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VARIETY OF PHYSICOCHEMICAL CHARACTERISTICS OF RAW MILK IN EL-GHARB REGION OF MOROCCO: THE RELATION BETWEEN COMPOSITION AND CLIMATIC CONDITIONS

Abstract: *Starting from January 2015 until December 2016, a daily monitoring of the production of milk at three farms in the region of Gharb in Morocco, the climatic and rainfall data were taking into consideration to evaluate their effect on the physicochemical composition, the aim behind this study is to highlight the variability of the characteristics of raw milk by the seasonal climatic change, and to statistically analyze these variabilities in relation with seasons and the production conditions. The selected farms are known for their mastery of farming techniques, equipped with the new means of livestock health control. The livestock is 165 milk cows from two breed (Prim' holstein and montbeliard). The samples were collected from the farms. One litre bulk of milk were made by mixing the morning and the evening milk and stored at 5°C until the measurement. The cows were milked by hand in milking boxes during feeding.*

Keywords: *Raw milk, climatic, physicochemical, production*

1. Introduction

The Climatic conditions and season present a major problem affecting the yield and composition of cow milk, Independently of the high demand on raw milk to an increasingly important demography, the quality of the raw milk is of outmost importance, as the major part of the milk is used in the production of dairy products and ingredients, that's why the dairy industry are becoming more demanding and the producer is obliged to seek to minimize variability and maintain the level of quality required as defined in the payment system. The aim of this study is to evaluate the effect of climatic conditions characterized the Algharb region on the yield and composition of raw milk obtained from two cow's breeds, This study can contribute as a support for the best choice of the breed cows according to the climatic characteristics of the area where the farm is located and can be do it for other regions with different climatic conditions.

The present work concerning a study of the qualitative and quantitative variabilities of raw milk during two years at three farms in three geographically separated areas located in the region ALGHARB, samplings are taken on a daily basis, and the physico-chemical analysis are made in a laboratory in 12 hours time limit. The cows are of the Montbeliarde breed, Prim'Holstein in 2 farms, while the test cows of the third farm are of Prim'Holstein's race, with the same feeding regime, the monitoring of the

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physicochemical composition of the raw milk will allow us to check the stability of milk in both breeds according to climate change and test area. The Gharb-Chrarda-Beni Hssen region is rich in water resources; it is the largest irrigation perimeter in the country with an area of 178,000 ha. (Centre Régional d'Investissement de la région Gharb-Chrarda-Béni Hssen, 2014)The East-West rainfall gradient varies between 450 and 530 mm whose 80% are concentrated between 15 October and 15 April. The rest of the year is characterized by an absence almost total of rainfall (Bouisfi & Chaoui, 2018).

The production of milk has been encouraged by a policy promoting the development of the production regarding the national dairy sector(Le Gal Pierre-Yves, Kuper Marcel, Moulin Charles-Henri, Puillet Laurence, & Sraïri Mohamed Taher, 2007). The livestock population in the region consists of 399,260 herds of cattle. In the GCBH region, the quantity of milk produced is estimated at almost 173 million liters in 2006, i.e. an average recipe of 1000 liters per day and per collection center. However, there is a great disparity at the regional level, between the quantity produced in the province of Kenitra and Sidi Kacem.

2. Literature review

Climate change, particularly global warming, may strongly affect production performances of farm animals and impact worldwide on livestock production (Nienaber, Hahn, & Eigenberg, 1999). The inevitable effects of the season on the variation of milk production and composition are studied by many authors (Coulon, Chilliard, & Rémond, 1991; Stanisiewski, 1985; Phillips & Schofield, 1989) reported by (Coulon et al., 1991).

Heat stress is a major source of production loss in the dairy and beef industry and whereas new knowledge about animal responses to the environment continues to be developed, managing animals to reduce the impact of climate remains a challenge (Hahn, Mader, & Eigenberg, 2003; Sprott, Selk, & Adams, 2001). An environmental profile provides baseline data on which to estimate average expected climatic conditions, their variation and the duration of any extremes. Such knowledge is necessary for understanding animal responses to environmental conditions and in assessing the need to expend economic and energy resources in order to improve the climate for animal production.

2.1. Season Effect

The season acts mainly through the duration of the day, most of the authors has indeed shown that a long duration of experimental illumination (15 to 16 hours per day), increased milk production and sometimes decreased the useful milk components. Decaen and Journet noted that the duration of the day is the criterion of the environment whose evolution is the most repetitive and especially the minima of fat and protein contents, are always held on the same dates, that is to say at the summer solstice when the duration of the day ceases to grow then when these begin to decrease (Decaen, Journet, Manis, & Marquis, 1966).

For Agabriel et al (1990), the month of August appears to be very unfavorable for cows at the beginning of lactation compared with the months of May to July. These authors confirm that at the constant lactation stage, the lowest protein levels are observed from February to July, but dairy yield is the highest at this time. Agabriel note that, despite the negative effect of the season on the rates of fat and protein content in late winter and spring, this period remains, however, the one where the Total solids content is the highest, about 10% higher than obtained in autumn (Agabriel, Coulon, Marty, & Cheneau, 1990). Season affects milk yield, component percentages. Ng-Kwai-Hang and Sargeant reported an inverse relationship between milk yield and component percentages, with summer milk production being higher but percentages of fat and protein being reduced compared with production in the fall and winter months (Ng-Kwai-Hang, Hayes, Moxley, & Monardes, 1984; Sargeant, Leslie, Shoukri, Martin, & Lissemore, 1998), Ng-Kwai-Hang concluded that milk and component yield variations were dependent on environmental conditions (Quist et al., 2008).

2.2. Climate effect

Climatic factors such as air temperature, solar radiation, relative humidity, air flow and their interactions, often limit animal performance (Sharma et al., 1983).

Quantifying direct environmental effects on milk production is difficult as milk production is also strongly affected by other factors such as nutritional management that may or may not be directly linked to environmental factors (Kadzere, Murphy, Silanikove, & Maltz, 2002). The analysis of the variability is made delicate because of numerous factors that could intervene, and the importance of the duration of theses variations(D'Hour & Coulon, 1994). Temperature, solar radiation, relative humidity, wind... are the climatic factors that act by their considerable interactions on the performance of livestock farming, the increase in ambient temperature (when it is maintained in the heat comfort zone of the cows) could have a favorable effect on milk production and disadvantageous to the milk's richness, which would be added to the effect of photoperiod (Coulon et al., 1991) reported (Agabriel et al., 1990). Cow's milk from temperate countries produced in a hot environment contains less fat, nitrogenous matter and lactose. The thermo-tolerance of animals varies in the opposite direction of their production, the less productive animals are the most resistant to heat temperature.

Several studies demonstrated the effects of environmental factors (temperature, relative humidity, solar radiation, and wind speed) on the productivity of beef and dairy cattle (Rhoads et al., 2009). These studies associated heat stress with decreases in productivity, such as milk yield, and reproductive performance. But studies on heat stress effects in temperate zones are rarely found (Lambertz, Sanker, & Gauly, 2014). The temperature-humidity index (THI) is a commonly used indicator of thermal conditions and the degree of heat stress and incorporates the effects of ambient temperature as well as relative humidity (Hubbard, Stooksbury, L. Hahn, & Mader, 1999). According to Rhoads, the milk yield is lower in heat-stressed cows than in cows that are kept in a thermoneutral environment (Rhoads et al., 2009). In Germany, Brügemann indicated a milk yield decline between 0.08 and 0.26 kg for each unit increase in THI unit, depending on the region (Brügemann, Gernand, König von Borstel, & König, 2012). In addition to declines in feed intake and milk yield, significant decreases in milk components (protein and fat) have been demonstrated in the hottest months of the year (Rodriquez, Mekonnen, Wilcox, Martin, & Krienke, 1985; Bouraoui, Lahmar, Majdoub, Djemali, & Belyea, 2002). Quist reported seasonal differences between summer and winter in fat and protein yield for the first lactation (Quist et al., 2008).

Under Mediterranean climatic conditions, a decrease in milk fat percentage of 0.34% from spring to summer has been observed (Bouraoui et al., 2002). In agreement, other studies conducted in heat-stress environments reported decreases in milk fat percentage (Rodriquez et al., 1985).

3. Material and methods

3.1. Data

The layout of the study variables is indexed according to a symbolization Xa,b,c for the characteristics of raw milk, Ya and Za for successively expressing precipitation and average temperature, details in the table 1.

Table 1. Symobolization for the characteristics of raw milk

Digital index	Zone	Race	Characteristics	Precipitation	Temperature
	a	b	c	Y	Z
1	Sidi Slimane	Montbeliarde	Fat Content		
2	Kenitra	Holstein	Protein Content		
3	Sidi Kacem		Average liters		
4			PC/FC		

3.2. Test population data

The tested population is selected from three farms located in Kenitra, Sidi Kacem and Sidi Slimane, the choice is justified by the quality and vigilance of livestock management (Table 2).

Milk production and composition vary according to genetic factors and the livestock environment, particularly those related to feeding. The latter are mostly predominant, because the genetic variability of the herds is reduced compared to that of the characteristics of the environment.

These often interact with one another (Coulon & Remond, 1991). Among all the environmental factors studied, the farmer can only rely on food to increase the production and rates of useful materials of milk (Journet & Chilliard, 1985; Hoden, Coulon, & Dulphy, 1985; Sutton, 1989; Coulon et al., 1991).

Table 2. Distribution of test population according to breed and farms

Farm	Test Population		Age (month)	
	Montbeliard	Holstein	Interval	Average
SIDI KACEM	54	0	[33-52]	35
SIDI SLIMAN	38	24	[31-50]	37
KENITRA	33	16	[31-55]	33

In order to meet the breeder's objectives, in particular the production of a calf / cow per year and to ensure a good production in quantity and quality of milk, it is necessary to follow an adequate diet to meet the different needs of the dairy cow. The ration ingested by the cow must yield enough energy (UFL: Feed Unit for Lctation), nitrogen (PDI: Protein Dispersibility Index), minerals (major and oligo elements), vitamins and water. To eliminate the feeding effect, the feeding behavior of the test population cows for the three farms follows a standard diet as shown in the table 3.

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3.3. Sampling of raw milk

Through proper sampling, a representative sample is obtained that provides an accurate estimate for the total amount of milk.

Sampling should be performed by an authorized, properly trained, person. It is important to obtain representative samples of the product. The condition of the sample should not be affected during storage and transport. During Storage and transport, precautions should be taken to prevent exposure to direct sunlight and other adverse conditions. The storage temperature after sampling should be reached as quickly as possible and should be between 0 and 4 °C. Samples should be transported to the testing laboratory immedi-ately after sampling.

Transport time should be as short as possible, generally, the samples of milk are delivered for testing on the same day they are taken for chemical examination. The result of analysis of any sample, if the temp-erature of sample has exceeded 10°C may be unreliable.

3.4. Qualitative data of raw milk

For the purpose of the study, each farm has identified the population cows for isola-tion, and the isolation makes it possible to properly manage the food system (quantity of food, quantity of water), as well as periodic veterinary checks, The disease of a cow of the population eliminates it from taking raw milk until its recovery. Each day, the average test population for each farm is measured, and samples are sent to the laboratory for qualitative raw milk analysis, meteorological measurements (temperature and precipitation rate) are carried out by pluviometer for precipitation rate and thermo-hygrometer for temperature. The analyses are collected after 30 hours, the physicochemical analyzes investigated are: the fat content (Gerber method), the protein content (Kjeldahl method). The Kjeldahl method has been the official worldwide standard for determination of nitrogen in all kinds of food and beverage samples. The Kjeldahl digestion converts nitrogen compounds (proteins, amines, organic compounds) into ammonia compounds. Free ammonia is released by the addition of caustics, which are then expulsed by distillation and subsequently titrated. Total Kjeldahl nitrogen or TKN is often used as a surrogate for the protein content in milk samples, the factor conversion from TKN to protein is 6,38('FIL', 1993). The traditional standard reference method for fat analysis is based on either weight or volumetric determination, there is many analytical methods for the determination of the fat content of milk; the Gerber test is widely used all over the world. The Gerber method for measuring fat content, milk fat is separated from proteins by adding sulfuric acid. The separation is facilitated by using amyl alcohol and centrifugation. The fat content is read directly via a special calibrated butyrometer.

Though not really a test, Mesure of quantity is the first check of milk collected. Quantity is measured in weight (kg) by digital weighing scale which allows opeators to read the measurement result quickly. Moreover, most of the digital weighing scales support auto-zeroing feature which helps minimizing the incur error caused by wear-and-tear or environment factors.

Table 3. Feeding behavior on winter and Pasture

Saison	Forage	Concentrated
Autumn	Silage Herb	15% MS of the ration
Winter	Corn silage	30% MS of the ration
Spring	Grass grazed	1 KG
Summer	Grass grazed	0 KG

4. Results

4.1. Methodology for statistical analysis of results

More than 10,000 raw milk samples were collected from all three farms over a period of 24 months in favor of this study, the analysis of the results which allowed detecting about 33 outliers, with 749 samples without results (forgetting analysis, forgetting of sampling, samples of the non-conforming condition of transport, national holidays ...). While 9020 samples are considered compliant for statistical analysis, 90.2% of the collected samples constitute the statistical analysis database, whose the results are summarized in Tables 4,5,6,7

Table 4. Results of Fat and Protein content of raw Milk 2015-2016. MT: Montbeliard breed - HT: Prim'Holstein breed SK: Sidi Kacem zone KEN: Kenitra zone SS: Sidi Slimane zone

Month		Fat content (g/kg)					Protein Content (g/kg)				
	Zone	SK	SS		KEN		SK	SS		KEN	
	Breed	MT	MT	HT	MT	HT	MT	MT	HT	MT	HT
Jan-15		38.1	37.7	38.3	36.7	37.8	32.0	31.6	30.7	32.8	31.0
Féb-15		37.6	37.4	39.1	36.8	37.7	31.4	31.8	30.9	32.7	31.5
Mar-15		37.3	36.9	38.5	36.5	37.6	31.0	31.9	31.1	32.2	31.5
Apr-15		36.7	35.4	38.4	36.3	37.5	31.4	31.6	30.8	31.7	31.2
May-15		36.5	35.7	37.5	36.0	36.7	30.9	31.1	30.5	31.2	30.3
Jun-15		35.4	35.3	36.5	35.2	36.3	30.6	30.9	30.3	30.8	29.9
Jul-15		35.3	35.3	36.2	36.5	35.8	30.8	31.1	29.9	31.3	29.9
Aug-15		34.3	34.7	36.0	36.0	35.0	30.4	31.1	30.2	31.3	29.2
Sep-15		35.2	36.0	36.2	35.6	35.5	30.8	32.2	30.5	31.6	30.0
Oct-15		36.0	36.7	36.9	35.9	36.4	31.3	32.3	31.0	32.1	30.5
Nov-15		37.6	36.6	37.5	37.6	37.3	31.9	32.4	31.2	32.4	30.7
Déc-15		38.1	37.9	37.7	37.8	38.0	32.3	32.1	31.3	32.7	31.1
Jan-16		38.3	38.1	38.2	37.6	38.4	32.8	32.4	31.5	32.2	31.2
Féb-16		38.2	37.8	37.8	37.7	38.3	32.8	32.0	31.0	32.4	31.2
Mar-16		38.0	37.5	38.3	37.3	38.0	32.4	31.8	31.2	31.8	30.8
Apr-16		36.8	37.0	37.7	36.8	37.6	31.8	31.7	31.1	31.5	30.5
May-16		36.3	36.2	36.7	36.2	37.5	31.4	31.2	30.8	31.2	30.3
Jun-16		35.3	35.3	36.5	35.8	36.9	30.6	30.6	30.6	30.9	30.1
Jul-16		34.7	35.8	36.0	35.6	36.8	30.0	30.4	30.2	30.9	29.9
Aug-16		35.3	35.8	36.2	35.3	36.2	30.2	30.2	30.4	30.2	29.9
Sep-16		36.2	35.8	36.9	35.0	36.8	30.7	30.4	30.8	29.8	30.3
Oct-16		37.1	36.5	37.2	35.5	37.1	31.4	31.2	30.9	30.5	30.9
Nov-16		37.7	37.4	37.8	36.1	37.5	31.9	31.9	31.1	31.2	31.0
Déc-16		38.3	37.9	38.4	37.2	38.0	32.6	32.3	31.2	31.9	31.4

Table 5. Average liters of raw Milk 2015.

Month		Average liters (kg)				
	Zone	SK	SS		KEN	
	Breed	MT	MT	HT	MT	HT
Jan-15		21.1	23.8	38.2	22.9	34.1
Féb-15		20.3	22.7	37.3	22.1	35.1
Mar-15		17.7	22.3	35.6	21.7	34.4
Apr-15		14.2	21.1	35.5	21.0	27.7
May-15		11.9	18.9	22.3	19.6	25.2
Jun-15		10.1	19.0	21.9	18.5	23.7
Jul-15		13.2	18.3	21.1	17.1	22.8
Aug-15		12.4	17.5	17.9	16.2	18.4
Sep-15		13.6	17.1	19.2	17.2	19.6
Oct-15		13.8	18.2	22.0	18.5	23.5
Nov-15		19.7	19.4	33.8	20.2	33.8
Déc-15		20.3	21.5	40.1	21.2	35.6

Table 6. Average liters of raw milk 2016.

Month		Average liters (kg)				
	Zone	SK	SS		KEN	
	Breed	MT	MT	HT	MT	HT
Jan-16		21.4	22.4	38.1	22.7	34.1
Féb-16		22.1	22.6	36.9	21.9	34.9
Mar-16		21.7	21.3	35.7	21.5	35.0
Apr-16		21.4	20.6	28.9	21.3	33.8
May-16		21.3	20.2	27.3	20.8	32.9
Jun-16		21.0	19.1	27.0	20.5	25.6
Jul-16		20.5	18.7	25.4	20.4	23.4
Aug-16		20.1	18.3	22.9	19.7	19.4
Sep-16		20.3	18.5	23.4	20.2	20.3
Oct-16		20.9	19.1	30.7	20.9	27.7
Nov-16		21.3	20.2	33.4	21.9	32.4
Déc-16		21.6	21.5	36.9	22.2	33.6

Table 7. Metereological Characteristics of the zones 2015-2016.

Month		Temperature °C									Precipitations (ml)		
	Zone	SK			SS			KEN			SK	SS	KEN
	Breed	MX	MN	AV	MX	MN	AV	MX	MN	AV	MX	MN	AV
Jan-15		18.2	7.1	12.7	17.1	6.1	11.6	17.7	7.9	12.8	116	124	122
Féb-15		18.4	7.0	12.7	17.5	6.2	11.8	17.8	7.7	12.7	47	48	36
Mar-15		21.4	8.4	15.0	20.8	9.8	15.3	20.3	8.4	14.4	29	32	28
Apr-15		25.9	11.4	18.7	24.2	10.2	17.2	24.0	11.3	17.6	49	50	50
May-15		31.8	14.1	22.6	26.5	10.6	18.6	24.4	13.8	19.0	03	00	15
Jun-15		31.3	16.3	23.8	32.6	14.8	23.7	28.1	16.0	22.1	00	00	00
Jul-15		32.7	18.0	25.4	35.6	15.5	27.1	28.4	17.5	22.9	00	00	00
Aug-15		35.0	18.8	26.9	36.9	19.0	28.0	30.1	18.0	24.1	00	00	00
Sep-15		31.7	18.3	25.0	31.5	18.4	25.0	28.5	17.5	22.3	7.3	14	6.6
Oct-15		31.2	15.9	23.6	28.5	13.8	21.2	29.3	15.7	22.5	29	16	52
Nov-15		22.8	12.4	17.2	21.7	7.9	14.8	21.2	12.4	16.8	195	271	299
Déc-15		17.1	7.8	12.5	19.2	3.9	11.6	16.8	8.1	12.5	75	112	116
Jan-16		17.0	8.9	10.1	16.9	6.5	11.2	17.6	7.8	12.7	145	66	113
Féb-16		16.9	6.1	11.2	18.1	7.0	12.0	17.4	6.6	12.0	49	44	30
Mar-16		19.4	10,4	14.6	20.7	8.2	13.7	19.6	11.0	15.3	186	125	143
Apr-16		23.8	11,2	17.2	21.8	9.6	15.8	22.7	11.1	16.9	37	43	61
May-16		25.5	11,8	18.3	22.9	9.4	19.1	23.9	11.8	17.9	24	30	25
Jun-16		32.1	15.9	23.6	28.4	10.8	21.2	28.3	15.5	21.9	00	00	00
Jul-16		35.6	19.4	26.9	29.6	12.1	25.4	30.1	18.7	24.4	00	00	00
Aug-16		37.4	20.0	28.7	30.4	15.6	25.2	32.1	19.5	25.8	00	00	00
Sep-16		32.1	19.4	25.7	25.6	19.2	22.6	29.6	18.6	24.0	7.5	8.5	22
Oct-16		28.9	14.9	21.9	24.3	17.3	20.2	26.5	14.8	20.7	155	4.2	26
Nov-16		21.2	8.15	14.8	21.5	10.1	13.1	21.3	8.9	15.1	896	622	61.2
Déc-16		20.3	5.3	13.0	20.1	6.5	12.0	18.7	6.5	12.6	435	481	47.8

4.2. Statistical Analysis

The statistical processing of the data makes it possible to establish links between the variables and to select the climatic parameters which have a significant influence on the characteristics of raw milk, average liters and physicochemical composition of raw milk. The analysis of the results is carried out by the professional software Minitab statistical data processing (version 16.1.0.0).

5. Discussion

5.1. Analysis of main components

The PCA (Principal Component Analysis) realized allows us to leave with two remarks (Figure 1). The first is a negative correlation between average temperatures and physicochemical characteristics, in particular the fat and protein content of raw milk, the exposure of the herds to extreme temperatures is related to the duration of the day, i.e. the duration of experimental illumination.

This might be as a result of the inevitable effects of the season on the variation of the production and the composition of the milk. This research study was confirmed by the studies of numerous authors (Coulon et al., 1991; Stanisiewski, 1985; Phillips & Schofield, 1989) reported by Coulon (Coulon et al., 1991). The second observation is mainly related to a negative correlation between average temperatures and precipitation rates, which is totally logical.

Most studies have shown that a long experimental illumination time (15 to 16 hours per day) increases milk production and sometimes reduces the richness of the milk into useful materials. These increases in milk production are associated with an increase in the intake (from 1 to 1.5 kg DM/d) according to Philips and Schofield (Phillips & Schofield, 1989). In the same sense, Decaen and Journet noted that the duration of the day is probably the criterion of the environment whose evolution is the most repeatable and especially the minimal of milk contents in fat and nitrogen always take place on the same date, that is to say, at the summer solstice when the duration of the day ceases to grow and then when the time begins to decrease (Decaen et al., 1966).

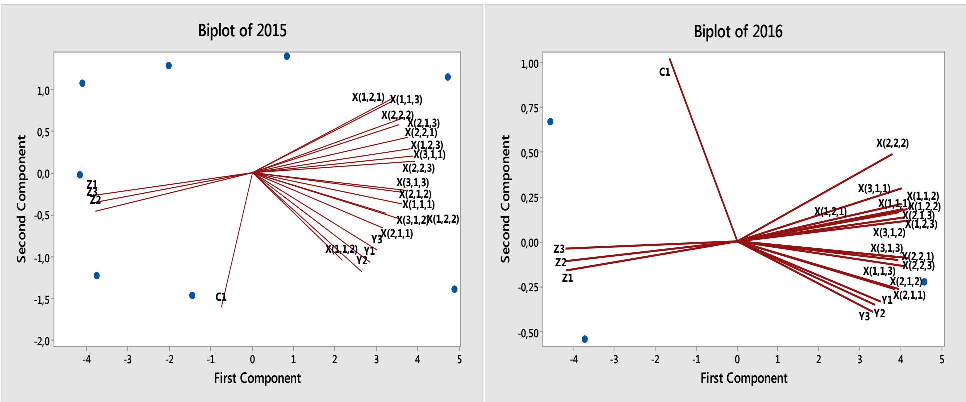

Figure 1. Biplot of the two years 2015-2016

5.2. Follow-up Fat content 2015-2016

Monitoring of the variation in fat content during two years of experimentation shows that the fat ratio for the three zones and the two breeds studied is at their lowest level during the summer season, this phenomenon could be linked to thermal stress (Figure 2).

The variability of parameter C1 with Fat content is significant, ranging from 34.33 to 39.14 in 2015 and from 34.68 to 38.43 g/kg in

2016, and strongly dependent on the season. From February and March (end of the winter season), the fat content starts to decrease to a minimum peak in the summer season (July and August), similar to the results of Samolovic who confirmed that the lowest values for the fat content recorded in July and August (33.7 and 33.9 g/kg), and the highest values recorded in various months in the autumn-winter period, which is in accordance with environmental conditions. The highest contents were 38.4 g/kg in January (Samolovac, Stojic, & Beskorovajni, 2012).

The appearance of the variation of fat content depends on the zone of rearing, for zones 1 and 2, the pace is identical for the two races, and this shows that the growth or decline rates of fat are related more to the characteristics of the livestock environment than to the physiology of livestock. One of the commonly used factors for variation in the fat content of raw milk is the proportion of the concentrate in the diet (Journet & Chilliard, 1985; Sutton, 1989). Intake of concentrate to grazing results in a decrease in the fat content of milk of -0.19 g / kg, close to the results of Delaby [-0.3 g / kg for each kg of DM of concentrate (Delaby, Peyraud, & Delagarde, 2003).

For a given breed, there is a fairly strong positive genetic bond between fat (TB) and protein (TP). In the same context, Rossetti and Jarrige report that selection on fat oil levels leads to a simultaneous improvement in protein content (Rossetti & Jarrige, 1957). The negative correlation between milk production and the fat content (r = -0,46) makes the selection of cows for high production and a high level of fat very difficult, results confirmed by the work of (Wattiaux, 1998).

The livestock of zone 2 had a stability of the average fat content gap between the Montbeliard and Holstein cows, the difference being of the order of 0.44 g / kg and 0.57 G / kg in 2015 and 2016, respectively, in zone 1, the average deviation decreased by 50% from 1.2 g / kg in 2015 to 0.6 g/kg in 2016. Due to the climatic characteristics of the two zones, in particular temperature and precipitation, the stability of the average fat content differentials between Montbeliard and Holstein cows in zone 2 is justified by a certain climatic stability (three months without precipitation June-July-August) and maximum temperatures not exceeding 30.1 °C during the two test years. Production of Holstein cows is influenced by extreme temperatures, such as Zone 1 where the temperature reached 36.9 °C and with 4 months without precipitation in 2015, the climate in 2016 became more suitable (3 months without precipitation and max temperature equal to 30.4 °C).

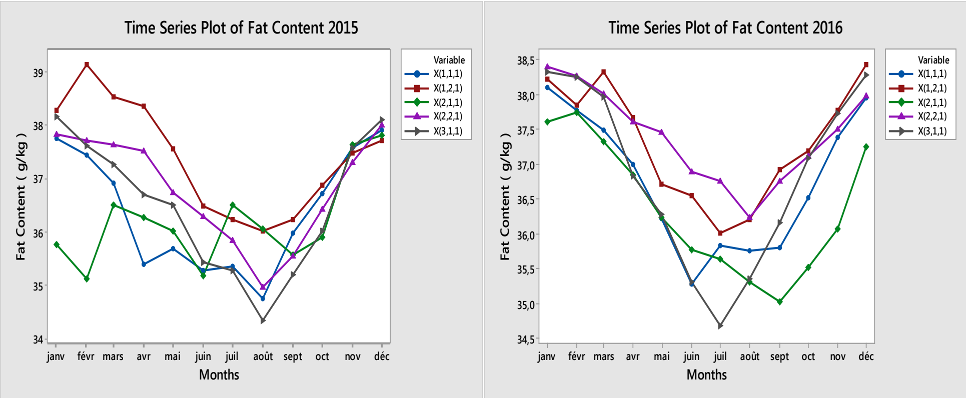

Figure 2. Times series plot of Fat Content 2015-2016

Similarly, Bandaranayaka and Holmes works conducted with two pairs of Jersey cows exposed to either 15 or 30°C air temperature, they found that the fat and protein contents of milk decreased (P<0.05) at 30 °C when intake was kept equal at both temperatures (Bandaranayaka & Holmes, 1976). High temperatures had an adverse effect on fat content (-2.4 g / kg between highest and lowest temperatures, P <0.05), P D'Hour and JB Coulon evaluated an effect of -0.9 g/kg between the highest and lowest temperatures (D'Hour & Coulon, 1994). Florida dairy farms examined the relationships between many variables, including milk composition and environmental temperature. As temperatures increased from 9.4 to 36.1 °C, the authors reported that milk fat concentration dropped from 3.85% to 3.31% (Staples & Thatcher, 2016).

5.3. Follow-up Protein content 2015-2016

Season affected concentrations of total Protein and serum Protein, levels of αs1- and β-caseins (as proportions of total casein), casein micelle size, zeta potential (Lin, O'Mahony, Kelly, & Guinee, 2017). The protein levels of our trials are at their lowest level during the summer season (July-August-September). This phenomenon could be linked to summer heat stress, the percentage of milk protein varies with the season. The Figure 3 showed that milk protein content is lower in summer and is rising again in the fall. In summer the reduction in consumption that accompanied hot days decrease the energy consumption by the cow. In addition, pasture cows not receiving sufficient energy and above all amino acids will have a decrease in the production of milk and milk protein. In the fall, cooler temperatures favor greater consumption; freshly harvested forages and rations rebalanced by protein and energy could probably explain in part, an increase in milk protein.

The protein content varies from 29.19 to 32.82 in 2015, and from 29.8 to 32.83 g / kg in 2016 and highly dependent on the season. The protein content begins to decrease to a minimum peak in the summer season (July and August), the results of Samolovac showed that the lowest values for the protein content recorded in July and August (31,5 g/kg), and the highest value recorded in various months in the autumn-winter period, which is in accordance with environmental conditions. The highest protein content was 3.37 g/kg in October and November (Samolovac et al., 2012), as well Bandaranayaka found that the protein contents of milk decreased (P<0.05) at 30 °C (Bandaranayaka & Holmes, 1976), in the same way the results reported by Stapes confirms that as temperatures increased from 9.4 to 36.1 °C, the milk protein dropped from 3.42 to 2.98%.

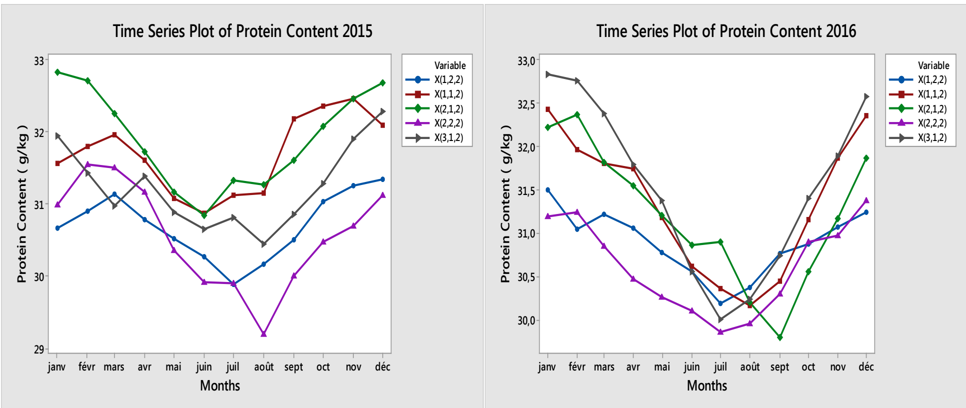

Figure 3. Times series plot of Protein Content 2015-2016

The rate of variation of protein content depends on the zone of rearing, for zones 1 and 2, the pace is almost identical for the two races, and this shows that the growth or decay tendencies are related to the characteristics of the environment, more than the physiology of livestock. The contribution of concentrate to pasture results in an increase in the milk protein content of 0.27 g/kg in 2015 and 0.15 g / kg in 2016, close to Delaby results (+ 0.24 g/Kg for each kg of DM of concentrate consumed) (Delaby et al., 2003).

For a given breed, Rossetti and Jarrige reported that breeding on butter levels leads to a simultaneous improvement in protein content (Rossetti & Jarrige, 1957). The low correlation between milk production and protein content (r = +0.30) the selection of cows for high production and high protein levels, confirmed by the work of (Wattiaux, 1998). The average difference in the TP between the Montbeliard and the Holstein cows in Zone 1 was 1.21 g / kg and 0.14 g / kg respectively in 2015 and 2016, Zone, the average deviation has increased from 0.56 g / kg in 2015 to 0.16 g / kg in 2016. These results can be explained by the fact that the minimum difference by the climatic effect (high temperatures in 2015). The Holstein cows which do not have resistance against the variability of the climate like that in the Montbeliards.

High temperatures had an adverse effect on the protein level (-1.84 g / kg in 2015 and -0.2 g/kg in 2016, P<0.05 between the highest and lowest temperatures, P <0.05), the maxi-mum temperature in 2016 was 30.4 ° C, on the other hand it reached 36.9 ° C in 2015, the effect of thermal stress justifies the reduction of the protein level. The tests of P D'Hour evaluated an effect of -1.1 g / kg, P <0.01 between the highest and lowest temperatures. Protein levels are at their lowest level during the summer season (July-August-September). This phenomenon could be linked to summer heat stress (D'Hour & Coulon, 1994), similarly Cop-pock found that milk composition changes and production declines, when environmental temperature exceeds the zone of thermoneutrality (Coppock, 1978).

One of the variation factors commonly used to explain changes in milk protein content, our tests showed an increase in the milk protein content of +0.13 g / kg in 2015 and +0.08 g / kg in 2016 for Each kg of DM of concentrate consumed, results lower than that was found by Delaby (+0.24 g / kg for each kg DM of concentrate) (Delaby et al., 2003).

5.4. Monitoring Ratio Protein Content / Fat Content 2015-2016

The ranking of the ratio is mainly related to the breed of livestock. In 2015, for Prim Holstein herds, the range of variation in the ratio is significant, it varies from 0.8432 to 0.8856 in 2015, whereas in 2016 the rank is reduced and the ratio varies from 0.8473 to 0,8613. For Montbeliard herds, the ratio ranges from 0.8092 to 0.8349 in 2015, and becomes 0.8132 to 0.8339 in 2016. The results showed that the ratio influence the variation of fat and protein content, especially the fat content located in denominator which varied significantly with the climate and the season.

The variation in the ratio of Prim Holstein herds in 2016 is moderate compared to 2015, an effect justified by a duration of 4 months without precipitation and extreme tempera-tures by 2015. For both races, the standard deviation of the ratio decreased from 2015 to 2016 in the 3 zones except in zone 2 where it retained the same standard deviation, the decrease in standard deviation is quite high in Holsteins than in Montbeliards , This is due to a visible resistance in Montbeliards against climatic variations.

For some time we pay much attention to the famous ratio protein / fat (P / G) (Figure 4). This ratio is calculated by the amount of protein produced in the milk divided by the amount of fat produced. This study revealed some of the factors that can influence this relationship. Genetics have an influence on the amount of protein and fat produced. For example, P / G ratios for herds in the 1997 Quebec Dairy Herd Analysis Program (PATLQ) (Léonard, 1997) varied from 0.80 in Jersey to 0.86 in Holstein. Thus Jersey has the highest average protein percentage of 3.92% and fat content can vary greatly from one farm to another thus influencing the ratio. Therefore, care must be taken when analyzing a report.

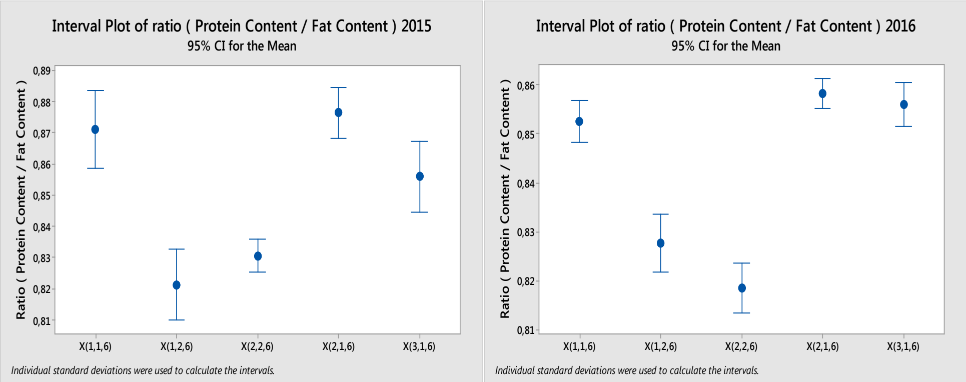

Figure 4. Interval plot of ratio (Protein Content / Fat Content) 2015-2016

The protein content of milk varies with the season. Our tests show that the milk protein ratio is lower in summer and is rising again in the fall. In summer the decreases in consumption that accompany hot days decrease the energy consumption by the cow. In addition, pasture cows not receiving sufficient energy and above all amino acids will have a decrease in the production of milk and milk protein. In the fall, cooler temperatures promote greater consumption, freshly harvested forages and rations - rebalanced for protein and energy - partly explain an increase in milk protein.

5.5. Follow-up of liters 2015-2016

In the Montbeliard herds, dairy production is minimal during the summer season, but there are no significant month to month produc-tion losses, whereas production in Holstein cows is peak production in February and March with an average of 35 kg per cow, a production which declines very quickly afterwards to reach a minimum in summer with an average of production which does not exceed 20 kg per cow; a gap that can reach 15 kg of milk per cow in 2015, this gap did not exceed 4.5 kg of milk per cow in 2016 (Figure 5).

The results of this study support the findings from previous studies, L. Samolovac found that milk yield, expressed via the milking average, obtained from Holstein Friesian cattle was lowest in months when external air temperatures was the highest (July and August), amounting to approximately 21.5kg, while in periods with relatively low temperatures, from late autumn until the spring, this value was the highest, remaining in the interval between 22.5 and 24.3kg (Samolovac et al., 2012), Seasonal differences in milk production are caused by periodic changes of environment over the year, which has a direct effect on animal's milk production through decreased Dry Matter Intake and an indirect effect through fluctuation in quantity and quality of feed.

Bohmanova analyzed meteorological data with test day milk yield data from herds near weather stations to identify the most appropriate temperature-humidity index (THI) to measure losses in milk production due to heat stress in the semiarid climate of Arizona (Phoenix) and the humid climate of Georgia (Athens) (Bohmanova, Misztal, & Cole, 2007).

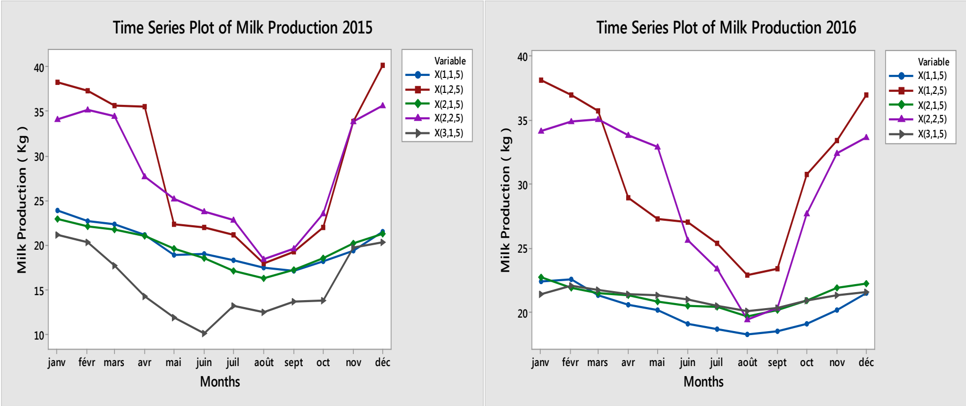

Figure 5. Times series plot of Milk Production 2015-2016

March, April, and May are months of maximal milk production in Phoenix, decline of milk production due to heat stress should be detected already in May. In Athens, milk production is at its maximum in April and starts to decline in May. Milk production in June, July, and August is significantly compromised by heat stress. In September, environmental conditions in Phoenix are worse than in Athens, even with use of cooling. Assuming that cows in both regions have on average similar heat tolerance, the fact that decline of milk production due to heat stress occurs in Phoenix at much higher temperature suggests that the causes of heat stress differ between environments (Bohmanova et al., 2007).

Igono reported that a precipitous drop in daily milk yield occurred after mid-June until late August. During this period, average daily milk yield dropped from 28.5 to 24.5 kg/day. This study conducted with milk production data from two commercial dairy farms from March 1990 to February 1991 were used to evaluate the seasonal effects identified in the environmental profile of central Arizona. Maximum mean daily milk yield (30.3 kg) occurred during the 61 days of the cool conditions in January and December, this period may be described as an "optimum thermoneutral" period for milk production by Holstein cows. (Igono, Bjotvedt, & Sanford-Crane, 1992), Roenfeldt found that Lactating dairy cows prefer ambient temperatures of between 5 and 25°C (the thermoneutral zone). At ambient temperatures above 26 °C, the cow reaches a point where she can no longer cool herself adequately and enters heat stress (Roenfeldt, 1998). It is reported that the change in the environment at the return to the barn does not seem to be the factor responsible for the drop in production. It seems, however, that this decline commonly observed at this period is mainly due to the change in diet.

5.6. Effect of temperature and precipitation

Temperature, solar radiation, relative humidity, wind ... are the climatic factors that act through their considerable interactions on the performance of the breeding. The unanimity of a group of authors on the effect of the temperatures and particularly the strongest on the production and the composition of the milk has been demonstrated by their numerous works. The increase in ambient temperature (when it is maintained in the thermal comfort zone of cows) could have a specific effect favorable to dairy production and unfavorable to the richness of the milk, in addition to the effect of Photoperiod report (Coulon et al., 1991; Agabriel et al., 1990).

Two trials were conducted on Frisian-Holstein dairy cows to study the effect of thermal stress on milk production, composition and dry matter intake in a Mediterranean climate. These tests were carried out in two periods which differ only in their THI values (Temperature-Humidity Index), which are 68 + - 3.75 and 78 + - 3.23 for spring and summer respectively. Daily THI is negatively correlated with milk production (r = -0.76) and ingestion (r = -0.24). When the THI value increased from 68 to 78, milk production decreased by 21% and dry matter intake by 9.6% (Bouraoui et al., 2002).

The ideal temperature for dairy production is around 10 °C. At temperatures of 20 to 30 °C, milk production decreases by 5% and 25% respectively, the effect of sunray is to increase the ambient temperature by a margin of 20 °C. And their production decreases (Dubreuil, 2000). An animal exposed to cold regulates its heat resistance by consuming more available food, otherwise it uses nutrients to the detriment of milk production or even exhausting its bodily reserves, thus milk production decreases with decrease in the temperature while fat and protein levels increase (Charron, 1988).

Heat stress is caused by a combination of environmental factors (temperature, relative humidity, solar radiation, air movement, and precipitation). Many indices combining different environmental factors to measure the level of heat stress have been proposed. However, their use is limited by poor availability of data. (Bohmanova et al., 2007). The majority of studies on heat stress in livestock have focused mainly on temperature and relative humidity (Ravagnolo, Misztal, & Hoogenboom, 2000; Bouraoui et al., 2002; Ray et al., 2004).

The impact of heat stress on production of cows is alleviated in many dairies by some kind of heat abatement system such as shades, fans, fog misters, and sprinklers. These systems differ in efficacy of cooling and thus create variation in thermal conditions to which cows are exposed (Ryan et al., 1992).

As temperatures increase from 15 to 25 °C, cows experience a small degree of loss in production. However, as temperatures exceed 25 °C, dramatic reductions in milk production can occur. As a result, 25 °C is usually considered the upper critical temperature for lactating dairy cows (Staples & Thatcher, 2016).

6. Conclusion

For a period from January 2015 to December 2016, daily monitoring of dairy production in three farms in the Gharb region of Morocco, climate and rainfall data are taken into account to evaluate their effect on physicochemical composition, the objective of this study is to highlight the variability of the characteristics of raw milk by seasonal climatic changes and to analyze this variability according to the season and the production conditions. The selected farms known for their mastery of farming techniques, farms equipped with the new means of animal health control, qualities allowed us to focus more specifically on the seasonal variability of the composition of raw milk.

The results indicates that milk production on the three farms of the ALGHARB region exceedingly decreases in summer months, due to unfavorable climate factors, who contribute to the exposure of dairy cows to heat stress. During the summer, the negative effect is evident, both in the quantity of milk produced, and in its quality, the fat and protein content in milk decreases, results justified by the increase in ambient temperature who above the upper critical temperature.

These results support the need for more frequent data collection from others farms either in algharb region or in others Moroccan regions to know more about the effects of season and climatic parameters on the milk production and its quality, a characterization of this milk variability will allow to identify management strategies and technological solutions, such as a physical modification of the environment (shading, cooling, improving barn ventilation, thermal insulation of roofs), improved nutritional management practice, etc., to permanently eliminate or at least minimize the consequences of temperature stress on lactating cows. In view of the tendency toward climate change, these problems will become more present and more intensive, while economic operating results will depend on the speed and quality of adapting existing technologies to the new situation.

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