Pakistan Vet. J., 2009, 29(1): 5-10.

NUTRITIVE VALUE OF JUMBO GRASS (*SORGHUM BICOLOUR SORGHUM SUDANEFE*) SILAGE IN LACTATING *NILI-RAVI* BUFFALOES

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ABSTRACT

This study was conducted to evaluate the feeding value of Jambo grass (*Sorghum bicolour Sorghum sudanefe*) silage as a replacement of conventional fodder (Jambo grass; JG) in the diet of lactating Nili Ravi buffaloes *(Bubalus bubalis).* Jumbo grass was ensiled with molasses (at 2% of fodder DM) on large scale in bunker silos for 30 days. Two experimental iso-nitrogenous and iso-energetic diets were formulated with 75:25% of forage to concentrate ratio on DM basis that contained 75% of JG fodder or silage and 25% concentrate. Twenty early lactating Nili-Ravi buffaloes were divided into two equal groups and fed experimental diets for 60 days at *ad libitum*. First 10 days were given for adaptation to new diets and the rest 50 days for sample collection. Daily feed intake and milk yield were recorded for each animal. Milk samples were analyzed for crude protein (CP), fat, solids not fat, total solids and non-protein nitrogen. During last week of the study, a digestibility trial was conducted. The acid insoluble ash was used as digestibility marker.

Intakes of dry matter (DMI), CP, neutral detergent fiber (NDF) and acid detergent fiber (ADF) were higher in animals fed control diet than those fed Jambo grass silage (JGS) diet. A significant difference among experimental diets for DMI may be due to the presence of fermentation products in ensiled material that might have depressed the intake in silage based diets. The apparent DM, CP, NDF and ADF digestibilities were non-significantly different between both experimental diets, showing a trivial loss of nutrients during silage making. Milk yield (4% FCM) and its composition did not show any treatment effect. The present results indicated that JG ensiled with 2% molasses for 30 days could safely replace the conventional fresh Jumbo grass fodder in the diet of lactating Nili Ravi buffaloes without affecting their milk yield.

Key words: Jambo grass, silage, digestibility, milk yield, buffalo.

INTRODUCTION

Fodder crops play pivotal role in the agricultural economy of developing countries by providing cheapest source of feed for livestock. The area under fodder crops in Punjab (Pakistan) has been estimated to be 2.7 million hectares, which is about 14-16% of the total cropped area with annual fodder production of 57 million tones, giving a national average of 21.1 tones per hectare (Bhatti, 2001; Bilal *et al.*, 2001). Due to low per acre yield and minimum area under fodder production, the available fodder supply is 54-60% less than that actually needed. This shortage in supply is being coupled with the reduction in area under fodder crops by 2% after each decade (Sarwar *et al*., 2002).

The performance of dairy animals depends on the consistent availability of quality fodder in adequate amount. Therefore, the critical limitation on profitable animal production in developing countries is the inadequacy of quality forage (Sarwar *et al*., 2002). In many developing countries because of ever growing human need for food, only limited cultivated land can be allocated to fodder production. Moreover, in our region, low per acre fodder yield and fodder scarcity periods, one is during summer months and second in the winter months, further aggravated the situation (Sarwar *et al*., 2002). In rest of the year, fodder is abundantly available and remains intact in the fields. Manipulating this surplus fodder can bridge the gap between supply and demand during scarcity periods. Manipulation of green fodder in sheep has shown promising results (Jabbar and Anjum, 2008). Preservation of surplus fodder by silage making when fodder is abundant can help to reduce its irregular supply pattern round the year.

Non-leguminous crops are extensively being used worldwide for silage making having relatively low buffering capacity and low concentrations of fermentable carbohydrates. Therefore, pH decline is not rapid and final pH is usually low (Bolsen *et al*., 1996). Any produce which has sufficient fermentable carbohydrate may be ensiled, but the most popular crop is the maize (Woolford, 1984), however, the silage can be made from sorghum, barley, millet, mott grass and Jambo grass (Tauqir *et al.,* 2007). Although there is some deterioration in quality of fodder during silage making but preservation of surplus fodder and making the land free for subsequent sowing are advantages of silage making. During the recent years, a number of high yielding varieties have been introduced; Jumbo grass (*Sorghum bicolour Sorghum sudanefe*) is one of the promising grasses because of its rapid growth and high yield (Stuart, 1990). It is popular because of its high productivity and ultra-late flowering nature triggered by short day length. It is also important because of its availability during summer fodder scarcity periods. However, the information regarding the nutritive value of Jambo grass (JG) and its silage under varying conditions is limited.

Therefore, the main aim of the present project was to evaluate the nutritive value of Jambo grass silage in comparison with the conventional fodder and its effect on feed intake, milk yield and its composition and digestibility in lactating buffaloes.

MATERIALS AND METHODS

Fodder

Jambo grass (*Sorghum bicolour Sorghum sudanefe*) seed was procured from Imperial Chemicals Industry, Pakistan Limited and sown in the fields at Livestock Production Research Institute, Bahadarnagar, Okara, Pakistan. All the recommended agronomic practices were followed during sowing of the crop.

Sample preparation and analyses

The JG harvested at full bloom was chopped, dried at 55^0C and ground to 2 mm particle size trough a Wiley mill. These samples were analyzed for DM, CP and total ash using method described by AOAC (1990), neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose, cellulose and acid detergent lignin (ADL) by method of Van-Soest *et al.* (1991). The JG harvested at full bloom was ensiled on large scale in bunker silos with molasses at 2% of fodder DM for 30 days in this trial. The Jambo grass fresh fodder was used as control.

Silage making

For silage making, the fodder was chopped using locally manufactured chopper. The silos were filled rapidly and pressed properly to remove air for good anaerobiasis. Each pit was covered with 4 inches thick layer of rice straw, followed by covering with a plastic sheet. The plastic sheet was then plastered with a blend of wheat straw and mud to avoid any cracking while drying. The silage was given 30 days of fermentation time. It was presumed that plastic sheet and mud plastering would provide anaerobic conditions for proper silage making. Plastic sheet was removed to take the silage for feeding, starting withdrawal of silage through the upper layer and working downwards to the lower layers. An amount of silage was taken out just sufficient for one day's feeding. After being taken silage from the pit, the plastic sheet was put back to keep the pit sealed.

Animals

Twenty early lactating Nili-Ravi buffaloes, 10 animals in each group with similar body weights and milk production were selected. The groups and diets were allotted to animals at random. Animals were housed on a concrete floor in separate pens. Fresh and clean water was made available in the sheds for whole experimental period.

Diets

Two experimental diets were formulated using 75:25% of forage to concentrate ratio on DM basis and were designated as control and JGS diets (Table 1). Control diet contained 75% of Jambo grass fodder, while JGS diet contained Jambo grass silage. All diets were formulated to be iso-nitrogenous and iso-energetic using NRC (2001) standards for energy and protein. Diets were mixed daily and fed twice a day at *ad libitum*. The trial lasted for 60 days, with first 10 days for dietary adaptation and 50 days for sample collection. Daily feed intake and milk production was averaged over 50 days.

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

Ingredients	Diets[1]	
	Control	**JGS**
Fodder	75.0	---
Silage	---	75.0
Rice polishing	3.60	3.25
Wheat bran	5.00	5.00
Maize gluten feed 30%	6.40	6.35
Maize oil cake	2.50	2.50
Canola meal	2.50	2.50
Cane molasses	4.00	4.00
Mineral Mixture	1.00	1.00
Urea	---	0.40
Chemical composition		
Dry matter	44.3	42.1
Crude protein	12.7	12.7
Neutral detergent fiber	62.8	58.8
Acid detergent fiber	32.4	34.0
Hemicellulose	30.4	24.7
Cellulose	27.5	27.2
Acid detergent lignin	3.43	4.26
Ash	8.88	9.50
NEL, Mcal/kg	1.33	1.32

[1]Control and JGS diets contain 75% Jambo grass fodder and Jambo grass silage, respectively.

Milk production and composition

Milk production was recorded daily for the last 50 days of the study. Milk samples (morning and evening) were collected weekly and were analyzed for CP, true protein (TP), non-protein nitrogen (NPN), fat, solids not fat (SNF) and total solids (TS) by the methods described by AOAC (1990).

Digestibility trial

During the last week of the study, a digestibility trial was conducted. Fecal grab samples were taken twice daily such that a sample was obtained for every 3-hour interval of 24-hour period (8 samples) between morning and evening feedings. The acid insoluble ash was used as digestibility marker (Van-Keulen and Young, 1977).

Sample collection and chemical analyses

The samples of Jambo grass fodder, its silage and experimental diets were taken during the course of study and were dried at 55^0C in a forced air oven. These samples were ground to 2 mm particle size through a Wiley mill, analyzed for DM, organic matter (OM), CP and ash by the methods of AOAC (1990), NDF, ADF and ADL by methods described by Van-Soest *et al.* (1991). Silage was also analyzed for pH and lactic acid contents (Baker and Summerson, 1961).

Feed offered and orts were sampled daily and composited by animal for analysis. Orts and fecal samples were also analyzed for DM, OM and CP (AOAC, 1990), NDF, ADF and ADL (Van-Soest *et al.*, 1991), for estimation of NE_L (NRC, 2001).

Statistical analysis

Mean values (± SE) of the data collected on different parameters (feed intake, milk production, milk composition and digestibility) for animals of two groups were computed. In order to ascertain the magnitude of difference in these parameters between the two groups, the data were analyzed using t test (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

Proximate and fiber composition of JG is shown in Table 2.

Table 2: Chemical composition of Jumbo grass (%DM basis)

Parameters	Amount (%)
Dry matter	15.9
Crude protein	11.0
Neutral detergent fiber	75.2
Acid detergent fiber	39.7
Acid detergent lignin	4.3
Hemicellulose	35.5
Cellulose	35.4
Ash	8.59
Gross energy (Mcal/kg)	3.28

Feed intake

Dry matter intake (DMI) by lactating buffaloes was higher ($p<0.05$) in animals fed control diet than those fed JGS diet (Table 3). This difference in DMI may be attributed to the presence of fermentation end products in silage-based diet, which might have depressed the DMI of silage based diet. Bolsen *et al.* (1996) also reported that intake of silage was lower than that of grass due to the presence of fermentation products in the former. They further explained that there had been significant correlation of DMI with silage pH, with the concentrations of acids in the silage DM (negative correlation) and with indices of fermentation quality. The latter include the proportion of ammonia nitrogen in the total nitrogen (negative), the proportion of lactic acid in total acids (positive), flieg index (positive; Rook and Thomas, 1982) and moisture content of the silage-based diets (Sarwar and Hasan, 2001). Therefore, presence of fermentable end products, increased water concentration of the diet and an associated increase in ammonia nitrogen could have depressed the high intake potential of JGS. In contrast to the present results, Bilal *et al.* (2001) reported that DMI was not affected by feeding silage-based diets when fed as total mixed ration or in combination with fresh fodder.

Table 3: Dry matter (DM) and crude protein (CP) intakes and their digestion by buffaloes fed control and JGS diets

Items	Diets[1]		SEM
	Control	JGS	
Dry matter intake (Kg/day)	13.3[a]	12.5[b]	0.14
Fecal DM (Kg/day)	0.58	0.56	0.02
Apparent DM digestibility (%)	56.7	55.1	1.08
DMI % body weight	2.86	2.69	0.18
CP intake (Kg/day)	1.74[a]	1.63[b]	0.02
Fecal CP (Kg/day)	0.50	0.47	0.01
Apparent CP digestibility (%)	71.3	71.13	0.69
Digestible nutrient intake (Kg/day)			
DM	7.54[a]	6.86[b]	0.14
CP	1.24[a]	1.16[b]	0.02

[1]Control and JGS diets contain 75% Jambo grass fodder and Jambo grass silage, respectively. Means within the same row bearing different superscripts differ significantly ($p<0.05$).

However, DM as a percent of body weight was higher (2.86%) in buffaloes fed control diet compared to those (2.69%) fed JGS diet but the difference was non-significant as previously reported by Khorasani *et al.* (1993). Similarly, digestible DMI was higher in animals fed control diet than JGS diet.

Neutral detergent fiber intake was significantly ($p<0.05$) higher (8.35 Kg/day) in buffaloes fed control diet than JGS (7.32 Kg/day) diet (Table 4). Similarly, NDF intake as percent of body weight showed significant ($p<0.05$) difference among control and JGS diets. Dado and Allen (1995) also reported that increased water concentration of the diet and silage quality could have depressed the high intake potential of silage based diet. The pH of the silage is an important indicator of quality (Rook and Thomas, 1982). In the current study, pH of Jambo grass silage was 4.45, therefore, the quality of JGS was fair. Similarly, digestible NDF intake was significantly higher in animals fed control diet when compared to those fed JGS diet.

The intake of ADF was significantly higher in animals' fed control diet than those fed JGS diet. This trend of ADF intake was due to the reason that experimental diets contained similar ADF content as was observed in ADF intake. However, ADF intake as percent body weight was similar across both the treatments. This significant variation in digestible DM, NDF and ADF intakes can be attributed to microbial fermentation during ensilation that caused significant changes in its digestibility and ultimately intake of nutrients (Bolsen *et al*., 1996).

Crude protein intake and intake of digestible CP showed a similar trend as was observed for DMI (Table 3). This supported the findings of Ruiz *et al*. (1992), who reported that excessive degradation of CP to NPN during ensilation could be a reason for low CP intake when silage based diets were fed to lactating animals. Although the concentration of CP in the diets and CP digestibility were similar but the significant trend of CP intake by lactating buffaloes was observed due to significant variation in DMI across both treatments.

Digestibility

The apparent DM digestibility (DMD) was non-significantly higher (56.7%) in animals fed control diet than those fed JGS (55.1%) diet (Table 3). Khorasani *et al*. (1993) reported a higher DMD of fodder based diets compared to silage based diets due to increased lignin content of the silage. It was suggested that digestibility of the cell wall is variable among various forage sources and is an inverse function of lignification. In the current investigation, silage based diet contained higher lignin contents (Table 2), hence the digestibility of silage based diets was lower. Yahaya *et al.* (2001) also reported that ensiling alfalfa and orchard grass for different fermentation periods at various moisture contents maintained a decreasing trend of digestibility in their respective silages.

Digestibility of DM in lactating and dry cows decreased as the level of silage increased therefore, it was assumed that intake was limited by physical constraints and these factors increased as more silage was used in the diet (Llamas-lamas and Combs, 1991). Similarly, in the present study, slightly higher DMD of control diet may be attributed to the better digestibility of JG fodder having lower lignin content.

Apparent digestibility of CP remained unchanged among both treatments (Table 3). This indicates that there would be a non-significant loss of CP contents during silage making. It is generally stated that if fodder is ensiled with good silage management practices using some nutritional additive to improve soluble carbohydrate concentration, the losses of nutrients would be minimized (Yahaya *et al*., 2001; Tauqir, 2007). From these results, it can be concluded that although there would be some loss of nutrients during silage making but following careful silage making practices, the losses could be minimized to non-significant levels. Khorasani *et al*. (1993) also reported a similar CP digestibility of grass silages. This notion was also supported by the milk production performance of buffaloes in this study (Table 5). Addition of nutritional additives to improve soluble carbohydrate concentration before ensilation and provision of good anaerobic conditions could reduce the loss of nutrients in the silage.

The NDF and ADF digestibility values were statistically non-significant among fodder and silage based diets (Table 4). Similarly, West *et al*. (1998) reported that apparent digestibility of ADF was not different for silage based diets, while NDF digestibility was greater for grass hay than silage based diets. Slightly better NDF digestibility of control diet in the present study could be explained by increased intake of highly digestible NDF of forage based diet or by decreased pH of rumen due to the presence of lactic acid in the silage based diet that might have affected digestibility of test diets. Torotich (1992) had substantiated the results of present study by reporting that depression in hemicellulose and cellulose digestibility of silage based diets was due to lower ruminal pH, which depressed the growth of cellulytic bacteria in the rumen. The rumen pH was lowered by high proportion of silage in these diets. Therefore, the variation in digestibility of different diets in the present study may be attributed to low ruminal pH due to respective diets.

Milk yield and composition

Milk yield (4% FCM) was higher (10.27 Kg/day) in animals fed control diet than those fed JGS (9.45 Kg/day) diet (Table 5). However, the difference in FCM yield was statistically non-significant ($p>0.05$) between both treatments. Same was true for fat, SNF, total solids and CP contents of milk.

Khorasani *et al*. (1993) reported that production of 4% FCM was not affected by diet type. Although there was a significant difference in DMI among animals fed control and test diet but there was no depression in milk production. These results may be attributed to the insignificant difference in DMI percent of body weight. Moreover, the intake of digestible nutrients by buffaloes fed silage-based diet might have provided more nutrients for the synthesis of milk. Murphy *et al.* (1982) reported that acetate production from soluble

Table 4: Fiber intake and its digestion by buffaloes fed control and JGS diets

Items	Diets[1]		SEM
	Control	JGS	
NDF intake (Kg/day)	8.35 [a]	7.32 [b]	0.08
NDFI % body weight	1.79 [a]	1.58 [b]	0.11
Fecal NDF (Kg/day)	0.43[a]	0.38 [b]	0.02
NDF digestibility (%)	48.5	47.8	2.31
ADF intake (Kg/day)	4.31[a]	4.07 [b]	0.04
ADFI % body weight	0.92	0.88	0.06
Fecal ADF (Kg/day)	0.21	0.20	0.02
ADF digestibility (%)	50.5	50.7	0.80
Digestible nutrient intake (Kg/day)			
NDF	4.05 [a]	3.50 [b]	0.18
ADF	2.17	2.06	0.16

[1]Control and JGS diets contain 75% Jambo grass fodder and Jambo grass silage, respectively. Means within same row with different superscripts differ significantly ($p<0.05$).

Table 5: Milk yield and composition by buffaloes fed control and JGS diets

Items	Diets[1]		SEM
	Control	JGS	
Milk yield (Kg/ day)	10.27	9.45	1.19
Milk fat (%)	5.81	5.95	0.09
Solids not fat (%)	9.17	9.05	0.14
Total solids (%)	15.0	15.0	0.16
Crude protein (%)	3.57	3.57	0.11
True protein (%)	3.35[a]	2.92[b]	0.10
Non-protein nitrogen (%)	0.22[b]	0.65[a]	0.13

Means within same row bearing different superscripts differ significantly ($p<0.05$). [1]Control and JGS diets contain 75% Jambo grass fodder and Jambo grass silage, respectively.

carbohydrates of roughages was higher than from concentrate diet, also less butyrate and no valerate were produced. Production of more acetate led to more fatty acid synthesis that might have increased percent fat in the milk which consequently improved 4%FCM yield. Such findings were previously described by Cant *et al.* (1991).

Percent CP in milk remained unaltered across both diets. Khorasani *et al.* (1993) reported no change in milk protein percentage when cows were fed diets containing various NSC concentrations without fat. The amino acids supplied by ruminally-protected protein in proper proportion and amount for milk protein synthesis would have been a reason for any change in milk protein content (Khorasani *et al.*, 1993). In the present study, all the experimental diets had the same ingredients in almost similar proportions except forage type with 75:25% of forage to concentrate ratio and had similar concentration of ruminally protected protein content.

Milk TP and NPN showed a significant but inverse trend among both treatments (Table 5). Percent milk fat and total solids showed a non-significant trend as was observed in DMI and NDFI percent body weight. These findings are consistent with those of Man and Wiktorsson (2001).

The availability of green fodder has large variation during different seasons of the year in our region. Two extremes of seasons, the summer and winter, impose a severe snag on the availability of fodders, adversely affecting livestock productivity. Hence, ensiling fodder during blossoming period would help to maintain round the year and uniform supply of feed to livestock. It may go a long way in bridging up the gap of nutrient supply during fodder scarcity periods and facilitating the farmers for profitable livestock farming.

Conclusion

The present study revealed that despite low feed intake and digestibility of silage-based diet, there was not any depression in milk yield and its composition in buffaloes. So, Jambo grass silage could safely replace the conventional fresh grass fodder in the diet of lactating Nili Ravi buffaloes without affecting their milk yield.

REFERENCES

AOAC, 1990. Official Methods of Analysis. 15th Ed., Association of Official Analytical Chemists. Arlington, Virginia, USA.

Baker, S. B. and W. H. Summerson, 1961. The calorimeteric determination of lacitc acid in biological material. J. Biol. Chem., 138: 535-545.

Bhatti, J. A., 2001. Improved fodder production in Punjab. Livestock and Dairy Magazine, 23: 38-39.

Bilal, M. Q., M. Abdullah and M. Lateef, 2001. Effect of mott dwarf elephant grass (*Pennisetum purpureum*) silage on dry matter intake, milk production, digestibility and rumen characteristics in Nili-Ravi buffaloes. In: Proc. 54th Annual Reciprocal Meat Conference (Vol. II). Indianapolis, Indiana, USA, July 24-28.

Bolsen, K. K., G. Ashbell and Z. G. Weinberg, 1996. Silage fermentation and silage additives: Review. Asian-Aust. J. Anim. Sci., 9: 483-493.

Cant, J. P., E. J. Depeters and R. L. Baldwin, 1991. Effect of dietary fat and postruminal casein administration on milk composition of lactating dairy cows. J. Dairy Sci., 74: 211-220.

Dado, R. G. and M. S. Allen, 1995. Intake limitations, feeding behavior and rumen function of cows challenged with rumen fill from dietary fiber of inert bulk. J. Dairy Sci., 78: 118-128.

Jabbar, M. A. and M. I. Anjum, 2008. Efect of diets with different forage to concentrate ratio for fattening of Lohi lambs. Pakistan Vet. J., 28(3): 150-152.

Khorasani, G. R., E. K. Okine, J. J. Kennelly and J. H. Helm, 1993. Effect of whole crop cereal grain silage substituted for alfalfa silage on performance of lactating dairy cows. J. Dairy Sci., 76: 3536-3544.

Llamas-lamas, G. and D. K. Combs, 1991. Effect of forage to concentrate ratio and intake level on utilization of early vegetative alfalfa silage by dairy cows. J. Dairy Sci., 74: 526-536.

Man, N. V. and H. Wiktorsson, 2001. Cassava tops ensiled with or without molasses as additive effect on quality, feed intake and digestibility by heifers. Asian-Aust. J. Anim. Sci 14: 624-630.

Murphy, M. R., R. L. Baldwin and L. J. Koong, 1982. Estimation of stoichiometric parameters for rumen fermentation of roughage and concentrate diets. J. Anim. Sci., 55: 411-421.

NRC, 2001. Nutrient Requirements of Dairy Cattle. 7th Ed., National Academy Press, Washington DC, USA.

Rook, J. A. F. and P. C. Thomas, 1982. Silage for milk production. National Institute of Research in Dairying, Reading, UK.

Ruiz, T. M., W. K. Sanchez, C. R. Straples and L. E. Sollenberger, 1992. Comparison of “Mott” dwarf elephant grass silage and corn silage for lactating dairy cows. J. Dairy Sci., 75: 533-540.

Sarwar, M. and Z. U. Hasan, 2001. Nutrient Metabolism in Ruminants. Friends Science Publishers, Faisalabad, Pakistan.

Sarwar, M., M. A. Khan and Z. Iqbal, 2002. Feed resources for livestock in Pakistan. Int. J. Agri. Biol., 4: 186-192.

Stuart, P. N., 1990. The Forage Book. Pub. Pacific Seeds. Toowoomba, Queensland, Australia.

Tauqir, N. A., M. A. Khan, M. Sarwar, Mahr-un-Nisa, C. S. Ali, W. S. Lee, H. J. Lee and H. S. Kim, 2007. Feeding value of Jambo grass silage and Mott grass silage for lactating Nili Ravi buffaloes. Asian-Aust. J. Anim. Sci., 20: 523-528.

Torotich, M. J., 1992. Minimizing the loss of ammonia during urea treatment of wheat straw for growing calves. MSc Thesis, Haryana Agri. Univ. Hissar, India.

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: 282-292.

Van-Soest, P. J., H. B. Robertson and B. A. Lewis, 1991. Method of dietary fiber and non-starch polysaccharides determination in relation to animal material. J. Dairy Sci., 74: 3583-3591.

West, J. W., P. Mandebvu, G. M. Hill and R. N. Gates, 1998. Intake, milk yield and digestion by dairy cows fed diets with increasing fiber content from Bermuda grass hay or silage. J. Dairy Sci., 81: 1599-1608.

Yahaya, M. S., A. Kimura, J. Harai, H. V. Jguyen, M. Kawai, J. Takahashi and S. Matsuoka, 2001. Evaluation of structural carbohydrate losses and digestibility in alfalfa and orchard grass during ensiling. Asian Aust. J. Anim Sci., 14: 1701-1711.

Snedecor, G. W. and W. G. Cochran, 1980. Statistical Mehods. 6th Ed., Iowa State Univ. Press, Ames, Iowa, USA.