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Effect of Feeding Dietary Treated Wheat Straw with Urea and Whey on Fattening Lambs Performance

Research Article

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ABSTRACT

This study was conducted to evaluate the effect of feeding treated wheat straw with urea and whey on fattening lambs performance. About 4.5 kg urea and 1.5 kg salt were dissolved in 40 L water and mixed with 30 L of whey. The solution was spread over 100 kg chopped wheat straw. Thirty two male lambs were randomly divided into four feeding groups to compare performance with diets based on barley supplemented with 30% wheat straw. Treatments were (1) 30% untreated wheat straw (UWS) (control), (2) 20% UWS + 10% treated wheat straw (TWS), (3) 10% UWS + 20% TWS, (4) 30% TWS. Lambs were fed with isocaloric and isonitrogenous grower diets. The animals were slaughtered after 85 days of feeding and carcass parameters were measured. Average final weights did not differ significantly between groups (P>0.05). However, average live daily and weight gain were significantly (P<0.03 and P<0.001, respectively) higher in lambs fed treatment 3. Feed conversion ratio was lowest in lambs fed 20% and 10% TWS followed by those fed control diet, which in turn were superior to those fed 30% TWS diet (P<0.03). The highest values for average live weight gain and live daily gain were observed for animals fed 20% TWS diet and the differences were only significantly higher than 30% TWS diet. However, carcass weights were similar for the diets (P>0.05). Dissection of different anatomical parts showed a higher percentage of lean meat, carcass fat and internal fat in animals fed TWS compared to control but the differences were not significant. The lambs showed similar growth rates like control group, however, feeding cost per kg of body weight gain was lower in the experimental diet. Carcass and meat quality were not affected by treatments. Thus, the diet containing TWS could not represent an economic advantage for procedures. The results indicate that TWS silage can replace as part of UWS. In conclusion supplementation of TWS with a barley based concentrate support did not have positive effect on fattening lambs performance before and after slaughtering.

KEY WORDS carcass traits, fattening lambs, performance, treated wheat straw, wheat straw.

INTRODUCTION

The feeds that are available to ruminants in developing countries are fibrous and relatively high in ligno-cellulose. These kinds of feeds have low digestibility and often have deficiencies in critical nutrients, such as protein, non-protein nitrogen and minerals. Continuous attempts have been made to improve the feeding value of low quality roughage through physiological, biological and chemical process (Chabaca *et al*. 2000; Selim *et al*. 2004). There is a large amount of crop residues, mainly wheat straw. The use of straw for cattle, sheep and goat fattening has been limited by their low intake. Consequent requirement for costly supplement straw is the most abundant of all agricultural residues and has a great potential as a feedstuff for ruminants in most semi-arid and sub tropical regions.

Considering the factors limiting the efficiency of fibrous material, it is clear that if domesticated animals fed mainly by these kinds of feeds, their production efficiency will be low. Therefore, processing of these by-products and reducing limiting factors will be essential. On the other hand, any progress in animal production efficiency (using fibrous by-products) depends on increasing the digestibility of diet. This can be achieved by reducing factors or their effects.

Ammoniation of crop residues through urea treatment is considered as the most viable chemical method to improve feeding value of crop residues for ruminants (Sarwar, 1994). Ensiling urea treated crop residues with acidified fermentable carbohydrates fix nitrogen (N) better, bring physico-chemical changes in ammoniated crop residues that favor better ruminal functions, intake and digestibility than untreated crop residues (Jianxin and Jun, 2002). Cereal straw is available in large amounts in many regions of the world and there has been considerable interest in using chopped straw in ruminant diets. The agricultural by-products like wheat straw have low digestibility because of their chemico-physical characteristics. Therefore, processing wheat straw for increasing its nutritive value is necessary. The objective of the present study was to test efficacy of feeding treated wheat straw by using whey, urea and salt on feed intake, growth, feed conversion, carcass analysis, offals and various organ weights of fattening lambs.

MATERIALS AND METHODS

Processing of wheat straw and diets

For processing of wheat straw, first wheat straw was chopped and to each of 100 kg chopped wheat straw 1.5 kg salts, 4.5 kg urea, 30 liters of fresh whey and 40 liters of water were added and then stored in silo. After 21 days the silo was opened and treated wheat straw was used in experimental diets. Four approximately isoenergetic (as metabolizable energy) and isonitrogenous diets were formulated to meet requirements (NRC, 1985) containing 0-30% treated wheat straw. The composition of diets given to different treatments were as follow: (1) control (0% treated wheat straw, 30% wheat straw); (2) 10% treated wheat straw, 20% wheat straw; (3) 20% treated wheat straw, 10% wheat straw and (4) 30% treated wheat straw, 0% wheat straw. Mineral and vitamin additions were the same in all experimental diets. Ingredients and nutrient composition of the experimental diets are shown in Table 1. Samples of the experimental diets were ground (1-mm screen) and analyzed for DM, CP, NDF, Na, Cl and K by the AOAC (1990) methods.

Feeding and management

The growth trial was conducted with 32 male lambs (6±1 month old) weighing an average of 26.5±1.5 kg live weight. The animals were randomly allocated to four treatments (8 lambs per treatment). Lambs were housed in individual pens in a sheltered, cemented-floor, open-side barn, well-ventilated and equipped with adequate feeding and watering facilities. All animals were bedded on straw.

Table 1 Ingredients and chemical composition of experimental diets (DM basis)

Item	Diet[a]			
	1	2	3	4
Ingredient (%)				
Wheat straw	30	20	10	0.0
Treated wheat straw	0.0	10	20	30
Barley grain, ground	44.55	46.20	46.20	45.10
Sunflower meal	4	4	4	4
Cottonseed meal	4.25	3	3	2.5
Wheat bran	15.00	15.00	15.30	17.00
Urea	0.8	0.4	0.1	0.0
Dicalcium phosphate	0.3	0.3	0.3	0.3
Sodium bicarbonate	0.5	0.5	0.5	0.5
Vitamin A, D, and E premix[b]	0.3	0.3	0.3	0.3
Trace-mineralized salt[c]	0.3	0.3	0.3	0.3
Chemical composition				
DM	90.60	90.50	90.00	90.70
ME (Mcal/kg DM)	2.67	2.70	2.80	2.90
CP	13.55	13.50	13.60	13.75
NDF	43.21	43.60	43.84	44.43
Na	0.364	0. 367	0.395	0.390
Cl	0.1665	0.1684	0.1687	0.1671
K	0.694	0.676	0.673	0.697
DCAD (meq/100 g DM)[d]	+ 29	+ 29	+ 29.6	+ 30

[a] Diets were (1) control (0% treated wheat straw, 30% wheat straw); (2) 10% treated wheat straw, 20% wheat straw; (3) 20% treated wheat straw, 10% wheat straw and (4) 30% treated wheat straw, 0% wheat straw.

[b] Contains 5,000,000 IU of Vitamin A; 5,000,000 IU of Vitamin D and 500,000 of Vitamin E per kg.

[c] Composition: 75.15% NaCl, 20.5% Dynamad, 3.046% Mn, 1.025% Cu-sulphate, 0.253% Zn-sulphate, 0.015% EDDI-80 and 0.011% Na-selenide.

[d] Dietary Cation Anion Difference (meq/100 g DM)= $(Na^{+} + K^{+}) - (Cl^{-})$.

All four groups were fed a control diet for 21 days prior to the start of the 85-day experimental period. Thereafter, one group (control) continued to receive the same diet while other groups received the diets 2, 3 and 4. The lambs were fed TMR diets *ad libitum* and twice daily (08:00 and 17:00 h) and the amounts of feed offered per animal were recorded daily and adjusted according to feed refusals. Fresh, clean water was available at all times. Body weights were recorded on a common day at the same time each week. Neither feed nor water was offered in the morning before lambs were weighed. The animals were maintained according to the guidelines set by the Iranian Council on Animal Care (1995). All lambs were sheared and treated externally with albendazole for parasites and vaccinated for Enterotoxaemia.

Carcass analysis

At the end of the experiment, all the animals were slaughtered on the same day after being fed for 85 days. After the lambs were bled, they were pelted and the head severed at the atlas joint. The weights of blood, head, feet and pelt were recorded. The lambs were then eviscerated, and the digestive tract and the internal organs were removed and taken to the laboratory for further study. All carcasses were hung by the Achiles tendon after slaughter. Warm and cold, after overnight chilling, carcass weights without head were recorded. The carcasses were chilled at 4 ºC for 24 h. Stomachs and its contents were weighed. Reticulo-rumen was separated from omasum and abomasum and all compartments were emptied, organs were washed and weighed. Intestines were emptied and weighed to determine intestinal contents. Intestinal fat, perirenal fat and the vital internal organs of liver, lungs, spleen and heart were also weighed. The dressing percentage was calculated as follows: (weight of carcass/live weight at slaughter) × 100. Cooler shrink refers to the loss of carcass weight between 0 and 24 h. The carcasses were split longitudinally into two parts. The right sides of carcasses were cut into six pieces (neck, shoulder, brisket, loin, legs and fat-tail) according to Kashan *et al.* (2005), and were weighed separately. Individual parts were then dissected into lean meat, bone, intramuscular fat, trimmings and weighed separately.

Statistical analyses

The GLM procedure (SAS, 2003) was used for variance analysis of data of growth performance, offals, commercial joints and carcass analysis of slaughtered lambs. The initial and final live weights of the lambs were used as co-variate for body and carcass weight, while carcass weight was used as a co-variate for the carcass components. The Duncan's test was used to compare means for significance.

RESULTS AND DISCUSSION

Premortem and postmortem examination of the lambs and their carcasses did not show any marked abnormality. Animal performance, feed intake and slaughter data are shown in Table 2. Feed intake was not affected by dietary treatments (P>0.05). Average final weights of lambs did not differ significantly between experimental groups. However, average live daily gain and live weight gain were significantly (P<0.01) higher in experimental diet 3.

Feed conversion ratio was the lowest in lambs fed experimental diet 3 (8.34) followed by those fed control diet (10.95), which in turn were superior to those fed 30% TWS diet (P<0.05). No significant differences observed between treatments for dressing percentage. However, dressing percentage on cold and warm slaughter weights increased numerically by increasing the amount of treated wheat straw in the diets. The dressing percentage of lambs fed control diet was close to the amount of lambs fed experimental diet 3. Cooler shrink was not affected by experimental diets. Adding treated wheat straw in the diets numerically increased the cooler shrink when compared with that of the control treatment. The cooler shrink of lambs fed diet 2 was numerically the highest. The effect of feeding treated wheat straw on offal parts of lambs was not significant (Table 3). There were no significant differences in weight and percentage yield of wholesale cuts (Table 4) due to treatments. Leg constituted the major wholesale cut recording uniformly (29% to 30%) in all groups, followed by brisket, shoulder, loin and neck with corresponding values of 17% to 22%, 15% to 17%, 14% to 16% and 4.9% to 5.1%, respectively.The effect of experimental diets on the carcass components of lambs is shown in Table 5. The weight of lean meat, bone, fat-tail and fat, and their percentage were not affected by feeding treated wheat straw. Full and empty weights of forestomach and abomasum were significantly influenced by experimental diets. The full weight of forestomach and abomasum of lambs fed experimental diet 4 was the lowest among other treatments (P<0.05). The empty weight of forestomach and abomasums of lambs fed experimental diet 3 was higher (P<0.01) than lambs fed experimental diet 4. In many researches, the effect of feeding treated wheat straw with different chemicals has been studied. Allam *et al.* (2009) fed treated wheat straw with urea, molasses and enzyme to growing male goats.

They observed that live weight gain in those animals increased significantly. Ma *et al.* (1990) reported that responses in live weight gain of cattle to ammoniation of wheat straw were significant. There was no variation in animals feed intake in the present study which is in contrast with those reported by Kent *et al.* (1988), Mahrous and Abo Ammou (2005), Gado *et al.* (2006), Fayed *et al.* (2008) and Allam *et al.* (2009) indicated that biological treatment of roughage improved feed intake.

However, in some studies (Dass *et al*. 2001; Mehra *et al.* 2001; Nisa *et al*. 2004) researchers found no difference in dry matter intake, when the urea treated wheat straw ensiled with fermentable sugar or organic acids was fed to buffaloes. Similar feed intake between animals in present study might be due to similar NDF concentration which probably has the same passage rate from the alimentary canal. In addition, the experimental diets had similar CP concentration and dietary cation-anion difference. Apart from the ani-

Table 2 Least square means (±SE) of performance and feed intake of lambs fed experimental diets

Item	Diet [a]				P value
	1	2	3	4	
Average initial weight (kg)	26.135±1.258	26.25±1.258	26.25±1.258	27.44±1.258	NS
Average final weight (kg)	38.74 ±1.153	39.12 ±1.152	40.88±1.152	36.95±1.162	NS
Average live daily gain (kg)	0.146^{ab} ±0.013	0.15^{ab}±0.013	0.17^{a}±0.013	0.12^{b}±0.013	0.0326
Average live weight gain (kg)	12.23^{ab}±1.14	12.6^{ab}±1.14	14.36^{a}±1.14	10^{b} ± 1.15	0.0015
Average feed intake (kg dry matter/day)	1.48±0.04	1.51±0.039	1.4±0.039	1.38±0.04	NS
Warm carcass weight (kg)	16.47±0.49	16.26±0.49	17.18±0.49	15.91±0.494	NS
Cold carcass weight (kg)	15.87±0.461	15.57±0.460	16.6±0.461	15.29±0.465	NS
Warm dressing percentage	42.27±0.973	41.53±0.972	42±0.972	43.51±0.981	NS
Cold dressing percentage	40.78±0.844	39.77±0.843	40.59±0.843	41.7±0.85	NS
Cooler shrink (% of warm carcass)	3.53±0.604	4.25±0.604	3.73±0.604	3.99±0.604	NS
Average feed conversion (kg dry matter/kg gain)	10.95^{ab}±1.172	10.34^{ab}±1.171	8.34^{a}±1.171	13.3^{8b}±1.181	0.0264

Means denoted with different letters (a-b) in a row differ.

[a] Diets were (1) control (0% treated wheat straw, 30% wheat straw); (2) 10% treated wheat straw, 20% wheat straw; (3) 20% treated wheat straw, 10% wheat straw and (4) 30% treated wheat straw, 0% wheat straw.

NS: non significant (P>0.05).

Table 3 Least square means (±SE) of offal parts of lambs fed experimental diets

Item	Diet [a]				P value
	1	2	3	4	
Feet (kg)	0.8± 0.027	0.79±0.027	0.84±0.027	0.75±0.027	NS
Pelt (kg)	4.35±0.185	3.96±0.184	4.53±0.184	4.09±0.186	NS
Heart (kg)	0.23±0.0499	0.12±0.0498	0.136±0.0498	0.137±0.05	NS
Liver (kg)	0.55±0.029	0.48±0.029	0.55±0.029	0.48±0.029	NS
Kidney (kg)	0.18±0.045	0.08±0.045	0.09±0.045	0.073±0.045	NS
Lung (kg)	0.414±0.022	0.421±0.022	0.47±0.022	0.414±0.022	NS
Blood (kg)	1.18±0.074	1.04±0.074	0.99±0.074	0.99±0.075	NS
Spleen (kg)	0.077±0.0078	0.066±0.0078	0.064±0.0078	0.07±0.0078	NS
Head (kg)	2.71±0.0926	2.55±0.0924	2.66±0.0924	2.39±0.0932	NS
Reproductive system (kg)	0.32±0.029	0.3±0.029	0.35±0.029	0.34±0.029	NS

[a] Diets were (1) control (0% treated wheat straw, 30% wheat straw); (2) 10% treated wheat straw, 20% wheat straw; (3) 20% treated wheat straw, 10% wheat straw and (4) 30% treated wheat straw, 0% wheat straw.

NS: non significant (P>0.05).

Table 4 Least square means (±SE) of carcass cuts of lambs fed experimental diets

Item	Diet [a]				P value
	1	2	3	4	
Neck (kg)	0.93±0.061	0.99±0.061	0.85±0.061	0.94±0.061	NS
Shoulder (kg)	2.95±0.066	2.84±0.066	2.75±0.067	2.69±0.066	NS
Brisket (kg)	3.22±0.226	3.05±0.226	3.53±0.228	3.89±0.226	NS
Loin (kg)	2.74±0.114	2.73±0.114	2.8±0.115	2.47±0.114	NS
Leg (kg)	5.18±0.104	5.14±0.104	5.34±0.105	5.01±0.104	NS
Fat-tail (kg)	2.35±0.178	2.44±0.178	2.34±0.179	2.22±0.178	NS

[a] Diets were (1) control (0% treated wheat straw, 30% wheat straw); (2) 10% treated wheat straw, 20% wheat straw; (3) 20% treated wheat straw, 10% wheat straw and (4) 30% treated wheat straw, 0% wheat straw.

NS: non significant (P>0.05).

Table 5 Least square means (±SE) of carcass components of lambs fed experimental experimental diets

Item	Diet[a]				P value
	1	2	3	4	
Lean meat (kg)	9.26±0.195	9.69±0.196	9.59±0.197	9.49±0.195	NS
Bone (kg)	2.65±0.185	2.90±0.185	2.90±0.186	2.72±0.185	NS
Intramuscular fat (kg)	2.82±0.178	2.89±0.179	3.06±0.180	3.20±0.178	NS
Intestinal fat (kg)	0.3 ±0.06	0.35 ±0.06	0.4±0.07	0.46±0.07	NS
Perirenal fat (kg)	0.14 ±0.03	0.155±0.03	0.162±0.03	0.168±0.03	NS
Internal fat (kg)	1.24±0.166	1.42±0.166	1.51±0.167	1.66±0.166	NS
Fat-tail (kg)	2.35±0.178	2.44±0.178	2.34±0.179	2.22±0.178	NS
Carcass fat (kg)	6.48±0.289	6.68±0.290	6.91±0.292	7.08±0.289	NS
Lean/bone ratio	5.32±1.087	3.4±1.090	3.22±1.097	3.49±1.086	NS
Lean/fat ratio	1.49±0.084	1.48±0.084	1.41±0.085	1.38±0.084	NS
Full intestines, without colon (kg)	7.15±1.516	3.05±1.519	3.19±1.529	2.61±1.515	NS
Empty intestines, without colon (kg)	1.13±0.12	1.46±0.12	1.15±0.12	1.05±0.12	NS
Full forestomach+abomasums (kg)	5.5^{a}±0.301	5.05^{ab}±0.302	5.47^{a}±0.304	4.15^{b}±0.301	0.0172
Empty forestomach+abomasums (kg)	1.07^{ab}±0.046	1.02^{ab}±0.046	1.20^{a}±0.046	0.92^{b}±0.046	0.0013
Lean meat (%)	56.59±1.207	58.84±1.21	58.24±1.218	57.48±1.206	NS
Bone (%)	16.30±1.059	17.65±1.061	17.67±1.068	16.55±1.058	NS
Intermuscular fat (%)	17.38±1.095	17.08±1.098	18.59±1.105	19.30±1.094	NS
Internal fat (%)	7.19±1.025	8.79±1.028	9.17±1.034	9.17±1.034	NS
Fat-tail (%)	14.25±1.07	14.77±1.072	14.15±1.079	13.22±1.069	NS
Carcass fat (%)	38.81±1.799	40.64±1.803	41.91±1.814	42.45±1.797	NS

Means denoted with different letters (a-b) in a row differ.
[a] Diets were (1) control (0% treated wheat straw, 30% wheat straw); (2) 10% treated wheat straw, 20% wheat straw; (3) 20% treated wheat straw, 10% wheat straw and (4) 30% treated wheat straw, 0% wheat straw.
NS: non significant (P>0.05).

mal type, concentration of fat, NDF, ADF, energy, dietary cation-anion difference, dietary CP degradability, forage type and processing method of roughage may control feed intake. Improving average feed conversion by increasing the proportion of TWS in experimental diets 2 and 3 might appear to follow that a better ruminal environment should lead to better animal performance. Because of no significant difference between lambs fed experimental diets in terms of feed intake and highest live weight gains in lambs fed diet 3, feed conversion was the highest in group fed with this experimental diet. These results are similar to the results obtained by Mahrous and Abou Ammou (2005), Gado *et al.* (2006), Fayed *et al.* (2008) and Allam *et al.* (2009), who reported that feed conversion was better with diet treated biologically compared with untreated.

Haddad and Ata (2009) examined growth performance of lambs fed on diets varying in concentrate and wheat straw. They reported that final body weight, total weight gain, daily weight gain and feed efficiency of the high wheat straw diets were significantly (P<0.05) higher than animals fed low wheat straw diets. Also, the carcass parameters of the high wheat straw treatments were significantly (P<0.05) higher than low wheat straw diets. This improvement might be related to lower risk of acidosis compared to feeding animals with high barley diets.

In the experiment reported here feeding TWS with urea provided a suitable environment for rumen microbes, therefore animal performance and carcass parameters have been improved. However, feed intake of lambs fed high forage diets is controlled by the gut full limitation (Haddad and Ata, 2009).

Lower values of dressing percentage which were measured in this experiment have been reported by others (Zervas *et al.* 1981; Butler-Hogg and Johnsson, 1986; Rogdakis *et al.* 1996; Panopoulou *et al.* 1991; Papadimitriou *et al.* 1989; Kandylis *et al.* 1998), which is possibly due to dressing percentage and is influenced by genotype (Zervas *et al.* 1981; Panopoulou *et al.* 1989; Papadimitriou *et al.* 1989). In the present study, the cooler shrink lambs fed experimental diets is similar to the required surface drying of 2-4% carcass weight loss, which is inhibitory to bacterial growth. More-O'Ferrall *et al.* (1989) reported highly significant differences in cooler shrink between breeds and suggested that the higher cooler shrink is an indicator of poorer water-holding capacity of the muscle, which could have commercial significance for the packaging trades. Non significant differences in the yield of different edible and inedible offal components of the lambs in different groups were found which confirms the findings of Kesava Rao *et al.* (1998) and Prasad and Sinha (1991). Greater full and empty forestomach weight in sheep on treated wheat straw diets compared with the control diet may be attributed to larger physical stimuli because of increased consumption of solid feed (Khan *et al*. 2008). The weight of forestomach (rumen+reticulum) is related to metabolic weight ($W^{0.75}$) of animal. In the present study, lambs fed diet containing 20% TWS and 10% UWS had higher metabolic weight than lambs fed other diets, thus the forestomach weight of this group was heavier compared with other groups. Intramuscular fat tended to be lowering in treatment one (control) and is in accordance with the results of internal and carcass fatness. Hadjipanayiotoua and Louca (1976) reported that feeding feed ingredients which has fermentable sugar like citrus pulp promotes acetate fermentation. In this experiment, lack of whey as an energetic feed ingredient caused lower fat content in control group. However, the differences were not significant in this case. The values for intramuscular and internal fat are much higher than those reported by other researchers (Butler-Hogg and Johnsson, 1986; Rogdakis *et al*. 1996; Kandylis *et al*. 1998), this may be due to different breeds and higher live weights of slaughtered lambs. It has been reported that the intestinal fat was 260g (Butler-Hogg and Johnsson, 1986), and between 198-238g (Rogdakis *et al*. 1996) in lambs at about 32 and 25 kg live weight of slaughter, respectively. In contrast, Kandylis *et al.* (1998) found 225-515g intestinal fat in growing-fattening lambs was slaughtered about 32-37 kg weight. Rogdakis *et al.* (1996) reported that the effect of sheep breed on the weight of intestinal fat was significant. Zervas *et al.* (1981) and Papadimitriou *et al.* (1989) concluded that the weight of perirenal fat was affected by sheep breed. The practical significance of measuring intestinal and perirenal fat is that these two measures of fatness are considered as the best available indicators of fat depots at the carcass weight of lambs. No official carcass grading is defined in Iran fatness standards, and the commercial value of carcass weight is differentiated by the above two variables and heavier carcass weights are now acceptable by local producers and consumers.

CONCLUSION

The results of this experiment indicate that supplementation of treated wheat straw (TWS) with barley based concentrate had some beneficial effect on the studied traits, although the differences in many cases failed to reach statistical significance. However, average feed conversion was significantly (P<0.03) lower in animals fed treatment. Urea treated wheat straw can be included up to 20% DM of growing sheep ration without any negative effect on productivity. It is worth mentioning that this inclusion can provide an opportunity for cost effective animal protein production. Further research is necessary to study the fermentation kinetics during ensiling and chemical changes in fiber content that occurred in wheat straw ensiled with urea and whey which has fermentable sugar sources having acidic pH. Supplementing the diets of lambs with treated wheat straw to increase its nutritive value may seem at first to be an expensive proposal; however, when one considers the better feed conversion and the shorter period on feed, treating wheat straw with urea and whey may prove to be beneficial.

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