American-Eurasian J. Agric. & Environ. Sci., 14 (9): 811-816, 2014
ISSN 1818-6769

DOI: 10.5829/idosi.aejaes.2014.14.09.12398

Effect of Substitution of Cotton Seed Meal by Two Various Protein Sources on Productive Performance of Fattening Crossbred Calves

H.H. Abd El-Rahman, Y.A.A. El-Nomeary, M.M. Shoukry and M.I. Mohamed

Department of Animal Production, National Research Centre, Dokki, Giza, Egypt

Abstract: This study was carried out to evaluate the effect of three different protein sources on nutrients digestibility, feeding value, growth performance and economic efficiency of growing calves diets. Twenty-four growing crossbred calves (Balady x Friesian) aged 9 months and weighed in average 238.29 ± 26.25 were randomly allocated into three similar groups (8 animals in each). Black cumin seed (*Nigella sativa*) meal (BCSM) and distiller's dried grains with solubles (DDGS) were incorporated into the experimental concentrate feed mixtures (CFM) to replace 100% of the cotton seed meal (CSM) as a source of protein (30% of total ration). The experimental feed mixtures were fed individually at 2% of calves' body weight in two parts daily at 8 a.m. and 4 p.m. Groundnut vine hay was offered at 1% of calves' body weight. The feeding trial lasted for 120 days, during this period animal's body weight were recorded biweekly and the feed intake was adjusted. At the middle of the feeding trial (60 days), four animals from each group were randomly chosen and using a grab sample method to determine the nutrients digestibility and feeding value of experimental rations. Silica (acid insoluble ash, AIA) was used as internal marker for determine the digestibility. The results indicated also that the digestion coefficients of DM, OM, CP and NFE were significantly ($p<0.05$) higher (69.75, 73.63, 68.93 and 75.78% for BCSM ration than those of CSM ration (64.27, 67.85, 62.25 and 72.65%) and DDGS ration (63.35, 66.75, 63.53 and 73.23%), respectively. On the other hand, nutritive values expressed as TDN or DCP were significantly ($p<0.05$) higher for BCSM ration (72.76 and 10.61 %) than the values of CSM (66.53 and 9.34 %) and DDGS (70.27 and 9.66 %) rations. The results revealed that the total dry matter intake as concentrate and roughage were not significantly different between all experimental rations. The results indicated that average daily gain for calves fed BCSM was 1209 g/d, followed by those fed DDGS and CSM which were 1096 and 1087 g/d, respectively. Feed conversion as a kg DMI/kg gain was better for group 2 (7.71) than groups 1 (8.38) and 3 (8.32). Total feed cost/head and feed cost/kg gain were the lowest for BCSM ration (2569 and 17.7 L.E.) compared with DDGS (2647 and 20.1 L.E.) and CSM (2683 and 20.6 L.E.) rations, respectively. On the other hand, the economic efficiency and economic feed efficiency of animals fed diet contained BCSM was higher (7.74 and 69.50%) than those fed diets contained CSM (2.51 and 45.60%) and DDGS (3.17 and 49.30 %), respectively. The present study suggested the possibility of substitution of CSM by BCSM and DDGS in rations for growing or fattening calves. Black cumin seed meal ration had better nutrients digestibility, feeding values, daily gain and feed efficiency and economical efficiency compared with CSM and DDGS rations.

Key words: Protein sources · Nutrients digestibility · Feeding values · Growth performance · Economic efficiency

INTRODUCTION

In Egypt, cotton seed meal (CSM) is the traditional plant protein source used in formulating ruminant concentrate feed mixture (CFM). But yearly quantity of CSM is considered the backbone of CFM produced. However, the CSM production is not sufficient to give CFM to cover livestock requirements [1]. Recent record high feed ingredient prices around the world are causing animal nutritionists to search for lower cost alternative

Corresponding Author: H.H. Abd El-Rahman, Department od Animal Production, National Research Centre, Dokki, Giza, Egypt.

feed ingredients to minimize the cost of feed animal production. Black cumin seed (*Nigella sativa*) is a spicy plant and it is a member of the Ranunculaceae family. Its extracted oil (37% of the seed content) is being used in some medicinal treatments such as asthma, respiratory depression and cough [2]. However, the residues after oil extraction (meals) are a good protein source for use in animal nutrition, adequately supplemented. In Egypt, the whole seeds or the products of black cumin seed are traditionally used as a flavoring agent for bakery products and for human consumption in medicinal treatments. Expanded utilization and cultivation of *Nigella sativa* for oil extraction make the seed meal available in reasonable amounts for animal feeding. Black cumin seed meal is a rich protein feed source, containing in average 35.2% crude protein [3]. Distiller's dried grains with solubles (DDGS) are the nutrient rich co-product of dry-milled ethanol production. Its utilization as a feed ingredient is well documented as both an energy and a protein supplement. Wet and dried distiller's grains with solubles are relatively high in protein (27 to 30%) and historically have been used as a protein supplement in feedlot cattle diets [4]. Protein and energy are the two major component of feed that influence of the growing and fattening animals. Different vegetable protein sources are used to formulate the rations for growing and fattening animals. These protein sources differ in amino acids profiles which results in varied responses of the animals [5].

The present study aimed to evaluate the effect of substitution of CSM by two protein sources (black cumin seed meal and distiller's dried grains with solubles) on nutrients digestibilities, feeding value, growth performance and economic efficiency of fattening calves.

MATERIALS AND METHODS

This study was carried out at the Dr. Francis Fahmy and Sons Farm, Berkash, Giza and on the Laboratories of Animal Production Department, National Research Center, Dokki, Giza, Egypt.

Feeding Trials: Twenty-four growing crossbred calves (Balady x Friesian), aged 9 months and weighed in average 238.29 ± 26.25 kg randomly allocated into three similar groups (8 animals in each). Black cumin seed (*Nigella sativa*) meal (BCSM) and distiller's dried grains with solubles (DDGS) were incorporated into of the experimental concentrate feed mixtures (CFM) to replace 100% of the cotton seed meal (CSM) as a source of protein (30% of the total ration). The formulation of the three experimental CFM is shown in Table 1. The experimental concentrate feed mixtures were fed individually at 2% of calves' body weight in two parts daily at 8 a.m. and 4 p.m. Groundnut vine hay was offered at 1% of calves body weight. Fresh water was freely available to animals all times. The feeding trial lasted for

Table 1: Ingredients (%) of the experimental concentrate feed mixtures.

Item	CFM1	CFM2	CFM3
Corn grains	50	50	50
Cotton seed meal (CSM)	30	-	-
Black cumin seed meal (BCSM)	-	30	-
Distiller's dried grains with solubles (DDGS)	-	-	30
Wheat bran	17.0	17.0	17.0
Lime stone	2.0	2.0	2.0
Salt	1.0	1.0	1.0

Table 2: Chemical composition of the concentrate feed mixtures and feed ingredients.

		Component, % on dry matter basis					
Item	DM	OM	CP	CF	EE	NFE	Ash
CFM1	87.92	93.80	14.77	18.37	3.45	57.21	6.20
CFM2	88.38	93.55	15.39	13.06	6.06	59.04	6.45
CFM3	87.92	93.82	15.21	11.84	5.88	60.89	6.18
Black cumin seed meal	91.53	92.55	29.75	13.23	16.98	32.59	7.45
Distillers dried grains with solubles	89.30	93.80	28.83	7.30	10.50	47.17	6.20
Cotton seed meal	98.25	93.75	25.65	26.12	3.35	38.63	6.25
Groundnut vine hay	89.20	88.65	14.38	25.10	2.91	46.26	11.35

120 days, during this period animal's body weight were recorded biweekly and the feed intake was adjusted. Chemical composition of feed ingredients is presented in Table 2.

Digestibility Trials: At the middle of the feeding trial (60 days), four animals from each group were randomly chosen and using a grab sample method to determine the nutrients digestibility and feeding value of experimental rations. Silica (acid insoluble ash, AIA) was used as internal marker for determine the digestibility [6]. At 4hrs after the morning feeding, fecal samples (approximately 100 g weight) were collected from the rectum. The fecal was dried at 60°C for 48 hrs and then ground to pass a 1mm size in feed mill for chemical analysis. Dry matter excreted in feces was calculated by dividing silica input in the feeds (grams of silica per day) by silica output in the feces (grams of silica per day). The digestibility coefficient of certain nutrient (DCN) was calculated according to the following equation:

$$DCN = 100 - \frac{100 \times \% \text{ AIA in feeds} \times \% \text{ Nutrient in feces}}{\% \text{ AIA in feces} \times \% \text{ Nutrient in feeds}}$$

Proximate Composition: The moisture content of the samples was determined by oven-drying to constant weight at 105°C. Crude protein (CP), ether extract (EE), crude fiber (CF) and ash content were determined according to the standard methods of AOAC [7]. Nitrogen free extract (NFE) were calculated by difference.

Statistical Analysis: The data of feeding and digestibility trials were statistically analyzed using General Linear Method of Statistical Analysis System [8]. Duncan multiple range test [9] was used to separate among means.

RESULTS AND DISCUSSION

Chemical Composition of the Feed Ingredients and the Experimental Rations: Chemical composition of feed ingredients and the experimental concentrate feed mixtures are shown in Table 2. There was a wide variation in chemical composition of different protein sources. CSM contained the highest CF and the lowest EE% and NFE% among other protein sources. DDGS contained the highest NFE and the lowest CF% compared with the other two protein sources. BCSM contained the highest CP% and EE%. These results are in agreement with Abd El-Rahman [10], who reported that BCSM contained the highest CP% (30.64%) and EE% (17.93%) contents compared with CSM. The high content of EE% recorded for BCSM was mainly due to the incomplete extraction of oil from cumin seeds during processing of meal. These results are in agreement with those obtained by Abd El-Rahman [10], Abd El-Ghani [11] and Abd El-Salam and Mousa [12]. The results in Table 2 indicated that all animals in three groups fed different concentrate feed mixtures were nearly similar in nutrients content expect CF and EE% content. All animals in the three groups fed isonitrogenous rations.

Digestibility Coefficients and Nutritive Value: Nutrient digestibility coefficients and nutritive values of experimental rations are presented in Table 3. The results showed that the digestion coefficients of DM, OM, CP and NFE were significantly ($p<0.05$) higher (69.75, 73.63, 68.93 and 75.78% for BCSM ration than CSM ration (64.27, 67.85, 62.25 and 72.65%) and DDGS ration (63.35, 66.75, 63.53 and 73.23%), respectively. On the other hand, nutritive values expressed as TDN or DCP were significantly ($p<0.05$) higher for BCSM ration than the values of the other two rations. These results are in agreement with those obtained by Abd El-Rahman [10], Abd El-Ghani [11] and El-Gendy *et al.* [13]. Data in Table 3 indicated that R3 including DDGS had lower CF digestibility and higher EE digestibility and nutritive values as TDN and DCP than R1 which containing CSM. The decreasing of CF digestibility might be related to lower CF proportion in R3, it caused faster passage rate of fiber particles from the rumen. This is in agreement with that of Van Soest [14], who found that there is relationship between fiber content in forages and CF digestibility as a result of the rate of passage of feed from the rumen.

Daily Feed Intake: The results in Table 4 showed the daily dry matter and nutrients intake by animals fed three rations. The results revealed that the total dry matter intake as concentrate and roughage were not significantly different between all experimental rations. These results are in agreement with those obtained by Kandylis *et al.* [15] and Suliman and Babiker [16], who observed no difference in feed intake by animals fed different protein sources like ground nut cake, sesame cake, cotton seed cake and sunflower seed cake. The total digestible nutrients intake (TDN) as kg/day and kg/100 kg BW and digestible crude protein intake (DCP) as g/day, $g/kgw^{0,75}$ and g/100 kg BW were significantly ($p<0.05$) higher for ration containing BCSM than the other rations which

Table 3: Digestion coefficients and nutritive value for experimental rations as fed to calves.

	Digestion coefficients, %						Feeding value, % DM	
Item	DM	OM	CP	CF	EE	NFE	TDN	DCP
R1	64.27^{b}	67.85^{b}	62.25^{b}	56.89^{ab}	70.78^{a}	72.65^{b}	66.53^{c}	9.34^{b}
R2	69.75^{a}	73.63^{a}	68.93^{a}	58.68^{a}	71.55^{a}	75.78^{a}	72.76^{a}	10.61^{a}
R3	63.35^{b}	66.75^{b}	63.53^{b}	53.96^{b}	72.85^{a}	73.23^{b}	70.27^{b}	9.66^{b}
±SE	3.20	3.36	2.97	2.62	1.75	1.88	2.95	0.12

a, b and c: means with different letters at the same column are significantly ($p< 0.05$) different.

Table 4: Dry matter, TDN and DCP intake of growing calves fed experimental rations.

	Experimental ration			
Item	R1	R2	R3	±SE
Av. Body weight (kg)	303.44	311.07	303.88	--
Metabolic body size	72.70	74.07	72.78	--
Dry matter intake (kg/day) of :				
CFM	6.07	6.22	6.08	0.19
Roughage	3.03	3.11	3.04	0.08
Total dry matter intake	9.10	9.33	9.12	0.24
Concentrate (%)	66.70	66.67	66.67	--
Roughage (%)	33.30	33.33	33.33	--
Feed intake as:				
Dry matter:				
Kg / day	9.10	9.33	9.12	0.24
g/kg $w^{0.75}$	125.17	125.96	125.31	1.13
Kg /100kgBW	3.00	3.00	3.00	--
TDN:				
Kg/day	6.05^{b}	6.79^{a}	6.41^{ab}	0.20
g/kg $w^{0.75}$	83.28	91.67	88.07	5.73
Kg/100kg BW	1.99^{c}	2.18^{a}	2.08^{b}	3.31
DCP:				
g/day	849.94^{c}	989.91^{a}	880.99^{b}	32.48
g/kg $w^{0.75}$	11.69^{c}	13.36^{a}	12.10^{b}	0.28
g/100kg BW	280.10^{c}	318.27^{a}	289.91^{b}	4.24

a, b and c: means with different letters at the same row are significantly ($p< 0.05$) different.

containing CSM and DDGS as protein sources. The increasing in intakes of TDN and DCP for ration containing BCSM than other rations, may be due to increasing in almost nutrients digestibility and feeding value as shown in Table 3.

Growth Performance and Economical Evaluation: The average daily weight gain (ADG) and feed conversion of the three experimental groups are presented in Table 5. The results indicated that average daily gain for calves fed CFM2 was 1209 g/d, followed by CFM3 and CFM1 which were 1096 and 1087 g/d, respectively. ADG of group 2 fed ration containing BCSM was significantly ($p<0.05$) higher than the other groups. This result might be attributed to the high TDN and DCP intake (Table 4). These results are in agreement with those obtained by Abd El-Rahman [10], who found that calves fed 100% BCSM as a source of protein recorded the highest ($p<0.05$) final body weight compared with 100% CSM. The animals fed ration 1 containing CSM showed lower average body weight than the other rations. This result may be due to lower TDN and DCP intakes compared with the other groups. Moreover, the protein of CFM is affected by the presence of gossypol bonds [17]. In agreement with results obtained in the present study, Khan *et al.* [18] using diets containing cotton seed meal (CSM) and canola meal (CM), found that CSM had less effectiveness for growing animals than (CM). Feed conversion as a kg DMI/kg gain was significantly better for group 2 (7.71) than groups 1 (8.38) and 3 (8.32). However, values obtained for feed conversion as kg TDNI or DCPI/ kg gain for the three groups were nearly similar. These results are in agreement with those obtained by Awadalla [19], Gabr *et al.* [20], El-Ayek *et al.*

Table 5: Growth performance and feed conversion for calves fed experimental rations.

	Experimental rations			
Item	R1	R2	R3	±SE
No. of animals	8	8	8	--
Experimental period (day)	120	120	120	--
Initial body weight (kg)	238.25	238.50	238.13	26.25
Final body weight (kg)	368.63[b]	383.63[a]	369.63[b]	22.00
Total body weight gain (kg /head / period)	130.38[b]	145.13[a]	131.50[b]	18.56
Average daily weight gain (g/h/d)	1086.5[b]	1209.42[a]	1095.83[b]	154.69
DM intake (kg/h/d):				
CFM	6.07	6.22	6.08	0.45
Roughage	3.03	3.11	3.04	0.22
Total dry matter intake	9.10	9.33	9.12	0.68
Feed conversion (kg intake/kg gain):				
DM	8.38[b]	7.71[a]	8.32[b]	--
TDN	5.57	5.62	5.85	--
DCP	0.78	0.82	0.80	--

a and b: means with different letters at the same row are significantly ($p< 0.05$) different.

Table 6: Economic evaluation of the experimental rations for growth performance of calves.

	Experimental rations		
Item	R1	R2	R3
No. of animals	8	8	8
Feeding period (day)	120	120	120
Purchase cost (L.E.*/head)[1]	7385.75	7393.5	7382.03
Feed cost (L.E./head)[2]	2682.63	2569.02	2646.58
Management cost (L.E./head)[3]	720	720	720
Total cost (L.E./head)[4]	10788.4	10682.52	10748.60
Selling income (L.E./head)[5]	11058.90	11508.90	11088.90
Net revenue (L.E./head)[6]	270.5	826.38	340.30
Economic efficiency (%)[7]	2.51	7.74	3.17
Feed cost (L.E./kg gain)	20.6	17.7	20.1
Economic feed efficiency (%)[8]	45.63	69.49	49.25

* L.E. = Egyptian pound that equal 0.1399 US$

1: Body weight X price of one kg (31.00 L.E.).

2: Calculated according to local price (2500, 2300, 2450, 2100, 1800, 3600, 2900,3400 and 1500 L.E. /ton for CFM1, CFM2, CFM3, corn grains, wheat bran, CSM, BCSM, DDGS and groundnut vine hay, respectively). 80 L.E. / ton CFM were added for operation and salt and lime stone costs.

3: Include operation and medicinal cost.

4: Include the management, purchase and feed cost.

5: Body weight x price of one kg at selling (30.00 L.E.).

6: Selling income - total cost.

7: Net revenue / total cost X 100.

8. Price of 1 kg gain – feed cost of 1 kg gain/Feed cost of 1 kg gain x 100.

[21], Abd El-Ghani [11] and Abd El-Rahman [10], who found that black cumin seed meal could be used as a good source of protein. Moreover, Mansour *et al*. [22] reported that using black cumin seed meal diet as a non-traditional source of plant protein to be substituted with soybean meal protein for calves to improve the function of immunological body system against different diseases and to reduce the risk to illness.

Based upon the difference in both growth rate and feeding cost per animal, the economical efficiency as affected by using different protein sources could be calculated (Table 6). Total feed cost/head and feed cost/kg gain were the lowest for BCSM (2569 and 17.7 L.E.) compared with DDGS (2647 and 20.1 L.E.) and CSM (2683 and 20.6 L.E.), respectively. This reduction of feed cost for R2 was due to the lower price of black cumin seed meal (2900 L.E.) compared with 3600 and 3400 L.E. /ton for cotton seed meal and distiller's dried grains with solubles, respectively along with the best feed conversion value obtained for R2 compared to the other rations. On the other hand, the economic efficiency and economic feed efficiency of animals fed diet contained BCSM was

higher (7.74 and 69.50%) than those fed diets contained CSM (2.51 and 45.60%) and DDGS (3.17 and 49.30 %), respectively.

CONCLUSION

The present study suggested the possibility of substitution of cotton seed meal by black cumin seed meal and distillers dried grains with solubles in rations for growing or fattening calves. Black cumin seed meal ration had better nutrients digestibility, feeding values, daily gain and feed efficiency and economical efficiency compared with cotton seed meal and distiller's dried grains with solubles rations.

REFERENCES

1. Agriculture Economics and Statistics Institute, 2000. Ministry of Agriculture, (A.E.S.I.). Agriculture Economics part 1. Agric. Res. Center, Cairo, Egypt.
2. Karawya, M.S., F.M. Hashim, S.M. Abd El-Wahab, K.S. El-Deeb, S.N. Soliman, I.A. Salam, N. Mokhtar and S. El-Hossiny, 1994. Essential oil and lipids of Nigella sativa seed and their biological activity. Zag. J. Pharm. Sci., 3(2): 49-55.
3. Khalifa, M.M., 1995. Nigella seed oil meal as a protein supplement in broiler diets. M. Sc. Thesis, Fac. of Agric., Alexandria Univ., Egypt.
4. Klopfenstein, T.J., G.E. Erickson and V.R. Bremer, 2008. Board-Invited Review: Use of distillers by-products in the beef cattle feeding industry. J. Anim. Sci., 86: 1223-1231.
5. Khaled, M.F., M. Sarwar, A.U. Rehman, M.A. Shahzad and N. Mukhtar, 2012. Effect of dietary sources on lambs performance: A Review. Iranian J. of Applied Animal Science, 2(2): 111-120.
6. Ferret, A., J. Plaixats, G. Caja, J. Gasa and P. Prio, 1999. Using markers to estimate apparent dry matter digestibility, fecal output and dry matter intake in dairy ewes fed Italian ryegrass hay or alfalfa hay. Small Rumin. Res., 33: 145-152.
7. AOAC, 1990. Association of Official Analytical Chemists. 15th Ed. Official Methods of Analysis. Washington, D.C., USA.
8. SAS, 2009. Statistical Analysis System. SAS Inst. Inc. Ed., Cary, NC.
9. Duncan, D.B., 1955. Multiple Range and Multiple F. Test. Biometrics, 11: 1-42.
10. Abd El-Rahman, H.H., 2008. Substitution of cotton seed meal by black cumin seed meal in calves diets. J. Agric. Sci., Mansoura Univ., 33(9): 6435-6441.
11. Abd El-Ghani, A.A., 2003. Effect of cumin seed meal (*Nigella sativa*) as a feed ingredient in growing lambs. Egypt. J. Nutr. & Feeds, 6(1): 49-57.
12. Abd El-Salam, O. and Kh. M. Mousa, 2003. Effect of feeding various sources of nitrogen on the performance of cow calves. Egypt. J. Nutr. & Feeds. (Special Issue), 6: 627-636.
13. El-Gendy, K.M., A.A. Zaki, Faten F. Abou-Ammo and M.F.A. Gamal, 2001. Nigella sativa meal as a protein supplement in ruminant rations. Egypt. J. Nutr. & Feeds, 4: 1-7.
14. Van Soest, P.J., 1982. Nutritional Ecology of the Ruminants. O and B Books Inc. Corvallis, Oregon. USA.
15. Kandylis, K., P.N. Nikokyris and K. Deligiannis, 1999. Performance of growing fattening lambs fed diets containing different proportions of cottonseed meal. J. Sci. Food. Agric., 79(12): 1-4.
16. Suliman, G.M. and S.A. Babiker, 2007. Effect of diet-protein source on lamb fattening. Res. J. Agric. & Biol. Sci., 3(5): 403-408.
17. Soliman, N.A.M., 2002. Studies on rumen metabolism. Ph.D. Thesis. Fac. of Agric. Al-Azhar Univ.
18. Khan, A.G., A. Azim, M.A. Nadeem and M.A. Khan, 1996. Effect of growing fattening diets on the growth performance of intensified Afghani lambs. Small Ruminant Research, 25(1): 39-42.
19. Awadalla, I.M., 1997. The use of black cumin seed (Nigella *sativa*) cake in ration of growing sheep. Egypt. J. Nutr. & Feeds. (Special Issue) 1: 243-249.
20. Gabr, A.A., S.A. Ayouty, A.A. Zaki, Faten F. Abou-Ammo and E.S.I. El-Gohary, 1998. Productive performance of lambs fed diets containing Nigella sativa meal. Egypt. J. Nutr. & Feeds, 1(2): 97-107.
21. El-Ayek, M.Y., A.A. Gabr and A.Z. Mehrez, 1999. Influence of substituting concentrate feed mixture by Nigella sativa meal on: 1- Animal performance and carcass traits of growing lambs. Egypt. J. Nutr. & Feeds, (Special Issue), 2: 265-277.
22. Mansour, Reem S., K.N. Adnan and Y.A. Nader, 2013. The effect of different Nigella sativa L. seed (cake) concentrations on leukocytes counts and some serum immunological parameters in calves. Tikrit J. of Pure Sci., 18(3): 31-34.