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Effect of Addition of Two Levels of Urea on Nutritional Value of Molasses Treated Tomato Straw Silage

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Abstract

The aim of this study was to determine the nutritive value of tomato straw ensiled for one month with two levels of urea and level of molasses, 0.0% urea +5%molasses (control), 3% urea +5%molasses, and 6% urea +5%molasses. Chemical composition of all treatments was determined by laboratory analysis; an in vitro two stages digestibility was carried out and physical character of the silage have been measured. The data was subjected to analysis of variance using complete randomized design (CRD). The study showed that the final pH was decreased and temperature were increased not significantly ($p>0.05$) while crude protein was increased significantly ($p<0.05$) with increase level of urea and due to incubation from 9.8%, 14.21% and 19.3% in the control, 3% and 6% urea after fermentation respectively. While crude fiber, neutral detergent fiber and acid detergent fiber were decreased significantly ($p<0.05$), acid detergent lignin slightly decreased. The in vitro dry matter, organic matter, crude protein and neutral detergent fiber digestibility were improved significantly ($p<0.05$) by addition of urea and fermentation. This study concluded that the addition of urea and fermentation improve the nutritive value of tomato straw silages in terms of high protein, low fiber contents and increased digestibility and recommended addition of different levels of molasses and urea in straws silage to improve digestibility.

Key words: Tomato, straw silage, urea

المستخلص

الهدف من هذه الدراسة هو تحديد القيمة الغذائية لتبن الطماطم المسولج لشهر واحد مع مستويين من اليوريا ومستوى من المولاس، 0.0٪ يوريا + 5٪ مولاس (الكنترول) ، 3٪ يوريا + 5٪ مولاس و 6 ٪ يوريا + 5٪ مولاس. حدد التركيب الكيميائي لجميع المعاملات بواسطة التحليل المختبري، أجري في المختبر الهضم في مرحلتين والخواص الفيزيائية للسيلاج و قيست. البيانات تم تحليلها بواسطة التصميم الكامل العشوائية (CRD). أظهرت الدراسة أن درجة الحموضة النهائية إنخفضت و زادت درجة الحرارة غير معنويا (P>0.05)، البروتين الخام إزداد معنوياً (P <0.05) مع زيادة مستوى اليوريا وبسبب التحضين من 9.8٪ ، 14.21٪ و 19.3٪ في الكنترول، 3٪ و 6٪ يوريا بعد التخمير على التوالي. بينما الألياف الخام، ألياف المنظفات المتعادلة و ألياف المنظفات الحمضية إنخفضت معنوياً (P<0.05) و اللجنين إنخفض غير معنوياً(P>0.05) هضم المادة الجافة، هضم المادة العضوية،هضم البروتين الخام و هضم ألياف المنظفات المتعادلة والحمضية تحسن معنوياً (P<0.05) عن طريق إضافة اليوريا والتخمير. خلصت الدراسة الى أن إضافة اليوريا والتخمير تحسن القيمة الغذائية من حيث نسبة البروتين العالية، محتويات الألياف المنخفضة وزيادة هضم سيلاج تبن الطماطم لذا نوصي باستخدام مستويات مختلفه من اليوريا والمولاس في سيلاج الاتبان لتحسين عملية الهضم للحيوان.

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Introduction

Agriculture plays a significant role in the world to feed the growing human population. Therefore, land for crop production will be used more intensively for human food production and consequently animal production will rely on feeding the by-products from the food produced for human consumption. This especially will be the case for rapidly growing economies in several parts of tropical region, also the increasing demand for meat and milk at a high rate. Thus, many countries in this area urgently need to increase their livestock production**.**

The feed resources for animals (cattle and other ruminants) in the tropical regions include mainly native plants, fodder trees, farm by-products (leaves and stems except for food use, straws, grains, bran's, etc.), food processing by-products (cassava meal, soybean curd residue, brewery spent grains, molasses, etc.) Siichi *et al*. (2005). Feed is the major input for livestock production and make over 70% of the cost. Livestock in the Sudan is estimated at 140 million head (60 million animal unit); proper investment in the huge animal wealth requires about 213 million tons of feed dry matter, whereas what is available from all resources e.g range, cereal, green forage and agro- industrial by –product is estimated at only 103 tons (Elkhidir, 2014).

Chemical treatment of crop residues with various alkalis, ammonia (NH3) compounds, Peroxides and other chemicals has increased digestibility and animal performance Sarwar *et al*. (2004). Among various chemicals, urea is the best for chemical treatment and helped in fixing urea-N in fiber for maximum microbial protein production (Sarwar *et al*., 2004). Hadjitanayiotou *et al*.(1993). Residues generally in the form of straws are receiving considerable attention due to scarcity of green fodder. However, efficient utilization of these crop residues by ruminants is hardly possible because these are high in fiber and low in protein. Thus effective and economical sources of energy and nitrogen (N) are needed to supplements low quality roughages diets for ruminants. Oil seed meals and cereal grains are effective supplements, but are very expensive and our farmers' community cannot afford the use of these feed ingredients in ruminant diets. This study was conducted with the following objectives:

1- To evaluate the nutritive value of tomato straw.

In semi – arid regions the major constraint to livestock productions low fodder availability, forage forms the basis of most ruminant ration, where its nutritional value is eventually improved by conservation through ensilage using simple technology. Silage widely used in ruminant nutrition for beef and dairy production, as a component of mixed diets due to its relatively low price. Nutritional value of silage depends upon the species and stage of growth of the harvested crop, it also depends on the changes resulting from the activities of plant enzymes, micro- organisms during the harvesting and storage period and upon the type of additives used to improve silage quality Lindgren *et al*. (1985), Muck (1993).

Tomato (*Solanum lycopersicum*) is one of the most widely cultivated vegetable crops in Mediterranean countries. Dried tomato has been fed to dairy cows and sheep (Weiss *et al*., 1997).

Molasses has been used as a fermentation stimulant for many years and recently there has been a renewed interest in it use. Molasses provides a relatively cheap source of fermentable carbohydrates for lactic acid bacteria, molasses in numerous silage experiments has been proven to be an effective silage additives in terms in promoting, reducing silage pH, discouraging clostridia fermentation and proteolysis and generally decreasing organic matter losses (Mc Donald *et al*., 1995).

2- To study the effects of addition of two levels of urea on the nutritive value of molasses treated tomato straw silage.

Materials and Methods

Study area:

The practical work of the present study was carried out at the laboratory of Animal Nutrition, Faculty of Animal Production University of Khartoum Shambat, from 24th February to 25th March 2014.

Preparation of silage:

Tomato straw of the end season production wilted from 76% to 60% moisture, chopped to lengths of 2-4 cm, then divided in to three groups (T1, T2 and T3) of 2.614 kg weight each.

Silage making:

Tomato straw in the three groups was treated with molasses 5% and two levels of urea 0.0%, 3% and 6% urea were applied for group one (T1), group two (T2) and group three (T3), respectively. The straw was then packed under a good compression to reduce the air in the silo which were rapidly closed, the silos (8 Jars) for each group were then stored under the room temperature for 30 days.

Initial and final pH and temperature were measured; the data for color, smell and texture were collected by questionnaire in the last day according to BAPH, (1996). In vitro two stages digestibility was carried out using method of Tilley and Terry (1963).

Laboratory Analysis:

Proximate analysis for treatments before and after ensiling for organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen free extract (NFE), moisture and ash were determined by the procedures of (AOAC, 1990). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined according to Van Soest *et al*. (1991). Lignin (lignin determined by solubilisation of cellulose) was determined using the method of Robertson and Van Soest (1981).

Statistical Analysis:

The data were subjected to analysis of variance using completely randomized design (CRD) according to Steel and Torrie (1996), the means were compared using least significant difference (LSD) between treatments.

Results

PH and temperature:

The lowest value (3.9) was recorded for T1 while the highest pH value was 5.49 for T2 (Table 1). Temperature as affected by addition of urea was shown in Table 2, there was no significant (p>0.05) differences in temperature between treatments. Temperature was ranged from 26.35 - 33.45c^0.

Colour, smell and texture:

Colour, smell and texture of tomato straw silage were shown in Table (3), the color was significantly (p<0.05) improved with addition of urea, the best colour green was observed in T3. The best smell (pleasant sweet) was detected in control T1 and T2; the bad smell was detected in T3, which was slightly acidulous.

The chemical composition of silage:

Crude fiber decreased significantly (p<0.05) with increase level of urea, the highest values 33.15% was recorded in T1 and the lowest values (24.25%) was in T3 after fermentation respectively (Table 4). In contrast, the crude protein content increased significantly (p<0.05) with increase level of urea, the highest value (19.3%) was showed in T3 and the lowest value (9.8%) was recorded in control T1, respectively after fermentation (Table 4).

NDF, ADF and ADL content were decreased significantly (p<0.05) with increase level of urea. The highest values 47.25%, 36.8% and 9.9% were recorded in T1 and lowest values (31%, 25.55% and 6.3%) were found in T3 after fermentation for NDF, ADF and ADL respectively (Table 4**)**. Similarly NFE content was decreased significantly (P<0.05) with increase level of urea from 36.4 to 29.84% in T1, T3 respectively (Table 4).

Table 1: Effect of different levels of urea on the pH of tomato straw silages

Treatments / Parameters	T1	T2	T3
Week 0	**6.07 ± 0.01^c**	**6.145 ± 0.01^b**	**6.185 ± 0.01^a**
Week 1	**4.5 ± 0.19^b**	**7.6 ± 0.19^a**	**8.24 ± 0.19^a**
Week 2	**4.07 ± 0.09^c**	**7.5 ± 0.09^b**	**8.1 ± 0.09^a**
Week 3	**3.86 ± 0.01^c**	**7.33 ± 0.01^b**	**8.025 ± 0.01^a**
Week 4	**3.905 ± 0.47**	**4.15 ± 0.47**	**5.49 ± 0.47**

a,b,c.:Means with different superscript within same row significantly differ (P<0.05).

T1: molasses 5% plus urea 0.0% (control) **T2**: molasses5% plus urea 3%, **T3**: molasses5% plus urea 6%.

Table2: Effect of different levels of urea on temperature of tomato straw silage

Treatments / Weeks	T1	T2	T3
Week 0	**27.4 ± 0.11^a**	**26.75 ± 0.11^b**	**26.35 ± 0.11^b**
Week 1	**32.5 ± 0.06^c**	**32.85 ± 0.06^b**	**33.2 ± 0.06^a**
Week 2	**33.45 ± 0.14**	**33.4 ± 0.14**	**33.2 ± 0.14**
Week 3	**30.65 ± 0.07**	**30.75 ± 0.07**	**30.5 ± 0.07**
Week4	**31.35 ± 0.09**	**31.4 ± 0.09**	**31.4 ± 0.09**

a,b,c**.** Means with different superscript within same rows significantly differ (P<0.05). T1: molasses 5% plus urea 0.0 % (control) T2: molasses5% plus urea 3% .T3: molasses5% plus urea 6%.

Table 3: Evaluation of color, smell, texture and acceptability of tomato straw silages as affected by different levels of urea

Treatments Parameters	T1	T2	T3
Colour	**Greenish yellow**	**Greenish**	**Green**
Smell	**Pleasant And sweet**	**Slightly acidulous**	**Ammonia smell**
Texture	**Loose and soft , non viscous**	**Loose and soft , non viscous**	**Loose and soft , non viscous**
Acceptability	**Very Acceptable**	**Very Acceptable**	**Acceptable**

Green yellow, Greenish and green: in general indicates good quality.
Smell: good (sweet, acids), satisfactory (light acidic).
Texture: the good texture (loose and soft, non viscous).
T1: molasses 5% plus urea 0.0 %(control).
T2: molasses5% plus urea 3% .T3: molasses5% plus urea 6%.

Table 4: Chemical composition (%) of tomato straw after fermentations and addition of different levels of urea

Treatments Parameters	T1	T2	T3
CP	**9.8 ± 0.13[c]**	**14.21 ±0.13[b]**	**19.3±0.13[a]**
CF	**33.15±2.56[a]**	**29.7 ± 2.56[b]**	**24.24±2.56[c]**
EE	**2.55 ± 0.91[b]**	**2.95 ± 0.91[ab]**	**2.97 ± 0.91[a]**
ASH	**16.0 ± 0.34**	**16.8 ± 0.34**	**17.2 ± 0.34**
NFE	**36.4 ± .63[a]**	**34.3 ±.63[a]**	**29.84±.63[b]**
NDF	**47.25±0.4[a]**	**38.5 ± 0.4[b]**	**31.0±0.4[c]**
ADF	**36.8 ± 1.75[a]**	**30.05±1.75[ab]**	**22.55±1.75[b]**
ADL	**9.9 ± 0.91**	**7.95 ± 0.91**	**6.3 ± 0.91**

CP: Crude protein, CF: Crude fiber, EE: Ether extract, NFE: Nitrogen free extract, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, ADL: Acid detergent lignin. T1: molasses 5% plus urea 0.0 %(control) T2: molasses5% plus urea 3% .T3: molasses5% plus urea 6%. a,b,c:Means with different superscript within same rows significantly differ (P<0.05).

Digestibility of tomato straw silage:

In-vitro Dry Matter Digestibility (DMD):

Dry matter digestibility (IVDMD), *in vitro* organic Matter Digestibility (IVOMD) and *in vitro* crude protein digestibility (IVCPD) were increased significantly ($p<0.05$) with increased level of urea, lowest values (70.83%, 58.65% and 76.85%) were observed in T1 and highest values (83.57%, 81.45% and 87.15%) were recorded inT3 for IVDMD, IVOMD and IVCPD, respectively (Table 5). Similarly in vitro neutral detergent fiber Digestibility (IVNDFD) in this study was increased significantly ($p<0.05$) with increase level of urea. The highest value (68.65%) was found in T3 and the lowest value (61.6%) was recorded in T1 (Table 5).

Table 5: Effect of different levels of urea (%) on DM, OM, CP and NDF digestibility's of tomato straw silage

Treatments Parameters	T1	T2	T3
DMD	**70.83± 0.69[c]**	**78.28± 0.69[b]**	**83.57± 0.69[a]**
OMD	**58.65± 2.25[b]**	**75.05± 2.25[a]**	**81.45± 2.25[a]**
CPD	**76.85± 0.09[c]**	**83.75± 0.09[b]**	**87.15± 0.09[a]**
NDFD	**61.6± 0.71[b]**	**65.9± 0.71[a]**	**68.65± 0.71[a]**

DMD: Dry matter Digestibility, OMD: Organic matter Digestibility CPD: Crude protein Digestibility, NDFD: Neutral Detergent fiber Digestibility
a,b,c..:Means with different superscript within same column significantly differ (P<0.05).
T1: molasses 5% plus urea 0.0 %(control)
T2: molasses5% plus urea 3% .T3: molasses5% plus urea 6%.

Discussion and Conclusion

The drop in pH values of tomato straw silage was attributed to improved activity of lactic acid producing bacteria and discourages the clostridia. This agree with Mc Donald *et al*. (1991) and Abraghoei *et al*. (2011).

Generally the temperature was increased from 27.4, 26.75 and 26.35c^0 to 31.35, 31.4 and 31.4c^0 in T1,T2 and T3 respectively, because the greater effect of the urea treatment at high temperatures may also be related to increased urea activity, as the optimum temperature of this enzyme's activity in the silo in 30c^o , which his agree with Du Preez (1983).

The colour was improved with addition of molasses and urea because molasses encourages activity of lactic acid bacteria and drops the pH value. The smell was decreased with increase level of urea and molasses, the less smell in T3 was slightly acidulous, this supported by BAPH (1996). Crude protein was increased in tomato silage due to addition of molasses and increase level of urea in tomato straw ensiling to improve or increase nitrogen content. This agree with Saadullah *et al*. (1981). Also the decrease in crude fiber, NFE, NDF, and ADF supported by Gohl.(1981).

Crude fiber decreased with increase level of urea due to increasing cell wall porosity, which makes polysaccharides more available to enzymatic hydrolysis, this agree with Kiangi *et al*. (1981). Also ash was improved and this result supported Nog and Hans. (1999) due to the high ash content in molasses (7.0 -11%).

The lower NDF and ADF in ensiled tomato straw was probably due to increased silage fermentation caused by the sugars in molasses, cell wall degradation by cellulytic clostridia or acid hydrolysis of fiber and the lower ADF, NDF content of the additives. This agree with Mc Donald *et al*. (1991) and Bay tock *et al.* (2005).

The molasses urea mixed silages had lower lignin was probably due to the lower lignin content of molasses, because lignin is relatively stable to hydrolysis during silo fermentation (Mc Donald *et al* ., 1991).

The estimated parameters of two stages digestibility in this study showed that the digestibility for nutrients increased with addition of molasses and increase of level urea. The NDF digestibility was increased because the treatment of straw with urea increases its nutritional value by making cellulose more available to the cellulolytic bacteria in the rumen Silva and Ørskov (1988).

The digestibility of dry matter was increased with increasing level of urea. This was consistent with opinion of Lang (1991). The increase of dry matter digestibility on each additional level of urea along with decreasing content of lignin in tomato straw silage. The nutrients were soluble rapidly digested by microbes (able to lose the lignocelluloses bonds to be easily digested and was able to supply nitrogen for the growth of rumen microbes).

Increasing digestibility of organic matter was also because increasing of digestibility of dry matter. The organic matter was part of the dry matter components, which would result in increasing digestibility of crude protein and crude fiber. Increasing the digestibility of organic matter was also caused by a decreasing in lignin content of tomato straw silage so it was easier for microbes to digest feed nutrients. This was consistent with the opinion of Maynard and Loosely (1979) that lignin was a limiting factor of degradation of feed nutrient. Digestibility of crude protein in this study was increased significantly ($p<0.05$) with addition of molasses and increasing level of urea due to increased protein content from the nitrogen of urea and decreased tannins because urea can break tannin-protein bond in tomato straw silage Ortiz *et al*. (1993).

In conclusion ensiling of tomato straw could be used as a mean of preserving it at the addition of urea plus molasses to tomato straw silages. Harvested at the ended stage of production seasons, improved the chemical composition content of straws after fermentation and have positive effects on silage nutritional values by increasing nutrients digestibility level of OMD, CPD, NDFD and DMD. Hence it was recommended ensiling of tomato straw as a mean of preservation and improvement of its nutritive value. It is also recommended adding molasses and/ or urea (at different levels) to improve the quality of silage.

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