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Impact of Lactation Stage on the Physicochemical Composition of Cow's Milk (Holstein Breed) Collected in Mostaganem Province (Algeria)

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Abstract
The aim objective of this study is to highlight the effect of the lactation stage on the nutritional quality of cow's milk and compare them with industrial milk. This study also made it possible to understand how the different phases of lactation influence the composition and properties of the milk produced. This understanding is crucial for optimizing livestock management practices. This study revealed that the lactation stage has a significant impact on the composition of cow's milk. The levels of fat (16 to 49g/l), proteins (26.3 to 29.8 g/l), lactose (38 to 44.9 g/l) and ash (5.4 to 6.4 g/l) vary depending on the different lactation stages. These variations also influence acidity (14 to 24°D) and pH (6.58 to 6.67).
Key words. Milk, cow, lactation stage, physicochemical, mostaganem.

Introduction

Cow's milk is widely consumed around the world and is produced by female cows. It is an important source of essential nutrients for humans, such as high-quality protein, calcium, vitamin D, and vitamin B12, thereby contributing to the health of bones, muscles, and the immune system. However, it is important to note that some people may be allergic or intolerant to cow's milk, and alternatives are available to meet their specific needs **(Smith, J, 2020)**.

In Algeria, raw milk is widely consumed, with nearly three billion liters per year **(Kirat, 2007)**, making it the largest consumer of raw milk in the Maghreb. Despite this, the country also imports milk powder to meet the growing demand. In 2009, raw milk production in Algeria did not exceed 2.45 billion liters, while the National Interprofessional Office of Milk (ONIL) imported 120,000 tons of milk powder for an amount of 862.76 millions dollars **(MADR, 2009)**. Moreover, with an estimated consumption of nearly 120 liters per capita per year, Algeria remains the largest consumer of milk in the Maghreb region **(Sawsan Kacimi, 2013)**.

ndeed, milk is considered a complex biological medium, composed of all the molecules necessary for the development of microorganisms. Its quality can be affected by numerous factors, such as contamination during and after milking, as well as the presence of mastitis infections **(Aggad et al., 2009)**. Several measures must be taken to reduce the risk of contamination and ensure safe human consumption, including proper milking hygiene and effective physicochemical control of the milk's quality.

The main objective of this study is to highlight the variability in the composition of cow's milk depending on the stage of lactation and to compare it with that of industrial milk. To achieve this, raw cow's milk samples were collected from three different lactation stages (first, second, and third stages). Physicochemical analyses were then carried out on the different milk samples to determine their initial biochemical qualities in terms of composition (proteins, lipids, lactose, minerals, acidity and pH).

Materials and Methods

Sampling

Milk collection was carried out in May 2020 from Holstein dairy cows. The milking process was performed manually from healthy cows at different lactation stages, and the milk was carefully collected in 1-liter bottles for each lactation stage. These bottles were then labeled for easy identification. The samples were placed in a cooler and transported to the laboratory at the Faculty of Natural and Life Sciences, Abdelhamid Ibn Badis University of Mostaganem, where they were immediately analyzed.

Physicochemical Analyses

The physicochemical characterization of the different milk samples in our experiment was performed using the "Lactoscan" device, model "Ultra Sonic N 16166." This device was used to determine the fat content, proteins, lactose, and mineral content (Ash). Acidity was determined by titration using sodium hydroxide with phenolphthalein as the color indicator. Finally, the pH was measured using an electronic pH meter by directly inserting the probe into the studied samples.

Results and Discussion

Physicochemical properties of different milks according to lactation stage

Table 1 summarizes the physicochemical results specific to the different milk samples in our experiment, highlighting the effect of the lactation stage on key parameters such as fat content, protein, lactose, and mineral content. Additionally, this table presents the different values for pH and acidity of the milks according to the lactation stage and industrial milk.

Table 1. Physicochemical composition of different milks according to lactation stage and industrial milk

	1st stage of lactation	**2nd stage of lactation**	**3rd stage of lactation**	**Industrial milk**
Lipids (g/l)	49	45	45	16
Proteins (g/l)	27.3	27.4	29.8	26.3
Ash (g/l)	5.8	5.8	6.4	5.4
Lactose (g/l)	42.9	40.3	44.9	38
pH	6.58	6.60	6.66	6.67
Acidity (°D)	24	21	19	14

Fat Content

The results showed fat contents of 49g/l, 45g/l, 45g/l, and 16g/l for the milk from the first, second, third lactation stages, and industrial milk, respectively. It is important to note that the milk from the third lactation stage has the highest concentration compared to the other milk samples in our experiment (Table 1).

The variability in fat content depends on several factors, such as climatic conditions, lactation stage, and diet **(Labioui et al., 2009)**. Fat content differs between cows at the beginning and the end of lactation. It is lower in cows at the beginning of lactation compared to those at the end of lactation.

According to **Pollott (2004)**, the rate of lipid secretion is the most variable during lactation, increasing by 1 to 10g/l from the beginning to the end of milking. Fat content declines after calving and reaches its minimum when cows are between 40 to 60 days postpartum, with a slight daily increase thereafter **(Schultz et al., 1990; Barber et al., 1997; Walker et al., 2004)**. This decline can be mainly explained by a dilution effect, as fat content inversely correlates with milk production **(Coulon et al., 1991; Varga and Ishler, 2007)**. The fat contents recorded in the different milk samples in our experiment are higher than those reported by **Sassi et al. (2018)**, which were around 33.72g/l.

Protein Content

For this important biochemical component, the concentrations obtained in this study were 27.3g/l, 27.4g/l, 29.8g/l, and 26.3g/l for the milk from the first, second, third lactation stages, and industrial milk, respectively. It is quite evident that the milk from the third lactation stage has the highest protein content compared to the other milk samples in our experiment (Table 1). Protein content varies according to the stages of lactation **(Chethouna, 2011)**. According to **Walker et al. (2012)**, who conducted a study on Holstein cows, the protein content has steadily decreased over the past few

decades and is approaching the value of 31g/l. Protein content (PC) is an important characteristic of milk, as it determines its market value; the higher the protein content, the higher the market value of the milk. The results recorded in this study are lower than those reported by **Bouterfa (2020)**, who highlighted a maximum protein content of 38.08g/l for milk from the second lactation stage.

Lactose Content

According to our results, the lactose content was around 44.9g/l for milk from the third lactation stage, while the first and second stages were marked by contents of 42.9g/l and 40.3g/l, respectively (Table 1). As for industrial milk, the lactose concentration was the lowest, with a rate of 38g/l. It is clear that lactose content varies according to the lactation stage and is influenced by this studied parameter.

Lactose is the major component of the dry matter in milk. Its average content is 50g/l of milk. Due to its low contribution to the energy content of milk (30%), it does not make milk a balanced food in terms of caloric distribution, with a weak sweet taste **(Wattiaux, 1996)**. The results of our experiment are lower than those obtained by **Bouterfa (2020)**, who found lactose levels in cow's milk collected in the Mostaganem region to be around 50g/l and 50.83g/l for the second and third lactation stages.

Ash Content

According to the results of our study, the mineral content was approximately 6.4g/l for milk from the third lactation stage, while the first and second lactation stages had identical contents of 5.8g/l. Finally, powdered (industrial) milk had the lowest mineral content, with a rate of 5.4g/l (Table 1). The results of our study are lower than those obtained by **Otman et al. (2022)**, who found ash contents of 7.21g/l, 7.91g/l, and 8g/l in cow, goat, and camel milk collected in the regions of El Oued and El Tarf, respectively.

pH

Marouf and Elmhal (2017) identify the normal pH of cow's milk as ranging between 6.5 and 6.7. In this regard, the results from our study showed a value of 6.58 for milk from the first lactation stage and 6.67 for industrial milk, and are in line with the standards recommended by various milk specialists.

In its fresh state, cow's milk has a pH ranging from 6.6 to 6.8. pH is an important parameter that determines the milk's suitability for further processing. According to **Alias (1984)**, the pH is not a constant value and can vary depending on the lactation cycle and dietary influences.

Acidity

The acidity of the different milk samples studied was 24°D, 21°D, 19°D, and 14°D for milk from the first, second, third lactation stages, and industrial milk, respectively (Table 1). These values are higher compared to those reported by **Otman et al. (2022)**, who recorded acidity values of 16.33°D, 18°D, and 18.66°D in cow, goat, and camel milk collected in the El Oued and El Tarf regions (Algeria).

Conclusion

At the end of this study, it was concluded that the lactation stage has a direct impact on the physicochemical composition of cow's milk, specifically affecting lipids, proteins, lactose, and mineral content. Additionally, the lactation stage plays an important role in the variation of milk's pH and acidity values. These findings necessitate further investigation into other biochemical compounds, such as fatty acids and amino acids.

References

Aggad, H., Mahouz, F., Ahmed Ammar, Y. et Kihal, M. (2009). Evaluation de la qualité Hygiénique du lait dans l'ouest algérien. Revue Méd. Vét., 160(12) ,590-595.

Alais Charles., 1984. Science du lait : Principes et techniques laitiers. Société d'édition et de promotion agro-alimentaires, industrielles et commerciales, 4ème éd, ISBN : 2-902899-02-5, 814 p.

Barber M. C., Clegg R.A., Travers M.T., Vernon R.G, (1997). Lipid metabolism in the lactating mammary gland. Biochi. Biophys. Acta (BBA) – Lipids Lipid Met. 1347:101-126.

Bouterfa Asma, 2020. Authentification et variabilité des fromages à pâtes molle type Camembert : influence du stade physiologique de la vache laitière. Thèse En Vue de l'Obtention du Diplôme de Doctorat 3ème cycle LMD, Université Abdelhamid Ibn Badis de Mostaganem, Algérie.

Chethouna F. 2011. Etude des caractéristiques physico-chimiques, biochimiques et la qualité microbiologiques du lait camelin pasteurisé, en comparaison avec le lait camelin cru. Memoire

Coulon J.B., Chilliard Y., Redmond B., 1991. Effets du stade physiologique et de la saison sur la composition chimique du lait de vache et ces caractéristique technologique (aptitude a la coagulation,lipolyse). INRA.Prod.Anim., Vol.4.N°3,pp :219-228.

Kirat Souhila, 2007. Les conditions d'émergence d'un système d'élevage spécialisé en engraissement et ses conséquences sur la redynamisation de l'exploitation agricole et la filière des viandes rouges bovines - Cas de la Wilaya de Jijel en Algérie. Thèse de Master of Science, Institut agronomique Méditerranéen de Montpellier (CIHEAM-IAMM) n° 87.

Labioui H., Laarousi E., Benzakour A., El yachioui M., Berny E. et Ouhssine M. 2009. Étude physico-chimique et microbiologique de laits crus. Bull. Soc. Pharm 148, Bordeaux, pp.7-16.

Marouf Ali A. S. , Elmhal Sara I., 2017. Monitoring pH During Pasteurization of Raw Cow's Milk using Nd:YAG Laser. International Journal of Advanced Research in Physical Science (IJARPS) Volume 4, Issue 12, PP 1-4

Otmane Rachedi Khadidja, Remadni Mouchira, Badi Yahiaouia, 2022. Comparative study of the physicochemical characteristics of different raw milks (camel, goat and cow) in El-Oued and Bougous (Wilaya of El-Tarf) region. Rev. Sci. Technol., Synthèse Vol 28 Numéro 2: 01-11.

Pollott G.E. 2004. Deconstructing milk yield and composition during lactation using biologically based lactation models J. dairy sci. 87, 2375-2387.

Sassi E., Attou S., Homrani A., Nemiche S. (2018). Effect of the season on the microbiological quality of raw cow's milk on the farm in western Algeria. Adv. Biores. Adv. Biores. Vol 9 [3] 108-122.

Sawsan Kacimi el Hassani S. 2013. La Dépendance Alimentaire en Algérie : Importation de Lait en Poudre versus Production Locale, Quelle Évolution ? Mediterranean Journal of Social Sciences MCSER Publishing, Rome-Italy, Vol 4 No 11, P. 152-158.

Schultz M.M., Hansenl B., Steuernagelg R., Kucka L, (1990). variation of milk, fat, protein and somatic cells for dairy cattle. J. Dairy Sci. 73,484- 493.

Smith, J. (2020). The Role of Cow's Milk in Human Nutrition. Journal of Dairy Science, 103(5), 3500-3510.

Varga G A., Ishler V.A. (2007). Managing nutrition for optimal milk components. Western Dairy Manag. Conf. Reno, NV, P. 1-14.

Walker G P., Dunshea F R., Doyle P T, (2004). Effects of nutrition and management onthe production and composition of milk fat and protein. J. Agric. Res.55:1009-1028.

Wattiaux, M.A. (1997). Dairy essentials (1st edition): Lactation and milking. The Babcock Publications, University of Wisconsin-Madison, 73-100.