

## **Effect of ensiling and level of supplementation with concentrates on the voluntary intake and digestibility of wheat straw by Arabi lambs**

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### **Abstract**

An experiment was conducted with 24 Arabi lambs to investigate the possibility to increase the utilization of wheat straw by ensiling with urea at rate of 1.5 % as a nitrogen source and to get the advantage of the additional digestion caused by the released ammonia, and molasses at rate of 10 % to encourage the fermentation responsible for silage making. Straw silage (ES) was compared with wheat straw (TS) containing both additives with the same rates, without ensiling. Both ES and TS were fed with two levels of concentrates. The straw silage was of medium quality with accepted palatability by lambs.

Results of the experiment showed that ensiling had no effect on the total dry matter intake (TDMI) and straw dry matter intake (SDMI), but the digestible dry matter intake (DDMI) was improved significantly ( $P < 0.05$ ). Doubling the concentrate level increased TDMI and DDMI significantly ( $P < 0.01$ ).

Digestibility trial pointed out that the ensiling improved dry matter digestibility (DMD) and its component significantly ( $P < 0.01$ ), except that of ether extract (EED) which was decreased significantly ( $P < 0.01$ ) as a result of doubling the concentrate level. pH of rumen fluid showed an expected values according to time of sampling and determinations. Results of this experiment also showed that ensiling wheat straw with urea and molasses could be beneficial procedure due to the improvement of both crude protein (CPD) and crude fiber (CFD) digestibilities and that the ensiling enhanced the utilization of urea N, the later needs more specific investigations.

### **Introduction**

Since large quantities of straws are available as a by products of cereals, it must be efficiently introduced in feeding. Straws was known to be of low quality roughage due to their high fibre and low protein contents, so that many experiments were done to investigate the possibility of improving the nutritive value by the addition of urea or other like materials to support the nitrogen content, however, little were done to improve this low nutritive value by ensiling, unless some separated studies on the fermented straws with some additives such as NaOH and other bases, urea and molasses and some green roughage. Elpat, Evskii and zharkov in on old study (1961) found that ensiling of oat straw with 1.74% urea increased crude protein content from 5.2 to 10.1% and reduced the nitrogen free extract content from 45.1 to 36.2 %, the same finding was stated by shultz et. al. (1974) in ryegrass straw. Salih (1983) conducted an experiment with ensiled wheat straw, the results reported a significant improvement in crude protein digestibility.

### **Materials and Methods**

Twenty four Arabi lambs with an initial weight of about 23 kg were used. The lambs were allotted randomly into four groups of six lambs each according to body weight. Individual

feeding was obtained by allotting each lamb in separated  $1.2 \times 1.2\text{m}^2$  pens. Lambs were fed either straw silage (ES) or wheat straw (TS) each with either 150 or 300 g/concentrate/head/day. Silage was made by soaking wheat straw in water for 1 hour, then the soaked straw was treated with diluted mixture of 1.5% urea and 10% molasses, each on a dry matter bases. Water in both soaking period and treating solution was added to bring the DM content to about 60%. The mixed materials were then packed properly and carefully in strong plastic sacs. Holes were made in one side, the other was exposed to a hand pressure, and then all sacs were stored in a clean suitable place covered with a thick plastic sheet. 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.

The control feed was mixed with the same materials without ensiling, so the mixing was taken place at a time of feeding. Half the concentrate was offered to the lambs firstly at 8 A.M, followed by the half of both ES and TS according to the expected feed intake of both roughages that estimated by the adaptation period which had taken place for 21 days just before the experiment started, plus 100 g in order to prevent any probable waste, the other half of concentrate was offered in the same previous way at 4 P.M. taking in a count that the roughages would be available to lambs at any time. Voluntary intake of feeds was determined by feeding the lambs on the designed feeds for 4 weeks bearing in mind the quantity of feed that available and that 3 weeks of feeding after the lambs had reached an approximately constant level of intake were enough to be true for exact feed intake. The first two days of the third week were designed to determine the pH of rumen fluid and the fourth week was designed for the determination of digestibility.

pH of silage samples were estimated according to the method of Latif (1977). Rumen pH was determined immediately using a field pH meter. Chemical analysis was done according to the methods recommended by the AOAC (1970).  $2 \times 2$  factorial design was used for statistical analysis of data. Ingredient composition of the feeds is shown in table 1.

Table 1: Ingredient composition of the feeds

Feeds	Straw silage (ES)	Wheat straw (ST)	Concentrate
Ingredient composition%			
Wheat straw	88.5	88.5	
Molasses	10.0	10.0	
Urea	1.5	1.5	
Corn			40.0
Wheat barn			37.5
Soybean			10.0
Salt			1.5
Calcium carbonate			1.0

### Result and discussion

Chemical analysis of feeds is presented in table 2. As shown in, addition of urea at both ensiling and feeding time increased the ash content of wheat straw, in both cases the effect of addition of molasses may be the reason for these increase. In case of silage the presence of lactate and the volatile fatty acids salts may be a partial reason for the increase of ash content (McDonald, et. al., 1963). Crude protein content was increased as a result of urea treatment, silage fermentations may be the reason for the 1.1% depression of CP content in ES as compared to TS (Johnson, et. al., 1967; Drennan, 1973).

Table 2: Chemical analysis of straws, concentrate and molasses

Feeds	DM %	% of DM				
		Ash	CP	CF	EE	NFE
Untreated straw (US)	93.95	8.65	3.84	42.12	0.62	44.77
Ensiled straw (ES)	65.52	17.24	5.42	34.07	0.63	42.64
Treated straw (TS)	63.62	15.01	6.52	30.20	0.89	47.38
Concentrate	91.84	6.21	15.93	7.35	0.63	68.54
Molasses	81.49	11.45	4.46	0.36	0.10	84.63

Urea treatment had also reduced the CF content. The reduction in CF was higher in TS, this may be due to the dilution effect with molasses (0.36% CF) (Petersen, et. al., 1981). In case of the silage, the reduction may be due to the degradation of one or more of the cell wall components (Gupta and Pradhan, 1977). Klopfenstein, et. al., (1972) reported similar results in ensiled maize stover straw.

Silage produced in this experiment was of medium quality according to the organoleptic characteristics, average pH for some samples was 5.48 as a result of urea treatment (Ryley, 1969). No negative signs were observed on the lambs due to urea treatment, all lambs were healthy and well performed.

#### Voluntary intake:

Table 3 showed that ensiling wheat straw insignificantly reduced the total dry matter intake (TDMI) with 53 g/day (12.88%) at the low level of concentrate, but doubling this level from 150 to 300 g/day minimized the difference in TDMI to 14.26 g/ day (3.31%)

Table 3: Total dry matter intake (TDMI), straws dry matter intake (SDMI) and digestible dry matter intake (DDMI) of the feeds used in the experiment.

Intakes	Feeds				significant differences
	ES <sub>150</sub>	ES <sub>300</sub>	TS <sub>150</sub>	TS <sub>300</sub>	
TDMI	497.99	691.08	551.83	705.33	TS <sub>300</sub> >ES <sub>150</sub> <sup>**</sup> , TS <sub>150</sub> <sup>**</sup> ES <sub>300</sub> > ES <sub>150</sub> <sup>**</sup> , TS <sub>150</sub> <sup>**</sup>
SDMI	360.73	415.56	414.07	429.81	
DDMI	314.98	456.21	294.96	413.30	ES <sub>300</sub> >TS <sub>150</sub> <sup>**</sup> , ES <sub>300</sub> <sup>**</sup> TS <sub>300</sub> >TS <sub>150</sub> <sup>**</sup> , ES <sub>150</sub> <sup>**</sup>

ES<sub>150</sub>, ES<sub>300</sub>: Straws silages fed with low and high level of concentrate respectively

TS<sub>150</sub>, TS<sub>300</sub>: Treated straws fed with low and high level of concentrate respectively

<sup>\*\*</sup> (P<0.01), <sup>\*</sup> (P<0.05).

The decreased intake of silage as compared to other feed was observed by many researchers (Goering, et. al., 1961; McCarrick, 1963; Mowat, 1971). The palatability in a fact is the main problem in this manner. The differences in intake of any feeds may be due to the palatability (Blaxter, et. al., 1961). Some undesirable changes occurred during the ensiling of poor roughages are related to the palatability characteristics, which in turn cause a reduction of silage intake. Jararige, et. al., (1981) found that the reduction in silage intake as compared with the intake of other fresh feeds was related to the loose of protein and carbohydrates during ensiling, in the current study there were 16.9 and 10% losses in CP and NFE contents of the straw respectively (table 2). The presence of ammonia in the ES may be another reason for this reduction in the DMI. Thomas, et. al., (1961) reported the same attribution. Wilkins, et. al., (1971) indicated that there was a negative relation between the voluntary intake and the

concentrations of both ammonia and organic acids, which were responsible for about 40% reduction in the voluntary intake (Clancy, et. al., 1977). Ensiling wheat straw as shown from table 3 caused a reduction in the TDMI with 9.75 and 2.02% when the ES were offered to lambs with the low and high level of concentrate respectively, doubling this level may improved the balance of the total feed causing less differences in the intake of ES and TS. Wilson and Wilkins (1973) and Stallings, et. al., (1979) noticed that the presence of protein degradation products during ensiling may cause a reduction in the silage DM intake. The only significant ( $P<0.05$ ) effect that observed in this experiment was in the DDMI when the high level of concentrate was offered to lambs, this increase which was 42.91 g/day, indicating that ensiling wheat straw with urea and molasses increased the DDMI with about 9.40% , but this increase was non significant when the ES was fed to lambs with low level of concentrate (20.02 g/day, or 6.35%), the significant improvement of the DDMI may be due to the significant improvement ( $P<0.01$ ) in dry matter digestibility (DMD) due to ensiling (table 4). The data presented in table 3 showed that better DDMI ( $P<0.01$ ) was obtained when the ES was supplemented with the high level of concentrate as compared with other feeds used in the experiment, the same results were observed in the DMD (table 4). These results are similar to those found by Jones (1972) which indicated that the main restrictions of the voluntary intake of feed with DMD of about 55- 65% was the digestion processes in the rumen and reticulum, in the current experiment DMD of ES supplemented with the low and high level of concentrate were 53.48 and 66.38% respectively .

#### Digestibility of feeds:

Digestibility trial depended on voluntary intake of both ES and TS supplemented with the previously mentioned level of concentrate. Although the digestibility determinations suppose that the collected feces containing the undigested feed may be not accurate, unless animals used in the digestibility trial consumed semi equal amounts of feeds (Heaney, 1973). Mudgal et. al., (1982) noticed that the DMD and OMD did not affected significantly ( $P<0.01$ ) by the level of feed intake. Holloway, et. al., (1981) demonstrated that digestibility determination was not being less efficient if it depended on the *ad libitum* feeding. Digestibility coefficients of the experimental feeds are shown in Table 4.

Table 4: Digestibility coefficients (%) of the dry matter (DMD), organic matter (OMD), crude protein (CPD), ether extract (EED) and nitrogen extract (NFED) of the experimental feeds.

Digestibility coefficients (%)	Feeds				Significant differences
	ES <sub>150</sub>	ES <sub>300</sub>	TS <sub>150</sub>	TS <sub>300</sub>	
DMD	63.69	66.38	53.48	59.06	ES <sub>300</sub> >TS <sub>150</sub> ** / ES <sub>150</sub> >TS <sub>150</sub> **
OMD	65.67	68.57	56.80	62.80	ES <sub>300</sub> >TS <sub>150</sub> ** / ES <sub>150</sub> >TS <sub>150</sub> **
CPD	69.19	67.10	64.72	63.56	ES <sub>150</sub> >TS <sub>150</sub> ** , TS <sub>300</sub> ** / ES <sub>300</sub> >TS <sub>300</sub> *
CFD	66.67	65.25	44.79	45.95	ES <sub>150</sub> >TS <sub>150</sub> ** , TS <sub>300</sub> ** / ES <sub>300</sub> >TS <sub>150</sub> ** , TS <sub>300</sub> **
EED	75.07	76.20	71.06	62.56	ES <sub>300</sub> >TS <sub>300</sub> ** / ES <sub>150</sub> > TS <sub>300</sub> ** / TS <sub>150</sub> >ES <sub>300</sub> **
NFED	64.13	69.72	60.53	68.62	ES <sub>300</sub> >TS <sub>150</sub> ** / TS <sub>300</sub> >TS <sub>150</sub> *

ES<sub>150</sub>, ES<sub>300</sub> :Straw silages fed with low and high level of concentrate respectively.

TS<sub>150</sub>, TS<sub>300</sub>: Treated straws fed with low and high level of concentrate respectively.

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

As shown, DMD was increased significantly ( $P < 0.01$ ) due to ensiling of wheat straw by 10.48 units at the low level of the supplement, but doubling this level from 150 to 300 g/head/day caused insignificant increase in the DMD (7.32 units only). This agreed with findings of Shultz, et. al., (1974) that the ensiling of ryegrass with 1% urea and 20% molasses for 40 days caused a significant increase in the in vitro dry matter digestibility (IVDMD). The reason for this improvement in DMD of wheat straw due to ensiling may be the quick analysis of added urea by the action of urease enzyme (Brooks, et. al., 1972 and Lall, et. al., 1980), and the exposure of the stored mass during ensiling to the fermentation products as well as the effect of ammonia, the later has an important role in breaking down bonds that linked lignin, cellulose and hemicellulose together (Klopfenstein, 1978) and increased rate of cellulose and hemicellulose degradation (Tarkow and Feist, 1969).

Organic matter digestibility (OMD) followed the same response as DMD, with a little increase, these increase may be due to the increasing digestibility of all nutrients due to ensiling. Ensiling improved the OMD significantly ( $P < 0.01$ ) by 8.87 units when the ES was supplemented with the low level of concentrate but no further improvement in OMD was obtained (5.77 units only) by doubling this level. The positive effect of ensiling on both DMD and OMD were noticed by Colenbrander, et. al., (1971) and Klopfenstein, et. al., (1973), these results indicated that ensiling low quality roughages with a non- protein nitrogen sources had a great benefits in improving the nutritive value of such these roughages.

Doubling the concentrate level improved the DMD, but this improvement was better when straw was fed to lambs without ensiling (5.58 vs. 2.42). In another words, ensiling straws seemed to have a positive effect on DMD, but no further improvement was obtained by doubling concentrate level. OMD showed similar response, the improvement in OMD of ES was 2.9 units, but for the TS, it was 6 units. Vadiveloo and Holmes (1979) found that the supplementation had less effect on roughages which were more digestible as compared to those which were less digestible. Table 4 showed that supplementation ES fed to lambs with low level of concentrate improved both DMD and OMD. Offering concentrates to lambs fed ES increased ammonia utilization for the microbial protein synthesis, this agreed with the fact that supplementation roughages which exposed to chemical effect with easily fermented carbohydrates enhancing ammonia utilization for the synthesis of microbial protein as compared to the supplementation of the untreated roughages (Klopfenstein, et. al., 1972). Crude protein digestibility (CPD) as shown in table 4 was improved significantly ( $P < 0.01$ ) due to ensiling. Salih (1983) reported an increase in CPD with a bout 4 units, this improvement was probably due to the chemical effect of ammonia produced from urea analysis during ensiling. Herrera-Saldana, et. al., (1983) demonstrated that ammonia treatment at level of 5% improved the CPD of straw significantly. Merchen and satter (1983) related these improvement to the increased amounts of nitrogen that available to rumen microorganisms, due to the increased solubility of silage nitrogen and the ratio of the non-protein nitrogen during ensiling, taking in account that ammonia is the essential source of nitrogen to many species of rumen bacteria (Hungate, 1966). Doubling the concentrate level from 150 to 300 g/day showed less increase in CPD. Latif (1977) reported such like this response.

Ensiling straws improved the crude fibre digestibility (CFD) significantly ( $P < 0.01$ ) by 21.88 and 19.30% when ES were fed to lambs supplemented with the high and low level of concentrate respectively. Gupta and pradhan (1977) reported that ensiling wheat straw with a mix of urea and molasses increased the digestion of cell wall and cellulose. Shultz, et. al., (1974) demonstrated that the microorganisms in silage degraded cellulose and hemicellulose of ryegrass treated with urea and molasses during ensiling. Elpat Evskii and Zharkov (1961) noticed that the cellulose content of the roughages was markedly decreased during silage fermentation. Exposure to ammonia may be another reason for this improvement of CFD.

Horton (1981) indicated that ammonia treatment led to a significant improvement of CFD of straws. Wilkinson (1983) reported that the treatment of low quality roughages with urea and the exposure to the released ammonia due to urea analysis during ensiling improved CFD similar to that of ammonia treatment. Doubling the concentrate level in the current experiment decreased CFD with 1.24 units, whereas it increased CFD of TS with about 1.16 units. According to these results, it seemed that offering the concentrate to lambs fed ES supplied rumen microorganisms with the readily fermented carbohydrates more than its requirements to metabolize the supplied amount of nitrogen by feeding ES causing a decrease in CFD, but lambs fed TS got less amount of carbohydrates causing little increase in CFD, thus the requirement for the readily fermented carbohydrates are little to stimulate rumen fermentations and the utilization of the energy of the CF (Pigden and Heaney, 1969).

Ensiling as shown table 4 significantly ( $P < 0.01$ ) improved ether extract digestibility EED. Salih (1983) reported similar results. Venkatachar, et. al., (1971) reported less values for EED in ragi straw treated with urea at level of 2% and molasses at rate of 10% as compared to value obtained in TS and ES of the current experiment, these differences were probably due to the kind of straw (White, et. al., 1973). Doubling the concentrate level had no additional effect on EED of ES, but it decreased the EED of TS, this probably due to the less value of EED of TS as compared to ES.

Ensiling improved the nitrogen free extract digestibility (NFED), Salih (1983) reported that ensiling wheat straw with urea and molasses improved the NFED insignificantly; the reason for this improvement may be the increased utilization of readily fermented carbohydrates by silage microorganisms during ensiling (Shultz, et. al., 1974). It was observed that the improvement of NFED due to ensiling (table 4) was greater with the low level of supplementation as compared to the NFED of TS; this was probably due to the role of supplement in minimizing the effect of silage fermentation (Aston and Taylor, 1980).

pH values of the rumen fluid of the lambs fed ES and TS with two levels of supplement twice a day are presented in table 5. It was found that these values were high before feeding, and then it was reduced at 2 hours after feeding as a result of offering concentrate. At 4 hours after feeding these values were increased. It was observed that lambs began to eat the ES and TS of the morning meal soon after it had finished the limited amounts of concentrates. Urea in both ES and TS that entering rumen of lambs would soon broken down to produce ammonia, thus pH values were high at 4 hours after feeding, where the quick fermentation of carbohydrates would be finished, and secreting high amounts of saliva by lambs during chewing and swallowing TS and ES, were a logical reasons for the observed increase of the pH values at 4 hours after feeding. Kropp, et. al., (1977) reported that ruminants secrete large amount of saliva during chewing and ruminating.

Table -5: pH values of rumen fluid for lambs fed the experimental feeds.

Time of sampling	Feeds			
	ES <sub>150</sub>	ES <sub>300</sub>	TS <sub>150</sub>	TS <sub>300</sub>
Before feeding	7.14	7.27	7.74	7.66
2 hours after feeding	6.71	6.92	6.87	6.91
4 hours after feeding	7.01	7.08	7.37	7.41

ES<sub>150</sub>, ES<sub>300</sub>: Straw silages fed with low and high of concentrate respectively.

TS<sub>150</sub>, TS<sub>300</sub>: Treated straws fed with low and high level of concentrate respectively.

pH of rumen fluid is a result of ammonia and volatile fatty acids concentrations presented in the rumen. It was observed that carbohydrates that entered the rumen through feed or by injection would markedly decreased ammonia concentration (Drori and Loosli, 1961). High pH values of rumen fluid mean the presence of high concentration of ammonia, this lead to

expect poor utilization of nitrogen (Caffrey, et. al., 1967). According to these facts, utilization of urea nitrogen in the current experiment was more in ES as compared to TS.

The results of this study showed that ensiling wheat straw with urea and molasses could be considered successful and beneficial because ensiling improved CPD and CFD significantly; CP and CF are the essential feed components that could limit the utilization of roughages like straws, Accordingly, ensiling, as it seemed from the experiment is acceptable and may be economical way to increase the utilization of poor quality roughages, addition of urea make use of the effect of ammonia produced during ensiling, moreover, it is an adequate source for growth and developing of many species of rumen microorganisms (Hungate, 1966).

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