VERMICOMPOST EFFECT ON THE PRODUCTION AND NUTRITIONAL QUALITY OF WHEAT HYDROPONICS FORAGE IN DIFFERENT HARVESTS DATES

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ABSTRACT

The study was carried out in Santa Maria, RS – Brazil, with the objective of evaluating the vermicompost effect on the production and nutritional quality of wheat hydroponics forage, cultivated in protected environment (high tunnel). It was adopted the experimental design in blocks at random, distributed in factorial scheme 2 x 4, two nutritional solutions; SNS – inorganic nutritive solution according to Santos et al. (2004)'s recommendation, SNSC – organic nutritive solution partly corrected attending Santos et al (2004)'s recommendation, and four periods of harvest (4, 8, 12 and 16 days after sowing). It was observed significance ($P<0.05$) to interaction nutritive solution x periods of harvest to variables: dry matter (DM), crude protein (CP), soluble protein (SP) and neutral detergent fiber (NDF). The variable ones presented square response to the period advance of harvest, being positive to DM and negative to CP, SP, and NDF, not only to SNS but also to SNSC. The period advance of the harvest in production of hydroponics forage determined linear increase in acid detergent fiber (ADF) and lignin (LIG), and linear reduction of "in vitro" dry matter digestibility (IVDMD). The forage cultivated with SNS presented higher substance of ADF and of IVDMD in relation of SNSC. The LIG substance did not obtain significant difference ($P<0.05$) among the solutions. Therefore, the organic solution of bovine vermicompost besides offering the hydroponics forage production of good nutritional quality of wheat, it allows the use of residue produced in property, decreasing the production cost of nutritive solution.

KEYWORDS: nutritive solution, organic, protected environment.

USO DE VERMICOMPOSTO NA PRODUÇÃO E QUALIDADE NUTRICIONAL DA FORRAGEM HIDROPÔNICA DE TRIGO EM DIFERENTES IDADES DE COLHEITAS

RESUMO

O estudo foi realizado em Santa Maria, RS – Brasil, com o objetivo de avaliar o efeito do vermicomposto na produção e na qualidade nutricional da forragem hidropônica de trigo, cultivada em ambiente protegido (túnel alto). Adotou-se o delineamento experimental em blocos ao acaso, distribuídos em esquema fatorial 2x4, duas soluções nutritivas; SNS- solução nutritiva inorgânica segundo recomendação de SANTOS et al., (2004), SNSC- solução nutritiva orgânica parcialmente corrigida para atender recomendação de SANTOS et al., (2004) e quatro idades de colheita (4, 8, 12 e 16 dias após a semeadura). Foi observada significância (P<0,05) à interação soluções nutritivas x idades de colheita para as variáveis: fitomassa seca (FS), proteína bruta (PB), proteína solúvel (PS) e fibra em detergente neutro (FDN). As variáveis apresentaram resposta quadrática ao avanço da idade de colheita, sendo positiva para FS e negativa para PB, PS e FDN, tanto para a SNS quanto SNSC. O avanço da idade de colheita na produção de forragem hidropônica determinou incremento linear no teor de fibra em detergente ácido (FDA) e lignina (LIG), e diminuição linear da digestibilidade "in vitro" da fitomassa seca (DIVFS). A forragem cultivada com SNS apresentou teor superior de FDA e de DIVFS em relação à SNSC. O teor de LIG não obteve diferença significativa (P>0,05) entre as soluções. Portanto, a solução orgânica de vermicomposto bovino além de proporcionar a produção de forragem hidropônica de trigo de boa qualidade nutricional, permite o aproveitamento de resíduo gerado na propriedade, diminuindo o custo da confecção da solução nutritiva.

PALAVRAS-CHAVE: solução nutritiva, orgânico, ambiente protegido.

INTRODUCTION

Hydroponics forage is an alternative to producers who need quality food to their animals, but do not arrange large extensions of lands. This technique has permitted excellent results in cattle-raising, with good gains of live weight, less termination time, bigger milk volumes, increasing of fertility and decreasing of production costs due to partial substitution of concentrated foods (FAO, 2001; GONZÁLES, 2003; ESPINOZA et al., 2004).

FLORES et al., (2004) emphasize that hydroponics forage is a great technological advance in the animal food; it can be produced during all over the year and offered to all animals in any phase of development (gestation, lactation, weaning and termination). However, nutritive solutions used in hydropony, generally, are originating from inorganic fertilizers, determining the exclusion of the technique use by producers who aim at sustainable agricultural development system (NICOLA, 2002).

Organic hydropony is a very recent technique in Brazil, however, it is already used in other countries with excellent results, several times much better than the obtained by inorganic hydropony, logically, inside its limitations (MARTINS, 2004). One of the important characteristics of organic hydropony is the possibility of getting on closed ecologic systems, with the maxim of recycling, determining less aggression to the environment.

The nutritive solution, in organic hydropony, is obtained from biodecompound organic materials through conventional system of compostage or through biodigestion (MARTINS, 2004). According to TIBAU (1984), dung has specific properties of high agriculture value, with the indol-acetic acid met in the animal urine which has powerful stimulating effect in the development of roots.

The vermicompost is considered the organic fertilizer with better potential of utilization, because it is easily produced in low costs. GONZÁLES (2003) reports that the utilization of organic fertilizers, as vermicompost, has very favorable signs in the production of hydroponics forage, in Mexico. NICOLA (2002), working with vermicompost, concluded that this can be used as nutritional source to lettuce cultivation in hydroponics system, but if it is used isolated, it does not offer adequate concentrations for culture growth, due to low nitrogen concentration, being needed complementation with inorganic nutrients.

Besides nutritive solution choice, the determination of ideal period of harvest is also important in the production system of hydroponics forage. The stage of forager plant influences its nutritive value, because as the plant grows and develops, it increases the fiber portion, while reduces the protein tenor and the digestion of the dry matter (VAN SOEST, 1994). In the hydroponics forage production, early harvests can result in low income by area, but late harvests can produce big competition between plants, and loss of nutritional quality (HENRIQUES, 2000).

Therefore, the work had the objective of evaluating the production and nutritional quality of wheat hydroponics forage, cultivated with nutritive inorganic and organic solutions (vermicompost) partially corrected, identifying the ideal period of harvest.

MATERIAL AND METHODS

The experiment was carried out in Santa Maria, RS – Brazil, in August, 2004. The geographic co ordinations of the place are: 29°43’S latitude, 53°43’W longitude and 95 m altitude. The local clime, according to W. Köeppen, belonged to “Cfa” type – subtropical humid clime with hot summers (MORENO, 1961).

Wheat hydroponics forage was cultivated in high tunnel, “Hermano” type, with 6 meters of width and 27 meters of length (162 m^2), placed in north – south direction, covered with low density of polyethylene (PEBD) with thickness of 150 micra, added against ultraviolet rays. Inside the tunnel, stonemasons with area of $1m^2$ were confectioned (experimental unity) with black PEBD of 100 micra of thickness, expanded on leveled ground, having the edges delimited by wood guidance with 6,0 cm of height, posted in the ground.

Wheat seeds (*Triticum aestivum* L.) were originating from harvest of the region, without chemical treatment. They were weighted, with 2 kg m^{-2} density, and placed in plastic buckets where the pre germination technique was accomplished, which consisted in seed in water for 12 hours associated with 24 hours of incubation. The sowing was accomplished manually, by lance, directly on plastic film.

It was adopted the blocks experimental outline at random with four repetitions to the variables of production, and three repetitions with two samples to variables of bromatologic composition, distributed in factorial scheme 2 x 4, two nutritive solutions; SNS – inorganic nutritive solution according to SANTOS et al., (2004)’s recommendation, SNSC – organic nutritive solution partly corrected attending SANTOS et al., (2004)’s recommendation, and four periods of harvest (4, 8, 12 and

16 days after sowing).

Macro nutrients which composed SANTOS et al., (2004) solution were (mg L^{-1}): N=190.6, P=34.0, K=233.3, Ca=125.0, Mg=27.0, S=35.1. The iron was chelate with EDTA and used in 1ml L^{-1} dose.

In the formulation of organic nutritive solution, it was used humus of earthworm (*Eisenia foetida*), produced from bovine dung, acquired through region producer. The nutritive solution was obtained according to proposed methodology by NICOLA (2002), in which it must be added humus and water in the proportion of 1:1 in volume (vermicompost pre diluted) in fiber glass reservoir with 1000 L capacity. After that, this mixture remains in rest during 72 hours, and after being filtered with the help of voile tissue, it obtains 80 % of liquid in media.

The pre diluted vermicompost was analyzed in the Laboratory of Soil Analysis of the Soils Department of Federal University of Pelotas– Brazil, for the determination of its composition. It was verified high potassium concentrations, calcium, magnesium, and sulfur, being necessary more one to the dilution of pre diluted vermicompost in order to attend the proposed recommendations by SANTOS et al., (2004). Therefore, it continued the dilution of 1L of pre diluted vermicompost in 4 L of water, and it obtained substance of macro nutrients (mg L^{-1}): N=14.2, P=4.8, K=336.4, Ca=129.0, Mg=86.2, S=27.4. However, it was verified very low nitrogen and phosphorus concentrations, it is being necessary correction with inorganic nutrients.

It was adopted the open hydroponics system, without reuse of nutritive solution. The nutritive solutions were stocked in two fiber glass tanks with 500 L capacity. Its application was effected with the help of watering cans four times a day in regular intervals, being distributed 4 L m^{-2} day^{-1} in media. In the first three days, the irrigation was accomplished only with water, and from these days, with nutritive solution.

Analysis of dry matter, crude protein, soluble protein, fiber in neutral detergent, fiber in acid detergent, lignin, and "in vitro" digestion of dry matter were accomplished at Animal Nutrition Laboratory (LNA) at Zootechny Department of Federal University of Santa Maria – Brazil, according to methodologies described by SILVA (1991), from compound samples of the group: seedlings, germinated and no germinated seeds, collected in each parcel in the size of 0.4 m x 0.4 m. The data obtained were submitted to analysis of variance, the nutritive solutions were compared to themselves by F test and the periods of harvest were evaluated through regression analysis.

RESULTS AND DISCUSSION

It was observed significance ($P < 0.05$) to interaction nutritive solutions x harvest periods to variables: dry matter (DM), crude protein (CP), soluble protein (SP) and neutral detergent fiber (NDF) (Figure 1). The equations demonstrated meaningful square response to both solutions, but with positive response to DM and negative to CP, SP and NDF.

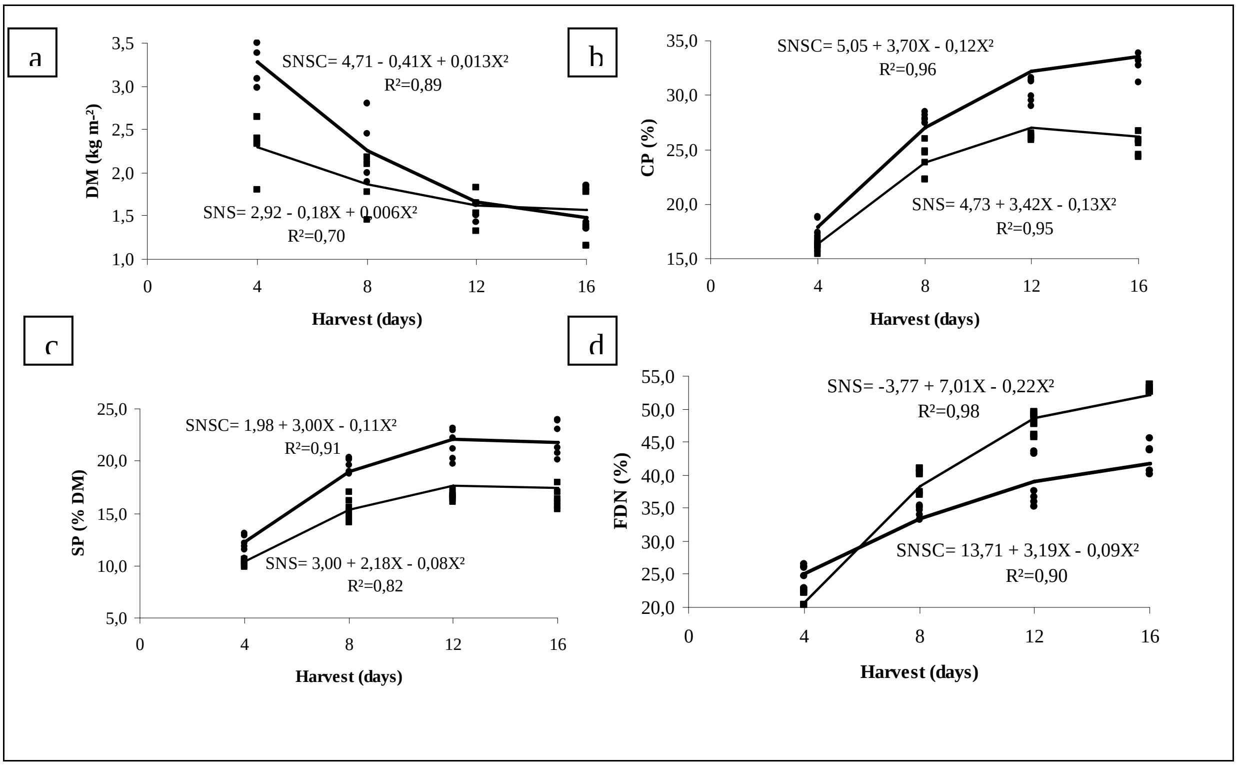

FIGURE 1 - Adjusted regression equations and determination coefficients to dry matter (DM), crude protein (CP), soluble protein (SP) and neutral detergent fiber (NDF) to SNS – inorganic nutritive solution according to Santos et al (2004)'s recommendation, SNSC – organic nutritive solution partly corrected attending to SANTOS et al., (2004)'s recommendation, UFSM – Brazil, 2005.

The production of DM presented positive square response to the advance of harvest period to SNS and SNSC, with low income in the last harvest during 16 days, (Figure 1a). Similar results was cited by FAO (2001), in oat hydroponics forage during 7, 11 and 15 days that verified decreased values 3.26, 2.95 and 2.27 Kg m^{-2} DM, respectively. ESPINOZA et al., (2004), in the cultivation of corn hydroponics forage, verified income of 1.87 Kg DM m^{-2} in the harvest for 9 days.

The decrease of DM (Figure 1a) with the advance of harvest period explains by the presence of no germinated seeds in samples, which present high substance of DM. Therefore, with the advance of the harvest period there was decomposition of these no germinated seeds, which cause decrease in DM of the samples. Besides of this, the elevated population density (around 43080 plants m^{-2}) can be provided competition among the seedlings by nutrients and light, causing estiolation and posterior dumpping, beside senescence of lowest leaves and seedlings of low height that remained shaded.

Hydroponics forage produced with the SNSC solution obtained higher values of DM in relation to SNS, in the harvests for 4 and 8 days (Figure 1a), but for 12 and 16 days the production of DM was similar between two solutions. However, instead of DM be more elevated for 4 and 8 days, it is not recommended the harvest in these periods because the nutritional quality of the forage is lower.

The crude protein substance presented negative square response in relation to the increase of the harvest period (Figure 1b). The maxim points placed next to 13 days to SNS, with 27.22 % CP, and 15 days to SNSC, with 33.55 % CP. Sandia

(2003) observed, in the wheat hydroponics forage, at 10, 14 and 16 days increased substance of CP, 20.33, 22.90, and 24.08 %, respectively, being these values next to the observed at SNS.

The protein content of hydroponics forage produced with SNSC in all periods of the harvest was higher to SNS (Figure 1b). This result can be attributed, according to COMPAGNONI & PUTZOLU (1985), to benefic effect that the substances presented in the vermicompost perform in plants, such as humic acids and phyto stimulants actions similar to phytohormones. Besides, according to KONONOVA (1961), soluble humic substances originated from organic fertilizers demonstrated positive effect in the growing and development of plants in determined microbians processes as nitrification and nitrogen assimilation. Therefore, the SNSC solution must have favored the absorption and metabolism of nitrogen in the plant, resulting in more protein substance.

ESPINOZA et al., (2004) emphasized that corn hydroponics forage has high protein substance (33.54 % CP) and that, due to this characteristic, it can be efficient alternative to supply the protein need in the diet of ruminant and no ruminant animals. Similarly, the protein supplementation with wheat hydroponics forage can be considered excellent option to complement animal food and increase the productivity of the cattle-raising, because diets with CP lowest to 7 % promote reduction in its digestion due to inadequate levels of nitrogen to rumen microorganisms, decreasing its population and, consequently, reducing the digestion and consume of DM (VAN SOEST, 1994).

In relation to soluble protein substance, it was observed negative square performance with the advance of harvest period (Figure 1c). The maxim points of SP to SNS and SNSC placed next to 13 days, with 17.82 % and 22.39 % at DM, respectively. The higher of SP on SNSC is due probably to present humic substances, because according to RAVEN et al., (1996) these substances stimulate oxidative phosphorilation occurring more absorption and transport of nutrients and increase in the synthesis of composts by plants, mainly the nitrogen ones. Comparatively, barley hydroponics forage, according to SANDIA (2003) has maxim SP substance of 15.63 % at DM, lowest substance value to the observed in this study. Therefore, wheat forage has better protein quality than barley.

Soluble protein is one of the factors that most influence in the protein degradation in relation to rumen, because this one tends to be faster or completely degraded (Tamminga, 1979). According to HUTJEN (1999) milk cows in phases of different lactation need SP 4.8 – 5.7 % at DM. Wheat hydroponic forage has SP values (Figure 1c) higher to exigent ones, confirming-it as excellent supplementary option.

It was verified negative square performance in relation to the increase of the harvest to fiber in neutral detergent in hydroponic forage cultivated with SNS and SNSC (Figure 1d). Similar results was verified by FAO (2001), in oat hydroponics forage at 7, 11, and 15 days that relates values of 56.0, 63.0, and 58.0 % NDF, respectively, however, the values are highers to the observed in this study. ESPINOZA et al., (2004) obtained in corn hydroponics forage, at 9 days, substances of 41.46 % NDF, similar to SNS observed.

NDF substance is inversely correlated to dry matter digestion and NDF levels above 55-65 % would not be indicated in ruminant diets, because it would limited the space at gastrointestinal treat, and, therefore, the consume (CONRAD et al., 1966; VAN SOEST, 1994). It was observed that NDF substances (Figure 1d) verified at corn hydroponics forage placed below the considered level as limit, being a good option to food complementation.

However, it must be considered that NDF substance must be at least from 25 to 28 %, with 75 % of this total being supplied by forages to cow diets in lactation (NRC, 1989). The most used concentrated ones at animal food, as corn, wheat, and soy, according to ROSTAGNO (2000), has NDF value equal to 11.40, 11.49, and 14.20 %, respectively. It can be concluded that the concentrated ones do not attend to the needs of this category, so the use of wheat hydroponics forage is adequate to food diet complementation, justifying the importance and the use of hydroponics system in the forage production, instead of the use of high quantities of grains in animal diets.

The interaction between nutritive solutions x periods of harvest was not significant (P > 0.05) in acid detergent fiber (ADF), lignin (LIG), and "*in vitro*" dry matter digestibility (IVDMD).

According to Table 1, LIG substance did not obtain significant difference (P>0.05) between SNS and SNSC solutions. Medium substances of ADF (21.98 %) and LIG (4.16 %) are lowest to the observed ones in native pasturage of RS, which has around 46.95 % and 7.26 %, respectively, and in sorghum silage 37.66 % and 9.10 %, respectively (VARGAS JUNIOR, 2000; SOARES, 2002).

MERTENS (1994) says that ADF substance indicates fiber quantity not digested around 30% or less, because these levels offer increase of dry matter consume by animals, so ADF values observed at wheat hydroponics forage (Table 1) indicate forage as being adequate to animal consume.

Table 1 - Acid detergent Fiber (ADF), lignin (LIG), cellulose (CEL), and "in vitro" dry matter digestibility (IVDMD) to SNS – inorganic nutritive solution according to SANTOS et al., (2004)'s recommendation, SNSC – organic nutritive solution partly corrected attending to SANTOS et al., (2004)'s recommendation, UFSM – Brazil, 2005.

Solution	ADF %	LIG %	IVDMD %
SNS	23.00	4.18	67.14
SNSC	20.74	4.14	69.24
F	7.47	6.00	3.45
Pr>F	0.1480	0.9554	0.0488
CV (%)	8.13	9.53	4.29

In relation to IVDMD, SNSC solution (69.24 %) was higher (P < 0.05) to SNS (67.14 %). This fact is also due to the benefic effect of humic substances in plants (KONONOVA, 1961; TIBAU, 1984; RAVEN et al., 1996). It was also observed that wheat forage present IVDMD substances higher to native pasturage in Brazil (41.68 %) and sorghum silage (43.25 %) (TONETTO et al., 2004). Wheat hydroponics forage also obtained IVDMD higher to tropical forages, which are situated between 55 and 60 % (Moore & Mott, 1973).

ADF substance presented linear increase in relation to the period of the harvest (Figure 2a). This fact is a consequence of plant maturity, because VAN SOEST (1994) says that ADF is constituted mainly of lignin and cellulose that increase their concentrations with the cycle advance. ESPINOZA et al., (2004) verified in corn hydroponics forages substance of 20.94 % ADF at 9 days, similar value to this study.

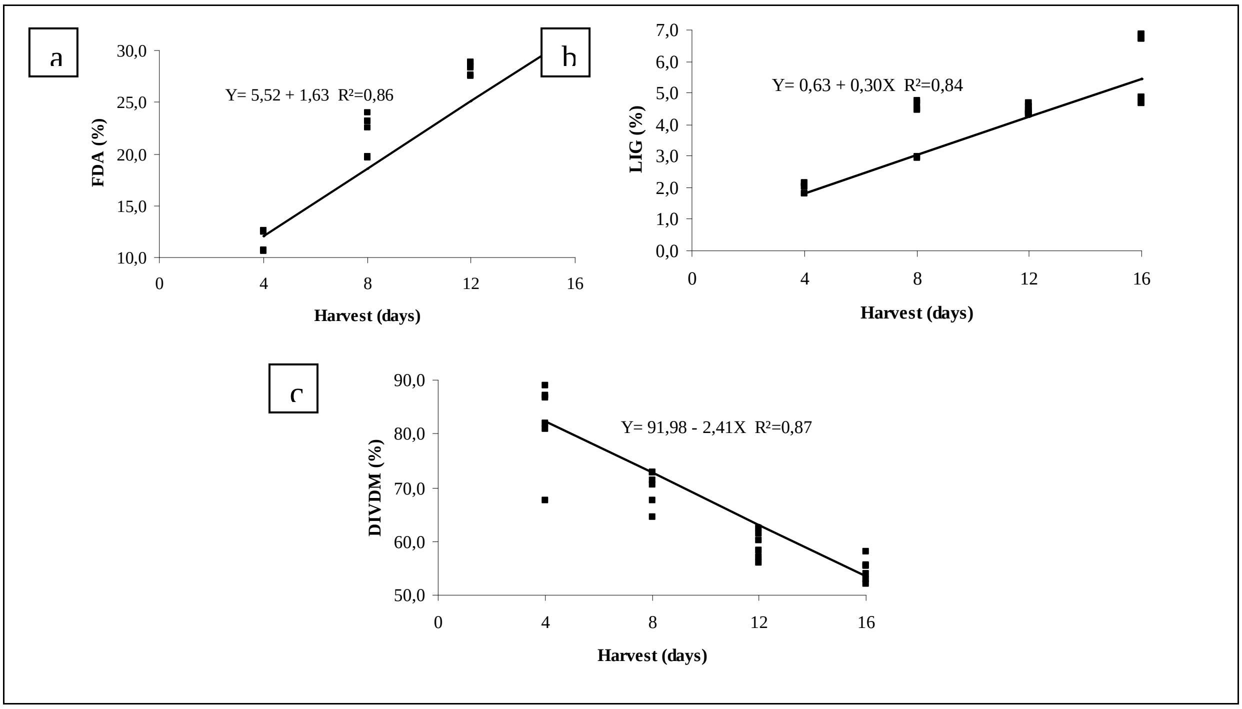

Figure 2 - Adjusted regression equations and determination coefficients to acid detergent fiber (ADF), lignin (LIG), and "in vitro" dry mater digestibility (IVDMD) to SNS – inorganic nutritive solution according to SANTOS et al (2004)'s recommendation, SNSC – organic nutritive solution partly corrected attending to SANTOS et al (2004)'s recommendation, UFSM – Brazil, 2005.

Lignin substance (LIG) presented linear increase in its substance with the increase of the harvest period (Figure 2b). FAO (2001) presents similar answer to oat hydroponics forage in which was verified values of 7.0 % and 8.1 % LIG at 7 and 11 days, respectively. According to VAN SOEST (1994), the lignin is considered indigestion and inhibitor of digestion of forage and its concentration increases with physiologic maturity of plants, performance observed in this study.

IVDMD of wheat hydroponics forage decreased linearly with the advance of the harvest period (Figure 2c). This fact is due to IVDMD of forage be negatively correlated with NDF and FDA substances, because with the plant maturity, the concentration of digestible components, as soluble carbohydrates, proteins, minerals, and other cell subjects, tend to decrease, and lignin proportion, cellulose, hemicelluloses, and other indigestible parts increase (MINSON, 1990). According to SANTOS (2000) and FAO (2001), oat hydroponics forage presents IVDMD of 74.90 to 81.60 %, respectively, near values to the obtained ones in the forth and eighth day of harvest.

CONCLUSIONS

The production of wheat hydroponics forage from organic solution of bovine vermicompost present advantages not only from the nutritional but also environmental point of view. The greatest nutritional quality is due to low level of NDF and greater substances of crude protein and soluble protein, when compared to forage produced with inorganic solution. Besides, it allows the use of a residue created in the property, decreasing ambient pollution and the production cost of nutritive solution.

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