Effect of addition of different levels of commercial inoculant of lactic acid bacteria and date juice on nutritive value of wheat straw silages

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Abstract

This study was conducted in the laboratory by preparing 60 samples (400-500 g, 5 replicates) of wheat straw silage to investigate the effect of addition of commercial inoculant of lactic acid bacteria at levels of 0, 1×10^5 and 1×10^6 cfu/g fresh matter date juice (debis) at levels 4, 6, 8 and 10%, at ensiling time on nutritive value of wheat straw. Therefore 12 different solutions were prepared to treat straw by mixing diluted date juice, urea at level of 1% and the bacterial inoculant. Results showed that addition of inoculant and increasing its level from 0, 1×10^5 and 1×10^6 cfu/g fresh matter increased ($P<0.01$) Fleig points from 42.72 to 74.01 and 104.51 points respectively. Significant ($P<0.01$) increase was also observed in in vitro digestibility of dry matter (IVDMD) from 41.38 to 45.03 and 50.03%, and organic matter (IVOMD) from 43.86 to 47.65 and 52.62% respectively. Higher ($P<0.01$) buffering capacity was associated with high level of inoculant at which aerobic stability of silage samples was decreased ($P<0.01$) to 63.20 hours. Results also showed that increasing level of date juice to 10% increased ($P<0.01$) Fleig points to 82.59 points, aerobic stability to 79.33 hours. Higher ($P<0.01$) IVDMD and IVOMD were achieved with higher levels of date juice. Characteristics of quality were also significantly ($P<0.01$) affected by the interaction between levels of inoculant and date juice.

Key word: Wheat straw, LAB inoculant, ensiling, urea

تأثير اضافة مستويات مختلفة من اللقاح التجاري لبكتيريا حامض اللاكتيك وعصير التمر في القيمة الغذائية لسايلج تبن الحنطة

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الملخص

اجريت الدراسة في المختبر بتصنيع 60 نموذج لسايلج تبن الحنطة (400-500 غم، 5 مكررات) للتحري عن تأثير اضافة اللقاح التجاري لبكتيريا حامض اللاكتيك بمستوى 0 و 1×10^5 و 1×10^6 وحدة مكونة للمستعمرات/غم مادة رطبة وعصير التمر (دبس) بمستوى 4 و 6 و 8 و 10%عند السيلجة في القيمة الغذائية لتبن الحنطة. لذلك فقد تم تحضير 12 محلول مختلف لمعاملة التبن وذلك بتخفيف الدبس بمستوياته الاربعة بكمية مناسبة من الماء مع اضافة 1% من اليوريا اللقاح البكتيري وفقا لمستوياته الثلاثة المذكورة. اظهرت النتائج ان اضافة اللقاح البكتيري وزيادة مستواه من 1×10^5 الى 1×10^6 وحدة مكونة للمستعمرات/غم مادة رطبة ادت الى زيادة ($P<0.01$) قيمة فليغ من 42.72 الى 74.01 و 104.51 نقطة على التوالي. كما ادى ذلك ايضا الى حصول زيادة معنوية ($P<0.01$) في الهضم المختبري للمادة الجافة من 41.38 الى 45.03 و 50.03% وللمادة العضوية ايضا من 43.86 الى 47.65 و 52.62% على التوالي. وارتبطت أعلى ($P<0.01$) قيمة للقابلية الدارئة عند اضافة اللقاح البكتيري بمستواه المرتفع الذي تراجعت ($P<0.01$) عنده الثباتية الهوائية لنماذج السايلج الى 63.20 ساعة فقط. واظهرت النتائج ايضا ان زيادة مستوى عصير التمر الى 10% ادت الى حصول زيادة معنوية ($P<0.01$) في قيمة فليغ الى 82.59 نقطة والثباتية الهوائية الى 79.33 ساعة. اما الهضم المختبري للمادة الجافة والمادة العضوية فقد ارتبطت أعلى القيم ($P<0.01$) في النماذج المصنعة بإضافة المستويات المرتفعة من عصير التمر. كما تأثرت خصائص نوعية السايلج معنويا بالتداخل بين مستوى اللقاح وعصير التمر.

الكلمات المفتاحية: سايلج تبن الحنطة، الخصائص الحسية، بكتيريا حامض اللاكتيك، السكريات الذائبة

Introduction

Shortage of feed is restricting factor for rapid progress of animal production. Sakhawat (27) indicated that quality of animal products and its economic value are affected by production of healthy, good quality feed. Crops by product particularly straw are being the main feed utilized by ruminants due to the continuous decrease in the arable lands that can be planted with green forages and natural pastures. These materials are characterized with unsuitable chemical composition to maintain good feeding for ruminants due to high crude fiber (CF) and low crude protein (CP) contents (26). Attempts were performed to improve this chemical composition by degrading the complex carbohydrates contents to yield more water soluble carbohydrate (WSC) available for rumen microbes (25). Different physical, chemical and biological treatments were used to improve nutritive value (NV) of straws along with ensiling which though it was widely used as preservation method to provide feed throughout the year or at a shortage of good pastures, it may improves the palatability of the diet (24). Therefore, silage is used as a dietary main ingredient of good NV, especially in dairy cow diet in addition to reduce total cost by lowering concentrate ratio.

Ensiling depends on the activity of lactic acid bacteria (LAB) to convert WSC into organic acids, particularly lactic acid (LA) in anaerobic condition (5). As a result pH of ensiled materials will decrease and microbial deterioration will be controlled (14). Application of additives in ensiling may help improving fermentation responsible for producing good quality silage (21). Many additives were tested to enhance production of LA through stimulation of silage fermentation and rapid decrease in pH (12). Microbial and enzymatic additives in addition to sources of WSC may serves to secure this goal (18). Non protein nitrogen compounds as urea is also used to improve nitrogen (N) content of ensiled materials and to provide silage microbes with N (32). Therefore, this study was conducted to investigate the possibility of improving NV of ensiled wheat straw using different levels of date juice (DJ) as a source of WSC and commercial inoculant of LAB.

Materials and methods

Preparation of wheat straw silage

Samples of wheat straw silage (WSS) were prepared in the Nutrition laboratory of Animal Production Department-Agriculture College-Al-Qasim Green University. Wheat straw (WS) was manually chopped into small pieces of 1-1.5 cm and treated with solutions containing 0, 1×10^5 or 1×10^5 cfu/g fresh matter (FM) levels of (Ecosyl, 8×10^{10} cfu/g of *Lactobacillus plantarum*, MTD/1, NCIMB 40027) commercial LAB inoculant and 4, 6, 8 or 10% of DJ. Levels of LAB inoculant were within those recommended by manufacturer. Tap water was added to soak straw, reduce its dry matter (DM) content to about 30% and spreading of additives. Urea was added to all samples at 1% to increase N content. Except LAB other additives were used on DM basis. Treated materials were well mixed, packed in double plastic bags, compacted by hands to exclude air and tightly closed. Plastic bags were then stored in pit silos, covered with soils and kept for 60 days. At the end of ensiling period silos and bags were opened and samples were moved to laboratory to determine the characteristics of nutritive value. Chemical and microbial compositions of wheat straw were shown in table 1.

Silage quality

Quality characteristics of silage included DM loss, Fleig points (Fp), aerobic stability (AS), buffering capacity (BC) and in vitro digestibility of DM and OM. DM loss was estimated as a percentage of difference in DM content of wheat straw before and after ensiling. Fp points were calculated using equation adopted by Kilic (10); $Fp = 220+(2\times DM\% -15) - 40 \times pH)$, where, Fp denote the values between 80-100 very good; 60-80 good quality, 40-60 moderate quality; 25-40 satisfying and <25 worthless. The AS was determined as described by Levital, et. al., (11), where, 120 g of samples were thoroughly shaken to ensure air exposure and then packed loosely in 500 ml plastic containers.

Table 1- Chemical (% of DM) and microbial (CFU/g FM) composition of straw

Nutrients	Wheat straw, WS	Urea	date juice, DJ
DM	91.85	-	68.75
% in DM			
Ash	10.85	-	2.57
CP	1.73	287.5	2.20
EE	1.48	-	-
NDF	72.35	-	-
ADF	46.71	-	-
ADL	31.52	-	-
Cellulose	15.19		
Hemicellulose	25.64		
IVDMD	39.32		
IVOMD	41.20		
Epiphytic microorganisms (log^{10} cfu/g WM of straw)			
Total aerobic bacteria	7.25		
Total anaerobic bacteria	8.57		
Lactic acid bacteria	3		
Clostridia	2		
Yeasts	5.43		
Molds	5.4		

WS= Wheat straw; DJ= Date juice; 287.5= 46 × 6.25; DM=dry matter; CP=crude protein; EE= ether extract; NDF=neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin; IVDMD=*in vitro* dry matter digestibility; IVOMD= *in vitro* organic matter digestibility

These containers were enveloped with black plastic sheet double-layered cheesecloth covered the orifices to prevent drying and contaminations. Small holes were made on top of each container to permit air exchange. Thermometer was inserted inside silage mass. An additional container filled with water was used to measure ambient temperature. Temperature of silage was recorded every 30 min. The AS was defined as time required to raise silage temperature by 2C$^{\circ}$ above ambient temperature. The BC was determined as described by Playne and McDonald (22). Where, 20g fresh material and 250 ml of distilled water were mixed together for 2 min using electric mixer with stop every 20 sec. The pH of the mixture was recorded. Then the supernatant was titrated first to pH 3 with 0·1 N HCl in order to release bicarbonate as carbon dioxide (R_1), and then was titrated to pH 6 with 0·l N NaOH (R_2). The BC was expressed as meq of alkali required to change the pH from 4 to 6 per 100 g of DM, after correction for the titration value of a 250 ml water blank.

BC (meq. NaOH/100g DM) = 390 /(R2-R1) × DM% of sample.

In vitro digestibility of DM and OM (IVDMD, IVOMD) of fresh wheat straw and silage samples were determined as described by Tilley and Terry (31). In this method, rumen of sheep was brought about from slaughterhouse and transferred immediately to the lab to maintain vitality of rumen microbes. Rumen fluid was filtered through double layers of cheese cloth and 0.5 g of samples were incubated with 10 ml of rumen fluid and 40 ml of artificial saliva for 48 h in a water bath (38 C°), CO_2 was injected twice a day. At the end of incubation contents were filtered and residues were dried at 105 C° for 24 h. Dried residues were weighed and combusted at 500 C° for 4 h. IVDMD and IVOMD were estimated using the following equations:

$$\text{IVDMD} = \frac{\text{DM sample – DM residue sample - DM residue blank}}{\text{DM sample}} \times 100$$

$$\text{IVOMD} = \frac{\text{OM sample – OM residue sample - OM residue blank}}{\text{OM sample}} \times 100$$

Data obtained were statistically analyzed as a 3 ×4 factorial experiment in completely randomized design using SAS (29).

Results and discussion

Characteristics of quality and nutritive value of silages

Table 2 shows the effect of levels of LAB inoculant (Ecocyl) and DJ (WSC) added at ensiling on characteristics of quality and nutritive value of silages. Results revealed that all these characteristics with exception of DM loss were significantly (P<0.01) affected by increasing level of inoculant. As shown Fp which represent according to Yilmaz and Gürsoy (35) numerical criteria for silage quality, adopted ascending trend (P<0.01) from 42.72 to 74.01 and 104.51 points for WSS prepared without and with addition of LAB inoculant at levels of $1×10^5$ and $1×10^6$ cfu/g FM respectively. Li and Cai (12) attained similar increase in Fp of rice straw silage due to addition of inoculant based on homofermentative LAB at level of $1×10^5$ cfu/g FM, mean values were 62.6 as compared with 47.3 for samples of silage prepared without addition of inoculant.

This significant increase in Fp may be due to effect of addition of inoculant on pH which is considered one of main fractions of the equation according to which Fp was estimated. LAB bacteria control silage fermentation and produce large quantity of LA which in turn reduce pH.

Increasing level of LAB inoculant increased BC, but the significant effect (P<0.01) was limited to $1×10^6$ cfu/g FM, mean values were 86.88, 90.32 and 112.84 meq NaOH/100 g DM for 0, $1×10^5$ and $1×10^6$ cfu/g FM levels respectively. BC reflects the resistance against changes in pH (28). Playne and McDonald (22) reported that the compounds of high BC are more resistant to reduction in the pH and the organic acids salts are responsible for most of the buffering effect in herbages and silages. Accordingly, higher BC values in samples of WSS prepared with addition of LAB inoculant at level of $1×10^5$ cfu/g FM as compared with those prepared without addition of inoculant in a current study can be explained by breakdown of cations produced by the breakdown of organic acids formed during ensiling, the cations would have to be neutralized by fermentation acids, such as lactic or acetic acids resulting in little change in BC. However, higher level of inoculant ($1×10^6$ cfu/g FM) increased the final value of BC due to excess cations associated with the probable increase in production of organic acids and its breakdown.

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Table 2- Effect of levels of LAB inoculant and date juice on quality characteristics and nutritive value of wheat straw silage (as appeared in the table ± SE)

Items	Level of inoculant cfu/g FM			Level of date juice (%)				*P*	
	0	1×10^5	1×10^6	4	6	8	10	LAB	DJ
DM loss, %	2.39 0.33 ±	3.00 ± 0.34	2.71 ± 0.27	2.30 ± 0.42	2.98 0.32 ±	2.73 ± 0.41	2.79 0.31 ±	NS	NS
Fp, pts.	42.72[c] 2.38 ±	74.01[b] 0.89 ±	104.51[a] 4.82 ±	69.44[bc] ± 4.35	67.50[c] 6.20±	75.48[b] 8.62±	82.59[a] 9.69 ±	**	**
BC, meq NaOH/100 g DM	86.88[b] ± 1.31	90.32[b] 2.41 ±	112.84[a] 3.49 ±	94.00 3.13 ±	94.14 4.96 ±	97.20 2.09 ±	101.39 ± 5.68	**	NS
AS, h	83.87[b] 0.48 ±	86.56[a] 0.62 ±	63.20[c] 0.84 ±	76.50[b] ± 3.17	78.48[ab] 2.42 ±	77.20[b] 3.06 ±	79.33[a] ± 2.79	**	**
IVDMD, %	41.38[c] 0.29 ±	45.03[b] 0.94 ±	50.03[a] 0.94 ±	43.53[c] ± 1.27	44.39[bc] 1.13 ±	46.67[ab] 1.32 ±	47.31[a] 1.27 ±	**	**
IVOMD, %	43.86[c] 0.46 ±	47.65[b] 1.12 ±	52.62[a] 1.08 ±	44.60[b] ± 1.27	46.60[b] ± 1.20	49.63[a] ± 1.34	51.35[a] ± 1.29	**	**

FM, fresh matter
LAB, lactic acid bacteria
DJ, date juice
DM, dry matter
Fp, Fleig points; pts, points
BC, buffering capacity
AS, aerobic stability; h, hour
IVDMD, in vitro dry matter digestibility
IVOMD, in vitro organic matter digestibility
NS, non-significant
Means having different letters at the same row are significantly different at ** ($P<0.01$)

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Results also showed that AS was increased (P<0.01) in WSS samples by 2.69 h due to addition of the low level of homofermentative LAB inoculant. However, increasing that level decreased (P<0.01) AS by 20.67 and 23.36 h as compared with AS in WSS prepared without and with addition of inoculant at low level. This result is consistent with that obtained by Muck (16), where well preserved, good quality LAB inoculated silages are particularly more susceptible to aerobic deterioration as compared with uninoculated silages soon after the opening of silos. Similarly, Nkosi, et. al., (20) reported that inoculation of whole-crop sweet sorghum with homofermentative LAB (L. *plantarum*) inoculant decreased AS from 53 to 46 h. The difference between the current study and the later one may due to the type of ensiled materials.

The decrease in AS of WSS samples in a current study due to addition of the higher level of inoculant may due to the increase in LA production which is less stable when silage exposed to air (33). Moon (15) affirmed low AS of silage with high concentration of LA. McDonald, et. al., (14) pointed out that aerobic microorganisms attack the surface of silage and ferment LA produced during anaerobic fermentation to water and carbon dioxide resulting in higher pH which in turn stimulate growth and counts of aerobic microorganisms.

Results revealed significant ascending increase (P<0.01) in IVDMD of WSS as a result of addition of LAB inoculant and increasing its level. The increases were 3.65 and 8.65% in WSS samples inoculated with 1×10^5 and 1×10^6 cfu/g FM levels as compared with WSS samples prepared without inoculant. Cai, et. al., (2) observed an increase in IVDMD of rice straw silage due to addition of LAB at ensiling, this was attributed by those workers to the effect of LAB inoculant in decreasing DM loss during silage fermentation.

Muck and Kung (17) in a review of studies carried out to investigate the effect of microbial inoculation on nutritive value of silage, they found that inoculant improved IVDMD in 30% of these studies. In another study, it was noticed that inoculation of whole rice crop with L. *plantarum* at level of 1×10^5 cfu/g FM increased IVDMD from 42.2 to 44.8% reduced production of methane, and improved utilization efficiency of energy (3). Kamarloiy and Yansari (9) demonstrated that microbial inoculation significantly improved digestibility of DM and other nutrients together with reducing pH.

Results of a current study also revealed similar changes in IVOMD as the changes in IVDMD, where addition of LAB inoculant at levels of 1×10^5 and 1×10^6 cfu/g FM increased (P<0.01) IVOMD from 43.86 to 57.65 and 52.62% respectively. As the significant response of IVDMD to addition of inoculant and increasing its level, the significant response of IVOMD may be attributed to degradation of CF constituents. Li and Cai (12) observed that ensiling rice straw with L. *plantarum* inoculant at level of 1×10^5 cfu/g FM decreased NDF content, this positively reflected on IVOMD. Wu and Han (34) attributed the improvement in IVOMD of silage to the degradation of cell wall constituents.

Though there was a positive results obtained in a current study, other study reported that digestibility of good quality silage was not affected by addition of inoculant at ensiling, with limited improve (1.57%) in case of poor quality silage (8).

Regarding effect of level of DJ on nutritive value of WSS, table 2 shows that Fp was significantly increased (P<0.01) to 82.69 pts. due addition of DJ at level of 10% as compared with 75.48, 67.50 and 69.44 pts. for 8, 6 and 4% levels of that source of WSC, respectively. Since there is a close relation between silage fermentation and level of WSC, the significant increase in Fp can be explained by the effect of level of WSC on pH, a part of equation by which Fp values were estimated. Güler, et. al., (6) referred to the direct relation between Fp values and level of WSC added at ensiling.

Water soluble carbohydrates are the substrate for silage microorganisms, especially, LAB to produce large quantity of LA and dominate the fermentation leading to a rapid decrease in pH (1). Yilmaz and Gürsoy (35) clarified that addition of molasses improved silage fermentation and therefore, increased Fp.

Results also showed that AS of WSS samples prepared with addition of DJ at level of 10% was higher (P<0.01) than that recorded by other WSS samples. These samples resisted for 2.13 and 2.83 h higher than those prepared with DJ at levels of 4 and 8% respectively. Consistently, Saeed and Muhamad (23) observed a 2.34 h increase in AS of corn cobs silage as a result of increasing level of DJ added at ensiling from 4 to 6%, but inconsistently, no more increase in AS was achieved by increasing level of DJ to 8 and 10%.

The improvement in AS resulted from addition of higher level of DJ may be due to the probable higher consumption of the WSC contents in WSS samples prepared with addition of this level of DJ as compared with those prepared with other levels. As WSC is a substrate for the activity of molds and yeasts responsible for prevention silage stability (30).

Results of a current study clarified a gradual increase in IVDMD with increasing level of DJ added to WS at ensiling from 4 to 6, 8 and 10%, values were 43.53, 46.67, 44.39 and 47.31% respectively. As shown higher (P<0.01) IVDMD was achieved with higher levels of DJ. The higher IVDMD achieved with increasing levels of DJ may be attributed to the degradation of cell wall constituents of WS by stimulated bacterial activity resulted from gaining higher amounts of DJ as a substrate.

Saeed (26) reported that increasing levels of molasses added at ensiling of WS from 5 to 10% was associated with a decrease in CF content from 38.36 to 36.67%, attributing this to the fitting condition for silage microorganism to utilize N sources with existence of WSC usually added to ensiled materials, then the degradation of complex carbohydrates of straw can be secured.

Higher (P<0.01) IVOMD was recorded in WSS samples prepared with addition of 10% as compared with those prepared with 4, 6 and 8% levels of DJ, the differences in IVOMD were 6.75, 4.75 and 1.72% respectively. However, the significant improve was associated with the higher levels of DJ only. The improvement of IVOMD may be associated with the degradation rate of cell wall constituents resulted from increasing level of WSC and the decrease in the content of these fractions. Hall (7) illustrated that supplementation of roughages with increased amounts of WSC improved digestion of CF.

The positive effect of addition of WSC at ensiling of forages and crops residues became well known, Denek and Can (4) stated that addition of molasses stimulates silage fermentations leading to changes in chemical composition of ensiled materials, rate and extent of these fermentations are affected by type and level of WSC existed.

Worth mentioning, ensiling WS with different levels of LAB inoculant, 0, 1×10^5 and 1×10^6 cfu/g FM increased IVDMD of WS from 39.32 to 41.38, 45.03 and 50.03%. IVDMD was increased to 43.53, 33.39, 46.67 and 47.31% due to addition of DJ at levels of 4, 6, 8 and 10% respectively. Similar improvement in IVOMD of WSS samples as compared with IVOMD in WS before ensiling was also observed. These results enhance the conclusion that ensiling can be used with suitable additives to improve the nutritive value of wheat straw and other low quality roughages.

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Table 3- Effect of interaction between levels of LAB inoculant and date juice on quality characteristics and nutritive value of wheat straw silage (as appeared in the table ± SE)

ulant I	0				1×10^5				1×10^6				*P*
%	4	6	8	10	4	6	8	10	4	6	8	10	
	1.63^{ed} 0.30 ±	3.50^{abc} 0.50 ±	1.76^{cde} 0.75 ±	2.68^{abcde} 0.77 ±	1.38^{e} 0.14 ±	3.04^{abcde} 0.76 ±	4.14^{a} 0.64 ±	3.46^{abcd} ± 0.47	3.90^{ab} 0.88 ±	2.39^{abcde} 0.29 ±	2.31^{abcde} 0.29 ±	2.23^{bcde} 0.20 ±	**
	53.78^{e} 4.58 ±	37.46^{f} 2.74 ±	36.65^{f} 3.76 ±	43.00^{ef} 4.33 ±	71.94^{d} 1.41 ±	73.29^{d} ± 2.59	75.82^{d} 1.38 ±	74.98^{d} 1.47 ±	82.60^{cd} 8.36 ±	91.76^{c} ± 3.05	113.98^{b} ± 4.20	129.78^{a} 1.55 ±	**
OH/g	89.29^{de} 2.28 ±	78.89^{e} 1.11 ±	91.67^{de} 0.65 ±	87.69^{de} 1.58 ±	84.24^{e} 2.89 ±	85.57^{e} 5.19 ±	100.98^{cd} 5.63 ±	90.51^{de} 0.48 ±	108.48^{bc} 2.74 ±	117.95^{ab} 3.44 ±	98.96^{cd} 1.43 ±	125.99^{a} 10.40 ±	**
	84.75^{bc} 1.11 ±	83.75^{bc} 1.31 ±	82.75^{c} 0.66 ±	84.25^{bc} 0.66 ±	84.75^{bc} 0.85 ±	85.50^{abc} 1.62 ±	87.25^{ab} 0.91 ±	88.75^{a} 0.85 ±	60.00^{e} 1.44 ±	66.20^{d} 0.48 ±	61.60^{e} 1.96 ±	65.00^{d} 1.00 ±	*
	40.81 0.63 ±	40.92 0.37 ±	41.50 0.84 ±	42.28 0.19 ±	41.63 0.56 ±	42.99 1.46 ±	47.59 1.19 ±	47.92 2.36 ±	48.17 2.87 ±	49.26 1.33 ±	50.93 2.17 ±	51.74 0.33 ±	NS
	41.89 0.63 ±	42.82 0.42 ±	44.57 0.83 ±	46.17 0.26 ±	42.68 0.56 ±	45.12 1.43 ±	50.74 1.15 ±	52.04 2.34 ±	49.21 2.85 ±	51.86 1.38 ±	53.57 2.52 ±	55.84 0.32 ±	NS

FM, fresh matter
DJ, date juice
DM, dry matter
Fp, Fleig points; pts, points
BC, buffering capacity
AS, aerobic stability; h, hour
IVDMD, in vitro dry matter digestibility
IVOMD, in vitro organic matter digestibility
NS, non-significant
Means having different letters at the same row are significantly different at * ($P<0.05$), ** ($P<0.01$)

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Effect of the interaction between levels of inoculant and DJ on characteristics of quality and nutritive value of WSS are shown in Table 3. Results revealed that characteristics of quality were significantly (P<0.01) affected by this interaction. Higher DM loss of 4.14% was estimated in WSS prepared with addition of LAB inoculant at level of 1×10^5 cfu/g FM and 8% of DJ. This may be due to the effect of both main factors, higher DM loss was associated with the lower level of inoculant. Lower DM loss was estimated in WSS samples prepared without or with the lower level of inoculant and the DJ level of 4%, values were 1.38 and 1.63% respectively. Li and Cai (12) reported that DM loss was (P<0.01) increased due to treatment of silage with inoculant and glucose. Moreover, DM loss in silage can also be explained by the silage fermentations and respiration of undesirable silage microorganisms (14).

Results of a current study revealed that higher (P<0.01) Fp (139.78 pts.) was estimated in WSS samples prepared with addition of ALB inoculant at level of 1×10^6 cfu/g FM and 10% of DJ, whereas lower value (36.65 pts.) was estimated in those prepared without addition of inoculant and 8% level of DJ. The increase in Fp value may be due to the decrease in pH resulted from the increase in LA production. Li and Cai (12) obtained similar result in rice straw silage due to addition of inoculant and glucose, Fp values in their study were 98.7 and 43.3 pts. for the treated and untreated silages respectively. In a current study, the significant increase in Fp can be attributed to the effect of both inoculant and DJ on pH values.

Results also revealed that BC was increased (P<0.01) due to addition of LAB inoculant at level of 1×10^6 cfu/g FM and 10% of DJ to 125.99 meq NaOH/g DM. This increase can be explained by the breakdown of organic acids and WSC to CO_2 and water (19).

Regarding effect of interaction between levels of inoculant and DJ on AS, results showed that higher (P<0.05) AS was achieved by WSS samples prepared addition of LBA inoculant at level of 1×10^6 cfu/g FM and 10% of DJ, where, samples were resisted for 88.75 h before the existence of aerobic deterioration. This may be due to the stability of samples against microorganisms responsible for aerobic deterioration which its growth and activity may be stopped at these levels of additives. Aerobic deterioration usually begins with fermentation of substrates by yeasts to produce CO_2, water and heat (16). However, aerobic deterioration can be decreased noticeably in silages with high antifungal agents such as acetic and propionic acids (13).

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