NUTRITIONAL EVALUATION OF *ENZOSE* AS REPLACEMENT OF CORN GRAIN FOR GROWING LAMBS

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ABSTRACT

The study was conducted to evaluate the potential of *enzose* as substitute of corn grain for energy in growing lambs. Five experimental diets were formulated. The control diet (E0) had no *enzose* whereas *enzose* replaced 20, 40, 60 and 80% corn grain in E20, E40, E60 and E 80 diets on the basis of energy supply, respectively. Fifty growing lambs were divided into 5 groups, 10 animals in each, in a randomized complete block design. The dry matter intake increased linearly with increasing the dietary *enzose* concentration. Similar trend was observed for crude protein, neutral and acid detergent fibres. Lambs fed E80 diet gained higher weight than those fed E0 diets. Maximum weight gain was recorded in lambs fed diets containing maximum concentration of *enzose*. Cost of feed per Kg live weight produced was higher in lambs fed E0 diet than those fed E80 diet; however, feed conversion ratio remained unaltered across all diets. Replacing corn with *enzose* had also non-significant effect on carcass characteristics. In conclusion, *enzose* can be used as an economical feed ingredient to replace corn grain upto 60%, without any adverse effects on growth performance of growing lambs.

Key words: *Enzose, nutrient utilization, growth, carcass characteristics, lambs*

INTRODUCTION

In Pakistan, nutritional requirements of animals are mainly met through fodders, forages, crop residues and rangelands. The area under fodder production is continuously depleting due to high pressure for cash crop production (Sarwar et al., 2002) limiting availability of fodders for the animals. Seasonal availability of fodders further worsens this situation. Forages and crop residues have low feeding value due to high lignifications and low fermentable carbohydrates (Klopfenstein et al., 1987). Whereas, most of the rangelands are being exploited by nomadic grazing as sheep and goats obtain about 60% of their feed from rangelands (Zaffruddin, 1997). As a result, the animals remain underfed. Sarwar *et al*. (2002) reported 38 and 24% deficiency in crude protein and total digestible nutrients, respectively. Through improving nutrition, animal productivity can be improved up to 50% from existing gene pool.

Agro-industrial byproducts are good source of energy and protein and have great potential to be used as a feed stuff for small ruminant feeding. These have high nutritive value and are available in abundant quantity at cheaper rates. Incorporating byproducts into the animal's diet not only results in reducing the nutrients gap between demand and supply but it also helps in cost effective ruminant production. So there is need to evaluate new agro-industrial byproducts for usage as sheep/goat feed.

Enzose, derived from the enzymatic conversion of corn starch, is a byproduct of the corn milling industry which contains 85% dextrose (Sarwar et al., 2007). It can be a promising substitute of concentrate (Khanum et al., 2007) and other expensive energy sources like corn grains. However, suggesting *enzose* as a potential replacement of any energy feed ingredient needs biological evaluation of this corn industry byproduct. Scientific information about the use of *enzose* in animal diet as an energy source or replacement of energy ingredient is scanty. Therefore, the present study was conducted to evaluate the nutritive value of *enzose* as an energy source to replace corn grains on nutrient intake, digestibility, growth performance and carcass characteristics in growing lambs.

MATERIALS & METHODS

The experiment was conducted at Animal Nutrition Research Centre, University of Agriculture, Faisalabad, Pakistan, to evaluate the nutritive value of *enzose* on growth performance of lambs. *Enzose* is a byproduct of the corn milling industry which contains 85% dextrose, with a pH of 3.5-4.5. It is a rich source of fermentable carbohydrates and availability is at cheaper rates (Sarwar et al., 2007). *Enzose* was used to evaluate as a substitute of corn grain for energy. Five iso-caloric and iso *nitrogenous* rations (E0, E20, E40, E 60 and E 80) were formulated to replace corn grain by *enzose* at the rate of 0, 20, 40, 60 and 80% on energy basis, respectively (Table 1). Fifty lambs (25$\pm$3 Kg) were divided into 5 groups of 10 animals each in a randomized complete block design.The trial lasted for 90 days. First 20 days were taken as adaptation period while remaining 70 days served as collection period. Lambs were fed *ad libitum.* Feed was offered twice a day (i.e. at 07:00 hour and 19.00 hour). Fresh water was made available for 24h during the experimental period.

The lambs were weighed fortnightly. Feed offered and residues were recorded daily. Faeces were collected daily, dried at 55°C, bulked and mixed at the end of each collection period. Feed and faecal samples were analyzed for acid detergent fiber (ADF), neutral detergent fiber (NDF) by the methods of VanSoest et al., (1991), crude protein (CP) using methods described by AOAC (2003). Economics of using *enzose* as a substitute of corn grain was also calculated.

Two animals from each group were slaughtered to evaluate carcass characteristics according to procedures described by Kashan et al. (2005). After slaughter, weight of different carcass components was recorded. Warm carcass weighted and recorded. Dressing percentage was calculated following the procedure described by Atti *et al.* (2004). Half carcass separable primal cuts and primal cuts with respective proportions of lean meat, fat and bone (as % of primal cut) were also calculated.

Data were analyzed using the general linear model procedure of SPSS (SPSS 10.0.1. 1999). In case of any significance, means were separated by Duncan's Multiple Range Test (Steel & Torrie 1984).

RESULTS & DISCUSSION

Nutrient ingestion and digestibilities

There was a linear increase in dry matter intake (DMI) by growing lambs when corn grain was gradually replaced by *enzose* (Table2). Similarly, intakes of CP, ADF and NDF followed the same trend. Nutrient digestibilities also increased ($p<0.05$) when corn grains were replaced with *enzose* (Table 2). Higher intake of nutrients by lambs fed E60 and E80 diets might be attributed to enhanced digestibility of these nutrients which thereby improved voluntary feed intake (Hogan, 1996). Sarwar et al. (1991) also reported that faster digestion rate of the potentially digestible feed enhanced DMI. Increased digestibility of nutrients may be due to readily fermentable carbohydrates supplied by *enzose*. This has resulted in increased ruminal fermentation and ruminal microbial activity which subsequently increased nutrient digestibility. Increased digestibility of DM, CP and NDF by supplementation of readily fermentable carbohydrates (molasses) has also been reported by Doyle and Panday (1990). Findings of this study are in concordance with Kozloski et al. (2006) who noticed that readily fermentable carbohydrates improved DM and OM digestibility in lambs. Supplementation of readily fermentable carbohydrates stimulates fiber digestion, reducing the lag time (Cheng *et al*., 1977; Hiltner and Dehority, 1983; Wanapat *et al*., 1985; Galloway *et al*., 1991). O'Kiely (1991) and Moore and Kennedy (1994) also reported that fermentable carbohydrates (molasses) stimulated better microbial activity which resultantly improved OM digestibility (Nisa et al., 2004a; Nisa et al., 2004b; Sarwar et al., 2004a).

Growth performance

Lambs fed E40, E60 and E80 diets gained significantly more weight than those fed E0 and E20 diets (Table 3). Although there was a slight increase in weight of lambs fed E20 diet when compare to E0diet but it was statistically non-significant. Increased weight gain with gradual replacement of corn grain by *enzose* might be attributed to either higher ruminal volatile fatty acid production or post rumen supply of amino acids or both due to efficient microbial proliferation and feed utilization.

Cost of feed per Kg live weight produced was higher in lambs fed E0 diet than all other treatments. Minimum cost of production was observed when corn was replaced with *enzose* at the rate of 60 and 80%, *enzose* costs about one third of corn (Table 3). However, feed conversion ratio remained unaltered among all treatments.

Results of this study supported the findings of Brooks and Iwanaga (1967) who reported enhanced weight gain by lambs fed diets containing fermentable energy source (molasses). Houdijk (1998) noticed that incorporating fermentable carbohydrates in animal's diet results in efficient utilization of excess indigestible protein which otherwise during fermentation is generally used to produce energy. It also results in beneficial alteration in composition of microbial population as indicated by lower ammonia and higher VFA concentrations (Konstantinov et al., 2004). Microorganisms might have retained greater quantity of N in the gut for their own growth (Sauer et al., 1980) taming utilization of N in cecum and colon (Kass et al., 1980; Rowan et al., 1992) which results in improved weight gain by the animal.

Carcass characteristics

Carcass measurements are shown in Table 4-6. There was no difference (P>0.05) between treatments for warm carcass weight and dressing percentage which normally represent function of live weight (Fehr et al., 1976). Likewise, skin, liver, kidney and heart weights didn't differ due to replacement of *enzose* with corn (Table 4). Half carcass separable primal cuts in lambs also remained unaltered in all diets and the same was true for lean, fat and bone proportions of these respective cuts (Table 5 and 6). Our findings were also supported by Garry et al. (2007) and Camp et al. (2003) who reported that fermentable carbohydrates source had non-significant effect on carcass characteristics.

Contrary to our findings, Pluske et al. (1998a) reported that fermentable carbohydrates have significant effect on dressing percentage. Dietary manipulation affects carcass characteristics (Fiems et al., 1999). Feeding diets rich in fermentable carbohydrates shifts rumen fermentation towards more propionic acid production, increasing concentration of insulin in the blood. Degree of animal fatness increased 1with the increase in serum insulin (Spencer 1985). However, Zhu et al. (1990) and Pluske et al. (1998b) observed a reduction in dressing percentage due to high contents of fermentable carbohydrates in the diet which might be due to gut fill.

Increased nutrient ingestion, utilization, weight gain and unaltered carcass characteristics reflect the suitability and potential of *enzose* as an economical energy ingredient when replaced with corn grains upto 60% in the diet of growing lambs.

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Table 1:Ingredients and chemical composition of experimental diets epresenting use of different concentrations of *enzose* as a substitute of corn grains for growing lambs

ngredients (%)	**Experimental Diets[1]**				
	E0	**E20**	**E40**	**E60**	**E80**
Corn grains	29.59	23.70	17.75	11.8	5.90
Wheat straw	12.00	12.00	12.00	12.00	12.00
Enzose	0.00	5.89	11.84	17.79	23.69
Canola meal	14.00	14.00	14.00	14.00	14.00
Sunflower meal	6.00	6.00	6.00	6.00	6.00
Cotton seed meal	8.10	8.10	8.10	8.10	8.10
Corn gluten 60%	0.00	0.70	1.50	2.30	3.05
Rice polishing	7.21	7.21	7.21	7.01	7.00
Maize bran	9.00	9.00	9.00	9.00	9.00
Maize oil cake	8.10	7.40	6.60	6.00	5.26
Maize oil	1.00	1.00	1.00	1.00	1.00
$NaHCO_3$	2.00	2.00	2.00	2.00	2.00
DCP	2.00	2.00	2.00	2.00	2.00
NaCl	1.00	1.00	1.00	1.00	1.00
Chemical Composition					
Dry matter	91.10	89.90	88.70	87.50	86.30
Crude protein	18.00	18.00	18.00	18.00	18.00
Total dig. nutrients	70.00	70.00	70.00	70.00	70.00
Neutral det. fiber	30.60	29.80	29.10	28.30	27.60
Acid detergent fiber	19.76	19.55	19.21	18.92	18.50

[1]E0, E20, E40, E60 & E80 diets contained *enzose* as replacement of corn grains at the rate of 0, 20, 40, 60 and 80% on the basis of energy supply by corn grains, respectively

Table 2: Effect of varying level of *Enzose* when replaced with corn grains on nutrients intake and their digestibilities in growing lambs

Parameters	Diets[1]					
	E0	E20	E40	E60	E80	SE
Nutrients intake (g/day)						
Dry matter	1422^{c}	1465^{bc}	1514^{b}	1544^{ab}	1561^{a}	18.51
Crude protein	255.96^{c}	263.7^{bc}	272.52^{b}	277.92^{ab}	280.98^{a}	3.34
Neutral det.fiber	435.13^{c}	436.57^{bc}	440.57^{b}	436.95^{a}	430.84^{ab}	4.47
Acid det.fiber	280.99^{c}	286.41^{bc}	290.84^{b}	292.12^{a}	288.78^{ab}	2.43
Nutrients digestibilities,%						
Dry matter	60.21^{c}	63.42^{bc}	63.71^{b}	64.32^{ab}	65.32^{a}	0.96
Crude protein	70.11^{c}	70.25^{bc}	70.93^{b}	71.36^{ab}	72.52^{a}	0.49
Neutral det.fiber	56.55^{c}	56.98^{bc}	57.68^{b}	58.12^{ab}	58.84^{a}	1.12
Acid det.fiber	49.22^{c}	50.35^{bc}	51.67^{b}	52.19^{ab}	52.36^{a}	0.89

[a, b, c] Means in a row with different superscripts differ significantly ($P < 0.05$).

[1]E0, E20, E40, E60 & E80 diets contained *enzose* as replacement of corn grains at the rate of 0, 20, 40, 60 and 80% on the basis of energy supply by corn grains, respectively.

Table 3: Effect of varying level of *Enzose* when replaced with corn grains on growth performance of growing lambs

Parameters	Diets[1]					
	E0	E20	E40	E60	E80	SE
Daily wt. gain (g/day)	200^{c}	206^{c}	216^{ab}	226^{a}	220^{b}	6.21
Cost (Rs) of feed /kg live weight produced	138^{a}	135^{ab}	132^{b}	127^{c}	128^{c}	4.24
Feed conversion ration	7.12	7.08	7.05	6.97	7.03	0.36

[a, b, c] Means in a row with different superscripts differ significantly ($P < 0.05$).

[1]E0, E20, E40, E60 & E80 diets contained *enzose* as replacement of corn grains at the rate of 0, 20, 40, 60 and 80% on the basis of energy supply by corn grains, respectively

Table 4: Effect of varying level of *enzose* when replaced with corn grains on carcass characteristics in growing lambs

Items (Kg)	Diets[1]					
	E0	E20	E40	E60	E80	SE
Pre-slaughter wt.	37.65	39.20	38.29	39.04	38.72	0.67
Warm carcass wt.	18.59	19.06	18.98	19.24	18.87	0.33
Dressing Percentage, %	48.77	48.65	49.55	49.28	49.38	0.64
Skin wt.	2.51	2.57	2.70	2.75	2.56	0.10
Feet wt.	1.65	1.76	1.60	1.70	1.79	0.09
Heart wt.	0.18	0.19	0.20	0.18	0.20	0.01
Liver wt.	0.61	0.65	0.74	0.58	0.56	0.06
Kidney wt.	0.11	0.12	0.13	0.13	0.13	0.01
Lung wt.	0.50	0.49	0.51	0.59	0.49	0.03

[1]E0, E20, E40, E60 & E80 diets contained *enzose* as replacement of corn grains at the rate of 0, 20, 40, 60 and 80% on the basis of energy supply by corn grains, respectively

Table 5: Effect of varying levels of *enzose* when replaced with corn grains on half carcass separable primal cuts in growing lambs

Items (Kg)	Diets[1]					
	E0	E20	E40	E60	E80	SE
Neck	1.75	1.88	1.83	1.87	1.75	0.08
Shoulder	3.52	3.72	3.60	3.73	3.68	0.09
Breast	3.25	3.54	3.49	3.42	3.45	0.18
Loin	4.11	4.14	4.00	4.19	3.80	0.10
Leg	5.97	5.76	6.07	6.03	5.99	0.26

[1]E0, E20, E40, E60 & E80 diets contained *enzose* as replacement of corn grains at the rate of 0, 20, 40, 60 and 80% on the basis of energy supply by corn grains, respectively.

Table 6: Effect of varying level of Enzose when replaced with corn grains on primal cuts with respective proportions of lean meat, fat and bone(% of primal cut) in lambs

Items		Diets[1]					
		E0	E20	E40	E60	E80	SE
Neck	Lean	62.19	63.76	63.51	63.19	64.11	1.36
	Fat	7.30	7.85	8.01	7.91	7.69	0.18
	Bone	30.51	28.39	28.48	28.90	27.86	1.28
Shoulder	Lean	63.66	63.88	64.55	63.46	64.06	1.43
	Fat	6.85	6.38	7.26	6.63	6.41	0.98
	Bone	29.49	29.75	28.19	29.91	29.53	0.88
Breast	Lean	55.21	54.68	55.44	55.73	56.35	0.59
	Fat	14.21	14.59	14.59	14.25	13.38	0.93
	Bone	30.58	30.74	29.98	30.03	30.28	0.72
Loin	Lean	62.76	60.90	61.55	62.64	61.25	0.54
	Fat	10.75	11.28	11.23	10.09	10.73	0.77
	Bone	26.49	27.83	27.23	27.28	28.03	0.74
Leg	Lean	67.65	67.79	67.49	68.33	68.09	0.94
	Fat	11.35	11.71	11.68	13.39	16.03	1.37
	Bone	21.00	20.50	20.84	19.75	20.53	0.68

[Lean, Fat and Bone proportions expressed as % age of respective primal cut**]**

[1]E0, E20, E40, E60 & E80 diets contained *enzose* as replacement of corn grains at the rate of 0, 20, 40, 60 and 80% on the basis of energy supply by corn grains, respectively.