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Correlation between climate conditions on physicochemical properties of bovine's milk in Morocco

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Milk production of dairy bovine in Morocco plays a major role in feeding a growing urban population. For that reason, the aim of this study was to evaluate and characterize the physicochemical properties of milk along with the climate change conditions, in Gharb Chrarda Beni Hssen (GCBH). Moreover, the correlations between bovine milk composition and Mediterranean climate conditions was examined on several milk collection provided from different centers and farms. Indeed, over 53 weeks, all samples were characterized in terms of pH=6.49, acidity 19.58 and 1.034 density in acid. The average of chemical contents showed protein content (TP) 3.05%, fat content (TB) 3.52% and the content of the defatted dry extract (DDE) 9.18%. Correlation coefficients between fat and protein reached +0.7; whereas between the defatted dry extract and the fat this coefficient reached +0.9 and+0.8 between the defatted dry extract and the proteins chemical composition of milk showed a considerable variability throughout. These variations are mainly due to fat, protein content and the defatted dry extract. Overall, this study showed also a positive correlation between these three components.

Keywords: Raw milk, Defatted dry extract, Protein, Fat, Morocco.

INTRODUCTION

The Gharb Chrarda Beni Hssen region (GCBH) covers an area of 7,990 km², or 1.12% of the Moroccan territory. The GCBH region benefits a Mediterranean climate, characterized by mild, wet winters and hot, dry summers, where average temperatures do not exceed 23 °C (HCP, 2013).

On the other hand, the livestock field provides the region with considerable wealth. Indeed, the region has a large and diversified livestock. Cattle account for 24.5%. Moreover, at the regional level, cattle make up 11.2% of the global national herd. Moreover, the improved breeds make up 80.4% of the cattle in the region compared to the national livestock (58.9%) (HCP, 2013).

Bovine milk is the main dairy product for human consumption, since it is a source of essential nutrients (Lu et al., 2018). Similarly, dairy farming has significant social and economic roles in creating jobs and wealth in the many farms holding cows (Akesbi and Maraveyas, 1997). The quality of milk depends on many factors related to its chemical composition. Indeed, the protein and fat content are two factors that can have effects on the quality of milk. The chemical composition of the milk varies in the course of the year, under the conjugated effect by many physiological, seasonal and food factors (Akesbi and Maraveyas, 1997). Indeed, improving the quality of milk has become a stated objective, and could be taken into account during the payment process of milk (Djemali and Guellouz, 2003). The few published works focused on hygienic quality without taking into account physical and chemical criteria (Sraïri et al., 2004).

The analysis of the characteristics of the milks Would help in identifying the correlation between the chemical components of the milk, particularly, between fat and protein content, the defatted dry extract and proteins. Furthermore, the correlation between defatted dry extract and fat content was measured over the year under seasonal effect in GCBH region of Morocco. Throughout the study, the breed effect was not preponderant (Agabriel et al., 1991). Hence, the aim of the current investigation was to perform the physicochemical parameters as well as the characterization of protein and fat content and defatted dry extract, of the collected milk provided from different cooperatives farms in GCBH region.

MATERIALS AND METHODS

Physicochemical analysis

Follow-up samples of milk mixture (Cistern) of the GCBH region were characterized by mild, wet winters and hot, dry summers, due to a weekly collection, over different periods, during June 2016 to May 2017. Milk tank was recovered during the collection of milk by the slag to represent the mixed milk of different farms on average (Vanel et al., 2014). A total of 53 samples were taken on the basis of milk production and marketing, regardless of the herd structure, to create a representative sample.

Physico-chemical analysis methods

The mixed milk samples were collected in sterile 0.5 L flasks and stored at 4 °C. They were transferred to the laboratory under a cold regime using a coolbox piled by pocket of ice (Yabrir et al., 2011).

The determination of the temperature was carried out by a thermometer in a vial filled with water which was kept with the samples in the coolbox (Sraïri et al., 2005). Furthermore, the analysis was performed to determine protein content, fat and defatted extract.

To determine the pH of milk, a pH-meter was used. Whereas the Dornic acidity was determined by acid-base titration using Dornic soda (N/9), and the density was measured by using a lacto-densimeter. Besides, the total dry extract was performed by paraboiling samples at 103°C +/- 2°C for 3 hours. Gerber method was used to determine fat content in milk samples, and it consists of an acid-butyrometric attack of milk and sulfuric acid. The separation phase was performed by centrifugation in the presence of isoamyl alcohol of the released fat content (Afnor, 2011) and the protein content is measured by the Kjeldahl method (Lynch and Barbano, 1999; Walstra, 1992).

RESULTS AND DISCUSSION

Physicochemical characteristics of milks

To evaluate the physicochemical characteristics of milks, several physicochemical parameters of the analyzed milk framed by their extreme values were determined such as pH, acidity and density (Table 1). As listed in this table, the measured pH upon arrival of raw milk samples in the laboratory was ranged from 6.47 to 6.70 with an average of 6.56. These values were close to the range (6.44 - 6.71) found by Labioui et al. (2009). The variability was related in particularly to the climate, the food availability, the state of health of the cows and milking conditions.

Moreover, the value acidity (essential parameter for milk monitoring preservation) varies from 15.9 to 17.5% with an average of 16.79%. Nevertheless, these values of fresh remained stable and were ranged from15-17.5% (Table 1).

Interestingly, it was noted that the pH variation and acidity were related to temperature variation. Thus, these parameters showed a stability when temperature was stable (Sboui et al., 2009).

On the other hand, the density was measured at 20 °C and reached values between 1.028 and 1.032 with an average value of 1.030. These values are similar to those found by several authors. Indeed, in the study of El-Hamdani et al. (2016), the average value of Moroccan milk density reached 1.031; whereas in United Kingdom, milk density showed an average value of 1.029 (Chen et al., 2014). The standard density of cow's milk should be around 1.030 up to 1.035. This value varies along with the increase of dry matter and conversely, it is related to fat content (Mathieu, 1998).

Chemical composition of milks

The descriptive characteristics of the chemical parameters (fat, protein and defatted dry weight for raw milk) are summarized in Table 2. The results showed an important charge of the chemical composition of milks. These charges of chemical composition were evaluated during one year.

The study of these data leads to the following remarks:

The evolution of the defatted dry extract is summarized in Figure 1. As listed, the milk produced in the period from mid-April to mid-September is considerably richer in defatted dry extract, protein and fat than the milk produced from the period of 23 September to 8 April. The differences are mainly due to diet and weather conditions.

Table 1. Descriptive statistics of physicochemical parameters

Statistic	pH	Acidity	Density
Nbr. of observations	81	81	81
Minimum	6.470	15.900	1.028
Maximum	6.700	17.500	1.032
1st Quartile	6.508	16.450	1.029
Median	6.540	16.800	1.030
3rd Quartile	6.613	17.200	1.031
Mean	6.556	16.792	1.030
Variance (n-1)	0.005	0.292	0.000
Standard deviation (n-1)	0.069	0.540	0.001
Variation coefficient	0.010	0.031	0.001

Table 2. Descriptive statistic of fat, protein and defatted dry weight for raw milk based on time (month)

Statistic	TB g/L	TP g/Kg	DDE g/L
Nbr. of observations	81	81	81
Minimum	33.620	28.860	89.470
Maximum	37.590	31.970	94.040
1st Quartile	34.200	29.830	91.020
Median	35.370	30.720	91.840
3rd Quartile	36.230	31.080	92.630
Mean	35.351	30.565	91.835
Variance (n-1)	1.248	0.702	1.179
Standard deviation (n-1)	1.117	0.838	1.086
Variation coefficient	0.031	0.027	0.012

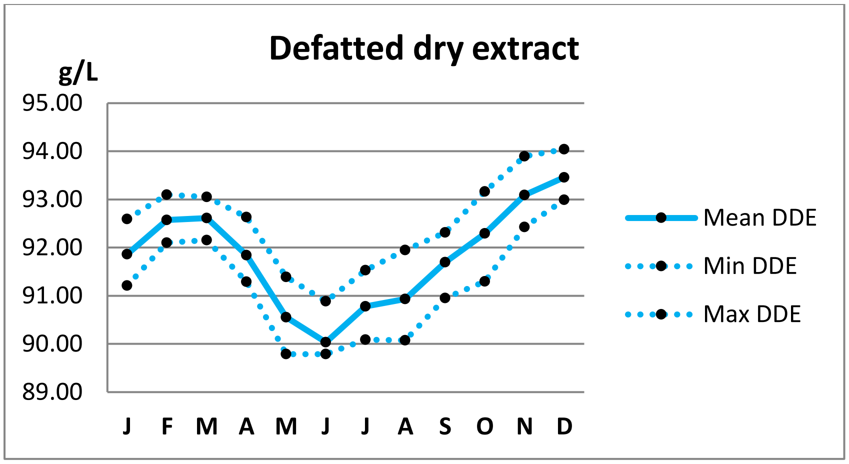

Figure 1. Seasonal variation in defatted dry extract from cow milks in the GCBH region

Therefore, according to another study, winter milk contains more dry matter, fat and protein than summer milk (Masson et al., 1978).

Moreover, the coefficients of variation showed a homogeneous trend in the three components, the fat content variations were the highest with 0.31% less than that found by Toral which reached 5% (Toral et al., 2013). Besides, CV of protein reached 0.27% less than that found by Millogo which (1.5–2%) (Millogo et al., 2009) ; whereas CV of the defatted dry extract attained 0.12%, less than 4.02% and 5.65% according to Brasil and Thiago respectively (Brasil et al., 2015; Caralho et al., 2015).

Furthermore, the defatted dry extract is the most stable component compared to the others with an average of 91.83 g/L which is greater than 88.84 g/L and 86.60 g/L reported by Labioui (Labioui et al., 2009) and Brasil (Brasil et al., 2015) respectively.

The fat content of the milk showed the fluctuations of greater amplitude, varying from 33.62 to 37.59 g/L with an average of 35.35 g/L, was in accordance with the AFNOR value (3.04%) (Afnor, 2011). This value remains similar to that found by Labioui 31.45g /L (Labioui et al., 2009). This could be explained by the use of food to modulate strongly and rapidly the composition of fatty acids (AG) milk, especially *via* the intake of lipid supplements in the ration. Variations in the nature and proportions of fodder (and particularly grazed grass) and concentrated foods rich in carbohydrates and proteins play a decisive role for the variations of the AG composition in the milks which have a of great mixture (Chilliard et al., 2010).

The evolution of protein charges is summarized in Figure 3. As showed, the protein content appeared more stable compared to the fat content of all collected milk (Figure 1). The maximum value reached 31.97 g/kg, while the minimum was 28.86 g/kg, and the average value attained 30.56 g/kg which is inferior than 31.9 g/kg average reported by Sraîri (Sraïri et al., 2005), and superior to the average value of 30.36 g/kg reported by Chrif (Chrif et al., 2018). According to our findings, the seasonal variations in milk proteins were similar to those reported by Chrif (Chrif et al., 2018) in 2015. Therefore, the current results showed certain stability in terms of proteins composition from one year to another in GCBH region of Morocco. The nutritional quality of bovine milk is mainly due to the excessive use of concentrates needed for the livestock.

The effectiveness of the diet is based on the respect of nutritional balances and especially on energy, protein and mineral inputs. The protein intakes are not only expressed in total protein or total nitrogenous matter (MAT) but amino acid (AA) digestible and in particular essential amino acids (IAA), such as lysine, threonine, methionine, cystine, tryptophan...(Peyronnet et al., 2014). Nutrients in the diet could obviously affect milk fat, but not milk protein (Sutton, 1989), which is in agreement with our result.

Figure 1, 2 and 3 also show that fat, protein and defatted solids content of milk from the GCBH region undergo variations during lactation: the values were mainly higher at the beginning and at the end of the year (in January, February, March and October, November, December) and the lowest values were recorded in June, July and August. The figures also show that fat content, proteins and defatted dry extracts decreased progressively in the same way in April and then increase significantly in September. Therefore, seasons showed a significant impact on milk properties.

The variation of the milk components could be related to several factors which influence milk quality such as: region, season, diet and nature or the producers: dairy cooperatives and farms (Bassbasi et al., 2013).

Overall, the analyzed mixing milk showed the best quality in terms of protein content, defatted dry extract as well as fat content. Several studies, which were conducted in different regions of Morocco (particularly the irrigated perimeters of GCBH), are in agreement with the current findings. Indeed, theses studies showed a relative homogeneity in adopted logics and strategies by breeders of so-called improved cow (crossed type and Holstein cows) (Sraïri, 2004).

Correlation between physical and chemical parameters

Significant correlations between the main milk components are summarized in Table 3. As listed, the correlation was detected between the different components of the milk. Proteins were strongly correlated between fat (r = 0.690) and defatted dry extract (r = 0.805). However, this correlation was weak with density (r = 0.360). The correlation of fat and defatted dry exact was also low with density (r = 0.100) and (r = 0.290) respectively. These results were similar to those found in the Oulmes region of Morocco, Spain and China (protein correlation and defatted dry extract r = 0.75, r = 0.9 and r = 0.64 respectively) (El-Hamdani et al., 2016; Vicente et al., 2017; Yang et al., 2013).

Figure 2. Seasonal variation of fat in cow milks in the GCBH region

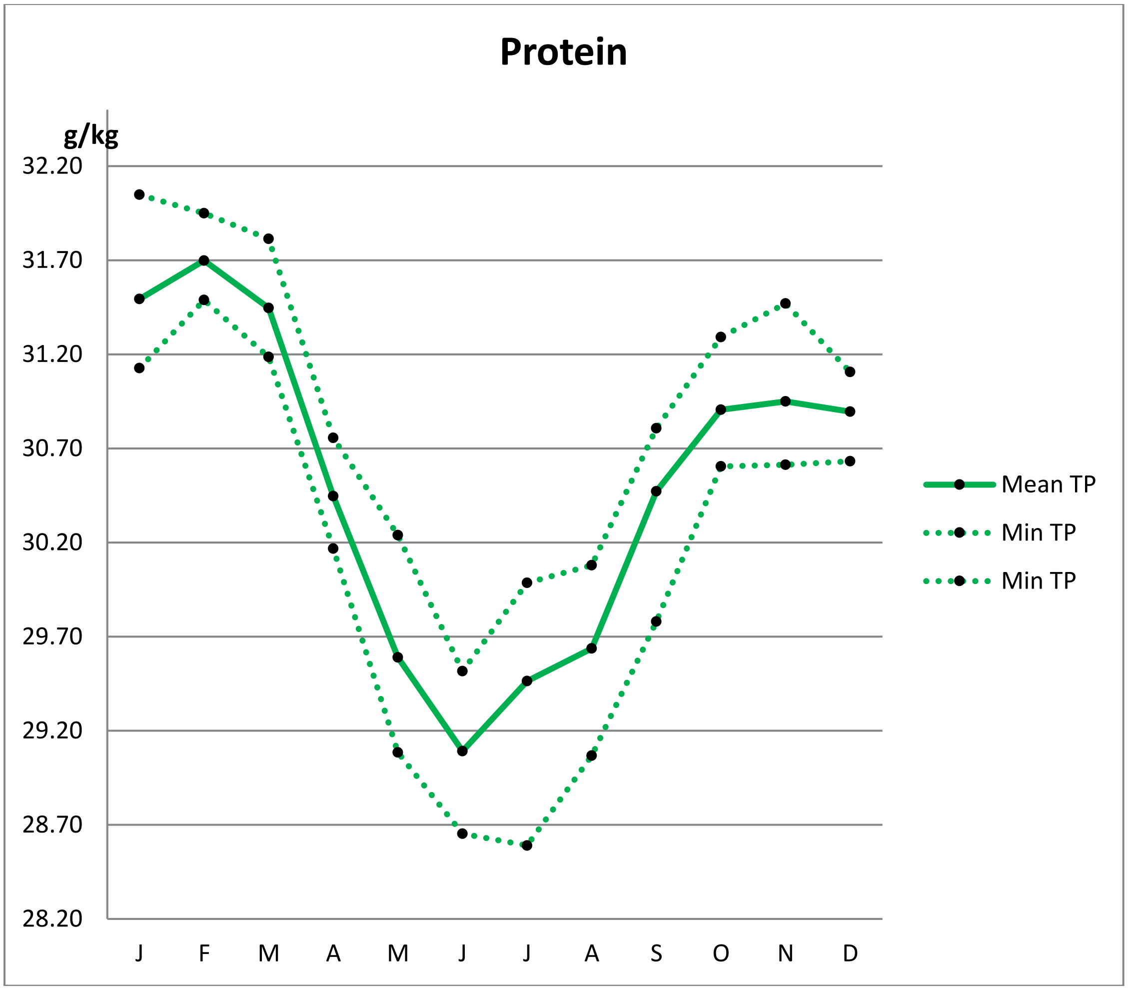

Figure 3. Seasonal variation in protein from cow milks in the GCBH region

Table 3. Correlation coefficients between raw milk composition parameters

Variables	TB	TP	DDE	Density
TB	1	0.690	0.791	0.100
TP	0.690	1	0.805	0.360
ESD	0.791	0.805	1	0.290
Density	0.100	0.360	0.290	1

In order to study the correlation between the chemical components of the mixing milk of the GCBH region, we performed a model where all values of protein content were presented in function of the defatted dry extract values.

Overall, the correlation coefficient obtained for the TP and DDE of the graph (a) (Figure 4) is significant with a $R^2 = 0.647$. On the contrary, results between TP and TB according to the graph (b) are not significant (R^2=0.476). Given that the first coefficient is higher than the second, points that belong to the graph (a) are agglomerated much closer to the line. Besides to this graphs (b) and (c), the scatter plot is a little more dispersed and indeed, these components are less correlated with each other than in the previous case.

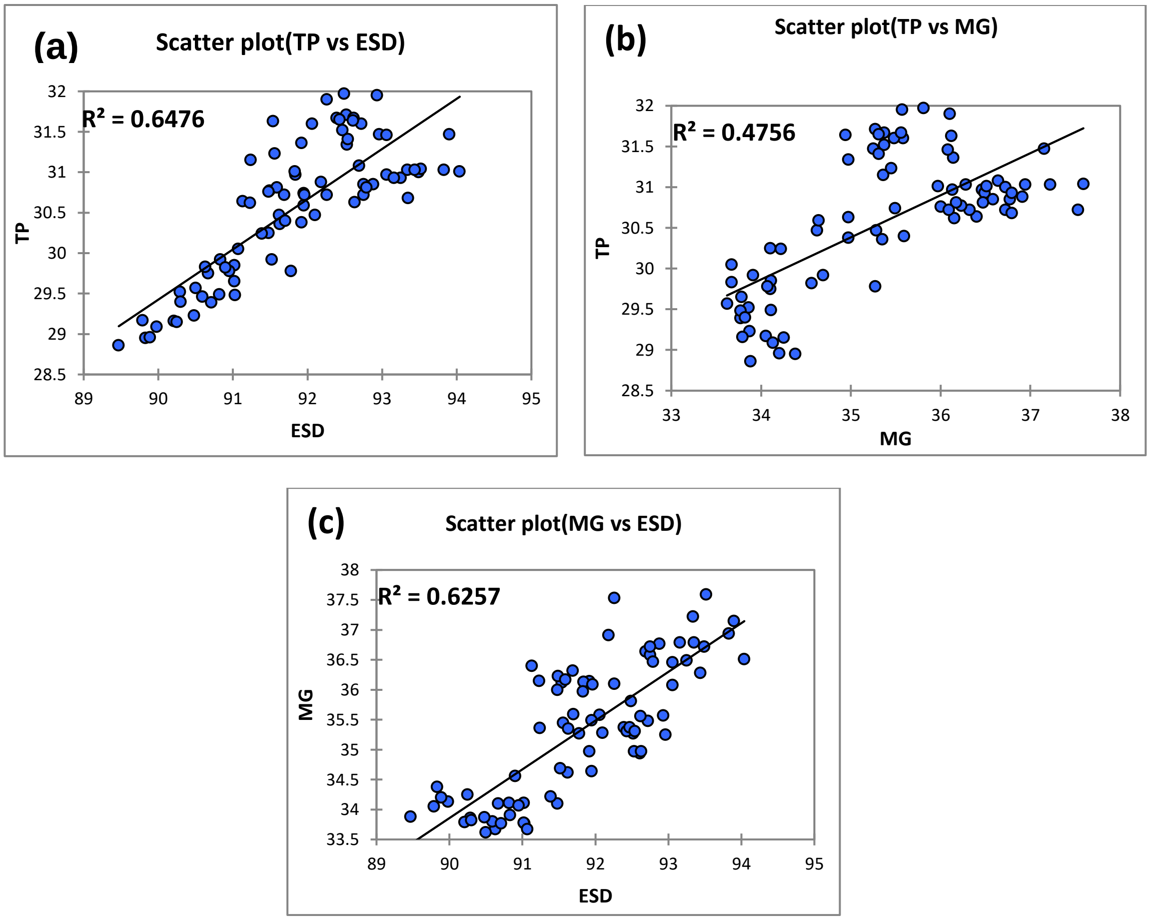

Figure 4. Linear representation between chemical parameters of the mixing milk

CONCLUSION

The mixing milk properties of the GCBH region showed the same tendency of variation under the influence of the season with a better quality. This significant increase in the quality of these components has been achieved thanks to a policy of genetic improvement, with the importation of dairy cattle. Thus, the period plays a very important role in the quality and quantity of the produced milk. Indeed, modifying milk quality by using technical approaches requires more financial support to the farmers in the future.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

This article does not contain any studies with human participants or animals performed by any of the authors.

AUTHOR CONTRIBUTIONS

M.C prepared and carried out the experiments and wrote the manuscript. A.E performed the data processing analysis and examined the manuscript. A.B. examined the manuscript. All authors have read and approved the final version.

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