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Research Article

Determination of the Feeding Values of Feedstuffs and Mixed Feeds Used in the Southeastern Anatolia Region of Turkey

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Abstract: It is very important to know the feeding value and metabolizable energy content of feedstuffs for balancing animal diets. Feeding value and energy content of animal feeds change according to maturity stage, soil conditions, fertilization, climate, processing methods, etc. There are no adequate tables that show the basic feeding values of feedstuffs grown in different regions of Turkey; therefore, the present study analyzed 8 different feedstuffs and 56 dairy and beef cattle mixed feeds to determine their feeding value and energy content. Additionally, the possibility of using these feedstuffs for ruminant nutrition is discussed. Crude protein content of the dairy cattle mixed feeds and cotton seed values were lower than standard values. This finding is very important for animal feeding in the region.

Key Words: Feedstuff, mixed feed, nutrient, quality

Güneydoğu Anadolu Bölgesinde Kullanılan Yem Ham Maddelerinin ve Karma Yemlerin Besin Maddeleri Yönünden Değerlendirilmesi

Özet: Yeterli ve dengeli bir rasyon hazırlayabilmek için, karma yeme girecek yem hammaddelerinin besin maddeleri ve enerji kapsamlarının bilinmesi çok önemlidir. Yemlerdeki besin maddeleri ve enerji miktarları; hammaddenin olgunluk derecesi, yetiştiği toprak, gübreleme, iklim ve işlenme metotları gibi bir takım faktörlere bağlı olarak değişebilmektedir. Ülkemizde değişik bölgelerde yetiştirilen ve üretilen yem ham maddelerinin temel besin maddeleri ve enerji içeriklerini gösteren çok az sayıda tablo bulunmaktadır. Bundan dolayı, bu araştırmada ruminant ve kanatlı beslenmesinde yaygın olarak kullanılan 8 farklı yem hammaddesi ile et ve süt sığırlarının beslenmesinde kullanılan 56 adet karma yemin temel besin maddeleri ve enerji içerikleri saptanmış ve bunların ruminant beslenmesinde kullanılma olanakları tartışılmıştır. Sığır süt yemlerinde ve pamuk tohumu küspesinde ham protein değerleri standart değerlerin altında tespit edilmiştir. Bu durum bölge hayvancılığı açısından oldukça önemlidir.

Anahtar Sözcükler: Hammadde, karma yem, besin maddesi, kalite

Introduction

Most feed grains are members of the Gramineae and Leguminosae families. Gramineae species are rich in energy, while Leguminosae species are rich in calcium and protein. Feed grains have lower cellulose content and are highly digestible. These grains are known as concentrate feeds due to their high digestibility (1). There was a negative relationship reported between the fiber and energy contents of feedstuffs (2). The nutrient contents of grains change according to maturity stage, size, ecological conditions, fertilization, etc. Large mature grains have higher starch content than immature small grains, while small grains have higher crude protein content. Feed grain Gramineae is an extensive family, but corn, sorghum, barley, and oat species have a particularly important role in animal nutrition. In addition, these species are grown as second and inter crops (3).

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Plant-originated feedstuffs are primarily used in animal mixed feeds. Animal mixed feeds contain approximately 90% of such products (1,4,5). In order to organize mixed feed production for feed manufacturers and consumers, animal mixed feed legislation was prepared (6).

Currently in Turkey, production of feedstuffs is insufficient and there have been some quality control problems. Production and quality problems lead governments to import basic feed grains. Low quality feed stuffs can cause serious nutritional disorders in animals (7). In order to prevent health problems that arise from imbalanced and insufficient nutrition, a higher quantity and quality of animal products used to manufacture mixed feeds is essential (5,8,9). Approximately 4.2% of ruminant mixed feeds are produced in the Southeastern Anatolia region of Turkey (10). Along with poultry feeds, approximately 2.4% of Turkey's total mixed feed is produced in the region (11). The genetic potential of animals and high quality feeds are the 2 most important factors for producing economical animal products. Increasing awareness of these factors may increase animal production productivity.

In EU countries, most feed mills have ISO 9000 quality standards. This kind of feed manufacturing produces high quality and standardized animal feeds. This standard is essential for producing standardized feed in Turkey (9). Feed manufacturing in the Southeastern Anatolia region is not high quality or standardized. One of the main reasons is low quality and non-standardized feedstuffs. Restrictions on manufacturers to produce standardized mixed feeds are not adequately enforced.

The nutrient content of feedstuffs changes according to field, season, climate, processing and storage conditions, irrigation, and fertilization (12); therefore, it is important to know the exact nutritional composition of feedstuffs. All components of feedstuffs need to be analyzed for proper nutritional value. In Turkey, only the approximate nutrient composition of feedstuffs is presented in nutritional tables; however, at the minimum, these nutrient tables should be prepared by considering different climatic conditions (13-17). As the tables used in Turkey are inadequate, using foreign sources of information to formulate animal diets can result in serious errors (13).

There are no standards for the nutritional value and energy content of feedstuffs according to regional origins in Turkey; therefore, the present study was conducted in the Southeastern Anatolia region of Turkey to determine the feeding value and energy content of 8 different feedstuffs, and 56 dairy and beef cattle mixed feeds widely used for the nutrition of ruminants and poultry. The possibility of using these feedstuffs for ruminant nutrition is also discussed.

Materials and Methods

In this research 8 different feedstuffs (196 feedstuff samples) widely used in the Southeastern Anatolia region for ruminant and poultry nutrition, and 56 dairy and beef cattle mixed feeds used as materials between 2003 and 2007 were analyzed. Samples of feedstuffs and mixed feeds were collected from stores. Nitrogen-free extract and metabolizable energy (ME) contents were determined, and classical sources were used for sample collection (18). When samples reached the laboratory their dry matter content was determined as soon as possible (3,18) and then they were stored at –20 °C.

Ruminant mixed feeds and feedstuffs were analyzed chemically by the AOAC method (19), and crude fiber was analyzed according to Crampton and Maynard (20). ME values of the samples used for ruminants were calculated as kcal/kg in organic matter (OM using the following equation (21):

ME (kcal/kg OM) = 3260 + 0.455 × A - (4.037 × B + 3.517 × C);

A = Crude protein, g/kg OM

B = Crude fiber, g/kg OM

C = Crude fat, g/kg OM.

The Minitab for Windows v.13.0 package program (22) was used for analyzing all feedstuffs and mixed feeds.

Results

The nutritional values of feedstuffs (wheat, wheat bran, barley, sorghum, corn, lentil, cicer, cottonseed meal), and dairy and beef cattle mixed feeds widely used in the Southeastern Anatolia region of Turkey are presented in Table 1. Dry matter, crude protein, crude fat, crude fiber, crude ash, nitrogen-free extract matter, and metabolizable energy values and distribution proportions of the feedstuffs and mixed feeds are presented in Tables 2, 3, 4, 5, 6, 7, and 8, respectively.

Table 1. Nutrient content of feedstuffs and mixed feeds (%).

		%						
		Dry matter	Crude protein	Crude fat	Crude fiber	Nitrogen-free extract matter	Crude ash	ME kcal/kg OM
Feedstuffs	n	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD	mean ± SD
Wheat	32	92.14 ± 0.58	14.44 ± 1.10	2.13 ± 0.24	4.62 ± 0.50	67.45 ± 1.50	3.5 ± 0.66	3039 ± 24.10
Wheat bran	28	91.41 ± 0.77	15.08 ± 0.99	3.65 ± 0.43	10.14 ± 0.78	58.44 ± 1.38	4.10 ± 0.56	2723 ± 38.60
Barley	28	92.54 ± 0.63	11.16 ± 0.52	2.37 ± 0.24	7.24 ± 0.81	68.15 ± 1.39	3.62 ± 0.21	2894 ± 43.00
Sorghum	22	91.94 ± 0.63	9.66 ± 0.62	3.43 ± 0.45	3.76 ± 0.49	72.79 ± 1.11	2.29 ± 0.19	3003 ± 32.30
Corn	23	91.45 ± 0.61	8.71 ± 0.63	3.36 ± 0.49	3.49 ± 0.51	74.11 ± 0.83	1.78 ± 0.41	3016 ± 22.80
Lentil	23	92.35 ± 0.36	25.71 ± 0.64	1.65 ± 0.21	4.54 ± 0.37	56.78 ± 0.88	3.67 ± 0.25	3120 ± 20.40
Cicer	20	92.86 ± 0.42	24.68 ± 1.17	5.09 ± 0.34	6.45 ± 0.38	54.15 ± 1.33	2.49 ± 0.24	2907 ± 46.80
Cotton s. meal	20	93.04 ± 0.56	27.19 ± 2.24	5.69 ± 0.98	21.70 ± 3.87	33.01 ± 3.13	5.45 ± 0.95	2176 ± 145.90
Mixed feeds								
Dairy cattle	30	90.71 ± 2.21	15.13 ± 2.31	2.72 ± 0.53	11.50 ± 2.62	53.52 ± 3.90	7.85 ± 1.49	2667 ± 124.40
Beef cattle	26	91.08 ± 2.27	12.60 ± 2.99	2.66 ± 0.78	11.20 ± 2.50	56.75 ± 3.80	7.87 ± 2.21	2673 ± 124.60

Table 2. Dry matter distribution proportions of feedstuffs and mixed feeds (%).

		Dry matter (%)								
Feedstuffs	n	89-90	90-91	91-92	92-93	93-94	94-95			
Wheat	32	-	-	46.88	43.75	9.38	-			
Wheat bran	28	-	39.29	39.29	21.43	-	-			
Barley	28	-	3.57	3.57	64.29	25.00	3.57			
Sorghum	22	-	-	54.55	36.36	9.09	-			
Corn	23	4.35	8.70	69.57	17.39	-	-			
Lentil	23	-	-	-	86.96	13.04	-			
Cicer	20	-	-	-	60.00	40.00	-			
Cotton s. meal	20	-	-	-	50.00	40.00	10.00			
Mixed feeds		84-85	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94
Dairy cattle	30	-	6.67	3.33	16.67	13.33	-	30.00	16.67	13.33
Beef cattle	26	3.85	-	3.85	11.53	11.54	7.69	11.54	26.92	23.08

Table 3. Crude protein distribution proportions of feedstuffs and mixed feeds (%).

		Crude protein (%)											
Feedstuffs	n	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	
Wheat	32	-	-	-	-	6.25	3.13	21.88	31.25	37.50	-	-	
Wheat bran	28	-	-	-	-	-	-	17.86	32.14	39.29	3.57	7.14	
Barley	28	-	-	-	32.14	60.71	7.14	-	-	-	-	-	
Sorghum	22	-	13.64	59.09	27.27	-	-	-	-	-	-	-	
Corn	23	8.70	65.22	26.09	-	-	-	-	-	-	-	-	
		22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31	31-32	32-33	33-34
Lentil	23	-	-	21.74	30.43	47.83	-	-	-	-	-	-	-
Cicer	20	10.00	20.00	10.00	50.00	10.00			-	-	-	-	-
Cotton seed m.	20	5.00	-	10.00	5.00	20.00	15.00	35.00	5.00	-	-	-	5.00
Mixed feeds		7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19
Dairy cattle	30	-	-	-	6.67	3.33	6.67	10.00	23.33	10.00	16.67	13.33	10.00
Beef cattle	26	3.85	7.69	7.69	11.54	19.23	7.69	15.38	3.85	7.69	3.85	7.69	3.85

Table 4. Crude fat distribution proportions of feed stuffs and mixed feeds (%).

		Crude fat (%)					
Feedstuffs	n	1-2	2-3	3-4	4-5	5-6	6-7
Wheat	32	25.00	75.00	-	-	-	-
Wheat bran	28	-	3.57	85.71	10.71	-	-
Barley	28	3.57	92.86	3.57	-	-	-
Sorghum	22	-	13.64	72.73	13.64	-	-
Corn	23	-	26.09	65.22	8.70	-	-
Lentil	23	95.65	4.35	-	-	-	-
Cicer	20	-	-	-	50.00	50.00	-
Cotton seed meal	20	-	-	10.00	10.00	40.00	40.00
Mixed feeds							
Dairy cattle	30	6.67	63.33	30.00	-	-	-
Beef cattle	26	23.08	42.31	23.08	11.54	-	-

Table 5. Crude fiber distribution proportions of feed stuffs and mixed feeds (%).

		Crude fiber (%)										
Feedstuffs	n	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13
Wheat	32	-	9.38	68.75	21.88	-	-	-	-	-	-	-
Wheat bran	28	-	-	-	-	-	-	3.57	50.00	32.14	10.71	3.57
Barley	28	-	-	-	3.57	42.86	32.14	21.43				
Sorghum	22	-	68.18	31.82	-	-	-	-				
Corn	23	13.04	65.22	21.74	-	-	-	-				
Lentil	23	-	-	78.26	21.74							
Cicer	20	-	-	-	10.00	75.00	15.00					
		14-15	15-16	18-19	19-20	20-21	21-22	22-23	23-24	24-25	26-27	27-28
Cotton s. meal	20	10.00	5.00	5.00	5.00	10.00	15.00	10.00	15.00	10.00	5.00	10.00
Mixed feeds		7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	
Dairy cattle	30	3.33	20.00	6.67	23.33	6.67	6.67	10.00	6.67	13.33	3.33	
Beef cattle	26	7.69	19.23	7.69	11.54	15.38	11.54	3.85	15.38	7.69	-	

Table 6. Crude ash distribution proportions of feedstuffs and mixed feeds (%).

		Crude ash (%)							
Feedstuffs	n	1-2	2-3	3-4	4-5	5-6	6-7	7-8	
Wheat	32	6.25	15.63	62.50	15.63	-	-	-	
Wheat bran	28	-	3.57	39.29	53.57	3.57	-	-	
Barley	28	-	-	96.43	3.57	-	-	-	
Sorghum	22	13.64	86.36	-	-	-	-	-	
Corn	23	65.22	34.78	-	-	-	-	-	
Lentil	23	-	-	86.96	13.04	-	-	-	
Cicer	20	-	95.00	5.00	-	-	-	-	
Cotton seed meal	20	-	-	-	35.00	40.00	15.00	10.00	
Mixed feeds		4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12
Dairy cattle	30	-	3.33	26.67	26.67	16.67	20.00	3.33	3.33
Beef cattle	26	15.38	3.85	15.38	19.23	15.38	11.54	7.69	11.54

Table 7. Nitrogen-free extract matter distribution proportions of feedstuffs and mixed feeds (%).

		Nitrogen-free extract matter (%)						
Feedstuffs	n	64-65	65-66	66-67	67-68	68-69	69-70	70-71
Wheat	32	-	9.38	43.75	15.63	18.75	6.23	6.26
Barley	28	3.57	3.57	17.86	7.14	42.86	17.86	7.14
		55-56	56-57	57-58	58-59	59-60	60-61	61-62
Wheat bran	28	-	14.29	25.00	35.71	10.71	10.71	3.57
Lentil	23	17.39	47.83	26.09	8.70			
		71-72	72-73	73-74	74-75	75-76		
Sorghum	22	27.27	27.27	31.82	9.09	4.55		
Corn	23	-	8.70	39.13	34.78	17.39		
		26-28	28-30	30-32	32-34	34-36	36-38	38-40
Cotton seed m.	20	5.00	15.00	15.00	35.00	10.00	15.00	5.00
		52-53	53-54	54-55	55-56	56-57	57-58	
Cicer	20	20.00	40.00	10.00	20.00	5.00	5.00	
Mixed feeds		46-48	48-50	50-52	52-54	54-56	56-58	58-60
Dairy cattle	30	10.00	10.00	20.00	10.00	26.67	13.33	10.00
		47-49	51-53	53-55	55-57	57-59	59-61	61-63
Beef cattle	26	3.85	11.54	23.08	11.54	15.38	15.38	19.23

Table 8. Metabolizable energy distribution proportions of feedstuffs and mixed feeds (%).

		Metabolizable energy (Mcal/kg of OM)					
Feedstuffs	n	2.95-3.00	3.00-3.05	3.05-3.10			
Wheat	32	6.25	53.13	40.62			
		2.60-2.65	2.65-2.70	2.70-2.75	2.75-2.80		
Wheat bran	28	10.71	10.72	53.57	25		
		2.80-2.85	2.85-2.90	2.90-2.95	2.95-3.00		
Barley	28	17.86	28.57	46.43	7.14		
		2.90-2.95	2.95-3.00	3.00-3.05			
Sorghum	22	4.55	27.27	68.18			
Corn	23	4.35	13.04	82.61			
		3.05-3.10	3.10-3.15				
Lentil	23	17.40	82.60				
		2.80-2.85	2.85-2.90	2.90-2.95	2.95-3.00	3.00-3.05	3.05-3.10
Cicer	20	10	30	55	-	-	5
		1.90-2.00	2.00-2.10	2.10-2.20	2.20-2.30	2.30-2.40	2.40-2.50
Cotton seed meal	20	10	25	30	20	5	10
Mixed feeds		2.40-2.50	2.50-2.60	2.60-2.70	2.70-2.80	2.80-2.90	
Dairy cattle	30	13.34	23.33	20	30	13.33	
Beef cattle	26	3.85	34.62	15.38	26.92	19.23	

Discussion

In the present study the nutrient value of the feedstuffs varied according to different factors and growing regions. In the Southeastern Anatolia region of Turkey, feed grains and wheat bran were affected less, but in particular crude protein content in dairy cattle feeds and cottonseed meal was less than the standard, which may have negatively affected animal productivity in the region.

Mean nutrient value of the dairy and beef cattle feeds were, respectively, as follows: crude protein, 15.13% and 12.60%; nitrogen-free extract matter, 53.52% and 56.75%; dry matter, 90.71% and 91.08%; crude fat, 2.72% and 2.66%; crude fiber, 11.50% and 11.20%; crude ash, 7.85% and 7.87%; metabolizable energy, 2667 and 2673 kcal/kg of OM (Table 1).

Çelik et al. (7) reported that there were statistically significant differences between dairy cattle diets in terms of crude ash ($P < 0.01$) and metabolic energy level ($P < 0.05$), and between beef cattle diets in dry matter ($P < 0.01$) and metabolic energy ($P < 0.05$) in the Marmara region of Turkey. At the same time, barleys from

southeastern Turkey differed significantly from those from the Marmara region, in terms of crude fat, fiber, and ash ($P < 0.05$), and ME ($P < 0.01$).

When we compared our results with those of studies from other countries the crude protein value of the feedstuffs from the Southeastern Anatolian region was lower, whereas dry matter, crude fat, and crude ash values were similar, and crude fiber content was higher than in feedstuffs from other countries (14-17). As such, feedstuffs in the study region had less nutritional value for animal feeds. These feedstuffs should not be used by farmers unless they know their exact nutritive values, as using them could result in malnutrition and/or nutritional disorders and consequent production losses.

Average dry matter content of all the investigated feedstuffs and mixed feeds was > 90% (Table 1), which is essential for good storage conditions. As seen in Table 2, for all of the investigated feedstuffs, 90% of dairy cattle mixed feeds, and 92% of the beef cattle feeds, there were no problems associated with feeding or storage due to fungus.

Protein content of feedstuffs is very important for ruminant nutrition. The highest protein content was in dairy cattle feed, followed by beef cattle feed, cottonseed meal, and wheat bran (Table 3). This was due to the collection methods for mixed feeds and feed stuffs. As seen in Table 3, according to chemical protein analysis of dairy feeds, 60% of 30 samples were below quality standards (16% crude protein). In beef cattle diets, 50% of 26 samples are of low quality (< 12% CP). In oil seed meals in particular, protein content varies according to seed hull content, oil obtaining method, and heating temperature and duration (7,9,12,13). Crude protein content of cotton seed meals from the Southeastern Anatolia region had low protein value (21.70%) because of high linter content.

The greatest crude fat differences were observed between feed stuffs from cotton seed meals (Table 4). Oil seed meal differences resulted from different oil obtaining methods used by the oil manufacturers. Hydraulic methods were used to obtain these cotton seed oils. Cotton seed meals obtained hydraulically are rich in oil and have high energy content, but low levels of protein. Nonetheless, they contain high amounts of polyunsaturated fat acids, which can easily cause oxidation; therefore, some antioxidants need to be added.

Crude fiber content affects digestibility of feeds. The highest crude fiber ranges were obtained from cotton seed meal, dairy cattle feed, and beef cattle diets (Table 5). As seen in Table 3, protein contents of the same feed stuffs varied widely. This is evidence of a negative correlation between the crude protein and crude fiber contents of feedstuffs (15,23,24). Mean crude fiber content of cotton seed meal grown in the Southeastern Anatolia region is approximately 21.70%, which is higher than the minimum standard (15-17) (Table 1). The main reason for this is the high seed hull content of the meal. The high crude fiber content of wheat bran (10.14%) limits the amount that can be used in ruminant diets. Approximately 82% of the investigated 28 wheat bran samples had 9%-11% crude fiber content.

Crude ash contents of dairy and beef cattle diets varied widely (Table 6). Feed composition, feed stuffs, stone, soil, and limestone contents of feeds can increase crude ash content of mixed feeds. For example, 27% of 30 dairy cattle feeds and 31% of 26 beef cattle diets had higher crude ash contents than the standard (max: 9%), (Table 6). In a trial by Alp et al. (13), except for wheat bran and cotton seed meal,all feed stuffs had less crude ash content than our results show. They reported that the crude ash contents of wheat bran and cotton seed meal were 5% and 5.89%, respectively, higher values than obtained in the present study.

Nitrogen-free extract matter contents of feed stuffs and mixed feeds were obtained by using chemical analysis results, and thus reflect all of the nutrient contents. As seen in Table 7, the highest nitrogen-free extract matter range was obtained from dairy and beef cattle diets.

It is thought that changes in organic matter and digestibility of cotton seed meal, and dairy and beef cattle mixed feeds can cause energy to vary widely (Table 8). In the present study, metabolic energy contents of 87% of dairy cattle mixed feeds and 94% of beef cattle feeds had more than 2500 kcal/kg of organic matter, which is higher than minimum standards.

Mixed feeds for ruminants have been produced in Turkey according to the Mixed Feed Law (No. 1734) since 1973 (9). Additionally, the Turkish Standards Institute (TSE) released another standard for the feed industry in 1991 (21). Our results showed that the samples we evaluated did meet the standards set by the TSE. It is thought that the low protein contents of dairy mixed feeds and high fiber contents of dairy and beef cattle

feeds were the result of an inadequate control mechanism.

The aim of controlling mixed feed and feed stuffs is to protect animal breeders from inferior products and guarantee the quality of animal products. Success in this goal will prevent unfair competition among feed manufacturers (25). The primary aim of Feed Law No 1734 is to prevent feed manufacturers from unfair competition, guarantee standard feed quality, and control marketing (9,10).

As a result, feed stuffs in the Southeastern Anatolia region have lower crude protein and higher crude fiber contents than foreign feed sources, and their nutritive value is lower. Nutritional and energy content tables for locally grown feed stuffs in Turkey are limited, which can make formulating animal diets without chemical analysis in Turkey difficult. It is, therefore, extremely important to prepare nutrition value tables for locally grown feed stuffs, especially for crude protein, fiber, and energy contents.

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