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ve Hastalıkları
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**Hayvan Besleme ve
Hastalıkları Alanında
Arařtırmalar ve
Deęerlendirmeler**

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BÖLÜM 1

RENKLİ TİFTİK KEÇİSİ YETİŞTİRİCİLİĞİ

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1. GİRİŞ

Keçi; beslenme davranışlarıyla, farklı beslenme koşullarına adaptasyon yeteneğiyle, engebeli arazilere uygun olan yapısal özellikleriyle, olumsuz çevre şartlarına dayanıklılığıyla, kaba yemleri ve selülozu sindirebilme yeteneklerine sahip bir ruminanttır. Bu yüzden iklim, arazi ve mera şartlarının elverişsiz olduğu bölgelerde koyun ve sığırlardan daha fazla keçi yetiştiriciliği yapılmakta ve üstelik çoğu yerlerde bulunduğu işletmede tek hayvan türü olarak keçi yetiştirilebilmektedir. Keçiler yalnız yamaçlara rahatlıkla tırmanabilen, keskin yamaçlar ve uçurum kenarlarında dolaşmaktan çekinmeyen bir hayvan türüdür. Bundan dolayı geçilmesi zor olan geçitlere keçiyolu denmektedir. Evcil keçi türlerinden et, süt, deri ve tiftiği için beslenen, aynı zamanda gübresi de kullanılabilen bir türdür. Günümüz dünyasında farklı iklim ve coğrafi şartlarına sahip tüm bölge ve ülkelerde keçi yetiştiriciliği yapılabilmektedir (Aydm, 1999).

Keçi eti öncelikle Orta ve Doğu Avrupa ülkeleriyle beraber Orta Amerika ile Güney Amerika ve Asya kıtasının çoğunlukla kırsal kesimlerinde yaşayan insanların vazgeçilmez bir protein kaynağıdır. Bu yüzden et üretimi açısından önemli bir yer tutmaktadır (Mahpoub ve Lu, 1988. Güney ve ark., 1990. Devandra, 1981).

Tiftik keçisinde başta tiftik verimi olmak üzere et, süt ve döl verimleri kalitesi üzerinde yapılacak çalışmalar, üreticilerin hayvanlardan daha fazla verim ve randıman almasında önemli bir rol oynamaktadır.

2. TIFTİK KEÇİSİ TARİHÇESİ

Keçilerin milattan önce 9000 ile 6000 yıllarında evcilleştirildiği öngörülmektedir (Özcan 1989). *Capra aegagrus hircus* dediğimiz evcil keçi, Bovidae familyasının Caprinae alt familyasından *Capra aegagrus hircus* alt türünü oluşturan çift tırnaklılara verilen isimdir. Evcil keçiler, Avrupa'nın doğusunda ve Orta Doğu'da yaşamlarını sürdüren ve insanlar tarafından yaban keçisinin ilk evcilleştirildiği hayvanlardan biridir (Oklahoma State University Board of Regents, 2008). 300'e yakın farklı türde keçi ırkı bulunmaktadır (Hirst, 2008). Bu türlerden biri olan Ankara (Tiftik) keçisi, Ankara'ya özgü bir keçi ırkıdır. Tiftik keçilerinin ataları 13. yüzyılda Orta Asya bölgesinden Anadolu topraklarına göç eden Türkler tarafından, Hazar Denizi'nin doğu kısmından getirilmiştir (Wayback, 2008). Orta Anadolu'nun iklim şartlarına zamanla adaptasyon sağlamış ve ülkemize ve Ankara ilimize has bir keçi türü olmuştur (AnkaraKeçisi.com, 2015).

Tiftik keçisi 1930'da totalde 61 ilde Tiftik keçisi yetiştiriciliği yapılırken 2000 yılında bu sayı bu sayı 26'ya, 2010 yılında 22 ilde ve şimdilerde ise 18 ile kadar gerilemiştir. Türkiye'de 1930'da totalde 2 839 973 adet

Tiftik keęisi sayısı 2000 yılında 373 000 başa gerilemiř olup gnmzde bu sayı 212 516 bařtır (www.tuik.gov.tr, 2023).

lkemiz haricinde çeřitli lkelerde yetiřtiricilięi yapılmaktadır. Bunlardan ABD, Gney Afrika, Yeni Zelanda, Kanada, Arjantin, Rusya ve Brezilya gibi lkelerde varlıęını srdrmektedir (Wayback, 2008). oęu lkelerde mohair diye isimlendirilen tiftik, dnyaya lkemizden yayılan Ankara Keęisi'nin bir rndr ve genel olarak dnyada 'The Angora Goat' řeklinde tanınmaktadır. Keęi yetiřtirme eskilerden beri lkemiz insanı iin olduka nemlidir. Keęi; Anadolu insanının beslenmesi, giyinmesi, barınması ve dięer benzeri konularda ekonomik artularıyla birlikte manevi anlamda nem tařımaktadır (Kaymakı ve Askın, 1997). Orta Anadolu'nun coęrafya ve iklimine adaptasyon saęlamıř ve ekonomik gelir saęlayan sekin bir tr olmuřtur. 1939'a kadar yalnız Orta Anadolu Blgesinde, zellikle Ankara ve evresindeki illerde ekonomik bir unsur olan Ankara Keęisi, bařka zaman dilimlerinde bu blgelerden dıř lkelere gnderilerek, yetiřtiricilięi yapılan her yerde asıl ismini korumuřtur. (www.kulturportali.gov.tr, 2023).

Hem dıř hem i piyasa pazarlarında 15. yzyıldan itibaren raębet gren ve lkemizde tiftięe baęlı geliřen bir dokuma sanayi ile birlikte tiftik iplięinden ve tiftikten ortaya ıkan kumařlar nemli bir ekonomik canlılık kazandırmıřtır. Bařlıca olarak Engr Sofu dedięimiz katıřsız tiftik iplięi 16 ile 18. yzyıllar arasında nemli lde eřitli Avrupa lkelerinde satılmıřtır. Ancak 18. yzyılın ortalarında tiftik iplięinden İngiltere'nin dokuma sanayisinde ilerle kaydetmesi zerine lkemizdeki tekstil sanayi ekonomisinin dřmesine neden olmuřtur. Ancak 19. yzyılda lkemizde tiftik iplięi yerine ham tiftik satılmaya bařlanılmıř ve ekonomik bazda bir sre daha ekonomik canlılık devam etmiřtir. Ancak 19. yzyıl sonrasında lkemiz dıřına Tiftik keęisinin ıkarılmasıyla ve Gney Afrika ile ABD gibi lkelerde yetiřtirilmeye bařlanmasıyla Ankara ilimizin tiftik retimi bitmiřtir. (www.ankaratb.org.tr, 2023).

Gney Afrika'da Tiftik keęisi ilk olarak 1836 senesinde Henderson aracılıęıyla lkemizden gtrlen 13 adet Tiftik keęisi ile bařlamıřtır. ABD ise Ankara keęisi yetiřtiricilięine 1849 senesinde Dr. James Davis'e ABD Bařkanı adına gnderilen 9 adet keęi ile bařlamıřtır. (Tamur ve Erman, 2003).

Osmanlı Devleti'nin son dnemlerinde, Tiftik keęisi yetiřtiricilięi ile elde edilen tiftięin nemi anlařılmıř, retiminin ve sanayisinin geliřtirilmesi konusunda giriřimlerde bulunulmuřtur. Bundan dolayı 1881'de dnemin padiřahı II. Abdlhamid'in fermanıyla Tiftik keęisinin yurt dıřına gnderilmesi ortadan kaldırılmıřtır. Buna raęmen 1911 senesinde lkemizin dnyadaki Ankara Tiftik keęisi poplasyonu % 38'e kadar geriye gitmiřtir (Tamur ve Erman, 2003).

3. TIFTİK KEÇİSİNİN GENEL ÖZELLİKLERİ

3.1. Tiftik Keçilerinin Morfolojik Özellikleri

Tiftik keçileri cüsse olarak ufak yapıdırlar. Anadolu'da yetiştirilen Tiftik keçileri genellikle boynuzlu olmaktadır. Erkeklerin boynuz yapısı dişilere oranla daha uzun ve daha iyi gelişmiştir. Yine erkek Tiftik keçilerinde başın yandan görünüşü dışbükey, dişilerde ise içbükeydir. Kulaklar çoğunlukla uzun ve sarkık olarak görülmektedir. (Kaymakçı ve Askın, 1997. Şengonca, 1989). Memelerin morfolojik yapısı dişi keçilerde memelerin vücuda bağlantısı lamina laterales ve lamina mediales ile asılı olması ve genç veya hiç sağılmamış büyüme evresine yeni girmiş keçilerde memenin şekli silindirik, yaşlı ve çok sütlü olan keçilerde konik biçimde bulunmaktadır. (Özcan, 2000).

Tablo 3.1.1. Renkli Tiftik keçilerin 2. ve 3. yaşındaki çeşitli verim özelliklerinin ortalama değerleri (Yertürk ve Odabaşoğlu, 2007)

Özellik	2 Yaşlı ($\bar{X} \pm S \bar{x}$)	3 Yaşlı ($\bar{X} \pm S \bar{x}$)
Canlı ağırlık (kg)	25.67±0.43	26.14±0.52
Tiftik verimi (g)	520±0.02	710±0.05
Cidago yüksekliği (cm)	55.05±0.39	56.02±0.40
Beden uzunluğu (cm)	63.60±0.38	66.37±0.37
Göğüs çevresi (cm)	79.40±0.64	82.68±0.68
Göğüs derinliği (cm)	26.86±0.28	28.29±0.31
Günlük süt verimi (g)	434.8±22.84	450.05±25.49
Laktasyon süresi (gün)	170±3.51	180.73±1.56
Gebelik oranı (%)	73.90	84.10
Doğum oranı (%)	67.39	77.27
Doğumdaki oğlak sayısı	1.06	1.09
İkizlik oranı (%)	6.45	8.82
Oğlaklarının yaşama gücü (%)	81.82	89.19
Tiftik randımanı %	78.55	78.40

Siirt ilinde ve çevre illerde yetiştirilen Tiftik ırkı keçilerinin saf yetiştirme, melezleme ve seleksiyon etkileriyle değişik renkler olan beyaz, kahverengi, siyah, deve tüyü, sarı, kırmızı ve gri renklerde görülmektedir (www.esk.gov.tr 2023). Ama renk bakımından çoğunlukla Anadolu'da bulunan Tiftik keçileri özellikle beyaz tiftik rengindedirler. Vücudun belli

bölgelerinde (yüz kısmı, ayak kısmı ve kulak kısımlarında) renk bulunabilmektedir. (Yertürk ve Odabaşıođlu, 1998).

3.2. Tiftik Verimi ve Özellikleri

Tiftik keçilerinin en önemli verimleri tiftik denilen elyafıdır. Tiftik keçisinde tiftik yapısı deri içerisinde folikül ya da kıl yatađı denilen birimlerin kılları oluřturmasıyla řekillenmektedir. Kılların řekillendiđi deri tabakasında oluřan tabakalar; epidermis (kutikula, pul), corium (korteks) ve subcutis olarak üç tabakadan řekillenmektedir. Tiftik keçilerinde bakım ve beslemeye bađlı olarak kıllarda ki büyümeler ve uzamalar devamlıdır.

Tiftik keçileri bir step (bozkır) hayvanı olmakla beraber nispeten yüksek bölgelerde, ortalama 800 metreden daha üst rakımlarda, yađışın az ve kuru olduđu bölgelerde yetiřtirilebilmektedir (www.tiftikbirlik.com.tr, 2017). Bu yüzden tiftiđin üretim miktarları ve alanları oldukça sınırlıdır olmaktadır. Dünyanın tiftik üretiminin neredeyse tamamına yakın bir bölümü, Güney Afrika Cumhuriyeti ve ABD; diđer bir bölümü ise Türkiye, Avustralya, Arjantin, Yeni Zelanda ve Lesoto gibi ülkeler aracılıđıyla sağlanılmaktadır. Tiftik keçisi yetiřtiriciliđi, Güney Afrika'ya 1800'lerin ortasında Anadolu'dan götürülen az sayıda keçi ile bařlayıp, kısa bir zaman içerisinde ülke kırsalında çokça yetiřtirilmeye bařlanmıřtır. Bu sebeple süreç içerisinde Tiftik keçisinin ırkının verimleri ve tiftiđinin kalitesi olarak Türkiye'nin önüne geçilmiş ve dünya piyasalarına hakim olmuřlardır (Chain, 2014).

Tablo 3.2.1. Dünya Tiftik Üretimi, (bin ton) (Review, 2000-2013)

YIL	GÜNEY AFRİKA	TÜRKİYE	ABD	ARJANTİN	YENİ ZELANDA	LESOTO	DİĐER	TOPLAM
2000	4,3	0,4	1	0,3	0,2	0,5	0	6,6
2001	4,2	0,3	0,8	0,3	0,2	0,5	0,3	6,5
2002	4,2	0,3	0,8	0,3	0,1	0,5	0,3	6,3
2003	4	0,3	0,9	0,3	0,2	0,5	0,3	6,3
2004	3,7	0,2	0,85	0,3	0,2	0,5	0,2	5,8
2005	3,6	0,3	0,8	0,3	0,2	0,6	0,3	6,0
2006	3,4	0,3	0,8	0,4	0,1	0,75	0,2	5,9
2007	3	0,35	0,55	0,45	0,1	0,75	0,2	5,4
2008	2,9	0,35	0,5	0,45	0,05	0,75	0,1	5,1
2009	2,6	0,3	0,5	0,7	0,1	0,75	0,2	5,1
2010	2,3	0,17	0,48	0,7	0,05	0,75	0,2	4,62
2011	2,23	0,15	0,35	0,7	0,04	0,75	0,2	3,91
2012	2,32	0,19	0,21	0,6	0,05	0,77	0,3	4,44

2013	2,40	0,26	0,15	0,5	0,03	0,80	0,2	4,33
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Ülkeler itibariyle 2000-2013 yılları arası dünya tiftik üretimi Mohair Review'den alınan verilerle Tablo 3.2.1.'de gösterilmiştir.

Tiftik keçilerinin vücutlarındaki tiftik renkleri; beyaz, siyah, gri, açık kırmızı, kahverengi, devetüyü ve sarı renklerden oluşabilmektedir. Aynı zamanda ince, kıvrımlı ve parlak özelliklere sahiptirler. Keçilerde ki tiftik örtüsü, yüz ve bacak kısımları haricinde bütün vücudu kaplamaktadır. (Yertürk ve Odabaşoğlu, 2007). Tiftik keçilerinin en önemli verimleri tiftik denilen elyafıdır. Dünyadaki keçi ırkları arasından en iyi özellikte elyaf üreten ırklar arasında Tiftik keçisi mevcuttur. Türkiye'de Tiftik keçilerinin kırkım zamanları ilkbaharda, belirli dünya ülkelerinde ise (Afrika, ABD ve Avustralya) hem ilkbahar hem de sonbaharda kırkımı yapılmakta ve tiftik elde edilmektedir. Miktar olarak tiftik verimleri erkeklerde 4-6 kilogram kadar, dişilerde ise 3-4 kilogram kadar alınabilmektedir. (www.esk.gov.tr/tr, 2023). Tiftik keçilerinde ki tiftik elyafı uzun, ince, parlak ve kıvrımlı olmakla birlikte, uzunluk ve incelik derecelerinin artışları istenilen özelliklerdir. Tiftikte kalınlığı 100 mikrondan daha büyük olan kemp kılları (ölü kıllar) olabilmektedir ve ekonomik olarak istenmezler. Hayvanlarda ki bakım ve beslemedeki yetersizliklerden dolayı kılların büyümesinde eksiklikler ve kılların yapısında anormallikler şekillenebilmektedir. Yapısı gereği tiftik; yüksek yalıtımlı, ısıya ve çekmeye dayanıklı, esneyen, parlak görünümlü, nem tutabilen, rahatlıkla boyanabilir, hatta astronotların giydikleri elbiselerin yapımında kullanılan düzgün ve kaygan yapıya sahip ve zararlı güneş ışınlarını geçirmeyen bir lif özelliğine sahip bir üründür. (Kaymakçı ve Askın, 1997. Şengonca, 1989. Devendra, 1982. Tepelli ve Çetin, 1993).



Şekil 3.2.1. Renkli Tiftik keçisi (Çaça 2023)

Tiftiđin elde edilmesinde hayvanın yaşı, genetik özellikleri gibi etkiler tiftik kalitesini açığa çıkaran başlıca özelliklerdendir ve tiftiđin kalitesi bakımından önemlidir. Başlıca kriterler çerçevesinde tiftiđin kalitesi anlaşılmaktadır. Bunlar; incelik, uzunluk, parlaklık, kıvrım sıklığı, dayanıklılık, esneklik gibi özelliklerdir. (Atay ve Öktem 2006). Tiftiđin inceliđi bakımından genç keçilerin lifleri daha inceyken, yaşı hayvanlarda artan yaşla birlikte lifler kalınlaşmakta ve kalitesi düşmektedir (Harmancıođlu, 1974). Tiftik keçilerinde tiftiđin inceliđi açısından yaşı ve cinsiyetin etkileri vardır. İncelik ve lüle uzunluđu bakımından ırk, yaş, bakım-besleme şekli, mevsim ve kırkım sayısı gibi faktörlerde etkilidir. Tiftiđin incelik ölçütlerinde 1 yaşı keçilerde ortalama 26 - 30 mikron, tekelerde ve anaçlarda 32 - 36 mikron olarak ölçülmüştür. (Aköz ve Sincer, 1961. Arıtürk ve ark., Gee ve Robie, 1973. Müftüođlu ve Örkız, 1982. Öztürk ve Goncagül, 1993. Utkanlar ve ark., 1961. Yalçın, 1982). Fakat ođlakların tiftik inceliđi 22-23 mikron olduđu ve anaç hayvanlarda bu rakam 38-39 mikron olarak tespit edilen çalışmalarda söz konusudur (Düzgüneş ve ark., 1986. Öztürk ve Örkız, 1990).



Şekil 3.2.2. Renkli Tiftik keçisi (Çaça 2023)

Tiftiđin işlendikten sonra oluşan ürünlerin kullanımına göre ince veya kalın şekilde eğilmekte ve son şeklini almaktadır. Tiftik dokuma ile örgü işleri şeklinde başlıca 2 kullanım sahasına sahiptir. Hem tiftik örgü ürünleri, hem de tiftiđin kumaşlarından dikilen giysilerden kaliteli ürünler elde edilmektedir. Yumuşak dokulu oluşlarına karşın dayanıklı olmaları, iç kısımlarına su geçirmemeleri ile birlikte bedeni yazın serin, kışın sıcak tutma özelliđine sahiptirler. Tiftikten elde edilen örgü ürünleri daha çok aile arasında üretilen ve kullanılan ürünlerdir. Dokumadan elde edilen ürünleri ise daha çok ticari bölümlerdeki ürünleri kapsamaktadır. Ülkemizde tiftik sektörü gereken oranda gelişmemiş endüstriyel bir sanayi kolu olduđundan dolayı, elde edilen tiftikler el sanatları şeklinde geleneksel ola-

rak tüketilmektedir. Ankara şehrine 16-18. yüzyıl dönemlerinde tiftik ve tiftiğe dayalı üretimlerden elde edilen Ankara Sofu bu anlamda önem arz etmekteydi. (www.kalkinmakutuphanesi.gov.tr, 2023).



Şekil 3.2.3. Geleneksel Siirt battaniyesi (www.kulturportali.gov.tr 2023)

Örnek olarak tiftiğe dayalı üretimlerden birisi olan Siirt battaniyesi özellikle kırsal bölgelerde yaşayan insanların tercih ettiği bir tiftik ürünüdür (Nakipoğlu, 2019).



Şekil 3.2.4. Renkli Tiftik keçisi (Çaça 2023)

Tablo 3.2.2. Keçilerin 2. ve 3. yaşındaki çeşitli tiftik verim özelliklerinin ortalama değerleri (Yertürk ve Odabaşoğlu, 2007)

ÖZELLİK	2 Yaşlı ($\bar{X} \pm S \bar{x}$)	3 Yaşlı ($\bar{X} \pm S \bar{x}$)
Tiftik verimi (g)	520±0.02	710±0.05
Tiftik randımanı %	78.55	78.40

Tablo 3.2.3. Keçilerin 2 .yaşlarındaki tiftiklerin incelik (μ) ve uzunluk (cm) değerleri (Yertürk ve Odabaşoğlu, 2007)

2 Yaşlı incelik			2 Yaşlı uzunluk			
Omuz bölgesi	Kaburga bölgesi	But bölgesi	Omuz bölgesi	Kaburga bölgesi	But bölgesi	
n	45	45	45	45	45	45
\bar{x}	31.60	35.38	34.40	15.88	16.75	14.89
S \bar{x}	0.71	0.70	0.85	0.31	0.32	0.26

Tablo 3.2.4. Keçilerin 3. yaşlarındaki tiftiklerin incelik (μ) ve uzunluk (cm) değerleri (Yertürk ve Odabaşoğlu, 2007)

3 Yaşlı incelik			3 Yaşlı uzunluk			
Omuz bölgesi	Kaburga bölgesi	But bölgesi	Omuz bölgesi	Kaburga bölgesi	But bölgesi	
n	33	33	33	33	33	33
\bar{x}	43.42	44.00	43.43	16.12	16.32	16.12
S \bar{x}	1.13	1.30	1.05	0.70	0.67	0.71

3.3. Tiftik Keçilerinde Büyüme

Büyüme ve gelişme hızı Tiftik keçilerinde yavaş ilerlemektedir. Bu irkin büyüme döneminde erkek keçiler dört yaşına, dişiler de altı yaşına kadar sürmektedir (Bilgen ve ark. 2008). Tiftik keçilerinin canlı ağırlık olarak dişi hayvanlar ortalama 30 ile 40 kilogram, tekelerde ise 40 ile 55 kilogram kadardır (Daşkıran ve ark., 2012). Çevre şartları bakımından Tiftik keçileri nemli ve rutubetli ortamlarda yaşayamaz. Tiftik keçisi yetiştiriciliğinin yapıldığı bölgeler başta Ankara olarak İç Anadolu Bölgesinin iç kısmı ile Ege bölgesinde, Marmara bölgesinde, Karadeniz bölgesinde, Doğu Anadolu bölgesinde ve Güneydoğu Anadolu bölgesinde belirli birkaç lokal sahada yapılmaktadır (Örkiz, 1980. Şahin 2013. Şen, 2015).



Şekil 3.3.1. Renkli Tiftik keçisi (Çaça 2023)

Renkli tiftik keçilerinde çeşitli verim özelliklerinin tespiti amacıyla yapılan bir çalışmada yarı entansif şartlarda erkek oğlaklarda doğum ağırlığı 2,24 kg, 90. günde süttten kesim ağırlığı 10,51 kg ve 6. aydaki canlı ağırlıkları 18,40 kg olarak ölçülmüştür. Dişi oğlaklarda ise doğum ağırlığı 2,10 ve 90. günde süttten kesim ağırlığı 9,23 ve 6. aydaki canlı ağırlıkları 15,20 kg bulmuştur. Çalışmada kullandığı 2 ve 3 yaşlı keçilerin canlı ağırlıklarını ise sırayla 25,67 ve 26,14 kg olarak bildirmiştir. Renkli tiftik keçisi oğlaklarında süt kesimine kadar ki yaşama gücü 2 ve 3 yaşlı keçilerin oğlaklarında sırasıyla % 81,82 ve % 89,19 olarak saptanmıştır (Yertürk, 1998).

3.4. Tiftik Keçilerinde Besi Performansı

Tiftik keçileri ülkemize has, küçük yapılı ve gelişim hızı geç olan bir ırk olması sebebiyle et verimi düşüktür. Bu nedenle et verimi konusunda yapılan çalışmaları da kısıtlıdır (DİE, 1992). Tiftik keçilerinde yüksek canlı ağırlıklarına sahip ve ileri yaşlarda ki hayvanların 1 kg canlı ağırlık kazanabilmesi, genç yaşta ve düşük canlı ağırlığına sahip hayvanlara göre daha fazla miktarda yem tüketmesi gerekmektedir. Fakat genç yaşta ve düşük canlı ağırlığında besiyeye alınan keçiler, genetik kapasitelerince beslendiklerinde daha az miktarda yemle daha yüksek canlı ağırlığına ulaşabilmektedir. Tiftik keçisinin verimlerini; et verimi, karkas ağırlığı, karkas randımanı ve karkas kalitesi gibi özellikler belirlemektedir. Bu özellikleri genotip ile birlikte cinsiyet, beslenme şekli, kesim yaşı, kesim ağırlığı, kondüsyon, kesim öncesi ve kesim sırasında hayvana yapılan muameleler gibi faktörler etkilemektedir (Johnston, 1983).

Daşkiran (1992), süttten kesim çağında besiyeye alınan Tiftik Keçisi erkek oğlaklarında, besi başı ve besi sonu ağırlıkları sıra ile 14,453 kg ve 24,060 kg, besi boyunca ortalama günlük canlı ağırlık artışı 135,9 gram,

günlük yem tüketimi 0,806 kg ve 1 kg canlı aęırlık artışı için kesif yem tüketimi ise 6,069 kg olarak bulunmuştur.

Tablo 3.4.1. Besiye alınan erkek oęlakların besi ve karkas özellikleri (Yertürk ve Odabaşıoęlu 2007)

Özellik	$\bar{X} \pm S_{\bar{x}}$
Oęlak kesim aęırlığı (kg)	17.19 \pm 1.21
Oęlak soęuk karkas aęırlığı (kg)	7.04 \pm 0.68
Soęuk karkas randımanı (%)	40.91 \pm 0.01
Tüketilen günlük kesif yem miktarı (g)	797
Tüketilen günlük kaba yem miktarı (g)	482
Oęlak günlük canlı aęırlık artışı (g)	54 \pm 2.33
Yemden yararlanma (kg)	9.99
Karkasta et oranı (%)	61 \pm 0.01
Karkasta Kemik oranı (%)	22 \pm 0.01
Karkasta Yaę oranı (%)	18 \pm 0.01



Şekil 3.4.1. Renkli Tiftik keęisi (Çaça 2023)

Koyuncu (1994)., Ankara keęisi X Kıl keęisinden olan melez erkek oęlaklarının entansif şartlarda yetmiş gün boyunca devam eden besi programında hayvanların besi başı 15,73 gram, besi sonu canlı aęırlıkları 29,69 gram, besi performansı 6,36 kilogram, günlük canlı aęırlık artışı 199 gram ve yem tüketimini 1268 gram olarak tespit edilmiştir.

Mowlem ve ark. (1985), Ankara keęisi X İngiliz Saanen keęilerinin melezlemesi sonucu ortaya çıkan yirmi dört haftalık oęlakların ortalama

canlı ağırlığını 25,3 kilogram, ortalama yem tüketimi 580 gram, ortalama günlük canlı ağırlık artışını ise 94 gram olarak saptamışlardır.

3.5. Tiftik Keçilerinde Süt Verimi

Hayvanlar kendi yavrularını beslemek amacıyla ilk birkaç ay süt salgırlarlar. Evcil hayvanlarda diğer verimler gibi süt verimlerinde de ıslah yoluyla zamanla önemli değer artışları sağlanmıştır. (Yalçın, 1981. Akçapınar, 1994. Antürk, 1977). Sütünün sahip olduğu özelliklerinden dolayı dünyada keçi yetiştiriciliğine olan ilgi artmıştır. Keçilerin sütü, anne sütüne en yakın değerlerde olmasından ötürü insan gıdası olarak tüketilebilmesinde farklılık arz eder. Keçi sütündeki kalsiyum içerik değeri anne sütüne oranla otuzdört kat daha fazladır. Sığır sütünün tüketiminde bazen ortaya çıkan sindirim sistemi gibi sorunlarının keçi sütünde görülmemesi birçok yönden keçi sütünü ayrıcalıklı hale getirmektedir (Ç.Ü., 2018). Keçilerin süt verimlerine etki eden faktörler; hayvanın ırkı veya genotipi, laktasyon sırası, sağım sayısı, canlı ağırlığı, bir doğumda oğlak sayısı, besleme gibi etkiler söz konusudur (Sönmez ve ark., 1971. Sahlu ve ark., 1999. Akçapınar, 2007).

Küçük ve ark. (2015), renkli Tiftik keçilerinin 120 günlük süre zarfında süt verimini 76,32 kilogram tespit ölçmüşlerdir.

Ankara keçileri oğlaklarını beslemek için genellikle sağılmaz bunun sebebi ise yıllık süt verimlerinin düşüklüğünden dolayıdır. Sağılan keçilerin yıllık süt verimi oğlakların emzirdikten sonra 25-35 kg, laktasyon süresi ise 3-3,5 ay kadar olduğu bildirilmektedir (Kaymakçı ve Askın, 1997. Şengonca, 1989).

Yertürk ve Odabaşoğlu (2007), renkli Tiftik keçilerinin 2 yaşındayken ortalama laktasyon süt verimi 74,81 kilogram ve laktasyon süresi 170,00 gün iken, 3 yaşındaki renkli Tiftik keçilerinde ise ortalama laktasyon süt verimi 81,50 kg ve laktasyon süresi 180,73 gün şeklinde elde etmişlerdir.

3.6. Tiftik Keçilerinde Döl Verimi ve Özellikleri

Keçi yetiştiriciliğinde döl verimi, verimliliği ve popülasyon geleceğini etkileyen en önemli faktörlerinden biridir. Sürü büyüklüğünün devamlılığı, seleksiyon ve ayıklama gibi konuların etkin bir biçimde yapılmasında döl veriminin artırılması önem taşımaktadır (Akçapınar, 1994). Sürü yönetiminden büyük ölçüde etkilenen döl verimi düşük kalıtım derecesidir (Samardzija ve ark., 2013). Döl verimi yaş, ırk, cinsiyet, beslenme ve bakım, iklim, yetiştirme koşulları ve hayvanların refah düzeyleri gibi çeşitli konulara bağlıdır. *Döl veriminde önemli olan ve istenilen durum, teke altı keçiye veya doğum yapan keçi başına doğan oğlak sayısı ile damızlık için bir keçiden alınabilecek oğlak sayısıdır.* Dişi keçinin birim

sürecinde ürettięi yumurta sayısı, gebelik oranı ve embriyo ölümleri döl verimini etkileyen faktörlerdir. Geç gelişmeleri ve küçük cüseye sahip olmaları bakımından Tiftik keçileri bu anlamda sıfat da ilk kullanma yaşı da geç olmaktadır. Keçilerin yaşları ve döl verimi arasında önemli bir ilişki vardır. Tiftik keçilerin gebelik oranı % 80-83 ve ikizlik oranları % 2-3 civarındadır ve bu bağlamda gebelik ve ikizlik oranları düşük olmaktadır (Shelton and Basset, 1970. Yalçın, 1986).

Renkli Tiftik keçilerinde çeşitli döl verimi performansı ve süt kesimine kadar ki yaşama gücü tarafından yapılan çalışmada; gebelik, kısırılık, doğum ve ikizlik oranı ile süttten kesimdeki yaşama gücü 2 yaşlı keçilerde sırasıyla % 73,90; 26,09; 67,39; 4,35 ve 81,82 ile 3 yaşlı keçilerde ise aynı sıra ile % 84,10; 15,91; 77,27; 6,82 ve 89,19 olarak bulunmuştur (Yertürk, 1998). Türkiye'deki araştırma enstitülerinde yapılan çalışmalarda ergin Ankara keçilerinin ikiz doğum, oğlakların süttten kesim ve 6. aya kadar ki yaşama gücünü (Güneş ve Evrim, 1993), % 11,55; % 99,0 ve %98,16; ikiz doğum ve süttten kesime kadar yaşama gücünü (Arıtürk ve ark., 1979), % 2, % 94,5; (Güneş ve ark., 2002) ikizlik oranını ortalama % 29,11; (Öztürk ve Goncağül, 1995), 3. ay ve 6. ay yasama gücünü % 83,61 ve 80,25 olarak bildirmişlerdir.

4. SONUÇ VE ÖNERİLER

Renkli Tiftik keçileri verimi açısından kaliteli tiftik verimi ile ön plandadır. Bazı araştırma ve gözlemler neticesinde renkli Tiftik keçileri **çoğunlukla Kıl keçileri olmak üzere bazı diğer keçi ırkları** ile yapılan saf yetiştirme, melezlemeler ve seleksiyonlar sonucu tiftiklerinde ki **çeşitli** renk varyasyonu ile birlikte et, süt, döl verimi gibi verimlerinde de olumlu değişimler gözlenebilmiştir. Bilindięi üzere Tiftik keçisinin en önemli verimi tiftik denilen elyafıdır. Günümüz tiftik **ücretleri** ve tiftikten alınabilen kar marjinaline bakıldığında ihtiyacı karşılama konusunda geride kalmaktadır. Ancak halk elinde bulunan ve diğer belirli verimleri yüksek keçi ırkları ile yapılabilecek saf yetiştirmeler, melezlenmeler ve yapılacak seleksiyonlar ile birlikte bu keçi ırkının kaliteli tiftik veriminin yanında diğer özelliklerinin geliştirilmesi ve yetiştiricilerin bu ırkın besicilięinin yapılmasında daha çok raębet görecektir. Bu yüzden ekonomik olarak diğer verimlerinin artışı da **önem arz etmektedir**.

Çeşitli bölgelerde yetiştirilen renkli Tiftik keçileri bölgenin coęrafik ve iklim **özelliklerine** adapte olabilen bir ırk olmasından ötürü rakımı yüksek ve daęlık alanlarda yetiştiricilięi yapılabilmektedir. Bunun için daha çok sayıda Tiftik keçi desteklerinin sağlanması ve devlet yardım desteklerinin sağlanmasıyla birlikte bu ırkın popülasyonun artışına teşvik edilecektir. Bir mera hayvanı olan Tiftik keçisinin beslenme alanları olan tiftik keçilerinin zarar vermeyeceęi yüksek ormanlar otlatmaya açılmalıdır. Tif-

tik keçileri için yapılacak olan ıslah çalışmaları konularında çeşitli ilgili birimlerle talepte bulunulması ve yetiştiricilerin daha çok teşvik edilmesi gerekmektedir. Milli değere sahip olan Tiftik keçi ırkının varlığını korumak ve ilerletmek hem maddi hem de eskilerden beri manevi değerlere sahip olduğumuz bu keçi ırkımız ülke adına olumlu etkiler sağlayacaktır.

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BÖLÜM 2

EFFECTS OF SUPPLEMENTAL NIACIN, CHOLINE AND BIOTIN ON SERUM TOTAL OXIDATION CAPACITY, TOTAL ANTIOXIDANT CAPACITY AND THE INCIDENCE OF SOME PERIPARTURIAL DISEASES IN TRANSITION DAIRY COWS¹

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¹ This chapter is derived from the doctoral thesis entitled “Effects of supplemental rumen protected niacin, rumen protected choline, biotin on some blood and milk parameters in transition dairy cows”. The aforementioned doctoral thesis was written by Cangir Uyarlar at Afyon Kocatepe University

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INTRODUCTION

The transition period is often described as the most problematic era in dairy cows which starts from three weeks before parturition to the third week of lactation (Grummer 1995; Drackley, 1999; Reynolds et. al., 2002; Coskun et al. 2009). Feeding standards and ration formulations of dairy cows have enormous alterations during this period. Along the period, cows start to consume rations with high cellulose and low energy rates, whereas they are used to consume low cellulosic and high energetic rations immediately after parturition (Mandebvu et al., 2003). Animals struggle to adapt to rapid diet changes and they become more vulnerable to metabolic and infectious diseases during this period. In order to continue their productivity and to be protected from metabolic diseases, it is inevitable to end this period without any problems (Overton and Waldron, 2004).

Nutrient requirements of dairy cows during the transition period change significantly. Thus, there must be perfect coordination in metabolism to adequately meet the energy, glucose, amino acid (AA) and Calcium (Ca) needs of the milk synthesis after calving (Overton and Waldron, 2004). The main difficulty for cows in the transition period is the sudden increasing needs for nutrients due to the rapid increase in milk yield after parturition (Drackley, 1999). During this period, when the last days of pregnancy and the first days of lactation are compared and the nutritional needs of the organism are taken into consideration, the requirement for glucose increases approximately 3 times, the requirement for AA increases 2 times, and the requirement for fatty acids increases 5 times (Bell, 1995). In addition, the requirement for Ca increases approximately 6-fold at parturition (Horst et al., 1997). As explained in a study (Drackley, 1999), the energy level that a cow should consume on the 4th postpartum day increases by 26%, while the metabolizable protein level increases by 25%. Therefore, cows spend most of the nutrients taken from their diet to meet milk yield demands, a very small amount is left to meet their living requirements

In this period, although nutritionists maximize the energy intake of animals in the diet, it is inadequate, so they turn to practices that regulate energy in metabolism, improve fat oxidation in the liver, and increase energy bioavailability in the organism (Overton and Waldron, 2004). This aim is often tried to be achieved by giving supplemental micronutrients to the diet (Zenobi et al., 2018). At this point, B vitamins are in a privileged position. B vitamins, which include exceptional vitamins such as folic acid, pyridoxine, pantothenic acid, cyanocobalamin, niacin, choline and biotin, are involved in the synthesis of energy-regulating enzymes in the organism and directly intervene in energy metabolism (LeBlanc et al., 2017).

Choline is a component in phospholipid form which is used as a precursor for phosphatidylcholine and acetylcholine synthesis in the liver; also, it serves as the methyl donor in fatty acid metabolism. Phosphatidylcholine plays a role in the absorption and transport of lipids, cell membrane structure, cell signaling, and the synthesis of lipoproteins in ruminants (Santos and Lima, 2010). Due to these properties, choline is defined as a lipotropic element in ruminant nutrition. (Elek et al., 2008). Choline accumulates in the organism as trimethyl-ethanolamine, and in mammals, it is essential in their diet for the normal functions of cells (Santos and Lima, 2010). Moreover, phosphatidylcholine is a crucially important component for the durability and replication of cells (Zhang et al., 2007). As the major portion of dietary choline is degraded by the rumen bacteria (Weiss and Gonzalo, 2006); supplying dietary supplemental choline as rumen protected is highly important for the reasonable benefit of the organism (Elek et al., 2008).

Niacin is a water-soluble vitamin which is the most widely used as an additive to dairy cattle rations (McDowell, 2002). Niacin gets involved in many mechanisms in energy production metabolism and acts in fatty and amino acid synthesis (Ilkhani et al., 2006). Moreover, examining the mechanisms that niacin plays a role, it has been reported that it can be beneficial for protection from diseases like ketosis and fatty liver (Weiss and Gonzalo, 2006). Niacin is known a water soluble vitamin that effects lipid metabolism and playing role to decrease lipid accumulation in liver as choline. Although there are several studies investigating the effects of niacin on performance and metabolic parameters during the transition period in dairy cows, no study has been found investigating its effect on the incidence of peripartal diseases such as retained placenta, mastitis and metritis. On the other hand, as stated by Weiss and Gonzalo (2006), more than 90% of niacin is degraded in the rumen or converted into other forms (Nicotine acid - NA, nicotinamide - NAM). Therefore, it has been asserted that further studies on the forms of rumen-protected niacin are needed in order to reveal the effects of Niacin in the organism more explicitly (Weiss and Gonzalo, 2006).

Biotin is an important co-enzyme that gets into the structures of three different carboxylase enzymes (acetyl CoA carboxylase, propionyl carboxylase, and pyruvate carboxylase) (Wal et al., 2023). According to Milligan et al. (1967), carboxylase enzymes are needed for the synthesis of propionate from hexose in rumen. By activating these enzymes, biotin helps protect dairy cows from energy metabolism-related diseases such as fatty liver or ketosis (McDowell, 2002). Biotin also serves in the keratinization and differentiation of epidermal cells (Budras et al., 1997). Several

studies report different findings about the degradation levels of dietary biotin in rumen (Evans, 2005).

The incidence of health problems in cows in the transition period increases significantly with the addition of other stress factors related to parturition and lactation, along with the stress caused by the increased nutritional needs after birth (Drackley, 1999). Retained placenta, metritis, mastitis and displaced abomasum are major energy metabolism-related diseases in the transition period (Mezzetti et al., 2021). These metabolic disorders, which are very important for dairy cow breeding, cause productivity losses in animals due to the high treatment costs. However, expensive treatment practices often fail and lead to cows being culled more soon than expected (Dağdelen et al., 2022). Therefore, nutritional practices that are beneficial to prevent these diseases, could help to increase the productive life of dairy cows

Oxidative stress is defined as the disruption of the balance between prooxidants and antioxidants in favor of prooxidants (Aydogdu et al., 2018). Oxygen-centered free radicals such as superoxide anion ($^{\circ}O_2^-$) and hydroxyl radical (OH°) and some non-radical oxygen derivatives such as hydrogen peroxide (H_2O_2) and hypochlorous acid ($HOCl$) are reactive oxygen metabolites that lead to increase oxidative stress (Ciani et al., 2015). Oxidative stress induces disorders of the physiological functions in the vital organs and leads to a decrease in the resistance capacity of all living creatures to diseases (Rizzo et al., 2012) On the other hand, there are many antioxidant molecules such as superoxide dismutase, glutathione, glutathione peroxidase, etc. play a role in preventing the formation of free radicals and protecting organisms from the hazardous effects of oxidative stress (Karasahin et al., 2021). If antioxidant systems are not sufficient to resist oxidative stress, oxidative damage develops in the cells and the functions of the cells are significantly disrupted (Perrone et al., 2010). It has been suggested constantly, that oxidative stress plays a role in the pathogenesis of many diseases and inflammatory conditions in humans, such as AIDS (Allard et al., 1998), influenza (Liu et al., 2017), and hepatitis (Paracha et al., 2013). Moreover, the increased incidence of transitional diseases such as mastitis in dairy cows (Sordillo and Aitken, 2009) is also associated with excessive oxidative stress. Hence, the balance between oxidative stress and antioxidant capacity of the organism is crucial for protect animals from diseases (Feng and Wang, 2020). Recently, nutritionists aiming to decrease oxidative capacity and increase antioxidant activity by diet (Prior and Wu, 2013).

Although some other studies have investigated the individual effects of the vitamins involved in total oxidative and antioxidative activities in cows, there is not adequate data on the effects of niacin, choline and biotin

in dairy cows. The aim of this study was to examine the effects of biotin, niacin and choline and their combinations on total oxidative and antioxidative activities and the incidence of some periparturient diseases such as retained placenta, metritis, mastitis and displacement of the abomasum in dairy cows during the transition period.

DESIGN OF THE STUDY

The study was conducted in “Korel Dairy Cow Breeding Company-Corporation” Afyonkarahisar/Turkey, located at 30° 55’ East Longitude and 38° 40’ North Latitude, with the approval of the Animal Experiments Ethics Committee of Afyon Kocatepe University under the document number “B.30.2.AKU.0.9Z.00.00/69”. A total of 42 multiparous Holstein dairy cows with similar previous milk yield (29 ± 5 l/day), live body weight (700 ± 50 kg), and body condition score (BCS, 3.50 ± 0.5) were selected as study material and assigned to 7 groups by random sampling method. The study started for each cow exactly 3 weeks before the expected calving date and finished 3 weeks after calving.

The groups were as follows:

Group I. Control (C): Cows did not receive any supplementation.

Group II. Choline (Cl): Cows drenched with choline (15g/day) throughout the study

Group III. Niacin (N): Cows drenched with niacin (12g/day) throughout the study

Group IV. Biotin (B): Cows drenched with biotin (20 mg/day) throughout the study

Group V. Biotin + Choline (BCL): Cows drenched with biotin (20 mg/day) and choline (15g/day) throughout the study

Group VI. Niacin + Choline (NCl): Cows drenched with niacin (12 g/day) and choline (15g/day) throughout the study

Group VII. Biotin + Niacin (BN): Cows drenched with biotin (20 mg/day) and niacin (12g/day) throughout the study.

Dose calculations for choline done according to Guretzky et al. (2006) (60 g of Reashure™ rumen-protected choline equivalent to 15 g of choline, 25% choline chloride, Balchem Encapsulates, Slate Hill, NY); for Niacin (Niashure™, Balchem Corporation, New Hampton, NY) according to Small (2010); and for biotin (Rovimix Roche Vitamins Inc., Parsippany, NJ) according to Zimmerly and Weiss (2001).

The cows were housed in free stall paddocks which had rubber bedding material. Dry and lactating cows were housed in separate paddocks. Lactating cows were milked three times a day with an automated milking parlor (GEA, Germany). All cows consumed the same diet which was formulated separately for the prepartum and postpartum period. Nutrient requirements of the cows determined according to NRC (2001). The diet was prepared and served to all animals as TMR (total mixed ration) which were given at Table 1. All feedstuffs were sampled and analyzed for crude protein, ether extract, crude fiber, crude ash, and dry matter according to AOAC (1984) whereas Acid Detergent Fiber (ADF), and Neutral Detergent Fiber (NDF) done according to Georing and Van Soest (1970). All data obtained from the feed analysis was used for the calculation of the metabolizable energy and protein content of the diet.

The blood samples were taken from the all animals and immediately centrifuged for 15 minutes at 3000 rpm at room temperature to obtain serum on the -21, -14, -7, 0, 7, 14, and 21st days (according to parturition). Serum samples were stored at -20 °C until the laboratory analysis. Total oxidative (TOS) and antioxidant capacity (TAS) were measured from all serum samples by using a colorimetric analyzer “Roche Cobas C111, Germany” and commercial kits (Rel Assay Diagnostics Assay Kit, Mega Tip Industry and Trade Limited Company, Gaziantep/Türkiye)

Routine health examinations were done daily by the veterinarian of the farm. Moreover, all animals checked for the clinical signs of retained placenta, metritis, mastitis and displaced abomasum. Retained placenta was diagnosed with cows that did not expel fetal membranes in the first 24 hours after calving. Metritis was diagnosed in cows that had a fever and abnormal vaginal discharge (odorous yellowish-brown color). Mastitis was diagnosed in cows that had a fever and/or swelling in the udder and abnormal odor, color, and/or clot in milk. All diagnosed diseases were defined as mild/moderate. Therefore none of the cows needed to separate from the herd and were not hospitalized in special conditions. Treatments were started immediately after diagnosis and all therapeutic practices were performed immediately following afternoon milking till full recovery had been observed. All treated cows were sent to their paddocks immediately after treatment practices were done.

The TAS and TOS results were evaluated using the JMP statistical pocket program (JMP, 2003) as GLM. The significance level was set at ($p \leq 0.05$).

Table 1
Formulation and Chemical Composition of The Diet

Feedstuffs (% Dry Matter)	Before Parturition	After Parturition
Corn Silage	30.1	26
Brewer's Yeast	4.9	5.2
Alfalfa Hay	14	18.2
Barley Straw	18.5	10.3
Wheat Bran	2.9	9.2
Barley Grain (Ground)	13.4	6.8
Corn Grain (Ground)	8.4	11
Cottonseed Meal	2.2	7.9
Soybean Meal	4.3	2.6
Rumen Protected Fat ¹	1	0.6
Rumen Protected Protein ²		0.6
Salt	0.14	0.3
Premix ³	0.16	0.04
Sodium Bicarbonate		0.5
Yeast ⁴		0.004
Limestone		0.7
Chemical Coposition of The Diet (%Dry Matter)		
Crude Protein	12.7	17
Rumen Degradable Protein	7.7	11.8
Rumen Undegradable Protein	5	5.2
NEL (mcal/kg) ⁵	1.47	1.58
NDF ⁶	45.94	39.89
ADF ⁷	27.28	23.42
Ca ⁸	0.46	0.72
P ⁹	0.27	0.42

Note

1 Megalac (Church & Dwight Co., Inc., Rinceton. NJ);

2 Soy Pass (Borregaard LignoTech);

3 Rovimix 302-FM/20:Ingredients in 1 kg; 15.000.000 IU vitamin A, 3.000.000 IU vitamin D3, 20.000 mg vitamin E, 10.000 mg manganese, 10.000 mg iron, 10.000 mg zinc, 5.000 mg copper, 100 mg cobalt, 100 mg iodine

4 Yeast (*Saccharomyces cerevisiae*, Beta Agri., Yüreğir/Adana)

5 NEL; Net Energy Lactation

6 NDF; Neutral Detargent Fiber

7 ADF; Acid Detergent Fiber

8 Ca; Calcium

9 P; Phosphorus

RESULTS

Weekly overall serum TOS and TAS concentrations of all groups are presented in Table 2, whereas week-by-week serum TOS and TAS concentrations shown in Table 2 and 3 and also figure 1 and 2, respectively. TOS level increased at the calving (PAR, Table 3) in all groups due to rising oxidative stress during parturition. TOS level was significantly higher ($p < 0,0001$) in the control group than those measured in the niacin and choline-administrated groups (CL, N, BCL, NCL, BN). However, only biotin-received cows showed similar TOS levels to control. Moreover, TOS levels remained lower ($p < 0,005$; $p < 0,005$; $p < 0,05$; week by week respectively) in the niacin and choline-administrated groups than in the control group in the first three weeks of the lactation. On the other hand, only biotin-received groups never showed significant differences with the control group throughout the transition period. TAS levels did not show a significant difference between groups in the prepartum weeks and the day of parturition. By the way, the TAS level was the lowest ($p < 0,05$) in the only biotin-treated group in the second week of lactation, whereas niacin and choline-treated groups (CL, N, BCL, NCL, BN) showed a significant increase ($p < 0,001$) as compared to control and biotin-treated groups in the third week of the lactation. These findings indicate that rumen protected niacin and choline supplementation to dairy cows during transition period can reduce oxidative stress by decreasing TOS and increasing TAS levels after parturition. On the other hand, biotin supplementation at the same period did not affect oxidative stress parameters in dairy cows.

Peripartal diseases highly related with lifelong productivity in dairy cows. The increase of retained placenta, mastitis and metritis cause a dramatic decrease in milk yield, fertility performance and productive life in dairy cows. In the study, only one cow with rumen-protected choline supplementation was diagnosed with mastitis (17%), while no cow was diagnosed with retained placenta or metritis. Similarly, only one cow with rumen-protected niacin and choline supplementation was diagnosed with retained placenta (17%), while no cow was diagnosed with mastitis or (0%) or metritis (0%). However, five cows in the control group (2 retained placenta, 1 mastitis, 1 metritis, overall 83%), six cows in the biotin group (2 retained placenta, 2 mastitis, 2 metritis, overall 100%), three cows in the niacin group (1 retained placenta, 1 mastitis, 1 metritis, overall 50%), two cows in the biotin and rumen-protected choline group (1 retained placenta, 1 metritis, overall 33%), three cows in the biotin and rumen-prote-

cted niacin group (1 retained placenta, 1 mastitis, 1 metritis, overall 50%) diagnosed with the peripartal diseases. These results indicate that rumen protected choline and niacin supplementation to dairy cows in transition period may improve the health status by decreasing the incidence of peripartal diseases.

Table 2

Effects of Rumen Protected Niacin, Rumen Protected Choline, Biotin and Their Combinations on Overall TOS and TAS Concentrations in Dairy Cows During Transition Period

Group ¹	TOS	TAS
C	8.35 ^a	0.92 ^c
CL	7.71 ^{bc}	1.03 ^a
N	7.83 ^{bc}	0.97 ^{bc}
B	8.05 ^{ab}	0.92 ^c
BCL	7.81 ^{bc}	1.01 ^{ab}
NCL	7.59 ^c	1.03 ^{ab}
BN	7.89 ^{bc}	0.98 ^{ab}
SEM ²	0.127	0.020
	P values ³	
Treatment	<.0001	<.0001
Time	<.0001	<.0001
Treatment×Time	0.0034	0.0390

Note. ¹ Groups; C (Control) without supplementation; CL (Choline) cows received 15 g of rumen-protected choline per day; N (Niacin) received 12 g of rumen-protected niacin per day; B (Biotin) cows received 20 mg of rumen-protected biotin per day; BCL (Biotin+Choline) cows received 20 mg of biotin and 15 g of rumen-protected choline per day; NCL (Niacin+Choline) cows received 12 g of niacin and 15 g of rumen-protected choline per day; BN (Biotin+Niacin) cows received 20 mg of biotin and 12 g of rumen-protected niacin per day. ² Standard error of mean. ³ P values; Values with different superscripts in the same row are significantly different ($p \leq 0.05$); T × T: Treatment × Time interaction; The treatment effects with time. Time dependant effects of treatments

Table.3

Effects of Rumen Protected Niacin, Rumen Protected Choline, Biotin and Their Combinations on Weekly TOS Concentrations in Dairy Cows During Transition Period

Groups ¹	Weeks ²						
	PRE3	PRE2	PRE1	PAR	POS1	POS2	POS3
C	6.65	7.52	8.53	9.01 ^a	8.92 ^a	8.82 ^a	8.98 ^a
CL	6.15	7.26	8.40	7.63 ^{cd}	8.41 ^{ab}	8.04 ^{bc}	8.05 ^b
N	6.65	7.77	8.12	8.16 ^{bc}	8.10 ^b	7.78 ^c	8.23 ^b
B	6.50	7.17	8.22	8.63 ^{ab}	8.94 ^a	8.48 ^{ab}	8.43 ^{ab}
BCL	6.51	7.85	8.30	8.00 ^{cd}	8.17 ^b	8.00 ^{bc}	7.82 ^b
NCL	6.48	7.20	7.76	7.50 ^d	8.05 ^b	7.86 ^c	8.30 ^b
BN	6.52	7.49	8.45	8.14 ^{bc}	8.06 ^b	8.45 ^{ab}	8.13 ^b
SEM ³	0.20	0.20	0.18	0.21	0.19	0.17	0.22
p	0.65	0.13	0.08	0.00	0.00	0.0	0.03

Note. ¹ Groups; C (Control) without supplementation; CL (Choline) cows received 15 g of rumen-protected choline per day; N (Niacin) received 12 g of rumen-protected niacin per day; B (Biotin) cows received 20 mg of rumen-protected choline per day; BCL (Biotin+Choline) cows received 20 mg of biotin and 15 g of rumen-protected choline per day; NCL (Niacin+Choline) cows received 12 g of niacin and 15 g of rumen-protected choline per day; BN (Biotin+Niacin) cows received 20 mg of biotin and 12 g of rumen-protected niacin per day. ² Weeks; PRE3 three weeks before parturition; PRE2 two weeks before parturition; PRE1 one week before parturition; PAR day of parturition; POS1 one week after parturition; POS2 two weeks after parturition; POS3 three weeks after parturition. ³ Standard error of mean. ³ P values; Values with different superscripts in the same row are significantly different ($p \leq 0.05$)

Table.4

Effects of Rumen Protected Niacin, Rumen Protected Choline, Biotin and Their Combinations on Weekly TAS Concentrations in Dairy Cows During Transition Period

Groups ¹	Weeks ²						
	PRE3	PRE2	PRE1	PAR	POS1	POS2	POS3
C	0.81	0.95	1.05	0.91	0.83	0.92 ^{abc}	0.97 ^d
CL	0.91	0.91	1.12	1.07	1.05	1.04 ^{ab}	1.10 ^{ab}
N	0.83	0.91	1.13	0.97	1.03	0.91 ^{abc}	1.02 ^{abc}
B	0.90	0.96	1.09	0.94	0.90	0.80 ^d	0.84 ^d
BCL	0.80	0.85	1.14	1.08	0.98	1.07 ^{ab}	1.14 ^{ab}
NCL	0.82	0.94	1.21	1.01	1.05	1.02 ^{ab}	1.15 ^a
BN	0.81	0.98	1.05	1.01	0.92	1.10 ^a	1.01 ^{bc}
SEM ³	0.06	0.05	0.04	0.05	0.05	0.05	0.043
p	0.79	0.69	0.22	0.26	0.07	0.00	0.00

Note. ¹ Groups; C (Control) without supplementation; CL (Choline) cows received 15 g of rumen-protected choline per day; N (Niacin) received 12 g of rumen-protected niacin per day; B (Biotin) cows received 20 mg of rumen-protected choline per day; BCL (Biotin+Choline) cows received 20 mg of biotin and 15 g of rumen-protected choline per day; NCL (Niacin+Choline) cows received 12 g of niacin and 15 g of rumen-protected choline per day; BN (Biotin+Niacin) cows received 20 mg of biotin and 12 g of rumen-protected niacin per day. ² Weeks; PRE3 three weeks before parturition; PRE2 two weeks before parturition; PRE1 one week before parturition; PAR day of parturition; POS1 one week after parturition; POS2 two weeks after parturition; POS3 three weeks after parturition. ³ Standard error of mean. ³ P values; Values with different superscripts in the same row are significantly different ($p \leq 0.05$)

Table 5

Effects of Rumen Protected Niacin, Rumen Protected Choline, Biotin and Their Combinations on The Incidence of Some Peripartal Diseases Such As Retained Placenta, Mastitis, Metritis in Dairy Cows During Transition Period

Groups ¹	RETAINED PLACENTA ²	MASTITIS ²	METRITIS ²
C	2	1	2
CL		1	
N	1	1	1
B	2	2	2
BCL	1		1
NCL	1		
BN	1	1	1

Note. ¹ Groups; C (Control) without supplementation; CL (Choline) cows received 15 g of rumen-protected choline per day; N (Niacin) received 12 g of rumen-protected niacin per day, B (Biotin) cows received 20 mg of rumen-protected choline per day; BCL (Biotin+Choline) cows received 20 mg of biotin and 15 g of rumen-protected choline per day; NCL (Niacin+Choline) cows received 12 g of niacin and 15 g of rumen-protected choline per day; BN (Biotin+Niacin) cows received 20 mg of biotin and 12 g of rumen-protected niacin per day. ² The numbers in the table show how many times each cow was diagnosed with which disease.

DISCUSSION

Oxidative stress is the formation of cellular damage in the organism that develops as a result of the balance between oxidants and antioxidants being disrupted in favor of the oxidant system and the excessive release of free radicals (Perrone et al., 2010). If the organism's antioxidant mechanisms are insufficient against oxidative stress, oxidative damage develops in the cells and this negatively affects the pathogenesis of many diseases and increases the severity of the disease (Allard et al., 1998; Liu et al., 2017; Aydogdu et al., 2018). The concentration of many oxidants and antioxidant molecules in blood can be measured separately by various analytical methods (Tarpey et al., 2004). However, in recent years, more practical methods referred to as "total oxidant status (TOS)" and "total antioxidant status (TAS)" have been developed that measure total oxidants and antioxidants in the blood (Erel, 2000). In the present study, oxidative stress dramatically increased on the day of parturition and remained high for the first three weeks of lactation. However, feeding cows with supplemental rumen-protected niacin and choline from three weeks before parturition to the 21st day of lactation decreased TOS at the parturition and the first three weeks of lactation. Additionally, this supplementation increased the TAS level on the third week of lactation. These findings are consistent with previous studies the decrease in oxidative stress with choline supplementation (Sachan et al., 2005; Mehta et al., 2009; Mehta et al., 2010). Moreover, Ossani et al. (2007) indicated that choline deficiency cause a significant increase in oxidative stress. The exact mechanism of choline on the decrease in oxidative stress is still unclear, however Sachan et al. (2005) expressed that choline is a very strong lipotropic agent and it enhance the mitochondrial activity at high lipolysis conditions. It's well known that, dairy cows undergo severe negative energy balance after parturition and extremely high lipolysis occurs due to compensate energy needs of the organism (Overton and Waldron, 2004). The current findings indicates that choline can decrease cellular oxidative stress by preventing lipomobilization and increasing mitochondrial activity. As well as choline, niacin

is also known as a strong lipotropic molecule for dairy cows (Weiss and Gonzalo, 2006; Pires and Grummer, 2007). Niacin decreases hepatocyte lipid accumulation and improves fatty acid metabolism during high blood cholesterol levels (Hamoud et al., 2013). Consistent with the present findings, previous studies indicated that niacin supplementation decreased the oxidative stress (Junqueira-Franco et al., 2006; Kamanna and Kashyap, 2007; Cho et al., 2009).

Although the transition period covers a short period of 6 weeks in total, according to many researchers, it is the most risky period in terms of metabolic and infectious diseases in dairy cows. Diseases such as retained placenta, ketosis, fatty liver syndrome, displaced abomasum, mastitis, and metritis, which cause the most economic losses and reduce the productive life of the cows, are most common in this period. Therefore, nutritional practices that increase the resistance of the cows to the periparturient diseases can increase the productivity and health status of dairy cows during transition period. In this study, dairy cows received rumen protected choline, rumen protected niacin and biotin throughout transition period. Results on the incidence of periparturient diseases showed that rumen-protected choline and rumen-protected niacin supplemented cows had fewer periparturient diseases than control and biotin received cows. Choline is a water soluble vitamin and well known that it prevents hepatic lipid accumulation in dairy cows (Zenobi et al., 2018). On the other hand, as Bolatti et al. (2020) indicated that, if choline is involved in the liver lipid oxidation mechanisms, then it could increase the metabolic strength of the animal and prevent it from periparturient diseases. However, in their research, supplemental rumen protected choline did not affect the incidence of periparturient diseases in dairy cows during transition period. Therefore, Bolatti et al. (2020) stated that both treatment and control groups showed acceptable incidence rates in periparturient diseases such as retained placenta (12,7%;17,2%), (10,9%;17,2%), mastitis (5,5%;5,2%) (control and choline treated groups respectively). On the other hand; similar with the current findings, Lima et al. (2012) indicated that supplemental rumen protected choline decreased the incidence of metritis (7,1%; 3,5%, control and treatment respectively) and mastitis (24,1%;13,4%, control and treatment respectively) while did not effect the incidence of retained placenta. Moreover, in the study, rumen protected choline and niacin supplementation improved the oxidative status by decreasing oxidative stress and also decreased the incidence of periparturient diseases. These findings brings to mind that there can be a strong collection between the severity of oxidative stress and the incidence of metabolic and infectious diseases in dairy cows during transition period.

CONCLUSION

The transition period is the most stressful period for dairy cows. In the present study, the effects of supplemental rumen-protected choline, rumen-protected niacin, biotin, and their combinations on total oxidative and antioxidant status and the incidence of some peripartal diseases. In conclusion, supplemental rumen-protected choline and niacin decreased TOS during and after parturition whereas increased TAS at the third week of the lactation. In addition, the supplementation of these two water-soluble vitamins to the dairy cattle diet decreased the incidence of mastitis, metritis, and retained placenta in the transition period. More detailed studies are needed to clarify the mechanisms of choline and niacin on oxidative stress and the prevention of peripartal diseases

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Conflicts of Interest: The authors declare that they have no conflicts of interest.

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BÖLÜM 3

OPPORTUNITIES FOR THE USE OF NEAR INFRA- RED SPECTROSCOPY (NIR) IN ANIMAL NUTRITION¹

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¹ This chapter is derived from the master thesis entitled “Determination of dry matter and crude ash in corn grain using NIR technology”. The aforementioned doctoral thesis was written by Gökhan SAĞLAM with advise of Dr. Cangir UYARLAR at Afyon Kocatepe University

Primary Field: HEALTH SCIENCES

Scientific Field: VETERINARY MEDICINE / ANIMAL NUTRITION AND NUTRITIONAL DISORDERS (CODE: 10102.02)

NIR (NEAR INFRARED) TECHNOLOGY

It is widely acknowledged that achieving high levels of animal productivity and maintaining quality nutrition and management practices are crucial for animal health (Corson et al., 1999). Producers are aware of the importance of quality in feed ingredients. NIR analysis stands out as a cost-effective device that facilitates the analysis process. NIR analysis is said to be less costly compared to chemical analyses when it comes to determining values such as crude protein, soluble carbohydrates, structural fibers, ash, and fat. Through NIR analysis, besides estimating the digestibility of animals, the metabolizable energy (ME) values of the feeds to be used can also be determined (Corson et al., 1999). Therefore, the use of NIR analysis in formulating rations is observed to be increasing worldwide.



Picture 1. Analysis demonstration on NIR device (Anonymous, 2017)

In NIR analysis, approximately 1 gram of feed sample can provide insight into the nutrient levels in the feed sample by performing spectral electromagnetic scanning in the wavelength range of 1100-2500 nm using an NIR device. In this mentioned spectral range, light is directly transmitted to the sample placed on the device. The wavelength of the reflected light (R) carries information that can identify chemical bonds within the sample, such as CH , $-\text{OH}$, $-\text{NH}$, and $-\text{SH}$. This reflected energy is stored in reciprocal logarithmic form ($\log 1/R$) to convert it into a form that can provide information about the chemical bonds in the feed sample (Baker and Barnes, 1990; J. Shenk and Westerhaus, 1991). Absorption bands ori-

ginating from water (1450 nm) and protein functional groups (2100-2200 nm) are shown in Figure 2.



Picture 2. Analysis demonstration on NIR device (Anonymous, 2017)

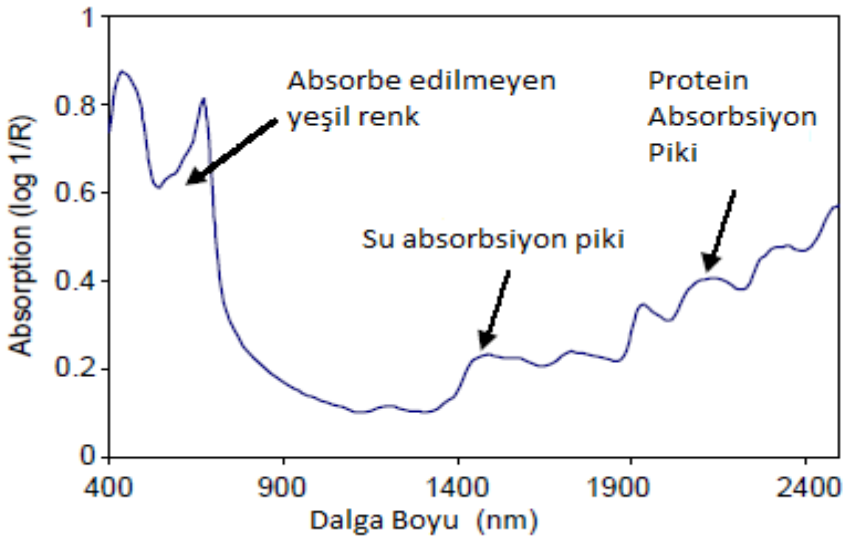


Figure 1. Example of original NIR spectra showing the relationship between increasing wavelength and absorbance

Absorbance is associated with all organic matter present in the feed sample. Proteins, lipids, structural fibers, sugars, and some fractions of these can be determined by the spectra obtained through absorbance. However, for accurate results from these analyses, NIR devices must be calibrated using spectra correlated with chemical analyses. Additionally, it should be noted that NIR techniques used for all types of analyses rely on a laboratory with high-quality references and accurate, well-maintained records.



Picture 3. *An NIR device used in feed analysis*

It is well known that the most important features of NIR device analyses in the industry are speed and low cost. While it has been found that determining the analysis values of feed mixtures produced in factories using traditional methods (ash, nitrogen, fiber, lipid, lipid) takes approximately 16 hours even when starting five analyses simultaneously, the NIR device completes these analyses with samples prepared to meet the conditions in 120-180 seconds. All types of ground roughage and concentrated feeds can be analyzed with this device and properly calibrated spectra. However, although similar, the amount of light absorbed by each prepared sample and the wavelength of the reflected light will vary. Therefore, sometimes different results can be obtained even in two analyses of the same sample (Corson et al., 1999). For this reason, as many and as accurate analysis results as possible should be uploaded to the database of the NIR device, and the wavelength variability in the calibration of the device should be minimized.

Advantages and Disadvantages of NIR Technique

Advantages:

The advantages of NIR device can be listed as follows:

1. It completes nutrient analysis in feed very easily and quickly compared to other analyses.
2. It allows analysis with a small amount of well-sampled sample.
3. Since there is no change in the chemical structure of the sample to be analyzed, it allows the sample to be reused.
4. It enables desired protein, fat, moisture, Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF) analyses to be performed simultaneously in terms of analysis value in feed raw material, and all these data are presented independently.
5. There is no need for the use of any chemical substances during the analysis of feed raw materials. Thus, it also contributes to environmental protection.
6. It allows analysis to be performed cost-effectively without the need for various analysis devices and chemical substances to be used for analysis in feed raw materials.

Disadvantages:

The disadvantages of NIR device can be listed as follows:

1. Due to the expensive NIR technology used for analysis, the investment cost is high.
2. Calibration is required for each of these products for the analyses to be performed, and it is difficult to perform calibrations.
3. When evaluated for analysis, reading differences exist among different NIR devices and due to the different Absorbance coefficients, it is very difficult to transfer calibrations made on one device to other devices.

NIR CALIBRATIONS

The accuracy of NIR measurements in determining feed composition depends on the breadth of the database used for calibration of the device. The best predictions can be made when separate data sets are used for each type of feed. For example, the feedTECH NIR system, a large-scale project used in New Zealand, has been calibrated for five different types of feed

(pasture, pasture silage, brassica crops, corn silage, and grain). For pasture, pasture silage, and corn silage, analyses were conducted on over 200 samples each using wet chemistry methods, and their spectra were recorded using NIR. Similarly, 100 samples were used for high-energy grain-based samples. For brassica crops (cabbage, canola, black cabbage, turnip, and kohlrabi), the same process was repeated using 80 samples. Wet chemistry analyses included dry matter, organic matter, ash, crude protein, lipid, soluble sugars, starch, NDF, ADF, and mineral contents. In addition to silage, analyses were conducted for pH, lactic acid, volatile fatty acids, and ammonia concentration. The wet chemistry analysis results were entered into the NIR database to establish a relationship with absorbance spectra (Landau et al., 2006).

Calibration was performed using principal component analysis (PCA) with primary derivative through PLS interpretation (Shenk and Westerhaus, 1991b). Calibration curve samples contain spectral data for each sample along with wet chemistry data. These curves demonstrate the model fit individually and separated by roughage type.

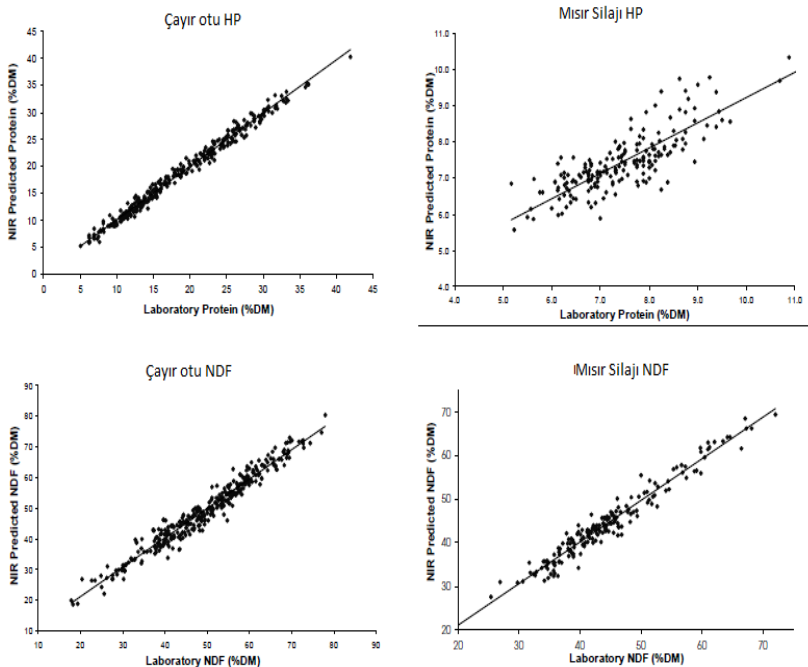


Figure 2. An example showing the relationship between NIR measurements and laboratory values of HP and NDF concentrations of corn silage and fescue. Each point represents each sample used in calibration (Corson et al., 1999).

The differences in prediction (R^2) between components among raw materials are shaped by various factors. These include variations in value ranges within the same feed type and interference from other components. For example, the presence of volatile fatty acids affects KM analysis because they will be lost during drying, which in turn affects the content calculation.

In Table 1, a sample from a study demonstrates a close relationship between some parameters predicted by NIR measurements and their actual laboratory analysis values.

	Number of samples	Average	Interval	R^2	SECV
Meadow grass					
Crude protein	339	18,5	5,0-36,2	0,99	0,95
NDF	360	49,4	17,8-78,0	0,95	2,79
Meltable candy	358	8,5	1,0-25,0	0,87	1,38
OM Digestibility	31	72,3	55,0-85,0	0,90	3,37
Corn Silage					
Crude Protein	181	7,51	4,41-13,12	0,68	0,62
NDF	184	44,2	18,6-72,2	0,96	2,11
Meltable candy	190	35,1	1,1-61,6	0,89	4,80
Lactic acid	76	3,9	0-10,8	0,84	0,87
pH	68	3,9	3,5-4,3	0,39	0,09

Table 1. An example of calibration based on nutrient analysis of fescue and corn silage samples (Corson et al., 1999)

The high R^2 value for the NDF parameter compared to other components indicates that NIR prediction for the NDF parameter is excellent for pasture and corn silage. Generally, as more values are added to the database, the R^2 value increases. For instance, in 1995, the R^2 value for soluble sugars parameter in the feedTECH NIR system was 0.55 (Corson et al., 1999), which increased to 0.87-0.88 when more data were added. However, NIR prediction is also influenced by the type of components and the range of current data. For example, the low R^2 value (0.38) for the pH parameter in corn silage is due to an error during analysis or recording and the narrow range of pH values in corn silage.

While most prediction samples are based on a direct correlation between spectra and chemical component analysis, some predictions are more generalized. For instance, DCAD represents the balance of anions and cations in the diet (Wilson, 1996), and predictions for this parame-

ter are influenced by the effect of potassium. As potassium concentration increases, the DCAD level also increases, and vice versa. The correlation coefficient between potassium concentration and DCAD is 0.78. However, NIR devices are not suitable for analyzing metabolic energy (ME) and organic matter (OM) digestibility in roughages due to the difficulty in NIR predictions, which arises from the type of feed. The NIR database for pasture contains approximately 35 feed samples with known in vivo digestibility obtained from animal trials conducted by Massey University and Agri-Research, and the spectra for predicting OM digestibility of feed samples were also obtained. ME was directly calculated from OM digestibility. The ME levels of pasture-based feeds (e.g., pasture silage, etc.) were calculated based on in vitro cellulase digestibility trials calibrated with in vivo standards (Dowman and Collins, 1982; Roughan and Holland, 1977). The ME value of corn silage was calculated based on the ADF values provided by NIR.

Usage Possibilities of NIR Technology in Animal Nutrition

It is known that NIR began to be used in the 1960s for determining the moisture levels of grains. In recent years, the number of NIR-supported analytical applications and their usage has significantly increased. Looking at the foundation of NIR technologies, it is understood that the logic of light absorption at different levels is due to the diversity of chemical bonds in certain segments of the spectral range between 1100-2500 nm (Corson et al., 1999). The theory of near-infrared spectroscopy (Hrushka, 1987) has been explained in detail, and the mathematical origins of these devices have been described (Martens and Naes, 1987).

In summary, during the calibration of the device, statistical analyses are used to transform each reflectance point into spectra points in the form of $\log(1/R)$ based on \log_{10} . The relationship between these spectral points and values determined by wet chemistry methods is established through chemometrics. All these statistical methods form the basis of calibration. Some reviews suggest that readings should also be taken for new samples with NIR (Deville and Givens, 1998; Foley et al., 1998). In these studies, the fundamental issues of acquiring and analyzing NIR spectra have been simplified. Especially regarding NIR technologies, the diversity of samples, mathematical transformations of spectra, and validation and calibration methods are being discussed.

Some published reviews also recommend taking readings with NIR for new samples (Deville and Givens, 1998; Foley et al., 1998).

In general, NIR studies are evaluated based on the quality of calibration and the linearity and sharpness of calibrations. Sharpness, someti-

mes evaluated based on the slope of the “Validation Equation,” has also been adopted in some studies for determining the accuracy of predictions using SEP (Standard Error of Prediction) and SECV (Standard Error of Cross Validation). SEP expresses the variation between prediction values and reference values when applied to an external validation dataset. SECV, on the other hand, indicates the standard error of the situation that occurs when we refer to subsets of data from the calibration dataset sequentially. It is important to note that if the calibration data is copied, this procedure (SECV procedure) can give overly optimistic results. Therefore, maximum importance should be given to the SECV value when developing calibrations (Naes et al., 2002).

Additionally, it is mentioned that the standard error of cross-validation (SECV) is not used for evaluating bias and validating prediction values. In the long run, even though the accuracy of NIR equations is seriously considered a problem, it is reported that the prediction error of SEP procedure is superior to the cross-validation error of SECV procedure. However, both SEP and SECV are widely used procedures for predicting sharpness.

As previously mentioned, NIR technology is widely used in various points and for different purposes in animal nutrition, most commonly for determining the nutrient composition of feed ingredients and rations. It is important to pay attention to and focus on regulating the nutrient content of rations and to ensure that the sampling represents all consumed or purchased feed ingredients or complete feeds.

Samples of green grass taken from fields are obtained by considering the grazing habits of the animals that graze the best and by taking samples from various locations of the pasture area. Silages, on the other hand, will give more accurate results when taken from the inner parts of the silage pits where the product will be placed, rather than from the outer parts. The sample of silage taken into sample bags is sent to the NIR laboratory for cooling and drying by sealing or tightly tying the mouthpieces. Subsequently, the samples are ground and prepared for analysis. Spectral information is compared with the spectrum in the database of the appropriate feed type, and composition predictions are made. (Corson et al., 1999). Results showing more than $\pm 5\%$ difference are defined as outliers, and they are sent back to the laboratory for chemical analysis to be confirmed. Confirmation is required.

Excessive high values may arise due to samples belonging to a different product from a different feed type or from sample contents developed in the databases of devices. After conducting the necessary tests in full for samples marked as outliers or erroneous values, and confirming that the results remain unchanged; values can be added to the databases to increase

the analysis accuracy of the NIR device against the possibility of similar sample specimens coming from elsewhere. (Corson et al., 1999).

The composition of feed ingredients can be expressed with 8-12 variables that can provide information on the quality of feeds. This information can be used in various ways. The interpretation of this information is necessary, especially when roughages are mixed or added to the ration, in order to meet the requirements of yield share (Corson et al., 1999). These devices have a good position in the investigation of agricultural products, including the possibility of coarse-concentrate feed selection to increase the quality of products produced in agricultural fields. (Marten et al., 1989; Abrams et al., 1987;).

The reasons limiting the conduct of NIR analyses can be explained as the low capacity to generate spectra that can be interpreted as indicative of sample characteristics and the shaping of a sharp calibration. In some research projects, NIR measurements cover very specific areas such as finding the condensed tannin content in roughages and determining diet formulation from fecal analyses. Advanced studies have been conducted to establish the connection between fecal and feed intake using NIR technology (Ünal & Garnworthy, 1999; Murray et al., 1994).

Samples of roughages harvested from fields are generally not sufficient for the optimal diet composition in animals, especially in high-sensory examinations of large and small ruminants (Corson et al., 1999). Thanks to NIR technology, information about nutrient levels in feeds can be rapidly obtained before and after harvesting. In order to prepare the diet to fully meet the needs of animals, the nutrient composition of the diet ingredients must be known accurately. This can only be achieved quickly and reliably with measurements made by NIR devices. Additionally, it is important to know that meadow-pasture qualities can vary throughout the entire season. Therefore, if there is an expectation of the most suitable feeding in terms of cost and quality from rations, nutrient analysis of feeds should be regularly performed (Corson et al., 1999). When acquiring or selling raw materials for ruminant feed production, the analysis values provided by these devices inform both the buyer and the seller about the values of the products. Since evaluations in animal feeding rely on cost-benefit analyses when preparing rations, these analyses must be continuously performed in raw material procurement and sales (Corson et al., 1999).

The first report on determining the quality of roughages through NIR (Norris et al., 1976) listed the SEP values of nutrients within the KM as follows: 0.95% for CP; 3.1% for NDF; 2.5% for ADF; and 2.1% for ADL. The advancement in NIR spectrometers and chemometric methods, as summarized by Dryden (2003), has likely increased the prediction accuracy over

time, even though similar sample sets were not re-evaluated. Calibration in NIR-derived roughage quality determination predictions generally provides more accurate results when compared to “wide-ranging” calibrations, although it is not always the case. Calibrations made with multiple species have a wider spectral variety. In other words, two different characteristics need to be put on the balance of the scale. The first is the robustness of the calibration, which needs to determine the properties of a wide range of samples such as typical natural pasture grasses. The second is the sharpness/accuracy of the calibration. For example, in samples collected from Stork’s bill dry grass, SEP values for CP, NDF, and ADF were 0.4-0.5%, while for ADL it was 1.6% (Berardo, 1997). In another study, samples were collected from pastures grazed by sheep and NIR analyses were performed. The SECV values for Tagasaste (*Chamaecytisus proliferus*) plants were as follows: 0.6% for CP; 1.6% for NDF; 1.0% for ADF; and 0.5% for lignin (Flinn et al., 1992). However, other researchers (Meuret et al., 1993) have determined higher SECV values in a range of Mediterranean pasture grass species.

If the calibration of these devices provides values close to chemical analysis values with a margin of error similar to that of wet chemistry results, the outcome is considered ideal. Since their first use in the industry, these devices have been considered as a standard technology for measurements of Crude Protein (CP) and Acid Detergent Fiber (ADF), as mentioned earlier (Barton & Windham, 1988).

In vitro procedures are frequently used to determine the energy content of ruminant roughages. There are two problems that need to be addressed here: 1) Do in vitro predictions made using NIR provide results as accurate as in vivo digestibility? 2) What is the level of accuracy of NIR analysis in in vitro digestibility?

A trial was conducted on 72 castrated rams in Ireland to examine how accurately the organic matter digestibility of grass silage could be determined using NIR (Park et al., 1997). The in vivo organic matter digestibility of silages ranged from 53% to 80%, and the SEP values for NIR analysis of organic matter digestibility ranged from 2.4% to 2.8%. A review also reported that NIR analysis of in vivo digestibility of hays and grass silages provided better prediction compared to the pepsin-cellulase procedure (Coleman et al., 1999). Additionally, high-quality NIR calibrations have been obtained for the following procedures: determination of Metabolizable Energy (ME) content for sheep using the in vitro pepsin-cellulase procedure in wheat forage (Adesogan et al., 1999); determination of in vivo digestibility for sheep and cattle using a neutral detergent-cellulase procedure in grass silage (De la Roza et al., 2000); determination of in

vivo digestibility in wheat straws using pepsin-cellulase and neutral detergent-cellulase procedures (Givens et al., 1991).

In a broad dataset of roughages, NIR analysis for in vitro digestibility of Crude Fiber (CF) yielded SEP values around 3.5% compared to the Tilley and Terry procedure (Tilley & Terry, 1963). Similarly, according to a fungal cellulase procedure reported by Norris et al. (1976), this value was around 2%.

NIR has the potential to predict ruminal CF degradation in roughages, but its predictive power and accuracy are not superior. While the R^2 value for easily degradable fractions representing 15-51% of total CF content was determined as 0.86, it was 0.78 for slowly degradable fractions representing 29-60% of total CF content. SEC values were also determined to be high (approximately 4.2% and 5.2%, respectively) (Todorov et al., 1994). An experiment was conducted comparing gas production technique, an average indicator of ruminal CF degradation, with NIR. Researchers attempted to measure gas productions and kinetics of dry grasses and silages in sheep rumen fluid using NIR. While total gas production was accurately detected for clover, grass hay, and maize silages ($SECV = 1.2$ ml within a range of 22-43 ml per syringe), this accuracy level couldn't be achieved for clover silage ($SECV = 2.5$ ml within a range of 13-36 ml per syringe). Except for clover hay, NIR predictions of degradation kinetics varied from poor to fair. While the R^2 values for grass hay were at 0.33, they were at 0.80 for maize silage (Landau et al., 2006).

Accumulated knowledge from trials based on ruminally and duodenally cannulated animals significantly contributed to shaping ruminant rations concerning ruminal degradability kinetics of ration nitrogen. Rumen protein outflow, determined as 0.05/hour in sheep with ruminal fistula, was estimated up to 75% using NIR technology. Researchers utilizing rumen-fistulated cattle fed with maize silage reported R^2 values of 0.79 and 0.72 for the determination of escaped protein percentage from the rumen and fermentable organic matter content when using NIR, stating that NIR had reasonable predictive power for these purposes (De Boever et al., 2003). However, the same researchers reported it was not feasible for true protein digestibility in the small intestine. In another study with sheep, NIR-based measurements could determine the in sacco degradability and effective CP degradability of leguminous roughages up to 87-99% ($SECV$ ranged from 70-96%, 2.6%) (Antoniewicz et al., 1995). They also reported a high parallelism ($R^2 > 0.92$) between the in-situ determination of protein fractions, including rapidly degradable proteins, slowly degradable proteins, and undegradable proteins, and their determination via NIR. However, they found that this level of precision ($R^2 = 0.87$) was not achieved for degradation rates, which was less satisfying than the other value. NIR-ba-

sed calibrations are performed using linear regression, which may pose calibration issues for parameters that do not inherently follow a linear trend, such as degradation kinetics.

In many applications, SEP or SECV values are quite close to the standard errors of the analytical procedures providing reference values. Although NIR technologies are considered to be in good condition for calculating energy values in ruminant feeds, NIR-based measurements still need some further development in terms of in vitro and in situ degradation kinetics. NIR-supported technologies will likely replace fistulated animals in calculating the ruminal degradation levels of feeds, which will be a significant step for animal welfare (Landau et al., 2006).

The determination of the chemical compositions of plant species in forest pastures, especially their tannin and other secondary metabolite levels, receives special attention in goat feeding. The total phenolics of the Tagasaste plant were analyzed with a margin of error of 1.2% and high linearity using NIR, while phenolic content was determined to be between 1.4% and 25.4% on a DM basis (Flinn et al., 1996). Calibrations have been developed for condensed tannin content in some plants, including *Lotus uliginosus schkuhr* (Smith & Kelman, 1997), *Leucaena leucocephala* (Wheeler et al., 1996), and *Sericea lespedeza* (Windham et al., 1988). In these narrowly focused studies involving single species, R² values ranged from 0.84 to 0.91, indicating quite satisfactory levels. Another researcher determined the total phenolics, total tannins, and condensed tannin contents in *Vicia* and *Lathyrus* species' fresh forage and hays using NIR, with levels found to be between 0.45%-3.4%, 0.13%-2.3%, and 0.05%-3.0% on a DM basis, respectively. The corresponding SECV levels for these values were 0.17%, 0.18%, and 0.23%, respectively (Goodchild et al., 1998).

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