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# Response of Growing Bulls Fed Ration Containing Different Levels of Citrus Pulp

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**Abstract:** The objective of this study was to assess the compared between corn silage and citrus pulp silage in two levels on nutrients digestibility, growth performance and blood metabolites of beef cattle. Thirty male, crossbred bulls (Friesian x Baladi) averaged 235 kg live body weight, 14-15 months old were divided into 3 groups of 10 animals in each according to live body weight. Animals in the control group or ration C) were fed 30% corn silage plus 70% concentrate feed mixture (CFM), while, the experimental animals were fed T1) 30% citrus pulp silage plus 70% CFM and T2) 45% citrus pulp silage plus 55%CFM. The experiment lasted for 120 days. Results indicated that no significant ($p>0.05$) differences observed among experimental groups in dry matter (DM), organic matter (OM), crude protein (CP) nitrogen free extract (NFE), acid detergent fiber (ADF), cellulose and hemicelluloses digestibilities. Crude fiber (CF) digestibility was significantly ($p<0.05$) increase for bulls fed control rations when compared with those fed the T1 and T2. Moreover, there were significantly ($p<0.05$) different between T1 and T2 rations. Ether extract digestibility was significantly ($p<0.05$) among all the experimental rations. The highest value was observed for bulls fed control ration then followed by T1 and T2. The corresponding values were 84.02, 78.48 and 71.11%, respectively. Neutral detergent fiber digestibility was significantly ($p<0.05$) higher for bulls fed control ration than those fed T1 and T2. Bulls fed control and T1 rations recorded significant ($p<0.05$) increase of TDN compared to those fed T2 rations. The corresponding values were 73.14, 72.56 and 68.61%, respectively. Digestible crude protein was significantly ($p<0.05$) increase for bulls fed T1 compared with the T2, however there was insignificantly ($p>0.05$) differences with those fed the T2 ration. Dry matter intake (DMI) was significantly ($p<0.05$) difference among the different experimental rations. Data indicated that bulls fed T2 recorded the lowest dry matter intake. Insignificant ($p>0.05$) differences in average daily gain (ADG) among treatments were detected. The highest average daily gain had been recorded with bulls fed T1, while the lowest average daily gain was recorded with bulls fed T2. The values were 1.15 and 1.02 Kg respectively. Blood parameters such as hemoglobin, hematocrit, total protein, urea, creatinine, triglycerides and cholesterol, did not record any significant differences among experimental animals. Mean while, cholesterol concentration was significantly ($p<0.05$) increase for bulls fed T1 compared with those fed control group, with insignificant ($p>0.05$) difference for T2. In conclusion, corn silage could be replaced by citrus silage in beef cattle rations without any adverse effects on nutrients digestibility, blood parameters and growth performance.

**Key words:** Bulls · Citrus pulp · Silage · Intake · Performance · Growth

## INTRODUCTION

Ruminants feeding systems based on locally available by-product feedstuffs are often a practical alternative because the rumen microbial ecosystem can utilize by-product feedstuffs which often contain high levels of structural fiber to meet their nutrient requirements for maintenance, growth, reproduction and milk production [1].

Mediterranean countries are responsible for 24% of world citrus production, generating many tones of residues in high citrus production areas. Feeding citrus pulp to small ruminants, characteristic livestock of the Mediterranean area, could be a practice that would

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diminish dependence on grains and contribute to reducing the environmental problems linked to their elimination [2].

Peels represent between 50 to 65% of total weight of the fruits and remain as the primary by-product. If not processed further, it becomes west produce odor, soil pollution, harborage for insects and can give rise to serious environmental pollution. In Egypt and in many Mediterranean countries, major quantities of the peel are not further processed. Some attempts were made to use these residues as livestock feed, although their low nutritional value.

Citrus pulp is a by-product derived from the citrus juice industry and includes a mixture of citrus peel, pulp and seeds [3]. It has favorable nutritional characteristics such as high energy content, a significant fiber content and high palatability, although its crude protein content is low [4].

Citrus pulp can be used in animal feeding either fresh or after ensilage or dehydration [5, 6 and 7].

The objective of the present work is compare between corn silage and citrus pulp silage in two levels on nutrients digestibility, nutrients value of ration, growth performance and blood metabolites of beef cattle.

## MATERIALS AND METHODS

**Experimental Animals and Rations:** Thirty male, crossbred bulls (Friesian x Baladi) averaged 235 kg live body weight, 14-15 months old were divided into 3 groups of 10 animals in each according to live body weight.

Corn silage and citrus silage made in Marina Company for Agriculture Development (El-Asad village, Misr Alexandria road).

Animals in the control group (C) were fed 30% corn silage plus 70% concentrate feed mixture (CFM), while, the experimental animals were fed (T1) 30% citrus pulp silage plus 70% CFM and (T2) 45% citrus pulp silage plus 55%CFM.

**Feeding Procedures:** The growing bulls were fed individually at rate of 3% of live body weight, CFM and forage offered twice daily and water was allowed freely all the day round. Orts were collected just before offering the next day's feed. Animals were weighted biweekly before morning feeding after 17 h fasting period. Amount of feeds was adjusted biweekly according to body weight changes. Feed intake was recorded, daily body weight gain and feed efficiency (kg. feed/kg. gain) were calculated.

**Digestion Trials:** Nutrients digestibility were determined by the acid insoluble ash (AIA) technique as described by Van Keulen and Young [8], to determine the digestion coefficients and the nutritive values of the experimental rations. At the end of growth trial, feces samples were collected for six successive days from each animal. Total digestible nutrients (TDN) were calculated according to the classic formula of McDonald *et al*. [9] as follows: TDN,% =[digestible CP,% + digestible CF,% + digestible NFE,% +( digestible EE,% *2.25)].

**Chemical Analysis:** Feeds and feces were analyzed for proximate analyses [10]. Nitrogen free extract was calculated by difference. Fiber fractions were analyzed according to Van Soest *et al*. [11].

**Blood Parameters:** At the end of the feeding trial, four hours post feeding blood samples were withdrawn from all the experimental animals. The blood samples were taken from the jugular vein in dry clean glasses tubes using heparin as anticoagulant and then centrifuged for 15 minutes at 4000 rpm to obtain plasma. Biochemical of blood plasma constituents were determined using commercial kits, total protein and creatinine as described by Tietz [12, 13], blood plasma urea was determined according to Patton and Grouch [14]. Alanin amino transferase (ALT) and activity of aspartate transferase (AST) were determined by the methods of Young [15].

**Statistical Analysis:** Data were analyzed using the general liner model procedure of SAS [16]. The differences among means were separated according to Duncan's New Multiple Range Test [17].

## RESULTS AND DISCUSSION

**Chemical Composition:** Chemical composition and cell wall constituents (DM basis) of concentrate feed mixture, corn silage and citrus pulp silage used throughout the study are shown in Table (1). There were any differences in the OM between corn silage and citrus pulp silage treatments. Corn silage showed the highest levels of crude fiber compared with CPS (above 23%), while ash content of corn silage and citrus pulp silage it was almost similar. Neutral detergent fiber and hemi-cellulose were (35.23%and 3.86%) in the citrus pulp silage compared with corn silage that was 44.97 % NDF, 12.22% Hemi-cellulose.

Table 1: Chemical analysis of feed ingredients (DM basis)

| | Ingredients | | |
|---|---|---|---|
| Item | CFM | CS | CPS |
| Chemical composition, DM % | | | |
| DM | 92.45 | 27.45 | 33.05 |
| OM | 89.98 | 88.81 | 89.86 |
| CP | 16.06 | 9.14 | 11.17 |
| EE | 6.74 | 2.12 | 3.73 |
| CF | 16.73 | 23.12 | 17.96 |
| NFE | 50.45 | 54.43 | 57.00 |
| Ash | 10.02 | 11.19 | 10.14 |
| Cell wall constituents, % | | | |
| NDF | 16.09 | 44.97 | 35.23 |
| ADF | 11.46 | 32.75 | 31.37 |
| ADL | 3.35 | 4.63 | 6.27 |
| Hemi-cellulose | 4.63 | 12.22 | 3.86 |
| Cellulose | 8.11 | 28.12 | 25.10 |

Hemi-cellulose = NDF-ADF Cellulose = ADF-ADL.

CFM: concentrate feed mixture. CS: Corn silage.

CPS: Citrus pulp silage.

Table 2: Calculated chemical composition of the experimental rations fed to bulls.

| | Experimental rations (DM basis) | | |
|---|---|---|---|
| Item | Control | T1 | T2 |
| DM | 92.05 | 90.45 | 90.03 |
| Chemical composition, DM % basis | | | |
| OM | 89.38 | 89.74 | 89.74 |
| Ash | 10.62 | 10.26 | 10.26 |
| CP | 14.24 | 14.60 | 13.82 |
| EE | 5.53 | 5.85 | 5.36 |
| CF | 18.39 | 17.09 | 17.31 |
| NFE | 51.22 | 52.20 | 53.25 |
| Fiber fractions | | | |
| NDF | 23.59 | 21.73 | 24.87 |
| ADF | 16.99 | 17.33 | 20.59 |
| ADL | 3.68 | 4.21 | 4.69 |
| Cellulose | 13.31 | 13.12 | 15.90 |
| Hemi cellulose | 6.06 | 4.40 | 4.28 |

Control: 30% corn silage+ 70% CFM, T1 : 30% citrus pulp silage+ 70% CFM,

T2 : 45% citrus pulp silage+ 55% CFM.

The chemical compositions of the experimental rations are shown in Table (2). Crude protein of the experimental rations was similar (14.24, 14.60 and 13.82 for control, T1 and T2, respectively). Rations contained about 17-19% CF, 22-25% NDF and 17-21% ADF.

Table 3: Nutrients digestibility and nutritive values of the experimental rations

| | Experimental rations | | | |
|---|---|---|---|---|
| Item | Control | T1 | T2 | ±SE |
| Nutrients digestibility (%) | | | | |
| DM | 71.02[a] | 71.27[a] | 69.94[a] | 1.22 |
| OM | 73.90[a] | 76.02[a] | 74.91[a] | 1.2 |
| CP | 69.64[a] | 70.48[a] | 68.95[a] | 1.29 |
| CF | 69.46[a] | 64.69[b] | 60.81[c] | 1.33 |
| EE | 84.02[a] | 78.48[b] | 71.11[c] | 1.29 |
| NFE | 78.08[a] | 78.23[a] | 75.08[a] | 1.26 |
| NDF | 69.31[a] | 54.48[b] | 56.14[b] | 2.21 |
| ADF | 53.86[a] | 55.89[a] | 59.83[a] | 2.29 |
| Cellulose | 64.63[a] | 61.76[a] | 59.15[a] | 4.19 |
| Hemicellulose | 56.69[a] | 55.28[a] | 53.62[a] | 3.34 |
| Nutritive values (%) | | | | |
| TDN | 73.14[a] | 72.56[a] | 68.61[b] | 1.12 |
| DCP | 9.92[ab] | 10.29[a] | 9.53[b] | 0.19 |

[a,b,...]: Means in the same row within each treatment having different super scripts differ (P<0.05) Control: 30% corn silage+ 70% CFM,

T1 : 30% citrus pulp silage+ 70% CFM, T2 : 45% citrus pulp silage+ 55% CFM.

**Digestion Coefficients and Nutritive Values:** The effects of added citrus pulp silage on nutrients digestibility and nutritive values of different tested rations are shown in Table (3). Dry matter, organic matter and crude protein digestibilities were insignificant (p>0.05) among all the experimental rations.

Data in Table (3) indicated that DM digestibility for T1 and T2 were 71.27 and 69.94%, respectively. These values didn't agree with that obtained by Ítavo *et al.* [18] who studied fresh orange pulp silage, with and without additives and obtained that DM digestibility values were ranged from 82.76 to 90.15%, respectively. Superior DM digestibility values were also reported by Weinberg *et al.* [19] and [20], being 89.2 and 84.00%, respectively. However, Henrique *et al.* [21] who used diets with high concentrate contents and increasing levels of citrus pulp (0, 25, 40 and 55%), indicated the lower dry matter digestibility values for diet (71.14; 71.29; 72.24 and 72.66, respectively).

The values of OM in Table (3) didn't comply with Ítavo *et al*. [18], reported coefficients between 90.28 and 92.15% and by Fegeros *et al.* [22] who reported 87.2% OM digestibility. While agreements with Macedo *et al*. [23] studies the mean OM values of the diets with 50% fresh orange pulp (73.35%) were similar to those reported by Henrique *et al.* [21], who obtained values of 74.71% for the 55% citrus pulp inclusion level in the diet.

The values of crude protein were higher than that recorded by Porcionato *et al.* [24] and [22] whom reported, respectively, mean values of 48.18 and 52.7% CP digestibility for citrus pulp. Branco *et al.* [7] reported 55.93 and 56.42% for diets with 20 and 40% fresh orange pulp, respectively. Also, Wainman and Dewey [25] reported that crude protein digestibility values for citrus pulp ranging from 40 to 65%.

Crude fiber digestibility was significantly ($p<0.05$) increased for bulls fed control rations compared with those fed T1 or T2, also there were significant ($p<0.05$) difference between T1 and T2 rations.

Ether extract digestibility was significantly ($p<0.05$) among all the experimental rations. The highest value was observed for bulls fed control ration then followed by T1, T2. The corresponding values were 84.02, 78.48 and 71.11% respectively. Which disagree by [18] whose values ranged from 42.41 to 49.50% and [7] who reported values of 63.93%. However, agreement with Fegeros *et al.* [22] and [21] assessed to citrus pulp and obtained 82.00 and 73.89% EE apparent digestibility, respectively.

Neutral detergent fiber digestibility was significantly ($p<0.05$) higher for bulls fed control ration versus those fed both T1, T2 which didn't agree with Ítavo *et al.* [18] who obtained 67.00% digestibility for NDF in fresh orange pulp silage and [21] reported values of 67.2%. Also Henrique *et al.* (2003) reported 66.39% NDF digestibility in diets with 55% substitution of corn by citrus pulp. Nitrogen free extract, acid detergent fiber, cellulose and hemi-cellulose digestibility of bulls fed all the experimental rations were not significantly ($p>0.05$).

Bulls fed control ration recorded significant ($p<0.05$) increase of TDN compared to those fed the T2 ration. The values were 73.14, 72.6 and 68.61% for control, T1 and T2, respectively. Furthermore, bulls fed T1 recorded significant values of TDN ($p<0.05$) with the T2 ration. Digestible crude protein was significantly ($p<0.05$) increase for bulls fed T1 compared with the T2. However there was insignificantly ($p>0.05$) different noticed with those fed the T2 and control rations. From nutrients digestibility and nutritive value data, bulls fed T1 ration showed better response than bulls fed T2 ration.

**Blood Parameters:** The main effects of the experimental rations on blood parameters of growing bulls are shown in Table (4). There were insignificant ($p>0.05$) differences among hematological parameters (Hb and Ht) concentrate of bulls fed the different experimental rations. Hemoglobin concentration was higher in T2 group than those of T1 and control groups. These results were agreed with Oni *et al.,* [26] investigate significant differences occurred at the end of the experiment for blood hemoglobin with the 75% citrus pulp replacement having the highest level of significance with the exception of 50% 10.10 g/dl and 75% 12.40 g/dl replacement treatments.

There were insignificant ($p>0.05$) differences among blood metabolites concentration (TP, urea, creatinine, triglycerides) of all bulls groups, but cholesterol concentration was significantly ($p<0.05$) increase for bulls fed T1compared with those fed control groups, while there were insignificantly ($p>0.05$) difference from those

Table 4: Effect of experimental rations on blood parameters of growing bulls

| | Experimental rations | | | |
|---|---|---|---|---|
| Item | Control | T1 | T2 | ±SE |
| Hemoglobin, g/dl | 12.99 | 12.41 | 13.27 | 1.14 |
| Hematocrit | 34.25 | 31.88 | 30.63 | 1.14 |
| Total protein, mg/dl | 7.58 | 7.55 | 7.23 | 0.18 |
| Urea, mg/dl | 36.25 | 33.25 | 32.75 | 2.26 |
| Creatinine, mg/dl | 1.11 | 1.15 | 1.41 | 0.12 |
| Cholesterol, mg/dl | 145.25$^{b}$ | 198.25$^{a}$ | 165.00$^{ab}$ | 12.11 |
| Triglycerides, mg/dl | 14.50 | 14.00 | 16.50 | 3.18 |
| AST, U/l | 74.50 | 68.75 | 87.00 | 6.96 |
| ALT, U/l | 37.50 | 39.50 | 39.25 | 2.83 |

$^{a,b,\cdots}$: Means in the same row within each treatment having different super scripts differ ($P<0.05$).

Table 5: Daily gain, nutrients intake and feed conversion ratio of bulls consumed different tested rations

| | Experimental rations | | | |
|---|---|---|---|---|
| Item | Control | T1 | T2 | ±SE |
| Initial body wt. (IBW), kg | 238.8 | 234.3 | 234.2 | 6.83 |
| Final body wt. (FBW), kg | 367.7 | 372 | 356.5 | 10.86 |
| Total body gain, kg | 128.9 | 137.7 | 122.3 | 9.43 |
| Daily gain, kg | 1.07 | 1.15 | 1.02 | 0.08 |
| Dry matter intake, kg/head/day | | | | |
| Roughage | 2.29$^{c}$ | 2.7$^{b}$ | 3.72$^{a}$ | 0.58 |
| Concentrate | 6.5$^{a}$ | 6.43$^{b}$ | 4.39$^{c}$ | 0.58 |
| Total | 8.8$^{b}$ | 9.14$^{a}$ | 8.11$^{c}$ | 0.58 |
| Total digestible nutrients | 73.14$^{a}$ | 72.56$^{b}$ | 68.61$^{c}$ | 1.15 |
| Digestible crude protein | 9.92$^{ab}$ | 10.29$^{a}$ | 9.53$^{c}$ | 0.19 |
| Feed Intake, kg/ Kg BW/day | | | | |
| Dry matter | 8.22$^{a}$ | 7.75$^{c}$ | 7.95$^{b}$ | 0.58 |
| Total digestible nutrients | 6.44$^{b}$ | 6..63$^{a}$ | 5.56$^{c}$ | 0.58 |
| Digestible crude protein | 0.87$^{b}$ | 0.94$^{a}$ | 0.77$^{c}$ | 0.01 |
| Feed conversion ratio (FCR), kg nutrient intake /kg gain Dry matter (DM) | 7.68$^{a}$ | 6.74$^{b}$ | 7.79$^{a}$ | 0.58 |
| Total digestible nutrients (TDN) | 6.02$^{a}$ | 5.77$^{b}$ | 5.45$^{c}$ | 0.58 |
| Digestible crude protein (DCP) | 0.82$^{a}$ | 0.82$^{a}$ | 0.75$^{b}$ | 0.01 |

$^{a,b,\cdots}$: Means in the same row within each treatment having different super scripts differ ($P<0.05$)

fed the T2. These results are in agreement with finding of Belibasakis and Tsirgogianni [27] that serum concentration of cholesterol was higher (235 mg/dl *vs.* 223 mg/dl) when cow were fed the diet containing dried citrus pulp.

The plasma transaminase activities of the experimental rations expressed as aspartate amino transferas (AST) and alanine amino transferase (ALT) were no significant differences among the treated groups.

**Growth Performance:** Data in Table (5) represent the nutrients intake (kg/h/d and kg/Kg BW), growth performance and feed conversion ratio of bulls fed the experimental rations containing different levels of orange pulp silage. No significant difference ($p>0.05$) in average daily gain (ADG) among treatments was detected.

The highest average daily gain value had been recorded with bulls fed T1, while the lowest average daily gain was recorded with bulls fed T2. Bulls showed significant ($p<0.05$) differences in dry matter intake (DMI) (kg/h/d) among the different experimental rations. Data indicated that bulls fed T2 recorded the lowest dry matter intake. All animals consumed their allowance of concentrate feed mixture. Ítavo *et al.* [28] who assessed a diet consisting of 70% oat hay and 30% fresh orange pulp silage and obtained DM intake of 4.23% WB and 109g/kg $WB^{0.75}$. Ítavo *et al.* [18] assessed to DM intake in dairy cows fed diets with different substitution levels of corn silage by fresh orange pulp silage and also observed a linear increase in DM intake as the substitution levels of corn silage by the fresh orange pulp silage increased and the highest intake was observed for the highest level of substitution assessed (75%).

The TDN intake for each kilogram body weight was significantly different ($p<0.05$) among all rations. The highest value was observed for bulls fed T1 ration, while the T2 ration has a lower value of TDN intake for Kilogram body weight and has a significant difference ($p<0.05$) with the other rations. The highest DCP intake for Kilogram body weight was recorded by animals received T1 followed by those received control ration. The lowest intake value was observed for bulls fed the T2 ration.

Concerning feed conversion ratio (FCR) bulls fed T1 ration recorded the better values in FCR as DM and TDN, while the T2 ration showed lowest value as DCP compared with control ration.

## CONCLUSION

Summing up, replacing of corn silage in control ration by citrus silage with 30 and 45 levels in experimental rations did not affect the growth performance nutrients digestibility and blood parameters from the feed conversion efficiency point of view.

## REFERENCES


1. Bampidis, V.A. and P.H. Robinson. 2006. Citrus by-products as ruminant feeds: A review. Anim. Feed Sci. Technol, 128: 175-217.
2. Piquer, O., M. Rodriguez, E. Blas, A. Cerisuelo, C. Fernandez and J.J. Pascual. 2011. Whole citrus fruits in total mixed rations for Mediterranean milking ewes. Milk production and composition. Options Méditerranéennes, A, pp: 99.
3. Lanza, A., 1982. Dried citrus pulp in animal feeding. In: Proceedings of the International Symposium on Food Industries and the Environment. Budapest, Hungary. Elsevier Pulishers, New York, NY, USA, pp: 189-198.
4. Martillotti, F., S. Bartocci and S. Terramoccia, 1996. Guida all'alimentazione dei ruminanti da latte. INEA, Rome (Italy).
5. Caparra, P., C.L. Mammola, F. Foti, V. Sarullo, R. Verdiglione and V. Scerra. 2000. Citrus pulp fresh as an ingredient in lamb diets: effects on carcass and meat quality. In: Proceedings of the Eighth International Congress of Mediterranean Federation for Health and Production of Ruminants, Giardini Naxos, Italy, 27-30 April, pp: 272-275.
6. Scerra, V., P. Caparra, F. Foti, M. Lanza and A. Priolo. 2001. Citrus pulp and wheat straw silage as an ingredient in lamb diets: effects on growth and carcass and meat quality. Small Rumin. Res., 40: 51-56.
7. Branco, A.F., L.M. Zeoula and I.N. Prado, 1994. Valor nutritivo da polpa de citrus in natura para ruminantes. Rev. Unimar, 16: 37-48.
8. Van Keulen, J. and B.A. Young, 1977. Evaluation of acid insoluble ash as a natural marker in ruminant digestibility studies. J. Anim. Sci., 44: 282-287.
9. Mcdonald, P., R.A. Edwards, J.F.D. Green halagh and C.A. Morgan, 1995. Animal nutrition 5th Ed., Copyright licensing LTD., London.
10. A.O.A.C., 1995. Official Methods of Analysis. 16th ed. Association of Official Analytical Chemists. Arlington, VA.
11. Van soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods for dietary fiber, neutral detergent fiber and non starch polysaccharides in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597.
12. Tietz, N.W., 1986. Text Book of Clinical Chemistry. W. B. Saunders, Philadelphia, pp: 1271.

13. Tietz, N.W., 1990. Clinical Guide to Laboratory Tests 2nd Ed. Philadelphia.
14. Patton, F.G. and S.R. Grouch, 1977. Colorimetric determination of urea, Anal. Chem, 49: 468.
15. Young, D.S., 1990. Effects of drugs on clinical laboratory testes, 3rd Ed, 3: 6-12.
16. SAS, 2000. Statistical Analysis system. SAS Users guide statistics. SAS Institute Inc., Cary, NC.
17. Duncan, D.B., 1955. Multiple range and multiple F test. Biometrics, 11: 1-42.
18. Ítavo, L.C.V., G.T. Santos, C.C. Jobim, T.V. Voltolini, K.P. Faria and C.C.B.F. Ítavo, 2000b. Composiçãoe digestibilidade aparente da silagem de bagaço de laranja. Rev. Bras. Zootecn., 29: 1485-1490.
19. Weinberg, Z.G., G. Pahlow and B. Dinter, 1988. The effect of treatment with urea, sorbic acid or dehydration on orange peel silage. Anim. Feed Sci. Tech., 20: 335-342.
20. Van Soest, P.J., 1994. Nutritional ecology of ruminant. 2nd. Cornell University. Ithaca, pp: 476.
21. Henrique, W., A.A.M. Sampaio, P.R. Leme, G.F. Alleoni, D.P.D. Lanna and E.B. Malheiros, 2003. Digestibilidade e balanço de nitrogênio em ovinos alimentados à base de dietas com elevado teor de concentrado e níveis crescentes de polpa cítrica peletizada. Rev. Bras. Zootecn., 32: 2007-2015.
22. Fegeros, K., G. Zervas, S. Stamouli and E. Apostolaki, 1995. Nutritive value of dried citrus pulp and its effect on milk yield and milk composition of lactating ewes. J. Dairy Sci., 78: 1116-1121.
23. Macedo, C.A.B., I.Y. Mizubuti, E.S. Pereira, E.L.A. Ribeiro, B.M.O. Ramos, R.M. Mori, A.P. Pinto, F.B. Moreira and M.N. Bonin. 2007. Apparent digestibility and nitrogen use of diets with different levels of fresh orange pulp. Arch. Zootec, 56(216): 907-917.
24. Porcionato, M.A.F., T.T. Berchielli, G.L. Franco, P. Andrade, R.N. Silveira and W.V.B. Soares, 2004. Digestibilidade, degradabilidade e concentração amoniacal no rúmen de bovines alimentados com polpa cítrica peletizada normal ou queimada. Rev. Bras. Zootecn., 33: 258-266.
25. Wainman, F.W. and J.S. Dewey, 1988. Feedstuffs evaluation unit-fifth report. Rowett Research Institute, pp: 123.
26. Oni, A.O., C.F.I. Onwuka, O.O. Oduguwa, O.S. Onifade and O.M. Arigbede, 2008. Utilization of citrus pulp based diets and Enterolobium cyclocarpum (JACQ. GRISEB) foliage by West African dwarf goats. Livest. Sci., 117: 184-191.
27. Belibasakis, N.G. and D. Tsirgogianni, 1996. Effect of dried citrus pulp on milk yield, milk composition of dairy cows. Anim. Feed Sci. Technol., 60: 87-92.
28. Ítavo, L.C.V., G.T. Santos, C.C. Jobim, T.V. Voltolini and C.C.B.F. Ítavo, 2000a. Substituição da silagemde milho pela silagem do bagaço de laranja na alimentação de vacas leiteiras. Consumo, produção e qualidade do leite. Rev. Bras. Zootecn., 29: 1498-1503.