Animal (2012), **6:7**, pp 1103–1107 © The Animal Consortium 2011
doi:10.1017/S1751731111002539

animal

Partial replacement of barley grain and soybean meal by fleabane (*Conyza bonariensis*) in diets of growing Awassi lambs

J. M. Abo Omar[1†] and M. Omar[2]

[1]Faculty of Agriculture, Department of Animal Production, An Najah National University, Nablus, Palestine; [2]Ministry of Agriculture, Director of Department of Animal Production, Tulkarm Governorate, Tulkarm, Palestine

(Received 16 May 2010; Accepted 3 November 2011; First published online 12 December 2011)

Effects of partial substitution of barley grain and soybean meal with fleabane (FB) Conyza bonariensis *on growth performances and body compositions of 24 male local Awassi lambs were studied. All lambs were male with an average BW of 20.3 kg (s.d. = 2.0 kg) at the beginning of the experiment. Animals were randomly divided into four groups of six lambs each. Lambs in each group received individually their cereal–soybean-based total mixed rations with levels of FB: 0, 50, 100 and 150 g/kg dry matter (DM) diet, which replaced similar values of barley and soybean meal. All rations were isonitrogenous and isocaloric. The fattening experiment lasted 9 weeks, after which all lambs were slaughtered. The composition of nutrients in the* C. bonariensis *were 89.6%, 15.0%, 28.0%, 30.0% and 10% for organic matter, CP, NDF, ADF and lignin, respectively. At the end of the experiment, lambs fed 100 and 150 g FB/kg DM diets gained more weight ($P < 0.05$) than those fed the control and 50 g FB/kg DM diets. The DM intake was lower in lambs fed the highest level of FB compared with intakes of lambs in other treatments. Diet content of FB had significant effect ($P < 0.05$) on weights of empty body, carcass, gut and external (hide, head and feet) among all animals. However, FB had no effects on lambs' thoracic organs (lungs and heart) and liver. Muscle, bone, omental and mesenteric fat, subcutaneous, intermuscular, pelvic and kidney fat weights (g/kg empty BW) were not affected by FB feeding. Carcass fat was decreased ($P < 0.05$) by the increase of FB. Total body fat was the same in all animals of the experiment.*

Keywords: Awassi lambs, fleabane, performance, carcass

Implications

This work is an initial attempt in finding a new nonconventional feed ingredient for feeding ruminants. The utilization of fleabane (FB), which is classified as weed in livestock rations will have positive impact in reducing livestock feed costs and the overall livelihood of rural farmers. Results of this research showed the advantages of feeding FB to growing lambs as indicated in animals' general performance and feed conversion ratios.

Introduction

In the Palestine Authority, as in many other Middle East countries, there is an acute shortage of conventional feedstuffs for livestock. The high cost of grain feed is one of the major obstacles facing lamb fattening projects (Abo Omar, 2002).

Fleabane (FB, *Conyza bonariensis*) is a perennial native summer plant of the family Asteraceae, considered in all agrosystems as a weed. This weed is part of the local rangelands and had been grazed by ruminants since ages. It plays an important role in supplying CP to grazing ruminants and contributes a significant proportion of herbage fed to ruminants. Often, it is plucked or cut and either fed as fresh or conserved fodder. This weed is widely available in local rangelands from northern to southern areas of Palestine. It is characterized by its adaptation to arid and semiarid conditions and low precipitation. This weed prevails in cultivated lands and may become a weed that increases the cost of cultivation for most of the farmers. Exploiting this weed as a nonconventional feed will reduce cost of ruminant feed and decrease its impact as a weed. However, no information is available on its nutritive value and its potential use as part of ruminants' diets.

There has been some interest in including *C. bonariensis* in diets of ruminants, and so far no real attempt has been made to evaluate its agronomic requirements or nutritional value. Laboratory analyses of *C. bonariensis* suggest a high nutritive value (J Abo Omar, unpublished data). CP (20%), NDF (62%), ADF (38%), Ca (0.7%), Fe (200 mg/kg), K (1.0%) and Mg contents (0.1%) are comparable to other forages commonly

† E-mail: aboomar57@najah.edu

fed to ruminants. It was reported that this weed has the ability to act as a natural antioxidant, which makes this herb advantageous to animals consuming this weed (Nasir and Ali, 1981) and is also of good palatability (Stubbendieck and Conard, 1989).

However, no literature is available about the potential of this weed as a ruminant feed. A close investigation of the possible role of this weed in ruminant feeding is quite desirable.

The objectives of this study were to investigate the nutritive value of *C. bonariensis* and the effects of partial replacement of barley grain by *C. bonariensis* weed on the feed intake, growth performance and carcass characteristics of Awassi fattening lambs.

Material and methods

C. bonariensis growing naturally was sampled for chemical analysis. Whole plants were cut ~7 cm above ground. The weed was harvested from a rangeland close to the study site at north of Tulkarm city at the end of summer at soft pod stage. The weed was sun dried, chopped into pieces of 1 cm length before ration formulation. The study site is considered as a semiarid area at an altitude of 150 m. The soil within the area is sandy loam. The annual rainfall is 500 mm in a season beginning from October until April.

Animals and diets

Care, handling and sampling procedures were approved by the An Najah National University (Nablus, Palestine), Animal Care and Use Committee before initiation of the trial.

This experiment was conducted at a private farm near Tulkarm city/Palestinian territories. A total of 24 weaned male Awassi lambs, with a mean weight of 20.3 kg (s.d. = 2.0 kg) and ~3 months of age were used. Experimental treatments were given to animals by stratified randomization on the basis of live BW, resulting in four groups of lambs with a similar distribution of initial BW. Lambs were fed individually and each lamb was considered as a replicate. Lambs were fed cereal–soybean-based total mixed rations (Table 1), where barley and soybean meal were partially substituted by FB at the following levels:

1. A control group without FB (CON; $n = 6$).
2. A 50 g FB/kg DM diet group (FB50; $n = 6$).
3. A 100 g FB/kg DM diet group (FB100; $n = 6$).
4. A 150 g FB/kg DM diet group (FB150; $n = 6$).

All diets were isonitrogenous/isocaloric, formulated to have 18% CP (DM basis) according to National Research Council (NRC, 1985).

Lambs were housed individually in 1 m × 1 m pens. Fresh drinking water was always made available.

Experimental procedure

After 6 days of adaptation to the control diet, each group received the corresponding experimental diet. The amounts of feed offered and refused were weighed daily and samples were collected for subsequent analyses. The amount of feed offered was adjusted daily on the basis of the previous day's intake, allowing refusals of 15% to 20%. Animals were weighed before morning feeding twice a week until slaughter.

Table 1 *The diet ingredients and chemical composition of experimental feeds given to Awassi lambs (%)*

	Treatment			
	CON	FB50	FB100	FB150
Barley	41.5	39.5	36.5	35.5
Wheat bran	10.0	10.0	10.0	10.0
Soybean meal	24.0	21.0	19.0	15.0
Wheat	10.0	10.0	10.0	10.0
Wheat straw	10.0	10.0	10.0	10.0
Sunflower oil	1.0	1.0	1.0	1.0
DCP	1.0	1.0	1.0	1.0
Limestone	1.5	1.5	1.5	1.5
Salt	0.5	0.5	0.5	0.5
Premix*	0.5	0.5	0.5	0.5
FB	0.0	5.0	10.0	15.0
Chemical analysis				
Dry matter	90.0	89.0	89.0	89.0
CP	18.0	18.1	18.2	18.1
ADF	10.5	12.0	11.8	13.3
NDF	17.0	20.0	23.3	25.0
Ash	6.0	6.0	7.0	6.0
Ca	0.9	0.93	0.90	0.90
P	0.6	0.65	0.61	0.60
ME** (kcal/kg)	2800	2780	2890	2788

CON = control; FB = fleabane; DCP = digestible crude protein; ME = metabolizable energy.
Diets were: (1) no FB (CON; $n = 6$), (2) 50 g/kg FB (FB50; $n = 6$), (3) 100 g/kg FB (FB100; $n = 6$) and (4) 150 g/kg FB (FB150; $n = 6$) of the total mixed diet.
*Composition per 1 kg contained, vitamin A, 2 000 000 IU; vitamin D3, 40 000 IU; vitamin E, 400 IU; Mn, 12.8 mg; Zn, 9.0 mg; I, 1.56 mg; Fe, 6.42 mg; Co, 50 mg; Se, 32 mg plus an antioxidant.
**ME, based on tabular values (National Research Council (NRC, 1985).

At the end of the growth trial (63 days), animals from all the groups were slaughtered.

Measurements at slaughter

Each lamb's BW was recorded before slaughter. After removing and weighing omental and mesenteric fat (OMF), weights of the different components of offal were recorded. These included skin, head, feet, heart, lungs and trachea, the digestive tract, liver and kidneys. All the components of the digestive tract (reticulo-rumen, omasum, abomasum and intestine) were weighed with digestive contents. The digestive tract contents' weight were also recorded. Its weight was subtracted from BW to obtain empty body weight (EBW). Carcasses were weighed warm (WCW) and cold (CCW) after storage for 24 h at 4°C. The commercial dressing percentage (CDP) was calculated as

$$\text{CDP}\,(\%) = 100 \times \text{WCW}/\text{BW}$$

Carcass cutting and dissection

Each carcass was split longitudinally in halves. The left half carcass was cut according to Colomer-Rocher *et al.* (1987) into shoulder, long leg, ribs, flank and neck. Every part was weighed and dissected into fat, muscles and bones. Other tissues such as tendons and lymph nodes were separated as waste. Pelvic and kidney fats were removed and their weights were recorded.

Laboratory analyses

Samples of diets and FB (whole plant samples that included stems, leaves, flowers and capsules) were dried (50°C), ground (1-mm screen) and stored for subsequent analyses. Dry matter (DM) was determined by drying at 105°C until constant weight. The mineral content was then determined by ashing at 600°C for 8 h. Nitrogen was determined by the Kjeldahl method ($CP = n \times 6.25$; Association of Analytical Communities (AOAC, 1990). NDF and ADF were determined according to Van Soest *et al*. (1991).

The samples were analyzed for the mineral elements using atomic absorption spectrophotometer (Shimadzu 650 model), whereas K and Na were determined using flame photometry.

Statistical methods

Data were tested using ANOVA (SAS Institute, 1988). Significant means were subjected to orthogonal polynomial test at $P < 0.05$ level.

Results

General observations

FB is an erect perennial rough stem branching extensively at the base of the plant with tapered leaves covered in stiff hairs, 20 to 75 cm in height. Found from spring to autumn, it is most prevalent in summer months. Narrow leaves are gray to green in color, measuring 2 to 6 cm in length, coarsely toothed and covered in fine hairs. Upper leaves are smaller and linear.

Nutrient composition of C. bonariensis

The composition of nutrients in *C. bonariensis* is presented in Table 2. The FB contents of organic matter, CP, NDF, ADF and lignin were 89.6%, 15%, 62%, 38% and 10%, respectively.

Feed intake, live weight gain and feed conversion ratio

DM intake, average daily gain (ADG) and feed conversion ratio were significantly affected by the inclusion of FB. Intake was lower ($P < 0.05$) in lambs fed the highest levels of FB diets (Table 3). However, the aggregate mean daily gain over the whole growth period was greater ($P < 0.05$) for the 100 and 150 g FB/kg DM diet than that for the 50% FB and control diets (Table 3). The 100 and 150 FB/kg diet had the highest ($P < 0.05$) conversion ratio (6.6 and 6.7 kg feed/kg BW gain). Regression analysis showed a linear significant effect.

EBW, dressing percentage and offal weights

EBW and carcass weights were affected by feeding FB. These were linearly increased with the increasing level of FB (Table 4). However, the dressing percentage was not affected by FB feeding. Offal weights when expressed as g/kg EBW showed that the lungs and heart (LH) and liver organ weights were comparable among lambs in all experimental groups. However, the highest level of FB had significant linear and quadratic effects on gut and hide, head and feet (HHF) weights, respectively (Table 5).

Table 2 *Chemical composition of fleabane used in the experiment*

Nutrient	DM (%)
DM	87.0
CP	15.0
Crude fat	2.0
Crude fiber	27.0
ADF	23.0
NDF	30.0
NFE	42.4
Ash	10.4

DM = dry matter; NFE = nitrogen-free extract.

Table 3 *DMI, ADG and CR of Awassi lambs fed different levels of FB*

	Treatment				
	DMI	Initial BW	Final BW	ADG	CR
CON	1820	23.5	36.8	211	8.1
FB50	1741	23.4	36.4	206	8.4
FB100	1733	23.9	40.4	261	6.6
FB150	1610	22.9	40.4	277	6.7
Regression analysis	Sig.	ns	Sig.	Sig.	Sig.
Linear	Sig.	ns	Sig.	Sig.	Sig.
Quadratic	ns	ns	ns	ns	ns

DMI = dry matter intake; ADG = average daily gain; CR = conversion ratio; FB = fleabane.

Table 4 *Slaughter BW, EBW and DP of Awassi lambs fed different levels of FB*

	Treatment			
	Final BW	EBW	Carcass weight	CDP
CON	36.8	31.3	16.4	47.0
FB50	36.4	31.3	16.0	47.5
FB100	40.4	34.3	18.4	49.1
FB150	40.4	34.7	18.8	49.1
Regression analysis	Sig.	Sig.	Sig.	ns
Linear	Sig.	Sig.	Sig.	ns
Quadratic	ns	ns	ns	ns

EBW = empty body weight; DP = dressing percentages; FB = fleabane; CDP = commercial dressing percentage; CON = control.

Carcass tissue composition and fat repartition

Muscle and bone tissue mean weights when expressed as g/kg EBW were not affected by FB feeding (Table 6). Animals of 150 g FB/kg DM diet had relatively lower carcass fat ($P < 0.05$) compared with those receiving zero and other levels of FB diets.

Carcass fat deposition did not vary with the addition of FB in the ration. A similar trend was observed in weights of total body fat, OMF, subcutaneous, intermuscular, pelvic and kidney fats.

Discussion

Laboratory analyses of *C. bonariensis* suggest a high nutritive value. The nutrient values were comparable to the results reported by previous research (J Abo Omar, unpublished data; Nasir and Ali, 1981).

As expected, the DM intake was declined as the level of FB increased. This result contrasts that of Stubbendieck and Conard (1989) who reported the fair palatability of FB. The anti-nutritional factors such as tannins, trypsin inhibitors and other phenolic compounds in FB might be the reason behind the intake depression. The significant linear increase in ADG in lambs fed 100 and 150 g FB/kg DM diet compared with lambs in the other two groups might be a result of some components in the FB, such as the natural antioxidants (Nasir and Ali, 1981).

The relatively low gain in Awassi lambs in this experiment can be explained by the short fattening period and on the other hand the low rate of gain of the small-sized Awassi breed compared with other heavy lamb breeds (Haddad *et al*., 2001). Several nonconventional feeds resulted in similar ADG results (Abo Omar, 2002; Obeidat *et al*., 2008; Zaza, 2008).

Lambs were slaughtered at different weights and had different EBW. Thereafter, lambs' tissues and organs that were tested were quantified (g/kg EBW). These parameters depend on slaughtering BW (Fehr *et al*., 1976; Marinova *et al*., 2001; Mourad *et al*., 2001; Naser, 2009). Weights (g/kg EBW) of gut and HHF were lower in lambs fed the highest level of FB. However, weights of liver and LH were the same in lambs in different experimental groups. Thonney *et al*. (1987) reported a gut weight decline with maturity. Volatile fatty acids and other nutrients produced by fermentation in the case of feeding of FB diet were probably not determinant for visceral organs' development (Ortigues and Doreau, 1995). Heavier mass of some tissues such as liver, kidney and gut was expected because of the high metabolic activity of these tissues. Such an observation was not detected in this experiment. The weight of offal components rich in bone and/or with a low metabolic activity (HHF) was decreased with FB feeding. This result is in disagreement with previous research where early maturing parts (Wallace, 1948; Prud'hon, 1976) are less affected by feeding in growing animals (Kamalzadeh *et al*., 1998).

Muscle and bone tissue weights when expressed as g/kg EBW were not affected by the FB supplemental level. Animals fed the 100 and 150 g FB/kg diets had lower carcass fat compared with other animals. This result is in agreement with the phenomenon that bone is a tissue with early development in all animal species and does not depend on feeding at older ages. In contrast, fat depots depend on nutrient utilization (Atti *et al*., 2004). The lower fat content observed in this study agrees with reports of Thonney *et al*. (1987), where male sheep had less fat depots, but contrasts the previous reports by Marinova *et al*., (2001) and Atti *et al*., (2004), where sunflower oil supplementation led to a decrease of the relative amount of meat carcass and an increase in fat content. The dissectible fat distribution was not affected by the regimen in this work. In fact, different adipose tissues were similar for all diet groups.

Intermuscular and abdomen fat depositions were not affected by FB feeding. Marinova *et al*. (2001) reported an increase in intermuscular fat as a result of sunflower oil supplementation.

Conclusion

It can be concluded that FB, a widespread weed in local territories, is a potential nonconventional feed and can be used in ruminant rations without any negative effects.

Table 5 *Offal weights (g/kg EBW) of Awassi lambs fed different levels of FB*

	Treatment			
	HHF	Gut	Liver	LH
CON	180	75.0	21.0	20.9
FB50	179.2	76.2	20.0	18.1
FB100	168.3	72.0	20.0	20.0
FB150	165.0	70.0	19.0	19.0
Regression analysis	ns	Sig.	ns	ns
Linear	ns	Sig.	ns	ns
Quadratic	Sig.	ns	ns	ns

EBW = empty body weight; FB = fleabane; HHF = hide, head and feet; LH = lungs and heart; CON = control.

Table 6 *Carcass tissues and fat depots weights (g/kg EBW) of Awassi lambs fed different levels of FB*

	Muscle	Bone	Fat	OMF	TBF	Subcutaneous fat	Intermuscular fat	Pelvic	Kidney	TBF/EBW
CON	319.6	125.8	78.6	41.9	112.6	27.9	53.3	3.8	15.0	11.3
FB50	314.4	123.2	73.6	44.1	115.2	27.2	54.0	4.0	14.8	11.5
FB100	327.2	131.4	77.8	39.8	117.6	27.0	53.4	4.1	15.3	11.7
FB150	329.4	133.3	71.4	40.1	119.6	27.3	54.0	4.5	15.0	11.9
Regression analysis	ns	ns	Sig.	ns	ns	ns	ns	ns	ns	ns
Linear	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Quadratic	ns	ns	Sig.	ns	ns	ns	ns	ns	ns	ns

EBW = empty body weight; FB = fleabane; OMF = omental and mesenteric fat; TBF = total body fat; CON = control.

Most of the tested parameters in the lambs fed with FB were similar or even better than that in control lambs that were fed commercial growing diets; therefore, some economical advantages can be achieved through feeding FB.

Acknowledgments

Authors are thankful to Dr Feras Sawalha and Dr Hassan Abu Qaoud from the Faculty of Agriculture, An Najah National University for their help in revising the manuscript and statistical analysis.

References

Abo Omar J 2002. Effects of feeding different levels of sesame oil cake on performance and digestibility of Awassi lambs. Small Ruminant Research 46, 187–190.

Association of Official Analytical Chemists (AOAC) 1990. Official methods of analysis. AOAC, Washington, DC, USA.

Atti N, Rouissi H and Mahouachi M 2004. The effect of dietary crude protein level on growth, carcass and meat composition of male goat kids in Tunisia. Small Ruminant Research 54, 89–97.

Colomer-Rocher F, Morand-Fehr P and Kirton H 1987. Standard methods and procedures for goats carcass evaluation, jointing and tissue separation. Livestock Production Science 17, 149–159.

Fehr P, Sauvant D, Delage J, Dumont B and Roy G 1976. Effect of feeding methods and age at slaughter on growth performances and carcass characteristics of entire young male goats. Livestock Production Science 3, 183–194.

Haddad SG, Nasr RE and Muwalla MM 2001. Optimum dietary crude protein level for finishing Awassi lambs. Small Ruminant Research 39, 41–46.

Kamalzadeh A, Koops WJ, van Bruchem J, Tamminga S and Zwart D 1998. Feed quality restriction and compensatory growth in growing sheep: development of body organs. Small Ruminant Research 29, 71–82.

Marinova P, Banskalieva V, Alexandrov S, Tzvetkova VH and Stanchev H 2001. Carcass composition and meat quality of kids fed sunflower oil supplemented diet. Small Ruminant Research 42, 217–225.

Mourad M, Gbanamou G and Balde LB 2001. Carcass characteristics of West African dwarf goats under extensive system. Small Ruminant Research 42, 81–85.

Naser O 2009. Effects of source and level of protein on general performance of lambs. Master thesis, An Najah National University, Nablus, Palestine.

Nasir S and Ali I 1981. The flora of West Pakistan, vol. 140. Pangraphics Press, Islamabad, Pakistan.

National Research Council (NRC) 1985. Nutrient requirements of sheep, 6th edition. National Academy Press, Washington, DC, USA.

Obeidat BS, Abdullah AY and Al-Lataifeh FA 2008. The effect of partial replacement of barley grains by *Prosopis juliflora* pods on growth performance, nutrient intake, digestibility, and carcass characteristics of Awassi lambs fed finishing diets. Animal Feed Science and Technology 146, 42–54.

Ortigues I and Doreau M 1995. Responses of splanchnic tissues of ruminants to changes in intake: absorption of digestion end products, tissue mass, metabolic activity and implications to whole animal energy metabolism. Annales de Zootechnie 44, 321–346.

Prud'hon M 1976. La croissance globale de l'agneau: ses caractéristiques et ses lois. Proceedings of the 2èmes Journées de la Recherche Ovine et Caprine: Croissance, engraissement et qualité des carcasses d'agneaux et de chevreaux, INRA–ITOVIC, 1–2 December 1976, Paris, France, pp. 6–20.

SAS Institute 1988. Statistical analysis system. SAS Institute Inc., Cary, NC, USA.

Stubbendieck J and Conard EC 1989. Common legumes of the Great Plains. University of Nebraska Press, Lincoln, NE, USA.

Thonney ML, Taylor CS, Murray JI and McClelland JH 1987. Breed and sex differences in equally mature sheep and goats. 2. Body components at slaughter. Animal Production 45, 261–276.

Van Soest PJ, Robertson JB and Lewis BA 1991. Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to nutrition. Journal of Dairy Science 74, 473–481.

Wallace LR 1948. The growth of lamb before and after birth in relation to the level of nutrition. Journal of Agricultural Sciences 39, 93–103.

Zaza A 2008. Effects of feeding different levels of by products silage on performance of Awassi lambs. Master thesis, An Najah National University, Nablus, Palestine.