flora in sheep. Devendra and Lewis [13] and Meggison [14] have demonstrated the depressing effect of fat on fiber digestibility. The same trend were observed by El-Gaafarawy *et al*. [15] and Abd El-Rahman *et al*. [16], with sheep fed different levels of *N. sativa* cake as un-conventional source of protein. Also, Abo Omar, [4] noticed that when Awassi lambs fed rations contained 10 and 20 % SSM. The nutritive value as total digestible nutrients (TDN) was significantly (P<0.05) lower with R2 compared to R1. But digestible crude protein (DCP) had not significant differences with slight increase with R2. These results may be due to the lower values of CF and EE digestibility of R2 compared to R1. These results contrasted with Abd El-Rahman *et al*. [16] when he replaced Jatropha seed meal by NSM.

Growth Performance, Feed Intake and Economical Study: Results of growth performance of lambs fed experimental rations are presented in Table 4. Body weights of the animal groups were similar at the start of the trial. No significant differences (P<0.05) observed between two rations in final weight, total weight and average daily gain. These results did not agree with Abo Omar [4] when lambs fed with 20% sesame oil cake compared to the other groups. On contrary, Abd El-Rahman *et al*. [16] fed growing Demeshgi goats and finding the highest value of average daily gain was recorded for goats fed ration contained 20 % NSM.

Intake as dry matter DMI, total digestible nutrients TDN and digestible crude protein DCP and feed conversion did not show any significant (P<0.05) differences between rations, which may elaborate the former results concerning total of daily gain in differences.

In spite of data of feed intake did not show any differences between rations, economical study explained a significant decrease in daily cost with R2 which contained NSM and SSM compared with R1 which contained commercial CFM. These results mainly due to the high cost of commercial CFM (2.36 LE/kg) compared with 1.94 LE/kg for tested CFM. Meantime the cost of

Table 4: Effect of experimental rations growth performance, feed intake and economical study of lambs

Item	Experimental rations R1	R2	P value
Initial body wt. (IBW), kg	28.71±0.09	28.57±1.79	0.945
Final body wt. (FBW), kg	43.07±0.96	44.28±2.21	0.624
Total body gain, kg	14.27±0.84	15.71±1.31	0.180
Daily gain, g	158±9.0	174±14	0.180
Dry matter intake, kg/head/day			
Roughage	0.36±0.02	0.36±0.04	0.806
Concentrate	0.72±0.008	0.73±0.019	0.806
Total	1.08±0.024	1.09±0.058	0.806
Feed Intake, kg/ Kg BW/day			
Total digestible nutrients	0.76±0.018	0.72±0.039	0.406
Digestible crude protein	0.12±0.002	0.13±0.007	0.392
Feed conversion kg feed/ kg gain			
Dry matter	6.89±0.38	6.96±0.505	0.260
TDN	4.81^{a}±0.005	4.14^{a}±0.01	<0.0001
DCP	0.76±0.003	0.75±0.001	0.288
Economical study			
Daily feed cost (LE)	2.50	2.28	----
Daily gain price (LE)	4.74	5.22	----
Economic efficiency	1.90	2.29	----
Improvement in profitability	100	131	----

Prices (LE: Egyptian pound): CFMC (2.36 LE/kg), CFMT (1.944 LE/kg), clover hay (1.60 LE/kg) and LBW (30 LE/kg). Means in the same row with different superscript are significantly different (P<0.05).

Table 5: Chemical composition, nutrients digestibility and nutritive values of the experimental rations (%) of calves

Item	Experimental rations R1	R2	P value
Chemical composition			
DM	93.64	93.54	----
OM	89.74	90.35	----
Ash	10.26	9.65	----
CP	12.99	13.50	----
EE	4.01	6.52	----
CF	18.63	11.92	----
NFE	54.11	58.41	----
Digestibility			
DM	72.51±1.09	74.42±1.16	0.300
OM	78.34±0.52	77.43±1.14	0.520
CP	71.02±1.70	67.61±1.44	0.201
EE	70.50^{b} ±4.07	85.66^{a} ±2.12	0.030
CF	66.57±0.86	67.65±2.13	0.664
NFE	50.92^{b} ±1.56	66.15^{a} ±1.73	0.040
Nutritive values			
TDN	55.00^{b} ±3.24	68.39^{a} ±1.75	0.022
DCP	9.22±0.22	9.13±0.19	0.758

Means in the same row with different superscript are significantly different (P<0.05).

feeding to produce 1kg of BWG was decreased by 17.19% with substitution SBM and CSM by NSM and SSM in the 2nd ration. Furthermore, economic efficiency as the ratio between price of daily gain and daily cost increased by 20.53% with feeding R2 compared with feeding R1 being 1.90 and 2.29, respectively. Also R2 recorded improvement in its profitability by 31% compared with control ration. Such results were mainly a reflection of the low cost of CFMT and the higher daily gain achieved by feeding R2. These results agreed with Abo Omar, [4], Abd El-Rahman *et al*. [16], Abd El-Ghani [17] and Abd El-Rahman [18].

Experiment II (Growing Calves):

Chemical Composition, Nutrients Digestibility and Nutritive Values: Chemical composition of the two rations was similar except for the EE content due to the high level of EE in the sesame meal and *Nigella sativa* meal when compared to CFMC contained the soybean meal and cotton seed meal. Sauvant *et al.* [19] and Obeidat *et al.* [20] reported the crude protein content in the sesame meal was 46%. However, Khan *et al.* [21] and Ayman Hejazi and Abo Omar [2] reported lower levels of the crude protein (i.e. 22.7 and 32.1%, respectively). Also, these differences noticed with NSM where Abd El-Rahman *et al*. [16] finding that crude protein in NSM was (28.85%). While, Abdel-Magid *et al*. [6] reported that protein content of MSM was 37.40 %. The reason for this disagreement might be due to the oil extraction process.

Digestibility of DM, OM, CP and CF were similar between two rations (Table 5). At the same time, EE and NFE showed significant increase (P<0.05) with R2 compared with R1. Nutritive values results as TDN and DCP showed significant differences between two rations in TDN and no differences in DCP. These results are inconsistent with Abo Omar [4],Obeidat *et al*. [20], Khan *et al.* [21] and Hossain *et al*. [22], who reported that inclusion of sesame meal improved nutrient digestibility. As well as, Abdel-Magid *et al*. [6] finding that substitution 30% or 60% of soybean meal by *Nigella sativa* meal in growing calves rations showed specific improvement in nutrients digestibility. These differences could be related to differences in animal species, level and nutrient content in meals and ration composition.

Growth Performance, Feed Intake and Economical Study: Initial and final body weights, ADG, feed intake, feed conversion ratio and economical study of gain are summarized in Table 6. At the beginning of the study, average initial body weight was similar between two groups. Final weight and ADG did not show significant

Table 6: Effect of experimental rations growth performance, feed intake and economical study

Item	Experimental rations R1	R2	P value
Initial body wt. (IBW), kg	247.50±3.44	246.30±3.71	0.882
Final body wt. (FBW), kg	380.00±5.11	393.90±6.61	0.295
Total body gain, kg	132.50±8.15	147.90±8.47	0.255
Daily gain, kg	1.104±0.068	1.23±0.071	0.232
Dry matter intake, kg/head/day			
Roughage	6.07±0.031	6.20±0.169	0.479
Concentrate	3.04±0.015	3.10±0.084	0.480
Total	9.11±0.46	9.30±0.25	0.470
Feed Intake, kg/ Kg BW/day			
Total digestible nutrients	5.011 [b] ±0.26	6.36 [a] ±0.17	0.0001
Digestible crude protein	0.84±0.0005	0.85±0.022	0.721
Feed conversion kg feed/ kg gain			
Dry matter	8.45±0.56	7.66±0.314	0.241
TDN	4.53[b]±0.01	5.17[a]±0.005	<0.0001
DCP	0.76±0.005	0.75±0.07	0.865
Economical study			
Daily feed cost	18.36	16.15	----
Daily gain price	27.62	30.75	----
Economic effeminacy	1.50	1.90	----
Improvement in profitability	100	157	----

Prices (LE: Egyptian pound): CFMC (2.36 LE/kg), CFMT (1.944 LE/kg), wheat straw (0.8 LE/kg) and LBW (26 LE/kg)..Means in the same row with different superscript are significantly different (P<0.05).

($P < 0.05$) differences. But there was a slight increase in average daily gain and final weight by 125 g and 15 kg with R2 compared with R1. Results revealed also that the total gain and daily gain for successive treatments appeared to be more affected by TDN intake. It was noticeable that R2 with the highest TDN intake 6.3kg/ day produced the highest total gain and daily gain (147.90 and 1.32 kg vs. 132.50 and 1.104 kg in control group). The same results noticed with Abdel-Magid *et al*. [6] when soybean meal replaced with NSM in calves rations. Similarly, Little *et al*. [23] noted an increase of the daily gain of calves supplemented with sesame meal when compared to calves supplemented with cottonseed. No significant difference observed in feed intake between two rations except TDN with R2 was highly significant. This may be due to the higher TDN of R2 (Table 5). As well as, feed conversion did not show significant difference between R1 and R2 with DM and DCP. While, total digestible nutrients recorded higher significant (P<0.05) value with R2 compared with R1. These results are in harmony with those obtained in the previous feeding trial with lambs.

Economical study showed a significant improvement by 57% when NSM and SSM used in R2. Abdel-Magid *et al*. [6] found that Feed costs (LE kg/gain) for ration containing NSM at 20 and 40% were 11.4% and 9.3%, respectively lower than the control ration. Mulugeta and Genrehiwot [24] noticed that sesame seed meal with the supplementation (300g SSM/d/intact sheep) returned a higher profit than the other supplemented and un-supplemented treatments.

CONCLUSION

Results of the two feeding trials showed that *Nigella sativa* meal and sesame seed meal is a good source of protein and can be successfully used as sole source of protein in rations of growing lambs and calves without causing any deleterious effect on performance. The use of *Nigella sativa* meal and sesame seed meal reduced feed cost and therefore it can be used to improve profitability.

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