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Effect of Feeding Bakery Waste on Sheep Performance and the Carcass Fat Quality

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Abstract: Using four Zandi sheep, digestibility and degradability of bakery waste and barley grain were determined by *in vivo* and *in situ* methods. The digestibility and degradability of bakery waste were 78.8 and 74.6 and that of barley grain were 86.8 and 77.1%, respectively. Twenty eight Zandi male lambs were fattened for 85 days with 4 experimental diets composed of 0, 6, 12.5 and 25% bakery waste in a completely randomized design. The lambs were slaughtered and the carcass traits, internal fat and tail-fat fatty acid concentration, iodine and saponification indices were determined. The effect of diets on dry matter intake, final live weight, average daily gain, Feed Conversion Ratio (FCR), carcass weight, internal fat weight, fat-tail weight, the palmitic and oleic acid contents of fat-tail and internal fat, saponification index and the fat-tail linoleic acid concentrations were not significant ($p>0.05$). The effect of diets on the internal fat and fat-tail iodine index and internal fat linoleic acid concentrations were significant ($p<0.05$). It is concluded that bakery waste can be included up to 25% of the fattening diets of the lambs without adversely affecting performance, with a resultant improvement in the quality of the tail fat and internal fat.

Key words: Bakery waste, carcass quality, degradability, fatty acids

INTRODUCTION

Ruminants are able to thrive on nutrients supplied by agricultural and feed wastes or by-products. Bakery waste is a kind of by-product, which can be used as a high energy feed for animal feeding. It is palatable and rich in carbohydrates, but its protein quality and the vitamin content are low and varies between different samples (Passini *et al*., 2001). The effect of substituting bakery waste up to 30% of the fattening diet of Angus beef cattle on carcass quality was not significant (Passini *et al*., 2001; Trenkle, 1983). Bakery waste can be substituted up to 25% of the grain of the diet and 10% of the TMR (Schorder, 1999). Use of bakery waste up to 25% of the fattening lambs diets did not affect their performance (Guiroy *et al*., 1996). Use of 10% bakery waste in Holstein steers caused feed cost reduction in comparison to corn (Passini *et al*., 2001). Utilization of bakery waste 20 and 40% of sheep diets increased diets digestibility (Champ and Church, 1980). The bakery waste is valuable by-product of Iranian traditional bakery (bread), e.g., Barbary, Sangak, Taftoon and Lavash and about two million ton is produced annually (Afzalzadeh, 2003). The dried bakery waste mixture contains crude protein, crude fibre, ether extract and ash, 12, 1.5, 0.7 and 4.3%, respectively. Metabolisable energy was calculated as a 13.3 $Mj\ kg^{-1}$ (Afzalzadeh, 2003). In Iran most sheep breeds are fat-tailed. The feeding management of animals can influence the size and quality of the fat-tail (Kashan *et al*., 1997). The quality of the fat-tail is better in terms of lower saturated fatty acid concentrations compared to internal fat (Kashan *et al*., 1997; Parvaneh, 1994).

The objective of this experiment was to study the effect of feeding bakery waste on performance of fattening lambs and the quality of the internal fat and tail-fat.

MATERIALS AND METHODS

Using four ruminally fistulated Zandi sheep, the *in vivo* digestibility (computed by difference) and the *in situ* degradability (Orskov *et al*., 1980) of bakery waste and barley grain were determined. The degradability was estimated by Eq. 1; fitted by NEWAY package (Neway, 1985).

$$P = a+b\,(1-e^{-ct}). \qquad (1)$$

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Where: P (%) = Potential degradability, a (%) = Intercept, b (%) = insoluble but degradable material, c (%/h) = constant rate of degradability, t = time (hours) and e = neperian value.

The soluble sugars of bakery waste and barley grain were determined by the AOAC method (AOAC, 1990).

Twenty eight Zandi male lambs were fattened with four experimental diets containing 0, 6, 12.5 and 25% of bakery waste in a completely randomized design. The composition and chemical analysis of the four treatment diets are shown in Table 1. All types of bakery waste were collected, ground and mixed with other feed ingredients. Sheep were fed a total mixed diet according to AFRC (1993) recommendations (Table 1). The animals were adapted for 14 days. During the following 85 days of the fattening period, the lambs were weighed once every other week and feed was distributed twice a day. Every week and before feeding the lambs, extra feed from the previous day was collected and weighed at the end of week. At the end of the fattening period all lambs were weighed before the morning feeding and then slaughtered. The weight of carcass, internal fat and fat-tail were recorded. The fat surrounding the intestine and kidney were considered as the internal fat. The saponification (Bofors, 1978; Kott *et al*., 2003) and iodine (Bofors, 1978) indices of the internal fat and fat-tail samples were determined. Using the gas chromatography method (Badings and Jong, 1983) the oleic, linoleic and palmitic fatty acids of the internal fat and fat-tail samples were determined. The data was analyzed by the GLM procedure of the SPSS program (1999) and means were tested by multiple Duncan test. Probabilities of $p<0.05$ were considered to be statistically significant.

Table 1: The components of the diet and the chemical analysis

	Diet			
Feed and ingredients	1	2	3	4
Bakery waste (%)	0	6	12.5	25
Lucerne hay (%)	40	40	40	40
Barley grain (%)	50	44	37.5	25
Cottonseed meal (%)	9	9	9	9
DCP (%)	1	1	1	1
Metabolizable Energy[1] MJ kg^{-1}	11.2	11.2	11.2	11.2
Fermentable metabolizable energy[1] (MJ kg^{-1})	10.2	10.3	10.3	10.4
Effective rumen degradable protein[1] (g kg^{-1})	122	119	119	117
RDP: FME[2]	8.4	8.6	8.7	8.9
Metabolizable protein[2] (g kg^{-1})	99	100	100	101
Fat[1] (g kg^{-1})	25	25	24	23
NDF[1] (g kg^{-1})	300	300	299	298
ENDF[1] (g kg^{-1})	210	210	211	210
Ca[1] (g kg^{-1})	9.3	9.3	9.4	9.5
P[1] (g kg^{-1})	6.8	6.7	6.7	6.5
Ca:P[2]	1.37	1.39	1.40	1.46

[1]AFRC (1993), [2]Calculated

RESULTS AND DISCUSSION

The dry matter degradability of the bakery waste and the barley grain are presented in Table 2 and Fig. 1. The effective dry matter degradability of the bakery waste and the barley grain were 86.8 and 77.1%, respectively. The rate of degradability of bakery waste was approximately twice of that of barley grain. Because of high soluble material of bakery waste, about 85% of the dry matter was degraded in 24 h. The dry matter digestibility of the bakery waste and the barley grain were 78.8(±4.4) and 74.6(±2.9)%, respectively. The dry matter digestibility of bakery waste is reported to be 80.8% (Afzalzader, 2003). The water soluble sugars of bakery waste and barley grain were 8.82 and 5.57%, respectively.

The results of Dry Matter Intake (DMI), final live weight, average daily gain, Feed Conversion Ratio (FCR), carcass weight (with internal fat), internal fat weight and fat-tail weight are shown in Table 3.

The effect of experimental diets on DMI, final live weight, average daily gain, FCR, carcass weight (with internal fat), internal fat weight and fat-tail weight differences were not significant ($p>0.05$). The internal fat and fat tail fatty-acid concentrations are presented in Table 4. The differences between fat-tail and internal fat palmitic, oleic and the fat-tail linoleic acid concentrations were not significant ($p>0.05$). The effect of diet on the mean internal fat linoleic acid was significant ($p<0.05$) which is in agreement with other reports (Al-Shabibi and Juma, 1973; Evans, 2001).

Table 2: The characteristics of dry matter degradability of bakery waste and barley grain

Feed	WL[1] (%)	a (%)	b (%)	c (%/h)	a+b (%)	ED[2] (%)	ED (%)	Lt[3] (h)	RSD[4] (%)
Bakery waste	48.2	48.1	47.2	0.19	95.3[a]	91.5	86.8	0.7	1.73
Barley grain	40.6	65.8	17.3	0.09	83.1[b]	80.1	77.1	0.5	1.73

[1]Washing loss, [2]ED: Effective Degradability with different passage rate, [3] Lag time, [4]RSD: Residual Standard Deviation

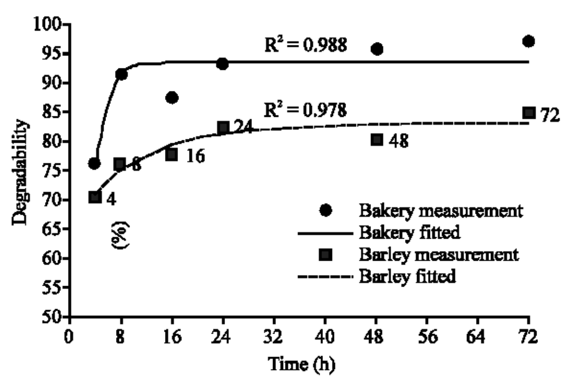

Fig. 1: Dry matter degradability curve of bakery waste and barley grain

Table 3: Mean (±SD) dry matter intakes, feed conversion ratio, body weight, daily gain, weight and percentage of the internal fat and fat tail of sheep

	Diet				
	1	2	3	4	
Traits					
Bakery waste (%)	0	6	12.5	25	P
Final live weight (kg)	46.3±4.3	46.8±3.8	46.2±4.8	45.5±4.7	NS[1]
Dry matter intake (g day^{-1})	1360±0.1	1340±0.1	1350±0.9	1330±0.1	NS
FCR[2]	7.6±0.9	6.8±0.8	7.7±0.9	7.1±0.7	NS
Daily gain (g)	188±1.8	202±1.9	199±1.7	195±1.5	NS
Carcass weight (kg)	19.6±1.2	20.7±1.1	19.0±1.2	19.6±1.1	NS
Internal fat (kg)	0.81±0.2	1.1±0.18	0.81±0.19	0.71±0.18	NS
Fat tail (kg)	3.6±0.38	3.3±0.35	3.7±0.36	3.4±0.30	NS
Internal fat (%)	1.7±0.3	2.3±0.3	1.7±0.3	1.5±0.3	NS
Fat tail (%)	18.4±0.6	16±0.7	19.5±0.6	17.4±0.6	NS

[1]Not significant: The differences between the means in a row are not significant (p>0.05), [2]FCR: Feed Conversion Ratio

Table 4: Mean (±SD) the fatty acid concentration of animals fat tail and internal fat

		Diet				
		1	2	3	4	
Bakery waste (%)						
Fatty acids (%)		0	6	12.5	25	P
Palmitic	Fat tail	30.3±1.4	30.8±0.4	31.6±0.3	33.1±0.4	NS[1]
	Internal fat	37.5±0.6	37.53±0.5	37.61±0.4	38±0.6	NS
Oleic	Fat tail	53.3±1.5	53.1±1.1	52.24±0.8	51.7±0.9	NS
	Internal fat	38.4±0.4	38.1±0.3	37.3±0.5	36.2±0.6	NS
Linoleic	Fat tail	4.4±0.4	4.6±0.2	4.9±0.6	5.2±0.7	NS
	Internal fat	6.2±0.3^{a}	6.4±0.4^{ab}	6.7 ±0.2^{ab}	7.4±0.1^{b}	*[2]

[1]Not significant: The differences between the means in a row are not significant (p>0.05), [2]Significant: The differences between the means in a row are significant (p<0.05)

Table 5: Mean (±SD) iodine and saponification indices of the fat tail and the internal fat

		Diet				
		1	2	3	4	
Item						
Bakery waste (%)		0	6	12.5	25	P
Iodine index	Fat tail	45.3±1.4^{a}	43.1±1.7^{a}	50.3±1.3^{b}	55.7±1.5^{c}	*
(g iodine/100g fat)	Internal fat	32.9±1.2^{a}	34.3±1.4^{a}	40.5±1.1^{b}	44.9±1.3^{c}	*
Saponification index	Fat tail	197.7±1.9	197.9±2.1	193.9±1.6	198.0±1.8	NS
(mg KOH/g fat)	Internal fat	182.9±1.8	183.7±2.0	181.3±1.5	184.4±1.6	NS

*Significant: The differences between the means in a row are significant (p<0.05), [NS]Not significant: The differences between the means in a row are not significant (p>0.05)

The iodine and saponification indices of internal fat and fat tail are presented in Table 5. The effect of experimental diets on iodine index of internal fat and fat tail were significant (p<0.05). The iodine index of internal fat was lower than that of tail-fat, which indicates lower unsaturated fatty acids in the internal fat. The saponification index of internal fat was lower than tail-fat, which means the molecular weight of fatty acids in the internal fat was heavier or length of fatty acids chain of internal fat was longer than the tail fat. The iodine index of the treatments with high levels of bakery waste was higher and shows that the unsaturated fatty acids were increased in the internal fat and fat tail. The iodine index of fat tail and internal fat in this study was higher than other reports (Shrinr *et al*., 1989; Unsal *et al*., 1994). The iodine index for tail and internal fat is reported as 41 and 38 (gram iodine per 100 g fat), respectively (Parvaneh, 1994). The higher iodine index of tail fat and internal fat in diets with 12.5 and 25% bakery waste shows that both fat depots had more unsaturated fatty acid than on other diets. The saponification index for fat tail and internal fat in this study was similar with other reports (Parvaneh, 1994; Unsal *et al*., 1994). The protozoa (Holotrichs) in the rumen can synthesize some fatty acids and phospholipids by using monosaccharides and acetate (Church, 1994). Higher soluble sugar in bakery waste could be cause of difference in synthesis of fatty acids by rumen microorganisms.

CONCLUSION

The effect of experimental diets on feedlot performance traits was not significant. Only difference between diets was the source of soluble carbohydrate.

Higher soluble sugar in bakery waste could be cause of differences in synthesis of fatty acids by rumen microorganisms, which can use in fat tail and internal fat. The bakery waste can be included up to 25% of the fattening diets of the lambs as a high energy feed without adversely affecting performance, with a resultant improvement in the quality of the internal fat and tail fat.

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