The Effect of Addition Urea and Ensiling Period on The Quality and Chemical Composition of Wheat Straw Silages

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Abstract
An in vitro experiment is conducted to study the effect of adding urea (0, 1.5 and 3% on dry matter, DM basis) and period of ensiling (15, 30, 45 and 60 days) on the quality and chemical composition of wheat straw (WS) silages. All samples are treated with 10% of molasses.
Results have shown that the addition of urea at the lower rate alters the color of silages from yellow to greenish yellow with the appearance of fermented fruit odor in samples ensiled for 60 days, but doubling urea level alters the color to dark yellow and brown as the ensiling period is proceeded with the appearance of ammonia odor.
The estimated Fleig points decline due to increasing the level of urea, but the proceeding of ensiling period increases these points. pH of silages are increased ($P<0.01$) due to urea treatment but it decreases ($P<0.01$) due to proceeding of ensiling period.
Regarding the compositional changes, results have shown that the addition of urea decreases ($P<0.01$) crude fiber (CF) and nitrogen free extract (NFE) contents, but it increases ($P<0.01$) crude protein (CP) content. Proceeding ensiling period decreases ($P<0.01$) CF and increases CP ($P<0.05$) and NFE ($P<0.01$). Generally , better results are accomplished at the lower level of urea and 60 days of ensiling.

Key Word: Barley Straw, Silage, Ensiling Period, Urea, Molasses.

Introduction

Large quantities of straws are accumulated as a by-product for cereals cultivation. These materials characterize with inconvenient chemical composition and inefficiently use in ruminants feeding due to the high CF and CP content (Saeed, 2008). Different attempts are conducted to improve this composition to ensure providing animals with the majority of their requirements for energy and protein. These attempts are focused on creating desirable changes in chemical composition of straws by degradation the carbohydrate complexes often present leading to increase the ratio of readily carbohydrate available to rumen microbes, this in turn will enhance the utilization of nitrogen (N) sources to increase microbial protein yield. Consequently, improvement of nutritive value of straws may decrease the dependence on good quality diets and lessen the economic charge of feeding.
Chemical treatment of roughages reduced its palatability (Stanton and Wittler, 2006). Ensiling may

overcome this problem due preferred flavor of fermented materials (Nour, 1987). Urea and molasses are added at ensiling time to increase N content and supplying readily fermented energy to stimulate the desirable fermentation occurred during storage, respectively. Better results are obtained by addition of molasses to wheat straw at rate of 10% on dry matter (DM) basis (Saeed and Latif, 2007; Saeed, 2008). Changes occurred during silage fermentation may also be influenced by ensiling period; this effect may interacted with other factors.

Taking into consideration that low N and high fiber contents of roughages are the main limitations affecting nutritive value of such this feeds (Van Soest, et. al., 1991). The level of N added would be the most important interacted factors. In a matter of fact, this is the essential objective that the current study aims to investigate.

Materials and Method

36 samples of WS silage are prepared in the laboratory according to the method of plastic sacs (Saeed, 2008). Wheat straw is soaked with water to reduce DM content to about 40-50%. Urea is added as a source of N at 3 levels (0, 1.5 and 3%), molasses is added at rate of 10% for all samples, and both are added on DM basis. Silage samples are ensiled for 4 periods (15, 30, 45 and 60 days). Organoleptic characteristics including color and odor, pH values determined as described by Latif (1977) and Fleig points (FP) estimated according to Kilic (1984) equation are all performed to evaluate silage quality. Kilic equation was:

FP = 220+ (2×DM% -15) – 40 × pH, and according to this equation the following quality scores of silages and the corresponded range of values are pursued. Very good (85-100), good (60-80), medium (55-60), accepted (25-40) and bad quality (< 25).

Chemical analysis are performed according to AOAC (1997) including determination of DM by drying on 80 C° in electric oven for 18 hours, ash by burning samples on 400 C° in electric furnace for 4 hours, CP by Kjeldahl method, CF by extraction in tecator fibertec system, Ether extract (EE) by extraction in tecator sohxtec system, NFE by difference.

Data concerning pH and chemical composition of silage samples are statistically analyzed according to 3 ×4 factorial experiment procedure by SAS (2001) with 3 replicates for each sample, LSD method is used to test the significance of differences between means. Chemical composition of WS and additives used in the current study is presented in table 1.

Table 1. Chemical composition of wheat straw and additives.

Ingredient	DM%	% of DM				
		Ash	CP	CF	EE	NFE
WS	73.55	8.85	3.74	42.12	0.63	44.77
molasses	81.49	11.45	3.46	0.36	0.10	84.63
urea	–	–	6.25×45	–	–	–

Results and Discussion

1- Silage quality

Information concerning color and odor of different silage samples as well as pH and FP values are used to evaluate silage quality. Results revealed that the color of untreated WS silage (UWS) and that treated with low level (1.5%) of urea (LTWS) adopted similar trend of change from yellow in samples ensiled for 15 days to greenish yellow in samples ensiled for 60 days, the gradual change in color was clear in LTWS as compared to change in UWS. Change of silage color from yellow to greenish yellow after 60 days of ensiling was reported by Caluya (1995) in rice straw silage. The change in color of silage in a current study may be attributed to the mode and extent of fermentation occurred during ensiling which seemed to be more active and close to completeness when ensiling was proceeded to 60 days. Dolberg, et. al., (1981) indicated that fermentation of most silages occurs in accelerated rates then slow down till reaching quantitative stability at 45 days of ensiling.

Regarding color of WS silage treated with high level (3%) of urea (HTWS), change from yellow to greenish yellow was observed in samples ensiled for 30 days, whereas, samples ensiled for 45 and 60 days characterized with dark yellow and brown color respectively. Difference in the trend of color change in samples ensiled for 45 and 60 days of this silage as compared to that of LTWS which ensiled for the same periods may be attributed to the increase in level of addition of urea (1.5 vs. 3%) through its probable effect on fermentation occurred during ensiling. Salih (1983) demonstrated that the completeness of fermentative changes in wheat straw silage treated with urea and molasses are achieved after 60 days of ensiling.

Regarding odor, it was shown that wet straw-like odor was appeared in samples of UWS except that ensiled for 60 days which characterized with odor of fermented fruits. Similar odor was noticed in samples of LTWS ensiled for 45 days, but this odor was concentrated in samples ensiled for 60 days. Saeed (2008) observed the appearance of fermented fruits odor in samples of WS silages treated with urea at rate of 1.5% and molasses at rate of 10%, similar odor was also detected in his study when WS was ensiled with the mentioned rate of molasses only, both silages are ensiled for 60 days. The appearance of this odor can be

explained by the formation of organic acids as a result of anaerobic oxidation of organic matter of straw (Catchpool and Henzell, 1971). In samples of HTWS, odor of stink straw was appeared especially in those ensiled for 15 and 30 days, this may be attributed to the presence of ammonia produced from degradation of added urea (Sarwar, et. al., 2006). Partial utilization of ammonia by silage microbes as a source of N at the later periods (45 and 60 days) of ensiling may explain the difference in concentration of odor.

Regarding pH values, effect of addition of urea and ensiling period and interaction between them on these values are shown in table 2. Statistical analysis revealed that addition of urea increased these values significantly ($P<0.01$) by 0.45 and 1.23 for samples of LTWS and HTWS respectively.

This may be attributed to the accumulation of ammonia produced from degradation of urea during ensiling (Saeed, 2008). The difference in the increase of pH as mentioned above is a direct reflection to increase pH values due to increasing level of urea.

Regarding effect of ensiling period, a general trend to decrease pH values of silage samples as this period proceeded was observed. This may correlates with the sufficient period of anaerobic fermentation responsible for silage formation which originate after exhausting of Oxygen initially existed in the samples, where, organic acids particularly lactic and acetic acids are produced during this fermentation leading to reduce pH to the extent that blocks microbial activity and preserves silage, this will depend on the environmental temperature, silage components and ensiling conditions (Dolberg, et. al., 1981).

Table 2. Main effect of addition of urea, ensiling period and interaction between them on pH values of WS silages.

Level of urea (%)	Ensiling periods (day)				Main effect of urea (%)
	15	30	45	60	
0	6.34	5.68	5.31	5.15	5.62
1.5	7.09	6.23	5.63	5.32	6.07
3	8.09	6.88	6.32	6.10	6.85
Main effect of ensiling period (%)	7.18	6.26	5.75	5.52	

L.S.D.	urea	ensiling period	urea × ensiling period
0.05	0.31	0.27	0.15
0.01	0.42	0.36	0.21

Results of the current study indicated that ensiling for 30 and 45 days decreased pH significantly ($P<0.01$) with about 0.92 and 1.43 units respectively, as compared to that recorded in samples ensiled for 15 days. Continuation of a significant decrease in pH may refers to incompleteness of silage fermentation as evident by the

insignificant decrease in pH silage ensiled for 60 days as compared to that ensiled for 45 days (5.52 vs. 5.75 units). The lowest value of pH of silage ensiled for 60 days may provide evidence on the preference of ensiling WS silages for 60 days, this indicator together with the fact that the extent of decrease was lessened with increasing period of ensiling from 45 to 60 days, may prompt the fact that the 60 days brought about sufficient period for silage microbes to achieve optimum activity for fermentation of soluble carbohydrates supplied by molasses in addition to that may be produced from the probable degradation of cell wall components due to microbial activity. Salih (1983) reported that continuation of ensiling for more than 60 days seemed useless, where; light increase in silage pH was recorded.

Results of the current study also revealed that pH values are significantly ($P<0.05$) affected by the interaction between level of urea and ensiling period, this may be attributed to the effect of urea on the mode of fermentation occurred during ensiling especially at the early periods. Glewen and Young (1982) demonstrated that addition of urea at ensiling time and its subsequent degradation to ammonia delayed the quantitative stability of silage as evidenced by increase in pH of silage.

Regarding FP, it was noticed that estimated values are adopted descending trend as level of urea increased; FP values are 77.90, 61.84 and 32.04 points for UWS, LTWS and HTWS respectively, whereas, it adopted ascending trend as ensiling period increased; FP values are 24.92, 56.82, 71.94 and 75.76 points for sample of silages ensiled for 15, 30, 45 and 60 days, respectively. This result indicates that it is possible to make silage of medium to good quality using WS as a basic material with the addition of urea and molasses, in addition to the priority of ensiling for 60 days.

2- Content of dry matter (%)

Changes in DM contents of WS silage as affected by addition of urea and ensiling period are presented in table 3.

As shown from statistical analysis addition of urea at ensiling time increased DM content of silages significantly ($P<0.01$) by 0.97 and 1.67 units for LTWS and HTWS as compared to UWS. This may be attributed to the slow down of fermentation occurred during the early periods of ensiling; Salih (1983) observed instability in pH of WS silage as an indicator for insufficiency of short period of ensiling to complete silage fermentation, this was explained by high level of urea added at ensiling time which may impede normal fermentation. Addition of molasses at rate of 10% seemed to provide silage microbes with energy required to ferment insoluble sugars, this may lead to decrease DM content of different samples of WS silage with proceeding of ensiling period, where, this decrease reach 2.45, 5.09 and 7.78% in WS silages ensiled for 30, 45 and 60 days as compared to that ensiled for 15 days. The direct relationship between the rate of DM

loss and ensiling period was attributed to mode and extent of fermentation which was affected by source and level of soluble sugars (Denek and Can, 2007). Saeed (2008) reported that the loss that may occur in DM content of WS silage was affected by level of molasses added at ensiling time rather than the level of urea, where addition of urea at similar low and high rates as in the current study, resulted in a light insignificant increase reached 0.16 and 0.51 units respectively.

Table 3. Main effect of addition of urea, ensiling period and interaction between them on DM content of WS silages.

Level of urea (%)	Ensiling periods (day)				Main effect of urea (%)
	15	30	45	60	
0	52.34	50.13	47.67	45.27	48.85
1.5	53.57	51.28	48.51	45.93	49.82
3	54.79	51.92	49.23	46.15	50.52
Main effect of ensiling period (%)	53.56	51.11	48.47	45.78	

L.S.D.	urea	ensiling period	urea × ensiling period
0.05	0.50	0.43	0.25
0.01	0.67	0.59	0.34

Results also revealed that DM content of WS silages was affected significantly ($P<0.05$) by interaction between addition of urea and ensiling period, where, table 3 shows that the loss in DM was 2.40, 2.58 vs. 3.08 units in samples of UWS, LTWS and HTWS ensiled for 60 days, respectively, as compared to the corresponded samples ensiled for 45 days.

3- Content of ash (%)

Changes in ash contents of WS silage as affected by addition of urea and ensiling period are presented in table 4.

Results revealed that addition of urea at ensiling time increased ash content of WS silages significantly ($P<0.01$) by 0.16 and 0.19 units for LTWS and HTWS as compared to UWS. Similar result was obtained by Saeed (2008). This increase may be attributed to the formation of organic salts during ensiling (Catchpool and Henzell, 1971) Ryley (1969) referred to the partial binding of ammonia produced from degradation of added urea with organic acids to form ammonium salts during anaerobic fermentation of silage, it seems that this was affected by level of urea added in a current study, where, lower ash content was recorded in samples of HTWS.

Table 4. Main effect of addition of urea, ensiling period and interaction between them on ash content of WS silages.

Level of urea (%)	Ensiling periods (day)				Main effect of urea (%)
	15	30	45	60	
0	10.24	10.14	9.98	9.74	10.02
1.5	10.35	10.27	10.15	9.95	10.18
3	10.40	10.33	10.18	9.95	10.21
Main effect of ensiling period (%)	10.33	10.24	10.10	9.88	

L.S.D.	urea	ensiling period	urea × ensiling period
0.05	0.12	0.10	NS
0.01	0.16	0.14	

Regarding effect of ensiling period, results showed that ensiling WS silages for 45 and 60 days decreased ash content significantly ($P<0.01$) by 0.23 and 0.45 units respectively, this may be attributed to the mode of fermentation occurred early, that characterized with the formation of leakage fluids (effluents) by which portion of mineral content of silage was lost perhaps as organic salts; Salih (1983) reported that ash content of WS silage treated with urea and molasses at rate of 3 and 10% respectively, and ensiled for 60 days was decreased by 6.39%, in a current study the percentage decrease was 4.35. Results also showed that the loss in ash content was related to fermentation period, higher ($P<0.01$) loss was recorded in samples ensiled for 60 days as compared to those ensiled for 15 days.

4- Content of crude protein CP (%)

Changes in CP contents of WS silage as affected by addition of urea and ensiling period are presented in table 5.

As shown, statistical analysis revealed that addition of urea at ensiling time increased ($P<0.01$) CP content of WS silage by 1.91 and 3.79 units for LTWS and HTWS as compared to UWS; This is most likely a result of presence of ammonia produced from urea added during ensiling due to microbial activity (Ryley, 1969; Salih, 1983). Saeed (2008) reported an increase in CP content of WS silages reached 2.01 and 4 units when urea was added at similar rates as in a current study. Ahuja, et.al., (1973) demonstrated that increasing urea concentration in spray solution used in treatment of WS silage resulted in a regulated increase in CP content of silage.

Table 5. Main effect of addition of urea, ensiling period and interaction between them on CP content of WS silages.

Level of urea (%)	Ensiling periods (day)				Main effect of urea (%)
	15	30	45	60	
0	3.30	3.29	3.27	3.28	3.28
1.5	5.15	5.17	5.19	5.26	5.19
3	7.01	7.04	7.08	7.18	7.07
Main effect of ensiling period (%)	5.15	5.16	5.18	5.24	

L.S.D.	urea	ensiling period	urea × ensiling period
0.05	0.08	0.07	NS
0.01	0.11	0.10	

Regarding the effect of ensiling period, results indicated that ensiling WS silage for 60 days increased CP content significantly ($P<0.05$) by 1.74% as compared to that ensiled for 15 days, this may be attributed to increase the ratio of NH_3-N that bound to fermented straw mass as ensiling period proceeded, therefore, higher binding of N released from degradation of urea was recorded when this period was continued to 60 days, the percentage increase in CP content of WS silage samples ensiled for this period as compared to those ensiled for 30 days was 1.75%. Trach, et. al., (1998) demonstrated that increasing level of urea added to rice straw at ensiling time increased ($P<0.05$) the ratio of organically bound N with proceeding of this period, hence, CP content increased by 1% when urea was added at rate of 2% on straw DM basis, this increase represents insoluble NH_3-N that chemically bound to straw cells. In a current study, a percentage increase of 0.19 and 0.58 in CP content was recorded in samples of WS silage ensiled for 30 and 45 days as compared to those ensiled for 15 days; Salih (1983) found that CP content in WS silage treated with 3% urea and 10% molasses was 6.3% and it was not changed even when ensiling period proceeded to 90 days.

In a current study ensiling for 60 days seems to provide enough time to ensure better relative binding of NH_3-N to with straw during ensiling. Sarwar, et. al., (2006) recorded the increase in CP content of WS silage after 40 days of ensiling. In another study, it was observed that more than half quantity of urea added to corn residuals (55-65% DM) was degraded after 2 days of ensiling and all this quantity was entirely disappeared after 20 days of ensiling (Oji and Mowat, 1977).

5- Content of crude fiber CF (%)

Changes in CF contents of WS silage as affected by addition of urea and ensiling period are presented in table 6. Statistical analysis showed that addition of urea decreased ($P<0.01$) CF content in WS silages by 1.47 and 2.57% when it was added at rate of 1.5 and 3% respectively. This agrees with

findings obtained by Saeed (2008), where, addition of urea to WS silage at similar rates as in a current study decreased (P<0.01) CF content by 1.40 and 2.66%. This decrease may be attributed to the partial breakdown of carbohydrate complexes present in straw that probably occurred due to increased activity of silage microbes as a result of its providing with a convenient N source accompanied with promoting level of readily fermented energy performed by a addition of a constant level (10%) of molasses in all prepared samples; However, this level may be not enough to maintain the vigor of silage microbes, inducing cellulytic bacteria to degrade the structural carbohydrate of straw and utilize its components to meet the increased microbial demand for energy. Catchpool and Henzell (1971) attributed a decrease of CF content in silages made form dry roughages to the breakdown of cell wall components due to increased vitality of bacterial species that possessed cellulase and hemicellulose activity.

Table 6. Main effect of addition of urea, ensiling period and interaction between them on CF content of WS silages

Level of urea (%)	Ensiling periods (day)				Main effect of urea (%)
	15	30	45	60	
0	42.07	40.15	38.80	38.33	39.84
1.5	40.87	38.24	37.83	36.56	38.37
3	40.18	37.08	36.75	35.23	37.27
Main effect of ensiling period (%)	41.04	38.49	37.79	36.69	

L.S.D.	urea	ensiling period	urea × ensiling period
0.05	0.25	0.22	0.13
0.01	0.34	0.33	0.17

The significant (P<0.01) decrease in CF content of HTWS as compared to LTWS (1.10 units or 2.86%) confirm the fact that N plays important role in ensiling, not by increasing CP content but by decreasing CF content too, this is clear from statistical analysis of CF contents of WS silages, where, it was significantly (P<0.05) decreased as affected by interaction between level of urea and ensiling period.

Regarding effect of ensiling period, results revealed that CF content of WS silage decreased significantly (P<0.01) with proceeding of this period, the decrease reached 2.55, 3.25 and 4.35 units in samples of silage ensiled for 30, 45 and 60 days respectively, as compared to that ensiled for 15 days. Shultz, et. al., (1974) reported that acid detergent fiber (ADF) and cell wall components are decreased with increasing period of ensiling until 64 days, this was attributed to increase microbial degradation of cellulose and hemicellulose. Ensiling WS urea-treated silage for 45 and 60 days decreased CF content by 3.7 and 6.3 units respectively, however, little decrease (0.6 units) was

recorded when this period was proceeded to 90 days as compared to that ensiled for 60 days. The later finding confirm the priority of samples ensiled for 60 days appeared in the current study, in which higher content of CP had been retained in addition to lower pH value. These may leads to believe that completeness of silage fermentations was achieved when ensiling period was proceeded to 60 days.

6- Content of ether extracts (EE) (%)

Changes in EE contents of WS silage as affected by addition of urea and ensiling period are presented in table 7. As shown EE content of WS silages increased ($P<0.05$) by 1.96 and 2.11% due to addition of urea at rate of 1.5 and 3% respectively as compared to control group, this increase may be attributed to presence of volatile fatty acids (VFA) formed during anaerobic fermentation.

Table 7. Main effect of addition of urea, ensiling period and interaction between them on EE content of WS silages

Level of urea (%)	Ensiling periods (day)				Main effect of urea (%)
	15	30	45	60	
0	0.67	0.65	0.65	0.66	0.662
1.5	0.67	0.67	0.67	0.68	0.675
3	0.67	0.67	0.68	0.68	0.676
Main effect of ensiling period (%)	0.671	0.666	0.670	0.677	

L.S.D.	urea	ensiling period	urea × ensiling period
0.05	0.012	NS	NS
0.01	0.016		

Gupta and Pradhan (1977) demonstrated that successful ensiling of straw with urea and molasses may involve the desired changes that stimulate extensive fermentation producing VFA such as lactate and acetate and reducing water activity to such extent that inhibits growth of butyrate producing bacteria. Though high pH in urea treated silages, it contained higher VFA concentration than untreated silages (Ryley, 1969). Results also revealed that the little insignificant increase in EE content of HTWS as compared to LTWS (0.676 vs. 0.675%) may suggests addition of urea at medial rates to wheat straw, particularly, it was previously shown in this concern that addition of urea at high rate (3%) decreased FP by 48.18% (from 61.84 to 32.04 units) as compared to addition of urea at low rate (1.5%).

7- Content of nitrogen free extracts (NFE) (%)

Changes in NFE contents of WS silage as affected by addition of urea and ensiling period are presented in table 8. Results pointed out that addition of urea at ensiling time decreased ($P<0.01$) the content of this nutrients by 0.62 and 1.45 units in LTWS and HTWS respectively as compared to UWS. Similar result was obtained by Saeed (2008),

where, addition of urea at similar low and high rates as in a current study decreased NFE contents in WS silages by 0.63 and 1.49 units respectively. This decrease may attributed to anaerobic fermentation leading to slower oxidation of soluble sugars, producing organic acids and raising heat in ensiled mass to a slower extent in comparison with aerobic fermentation. White, et al., (1973) referred to the negative correlation between NFE and CP contents in urea-treated silages. Kilik (1984) reported that addition of urea resulted in formation of ammonia during fermentation leading to decrease the content of soluble carbohydrates.

Table 8. Main effect of addition of urea, ensiling period and interaction between them on NFE content of WS silages

Level of urea (%)	Ensiling periods (day)				Main effect of urea (%)
	15	30	45	60	
0	43.71	45.82	47.29	47.97	46.19
1.5	42.95	45.65	46.15	47.53	45.57
3	41.76	44.87	45.30	47.01	44.74
Main effect of ensiling period (%)	42.81	45.45	46.25	47.50	

L.S.D.	urea	ensiling period	urea × ensiling period
0.05	0.25	0.22	0.13
0.01	0.34	0.30	0.17

The high acceptable accuracy and control intended in laboratorial preparing of silage seems to participate in a light decrease in NFE content through diminishing gaps of air in the sacs by squeezing, though the fiber nature of straw that impeded maintaining moderate heat required to preserve silages which according to Brooks, et. al., (1972) should not exceed 30 C°.

Regarding to ensiling period, results revealed that NFE content of WS silage was increased ($P<0.01$) by 2.64, 3.44 and 4.69 units with proceeding this period for 30, 45 and 60 days respectively, as compared to ensiling for 15 days only. Salih (1983) reported that proceeding ensiling period of WS 3% urea and 10% molasses-treated silage from 45 to 60 days increased NFE content by 4.9 units, however, this trend was not going on even when this period was proceeded to 90 days, where, only 0.4 units increase was recorded. These results refer to the priority of ensiling WS silage for 60 days and that ensiling WS silage for too shorter or too longer periods is useless, this may due to completeness of fermentation and ideality of its mode.

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تأثير إضافة اليوريا وفترة السيلجة على نوعية سايلج تبن الحنطة وتركيبه الكيميائي

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الخلاصة

أجريت تجربة مختبريه لدراسة تأثير اضافة اليوريا (0 و 1.5 و 3 % على اساس المادة الجافة) وفترة السيلجة (15 و 30 و 45 و 60 يوم) على نوعية سايلج تبن الحنطة وتركيبه الكيميائي. عوملت جميع النماذج بالمولاس بمعدل 10%.

وقد اظهرت النتائج ان اضافة اليوريا بالمستوى المنخفض أدت الى تغير لون السايلج من اللون الأصفر الى اللون الأصفر المخضر وظهور رائحة الفواكه المتخمرة في النماذج المخزونة لمدة 60 يوما، فيما أدت مضاعفة ذلك المستوى الى تغير اللون الى الأصفر الداكن والبني بامتداد فترة السيلجة مع ظهور رائحة الأمونيا فيها.

وقد انخفضت قيم فليغ المحسوبة نتيجة لزيادة مستوى اليوريا بينما يؤدي امتداد فترة السيلجة الى ارتفاعها. وقد لوحظ ارتفاع ($P<0.01$) قيم الأس الهيدروجيني في السايلج نتيجة لإضافة اليوريا لكنها انخفضت ($P<0.01$) بامتداد فترة السيلجة.

فيما يتعلق بالتغيرات التركيبية اشارت النتائج الى ان اضافة اليوريا يؤدي إلى خفض ($P<0.01$) المحتوى من الألياف الخام والمستخلص الخالي من النتروجين فيما تسبب ذلك في رفع المحتوى البروتيني ($P<0.01$)، وأدى امتداد فترة السيلجة الى خفض ($P<0.01$) المحتوى من الألياف الخام ورفع المحتوى البروتيني ($P<0.05$) والمستخلص الخالي من النتروجين ($P<0.01$). وبصورة عامة تحققت أفضل النتائج في التجربة عند استخدام المستوى المنخفض من اليوريا والسيلجة لمدة 60 يوما.

الكلمات المفتاحية : تبن الشعير ، السيلجة ، فترة السيلجة ، اليوريا ، المولاس