

Comparison of Cows' Milk in Terms of Quantity and Content Raised under Organic and Conventional Conditions

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Abstract

Intensive agriculture has caused serious adverse effects on human and animal health and serious environmental damage. Organic agriculture has developed as a reaction to the negative effects of intensive agriculture. According to current data, organic agriculture is carried out in 181 countries on an area of 69.8 million hectares and the market volume is estimated to be 100 billion dollars. Milk and dairy products are among the most demanded organic products after fruits and vegetables. Organic dairy cattle farms, differ from conventional dairy farms in that they are based on pasture, contain basic practices for animal welfare and use limited concentration in ration. That difference is expected to cause some differences in milk yield and components. In the present study, it was aimed to compare the milk and milk content of cows raised in organic and conventional condition in accordance with this purpose, it was aimed to compare the milk content and nutrient contents of cows reared under organic and conventional conditions. In the ration, due to the limited use of concentrated feed, the milk of cows raised under organic conditions was being lower. There wasn't any difference between the two management methods in terms of protein, fat and lactose which are the main components of milk. The milk of cows raised in organic conditions was more rich in unsaturated fatty acids, conjugated linoleic acid and omega-3, which had many positive effects on human health.

Keywords: Organic agriculture, organic dairy farm, organic milk, Holstein Friesian

Organik ve Konvansiyonel Şartlarda Yetiştirilen İneklerin Sütlerinin Miktar ve İçerik Bakımından Karşılaştırılması

Öz

Entansif tarım, insan ve hayvan sağlığı üzerinde bazı olumsuzluklara, çevre üzerinde ise ağır tahribatlara neden olmuştur. Organik tarım, entansif tarımın ortaya çıkarmış olduğu olumsuzluklara karşı bir reaksiyon olarak gelişme göstermiştir. Güncel verilere göre, 181 ülkede 69.8 milyon hektarlık alanda organik tarım yapılmakta, pazar hacminin 100 milyar dolar olduğu tahmin edilmektedir. Süt ve ürünleri, meyve ve sebzededen sonra en fazla talep edilen organik ürünlerin başında yer almaktadır. Organik süt sığırı işletmeleri, meraya dayalı olması, hayvan refahına yönelik temel uygulamalar içermesi ve rasyonda sınırlı oranda kesif kullanılması bakımından, konvansiyonel işletmelerden farklılık göstermektedir. Bu farklılığın süt verimi ve bileşenleri üzerinde bazı farklılıklara neden olması beklenmektedir. Bu çalışmada, organik ve konvansiyonel şartlarda yetiştirilen ineklerin sütlerinin miktar ve içerik bakımından karşılaştırılması amaçlanmıştır. Bu amaçla, organik ve konvansiyonel şartlarda yetiştirilen ineklerin süt miktarı ve besin madde içeriklerinin karşılaştırılması amaçlanmıştır. Rasyonda sınırlı oranda kesif yem kullanılmasından dolayı, organik şartlarda yetiştirilen ineklerin sütleri daha düşük olmuştur. İki yetiştirme metodu arasında sütün temel bileşenlerinden olan protein, yağ ve laktöz bakımından bir farklılık olmamıştır. Organik şartlarda yetiştirilen ineklerin sütleri, insan sağlığı üzerine çok sayıda olumlu etkisi bulunan doymamış yağ asidi, konjuge linoleik asit ve omega-3 bakımından daha zengin olmuştur. Bu durumun beslenmeden kaynaklandığı bildirilmiştir. Organik süt sığırı işletmelerinde meraya dayalı bir üretim sisteminde taze ve yeşil yemlerin daha fazla tüketimi, rasyonda kaba yemin fazla olması ve sınırlı oranda kesif yemin kullanılması bu sonucu ortaya çıkarmıştır.

Anahtar Kelimeler: Organik tarım, organik süt sığırı işletmesi, organik süt, Siyah Alaca

Introduction

The world population is expected to reach 9 billion by 2050, resulting in 50% more food needed (Muller et al., 2017). The most frequently used method for the elimination of this need is the method of intensive agricultural production. However, this agricultural method has been implemented since 1960; there has been a great many adversities on human and animal health, and very severe damage to the environment (Evenson and Gollin, 2003; Bayram et al., 2013). Organic agriculture method has emerged as a reaction against the negative effects of the intensive input agricultural method (Röss et al., 2008; Bayram and Acar, 2018). According to current data, organic farming is carried out on 69.8 million hectares in 181 different countries and the market volume is estimated to be 100 billion dollars (Willer and Lernoud, 2019).

The main reasons why consumers prefer organic products are; health and nutrition concerns, sensitivities to the environment and animal welfare, and distrust towards products from the intensive agricultural production (Hoffmann and Wivstad, 2015; Smigic et al., 2017). Among the organic products, the most demanded products are fruit, vegetable and followed by milk and milk products (Palupi et al., 2012). In order to meet the demands for milk and milk products, there have been significant increases in the number, structural size and milk amount of dairy cattle farms both in our country and in other countries (Bayram et al., 2013). Organic dairy cattle farms differ from conventional production in that it is based on pasture contain basic practices for animal welfare and used limited concentrate in ration. This difference; it is expected to cause some changes on milk yield and content.

Materials and Methods

The aim of this study; to compare milk and nutrients of cows reared under organic and conventional conditions. For this purpose, articles published in Turkish and English between 2000 and 2019 were searched such as in the database of CAB abstracts, Scopus, and Web of Science. The results obtained milk quantities and nutrient content are summarized below.

Comparison of Milk Quantity

The studies comparing the milk amounts of cows reared under organic and conventional conditions are summarized in Table 1. Milk of cows reared under organic conditions (actual, 305 days, daily) was reported to be 10.0% to 35.4% lower than conventional condition. Milk quantity is under the influence of factors such as feed, breed, management and genetics rather than the production system (Smigic et al., 2017). Conventional dairy farms focus on producing more milk by applying modern nutrition techniques to breeds with high genetic capacity, while organic dairy farms are focused on producing higher quality milk rather than the amount of milk. This difference in favour of conventional cows in studies comparing the amount of milk between the two breeding methods is due to the limited of concentrated feed in the rations of organically bred cows (Rosati and Aumaitra, 2004; Roesch et al., 2005; Nauta et al., 2006).

It was reported that cows reared under organic conditions did not mobilize more body than conventional conditions and organic cows decreased milk yield according to feed intake (Fall et al., 2008; Germo et al., 2010). For this reason, in case of malnutrition, the first and most important reaction of organic cows is the decrease in milk yield. When table 1 is examined, there are also significant differences between the milk yields reported for organic dairy cattle in different countries. The most important factor in the emergence of this difference is that the concentrate feed rates used in the daily rations of organic dairy

cattle are different. Study conducted by Wallenbeck et al. (2018) reported that in France, Germany, Spain, England and Sweden, the amount of concentrate consumed per cow per year is 616, 1200, 1500, 1800 and 2237 kg, respectively.

Table 1. Comparison of the amounts of milk

References	Traits	Management		Difference (%)
		Organic	Conventional	
Hardeng and Edge (2001)	305 daily milk	4 784	6 129	-21.9
	peak milk yield	23.07	27.71	-16.8
Rosati and Aumaitra (2004)	Milk yield	6 000	8 900	-32.5
Sato et al. (2005)	Daily milk yield	20.2	23.7	-14.8
Valle et al. (2007)	305 daily milk	5 081	6 110	-16.8
Thomassen et al. (2008)	305 daily milk	6 138	7 991	-23.2
Sundberg et al. (2009)	Milk yield	6 725	7 474	-10.0
Germo et al. (2010)	Milk yield	6 155	7 188	-14.3
Bermudez et al. (2017)	Milk yield	6 962	9 987	-30.2
	Daily milk yield	22.8	35.3	-35.4

Comparison of Nutrient Contents of Milk

The nutrient contents of the milk of cows raised under organic and conventional conditions are given in Table 2. When the related table is examined, although the protein value of the milk of cows raised under conventional conditions is higher, it can be said that there is no systematic difference between the two breeding systems. Bermudez et al. (2017) reported that protein, which is one of the main nutrients of milk, is less variable than the amount of milk. Palupi et al. (2012) reported that organic milk had higher protein content (0.56 ± 0.24) than conventional milk. In the organic management system, due to the prohibition of the use of chemical fertilizers, it has been reported that cows fed with feedstuffs containing more nitrogen containing manure may have higher milk proteins (Capuano et al., 2012). On the other hand, Kourimska et al. (2014) reported that the protein ratio in the milk obtained under organic conditions may be low as a result of low starch intake caused by the use of limited concentrate feed in the ration.

Milk fat is one of the most variable nutrients among milk components. Approximately 50% of milk fat is satisfied from daily rations. Table 2 shows the milk fat percentage of cows reared under organic and conventional conditions. When the Table is examined, it can be said that there is no systematic difference between the two breeds, although organic milk has a higher percentage of fat. Palupi et al. (2012) reported that organic milk had higher fat percentage (0.21 ± 0.08). That difference was attributed to the excess of roughage and fresh green feed in organic daily ration (Capuano et al., 2012). Rosati and Aumaitra (2004) reported that the percentage of fat in milk is lower as a result of the use of highly concentrated feed in the rations of cows raised under conventional conditions.

Lactose, known as milk sugar, is an important carbohydrate in nature that is found only in milk. Lactose, which is 4.80% in cow's milk, is more stable compared to other nutrients and does not show much variation. Studies comparing the lactose content of the two management systems, except one, were generally close to each other (Table 2).

Saturated and unsaturated fatty acids in cow's milk have a great effect on human health. Saturated fatty acid (SFA), which constitutes an important part of fatty acids in cow's milk, has a negative effect on human health, especially cardiovascular disorders, and monounsaturated (MUFA) and polyunsaturated (PUFA) acids have a positive effect (Shingfield et al., 2005; Butler et al., 2010). Since fatty acids vary in daily nutrients, a ration should be prepared to reduce saturated fatty acids and increase unsaturated fatty

acids (Shingfield et al., 2015). There are many studies comparing saturated and unsaturated fatty acids of milk produced under organic and conventional conditions (Butler et al., 2008; Collomb et al., 2008; Fall et al., 2008; Butler et al., 2010; Lavrencic et al., 2017). In an important part of these studies; milk produced under organic conditions has lower saturated fat and higher unsaturated fat content (Table 2). Especially polyunsaturated fatty acid (PUFA) differ is more in favour of organic milk (Table 2). It can be said that this is entirely due to nutrition. The amount of saturated and unsaturated fatty acids in cow's milk is more related to the amount and content of daily ration provided to cows rather than to the production system.

Table 2. Comparison of nutritional content of milk

References	Management		Difference (%)
	Organic	Conventional	
Protein (g/100 gr) %			
Byström et al. (2002)	3.50	3.50	0
Roesch et al. (2005)	3.00	3.03	-1.0
Fanti et al. (2008)	3.31	3.01	10.0
Butler et al. (2009)	3.18	3.17	0.3
Kourimska et al. (2014)	3.28	3.33	-1.5
Bermudez et al. (2017)	3.14	3.18	-1.3
Fat (g/100 gr) %			
Byström et al. (2002)	4.50	4.5	0
Wleck et al. (2003)	4.11	4.22	-2.6
Roesch et al. (2005)	3.84	3.87	-1.0
Butler et al. (2010)	3.75	3.49	7.5
Kourimska et al. (2014)	4.03	3.99	1.0
Bermudez et al. (2017)	3.86	3.82	1.0
Laktose (g/100 gr) %			
Byström et al. (2002)	4.70	4.70	0
Roesch et al. (2005)	4.90	4.90	0
Kourimska et al. (2014)	4.0	4.84	-17.3
Fanti et al. (2008)	4.42	4.37	1.0
Saturated Fatty Acid (g/kg)			
Butler et al. (2008)	672	691	-3.0
Collomb et al. (2008)	606	604	0.3
Butler et al. (2010)	699	707	-1.3
Monounsaturated Fatty Acid (g/kg)			
Butler et al. (2008)	289	275	5.0
Collomb et al. (2008)	244	249	-2.0
Butler et al. (2010)	261	262	-0.5
Polyunsaturated Fatty Acid (g/kg)			
Butler et al. (2008)	82	59	39
Collomb et al. (2008)	50	47	6.4
Butler et al. (2010)	39.4	31.8	24.0
Conjugated Linoleic Acid (g/kg)			
Butler et al. (2008)	14.4	9.11	58
Collomb et al. (2008)	13.9	12.1	15
Butler et al. (2010)	7.4	5.6	29.5
Omega-3 (g/kg)			
Butler et al. (2008)	10.2	6.2	64.5
Collomb et al. (2008)	15.5	13.8	12.0
Butler et al. (2010)	8.8	5.5	60

Comparing studies the conjugated linoleic acid and omega-3 contents of the milks obtained in organic and conventional conditions (Table 2), organic milk has higher values in terms of both nutrients. Palupi et al. (2012) reported that organic milk has a higher

conjugated linoleic acid (0.68 ± 0.13) and omega-3 (0.84 ± 0.14) average. The reason for this difference, in organic dairy cattle farms is mainly attributed to the excess of rough and green feeds (Capuano et al., 2012; Palupi et al., 2012). In the another study was reported that the amount of conjugated linoleic acid, which has many positive effects on human health, increased in the milk of cows fed with high fiber foods (Bergamo et al., 2003).

It has been reported that the mineral content of milk obtained is higher in conventional dairy farms than that of organic milk due to the regular addition of macro and micro minerals to the concentrate feed (Rey-Crespo et al., 2013). Srednicka-Tober et al. (2016) reported that there is no significant difference between organic and conventional milk in terms of macro elements such as Ca, Mg, P and K. In both studies (Rey-Crespo et al., 2013; Srednicka-Tober et al., 2016) reported that organic milk had a very low value in terms of iodine required for the production of thyroid hormone, which is essential for the regular functioning of metabolism ($78 \mu\text{g} / \text{g}$, $157 \mu\text{g} / \text{g}$).

It was reported that α -tocopherol and β -caroten contents of milk obtained from organic conditions were higher (Slots et al., 2009; Mogensen, 2012). The reason for the higher content of α -tocopherol and β -carotene has been attributed to the excess of fresh and green feeds in daily ration by pasture-feeding (Slots et al., 2009; Mogensen, 2012). In the meta-analysis study conducted by Palupi et al. (2012) reported that organic milks have higher mean α -tocopherol (0.44 ± 0.62) and β -carotene (0.49 ± 0.60). In both studies (Ellis et al., 2007; Bergamo et al., 2003) has been reported that conventional milk has higher vitamin A content.

Conclusion

As a result, organic milk yields were lower due to the limited use of concentrate feed in dairy cattle farms. In the ration, due to the in high quantity rough feed and green feeds and the limited feed content, the unsaturated fatty acid, conjugated linoleic acid and omega-3 caused organic milk to be richer.

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