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Comparison of fatty acid composition of milk from Holstein and local breed cows in two breeding systems

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RESEARCH ARTICLE

Abstract
Milk production and quality are influenced by many factors, including nutrition, management practices and breed. The aim of this study was to determine the effect of farming management system and breed on the milk yield, and fatty acid composition of the milk from 50 confinement-fed cows that were fed a total mixed ration, and 52 pasture-fed cows grazed together in rangeland. Individual milk samples (N = 102) were collected once in February. Milk from local breed was characterized by a significantly lower milk yield, and somatic cell count, and a higher protein content than the Holstein breed. The fatty acid composition was relatively the same in both breeds. The result showed that farming management system has no significant effect on the milk yield, somatic cell count, and fat contents, while there was a significant effect on protein content and fatty acid composition. The milk of Holstein cows from extensive system was characterized by more favorable fat fractions with significantly lower concentrations of C10:0, C12:0, C14:0, the sum of short and medium chain saturated fatty acids and n-6: n-3 ratio, and also by higher concentration of unsaturated fatty acids and the sum of n-3 than the milk of Holstein from intensive system.

Keywords: farming management system; breed; milk fat composition.

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INTRODUCTION
Algeria is the most important milk consumer country in the Maghreb with a dairy production of 75% covered by the cattle herd. To increase local milk production, Algeria has imported dairy cows with high genetic potential since the 1970s (Madani and Mouffok, 2008). This population is dominated by the Holstein breed originated from Europe. The cattle are oriented towards milk production in an intensive system. In parallel, local dairy production is also made of the local herd represented essentially by the Brune de l'Atlas breed. The latter is raised in the extensive system and has an important place in families and national economy (Yakhlef, 1989). The extensive system is based on a traditional transhumance system between highland and lowland areas. Compared to the imported breeds, the local breed has a relatively high level of genetic diversity, characterized by an adaptation to the harsh environmental conditions. According to Gardini et al. (2007), the development of dairy cattle breeds with potential for high milk production has threatened internationally the existence of many local breeds of dairy cattles. The same trend applies to Algeria; the number of cows of local breed

has gradually decreased and replaced by the imported cows. Moreover, the high consumption of milk in Algeria is one of the intake vectors of saturated fatty acids (SFAs). Due to the atherogenic effect of some SFAs when they are consumed in excess, it is important to know the variation factors of the fatty acids (FAs) composition in milk fat. Although the impact of feeding diets on cow's milk FAs composition has been widely studied (Carroll et al., 2006; Chilliard et al., 2007), there are limited information on the effect of dairy breeds and farming system on milk composition (Lawless et al., 1999; Drackley et al., 2001; Stergiadis et al., 2015). The FAs in milk are affected by various factors i.e. endogenous (breed, individual milk production, state of health, lactation stage) and exogenous (environmental conditions and farm management) (Soyeurt and Gengler, 2008; Stergiadis et al., 2015; Adamska et al., 2016). However, according to our knowledge, there were no studies analyzing the composition of FA in milk from the two main breeds (Holstein and local cows) in relation to their farming management system. Furthermore, milk production is a vital part of national economy in Algeria especially in Kabylia region where the milk processing is a very important activity for small farmers. Although Kabylia is a mountainous region, it is among the largest milk producing regions in Algeria (Kadi et al., 2007). It would be therefore interesting to study the production and the quality of milk of different cattle herds in this region. Hence, the aim of this study was to determine the differences in milk yield and fatty acid composition in milk from the two main dairy breeds in Algeria, Holstein and local cows, milked and kept under real breeding conditions in two different farming systems.

MATERIALS AND METHODS

Site, animals and feeding

The current study was performed in Tizi Ouzou (Kabylia), located in the central coast of Algeria. It is characterized by 80% of mountainous relief; it has a Mediterranean climate, with two distinct seasons, hot and dry in summer (peak temperatures reaching 38°C), but cold and wet in winter, with an average rainfall between 600 to 1000 mm per year and a minimum temperature below freezing.

Two types of farms were chosen in Tizi Ouzou region; one is located in the plain area of Draa Ben Khedda (altitude 56 m above sea level). It is a state farm having a large number of cows composed of different imported breeds; which are raised in an intensive farming system. In this farm, the predominant animal breeds are Holstein cows. All the selected animals for sampling (50 Holstein cows) were multiparous in the middle of the lactation (characteristics in Table 1). The animals were confined and kept under the same breeding conditions. Cows were milked twice a day at 6: 00 and 18: 00 in the milking parlor and the yield was recorded. They received a standard diet prepared as a total mixed ration based on fodders and supplemented with a commercial concentrate feed in order to increase the production level of cows (Table 2 and 3), offered in an individual stall in the milking parlor in two equal feeds each day and had access to water and salt *ad-libitum*. The animals did not graze during our study.

The other 4 farms were located in a mountainous area of Kabylia with an altitude of 1500 m above sea level. A total of 52 multiparous cows were chosen in the middle of a lactation period (36 Holstein and 16 local cows). Local cows were originated from a local autochthonous breed known as Brune de l'Atlas. Cows were hand-milked twice per day, in the morning at 6: 00 before going out to grazing, and at 17: 00 when they returned to the stable. In these farms, cows grazed for full days and fed with hay and barley when necessary. They were not given a concentrate supplementation during exploitation, and were adapted throughout the year to the mountain grazing environment.

Table 1. The mains characteristics of two types of farms

	S_1 (confined cows)	S_2 (pasture based in Mountain area)
Breeds	Holstein (H_1)	Local breed (BL), Holstein (H_2)
Type of farming system	Intensive	Extensive
Number of farms	01	04
Overall Number of cows	250 heads	Max 20 heads/ Farm
Number of cows sampled	50	52 (36 Holstein and 16 local cows)
Days of lactation	150	130
Mean live weight (kg)	500-650	250-300 (BL), 500-600 (H_2)
Milking system	Milking parlor	Hand milking
Animal condition	Loose (free-stall barn)	Loose
Feed	Rationed feed	Pasture
Concentrate intake (Kg/animal/day)	10	-

S_1: intensive system; S_2: extensive system

A survey was carried out using a detailed questionnaires completed with farmers to record management and feeding during the study. Indeed, according to field observations carried out among farmers following the approach of Collomb et al. (1999), on a fenced area as homogeneous as possible the main forage species in the region are *Rosa sempervirens, Phillyrea angustifolia, Cytisus spinosus, Myrtus communis, Asphodelus microcarpus, Sinapis arvensis, Hedysarum flexuosum, Pistacia lentiscus, Rubus fruticosus, Inula viscosa, Dittrichia viscosa, Erica arborca,* and *Lavandula stœchas*.

Table 2. Components Composition of the feed ration of H_1 cows

Composition	Content
Ingredient composition (Kg fresh weigh per cow and day)	
Ryegrass silage	40
Fresh cut clover	20
Oat hay	2
Concentrate	10
Ingredient composition of the concentrate %	
Maize grains	50
Wheat bran	22
Soybean meal	25
Mineral-vitamin mixture*	3

* Composition per kilogram: 9000, 7000 mg of calcium and phosphorus; 60, 12, 144, 0,6, 0,3, 1,5, 108 mg of iron, copper, zinc, cobalt, selenium, iodine and manganese respectively; 15000 IU vitamin A; 2000 IU vitamin D_3; 30 IU vitamin E.

Table 3. Chemical composition of feed components

Components of diet	Dry matter	Ash	Crude protein	Crude fat	Crude fiber	Starch
	%	% dry matter				
Ryegrass silage	15.7	09.1	13.2	2.98	27.6	-
Fresh cut Clover	13.5	12.65	21.8	2.8	23.5	-
Oat Hay	87.02	7.8	6.8	2.05	43.2	-
Concentrate	88.32	5.57	22.28	03.7	10.91	35.9

Milk and feed compositional analysis

Feed

Samples were grinded and analyzed for dry matter by drying at 100 °C for 16 h (AOAC,1990; method 934.01). Ash was analyzed after combustion at 600 °C for 2h (AOAC,1990; method 942.05). Crude protein was calculated as 6.25 x total N according Kjeldhal method (AOAC, 1990; method 988.05). Crude fat was analyzed by extraction with petroleum ether (AOAC, 1990; method 920.39). Starch in concentrate was analyzed by an enzymatic calorimetric technique according to Bach Knudsen et al. (1987).

Milk

Individual samples were collected once from each farm in the morning in February 2017. After collection, each sample (250 ml) was placed into two sterile bottles for chemical analysis. The first portion was analyzed for fat, protein, and lactose using Milkoscan FT120 apparatus Fourier transformed infrared spectroscopy (Foss electric A/S Hillered, Denmark). The SCC values were obtained by fluoro-electronic method using Fossomatic 5000 FC counter (Foss electric A/S Hillered, Denmark).

The remaining portion was stored at −20 °C until analysis of the fatty acid profiles. Milk fat extraction was carried out according to Röse- Gottlieb method NF EN ISO 1211 (AFNOR, 1986). Fatty acid methyl esters (FAMEs) were prepared according to the NF T60-233 method (AFNOR, 2000). The FAMEs of milk were analyzed by gas chromatography method (GC) using an Agilent technologies 6890A instrument (USA) equipped with a flame ionization detector, a splitless injector, and a capillary column Omegawax (30m × 0.25mm x 0.25 µm film thickness). For identification of FAs, the obtained peaks were compared to those of a standard sample (Supelco, 37-component FAME Mix from Supelco analytical, USA).

FAME's identification was confirmed by Gas Chromatography coupled to mass spectrometry (GC/MS) analysis using an Agilent Spectrometry technology 5975C insert XL ET / CI MSD Chem Station, with triple- axis detector coupled with an Agilent 7890A Gas Chromatograph. In FID as in GC-MS, temperature conditions were as follow: isotherm at 50 °C for 1 min, then increased to 150 °C by 30 °C /min, which was further increased to 250 °C at a rate of 5 °C/min and then maintained for 10 minutes.

Detector and injector were operating in splitless mode at 260 °C; the carrier gas was helium at a constant flow rate fixed at 1ml /min. In GC-MS 0.5 µl of the FAMEs in Hexan was injected into the capillary column of VF–WAX ms (30 m x 0.25 µm x 0.25 µm film thickness). The mass range scanned (EI at 70 eV) was from m/z = 40 to m/z = 450. Identification of FAs was performed by comparing their chromatographic retention times and MS spectra with those of Wiley 275.L and Pal 600K.I Spectral Database.

Statistical Analysis

ANOVA analysis was performed with XLSTAT (Addinsoft, 2019). Furthermore, both fisher (LSD) and Tukey (HSD) tests were used for pairwise multiple comparisons for the H1*H2 and H2*BL races. Differences were considered statistically significant at P <0.05.

RESULTS AND DISCUSSIONS

Basic composition

The yield of milk and basic milk components related to breed and farming system during the period of milk sampling are reported in Table 4.

Table 4. Means (±SD) and significance of the breed and farming management system effect on the yield and basic composition of milk samples

	S1	S2		P-values	
Variable	**H_1**	**H_2**	**BL**	**FS (H_1*H_2)**	**Breed (H2*BL)**
Milk yield (Kg/cow/day)	19.68 ± 6.75	20.04 ± 5.31	7.92 ± 2.61	0.793	< 0.001
Fat content (g/kg milk)	41.66 ± 9.52	38.5 ± 7.99	42.17 ± 15.22	0.109	0.278
Proteins content (g/kg milk)	31.9 ± 1.75	31.01 ± 1.52	33.13 ± 3.63	0.018	0.006
Lactose (g/kg milk)	46.53 ± 2.77	44.86 ± 3.05	45.48 ± 3.23	0.010	0.538
SCC ($x10^3$)	166.06 ± 154.45	104.66 ± 73.08	19.25 ± 2.12	0.516	0.003

S_1: intensive system, S_2: extensive system, H_1, H_2: Holstein cows, BL: local breed (Brune de l'Atlas), FS: Farming management system.

The results showed a high significant effect (P < 0.001) of breed on milk yield between Holstein and local breed cows. Indeed, several authors (Chiofalo et al., 2000; Hansen et al, 2006; De Marchi et al., 2007; Mapekula et al., 2011; Stergiadis et al., 2015) confirmed the effect of breed on milk production and have indicated that milk from local breeds is characterized by a low milk yield. However, the local cows have a great rusticity, and are appreciated by breeders in mountainous areas for their better adaptation to the difficult conditions of mountain pastures. Similar characteristics were confirmed by Zendri et al. (2016) for the local breeds (Mostly Rendena and Alpine Grey).

Although the Holstein cows used in the intensive farm were generally in better conditions (environment, feeding with high concentrate supplementation and management health), they had a production similar to those kept in the mountain system, whereas in Europe the average milk yield of Holstein cows ranges between 24,54 kg/d and 30,5Kg/d (Coulon et al., 1998; Cauty and Perreau, 2002; Pešek et al., 2005). In addition, Ahlman (2010) showed similar results when considering Swedish Holstein and Swedish Red cows in organic and conventional systems in Sweden. Moreover, White et al. (2001) reported a higher daily production for confined Holstein compared to pastured Holstein cows. In fact, the specialized dairy breed (H_1 and H_2) was not able to express its productive potential in the two types of system since the milk yield was similar for the two Holstein groups. The problem of adaptation of the exogenous population is probably the main factor influencing the milk production (Madani and Mouffok 2008; Snousi et al., 2010).

In this study, milk fat, lactose and protein values of the different milk samples were similar on average to those reported by several authors (Coulon et al., 1998; Cauty and Perreau, 2002; Bony et al., 2005; Pešek et al., 2005) who indicated that for cattle breeds these values ranged from 31.13 to 33.3 g/kg, and from 39.8 to 41.9 g/kg of milk for the protein and fat content respectively.

There was a significant effect of farming management system on milk composition between the two groups of Holstein cows. Indeed, milk produced by H_1 cows had higher lactose and protein concentrations (P <0.05) compared to milk from H_2 cows. Such differences were mainly due to protein and energy intakes contained in the feed ration (concentrate and silage) of H_1 cows. According to O'Callaghan et al. (2019), several external factors can affect the milk protein content, among which is energy intake.

Protein content was higher (P < 0,01) in BL milk versus milk from H_2. These results were consistent with those obtained by other authors (Chiofalo et al., 2000; Pesek et al., 2005; Stocco et al., 2017; Samkovà et al., 2018), who compared autochthonous breeds to Holstein breed. Furthermore, the higher protein content in milk from local cows might indicate that these cows have the ability to convert poor quality feed to milk protein (Mapekula et al., 2011). The milk fat concentrations were not significantly different between H_2 and BL breeds. A similar observation concerning milk fat content was reported by Lawless et al. (1999), who confirmed that milk fat concentrations were not significantly different among the breeds when all cows were grazed together in one group. In this study, the values found in fat and protein for the local cows were higher than those reported by Mahecha et al. (2008) for their milk samples from local breed (Lucerna cows), grazed in a silvopastoral area.

When considering the sanitary condition of the farms, milk from the intensive farm practicing stall-feeding had an increased somatic cell count (SCC) than the farms practicing grazing system. No significant difference was observed between Holstein cows although H_1 showed a higher value. The increased risk of mastitis (SCC) in stall-fed cows was also reported by Dehinenet et al. (2013).

The SCC is a quantitative index of mastitis condition and milk quality of ruminants. Therefore, it is a good measure for udder health (Millogo et al., 2008; Hamed et al., 2012; Li et al., 2014). The observed low SCC concentration in milk from local cows ($P < 0.01$) versus H_2 cows was a consequence of their low milk yield. It should be noted that the effect of breeding practices used (such as milking process), management, genetics, climate and milk yield are known to influence this milk trait (Bytyqi et al., 2010; Hamed et al., 2012; Rodriguez- Bermúdez et al., 2017).

Fatty acids

The total fatty acids (FAs) profiles of the milk fat from the three herds of cows is presented in Table 5. Contents of saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) determined in our study were within the range reported for these FA groups (Delaby et al., 2001). Furthermore, several authors (Dewhurst et al., 2006; Soyeurt et al., 2006; Chilliard et al., 2007; Ferlay et al., 2008) indicated that milk fat typically contains a high proportion of SFAs (70-75%) and MUFAs (25-26%), and small amounts of PUFAs (4-5%). Moreover, the most abundant FA in milk from all cows were palmitic (C16:0), and oleic acid (C18:1 n-9 cis), which are responsible for about 50% of the FAs content.

In general, the obtained data showed higher proportions of individual SFAs in milk from confined cows (H_1) compared to those of pastured cows (H_2), except for the proportion of arachidic acid (C20:0), which is more elevated ($P < 0{,}01$) in the group of H_2 cows. However, differences were significant for capric acid (C10:0; $P < 0{,}05$), lauric acid (C12:0; $P < 0{,}05$), myristic acid (C14:0; $P < 0{,}01$), and pentadecanoic acid (C15:0; $P < 0{,}01$), while major SFAs such as C16:0 and stearic acid (C18:0) did not differ between the two groups. Similar results were reported by Hanuš, et al. (2016), who compared grazing cows with non- grazing cows. In contrast, in the extensive farms, the proportions of individual SFAs were relatively similar in both breeds.

These results were also in disagreement with those reported by White et al. (2001), who found that pasture-fed cows produced significantly more C10:0, C12:0, and C14:0. Most of these acids of SFAs group are highly related to an increased risk of atherosclerosis, obesity, and coronary heart diseases (Chilliard et al., 2007; Haug et al., 2007; Falchero et al., 2010). The major part (80% to 85%) of the C16 FA in milk was derived from de novo synthesis (Hymoller et al., 2014), while long-chain FA (≥ C18) are derived from precursors in the blood (Bauman and Griinari, 2003).

Although the sum of MUFAs and of PUFAs did not differ significantly among the cattle groups, we observed higher contents of the following FAs in H_2 versus H_1 cows: pentadecenoic acid: C15:1 ($P < 0{,}001$), heptadecenoic acid: C17:1 ($P < 0.001$), vaccenic acid: t11-C18:1 ($P < 0.05$), eicosenoic acid: C20:1 ($P < 0.05$), α-linolenic acid: C18:3n-3 ($P < 0.01$), and eicosatrienoic acid: C20:3n-6 ($P < 0.01$). A similar result was observed for the sum of n-3 FAs. Indeed, previous studies showed that n-3 FA was affected by farming management system in general (Ellis et al., 2006), and feeding in particular (Meribai et al., 2015). In milk fat, linear odd-chain FAs (C15:0 and C17:0) can be largely synthesized by rumen microflore, but about 10% originate from diet and animal de novo synthesis from propionate (Falchero et al., 2010), whereas Δ^9- desaturase activity in the mammry gland is responsible for the conversion of C15:0 and C17:0 to C15:1 and C17:1 respectively (Vlaeminock et al., 2006). Consequently the main cause for the higher level of C15:1 in milk fat from H_2 versus H_1 and BL could be the higher activity of the Δ^9-desaturase in mammary tissue of Holstein cows grazing in the mountain pastures.

The vaccenic acid was observed in a negligible amount in this study. It is considered as the most important trans isomer, and its presence in milk fat is the result of an incomplete hydrogenation of unsaturated dietary lipids in the rumen (Mac Gibbon and Taylor, 2006).

Oleic acid (C18: 1n-9) was also slightly higher in milk fat from H_2 cows but did not differ between the cow groups. Hanuš et al. (2016) determined a higher proportion of MUFAs in grazing cows compared to non-grazing cows. In our study, this FA group tended to be influenced ($P = 0.05$) by feeding system (H_1 compared to H_2), while UFAs group was higher ($P < 0.05$) in milk from H_2 cows compared to H_1 cows. The MUFAs, PUFAs, and UFAs groups are desirable characteristics in milk. Indeed, a higher proportion of these FAs groups in milk fat seems to be favorable for the human health especially for their impact on the level of cholesterol in the blood (Haug et al., 2007), and the positive role on arteriosclerosis, diabetes, and cancer (Soyeurt et al., 2006). It is well known that UFAs may decrease the risk of cardiovascular diseases (Mahecha et al., 2008).

Table 5. Means (±SD) and significance of the breed and farming management system on the fatty acid (FA) profile (% FA) of milk samples

	S1	S2			
	H1	H2	BL	P-values	
Fatty acids				**FS (H1*H2)**	**Breed (H2*BL)**
SFA					
C4:0	0.73 ± 3.13	0.66 ± 0.68	0.66 ± 2.12	0.918	0.995
C6:0	0.78 ± 0.54	0.69 ± 0.42	0.82 ± 0.88	0.546	0.563
C8:0	0.64 ± 0.38	0.47 ± 0.38	0.46 ± 0.39	0.130	0.887
C10:0	2.26 ± 0.95	1.64 ± 1	1.84 ± 0.81	0.022	0.505
C12:0	3.3 ± 1.15	2.55 ± 1.19	2.53 ± 1.08	0.024	0.939
C14:0	12.30 ± 2.87	10.20 ±2.04	10.71 ± 1.97	0.005	0.452
C15:0	1.48 ± 0.62	0.96 ± 0.42	1.18 ± 0.23	0.001	0.068
C16:0	33.13 ± 5.99	31.16 ± 5.23	30.97 ± 8.00	0.215	0.936
C17:0	0.69 ± 0.26	0.77 ± 0.27	0.82 ± 0.26	0.229	0.566
C18:0	11.52 ± 3.84	13.07 ± 5.49	12.55 ± 6.72	0.208	0.800
C20:0	0.19 ± 0.17	0.48 ± 0.44	0.24 ± 0.27	0.001	0.068
C22:0	0.04 ± 0.06	0.01 ± 0.03	0.04 ± 0.08	0.142	0.219
MUFA					
C12 :1	0.064 ± 0.29	0.06 ± 0.072	0.04 ± 0.057	0.941	0.569
C14 :1	0.79 ± 0.57	0.93 ± 0.33	0.73 ± 0.47	0.300	0.133
C15 :1	0.16 ± 0.21	0.48 ± 0.37	0.27 ± 0.18	< 0.0001	0.044
C16 :1	1.46 ± 0.96	1.91 ± 0.78	1.94 ± 1.15	0.079	0.909
C17 :1	0.28 ± 0.29	0.59 ± 0.18	0.46 ± 0.36	< 0.0001	0.165
C18 :1	21.81 ± 8.57	24.63 ± 5.17	24.41 ± 5.59	0.181	0.903
C18 :1 t11 (VA)	0.14 ± 0.29	1.09 ± 2.65	0.58 ± 0.75	0.027	0.467
C20 :1	0.15 ± 0.19	0.32 ± 0.42	0.23 ± 0.32	0.031	0.490
PUFA					
C18 :2n-6 (LA)	2.51 ± 0.88	2.23 ± 0.75	2.73 ± 0.93	0.242	0.087
C18 :2 RA	0.35 ± 0.69	0.29 ± 0.26	0.34 ± 0.38	0.693	0.661
C18:3n-3 (ALA)	0.49 ± 0.36	1.22 ± 1.03	0.72 ± 0.95	0.000	0.145
C18:3n-6	0.14 ± 0.22	0.20± 0.24	0.13 ± 0.28	0.375	0.375
C20:3n-6	0.05 ± 0.07	0.18 ± 0.26	0.07 ± 0.13	0.005	0.129
C20:3n-3	0.07 ± 0.09	0.06 ± 0.1	0.07 ± 0.13	0.743	0.780
C20:4n-6	0.02 ± 0.04	0.02 ± 0.04	0.02 ± 0.05	0.635	0.698
Groups of FA					
SMCSFA	56.39±9.12	50.17±9.38	51.6 ±9.53	0.016	0.644
LCSFA	11.76 ± 3.79	13.57 ± 5.57	12.84 ± 6.9	0.143	0.727
SFA	68.15 ± 9.33	63.74 ± 5.23	64.49 ± 7.68	0.055	0.731
MUFA	25.85 ± 8.69	29.99 ± 4.55	28.86 ± 5.07	0.050	0.484
PUFA	3.87 ± 0.87	4.21 ± 1.40	4.18 ± 1.79	0.248	0.962
UFA	29.64 ± 8.6	34.2 ± 5.04	33.05 ± 5.39	0.033	0.511
∑n-6	2.58 ± 0.88	2.43 ± 0.74	2.82 ± 0.98	0.516	0.185
∑n-3	0.57±0.38	1.29±1.11	0.8±0.96	0.000	0.170
n-6: n-3	5.43±4.18	2.88±3.67	7.26 ± 6.13	0.024	0.012

FS – Farming management system, SMCSFA – Short and medium Chain Saturated Fatty Acids (C4 – C17), LCSFA – Long Chain Saturated Fatty Acids (C18-C22), MUFA – Monounsaturated Fatty Acids, PUFA – Polyunsaturated Fatty Acids, UFA – Unsaturated Fatty Acids.

However, a higher ($P < 0.05$) level of the sum of short and medium chain saturated fatty acids (SMCSFA) was observed in H_1 compared to H_2 cows, which is mainly due to the significant differences in C10:0, C12:0, C14:0 and C15:0. Conversely, n-6: n-3 ratio was lower in H_2 cows ($P < 0.05$) versus H_1 and BL. This result was in agreement with that of Mapekula et al. (2011) who reported that this ratio was higher in milk from local breed cows (Nguni). Moreover, according to Amould and soyeurt, (2009), it is important to reach and keep a lower ratio of n-6: n-3 (lower than 5) in order to prevent the risk of cardiovascular diseases, cancer, autoimmune disorders, obesity, etc.

In the current study, feed rations of H_1 cows were based on fresh clover, ryegrass silage, oat hay, and were supplemented mainly with concentrate with zero grazing, unlike local breed and H_2 cows in mountains, which were fed only on pasture in the forest and received no or low amounts of supplementation.

The period of sampling (February) coincides with the period of high forage availability and rich biodiversity of grazing species in natural grasslands and rangelands in our mountain farms (Kadi et al., 2019). Therefore, the feeding regimen of cows is probably the main factor influencing FAs composition of milk. According to Stergiadis et al. (2015), feeding diets used in organic and other low-input, pasture-based dairy production systems are known to increase concentrations of nutritionally desirable monounsaturated FAs (MUFAs), such as vaccenic acid (VA; t11 C18:1), and polyunsaturated FAs (PUFAs), such as α-linolenic acid. Furthermore, it has clearly been demonstrated that altitude greatly influences milk quality depending on its origin (plain or mountain). In fact, the specificity of mountain milk is directly linked to a diet based on permanent grassland and probably to a complex floristic diversity. As a result, the content of these milks in UFA tends to increase due the presence of dicotyledonous plants rich in secondary metabolites; the later appear to influence the ruminal biohydrogenation process in fatty acids (Collomb et al., 2008; Ferlay et al., 2008; Réviron et al., 2008). On the other hand, breeding in lowland area is characterized by the use of sufficient quantities of fodder produced on the farm (legume silage and green grass fodder), while concentrates are purchased in variable quantities.

The effect of the breed was negligible in explaining the variation of the FAs proportions between H_2 and BL cows, except for C15:1 and n-6: n-3 ratio ($P < 0.05$). Many authors agreed that the contents of most of the individual fatty acids did not differ considerably among the breeds and reported that the effect of the breed on FAs profiles is minor compared with the effects of feeding and husbandry conditions prevailing in the geographical studied area (Pesëk et al., 2005; Ferlay et al., 2008; Hanuš et al., 2016; Samková et al., 2018).

CONCLUSIONS

In the present study, the breed effect between BL and H_2 cows under the same rearing conditions was mainly seen in the milk yield, SCC, and protein contents. This explains the lower productivity and consequently the low risk of mastitis of the local cows under low-input system. On the contrary, breed has only a minor influence on the FA profile of milk fat. However, the higher variations in FA composition among the three cattle groups were observed in H_2 versus H_1 cows. Milk fat from confinement-fed cows (H_1) was characterized by a higher proportion of SFAs such as capric acid, lauric acid, and myristic acid. In addition, the sum of UFAs and individual FAs of the H_2 cows such as C15:1, and α-linolenic acid were more abundant in milk fat, but the n-6: n-3 ratio was lower. The observed variability in FA composition was closely linked to the variants of feeding and rearing conditions.

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Conflicts of Interest

The authors declare that there are no conflicts of interest associated with this study.

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