DOI:10.5216/cab.v12i2.6744

NUTRIENTS INTAKE AND WATER BALANCE OF EQUINE FED DIETS WITH DIFFERENT LEVELS OF INCLUSION OF ALFALFA HAY

Leonir Bueno Ribeiro1, Carlos Eduardo Furtado2, Roberta Ariboni Brandi3, Andréa Cristina Souza Paula4, Cleiton Luiz Tonello5, Daniel Augusto Afonso6

1- MSc in Animal Science, UEM/ Maringá. – leonirbueno@hotmail.com
2 – Professor, PhD, Universidade Estadual de Maringá – UEM. DZO - Departamento de Zootecnia.
3 – Professor, PhD, Animal Science Department - FZEA/USP
4 – Animal Science Graduate, Universidade Estadual de Maringá – UEM
5 - Animal Science Graduate, Escola Superior de Agronomia de Paraguaçu Paulista – ESAPP
6 – Under-grad sutdent of Animal Sciences, Escola Superior de Agronomia de Paraguaçu Paulista – ESAPP

ABSTRACT

The objective of this study was to evaluate the nutrients intake and water balance of horses in maintenance, fed with conventional hay. Six male horses at an average age of nine years and body weight of 361.16 ± 12 kg were used, in a (6x6) latin square design, housed in metabolism cages. The treatments were FTT: 100% Tifton hay; FTO: 80% Tifton hay + 20% Alfalfa hay; FTS: 60% Tifton hay + 40% Alfalfa hay; FTQ: 40% Tifton hay + 60% Alfalfa hay; FTV: 20% Tifton hay + 80% Alfalfa hay; FAT: 100% Alfalfa hay. The quantities of food provided were 2.25% of BW in order to obtain surplus. To determine the water intake, drinkers for ad libitum water supply were used. Dry matter, CP, EE and MM intakes increased ($P \leq 0.05$) as the amount of alfalfa hay was increased in the diets, indicating that these elements are related to the diets chemical composition. Similarly, NDF and ADF intake decreased ($P \leq 0.05$) as alfalfa hay was increased in the diets. The values of water intake and excretion were influenced by the chemical composition of the diet, affecting water intake in function of the dry matter (L/ kg of DM) and the water balance. Regarding water intake and excretion, the animals were in positive water balance in all treatments. FTT treatment had lowest urinary and fecal excretion of water compared to the other treatments.

KEYWORDS: Feeding; horse; hydration; nutrition.

RESUMO

CONSUMO DE NUTRIENTES E BALANÇO HÍDRICO EM EQUINOS RECEBENDO DIETAS COM DIFERENTES NÍVEIS DE INCLUSÃO DE FENO DE ALFAFA

Objetivou-se avaliar o consumo de nutrientes e o balanço hídrico em equinos em mantença, alimentados com fenos convencionais. Utilizaram-se seis equinos machos com idade média de nove anos e PV de 361,16 ± 12 kg, em

delineamento quadrado latino (6x6), alojados em gaiolas de metabolismo. Os tratamentos foram FTT: 100% Feno de Tifton; FTO: 80% Feno de Tifton + 20% de Feno de Alfafa; FTS: 60% Feno de Tifton + 40% de Feno de Alfafa; FTQ: 40% Feno de Tifton + 60% de Feno de Alfafa; FTV: 20% Feno de Tifton + 80% de Feno de Alfafa; FAT: 100% de Feno de Alfafa. As quantidades de alimentos fornecidos foram de 2,25 % do PV, obtendo-se sobras. Para o consumo de água, utilizaram-se bebedouros com fornecimento de água à vontade. Os consumos de PB, EE e MM aumentaram à medida que o feno de alfafa foi incrementado nas dietas indicando que esses elementos estão relacionados à composição química das dietas. Os valores de consumo e de excreção de água foram influenciados pela composição química da dieta, influenciando diretamente no consumo de água em relação à matéria seca (L/kg de MSI) e no balanço hídrico. Com relação ao consumo e excreção de água, observou-se que em todos os tratamentos os animais apresentaram-se em balanço hídrico positivo. O tratamento FTT apresentou uma menor excreção fecal e urinária de água em relação aos demais tratamentos.

KEYWORDS: Feeding; horse; hydration; nutrition

INTRODUCTION

In some equestrian sports such as endurance riding and horse gait, in which the animal goes long distances, the supply of nutrients and electrolytes kept in their digestive tract is essential for the animal to complete the tests efficiently. Many nutritionists recommend the use of grass hay instead of the traditional alfalfa hay, because its protein content makes it possible to spend greater amount of energy and to carry out the protein metabolism, consequently, greater water excretion. Approximately 90% of weight loss represents changes in fluid balance, and the weight loss during an endurance riding is largely attributed to dehydration (LEWIS, 2000; NRC, 2007).

Amongst the required nutrients, water is often neglected, for being "cheap and abundant" and, according to NYMAN & DAHLBORN (2000), horses submitted to physical stress present large increase in heat production due to the inefficiency of the energy metabolism. Therefore, 40-60 times more heat was observed in animals that perform moderate to high intensity exercises than that produced by basal metabolism, being sweating the main route for heat dispersion in horses, in which sweat volume depends in part of the exercise intensity, distance, type of gait and terrain and the amount of weight carried, directly influencing water intake (EATON, 1994; ERIKSON, 1996; GOER et al. 2000). However, it is difficult to predict needs of water intake of athletic horses (NRC 2007).

Thus, the purpose of this study was to evaluate nutrients intake and water balance in adult horses, when submitted to conventional hay diets with different inclusion levels of alfalfa hay.

MATERIAL AND METHODS

The experiment was carried out at the Experimental Horse Farm in Iguatemi, Universidade Estadual de Maringá-UEM. We used six male crossbred horses at nine years old and with mean weight of 361.16 ± 12 kg in a (6x6) latin square experimental design, housed in metabolism cages.

The treatments consisted of six experimental diets of different proportions of Tifton 85 hay (Cynodon dactylon) and alfalfa hay (Medigaco sativa sp.), as follows: FTT: 100% Tifton hay; FTO: 80% Tifton hay + 20% alfalfa hay; FTS: 60% Tifton hay + 40% alfalfa hay; FTQ: 40% Tifton hay + 60% alfalfa hay; FTV: 20% Tifton hay + 80% alfalfa hay; FAT: 100% alfalfa hay. Feed was provided in amounts of approximately 2.25% of BW of the animals divided into three meals a day (08:00 a.m., 03:00 p.m. and 09:00p.m.) in order to obtain leftovers, allowing consumption calculations. The chemical analyzes of diet samples were carried out according to methodology and techniques described by AOAC (1990), SILVA (2002) and VAN SOEST (1991) and are shown in Table 1.

The experimental period lasted 66 days, being seven days for diet adaptation and four days for data collection. Water volume was obtained by using graded troughs (bucket tyoes) and ad libitum supply in order to determine the intake. The ambient temperatures (averaged 20.3°C) were measured using a thermometer (mercury column type), at the same time of the diets supply. The data were

evaluated by analysis of variance and means compared by Tukey test at 5% probability, using Statistical Analysis System and Genetics - version 9.1 software (UNIVERSIDADE FEDERAL DE VIÇOSA, 2008).

Table 1 – Chemical composition of the experimental diets expressed in (%) Dry Matter

Nutrients[1](%)	Treatments					
	FTT	FTO	FTS	FTQ	FTV	FAT
Dry Matter	91.1	91.02	90.94	90.86	90.78	90.69
Organic Matter	86.87	86.21	85.56	84.91	84.25	83.6
Ether Extract	1.01	1.02	1.02	1.03	1.04	1.05
Crude Protein	4.93	7.34	9.75	12.16	14.58	16.99
NDF	73.87	68.31	62.76	57.2	51.64	46.09
ADF	37.1	36.05	35	33.95	32.91	31.86
Mineral Matter	4.35	4.9	5.45	6.01	6.56	7.12

1 - Analysis carried out at the Laboratory of Animal Nutrition of the Animal Science School - UEM

RESULTS AND DISCUSSION

It is observed in Table 2 that dry matter intake (DMI), crude protein intake (CPI), ether extract intake (EEI) and mineral matter intake (MMI) increased ($P \leq 0.05$) as alfalfa hay was added to the diets, indicating that the values obtained may be mainly related with the chemical composition of diets (CP, NDF and ADF), supported by the similarity of dry matter levels within treatments (FRAPE, 1998; LEWIS, 2000; NRC, 2007).Horses can increase dry matter intake in order to meet energy needs; however, the inclusion of oil can make diets more palatable and increase energy density, besides the characteristics of the feed regarding energy content and density (EATON, 1994; NRC, 2007).

Table 2 – Nutrients intake (g/day) by horses fed Tifton and alfalfa hay

Variables	Treatments						CV%
	FTT	FTO	FTS	FTQ	FTV	FAT	
DMI	5602.55^{b}	6672 32^{a}	7214.21^{a}	6964.27^{a}	7056.31^{a}	7038.97^{a}	7.98
CPI	275.97^{f}	489 05^{e}	702.50^{d}	846.17^{c}	1027.89^{b}	1195.79^{a}	7.13
EEI	62.09^{b}	74 57^{a}	81.29^{a}	79.12^{a}	80.82^{a}	81.27^{a}	7.86
NDFI	4138.48^{ab}	4559 33^{a}	4529.52^{a}	3985.67^{ab}	3645.60^{bc}	3244.14^{c}	9.59
ADFI	2078.28^{b}	240547^{a}	2525,40^{a}	2364.95^{ab}	2322.16^{ab}	2242.45^{ab}	8.45
MMI	243.44^{e}	326.80^{d}	393.28^{c}	418.29^{bc}	463.03^{ab}	501.07^{a}	6.99

Means followed by the same letter in the line does not differ statistically by Tukey test at 5%.

On the other hand, NDF and ADF intake decreased ($P \leq 0.05$) as alfalfa hay was increased in the diets. For treatments with the highest level of Tifton hay, lower nutrient intake was observed, indicating that horses can increase dry matter intake in order to meet the nutritional requirements; however, they are limited by the fiber fraction content of the diet (NDF and ADF).

In the present study, dry matter intake varied among treatments from 1.52 to 1.98% BW. According to the NRC (1989), horses consume 1.5 to 3.0% of their body weight in dry matter basis daily, depending on the available quantity, quality and physiological stage of the plants. When the

animal's energy requirement is not met by dietary intake from exclusively forage-based diet supply under ad libitum regimen, at least 1.0% BW of forage and concentrate supplementation is recommended. The NRC (2007) recommends 2.0% BW of dry matter intake for animals in maintenance.

Table 3 presents (L/day) the water intake (WI), water intake in the diet (WID), the relationship between liters per kg of dry matter intake (RLM), fecal excretion of water (FEW), urinary excretion of water (UEW) and water balance (WB). The values of WI, WID, FEW, and UEW increased ($P \leq 0.05$) as alfalfa hay was added to the diets. Water intake (WI + WID) and water excretion (FEW + UEW) were influenced by both the chemical composition of the diets (CP, NDF and ADF) and the nutrients intake (DM, CP, NDF and ADF), justified by fluid drag by the fiber fraction in the feces (FRAPE, 1998). Although the nitrogen excretion was not assessed in this study, we can suggest that the higher water intake in the diets with increasing levels of alfalfa hay may be related to the greater need for nitrogen excretion (NRC, 2007).

Table 3 – Parameters associated with both the relation water/kg of dry matter intake and water balance (L/day) of horses fed Tifton and alfalfa hay

Variables	Treatmens						CV%
	FTT	FTO	FTS	FTQ	FTV	FAT	
WI	22.08^{b}	26.08^{ab}	28.67^{ab}	26.71^{ab}	24.75^{ab}	32.42^{a}	17.78
WID	0.547^{b}	0.658^{a}	0.719^{a}	0.701^{a}	0.717^{a}	0.722^{a}	7.84
RLM	4.06^{ab}	3.93^{b}	3.96^{b}	3.82^{b}	3.48^{b}	4.61^{a}	9.13
FEW	10.96^{c}	13.73^{ab}	15.08^{a}	12.77^{b}	13.83^{ab}	12.28^{bc}	7.48
USW	2.50^{c}	3.16^{cd}	3.96^{cd}	5.48^{bc}	7.00^{ab}	8.83^{a}	25.12
WB	9.17^{b}	9.85^{b}	10.34^{b}	9.16^{b}	9.63^{b}	12.03^{a}	18.45

Means followed by the same letter in the line does not differ statistically by Tukey test at 1%.

For water intake (WI), there was a significant difference between treatments, and FAT treatment showed the highest value (32.42 L/day), followed by FTO, FTS, FTQ and FTV treatments, with average value of 26.55 L / day. The values observed in this study are above those found by GALZERANO et at. (2006) and BRETAS et al. (2007), who verified 13.13 and 19.24 L / day, for diets composed of Tifton and Tifton associated with alfalfa, respectively. Water intake by horses may be related mainly to the dry matter and protein levels in diets offered to the animals, and by observing Table 1, it can be inferred that the animals had lower nitrogen intake when fed FTT diet compared to the others, which may be due to the greater need for nitrogen excretion. According to OLIVEIRA et al. (2003), urea resulted from the hepatic metabolism of ammonia absorbed in the intestine and originated from amino acids catabolism is the metabolite of greater excretion in urine, and higher water intake is needed in order to provide metabolic conditions for such to happen. FONNESBECK (1968) observed water consumption at will during metabolism trials with horses in maintenance, suggesting the possibility of performing regression equations that explain the use of water as a function of dry matter intake with a high degree of confidence.

Regarding water intake in the diet (WID), significant differences were found only in FTT treatment, in which the lowest value (0.547 L / day) was observed. The other treatments did not differ statistically, averaging 0.703 L / day. Water intake in the diet is related to the dry matter content or the total amount of feed consumed, as well as the water intake can also vary with the type of forage processing (crushed, ground, pellets) and the kind of conservation (in natura, silage, hay), because the concentration of nutrients (protein, minerals, fiber levels and other components) is different considering the type of food and type of

presentation, affecting water intake (CUNHA, 1991; GALZERANO et al.2006; BRETAS et al.2007 NRC, 2007).

OLIVEIRA et al. (2003) reported a daily water intake, with an average of 3.88 L / kg of DMI, providing diets with different concentrate:forage ratios for horses. According to the NRC (2007), animals fed complete diets have an average of 2.9 L / kg DMI, thus the minimum intake of 2-3 L / DM kg is recommended

NYMAN & DAHLBORN (2000) reported values of water intake between 0.043 and 0.058 L / kg BW for horses fed mixed diets of hay and oats. This values are lower than the ones obtained in this study. CYMBALUK (1989) reported water intake from 2.7 to 5.5 L/100 kg of body weight for horses kept in stalls under moderate temperatures. GOER et al. (2000), studying horses with average weight of 500 kg in moderate physical activity, reported water intake of 8.2 L / 100 kg BW.

Regarding the relationship between water intake in liters per kg of dry matter intake (RLM), there was a statistical difference ($P \leq 0.05$) among treatments, and FAT treatment showed the highest value (4.61 L / kg of DMI), followed by FTT treatment (4.06 L / kg of DMI). The other treatments did not differ among each other, presenting an average value of 3.79 L / kg of DMI. OLIVEIRA et al. (2003) reported an average daily water intake of 3.88 L / kg of DMI, providing diets with different concentrate:forage ratios for horses. According to the NRC (2007), animals fed exclusive diet of hay consume water in a ratio of 3.6 L/ kg of DMI, while for animals fed diets of hay and concentrate this ratio is 2.9:1; however, the intake of 2-3 liters / kg of DMI is recommended.

FRAPE (1998) points out that water intake by horses fed hay-based diets is between 2-4 L / kg MSI. The water intake per kg of dry matter intake observed in this study is slightly above, but it is similar to the intake values found by BRETAS et al. (2007) of 2.56 and 3.91 L / kg of MSI, respectively, for exclusive diets of Tifton and diets of Tifton associated with alfalfa. It is noteworthy that the value found by BRETAS et al. (2007) for diets of Tifton associated with alfalfa is similar to the average found in the present work for the other treatments (FTO, FTS, FTQ and FTV), which showed no significant differences, presenting an average value of 3.79 L / kg MSI. GALZERANO et al. (2006) and BRETAS et al. (2007) found higher values than those verified by PEARSON MERRITT (1991), who found intake of 1.92 L / kg of DMI; however, the values are in general similar to the ones found by CYMBALUK (1989), 3.21 and 3.42L / kg of MSI, respectively.

The amount of water consumed and excreted by horses is therefore related to several factors, as noted earlier, such as the chemical composition of the feed, especially associated with the protein, mineral and fiber content; however, the diet digestibility, temperature and relative air humidity, physical activity and physiological stage of the animals are vectors of cumulative losses and must be compensated by water intake (CYMBALUK, 1989; KRISTULA & McDONNELL, 1994; McDONNELL & KRISTULA, 1996).

According to McDONNELL et al. (1999), horses in stalls, consuming water in buckets, possibly because of the physical and compulsive stimulus to consumption, may present an increased water intake up to 30% compared to animals receiving water through automatic water troughs, which could explain, among other aspects previously mentioned, a possible increase in water consumption per kg of dry matter intake when compared to other authors´studies.

As for fecal excretion of water (FEW), there were significant differences, and FTS treatment showed the highest value (15.08 L / day), followed by FTO treatment (13.73 L / day). The values found in this study were higher than those found by BRETAS et al. (2007) who, working with horses fed diets of Tifton and Tifton associated with alfalfa, found values of 4.28 and 7.93 L/ day, respectively. OLIVEIRA et al. (2003) evaluated diets for horses with increasing levels of coast cross hay, and reported that the level of roughage in the diet did not affect water intake. However, water excretion in feces was increased by the addition of roughage to the diet, influencing water balance. By observing the values of DMI, NDFI and ADFI for FTO and FTS treatments (Table 2), and comparing them with the values of the same treatments shown in Table 3,

it can be seen that the highest values of dry matter and fiber fraction intake (NDF and ADF) were obtained by treatments with the highest fecal excretion of water. Thus, the highest values of water excretion via feces can be explained by the diet composition. CYMBALUK (1989) reported in a study that the highest values of fecal excretion of water are found when animals are fed grass hay diets.

FONNESBECK (1968) reported that water excretion in feces is the major route of excretion by horses, but GROENENDYK et al. (1988) demonstrated that horses consuming alfalfa hay excreted water mainly through urine. This indicates that the values obtained are mainly related to the chemical composition of diets (CP, NDF and ADF) and their respective intake (DMI, CPI, NDFI and ADFI), supported by the similarity of DM levels among treatments (FRAPE, 1998; LEWIS, 2000; NRC, 2007).

As for urinary excretion of water (UEW.), there was a difference ($P \leq 0.05$) among treatments, and FAT treatment showed the highest value (8.83 L / day). The lowest value was observed in FTT treatment (2.50 L/ day). The values verified in this study follow the standard described by FONNESBECK (1968) and GROENENDYK et al.1988

Regarding water intake and excretion, animals were in positive water balance (WB) in all treatments. FAT treatment showed the highest value of water balance (12.03 L / day); on the other hand, this treatment showed higher urinary excretion of water, consequently, higher water consumption (liters) and water intake (liters) per kg of DMI, suggesting that FAT or diets with higher levels of crude protein can induce a greater electrolytes loss if water intake is not adequate, possibly due to the need to metabolize the protein fraction of the diet (LEWIS, 2000).

CYMBALUK (1989), evaluating horses fed a diet consisting solely of grass hay or legume and / or associated with the concentrate diet, observed values of water excretion in feces close to those observed in this study. These values refer to the increasing proportion of the fiber fraction and protein fraction in the diets.

OLIVEIRA et al. (2003), evaluating horses fed exclusive diets of hay, noted higher water intake compared to animals fed mixed diets. Diets containing high levels of fiber may develop a shorter retention time in the gastrointestinal tract, which may lead to increase of the water loss in feces, consequently, an increase in water consumption (RIBEIRO et al., 2009).

CONCLUSION

The intakes of CP, EE and MM increased as the alfalfa hay was increased in the diets, indicating that these values are related to the chemical composition of diets. The values of water intake and excretion were influenced by the chemical composition of the diet, directly influencing the consumption of water per dry matter (L / kg DMI) and water balance. Regarding water intake and excretion, animals were in positive fluid balance in all treatments. FTT treatment presented the lowest fecal and urinary excretion of water compared to the other treatments, and FAT treatment showed the highest values for both parameters.

REFERÊNCIAS

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS - AOAC. **Official Methods of Analysis**, 15. ed. Arlington: Virginia, 1990. 1117p.

BRETAS, A.A.; ALMEIDA, F.Q.; VIEIRA, A.A.; ALMEIDA, M.I.V.; PIMENTEL, R.R.M.; SILVA, V.P.; SANTOS, T.M.; GODOI, F.N.; GALZERANO, L. Balanço hídrico e de nitrogênio em equinos alimentos com feno de alfafa, feno de tifton-85 e concentrado. **Revista Brasileira de Ciência Veterinária**, v.14, n.3, p.150-154, 2007.

CYMBALUK, N.F. Water balance of horses fed various diets. **Equine Practice**, v.11, n.1, p.19-24, 1989.

EATON, M. D. Energetic and Performance. In: _. **The Athletic Horse:** principles and practice of equine sports medicine, W. B. Sauders Company, Philadelphia, p. 49-62. 1994.

ERIKSON, H. H. Fisiologia do Exercício; In: _. **Fisiologia dos Animais Domésticos**, 11ª ed., Rio de Janeiro, Guanabara Koogan S.A., p. 277-296. 1996.

FONNESBECK, P.V. Consumption and excretion of water by horses receiving all hay and hay-grain diets. **Journal of Animal Science**, v. 27 p.1350-1356, 1968.

FRAPE, D. **Equine nutrition and feeding**. 2.ed. Oxford: Blackwell Science Ltda. 1998. 564p.

GALZERANO, L.; BRETAS, A. A.; MORGADO, E.;

ALMEIDA, F.Q.; Balanço hídrico e balanço de nitrogênio em equinos alimentos com diferentes dietas. **Revista Electrónica de Veterinária - REDVET**. v.7, n.11, 2006. Disponível em: <http://www.veterinaria.org/revistas/redvet/n101006.html>

GOER, R.J.; MCCUTCHEON, L.J.; ECKER, G.L.; LINDINGER, M.I. heat storage in horses during submaximal exercise before and after humid heat acclimation. **Journal of Applied Physiology**, v.89, p. 2283 – 2293. 2000.

GROENENDYK, S.; ENGLISH, P.B. External balance of water and electrolytes in the horse. **Equine Veterinary Journal**, v.20, p.189-193, 1988.

KRISTULA, MA, MCDONNELL, SM. Drinking water temperature affects consumption of water during cold winter weather in ponies. **Applied Animal Behavior Scince**; v.41 p.155-160, 1994.

LEWIS, L.D. **Nutrição Clínica Equina:** Alimentação e Cuidados. São Paulo, Ed. Roca, 2000. 710p.

MCDONNELL, S.M.; FREEMAN, D.A.; CYMBALUK, N.F.; SCHOTT, H.C. Behavior of stabled horses provided continuous or intermittent access to water. **Animal Journal Veterinary Review**, v.60 p.1451- 1456, 1999.

MCDONNELL, S.M.; KRISTULA, M.A. No effect of drinking water temperature (ambient vs. chilled) on consumption of water during hot summer weather in ponies. **Applied Animal Behavior Science**, v. 41p.155-160, 1996.

NATIONAL RESEARCH COUNCIL – NRC, 1989. **Nutrient Requirements of Horses**, 5th revised, Washington DC. 1989. 112p.

NATIONAL RESEARCH COUNCIL – NRC, 2007. **Nutrient Requirements of Horses**, 6th revised, Washington DC. 2007. 341p.

NYMAN, S.; DAHLBORN, K. Effect of water supply method and flow rate on drinking behavior and fluid balance in horses. **Physiologic Behavior**, v.73, p.1-8, 2000.

OLIVEIRA, C.A.A.; ALMEIDA, F. Q.; VIEIRA, A. A.; LANA, A.M.Q.; MACEDO, R.; LOPES, B.A. Cinética de Passagem da Digesta, Balanço Hídrico e de Nitrogênio em Eqüinos Consumindo Dietas com Diferentes Proporções de Volumoso e Concentrado. **Revista Brasileira de Zootecnia**, v.32, n.1, p.140-149, 2003.

PEARSON, R.A.; MERRIT, J.B. Intake, digestion and gastrointestinal transit in resting donkeys and ponies and exercised donkeys given *ad libitum* hay and straw diets. **Equine Veterinary Journal**, v.23, n.5, p.339-343, 1991.

RIBEIRO, L.B.; ARRUDA, A.M.V.; PEREIRA, E.S.; TONELLO, C.L.; BARRETO, J.C. Avaliação do consumo de nutrientes e água por equinos alimentos com dietas contendo diferentes subprodutos agroindustriais. **Revista da Faculdade de Zootecnia, Veterinária e Agronomia – FZVA**, Uruguaiana, v.16, n.1, p. 120-133. 2009.

SILVA, J.D. **Análises de Alimentos:** Métodos Químicos e Biológicos, Imprensa Universitária, Viçosa, UFV, 2002. 235p.

UNIVERSIDADE FEDERAL DE VIÇOSA - UFV. **Sistema de análises estatísticas e genéticas - SAEG**. Versão 9.1. Viçosa, MG, 2008. (CD-ROM).

VAN SOEST, P.J.; ROBERTSON, J.B.; LEWIS, B.A. Methods for dietary fiber, neutral detergent fiber and non starch polysaccharides in relation to animal nutrition. **Journal of Dairy Science**, v.74, p.3583-3597. 1991.

Protocolado em: 23 jul. 2009. Aceito em: 10 mar. 2011.