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The effects of dietary inclusion rate of molasses distillers soluble on nutrients digestibility, performance and some blood biological parameters of fattening lambs

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Abstract The molasses distillers condensed soluble (MDCS) is a by-product, mineral-rich liquid, yeast and fermentation of soluble components which have been produced after distillation and alcohol production. Because of water content, pH and the high concentration of some of the mineral salts, this by-product is known as a contaminated matter and environmental pollutant. However, MDCS has a substantial value as animal feedstuff. In this study the chemical composition of MDCS and its effect on growth performance of fattening lambs, blood biochemical parameters were determined. A completely randomized design was performed with 3 treatments (6 lambs in each). The basal diet was alfalfa hay and corn, barely and soybean meal in the pelleted diet. The treatments were basal diet as a control, and the basal diet containing 5 or 10 percent of MDCS per Kg DM of pellet. DM, CP, Ash and ME of MSCD were 65.2, 22.3, 21.2 percent and 2566 Kcal/kg, respectively. The results indicated that in-vivo digestibility of DM, OM, CP, NDF of experimental diets were affected by incorporation of MSCD ($P<0.05$). The DMD, OMD and DNDF were increased ($P<0.05$) by adding MSCD at the level of 10%. There were no significant differences between treatments concerning average daily gain, dry matter intake and feed conversion ratio. The serum metabolites and livers enzymes were not affected due to incorporation of MCDS in diets. In conclusion, MDCS as a cheap and good source of protein and energy can be mixed with hay or concentrate and could be safely used as a feed ingredient up to 10% of fattening lambs diet without any detrimental effects.

Key words: *MSCD, lambs, pellet, digestibility, blood metabolites, nutritive value*

Introduction

Ethanol is produced by grain crop (corn, wheat, barley) potato or molasses. Molasses is a typical alcoholic distillate in Iran. Molasses can also be used as the basic material for other fermentation processes yielding citric acid,

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yeast, monosodium glutamate, acetic acid and acetone. The molasses distillers condensed soluble (MDCS) is mineral – rich liquid, yeast and fermentation of soluble components have been produced after distillation and the alcohol production. Its production is depending on geographical location, cost and availability of these matters (www. Ddgs.umn.edu; Lodge, 1997). It is reasonable to take advantage of the large amounts of MDCS being produced. The water content, pH or the high concentration of some of mineral salts are unacceptable for incorporation of distillers grains to animal feeds [10, 12]. DDCS have a substantial value as animal feedstuff by removing the water, however, is not sufficient to render MDCS very useful as animal feed supplement, because following reduction of the water content of MDCS; as the mineral salts tend to precipitate out of the mixture (Ham, 1994; Potter, 1985). The precipitation has a crystalline character and forms a hard packed sediment cake which is difficult to remove and cannot be easily re-dispersed through the mixture. However, removing the precipitation and related processing steps contribute to the cost of the final product (Chen, 1981; Shen, 1998).

As the recovered by-product of MDCS has a low pH (=4), it is advantageous to raise or even neutralize the pH. This pH adjustment can be achieved by adding sodium hydroxide, ammonia or any other feed grade alkali. Neutralization with ammonia is desirable, because the nitrogen can serve as a protein source in the animal feed (Jacob, 2005; Shen, 1998). Corn or molasses condensed distillers soluble are relatively high in CP (15 to 25%; DM basis), which makes the product an attractive supplement for low-quality forages. Low-quality forages and by-pass residues are abundant, valuable feed resources for ruminant animals (NRC, 1983). Improved cellulose digestion by addition of either dried distillers soluble or corn distiller's soluble has been reported Chen *et al*. (1981); Kamalzadeh (1984). However, little is known about optimum levels of this by-product in low-quality forage-based diets and subsequent effects on ruminal fermentation and digestion. Little research has been done regarding the effect of MDCS on the growth performance of fattening lambs, blood biochemical parameters and carcass characteristic.

Veyskarami (2008) indicated that MDCS as a very cheap source of protein and energy mixed with hay and safely used as a feed ingredient up to 15 percent in Lori fattening lambs ration without any clinical signs. Meanwhile, he has mentioned some problems with preparation and storage of alfalfa containing MCDS rations. The propose of this study was to determine the chemical composition of molasses distillers condensed soluble (MDCS) as dietary energy and protein supplement and to evaluate the effect of different levels of MCDS supplementation in the pelleted form on digestibility, growth performance, blood biochemical parameters and carcass characteristics of Sanjabi lambs.

Material and methods

This study was conducted at the Animal farm of Razi University, in Kermanshah province - Iran (34°18'N and 47°3'E). All animal care, handling techniques, and surgical procedures were approved by the Razi University Animal Care Using Committee before initiation of the research. Eighteen male Sanjabi lambs (28.46±1.46 kg) were used in a completely randomized design with 3 treatments and 6 replications (6 lambs in each). The lambs were randomly allocated to individual pens with free access to feed and water. The daily rations were 50 % pellet with different levels of MCDS (0, 5, and 10 %) and 50 % alfalfa hay. The MDCS were obtained from an alcohol fuels production factory. The chemical compositions of feeds were analyzed according to AOAC (1990). The digestibility, blood biochemical parameters and carcass characteristics were performed during fattening period. The minerals Ca, P, Na, K, Mg, S were measured using determined by flame atomic absorption spectrophotometer (AAS) and Fe, Zn, Se and Cu were analyzed using ICP-OES (model: optimum 7300 DV simultaneous ICP-OES, Perkin Elmer USA, nebulizer type: glass concentric with pressure of 200 kPa). The gross energy was calculated by calorimetric bomb (Pars. model 2000) and ME estimated according to Menke *et al*. (1979) and Makkar (2003).

Experimental fattening period was 105 days in length, allowing 14 d as adaptation period to the treatments diets. Lambs weighed and recorded at the beginning and then after 2 weeks interval. At the end of fatting period, nine lambs (three lambs from each group) were randomly housed in individual pens stanchions (0/9 × 1/2 m) to estimate the effect of MCDS levels on nutrients digestibility. The lambs were offered hay and pellet at 08:00 and 17:00 and were allowed free access to water and salt blocks. Feed refusals, feces and urine excreted by each animal were recorded daily at 08:30 h over 7 days and sub-sampled for further analysis. Blood samples were taken in sterile non-heparinised vacutainer tubes from each lamb via jugular vein-puncture on day 1 and at the end of experiment. Blood samples were centrifuged for 15 min at 2000 rpm. Serum aliquoted in different fractions and the serum samples stored at −20 ◦C until analysis, then analyzed for Glucose, Creatinine, triglycerides, cholesterol and liver’s enzymes (ALP, AST and ALT). Glucose was estimated using glucose oxidase (Sacks, 1999; Thomas, 1998), Urea was measured according to method of Berthelot (Newman *et al*., 1999), Creatinine through Jaffe method, triglycerides by lipoprotein lipase method using Pars test kit, cholesterol by cholesterol-oxidant method using the Pars kits test. The effect of

MDCS on lamb's health was investigated by monitoring the color and weight of liver and kidneys. Evaluations of carcass component of lambs were followed by slaughtering of 3 lambs from each group at the end of fattening period. The carcass was divided into individual components and weighed separately as internal organs (liver, heart, lungs and trachea, kidneys, testes and spleen), head, feet and carcass. Visceral fat (separable fat in the body cavity) was separated at the time of harvesting and weighed. The kidney fat was also physically separated from both sides and weighed. Carcass was weighed hot (approximately 1 h after harvesting) and then chilled (-4°C) for approximately 24 h. After chilling, the carcass was weighed again and then longitudinally halved with a band saw. Four-part stomach of each animal weighed carefully after removing the abdominal area Stomach contents have been emptied and weighed.

Data were analyzed as a complete randomized design using MIXED procedure of SAS (version 9.1, SAS Inc., Cary, NC). Multiple comparisons among means were performed with the Duncan method. The model included MCDS level and period as fixed effects, and lamb as a random effect. Daily weight gain was analyzed as a repeated measurement using GLM procedure (SAS Version 9.1, SAS Inc., Cary, 2001).

Table 1. Components, Ingredients and Nutrient composition of Diets and Pellets

	Control	5% MCDS	10% MCDS
Components %			
Alfalfa hay	50	50	50
Pellet	50	50	50
Pellet Ingredients %			
Barley grain	25	25	25
Soybean meal	15	15	14
Wheat barn	5	5	1
Corn seed	50	50	50
MCDS	0	5	10
Molasses	5	0	0
Nutrient composition(pellets)			
DM %	95.1	95	95
ME (Mcal/kg)	3.11	3.13	3.19
CP (gr/Kg/DM)	166.3	167.2	168.8
NDF(gr/Kg/DM)	155.7	156.1	150.5
EE(g/Kg/DM)	28.35	28.55	26.35
ASH	33.5	44.2	54.6
Ca (gr/Kg/DM)	1.82	1.75	2.20
P (gr/Kg/DM)	3.41	3.48	3.26
k (gr/Kg/DM)	10.67	11.12	12.47
S(gr/Kg/DM)	1.12	1.72	2.11
Na (gr/Kg/DM)	1.06	1.9	2.46
FE (mg/Kg/DM)	75	84	90
Cu (mg/Kg/DM)	6.9	7.9	9.1
Zn(mg/Kg/DM)	36	40	41.3
Se (mg/Kg/DM)	0.65	0.71	0.76

Results and discussions

The chemical composition of MSCD and Diets

The chemical compositions of the MSCD and experimental pellets are given in Table 1. Molasses condensed distillers soluble are relatively high in CP (20 to 25%; DM basis), which makes it an attractive supplement for low-quality forages. These results are in agreement with results reported by Veyskarmi (2008). The ash content of MCDS was high (20-26%) which is one of the reasons of its limitations in diet.

Digestibility of Nutrient composition of diets

Based on the data from Table 2 the MSCD treatments had positive effect on nutrient digestibility. Digestibility of DM from animals fed on the pellet containing 10% MCDS was significantly higher than that of control (P<0.05). Veyskarami *et al*. (2009) also observed an increase in vivo and in vitro DM digestibility following incorporation of 15% MCDS to the diets. In other study the addition of MCDS increased Cp and CF digestibility of feedstuffs with low protein (Kamalzadeh, 1984; Tillman *et al*., 1951). Gilbery *et al*. (2006) also reported that applying corn condensed distillation soluble (CCDS) up to 15%, caused an increase in DM digestibility of forage. Hunt *et al*. (1983) indicated that silage digestibility increased when prepared with different levels of condensed distillation soluble.

Table 2. Mean ($\bar{x}$ ±SD) weight and growth traits of lambs

Trait (kg)	Groups			
	Control	%5MCDS	%10 MCDS	Sig.
Initial weight(Kg)	28.27±1.18	27.49±1.3	28.62±1.26	0.8852
Final weight(Kg)	45.58±1.13	46.01±1.18	46.32±1.23	0.5614
ADG(g)	191.05±9.05	193.30±9.11	196.20±9.53	0.1187
FCR	6.29±0.70	6.29±0.73	6.27±0.72	0.9802

*Within rows differences were statistically significant at P<0.05.

The OM digestibility of treated diets with MCDS were higher than that of control (P<0.05). An increase in OM digestibility of diet with 15% MCDS has been reported by Veyskaramy (2008). Also these results are in good agreement with reports by Stemme (2005) that MCDS increased OM digestibility. Incorporation of MDCS to the diets also enhanced (P<0.05) CP digestibility. Archibeque *et al*. (2007) reported that addition of CCDS up to 15% to silage-based diets with low protein content caused an increase in CP digestibility of forage (34% in the base feed and 57.3% in the base feed with 15% CCDS) ($P< 0.05$).

Fiber digestion was influenced by adding MCDS to the pellet ($p<0.05$) at 10% level replacement. An increase in fiber digestibility of low protein rations due to addition of MCDS has been also reported by Kamalzadeh (2004) and Veyskaramy *et al*. (2009). An increment in NDF and ADF digestibility of diets also has been reported by Archibeque *et al.* (2007) and Veykaramy (2008). The EE and GE digestibility of diets were not influenced significantly due to addition of MCDS in the pellets.

Average daily gain and feed conversion ratio

The changes of body weights of lambs during the experiment are presented in Table 3. Average daily gain (ADG), final body weight and feed conversion ratio (FCR) of fattening lambs were not influenced by addition of MCDS, significantly. Similar finding has been recorded by Veyskarami (2008). There was no additional ADG, growth performance of lambs and different FCR due to incorporation of corn and sorghum distiller's byproducts Lodge *et al*. (1997) and corn distiller's grains with soluble Ham (1994).

Table 3. Mean ($\bar{x}$ ±SD) blood parameters of lambs at the start of experiment (day 1)

Blood parameters	Lamb groups			
	Control	5% MCDS	10% MCDS	Sig.
Urea (mg/dl)	36.27±6.5	35.00±5.71	34.08±6.61	0.2546
Total protein (mg/dl)	6.25±0.64	6.64±0.87	6.68±0.61	0.1024
Glucose (mg/dl)	62.83±9.62	63.08±8.68	64.28±10.3	0.9124
Triglycerides (mg/dl)	28.26±12.22	28.46±13.39	29.45±16.09	0.4367
Cholesterol (mg/dl)	53.21±4.32	53.38±6.42	54.33±5.33	0.7846
Ceratinin (mg/dl)	0.78±0.16	0.79±0.14	0.81±0.15	0.7225
Albumin (mg/dl)	2.83±0.38	2.86±0.91	3.02±0.35	0.3604
Calcium (mg/dl)	10.98±0.6	10.76±0.8	11.07±0.65	0.3962
Phosphor (mg/dl)	6.86±0.72	6.98±1.3	7.52±1.07	0.3358
Sodium (mmol/dl)	125.83±3.01	126.17±3.35	127.58±2.81	0.3411
Potassium (mmol/dl)	4.68±0.36	4.71±.0.25	4.75±0.3	0.2722
Iron (mmol/dl)	146.58±5.53	147.17±17	149.83±4.3	0.2016
AST (mmol/l)	89.47±11.23	87.38±23.82	88.21±12.46	0.9424
ALT (mmol/l)	13.67±6.26	14.08±4.97	15.33±4.53	0.3246
ALP (mmol/l)	528.2±14.1	528.46±18.31	530.51±10.91	0.5427

* Within rows differences were statistically significant at $P<0.05$.

AST=Aspartate amno Transferase ALT=Alanin amno Transferase ALP=Alkalin phosfatase

Blood biochemical metabolites

The blood metabolites of lambs during the fattening period are presented in Table 4 and 5. As a results of measuring serum levels of some metabolites of lambs receiving pellets containing MCDS or without MCDS showed the MCDS was not significantly affect on glucose, cholesterol, triglycerides, urea, creatinine and albumin concentrations (P>0.05). Blood glucose, cholesterol, triglycerides, urea, creatinine and albumin concentrations were not altered following addition of MCDS to the pellets (P>0.05). The mean blood total protein of lambs which received the pellet containing 10% MCDS was higher than that of control (p=0.08). The serum concentrations of minerals sodium, potassium, calcium, phosphorus and iron did not differ between treatments (P>0.05) (Table 5). The liver's enzymes (AST, ALT and ALP) were also not influenced significantly and were at the normal levels in all lambs.

Table 4. Mean ($\bar{x}$ ±SD) blood parameters of lambs at the end of experiment (day 90)

Blood parameters	**Lamb groups**			
	Control	5% MCDS	10% MCDS	Sig.
Urea (mg/dl)	39.17±4.6	35.00±7.62	34.08±5.48	0.2953
Total protein (mg/dl)	6.37±0.42	6.72±0.48	6.88±0.65	0.0823
Glucose (mg/dl)	64.83±9.12	66.08±9.9	66.17±12.7	0.9006
Triglycerides (mg/dl)	28.08±12.22	28.42±13.39	31.25±16.09	0.4488
Cholesterol (mg/dl)	53.17±3.35	54.08±11.07	55.33±8.03	0.8011
Ceratinin (mg/dl)	0.77±0.11	0.79±0.14	0.82±0.1	0.7225
Albumin (mg/dl)	2.95±0.25	2.88±0.55	3.12±0.35	0.3522
Calcium (mg/dl)	10.98±0.6	10.76±0.8	11.07±0.65	0.3962
Phosphor (mg/dl)	6.86±0.72	6.98±1.3	7.52±1.07	0.3358
Sodium (mmol/dl)	137.83±3.01	139.17±3.35	137.58±2.81	0.3411
Potassium (mmol/dl)	4.85±0.36	4.79±.0.25	4.87±0.3	0.2722
Iron (mmol/dl)	162.58±5.53	163.17±17	165.83±4.3	0.2016
AST (mmol/l)	91.17±10.33	89.58±13.93	90.25±10.64	0.9540
ALT (mmol/l)	13.67±5.16	16.08±3.96	17.33±6.23	0.2328
ALP (mmol/l)	538.0±14.6	538.58±18.39	542.41±10.94	0.6170

* Within rows differences were statistically significant at P<0.05.
AST=Aspartate amno Transferase, ALT=Alanin amno Transferase, ALP=Alkalin phosphatase

Table 5. Mean ($\bar{x}$ ±SD) carcass characteristics and proportional yield of lambs

Traits	Control	5%MCDS	10% MCDS	Sig.
Carcass weight (kg)				
Slaughter weight	46.35±0.13	46.41±0.97	47.04±0.44	0.3660
Warm Carcass Weight (WCW)	24.84±0.99	24.25±0.73	24.22±0.34	0.5252
Cold carcass weight	23.82±0.61	23.07±0.91	24.28±0.36	0.1609
Carcass percentage (%)				
Carcass percentage	52.39±1.62	52.42±0.44	52.46±0.92	0.9973
Fillet Muscle Cutting Plane (cm^2)				
Fillet Muscle Cutting Plane	16.11±0.14	16.25±0.23	16.62±0.41	0.1247
Proportion of wholesale cuts and organs (%)				
Neck	6.2±0.5	6.4±0.4	5.8±0.7	0.4661
Nape	2.2±0.12	2.3±0.24	2.3±0.23	0.5513
Fillet	7.2±0.73	6.8±0.11	6.3±0.61	0.3558
Loin	6.3±0.32	6.07±0.6	6.33±0.32	0.1479
Hands	15.5±0.31	16.62±1.32	15.90±1.13	0.4180
Legs	29.31±0.40	29.41±1.11	28.82±0.83	0.5479
Chest	12.01±0.42	12.03±1.34	12.52±0.63	0.6909
Around kidney	4.01±0.42	3.51±0.33	3.92±0.53	0.3931
Head	5.56±0.02	5.19±0.36	5.29±0.05	0.1635
Four feet	2.49±0.11	2.35±0.07	2.33±0.15	0.2440
Pelt	12.39±0.52	11.23±1.24	10.71±0.79	0.1451
Full Rumen	20.00±0.48	19.11±0.17	18.22±2.48	0.3865
Empty Rumen	3.76±0.13	4.14±0.81	3.69±0.76	0.6763
Full Intestine	6.03±0.05	5.95±0.23	5.94±0.09	0.7071
Empty Intestine	2.33±0.13	2.46±0.25	2.62±0.17	0.2639
Spleen	0.27±0.06	0.23±0.011	0.25±0.26	0.4938
Liver	1.51±0.03	1.33±0.16	1.36±0.09	0.1633
Testes	0.78±0.08	0.66±0.13	0.76±0.15	0.1729
Lungs	0.95±0.08	1.10±0.13	0.98±0.15	0.3553
Heart	0.46±0.03	0.39±0.08	0.47±0.06	0.3366
Kidney	0.27±0.01	0.24±0.03	0.28±0.06	0.4881
Internal fat	1.46±0.22	1.23±0.03	1.31±0.05	0.0009*
Fat –Tail	8.30±0.61	8.22±0.21	9.45±0.21	0.0130*
Internal fat and Fat- Tail	9.74±0.62	9.39±0.28	11.73±0.15	0.0160*

* Within rows differences were statistically significant at $P<0.05$.

Carcass characteristics

The slaughter and carcass characteristics of the lambs are summarized in Table 6. The results showed that incorporation of MCDS did not affect carcass weight and carcass percentage of fattening lambs compared with control. Moreover, proportion of wholesale cuts and organs of lambs fed on diets containing MCDS were similar to those of control (p>0.05).The dressing percentage in lambs of control group were lower than MCDS treatments (P>0.05). Liver weights as well as color of livers and kidneys of all lambs were normal. A similar result concerning carcass characteristics has been reported by Veyskarami (2008) on Lori fattening lambsusing 15 % MCDS treatment. Internal fat of lambs fed on diets containing MCDS were lower than that of control (p<0.05), however, lambs offered diets with 10% MCDS had a higher (p<0.05) percentage of fat-tail than that of other lambs.

Conclusion

The results obtained from this experiment showed that the diets containing different levels of MCDS can be used up to 10% percent of daily ration without any negative effects on fattening lambs performance. The DMD, OMD and DNDF were increased by adding MSCD at the level of 10%. There were no significant differences between treatments concerning average daily gain, dry matter intake and feed conversion ratio. It can be concluded that MDCS can be mixed with alfalfa hay or concentrate in mesh or pellet form and safely be used as a feed ingredient up to 15 percent of fattening lambs ration without any clinical signs. Further study needs to find optimum levels of MCDS in the animal rations.

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References

AOAC (1997). Official Methods of Analysis. 16th ed. Assoc. Off. Anal. Chem., Arlington, VA.

Archibeque, S. L., H.C. Freetly and C.L. Ferrell (2007). Feeding distillers grains supplements to improve amino acid nurture of lambs consuming moderate-quality forages J. Anim Sci. 2007:691-701.

Burroughs, W., J. Long, P. Gerlaugh and R.M. Bethke (1950). Cellulose digestion by rumen microorganisms as influenced by cereal grains and protein-rich feeds commonly fed to cattle using an artificial rumen. J. Anim. Sci. 9:523–530.

Caton, J.S. and D.V. Dhuyvetter (1997). Influence of energy supplementation on grazing ruminants: Requirements and responses. J. Anim. Sci. 75533–542.

Chen, M.C. and C.B. Ammerman, P.R. Henry, A.Z. Palmer and S.K. Long (1981). Citrus Condensed Molasses Soluble as an Energy Source for Ruminants. J. Anim. Sci. 53:253-259.

Chen, M.C., W.M. Beeson and T.W. Perry (1976). In Vitro Studies on the Effect of Screening Corn Distillers Soluble on Cellulose Digestion and Microbial Protein Synthesis. J. Anim. Sci. 43:1280-1285.

Department of Animal Science in University of Minnesota. The Value and Use of Distillers Grains By-products in Livestock and Poultry Feeds (www.Ddgs.umn.edu).
Gilbery, T.C., G.P. Lardy, S.A. Soto-Navarro, M.L. Bauer, and J.S. Caton (2006). Effects of corn condensed distiller's soluble supplementation on ruminal fermentation, digestion, and in situ disappearance in steers consuming low-quality hay J. Anim. Sci. 84:1468-1480.
Ham, G.A., R.A. Stock and R.P. Huffman (1994). Wet corn distillers by product compared with dried corn distillers grains soluble as a source of protein and energy for ruminant. J. Anim. Sci. 72:3246-3257.
Hatch, C.F., T.W. Perry and W.M. Beeson (1972). Effect of corn distillers soluble and brewers dried grains with yeast in Urea-containing rations tear performance. J. Anim. Sci. 34:326-331.
Hunt, C.W., J.A. Paterson, J.R. Fischer and J.E. Williams (1983). "The effect of sodium hydroxide treatment of fescue-corn stillage diets on intake, digestibility and performance with lambs." J. Anim. Sci. 57: pp. 1013.
Jacob, M.E., J.T. Fox and T.G. Nagaraja (2005). Effect of distillers grain on fecal prevalence in-vitro growth of E.coli. Kansas State University, Manhattan.
Kamalzadeh, A. (1984). Principal and suitability of animal feeds. Abasi Publisher. Tehran, Iran
Larson, E. M., R.A. Stock, T.J. Klopfenstein, M.H. Sindt and R.P. Huffman (1993). Feeding value of wet distillers byproducts for finishing ruminants J. Anim. Sci. 71:2228-2236.
Lodge, S.L., R.A. Stock, T.J. Klopfenstein, D.H. Shain and D.W. Herold (1997). Evaluation of corn and sorghum distillers by products. J. Anim. Sci. 75:37-43.
Makkar, H.P.S. (2003). Effects and fate of tannins in ruminant animals, adaptation to tannins, and strategies to overcome detrimental effects of feeding tannin-rich-feeds. Small Rumin. Res. 49:241-256.
Menke, K.H., L. Roab, A. Salewski, H. Steingass, D. Fritz and W. Schneider (1979). The estimation of the digestibility and metabolizable energy content of ruminant feedstuffs from the gas production when they are incubated with rumen liquor in vitro. J. Agric. Sci. pp. 217-222.
Newman, D.J. (1999). Price CP. Renal function and nitrogen metabolites. In: Burtis CA. Ashwood ER, editors. Tietz Textbook of Clinical Chemistry. 3rd ed. Philadelphia. W.B. Saunders Company. pp.1204-1270.
Sacks, D.B. (1999). Cabohydrate. In: Burtis CA, Ashwood ER. Editor. Tietz Textbook of Clinical Chemistry. 3rd ed. Philadelphia. W.B Saunders Company. pp. 750-808.
Shen, J. (1998). Stabilized molasses distillers condensed soluble. United States Patent. pp. 478-928.
Stemme, K., B. Gerdes, A. Harms, Kamphues (2005). Beet-vinasse (condensed molasses solubles) as an ingredient in diets for cattle and pigs - nutritive value and limitations. J. Anim. Physio. pp: 3-6 and Anim. Nutr. pp. 79-83.
Potter, S G., A. Moya, and C.B. Ammerman (1985). Sugarcane condensed molasses soluble as a feed ingredient for finishing cattle. J. Anim. Sci. 60:839-846.
Thomas, L. (1998). Clinical laboratory Diagnostics. Glucose determination Frankfurt. TH-Book Verlagsgesellschaft. pp. 7-131.
Tillman, A.D. and J.F. Kidwell (1951). The Value of Ammoniated Condensed Distillers Molasses Soluble as a Feed for Beef Cattle. J. Anim. Sci. 10:934-938.

Veyskarami, S., Sh. Safari Monjeghtapeh and M.M. Moeini (2009). Nutritive value of molasses distillers condensed soluble and its effect on growth performance of Lori Lamb. Record Number 20103049853-Sustainable animal husbandry: prevention is better than cure, Volume 2. Proceedings of the 14th International Congress of the International Society for Animal Hygiene (ISAH), Vechta, Germany, 19th to 23rd July 2009, pp. 1009-1012.

Veyskarami, S. (2008). Chemical characteristics, nutrient digestibility and nutritive value of condensed molasses distiller on growth performance of lori lambs, in vitro and invivo. Msc theses, Razi University, Kermanshah, Iran.

Waller, J., T. Klopfenstein and M. Poos (1980). Distillers Feeds as Protein Sources for Growing Ruminants. J. Anim. Sci. 51:1154-1167.

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