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EFFECTS OF CONCENTRATED FEEDS ON GROWTH PERFORMANCE, BLOOD PROFILES AND CARCASS CHARACTERISTICS OF DEZHOU DONKEYS

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ABSTRACT

The nutritional requirements of donkeys have not been studied well, therefore, donkeys are being fed according to the horse nutritional plans in China. Keeping in mind the importance of the topic, the best concentrate feed was searched among three different levels i.e., 1, 1.25 and 1.5% based on growth performance, blood profiles and carcass characteristics. In this study, 30 male Dezhou donkeys (weight: 147.36±6.32 kg; age：210±10 days) were randomly divided into 3 groups according to daily concentrate intake: 1.00% (Group 1.00), 1.25% (Group 1.25) and 1.50% (Group 1.50) of live weight. Roughage in the form of beanstalk was the only forage for all groups. On the basis of their growth performance, blood parameters, carcass characteristics and visceral indexes, we found that Group 1.50 and 1.25 showed higher average body gain, body sides and carcass percentage ($P \leq 0.05$) than Group 1.00, the visceral indices and blood parameters showed no difference among 3 groups ($P > 0.05$). Based on all the fundamental measurements, we could draw a conclusion that concentrates at 1.25% of live weight level is the most efficient quantity to feed Dezhou donkeys.

Keywords: Dezhou donkeys; Concentrate level; Carcass percentage; Dressing percentage; Visceral index.

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INTRODUCTION

As one kind of monogastric herbivorous animal, donkeys have the unique nutritional and physiological characteristics. It's regrettable that considered as an important meat-producing animal in many countries, especially in China, the research of donkey's breeding for meat production has been overlooked for a long time. Since nutritional needs have not received as much attention as those of the horse. Hence, the nutritional requirements of the horse are still the main reference for donkey breeders in China (Pearson *et al*. 2001). As described previously (Maloiy 1973), intake of 3.1% dry matter per unit weight for donkeys is higher than other herbivores. According to previous reported results (Pearson & Merritt 1991), the dry matter intake of donkey ranged from 0.83% to 2.6% per unit weight. Some researcher thinks the variations in dry matter percentage among different research groups could partially be due to different breeding ways (Franco *et al*. 2013).

Concentrate feed intake affects the dry matter intake and the performance of donkeys since it provides most of the nutrition. Concentrate supplementation intake for donkeys have been extrapolated from the horse recently (Wei *et al*. 2018). According to da Silva *et al*. (2015), with the increase in the concentrate levels in feedlot diets of crossbred dairy steers, the performance and physical characteristics of the carcass changed significantly. Demand for donkey's meat and hides in China is increasing day by day that necessitates donkeys must be healthy. The effects of concentrate levels on the performance of Dezhou donkeys have not been studied. Therefore, considering the increasing interest of the donkeys in China and the paucity of knowledge regarding the feeding practice parameters, we investigated the optimum amount of concentrate feed of Dezhou donkeys during the fattening stage, which may be further utilized to improve Dezhou donkey performance.

MATERIALS AND METHODS

Experiments were conducted from January to September, 2017 for 270 days at the Tianlong Farm of Dong-E-E-Jiao Co. Ltd. (http://www. dongeejiao.com/). The animal experiments were approved by the Animal Welfare Committee, Liaocheng University, Liaocheng, Shandong, China. All the procedures were conducted in accordance with the guidelines of Dong-E-E-Jiao Co. Ltd.

Animals and experimental design: Thirty healthy Dezhou donkeys, at the age of 8 months with weights of 147.36±6.32 kg, were randomly divided into three equal treatment groups for the feeding of diet with concentrate supplement at the level of 1.00% (Group 1.00), 1.25% (Group 1.25) and 1.50% (Group 1.50) of live weight. After a period of adaptation (7 days), the trial period began. Beanstalk the only form of forage was offered to all donkeys. All donkeys were fed in individual stalls (3×4 m) with a feeder (1.0 m long), and an automatic water dispenser was also provided. The entire feeding process was carried out under outdoor natural lighting and conducted by a specially trained person. The composition and nutrition levels of concentrate and roughage feed are listed in Table 1. Five donkeys were randomly selected from each group and fasted for 12h before slaughter at the end of the feeding process. An electrical stunner (about 280 voltages) was used to stun the donkeys, after that slaughtered at Dong-E-E-Jiao Co., Ltd. Shandong Province, China.

Feeding and management: Donkeys were fed forage at 7:00, 11:00, 17:00 and 22:00 hours while concentrate at 7:00 and 17:00 hours daily. Animals were allowed to drink water *ad libitum*. Each donkey in each group was weighed every month in order to adjust the concentrate quantity and calculate the cumulative growth and monthly weight gain.

Growth performance parameters: At the end of the experiment (day 270), the number of days in the feedlot (DF days), initial body weights (IBW), final body weights (FBW), body length (BL), chest circumference (CC), width (CW) and depth (CD) indices were recorded following the procedure described previously (Xiao *et al*. 2012a).

Hemato-biochemical profiles: To get the evaluation of hemato-biochemical parameters, two blood samples were obtained at the end of the feeding experiment, from the jugular vein of each donkey, with or without anticoagulant. The blood samples collected without anticoagulants were allowed to clot, then the coagulant tubes were centrifuged for 10 min at 2000 rpm, and the serum was stored at -20°C until further analysis (Majeed *et al*. 2018). Serum total proteins (STP), albumin (ALB), globulin (GLB), urea (UREA), triglyceride (TG), alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), Gamma-Glutamyl transferase (GGT), and lactic dehydrogenase (LDH) were determined (Ijaz *et al*. 2018) using commercial analytical kits (TP A045-2-2, ALB A028-2-1, GLB C153, TG A110-2-1, UREA C013-2-1, ALT C009-3-1, AST C010-3-1, ALP A059-3-1, GGT C017-1-1, LDH A020-2-2, Nanjing, China) according to the manufacturer's instructions in People's Hospital of Liaocheng, Liaocheng City, Shandong province, China.

The blood samples collected with anticoagulant were subjected for hematological analysis (Yang *et al*. 2019). The whole blood red blood cell (RBC), hematocrit (HCT), white blood cell (WBC), lymphocyte (LYMPH), monocyte (MONO), Eosinophils (EO) and neutrophilic granulocyte (NEUT) were determined use intelligent automatic blood cell analyzer (Beckman coulter, LH750). Hemoglobin (HB) was detected (Tharwat *et al*. 2018) using commercial analytical kits (A102-1-1, Nanjing, China).

Carcass characteristics and visceral indices: At the end of the experiment, 5 random donkeys were slaughtered in each group. The dressing quantity, abdominal fat, visceral adipose area, muscles, and bones were weighed. Meanwhile, the heart, liver, spleen, lungs, kidneys, pancreas, stomach and intestines were weighed to test visceral index. Calculation formulas were followed as described previously (Fitzsimons *et al*. 2014):

Carcass percentage (CP) = Carcass quantity ÷ living weight before slaughter×100

Net meat percentage (NMP) = Net meat quantity of carcass ÷ living weight before slaughter×100

Bone weight percentage (BWP) = Bone quantity ÷ living weight before slaughter×100

Dressing percentage (DP) = Dressing quantity ÷ living weight before slaughter×100

Net dressing and meat percentage = Net dressing and meat quantity ÷ carcass quantity×100

Visceral index = Visceral quantity ÷ living weight before slaughter×100

Eye muscle area (EMA): the area of *Longissimus Thoracis* corresponding to the 17th and 18th ribs, measured with sulfate paper and surface area calculated.

Statistical analysis: Data were analyzed by one-way analysis of variance (ANOVA). The SPSS Statistics 19 (IBM, USA) and LDS (Least-significant Difference) were used to compare the mean of each index, as mean±SEM from 5 or 10 donkeys, and each index of the individual was conducted in triplicate. To know the growth pattern (body weight), and time x treatment effect of the different levels of concentrate feed analysis was carried out by repeated measure analysis. The differences of the mean were considered having a significance level of $P \leq 0.05$ and a high significance level of $P \leq 0.01$.

RESULTS

Growth performance: Parametric estimates and statistical analysis performed on the growth performances are listed in Table 2. There was no difference in IBW and CD among all Groups. FBW and CW were significantly higher in Groups 1.50 and 1.25 than Group 1.00 ($P \le 0.01$). The ABG, BL, and CC in Group 1.25 were higher than Group 1.00 ($P \le 0.05$), however, growth performance indices did not differ between Groups 1.50 and 1.25 ($P > 0.05$).

As can be seen from Fig.1, body cumulative growth increased significantly ($P \le 0.01$). with the extended time period. The weight changes of the 3 groups were consistent, and the weight of the 1.5 and 1.25 groups was significantly higher than that of the 1.0 group from the fourth month of the experiment. As shown in Fig. 2, the daily weight gain of Group 1.5 and Group 1.25 were significantly ($P \le 0.01$) higher than Group 1.0 in the second and third month of the experiment. The daily body weight gain of Groups 1.5 and 1.25 had a rapid decline from fourth month of the experiment but was relatively stable in Group 1.0 (Fig. 2).

Blood indexes: We found no difference in biochemical parameters in all treatments (Table 3). The indices of STP, ALB, GLB, and HB were the highest in Group 1.25, these indices are closely related to the growth performance of donkeys (Table 2). In other words, these results explain that this group had the best growth performance in this experiment. Triglyceride and BUN did not vary among groups. Among blood metabolic enzymes there were no significant differences in AST, ALT, ALP and LDH values among all groups ($P > 0.05$), but the GGT was significantly ($P \le 0.05$) higher in Group 1.50 than 1.00 (Table 4).

As shown in Table 5, there was no significant difference between most blood cells indices in all group of the Dezhou donkey with the increase of feed amount of concentrate, except monocytes those were higher in Group 1.25 than Group 1.00 ($P \le 0.01$) and Group 1.50 ($P \le 0.05$) while there was no difference on Group 1.50 and 1.00.

Carcass characteristics: CP and NMP are important indices to measure animal growth performance and slaughter performance. We found that CP was higher in Group 1.50 than Group 1.0 and Group 1.25, reaching a mean value of 61.04+1.94. We found no differences in NMP, BMP and EMA (Table 6), but the EMA and NMP were higher and BWP was lower in Group 1.50. This demonstrates that feed quantity at 1% has limited growth. BWP was high when donkeys were short of feed. AFP and DMP ($P \le 0.01$) were significantly ($P \le 0.01$) different between Group 1.50 and other Groups, with the lowest values for DP (Table 6). With the highest feed quantity, there was much fat deposition, and the fats gathered in the belly. The bone growth was almost stereotyped after 7 to 8 months of age, then the body weight increase was mainly dominated by fat and muscle deposition.

Visceral indices: Parametric estimates and statistical analysis performed on the visceral indices exhibited non- significant difference between all groups (Table 7), suggesting that the development of these organs in donkeys was almost stereotyped after 7 to 8 months, and then grew coordinated with the growth of the whole body, which may be the instinctive coordination of the overall development of animals and organ development.

Results of visceral adipose are presented in Table 8. Visceral fat deposits were first deposited around the kidneys and then around the liver. The kidneys fat significantly ($P \le 0.01$) increased in Group 1.50 with the increase of amount of supplementary feed, while the liver fat 1.25% was significantly higher than the other two groups ($P \le 0.01$). The pericardial fat and peri-pulmonary fat indices also increased in Group 1.25, but the difference was not significant.

Table 1. Concentrate composition and nutritional components of the concentrate and roughage (air dry basis).

Composition		Nutrition components	Feed nutrition levels	
Concentrate	%		Concentrate feed	Beanstalk
Corn	54.00	Dry matter (%)	88.40	91.04
Soybean meal	25.00	Digestible Energy (MJ·kg^{-1})	13.19	-
Wheat bran	15.00	Crude Protein (%)	18.54	5.94
Soya-bean oil	1.00	Neutral detergent fiber (%)	13.98	69.48
Salt	0.50	Acid detergent fiber (%)	3.21	47.92
Lys	0.50	Ether extract (%)	1.63	-
Premix	4.00	Calcium (%)	0.86	-
		Total phosphorus (%)	0.75	-
Total	100	Lysine (%)	1.20	-

Note: Premix provides quantity/kg: V_A 20 000IU, V_D 3 500IU, V_E 50mg, V_K 2.5mg, VB_1 2.5mg, VB_2 8.0mg, VB_3 25mg, VB_5 32mg, VB_6 0.5mg, VB_9 0.5mg, Cu 30mg, Fe 200mg, Mn 50mg, Zn 220mg, Se 0.45mg, I 2.0 mg, VB_{12} 50μg, VH 90μg. The nutritional content is measured except Lys and DE (Calculate according to feed database).

Table 2. Effect of concentrate feed levels on the growth performances of Dezhou donkeys.

Parameters	Units	Concentrate feed level (%)			P Value
		1.00	1.25	1.50	
Initial body weights (IBW)	Kg	147.1±9.4	147.6±6.9	148.0±7.1	0.531
Final body weight (FBW)	Kg	207.6±4.3^{B}	232.8±1.4^{A}	230.4±1.4^{A}	0.001
Average body gain (ABG)	Kg	60.5±11.1^{b}	85.2±7.5^{a}	82.4±6.3^{a}	0.022
Body length (BL)	Cm	127.4±3.0^{b}	132.8±0.8^{a}	136.3±1.2^{a}	0.013
Chest circumference (CC)	Cm	128.1±2.6^{b}	138.8±1.3^{a}	134.6±1.1^{a}	0.001
Chest width (CW)	Cm	25.3±1.3^{B}	32.4±1.1^{A}	30.2±0.4^{A}	0.001
Chest depth (CD)	Cm	52.6±0.8	53.4±1.2	52.0±0.4	0.432

Values (mean+SEM) with different capital letters in a row indicate significant difference at $P \le 0.01$, while small letters indicate significant difference at $P \le 0.05$. Compare capital letters first, then the small ones.

Table 3. Effect of concentrate feed levels on the blood biochemical parameters (mean+SEM) of Dezhou donkeys.

Parameters	Units	Concentrate feed level (%)			P Value
		1.00	1.25	1.50	
Serum Total protein (STP)	$g \cdot L^{-1}$	69.54±1.84	73.64±0.93	71.94±1.83	0.228
Albumin (ALB)	$g \cdot L^{-1}$	29.26±0.66	29.86±1.24	29.00±0.39	0.766
Globulin (GLB)	$g \cdot L^{-1}$	40.28±1.70	43.78±1.11	42.94±1.59	0.261
Triglyceride	$mmol \cdot L^{-1}$	0.42±0.16	0.25±0.02	0.62±0.08	0.066
Blood Urea Nitrogen (BUN)	$mmol \cdot L^{-1}$	5.77±0.15	5.89±0.37	6.28±0.22	0.380

Table 4. Effect of concentrate feed levels on the blood metabolic enzymes of Dezhou donkeys.

Parameters	Concentrate feed level (%)			P Value
	1.00	1.25	1.50	
Alanine aminotransferase (ALT)	15.88±1.79	17.26±3.65	17.34±3.81	0.937
Aspartate Aminotransferase (AST)	413.10±41.78	388.96±29.32	430.82±17.56	0.645
Alkaline phosphatase (ALP)	211.60±10.41	242.20±22.05	255.20±10.53	0.162
Gamma-Glutamyl transferase (GGT)	25.40±3.26^{b}	29.80±14.61^{ab}	55.20±4.81^{a}	0.040
Lactic dehydrogenase (LDH)	393.40±69.19	479.60±21.64	680.40+61.69	0.330

Values (mean+SEM) bearing small letters in the row differ significantly ($P \le 0.05$). Units are in $IU \cdot L^{-1}$

DISCUSSION

In support of our hypothesis, we found that concentrate feeding levels affect the growth performances of donkeys as also reported in dairy bulls (Huuskonen *et al.* 2014). The donkeys with similar IBW at the start of the experiment, however, at the end of the experiment, the FBW and ABG were significantly higher in Groups 1.50 and 1.25 than Group 1.00, and there was no difference between Group 1.50 and Group 1.25. According to Saastamoinen (1990), first year is the period for optimum development in body size and weight of foals that has also been observed in the present experiment (Fig. 1). It is documented that first three years are the key period for the development of body weight in donkeys (Xiao *et al.* 2012b). The significant increase in FBW of Groups 1.50 and 1.25 indicated that these diets satisfied the growth requirements. This conformed to the literature about the IBW that was determined by the level of concentrate in the diet (Pinto *et al.* 2015). As is obvious from Fig. 2, the daily weight gains of Group 1.5 and Group 1.25 were significant ($P \le 0.01$) higher than Group 1.0 at the second and third month of experiment, but there was no difference between this two groups, this could be the breed different, however, the adult daily body weight gain and fat contents for different donkey breeds differ significantly (Martin-Rosset & Jean-Louis 2015). In the present experiment, all of the body sizes don't conform to already reported equation about live weight and body sizes of the donkey (Pearson & Ouassat 1996). This difference might be since the animal's growth curve is affected by their breed, performance, nutrition, management, and so on (Pinto *et al.* 2015). According to a published report, maintenance demand of protein for the donkey is 120 g/d per 100kg body weight (Pearson *et al.* 2001). Donkeys are sensitive to energy, and when the energy demand is met, the demand for protein can be reduced (Wood *et al.* 2007). Therefore, the nutrition of donkeys must also be studied in terms of energy and protein requirements.

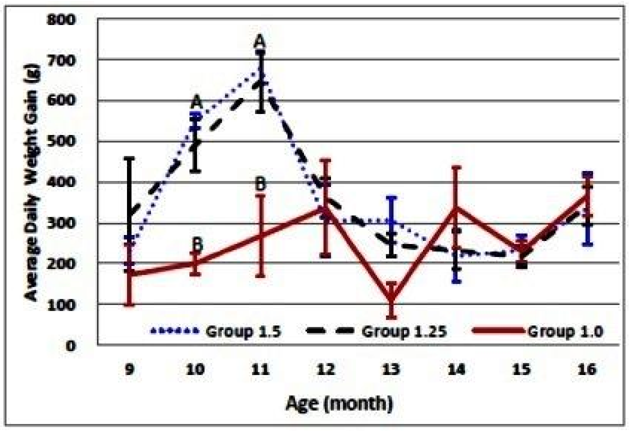

Fig. 1. The cumulative (body weight) growth of Dezhou donkey fed different levels of concentrate feed. Line graph (mean+SEM) bearing different capital letters from the other line graph differ significantly (*P≤0.01*).

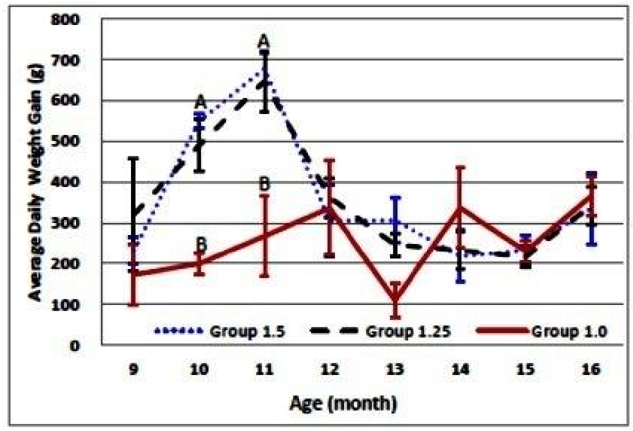

Fig. 2. The relative growth (body weight gain) of Dezhou donkey fed different levels of concentrate feed. Line graph (mean+SEM) bearing different capital letters from the other line graph differ significantly (*P≤0.01*).

Table 5. Effect of concentrate feed levels on the hematological values in Dezhou donkeys.

Parameters	Units	Concentrate feed level (%)			P Value
		1.00	1.25	1.50	
Red blood cells (RBC)	10^{12}/L	6.58±0.33	6.95±0.45	8.67±5.06	0.640
Hemoglobin (HB)	$g·L^{-1}$	114±8.60	116±8.40	155±91.27	0.660
Hematocrit (HCT)	%	33.14±2.32	33.75±3.15	32.96±1.69	0.190
White blood cells (WBC)	10^9/L	13.77±3.59	16.87±2.26	12.27±1.52	0.170
Neutrophils (NEUT)	10^9/L	6.93±2.56	7.73±2.27	5.11±2.80	0.590
Lymphocytes (LYMPH)	10^9/L	2.71±1.54	3.57±1.80	4.67±1.39	0.290
Monocytes (MONO)	10^9/L	$0.81±0.22^b$	$5.97±2.56^a$	$1.93±2.56^b$	0.030
Eosinophils (EO)	10^9/L	0.09±0.09	0.23±0.18	7.75±5.27	0.490

Values (mean+SEM) with different letters in a row indicate significant differences at *P≤0.05*.

Table 6. Effect of concentrate feed levels on the carcass traits of Dezhou donkeys.

Parameters	Units	Concentrate feed level (%)			P Value
		1.00	1.25	1.50	
Carcass percentage (CP)	%	55.25±0.33	56.38±1.04	61.04±1.94	0.591
Net meat percentage (NMP)	%	33.27±0.51	33.62±1.21	37.98±3.41	0.193
Bone weight percentage (BWP)	%	16.6±1.05	15.63±0.58	13.59±1.20	0.077
Dressing percentage (DP)	%	$8.81±0.12^A$	$8.91±0.25^A$	$7.30±0.58^B$	0.008
Abdominal fat percentage (ABP)	%	$0.89±0.27^B$	$1.27±0.35^B$	$2.96+0.55^A$	0.003
Dressing and meat percentage (AFP)	%	$42.08±0.56^B$	$42.53±1.01^B$	$2.96±0.55^A$	0.003
Eye muscle area (EMA)	cm^2	77.75±8.44	78.61±7.52	78.09±5.29	0.732

Values (mean+SEM) with different letters in a row indicate significant differences at *P≤0.05*.

Table 7. Effect of concentrate feed levels on the visceral indices (% of body weight) of Dezhou donkeys.

Organs	Concentrate feed level (%)			P Value
	1.00	1.25	1.50	
Heart	0.56±0.01	0.51±0.00	0.54±0.01	0.180
Liver	1.14±0.06	1.17±0.02	1.17±0.07	0.850
Lungs	1.30±0.29	1.08±0.19	0.80±0.05	0.155
Kidneys	0.26±0.01	0.26±0.01	0.29±0.01	0.085
Stomach	0.34±0.03	0.33±0.01	0.36+0.00	0.581
Intestines	3.76±0.20	3.67±0.40	3.95+0.28	0.765

Table 8. Effect of concentrate feed levels on the visceral adipose area (%) indices of Dezhou donkeys.

Parameters	Concentrate feed level (%)			P Value
	1.00	1.25	1.50	
Pericardial fat	16.48±5.85	26.70±4.51	12.47±2.06	0.187
Perihepatic fat	0.52±0.23^{c}	4.69±0.76^{a}	2.48±0.79^{b}	0.001
Peripulmonary fat	3.50±0.74	8.40±2.57	5.17±1.58	0.132
Perirenal fat	86.34±7.84^{B}	162.44±45.71^{B}	319.31±36.02^{A}	0.001

Values (mean+SEM) with different capital letters in a row indicate significant difference at $P \leq 0.01$, while small letters indicate significant difference at $P \leq 0.05$.

Serum total proteins and albumin reflect the nutrition level of protein in the diet and the degree of digestion and absorption of protein in animals to some extent (Veronesi *et al*. 2014; Quartuccio *et al*. 2015). It is documented that hematological and serum biochemical parameters of working donkeys were significantly affected ($P \leq 0.05$) by age (Lemma and Moges 2009). The TG is a direct indicator of fat digestion and absorption, and low BUN indicates a high protein utilization (Kojouri & Sharifi 2013). In our experiment, we found no difference in blood parameters in all treatment groups, but all of the blood indexes were within the normal range (Mori *et al*. 2004). Previous studies carried out on newborn donkeys were found that high nutrition levels can significantly increase hematologic and biochemical parameters (Veronesi *et al*. 2014). It is thought that plasma TG levels are usually higher in donkeys compared with horses (Zinkl *et al*. 1990). The indices of STP, ALB, and GLB were the highest in Group 1.25, these indices are closely related to the growth performance of donkeys (Sarriés & Beriain 2005). In other words, these results explain that this group had the best growth performance in the present study.

The changes in serum metabolic enzymes reflect the changes in the body's metabolic function. There were non-significant differences in AST, ALT, ALP and LDH values among all groups, but these values all tended to improve along with concentrate increase in the present study. It is generally believed that the activity of AST and ALT in serum is positively correlated with the daily weight gain of animals, thus high activity indicates strong growth promoting effect (Meira *et al*. 2009). The activity of AST and ALT increased at first and then decreased with the increase of protein level, and finally increased again, with activity the highest when the protein level was 26% (Keser & Bilal, 2008). This phenomenon might be due to some damage to the liver (Wu *et al*. 2013). ALP is one of the important indices of the growth performance regulating the metabolism of proteins, fat, and carbohydrate with kinase (Xie *et al*. 2017). Similarly, it has been reported previously that the increase in ALP activity is beneficial in increasing the growth rate of animals (Adamu *et al*. 2013). GGT was higher in Group 1.50 and Group 1.00, perhaps because of donkeys do not have gallbladders and have developed fatty livers after being fed high concentrate for a long time (Perry *et al*. 1998). Blood cells and blood routine indicators often together reflect the effects of nutritional factors on the body (Divers *et al*. 2006) and body health (Sampaio *et al*. 2018). Hematological values of donkeys are largely influenced by age, sex, physical factors of the environment and physical activity (Zakari *et al*. 2016).

The CP and NMP are important indices to measure animal growth performance and slaughter performance. Many studies have shown a close relationship between dietary nutrition and animal slaughter performance (Asaniyan 2014). It has been reported that the slaughter rate of lambs increases with the increase of live weight before slaughter (Simeonov *et al*. 2014). We found that CP was higher in Group 1.50 than Group 1.0 ($P \leq 0.01$) and Group 1.25 ($P \leq 0.05$), reaching a mean value of 61.04%. This CP level in the present study was higher than 52.5%, 53.9% and 59.3% previous reported (Lanza *et al*. 2009; Franco *et al*. 2013; Polidori *et al*. 2015). The difference could be due to breed, age at slaughter and feed nutrition, etc.

The NMP, BWP, and EMA were similar among the three groups, but the EMA and NMP were higher in Group 1.50, whereas, BWP was lower. Similar to our results, Vaz *et al.* (2002) verified that cross-bred cattle did not change the NMP, BWP, and EMA with the improvement in concentrate level. It was reported previously that the increasing concentrate level increased carcass gain and dressing proportion of the bulls but had no effects on carcass conformation or fat score (Huuskonen *et al*. 2014). In our study, he AFP and DMP ($P \leq 0.01$) in Group 1.50 were significantly higher than other groups, and the DP resulted in the opposite with the other groups ($P \leq 0.01$). With the highest feed quantity, there was much fat deposition, and the fats gathered in the belly (Rotta *et al*. 2009). The bone growth was almost stereotyped after 7 to 8 months of age afterward body weight increase was mainly dominated by fat and muscle deposition. BWP was high when donkeys were short of feed. This demonstrates that feed quantity at 1% limited growth perhaps.

The quantity and organ index of visceral reflect the functional status of the animal body to a certain extent, which is of great significance for theoretical research and production practice. It has been pointed out that the visceral organ indices can be used as an approximate index of its function, which often reflects the nutritional status of animals and the physiological state of the viscera (Humphrey & Kumaratilake 2017). In the present study, there was no significant difference in visceral indices between all groups, suggesting that the development of these organs in donkeys was almost stereotyped up to 7 to 8 months, and then grew coordinated with the growth of the whole body, which may be the instinctive coordination of the overall development of animals and organ development. This is consistent with that reported previously that concentrate levels have no significant influence on the viscera index (Zhao *et al*. 2014).

Excessive nutrition intake of animals leads to fat deposition, the fat deposition sequence and parts differing in different animals. In donkeys when fat deposition starts, it first deposits around the kidneys and then around the liver, thus more fat deposition will the improve energetic level of the diet (Alexandra *et al*. 2011). Thus, with the increase of the amount of supplementary feed in the present study, the kidney fat significantly increased ($P \le 0.01$), and the liver fat in 1.25 group was significantly higher than in the other two groups ($P \le 0.05$).

Conclusions: We concluded that while feeding to Dezhou donkeys, as the amount of concentrate feed increased, the growth performance, carcass characteristic and carcass traits improved to a certain extent, specifically in Group 1.50. The higher growth performance and carcass characteristic were obtained in 1.25 and 1.50 concentrate feed levels. Combining input-output ratio and lean meat, 1.25% concentrate supplement was found to be the best choice.

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