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Conservación de desperdicio de tomate mediante ensilaje

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PRESERVATION OF FRESH TOMATO WASTE BY SILAGE

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SUMMARY

A study was conducted to conserve fresh tomato wasted by agroindustry through silage. Tomato was mixed with 1 of 4 additives (3% of additive, DM basis): cane molasses (M), brews yeast (Y), a mix 1:1 of M and Y (M:Y), or no additive (C). After a 140 days period of silage, pH and chemical composition of silages were measured. The pH was greater (P<0.05) in C followed by Y, M:Y and M, but all treatments observed suitable pH levels to sustain silage conditions. The dry matter, ash, ether extract, neutral detergent fiber and acid detergent fiber contents were similar (P>0.05) among treatments; however, crude protein content was greater (P<0.05) in Y and M:Y treatments. It is concluded that fresh tomato can be ensiled for 140 days preserving its chemical composition even without the use of additives, but addition of brewer's yeast with or without cane molasses improves the crude protein content of the silage.

CONSERVACIÓN DE DESPERDICIO DE TOMATE MEDIANTE ENSILAJE

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RESUMEN

Este estudio fue conducido a fin de conservar el desperdicio de tomate de la agroindustria mediante ensilaje. Se mezclaron tomates con 1 de 4 aditivos (3% de aditivo en base a MS): melaza de caña (M), levadura de cervecería (Y), una mezcla 1:1 de M e Y (M:Y), o sin aditivos (C). Después de 140 días de ensilaje, el pH y la composición química de los ensilajes fueron evaluados. El pH fue mayor (P<0,05) en C, seguidos por Y, M:Y y M, pero en todos los tratamientos se observaron niveles de pH adecuados para mantener las condiciones de ensilaje. Los contenidos de materia seca, cenizas, extracto etéreo, fibra detergente neutra y fibra detergente ácida fueron similares (P>0,05) entre los tratamientos; sin embargo, el contenido de proteína cruda fue mayor (P<0,05) en los tratamientos M:Y e Y. Se concluye que el tomate fresco puede ser ensilado durante 140 días conservando su composición química aun sin el uso de aditivos; sin embargo, la adición de levadura de cervecería con o sin melaza de caña mejora el contenido de proteína cruda del ensilaje.

Introduction

Tomato originated in South America, but it is considered to have been domesticated in Mexico (Pickersgill, 2007). It is one of the main vegetable crps cultivated in the world, with a global production of 159×106ton in 2011, 44% more than was produced in 2000 (FAOSTAT, 2013).

Tomatoes are consumed in fresh form, and a minor proportion is used in processed products such as juice, paste, sauce, ketchup and others (Peralta and Spooner, 2007). However, more than 10% of the total production does not meet consumer requirements, resulting in post-harvest waste (Geisman, 1981). The percentage of waste could be greater in regions where a tomato processing industry is not present, when tomato is produced in open field, or when greenhouse tomatoes are exported and more products is discarded (Riggi and Avola, 2010). Some byproducts have a high level of humidity and are therefore frequently dried before being stored or transported; nevertheless, due to environmental concerns and the additional expenses from fuel cost for drying, the use of wet byproducts is becoming popular among farmers. Moist feed are usually perishable due to aerobic decay, which produces nutrient loss and contamination with microorganism and their toxins. Thus, fermentation is an option for storage of wet byproducts.

All of these situations occurs in the central region of Mexico, therefore high amounts of tomato is available and could be used as animal feed. Thus, the aim of the study was evaluate the preservation of fresh tomato waste by silage

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CONSERVAÇÃO DE RESÍDUOS DE TOMATE MEDIANTE ENSILAGEM

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RESUMO

Este estudo foi conduzido com a finalidade de conservar o resíduo de tomate da agroindústria através da ensilagem. Se misturaram tomates com 1 de 4 aditivos (3% de aditivo em base a MS): melaço de cana (M), levedura de cerveja (Y), uma mistura 1:1 de M e Y (M:Y), ou sem aditivos (C). Depois de 140 dias de ensilagem, o pH e a composição química das ensilagens foram avaliados. O pH foi maior (P<0,05) em C, seguidos por Y, M:Y e M, mas em todos os tratamentos foram observados níveis de pH adequados para manter as condições de ensilagem. Os conteúdos de matéria seca, cinzas, extrato etéreo, fibra detergente neutra e fibra detergente ácida foram similares (P>0,05) entre os tratamentos; no entanto, o conteúdo de proteína crua foi maior (P<0,05) nos tratamentos M:Y e Y. Conclui-se que o tomate fresco pode ser ensilado durante 140 dias conservando sua composição química, ainda sem o uso de aditivos; no entanto, a adição de levedura de cerveja com ou sem melaço de cana melhora o conteúdo de proteína crua da ensilagem.

Materials and Methods

Tomato collection site

Discarded tomatoes (*Solanum lycopersicum L.* var. Saladette) were collected from selection line in an open field production in Zacatecas. Altitude varies from 1950 to 2400masl, average temperature is 14 to 19 ºC, and annual rainfall is 375 to 430 mm (INIFAP, 2013).

Approximately 400kg of discarded tomatoes were collected on selection lines, transported to the experimental site, stored under roofed facilities with sloped concrete floor, and covered with plastic for 5 days. Then, 240kg were divided into 4 portions of 60kg each. Each portion was mixed (3% on DM basis) with one of four additives (treatments): cane molasses (M), brewest yeast (Y), a mix 1:1 of M and Y (M:Y), or no additive (C). Mixed samples were placed into PVC microsilage containers of 7.5cm diameter and 50cm long. Twenty PVC containers by treatment were filled and compacted to remove accumulated air, sealed with plastic and identified.

In 10 containers per treatment, pH was measured every 7 days during the initial 28 days, and then every 14 days until completing 140 days of silage. At the end of each of the silage periods the containers were opened to measure pH and to withdraw the contents. At days 0, 70 and 140, the content of three containers per treatment was dried in a forced air oven at 65°C for 60h. Dried samples were ground in a Wiley mill with a 2mm mesh (Thomas Scientific, Swedesboro, NJ, USA) and stored in plastic bags for further chemical analyses. Dry matter (DM), ash, crude protein (CP), ether extract (EE), neutral detergent fibre (NDF), and acid detergent fibre (ADF) were determined using the AOAC (2006) methods.

Statistical analysis

Data were analyzed by two-way analyses of variance using the GLM procedure of SAS (2000), with additive and silage period as independent variables. Means were separated by means of the Tukey multiple range test at P<0.05.

Results and Discussion

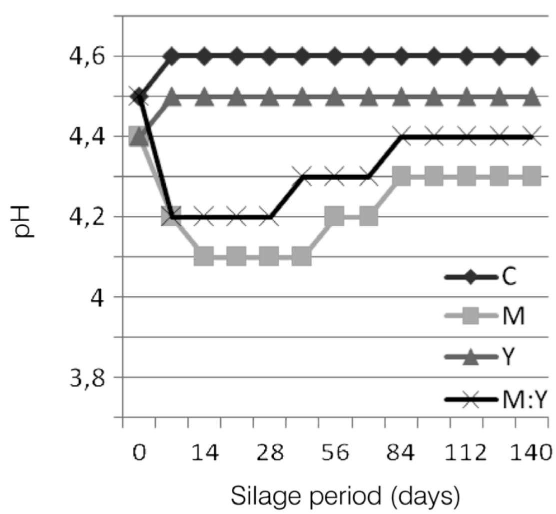

Figure 1. pH of tomato silage added with 5% of cane molasses on DM basis (M), 5% of brewer´s yeast on DM basis (Y), or a mixture of both (M:Y). C: control, tomato silage without additives.

The pH of the silage with the different additives is shown in Figure 1. It presented differences (P<0.01), with higher pH values for C (4.6) and Y (4.5), followed by the M:Y, (4.3) and M (4.2) treatments. Addition of molasses decreased pH, which is in agreement with other studies (Evers and Carroll, 1998; Islam *et al*., 2001; Abarghoei *et al.,* 2011). The pH in C and Y treatments was sustained form the 7 days post silage; however, the M and M:Y treatments showed the lowest pH values from 7 to 28 days in the M:Y treatment and from 14 to 42 days in M. Thereafter a slight increment and stabilization of the pH value after 84 days was observed.

All the pH values obtained during the trial were within the optimal range for silages (Rooke and Hatfield, 2003). Megias *et al.* (2008), in a whole tomato silage, obtained a lower pH average (mean of 4.1) compared with this study (4.4). Yusufu *et al.* (2009) ensiled tomato pomace and corn stalks during 60 days and reported that the pH decreased as the fermentation period was longer. However, Hadjipanayiotou (1994) reported a higher pH in tomato pulp (5.0) as compared with fresh tomato (4.2) after ensiling during 60 days; moreover, the addition of poultry litter or wheat straw did not reduce the pH. For their part, Ziaei and Molaei (2010) reported a pH of 4.5 when they added 5 or 10% (as feed basis) of wheat straw in a tomato paste silage during 90 days. Weiss *et al.* (1997), upon addition of 6 or 12% (DM basis) of tomato pomace to a corn plant silage, reported similar pH as in tomato silage during the initial 3 d and after 56 days of silage.

The chemical composition of the tomato silages is shown in Table I. Brewer´s yeast addition (Y) increased CP content (P<0.01) in relation to C treatment (23.1% *vs* 21.9%, respectively), which agrees with Hadjipanayiotou (1994), who added 10% of poultry litter or straw in tomato pulp silage and reported greater CP in the poultry littler treatment (23.3%) compared with the control (21.6%) or straw (15.4%) treatments. Furthermore, Ziaei and Molaei (2010) ensiled wheat straw with tomato pomace and observed a decrease (P<0.05) in the CP content of 20.5, 13.7 and 6.1%, when the straw proportion was at levels of 0, 5 and 10%, respectively.

In the present experiment the chemical composition was simi-

TABLE I
CHEMICAL COMPOSITION OF TOMATO SILAGE AT DIFFERENT SILAGE PERIODS AND ADDITIVES

	Silage period (days)				SEM
	0	14	70	140	
Dry matter, %	25.0	24.0	24.0	24.0	1.4
Ash, %	10.4	10.5	10.5	10.5	0.6
Crude protein, %	22.4	22.2	22	21.9	0.3
Ether extract, %	3.8	3.8	3.9	3.8	0.2
Neutral detergent fiber, %	22.4	22.4	22.2	22.5	0.6
Acid detergent fiber, %	14.2	14.2	14.4	14.4	0.4
	Additive				
	C	M	Y	M:Y	SEM
Dry matter, %	24.0	23.0	24.0	24.0	0.8
Ash, %	10.5	11.2	10.8	10.9	0.4
Crude protein, %	21.9 y	23.1 x	23.2 x	23.1 x	0.2
Ether extract, %	3.8	3.7	3.7	3.8	0.1
Neutral detergent fiber, %	22.5	21.5	22.5	21.8	0.6
Acid detergent fiber, %	14.4	13.8	14.2	14.3	0.3

SEM: standard error of the mean; C: control, tomato silage without additives; M: tomato silage added with 5% of cane molasses on DM basis; Y: tomato silage added with 5% of brewer´s yeast on DM basis; M:Y: tomato silage added with 5% of cane molasses and 5% of brewer's yeast on DM basis; x, y: different letters among rows indicate significant differences (P<0.05).

lar (P>0.05) across the silage periods (Table I), which contrasts with the results reported by Megias *et al.* (2008), who added formic acid, salt or beet pulp in tomato silages and observed greater DM and CP levels after 30 days. In addition, Yusufu *et al.* (2009) mention that CP and ADF increased (P<0.05) as fermentation time was prolonged in a tomato pomace and corn stalk mix ensiled during 60 days. Hadjipanayiotou (1994) fermented tomato pulp without additives during 60 days and reported a larger CP level for silage (24.2%) as compared with the fresh one (21.6%). He also reported a lower (P<0.05) DM content after ensiling (20.7% in fresh *vs* 17.2% in the silage). Horticulture byproducts generate high quantity of effluents during silage because of their high water content, which may increase the dry matter concentration (Martinez-Teruel *et al.,* 2007). In this study the PVC microsilage containers were sealed and therefore no effluents were lost during the process.

Conclusions

Fresh tomato can be ensiled for 140 days preserving its chemical composition even without the use of additives, but addition of brewer´s yeast with or without cane molasses improves the CP content of the silage.

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