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THE USE OF UNMARKETABLE CRACKED EGGS AND WHEY TO INCREASE THE NUTRITIVE VALUE OF BARLEY STRAW

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In this study, unmarketable cracked egg (UCE)+Whey mix (60 % egg+ 40 % whey) were added to barley straw to increase its nutritive value. This straw was compared to alfalfa hay. Twenty lambs approximately 7 mo of age (each group included 10 lambs) were used in a randomized design. Experimental groups were Alfalfa group with alfalfa hay and Straw+E+W group with added UCE+Whey mix barley straw. Prepared rations were isocaloric and isonitrogenous. We investigated the effect of both rations on feed intake, BW gain, feed conversion ratio and digestibility of nutrients. Daily feed intake, daily BW gain and feed efficiency in alfalfa and Straw+E+W group were: for feed intake 1361.06 g and 1209.91 g ($p<0.05$); for daily BW gain 250.00 g and 246.43 g ($p>0.05$) and for feed conversion ratio 5.44 and 4.91 ($p<0.05$) respectively. Digestibility of nutrients was not significantly different between groups ($p>0.05$). As shown, the feed intake was lower in Straw+E+W group, the lambs in Straw+E+W group had better performance. The cause of this maybe the use of higher quality protein sources. While soybean meal, sunflower seed meal and alfalfa hay were used as protein sources in the Alfalfa group. A higher quality protein source, like UCE was used in the Straw+E+W group. It can be concluded that the addition of quality protein sources, like egg and whey, increased the nutritive value of barley straw.

Key words: digestibility, egg, lamb, performance, straw, whey.

INTRODUCTION

A large amount of straw is gained as a by-product after harvesting grains. This straw is use at a high ratio in the feed for ruminant ration in different regions of the world and in Turkey (Çerçi *et al*., 2002) but, grain straw has low nutritient value (especially protein) and low digestibility. Straw was treated by physical (Sundostol, 1981) and chemical methods (Macdearmid *et al*., 1988; Williams *et al*.,1985; Zyubin, 1985; Bergner *et al*., 1984; Cloete and Kritzinger, 1984; Catalan, 1983) to increase the nutritive value and digestibility. These treatments have been usually left on the experimental level, as the physical treatments did not result in the required quality; and the treatment of straw with chemicals is difficult,

expensive and chemicals can cause environmental pollution and toxicity owing to faulty dosage.

Egg is an important alternative feed ingredient that contains high quality crude protein and crude fat (Quigley, 2002). Recently, this quality protein and fat source has attracted attention of researchers. In a limited number of studies nonedible egg was used as an alternative nutrient in animal nutrition (Quigley, 2002; Hill *et al*., 2001; Kellogg *et al*., 2000; Scott *et al*., 1999). An impressive amount of eggs are cracked and damaged during transport, storage or marketing (Bell *et al*., 2001; Hara-Kudo *et al*., 2001; Patterson, 2001; Todd 1996), such damaged eggs are not fit for human consumption (Todd, 1996).

Whey is the liquid by-product of cheese production. Every 10 units of full fat milk will yield about 1 unit of cheese and 9 units of liquid whey. Liquid whey is about 92-93 percent water and includes approximately half of the original nutrients of milk, such as protein, calcium and lactose. Whey is given to humans and animals as liquid or dried because of high-quality protein (Walzem *et al*., 2002), calcium, and vitamin content. As it is quite cheap whey is offered to lambs and calves (Kushibiki *et al*., 2001; de Wit, 1998) in the growing period, and is used in milk replacers (Lammers *et al*., 1998; Terosky *et al*., 1997), feeds for cattle (Auldist *et al*., 2000), swine (Kilshaw *et al*.,1982), poultry, pet foods, and infant formulas (de Wit, 1998; Schanler and Garza, 1987; Gunn and Stunzner, 1986).

Published literature data does not show adequate information on the nutritive evaluation of nonedible cracked eggs and whey added to low quality forage like straw. In this study, we aimed to treat straw with a quality protein source of UCE and whey thus increasing the nutritive value of barley straw. For this purpose, 60 % egg+40 % whey mixture was added to barley straw thus increasing the protein level of barley straw to the protein level of alfalfa hay (14 %). We investigated the effect of both feeds on performance and digestibility of nutrients in lambs.

MATERIAL AND METHODS

Animals and feeds: In this study, twenty 7-month-old lambs were used. All animals have been vaccinated (against foot and mouth disease, enterotoxaemia etc.) and treated against internal and external parasites prior to the experiment. There were 10 animals per experimental group and the weights of the lambs were balanced between the groups at the beginning of the experiment.

Alfalfa hay, straw, concentrate and whey were obtained from the Research and Application Farm of Firat University (RAFUF, Elazig, Turkey). Cracked eggs were provided from a commercial laying hen company (Umut Tavukçuluk, Tic.A.S., Elazig, Turkey). As the source of forage, alfalfa hay was added into the first ration (Alfalfa Group) and straw treated with egg+whey mix was added to the second ration (Straw+E+W Group). This mixture was formed by 60 % egg and 40 % whey. This mix was added to the straw until the protein level of straw was equal to the alfalfa hay (14 %). This mixture was then sprayed onto the straw in three stages and at the end of each stage eggs and straw were well mixed by hand. The straw was dried on a plastic sheet and offered to the animals when it

was completely dry. Rations used in the experiment were designed to be isocaloric and isonitrogenous (Table 1).

Table1. Formulation of rations

Feeds	Alfalfa	Straw+E+W
Barley straw, %	–	20.00
Alfalfa hay, %	20.00	–
Barley, %	62.40	62.40
Soybean meal, %	4.00	4.00
Sunflower seed meal, %	12.00	12.00
Limestone, %	0.80	0.80
Salt, %	0.40	0.40
Vitamin Premix*, %	0.20	0.20
Trace min. Premix**, %	0.20	0.20
Analysis		
Dry matter, %	90.00	90.00
Crude protein, %	16.02	16.02
Ash, %	7.00	8.70
Ether extract, %	2.61	4.83
Crude fiber, %	11.49	13.29
Nitrogen free extract, %	52.88	47.16
ME, MJ/kg DM+	12.06	12.03

*: Per kg include; 1.200.000 IU vit A, 200.000 IU vit D_3, 5.000 mg vit E, 100 mg vit K_3, 100 mg vit B_1, 50 mg vit B_2, 10 mg vit B_6, 500 mg Niacin, 300 mg Cal-D-Pentotenate and 100 mg vit C.
**: Per kg include; 5.000 mg Fe, 5.000 mg Zn, 1.000 mg Cu, 200 mg I, 50 mg Co, 30 mg Se, 54.000 mg P, 319.000 mg Ca, 100.000 mg NaCl and 15.000 mg Antioxidant.
+: Determined by calculation.

Experimental procedure and sampling: The experiment was carried out in individual cages using the facilities in the RAFUF. Lambs were weighed following overnight fasting, and three groups, each consisting of 10 lambs, were formed by balancing body weights. The experiment started in all groups at the same time and each lamb was fed individually. The experiment consisted of a 14 day pre-experimental period and 56 days of sampling period. After the sampling period a 10 day digestibility period was carried out. Feedstuffs and water were offered *ad libitum* throughout the study except during the digestibility trial when only 90 % of the feedstuff was offered daily. The animals were fed twice a day, at 08.00 and 18.00 hours.

Daily feed consumption was determined following 14 days pre-experimental period by calculating the difference between consumed feed and left-over. For that purpose, each day, feed was weighed and offered *ad libitum* and the following

morning the left-over feed was deduced. Body weight gain, after the pre-experimental period, lambs fasted overnight were weighed and initial body weight was determined. Weighing was carried fortnightly throughout the study and daily BW gain was calculated by dividing it by 14. Feed efficiency ratio was calculated by dividing daily feed consumption to daily BW gain.

For the determination of left-over feed, metabolic pens were cleaned each day and spilled feed particles were carefully collected and weighed everyday before morning feedings. Left-overs were placed into separate plastic bags and at the end of the experiment a subsample (10 %) was taken and dried at 60 ^{o}C for 36-48 hours for subsequent analyses.

During the digestibility study waterproof plastic bags were fitted to the back of the animals for the collection of faces. Before morning and noon feedings, faces was removed from the bags and weighed. A subsample (100 g) was taken from daily collected faces for 5 consecutive days and ground after drying at 60 ^{o}C for 36-48 hours for the assessment of dry matter and chemical analyses.

Chemical analyses was carried out in the feed consumed and refused and in the faces. Dry matter, ash, organic matter, crude protein and ether extracts were determined according to A.O.A.C (1990), crude cellulose was determined according to Crampton and Maynard (1983), energy content of the feed was calculated according to Meyer *et al*. (1984).

All data were subjected to analysis by Mann-Whitney U test using procedures of SPSS statistical program (1993).

RESULTS AND DISCUSSION

Feed intake at days 1-56 of the experiment is presented in Table 2. From 1 to 56 days, feed intakes differed ($p<0.05$) between treatments. The intake in lambs fed the ration containing Alfalfa was higher than in Straw+E+W group. The reason for lower feed intake in Straw+E+W group could be due to high level of crude fiber in the feed and/or to the taste of straw+egg+whey mixture.

Table 2. Daily feed intake (g)

Days	Alfalfa	Straw+E+W	*P
1-14	1193.64	1055.47	*
14-28	1389.46	1230.14	*
28-42	1406.68	1249.18	*
42-56	1454.46	1304.87	*
1-56	1361.06	1209.91	*

*: $p<0.05$

The BW gain and daily BW gain during the experiment are presented in Table 3 and 4. The BW gain and daily BW gain were similar between groups ($p>0.05$). Feed conversion was significantly improved by the addition of the

cracked egg+whey mix (Table 5) ($p<0.05$). At day 56, feed conversion ratio in Straw+E+W group was improved approximately 10% compared to the Alfalfa group. Considering that the meals were isocaloric and isonitrogenous, these differences may arise from using good quality protein sources. While soybean meal, sunflower seed meal and alfalfa hay were used as protein sources in Alfalfa group, egg and whey were used as protein sources in the Straw+E+W group. The amino acid composition is better in egg and whey proteins than soybean meal, sunflower seed meal and alfalfa hay. Besides, egg is high in nutrients and the high quality protein is used as a standard for the assessment of the protein quality of other feedstuffs (Tekinsen and Çelik 1995) due to its excellent amino acid profile and biological value of proteins (Yamamato *et al*., 1997). In growing animals, amino acid composition is very important for the synthesis of body proteins. If an imbalance or deficiency of one or more essential amino acids is present body protein synthesis is impaired. Therefore, for an adequate and balanced growth up in young animals, not only the feed protein levels have to be adequate (Anderson *et al.,* 1988; Comeford *et al*., 1992, Çerçi *et al*., 1996), but the amino acid profile and the biological value of proteins has to be balanced as well. In this study, better performance shown by animals in Straw+E+W group may be due to the use of high quality animal protein sources like egg and whey in addition to vegetal protein sources like soybean meal, sunflower seed meal and alfalfa hay.

Table 3. Body weight gain (kg)

Days	Alfalfa	Straw+E+W	P
Initial	28.3	28.4	NS
14^{th} d	31.5	31.8	NS
28^{th} d	34.9	35.3	NS
42^{th} d	38.5	38.9	NS
56^{th} d	42.3	42.2	NS

NS: Not significant ($p>0.05$)

Table 4. Daily body weight gain (g/d)

Days	Alfalfa	Straw+E+W	P
1-14	228.57	242.86	*
14-28	242.86	250.00	NS
28-42	257.14	257.14	NS
42-56	271.42	235.71	*
1-56	250.00	246.43	NS

NS: Not significant ($p>0.05$), *: $p<0.05$

Table 5. Feed conversion ratio in groups, g feed intake/ g BW gain

Days	Alfalfa	Straw+E+W	P
1-14	5.22	4.34	*
14-28	5.72	4.92	*
28-42	5.47	4.86	*
42-56	5.36	5.53	NS
1-56	5.44	4.91	*

NS: Not significant ($p>0.05$), *: $p<0.05$

The significantly improved feed conversion in lambs fed Straw+E+W in this study is in agreement to the available literature data. Published papers report that BW gain and feed conversion ratio increased with increasing protein quality (Fluharty *et al*., 1994; Sahlu *et al*., 1992; Hussein and Jordan, 1991; Houghton *et al*., 1990). Fahmy *et al*. (1992) reported that average daily body weight gain of lambs fed fish meal (226 g) and corn gluten-blood meal (217 g) were higher than that of lambs fed soybean meal (189 g) or control (186 g) diets and feed conversion ratio of lambs fed fish meal (4.99) and corn gluten-blood meal (5.11) were higher than that of lambs fed soybean meal (5.48) or control (5.76) diets. Stock *et al.* (1983) reported that there was a significantly greater conversion of protein in blood meal supplemented lambs than in soybean meal supplemented lambs and, daily weight gain and feed conversion ratio increased linearly with protein levels. Literland *et al.* (2000) reported that average daily body weight gain was greater in the fish meal group compared to the corn gluten meal, cottonseed meal and feather meal groups. Hussein *et al.* (1991) reported that average daily body weight gain of growing-finishing lambs improved by replacing soybean meal with fish meal in the diet. Hassan and Byrant (1986) showed that lambs given fish meal had greater body weight gain than unsupplemented lambs. Blasi *et al*. (1991) reported that the addition of blood meal increased daily gain compared to feather meal. Lu *et al.* (1990) reported that milk yield was higher in meat and bone meal supplemented group than in soybean meal group. On the contrary, Schloesser *et al.* (1993) reported that compared to soybean meal, no advantages were detected for blood meal supplementation and dietary treatments had no influence on ewe BW. Peterson *et al.* (1983) reported that daily gains were not affected by protein sources. Similarly, in a study carried out by Sommer *et al.* (12) it was demonstrated that, in isonitrogenous diets the usage of soybean meal, cottonseed meal, sunflower meal and rapeseed meal as sources of protein did not result in significant differences in growth rates in ruminants.

The digestibility of dry matter, crude protein, ash, ether extract, crude fiber and nitrogen free extract was to be found similar between groups (Table 6) ($p>0.05$). Rations had similar chemical composition (Table 1) and physical properties. Peterson *et al.* (1983) reported that the digestibility of nutrients was not changed by protein source.

Table 6. Digestibility of nutrients, %

	Alfalfa	Straw+E+W	P
Dry matter	72.88	72.96	NS
Crude protein	74.31	74.53	NS
Ash	41.10	41.05	NS
Ether extract	83.14	83.00	NS
Crude fiber	41.20	40.95	NS
Nitrogen free ext.	75.80	75.75	NS

NS: Not significant ($p>0.05$)

In conclusion, low quality forages like barley straw treated with high quality protein sources like UCE and whey in young animals may be an alternative to quality forage like alfalfa hay.

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UPOTREBA NEPRODATIH, NAPRSLIH JAJA I SURUTKE U POVEĆANJU NUTRITIVNE VREDNOSTI JEČMENE SLAME

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SADRŽAJ

U ovom radu je ispitivan uticaj mešavine neprodatih, naprslih jaja (UCE) + surutke (60% + 40% surutke) dodavane ječmenoj slami, u cilju povećanja njene nutritivne vrednosti. Slama je poređena sa senom lucerke. U slučajnom uzorku je korišćeno dvadeset jagnjadi, prosećne starosti od 7 meseci (svaka grupa se sastojala od po 10 jagnjadi). Obroci su pripremljeni tako, da budu izokalorični i izonutrigeni i ispitivani su njihovi efekti na uzimanje hrane, povećanje telesne mase, konverziju hrane i svarljivost hranljivih materija. Merena je dnevna konzumacija hrane, telesna masa i efikasnost ishrane u grupi sa lucerkom i slama+ jaja + su-

rutka (drugoj) grupi i utvrđeno je, da dnevna konzumacija hrane iznosi 1361.06 g i 1209.91 g ($p<0.05$), dnevno povećanje telesne mase 250.00 g i 246.43 g ($p>0.05$), odnos konverzije hrane 5.44 i 4.91 ($p<0.05$). U obe grupe, svarljivost hranljivih materija je bila slična ($p>0.05$). Konzumacija hrane je bila manja u slama+ jaja + surutka grupi, ali su jagnjad iz ove grupe ispoljila bolje napredovanje i uzrok može biti kvalitet izvora proteina. Autori su zaključili da dodavanje kvalitetnog izvora proteina, kao što su jaja, povećava nutritivnu vrednost ječmene slame.