

Effect of time of ensiling on the nutritive value of wheat straw treated with urea and molasses

A. A. Saeed
College of Agriculture
Babylon University

and

F. A. Latif
College of Agriculture
Baghdad University

Abstract

An experiment was conducted with 20 Arabi lambs to study the effect of ensiling time on the nutritive value of wheat straw. Two silages containing 3% urea and 10% molasses, made at early and late summer, were compared in this experiment. Both silages were fed to lambs supplemented with two levels of concentrates. Results showed that ensiling straw at late summer seemed to produce better silage as compared to the quality of early summer silage, according to the chemical composition and organoleptic characteristics, this was probably due to the optimum temperature and short day as compared to the conditions of early summer where high temperature and long day. It was found that storing silage in a high temperature conditions (35.5 C°) during July and August reduced intake significantly (P<0.01), which were attributed to the secondary fermentations occurred during ensiling, causing a change in the palatability, but doubling the concentrate level minimized the differences between the two silages, however, it was observed that making straw silage at late summer (during October and November, with a mean temperature of 21.9 C°) reduced DM, OM, NFE digestibilities (P<0.05), and EE digestibility (P<0.01) but it improved CF digestibility (P<0.05). CP digestibility did not influenced significantly by ensiling time. Doubling the concentrate level reduced CP and CF digestibility (P<0.05), but it increased the digestibility of EE (P<0.05).

Introduction

Since large quantities of straws were accumulated as a by product of cereals, it would be efficiently introduced in feeding programs. Many methods were used to improve the low nutritive value of straws, which was attributed to the low content of crude protein and high content of crude fiber. Some methods were physical, others were chemical. Pal and Negi (1977) reported that the correct chemical treatment of straws improved crude protein digestibility. Ensiling is a preservation way, but it could be beneficial, if a good and scientific effort were followed in making silage.

The time of ensiling did not investigated, especially in Iraqi conditions. The importance of environmental temperature in making silage was well recognized, it was related to the fermentation processes occurred during ensiling.

Good quality silage may be produced if desirable fermentations are obtained. In a high temperature seasons and/or areas, a secondary fermentation was often expected to occur during ensiling. Wilkins, et. al., (1971) indicated that the nutrients losses due to the secondary fermentation of lactic acid to produce butyric acid and the deamination of proteins by the action of Clostridia, these losses were related to the reduction of dry matter intake. Watson and Nash (1960) demonstrated that the proteineous fractions of silage could be affected by the ensiling in a high temperature condition. In such conditions, chemical reactions occurred in a stored roughage, could be accelerated by the high temperature (Dolberg, et. al., 1981), therefore the time of ensiling should be adjusted by the lowering these period.

Materials and methods

Twenty Arabi lambs were allotted randomly into four groups of five lambs each according to the bodyweight. Lambs were fed either wheat straw silage made at early summer (ES) or wheat straw silage made at late summer (LS). ES was stored during July and August with a mean environmental temperature of 35.5 C°, while LS was stored during October and November with a mean environmental temperature of 21.9 C°. Both ES and LS were fed to lambs supplemented with 150 or 300 g concentrate/head/day.

Silages were made by soaking wheat straw in water for 1 hour, the soaked straws were then treated with a diluted mixture of 3% urea and 10% molasses, each on a dry matter bases, water in both soaking period and in a treating solution was added to bring the DM content to about 60%. The mixed materials were packed in strong plastic sacs, then all sacs were stored in a suitable place, covers and weights were placed on stacked sacs. The stored materials were left for 60 days, then they opened one by one and random samples were taken for chemical analysis, the remaining materials were exposed to air in order to let the non-bonded ammonia to escape.

Feeds were available to lambs at any time, voluntary intake of feeds were determined by feeding the lambs on the experimental feeds for 3 weeks, the fourth week was designed for the determination of the digestibility.

pH of silage samples were determined according to the method of Latif (1977). Chemical analysis was done according to the methods recommended by the AOAC (1970). 2×2 factorial experiment design was used for the statistical analysis. Ingredient composition of the feeds used in the experiment is shown in table1.

Table-1: Ingredient composition (%) of experimental feeds

Feeds	ES	LS	Conc.
Ingredient composition %			
Wheat straw	87.0	87.0	
Molasses	10.0	10.0	
Urea	3.0	3.0	
Corn			40.0
Wheat barn			37.5
Barley			10.0
Soybean			10.0
Salt			1.5
Calcium carbonate			1.0

ES: wheat straw silage made at early summer.

LS: wheat straw silage made at late summer.

Conc.: concentrate.

Result and discussion

Chemical composition of feeds used in the experiment is shown in table 2. It was observed that ensiling wheat straw increased the ash content of both silages (LS and ES), this increase was probably due to the formation of organic acids during ensiling (McDonald et. al., 1973 a). Time of ensiling had no effect on the ash content of the produced silages, although there was 4% increase in the LS as compared to ES. Crude protein content of straw silages was increased due to the effect of added urea (Johnson, et. al., 1967). It was clear that ensiling wheat straw early in summer caused less increase in CP content (3.57%), this may be due to the effect of environmental temperature on the early stages of silage fermentation (Wilkinson, 1983). Plant respiration at the beginning of ensiling and the subsequent protein degradation by heat may be another reason for this difference.

Table 2: Chemical composition of concentrate, wheat straw (WS), and straw silage made at late (LS) and at early summer (ES) and molasses.

Feeds	DM%	% of DM				
		Ash	CP	CF	EE	NFE
Concentrate	91.84	6.21	15.93	7.35	0.63	68.54
Wheat straw (WS)	93.95	8.65	3.84	42.12	0.62	44.77
Straw silage of late summer (LS)	57.61	27.49	8.49	29.91	0.65	33.46
Straw silage of early summer (ES)	53.67	26.82	7.87	32.81	0.66	31.84
Molasses	81.49	11.45	3.46	0.36	0.10	84.63

The losses in DM of ES as well as the reduction in CP content may be considered an evidence, that a secondary fermentations may occurred. McDonald, et. al., (1973b) noticed that a secondary fermentations of silage were related to the losses of nutrients. Ensiling reduced the CF content of straw by 28.99 and 26.69% in LS and ES respectively; this may be due to the role of released ammonia from urea analysis during ensiling (Herrera-Saldana, et. al., 1983). Ensiling straw at late summer caused more reduction in CF content as compared to ensiling straw in early summer, this was probably due to higher degradation of the added urea during processing by the effect of heat (Ahuja, et. al., 1973), leading to reduce the amount of urea that available during ensiling and the subsequent exposure of straw mass to a released ammonia.

It was also observed from that time of ensiling had no effect on the EE, but it reduced the NFE content of straw due to the silage fermentations. McDonald, et. al. (1973a) reported that silage fermentations were related to the production of short chain fatty acids from the soluble carbohydrates fermentation. The higher losses of DM and CP in the ES as compared to LS were due to the secondary fermentations as evidenced by the reduction of the NFE content of ES which was a probable result to the activity of clostridia in breaking down of sugars and proteins (Breirem and Ulvesli, 1960).

Feed intake

Total dry matter intake (TDMI), silage dry matter intake (SDMI) and digestible dry matter intake (DDMI) of the experimental feeds are shown in table 3. It was observed that ensiling straw at early summer reduced the SDMI significantly ($P < 0.01$), but doubling the concentrate level minimized this reduction ($P < 0.05$), this was probably due to the secondary fermentations that occurred when straw was ensiled at high environmental temperature (Wilkins et. al., 1971). According to the similarity of the pH of both silages (7.90 and 8.15 for LS and ES respectively), it seemed that the high value of pH had no effect on the SDMI, then the reduction of SDMI may be attributed to the silage quality, which was extensively influenced by the changes that occurred in the characteristics of fermentation when straw was ensiled at a high temperature. Watson and Nash (1960) demonstrated that ensiling at high temperature influenced the proteineous fractions of the silage; this may in turn have negative effects on the voluntary intake (Drennan, 1973). Ammonia that produced from urea analysis during ensiling was organically bonded with the straw mass, thus it would lost in the rumen by low rates, this fact may probably occurred to a great extent in ES as compared to LS due to the proteins degradation during ensiling and consequently high levels of ammonia concentration in the rumen of lambs fed on ES, and the decreased intake of this silage (Wilson et. al., 1975). The results showed that TDMI were higher when LS fed to lambs as compared to ES. It was observed that ensiling straw at late summer increased TDMI significantly ($P < 0.01$) as compared to ES, when both silages were supplemented with low level of concentrate. it seemed that the low level of supplementation had no effect on the TDMI, which may influenced by the quality of silages, attributed to the effect of

time of ensiling, because doubling the level of supplementation improved the TDMI of ES significantly ($P<0.01$) as compared to LS. TDMI were influenced by the palatability of fed more than the chemical composition of both silages, because the CP content of both silages were semi equal (8.49 vs. 7.78 % for LS and ES respectively). Doubling the concentrate level improved the palatability of total feed and improved the rumen condition, which was reflected in increased TDMI of the poor silage.

Table 3: Total dry matter intake (TDMI), silage dry matter intake (SDMI) and digestible dry matter intake (DDMI) g/day of the late summer straw silage (LS) and early summer straw silage (ES).

Intake g/day	Feeds				Significant differences
	LS ₁₅₀	LS ₃₀₀	ES ₁₅₀	ES ₃₀₀	
TDMI	605.80	631.27	296.19	495.07	LS ₁₅₀ ,LS ₃₀₀ ,ES ₃₀₀ >ES ₁₅₀ **
SDMI	468.04	355.75	158.83	219.55	LS ₁₅₀ >ES ₁₅₀ ** ,ES ₃₀₀ ** LS ₃₀₀ >ES ₁₅₀ ** ,ES ₃₀₀ *
DDMI	402.21	371.80	221.71	322.34	LS ₁₅₀ >ES ₁₅₀ ** ,ES ₃₀₀ ** LS ₃₀₀ >ES ₁₅₀ * ,ES ₃₀₀ ** ES ₃₀₀ >ES ₁₅₀ **

*($P<0.05$), ** ($P<0.01$).

Ensiling straw at early summer reduced the DDMI significantly ($P<0.01$) when both silages were supplemented with low level of concentrate, but doubling this level to 300 g/day minimized the differences. These results indicated that DDMI did not affected by the dry matter digestibility (table 4). DMD of the silages were higher than the value of DMD reported by Conrad, et. al., (1964), the later study showed a relation between the DMD and the DMI, but the DMI of both straw silages in the current study were related to physiological condition of the experimental lambs more than it related to the feed residual that remained in the alimentary tract as well as the effect of silage fermentations on the relation between the voluntary intake and the digestibility (Thomas et. al., 1981). Minson (1981) noticed that the DMI was influenced by the digestibility, outflow rate of the digested feed fractions (time of emptiness) and rumen capacity, in the current experiment DMI may be related to the slow passage of digested feed fractions through rumen for physiological reasons perhaps. Deswysen and Ehrlein (1981) explained the decreased intake of silage by the delay or the less efficient mechanical degradation of feed fractions by the activity of pseudo-ruminating, when the silage remained more time in the rumen and reticulum, and this had a negative effect on the voluntary intake. Campling (1966) indicated that long retention time of silage fractions in the rumen lead to a reduction of intake; this case was attributed to the physical form of silage. The results of the voluntary intake in the current study indicated that the interaction between the time of ensiling and the level of supplementation had a significant effect on the intake, and that the carbohydrates and/or proteins of the concentrates influenced the utilization of both silages.

Feed digestibility:

The coefficients of dry matter digestibility (DMD) and their organic components for the experimental feed are shown in table 4. As shown, best digestibilities of dry matter (DMD), organic matter (OMD), ether extract (EED) and nitrogen free extract (NFED) were achieved in the straw silage of early summer (ES), this improvement was probably due to the decreased intake of this silage. The quality of ES was poor due to the secondary fermentations that occurred during ensiling, which attributed to the high temperature, thus, the improvement of DM and OM digestibilities were not agreed to the previous fact of the poor quality of ES, because the

exposure of the stored straw mass during ensiling to a high temperature and the secondary fermentations were usually caused a reduction of digestibility (Yu and Thomas, 1975), this reduction could be higher if silage exposed to a high temperature for a long time (Catchpool and Henzell, 1971), the little amount of silage that retained in the rumen of lambs and the expected adequate attack of microorganisms were a probable reason for the increase of the digestibility of ES as compared to the DMD and OMD of the LS, which were more palatable and recorded higher DMI by lambs. Brown (1966) indicated such like these relation, without ignoring a possible effects of another factors influencing the relation between intake and digestibility.

Table 4: Digestibility coefficient of dry matter (DMD), organic matter (OMD), crude protein (CPD), crude fiber (CFD), ether extract (EED), and nitrogen free extract (NFED) (%) of the experimental feed.

Item	Feeds				Significant differences
	LS ₁₅₀	LS ₃₀₀	ES ₁₅₀	ES ₃₀₀	
DMD (%)	62.79	60.91	68.83	64.82	*****
OMD (%)	63.91	63.76	69.53	65.89	*****
CPD (%)	70.50	69.30	69.19	67.03	*****
CFD (%)	66.30	57.14	61.16	52.39	LS ₁₅₀ >LS ₃₀₀ [*] , ES ₃₀₀ ^{**} ES ₁₅₀ >ES ₃₀₀ [*]
EED (%)	77.36	73.54	81.44	79.92	ES ₁₅₀ >LS ₁₅₀ [*] , LS ₃₀₀ [*] ES ₃₀₀ >LS ₁₅₀ ^{**} LS ₁₅₀ >LS ₃₀₀ [*]
NFED (%)	60.56	64.32	71.91	69.00	ES ₁₅₀ >LS ₁₅₀ [*]

LS₁₅₀, LS₃₀₀: Wheat straw silage of late summer supplemented with low and high level of concentrate respectively.

ES₁₅₀, ES₃₀₀: Wheat straw silage of early summer supplemented with low and high level of concentrate respectively

* (P<0.05), ** (P<0.01)

It was observed from the above table that the differences in DMD and OMD were not significant; although an increase in DMD and OMD of ES were obtained as compared to LS when both silages were fed to lambs supplemented with the low level of concentrate (6.04 and 5.62 units for DMD and OMD respectively). Doubling the level of supplementation appeared to minimize these non significant differences (3.91 vs. 2.13), the little higher DMD and OMD attributing to the doubling of supplement level may due to the decreased digestibility of ES which related to the increased amounts of total dry matter retained in the alimentary tract of lambs.

Regarding crude protein digestibility, it was shown that CPD of late summer silage was better than CPD of early summer silage, this probably due to the effect of protein degradation by heat during ensiling, as was shown previously by the decreased intake of this silage. Yu and Thomas (1975, 1976) demonstrated that silage which exposed to protein degradation by heat had a decreased in vitro CPD and a decreased nitrogen retention by sheep in the current experiment, the ratio of nitrogen retention (N eaten-N excreted) was only 25% of the total nitrogen intake by lambs fed ES. It was also observed from table-4 that ensiling wheat straw at late summer improved the CPD by 1.13 and 2.27 units at the low and high level of supplementation respectively as compared to the early summer silage, this two different increases in CPD were probably due to the increased intake of CP at the high level of concentrate in both silages (Raleigh and Wallace, 1963). Doubling the concentrate level led to reduce the CPD of LS and ES by 1.20 and 2.16 units respectively, this agreed with the findings of Forbes et al. (1967) and

Latif (1977). The decreased CPD of both silages may be due to the increased intake of nitrogen without supplying with enough energy sources that should be available to ensure adequate utilization of the supplied nitrogen. Roy (1975) noticed that there was a full subsequent relation between the source of carbohydrate and protein digestibility in the rumen and that better utilization of proteins may be ensured when enough carbohydrates were available.

The results of digestibility trial indicated that crude fiber digestibility (CFD) was reduced by 5.14 and 4.75 units due to ensiling wheat straw at early summer, when ES was offered to lambs supplemented with low and high level of concentrate respectively, this reduction in CFD was probably due to the decreased activity of the cellulose analysis by rumen microorganisms, caused by the decreased pH of rumen fluid contents (Horton and Nicholson, 1981). Doubling the concentrate level reduced CFD significantly ($P < 0.05$) by 9.16 and 8.77 units for LS and ES respectively. Ether extract digestibility (EED) of the late summer silage was significantly higher than that of early summer silage (4.08 and 6.38 units) when both silages were fed with low and high level of supplementation.

Nitrogen free extract digestibility (NFED) showed the same responses as EED, both digestibilities were improved significantly by ensiling at early summer, but doubling concentrate level improved the NFED of ES, while it reduced the EED and NFED of this silage.

The results of this experiment suggested that reducing the ensiling time when the environmental temperature is very high or protecting the surface of ensiled materials that exposed directly to sun heat, may be a beneficial procedure to preserve and ensure an accepted silage quality.

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